3rd National Conference on Global Change

SOUTHERN SUN ELANGENI & MAHARANI HOTEL, DURBAN

05 – 08 December 2016
South African Global Change Science Committee 2016

• Dr Nicky Allsopp, Director: Fynbos Node Manager, South African Environmental Observation Network (SAEON)

• Dr Emma Archer van Garderen, Climate Studies, Modelling and Environmental Health, CSIR

• Mr Barney Kgope, Director: Carbon Sinks, Department of Environmental Affairs

• Prof Guy Midgley, Botany and Zoology, Stellenbosch University

• Dr Chris Moseki, Specialist Scientist: Climate Change Research, Department of Water and Sanitation

• Dr Tshifhiwa Nangammbi, Senior Lecturer, Tshwane University of Technology

• Prof Mark New, Pro-VC and Director, African Climate and Development Initiative, University of Cape Town

• Dr Hannes Rautenbach, Chief Scientist: Climate Change and Variability, South African Weather Service

• Prof Chris Reason, Department of Oceanography, University of Cape Town

• Prof Coleen Vogel, School of Animal, Plant and Environmental Sciences, University of Witwatersrand
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Messages of Support

From the South African Global Change Science Committee

It is our pleasure, on behalf of the South African Global Change Science Committee, to welcome all the attendees to the 2016 Global Change Conference in Durban. Continuing the tradition of the past several years, we have once again had a very strong response in the form of submitted papers and posters, especially from the student body engaged in global change science, and for side events, special sessions and applications to chair sessions. The breadth and quality of the poster and paper programme attests to an enthusiastic and dedicated body of students, lecturers and other professionals involved in this complex field. We hope that we have been able to accommodate as many people as possible in a way that is helpful and valuable to them. We also welcome the participation of representatives from various government departments, the business sector and NGOs, who are the actors who make use of the scientific results produced under the Global Change banner.

We acknowledge that this year has been a tumultuous one for South African universities, and we are pleased to be able to hold this conference to support the careers of those students who are engaging in some of the most important topics of study for the future of this country. We are convinced that this is an area of science seeing significant and meaningful transformation, and we trust that this conference will contribute to accelerating that effort. This is the energy that will continue to position South Africa so well in relevant international negotiating forums, and to support strong national to local policy making and implementation.

The links between fundamental and applied science, and the science/policy interface is particularly strong in South Africa in this area of work, and we hope through this conference to be able to strengthen this even further. We therefore welcome officials from various government departments who make use of the scientific results produced under the Global Change banner. We look forward to engaging in the challenging trans-disciplinary discussions that are so necessary to their work, and we especially hope to foster an environment of active mutual learning.

Finally, we hope through this conference to be able to convince national and international funding agencies that the quality and impact of this work has been worth the investment, and to encourage them to increase their investments to advance Global Change Science at a time when the world is in dire need of clear scientific and evidence-based guidance on the linkages between environmental and socio-economic policy.

Professor Guy Midgley and Dr Chris Moseki
Co-Chairs: South African Global Change Science Committee
From the Department of Science and Technology

The Department of Science and Technology is impressed by the richness and wealth of knowledge that is evident in the set of scientific and technical papers presented at the 3rd National Conference on Global Change. Such scientific output is an important feature of the global change conferences we have had so far. It demonstrates that we have a good pool of dedicated researchers and aspiring young scientists. The DST, through generous support to various global change research programmes, is helping to shape and nurture these individuals, so that they can in turn contribute to addressing the socio-economic challenges South Africa and the sub-Saharan region is facing. We encourage these young researchers to continue with their excellent research work and assist Government in creating an informed society.

Mr Leluma Matooane, Director: Earth Systems Science, DST

From the National Research Foundation

The National Research Foundation welcomes all participants to this year’s Global Change Conference. This event offers an opportunity for both researchers, academics and students to engage, discuss and network on some of the most pivotal and relevant issues within the ambit of Global Change facing the country and the region. This event also offers an opportunity to ‘bridge the gap’ between scientific knowledge and the use of this knowledge to improve the livelihoods of people on the ground. In a manner of speaking, the conference offers a platform to look for practical and appropriate ways to ‘take science to the ground’. In addition, the NRF believes that this process can be facilitated by ushering in a cohort of young emerging scientists that will add to and influence the community of practice within Global Change in South Africa and the region.

This conference is part of that transformational mechanism.

NRF Global Change Unit

From the University of KwaZulu-Natal

On behalf of the University of KwaZulu-Natal, we are proud to host the 3rd National Conference on Global Change in partnership with the Department of Science and Technology and the National Research Foundation. At UKZN, we instill an approach that the research our students and academics are doing will seek viable solutions to complex global challenges that cut across disciplines, creating new knowledge in the process. It is also a privilege to welcome such a diverse global change research community to our shores in order to share recent progress being made in the broad global change landscape.

Over these few days, you will witness the brightest young ‘green’ minds in South Africa, share, discuss and consider ways to secure and sustain our planet into the future. Through your rich debates, oral, poster and plenary sessions, you will explore solutions and pathways for seemingly insurmountable challenges around climate stabilisation, water security, food security, pollution, the environment, transformation and health.

As the knowledge leaders of tomorrow in the area of global change research, I wish you well in your upcoming deliberations. I hope that this time spent together will spark increased understanding of our changing earth systems so that our communities can respond effectively and precipitate and implement those critical interventions and policies that will positively affect our prospects for improved human livelihood options across the globe.

Dr Albert van Jaarsveld, Vice-Chancellor and Principal, UKZN
# 3rd National Conference on Global Change

**CONFERENCE CO-CHAIRS:** Professor Guy Midgley and Dr Chris Moseki

**DAY ONE: MONDAY, 05 DECEMBER 2016**

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<td>07:00 – 08:15</td>
<td><strong>REGISTRATION</strong></td>
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<td>08:15 – 09:45</td>
<td><strong>SESSION 1: Opening Plenary</strong></td>
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<td><strong>Chair:</strong> Mr Imraan Patel</td>
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<td><strong>Venue:</strong> Elangeni - Great Illanga</td>
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<tr>
<td>• Official Opening: Conference Aim and Expectations – <em>Mr Imraan Patel</em>, DDG: Socio-Economic Innovation Partnerships, Department of Science and Technology – 5 mins</td>
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<td>• Welcome Remarks from the Host Institution - <em>Prof Deo Jaganyi</em>, DVC: Agriculture, Engineering and Science, UKZN – 5 mins</td>
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<td>• Global Change at UKZN (video) – 10 mins</td>
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<td>• NRF perspective – <em>Dr Gansen Pillay</em> – 10 mins</td>
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<td>• DEA perspective – <em>Ms Judy Beaumont</em> – 10 mins</td>
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<td>• KEYNOTE ADDRESS: Reflecting on Climate Change Adaptation Science from a Developing Country Perspective - <em>Dr Saleemul Huq</em>, Director of the International Centre for Climate Change and Development, Bangladesh – 30 mins</td>
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<td>• Reflections and Q &amp; A session – 15 mins</td>
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<td>09:45 – 10:15</td>
<td><strong>TEA AND POSTER SESSION</strong></td>
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## SESSION 2: Parallel Sessions

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<th>Session 2C: Carbon Sequestration</th>
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<tr>
<td>Chair: Tumisang Polasi</td>
<td>Chair: Afikile Nohaji</td>
<td>Chair: Peter Ejidike</td>
<td>Chair: Tembakazi Silwana</td>
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### Analysis of extreme weather events over the Limpopo/Botswana region: An attribution study on heat wave events and extreme hot days – *Peliwe Jubase*

### From power station emissions to ecological impacts in streams: first results from the AcidWater bilateral NRF-SANCOOP Project – *Chris Curtis*

### Synthesis and Characterization of Nanocomposite SAPO-34/Ceramic Membrane for Post-combustion CO2 capture – *Kgaphola Kedibone*

### Phytochemical distribution in whole seed (undeulled) and cotyledon (dehulled) of Bambara groundnut (Vigna subterrenea) seeds and their contribution to antioxidant activities – *Adedayo Bukola*

### The vulnerability of coastal communities in Solomon Islands to climate change – *Willem Malherbe*

### Monitoring water quality using satellite remote sensing: A case study of the Vaal Dam, South Africa – *Keneilwe Hlahane*

### Geomechanical Characterisation and Probabilistic Risk Assessment for a CO2 Storage Project in E-M gas field, South Africa: A Feasibility Study – *Eric Saffou*

### The Farmer Field Schools approach to promoting small-scale farmers’ knowledge, and production in Nkonkobe local municipality – *Asanda Apleni*

### Risks and Vulnerabilities in rural Junior Secondary Schools in the Eastern Cape Province: Implications for School Management – *Noloyiso Nongalo*

### River pollution changes related to diverse land-use patterns and seasonal change – *Reuben Lazarus*

### Sustainable use of Coal for Energy Production in South Africa with less CO2 Emission: CO2 Capture and Storage a promising option – *Kelvin Yoro*

### Conservation agriculture with acacia and moringa in agroforestry system for fodder production in Limpopo province – *Kingsley Ayisi*

### Fire Danger Rating in South Africa under Projected Climate Change Scenarios – *Stefanie Schutte*

### Using stream flow changes and nutrient enrichment to determine the effectiveness of macroinvertebrates as biological indicators of river health – *Nqobile Lushozi*

### Response of yellow QPM inbred lines to drought stress tolerance in seedling stage – *Nyasha Chiuta*

### The vicious cycle of soil erosion impact and agriculture in South Africa: implications for climate change and variability – *Ikponmwosa D. Ighodaro*
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<th>12:45 – 14:15</th>
<th>SESSION 3 : Parallel Sessions</th>
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<td><strong>Session 3A: Risks and Vulnerability</strong>&lt;br&gt;Chair: Christian Lueme Lokotola&lt;br&gt;Venue: Maharani – Tugela Room</td>
<td><strong>Session 3B: Freshwater</strong>&lt;br&gt;Chair: Chris Curtis&lt;br&gt;Venue: Elangeni – Small Illogas</td>
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<tr>
<td>El Niño and the climate change futures of southern Africa – <strong>François Engelbrecht</strong></td>
<td>Diversity of freshwater fish parasites and water quality of Kwen Dam, Mpumalanga Province, South Africa – <strong>Precious Mokonyane</strong></td>
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<td>An assessment of water security and hydrology resources in the face of climate variability: The case study of Nkonkobe Local Municipality, Eastern Cape, South Africa - <strong>Tineyi H. Pindura</strong></td>
<td>Lake Sibayi variations in response to climate change in Northern KwaZulu-Natal, South Africa. – <strong>Francis Nsubuga</strong></td>
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<td>Improving the understanding of water and climate related hazards that pose a risk to the agricultural sector in the Upper Thukela Catchment – <strong>Mlungisi Shabalala</strong></td>
<td>The long-term variability analyses of flow and water temperature regime in the Luvuvhu River catchment – <strong>Pfananani Ramulifho</strong></td>
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<td>Relative Risk Assessment of threats to the wellbeing of the socio-ecological endpoints of the Amatikulu/Nyoni Catchment, KwaZulu-Natal – <strong>Mhali Sosibo</strong></td>
<td>The use of Periphyton and Macro-invertebrates and their susceptibility to changes in river flow characteristics and nutrient composition as an indicator of river health – <strong>Samiksha Singh</strong></td>
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<td>Are Cape lowland vegetation fragments doomed for climatic extinction? – <strong>Nasiphi Ntshanga</strong></td>
<td>Variability in communities of selected South African river dominated estuaries: clues for the risk of flow alterations and water resource use – <strong>Madonna Vezi</strong></td>
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<td>14:15 – 14:30</td>
<td>TEA AND POSTER SESSION</td>
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### SESSION 4: Parallel Sessions

| Side Event A: Could Solar Radiation Geoengineering buy time to a low Carbon future?  
Convener: Dr Pedro Monteiro, CSIR  
Venue: Maharani – Tugela Room | Session 4B: Energy  
Chair: KeChrist Obileke  
Venue: Elangeni – Small Illangs | Session 4C: Oceanography  
Chair: Morgana Tagliarolo  
Venue: Elangeni – Suites 4-5 | Session 4D: Food Production  
Chair: Sydney Ngwenya  
Venue: Maharani – Umgeni and Congella Room |
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<td>To stimulate initial discussion on the likely need for radiation management geoengineering to avoid catastrophic transgressions of planetary boundaries.</td>
<td>Computational Fluid Dynamic Simulation of the performance of a waste heat recovery unit – <strong>Nwabunwanne Nwokolo</strong></td>
<td>The Seasonal Cycle of CO2 in the Southern Ocean: Diagnosing biases in CMIP5 Earth Systems Models – <strong>Precious Mongwe</strong></td>
<td>Can the environmental impact of beef production be reduced? – <strong>Motshabi Mokolobate</strong></td>
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<td>Assessment of Zeolite-catalysis of fat-produced bio-fuel – <strong>Lawrence Obidike</strong></td>
<td>Sea Level rise and variability along the east and south coast of southern Africa based on monthly tide gauge records – <strong>Bernardino Nhantumbo</strong></td>
<td>Nitrogen fertilizer and biochar application rate effect on soil physicochemical properties and grain yield of maize – <strong>Adlet Phophi Mulaudzi</strong></td>
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<td>Dark Fermentative Biohydrogen Production using South African Biowaste Effluents – <strong>Patrick Sekoai</strong></td>
<td>Climate change in coastal waters: time series properties affecting trend estimation – <strong>Robert Schlegel</strong></td>
<td>Stomatal behaviour of cowpea genotypes grown under drought conditions – <strong>Lawrence Munjonji</strong></td>
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<td>Coastal and offshore co-occurrences of marine heatwaves and cold-spells around South Africa – <strong>Albertus Smit</strong></td>
<td>The potential of locally produced biochar as an alternative remedy for the improvement of nutrient depleted soils in the Eastern Cape – <strong>Zinziswa Ngeva</strong></td>
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<td>Cyclic or Episodic Changes to the Northern Shore of the Thukela Wave-Dominated Delta – <strong>Alan Smith</strong></td>
<td>Adaptation to the Impacts of Climate Change on Agriculture in eThekwini: A literature Review - <strong>Nokubonga Shezi</strong></td>
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<td>The importance of ocean acidification research in South Africa: a case study of early stage Argyrosomus japonicus – <strong>Carla Edworthy</strong></td>
<td>‘An examination of small-scale farmers’ response to government’s agricultural policies affecting agriculture and development in eThekwini Municipality – <strong>Ntandokazi Ninela</strong></td>
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### 16:00 – 17:00  
PARALLEL SIDE EVENTS AND POSTER SESSION
### Parallel Side Events

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<tr>
<td>16:00</td>
<td><em><strong>Side Event A continued</strong></em>&lt;br&gt;Convener: Dr Pedro Monteiro, CSIR&lt;br&gt;Venue: Maharani – Tugela Room</td>
<td>To stimulate initial discussion on the likely need for radiation management geoengineering to avoid catastrophic transgressions of planetary boundaries</td>
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<td>16:00</td>
<td><em><strong>Side Event B: FBIP</strong></em>&lt;br&gt;Convener: Dr Michelle Hamer, SANBI&lt;br&gt;Venue: Elangeni – Small Ilangas</td>
<td>To promote the FBIP as a mechanism for accessing funding; to promote the idea of data sharing and access and long term security of foundational biodiversity data sets.</td>
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<td>16:00</td>
<td><em><strong>Side Event C: COP Paris Outcomes</strong></em>&lt;br&gt;Convener: Mr Dumisani Mthembu, DST&lt;br&gt;Venue: Elangeni – Suites 4-5</td>
<td>The purpose of the event will be to engage the science community on the outcomes of the Paris Agreement on climate change and how science, technology and innovation can support the implementation of the Agreement and support South Africa in fulfilling its obligations. It is hoped that the workshop will endeavour to define and articulate the role of science, technology and innovation practitioners in implementing the Paris Agreement on climate change.</td>
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<td>16:00</td>
<td><em><strong>Side Event D: ACCESS: The Next Five Years</strong></em>&lt;br&gt;Convener: Dr Neville Sweijd, ACCESS&lt;br&gt;Venue: Maharani – Umgeni and Congella Room</td>
<td>Update of and discussion about where ACCESS is in terms of implementation of its Phase 2 research programme.</td>
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**17:00**

GROUP PHOTO **Venue: Pool deck, Elangeni Hotel**

**18:00 – 21:00**

COCKTAILS AND NETWORKING **Venue: California Dreaming (along the beachfront)**
### DAY TWO: TUESDAY, 06 DECEMBER 2016

**REGISTRATION**

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<td>08:15 – 09:45</td>
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#### SESSION 5: Parallel Sessions

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<th>Session 5D: Ecosystem Services</th>
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<td>Chair: Katlego Mashiane</td>
<td>Chair: Temitope Samuel Egbebiyi</td>
<td>Chair: Charline Kamburona</td>
<td>Chair: Zivanai Tsvuura</td>
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- **Session 5A: Food Production**
  - The interaction between developing livestock production systems, increased product demand and potential climate change in the Eastern Cape Province of South Africa – **Jean Rust**

- **Session 5B: Climate Modelling**
  - A Systems Approach to Understanding Complex Estuarine Functioning During Increased Climatic Variability Through Ecological Network Analysis – **Christopher Waspe**
  - Implementing the Green City Policy in Municipal Spatial Planning: The Case of Buffalo City Metropolitan Municipality – **Abongile Dlani**

- **Session 5C: Urban Ecology**
  - Towards an Improved Understanding of the Influence of Rain gauge Design, Slope and Aspect on Rainfall Measurements: A Cross-Calibration Study – **Byron Gray**
  - An examination of the spatial expansion of the city of Tshwane: 2001-2016 – **Lungelo Dube**

- **Session 5D: Ecosystem Services**
  - Limpopo Living Landscapes - German-South African collaboration - **Jürgen Schellberg**
  - Towards an Improved Understanding of the Influence of Rain gauge Design, Slope and Aspect on Rainfall Measurements: A Cross-Calibration Study – **Byron Gray**
  - Spatiotemporal rural savanna dynamics for sustainability – **Barend Erasmus**
  - Research and development to support climate smart livestock production in the era of climate change - **Michiel Scholtz**
  - The sensitivity of simulated temperatures in climate models to aerosols over southern Africa – **Thabo Makgoale**
  - Planning for a low carbon, climate resilient city: The linkages between mitigation, adaptation, and urban development – **Meryl Jagarnath**

- **Multiscale Drivers of Sugarcane Expansion and Impacts on Water Resources in Southern Africa – Simphiwe Ngcobo**
  - Impacts of spectral nudging on the simulation of present-day rainfall patterns over southern Africa – **Mavhungu Muthige**
  - Patterns of Residential Densification in Johannesburg, 1996-2011 – **Miriam M. Maina**

- **Integrating indigenous knowledge with scientific seasonal forecasts for small scale farmers: A review – Khulubwa N. Xoxo**
  - Atmospheric Research at UKZN, Durban – **Sivakumar Venkataraman**

- **Strengthening science-policy-practice interface in a World Characterised by Rapid Change - Leocadia Zhou**
  - Impact of spatio-temporal variability of the Mascarene High on weather over southern Africa – **Nkosinathi G. Xulu**

- **Impacts of climate change on water availability in rural Cibeni location, Libode Eastern cape, South Africa – Ntandoyenkosi Moyo**

- **Is there a relationship between the colour of sample water and dissolved organic carbon (DOC) in mountainous catchments under contrasting land uses at the Cathedral Peak Research Site (CPRS), Drakensberg? – Aobakwe Lenkwe**

- **Climate variability and population growth: Implications on Water Rights and future water distribution in Mthatha River catchment – Yiseyon S. Hosu**

- **Atmospheric Research at UKZN, Durban – Sivakumar Venkataraman**

- **Impacts of spectral nudging on the simulation of present-day rainfall patterns over southern Africa – Mavhungu Muthige**

- **Patterns of Residential Densification in Johannesburg, 1996-2011 – Miriam M. Maina**

- **Atmospheric Research at UKZN, Durban – Sivakumar Venkataraman**

- **Impacts of climate change on water availability in rural Cibeni location, Libode Eastern cape, South Africa – Ntandoyenkosi Moyo**

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<td>10:15 – 11:45</td>
<td><strong>SESSION 6 : Plenary</strong>&lt;br&gt;<strong>THEME:</strong> Global Change Landscape: Programmes and Opportunities&lt;br&gt;<strong>Chair:</strong> Dr Thomas Auf der Heyde, DDG: Research Development and Support, Department of Science and Technology&lt;br&gt;<strong>Venue:</strong> Elangeni – Suites 1-4&lt;br&gt;• Opening: Dr Phil Mjwara, DG, Department of Science and Technology - 5 mins&lt;br&gt;• DST/NRF lead power point presentation: Overview of DST/NRF funded global change and environmental services programmes - scope, impact/outputs, supporting instruments and opportunities - Mr Leluma Matooane and Dr Henry Roman - 25 mins&lt;br&gt;• Perspectives from the Department of Environmental Affairs - Mr Brian Mantlana / Mr Barney Kgope - 10 mins&lt;br&gt;• Perspectives from civil society: World Wide Fund for Nature - 5mins&lt;br&gt;• Panel: Reflections and Q and A</td>
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<td>11:45 – 12:45</td>
<td><strong>LUNCH AND POSTER SESSION</strong></td>
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<td><strong>Chair:</strong> Meryl Jagarnath</td>
<td><strong>Chair:</strong> Paulina Mabapa</td>
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<td><strong>Venue:</strong> Maharani – Tugela Room</td>
<td><strong>Venue:</strong> Elangeni – Suites 1-4</td>
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<tr>
<td>Gender Dimensions of Climate Change and Implications for Agricultural Production. The Case of Nkonkobe Local Municipality – <strong>Sipumle Qapeshu</strong></td>
<td>Financing Global Change: The case for Green Bonds – <strong>Kamleshan Pillay</strong></td>
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<tr>
<td>Assessing and mapping the adaptive capacity of resource-poor households to changing climate: A case study of Nkonkobe Local Municipality – <strong>Martin M. Chari</strong></td>
<td>Domestic water conservation actions as linked to access to information, motivation and capacity across a socioeconomic gradient in George, South Africa – <strong>Verouschka Sonn</strong></td>
</tr>
<tr>
<td>Smallholder agricultural commercialisation and market risk implications on agricultural development – <strong>Sydney Ngwenya</strong></td>
<td>Climate Change Responses: Synergies and trade-offs – <strong>Tirusha Thambiran</strong></td>
</tr>
<tr>
<td>Soil Nutrient Depletion: A hidden threat to resource-limited farmers of the Eastern Cape in an era of global climate change – <strong>Zolani Mkile</strong></td>
<td>An assessment of L-band ALOS 2 PALSAr 2 data for aboveground biomass monitoring in different forest ecosystems – <strong>Kuhle Ndyamboti</strong></td>
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**14:15 – 14:30**
TEA AND POSTER SESSION
## SESSION 8: Parallel Sessions

<table>
<thead>
<tr>
<th>Session 8A: Livelihoods and Poverty</th>
<th>Session 8B: Climate Change Adaptation and Mitigation</th>
<th>Session 8C: Marine and Coastal</th>
<th>Session 8D: Terrestrial Ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair: Nongalo Noloyiso</td>
<td>Chair: Ndoni Mcunu</td>
<td>Chair: Natalie Ragoasha</td>
<td>Chair: Nokukhanya Mhlongo</td>
</tr>
</tbody>
</table>

### Session 8A: Livelihoods and Poverty
- A review of poverty reduction within local climate change initiatives: a case of eThekwini Municipality – **Kathleen Diga**
- Competing Knowledge Systems in Climate Change Discourse: A Review of Perspectives from eThekwini Municipality – **Siyabonga Ntombela**
- Climate Change Adaptation and Poverty Reeducation Co-benefits: Evidence from the Sihlanzimvelo Project in eThekwini Municipality – **Andrew E. Okem**
- An Environmental Injustice to the Rural Poor Climate Change and Drought – **Zibongiwe Mpongwana**

### Session 8B: Climate Change Adaptation and Mitigation
- Transdisciplinarity within South Africa’s global change research: How (well?) are we doing? – **Taufeeq Dhansay**
- Citizen Science in the Karoo: Tool for community engagement and citizen stewardship – **Nyaradzo Dhliwayo**
- Moringa oleifera physiological productivity and soil organic carbon for climate change mitigation – **Moshibudi P. Mabapa**
- Climate Change and Seasonality: Investigating how the Perceptions of Farmers in KwaZulu-Natal (Mshwathi) Relate to the Climate Records – **Nelisiwe Mofutsanyana**

### Session 8C: Marine and Coastal
- Interrogating power politics in a transdisciplinary research group designing a participatory process in coastal management – **Andisiwe Jukuda**
- Relative sea-level rise and the potential for subsidence of the Swartkops Estuary intertidal salt marshes, South Africa – **Thomas Bornman**
- What can we learn about global change from corals in inter-tidal rock pools? – **David Glassom**
- Beach webcams as tools for monitoring and understanding coastal change: an applied case study of Chain Rocks beach, Amanzimtoti – **Lisa Guastella**

### Session 8D: Terrestrial Ecology
- Invasive species reproductive advantage: observations and predictions in a heterogeneous world - **Cristián Monaco**
- Determining Vegetation and Water Use Modelling Parameters for a New Hydrological Baseline Land Cover in South Africa – **Megan McNamara**
- The contribution of OCBIL theory to South African conservation strategies: Analysis of the level of endemism in plant species on OCBILs as compared to YODFELs in the Cape Floristic Region – **Sboniso Mjaja**
- Foraging behaviour responses during the heat of the day in Cape Sugarbirds: sex-specific variation in flower visitation rates – **Mokgatla Molepo**
- Effects of flood events on estuarine fish communities – **Nicola James**
- Epigeic ant diversity at Ukulinga Research farm: Impacts of grazing, burning and alien invasive across a long-term experimental farm, Pietermaritzburg KwaZulu-Natal – **Caswell Munyai**
- The influence of environmental variability on the abundance of chokka squid off the south coast of South Africa – **Jessica Joyner**
- African Geodetic Reference Frame monitoring Global Change over Africa – **Ivan Muzondo**

### Other Topics
- A review of nutrition supplementation programme on children’s global malnutrition severity in Mqanduli, Eastern Cape, South Africa – **Bulelwa P. Nogidela**
- Climate change, food insecurity, and the impact of nutrition supplementation programme on children’s global malnutrition severity in Mqanduli, Eastern Cape, South Africa – **Phindile Ngubane**
- The estimation of a satellite based spatially derived drought index from hydrological system drivers: Rainfall and Evapotranspiration – **Maqsooda Mahomed**
- The influence of environmental variability on the abundance of chokka squid off the south coast of South Africa – **Jessica Joyner**
- Epigeic ant diversity at Ukulinga Research farm: Impacts of grazing, burning and alien invasive across a long-term experimental farm, Pietermaritzburg KwaZulu-Natal – **Caswell Munyai**
### Parallel Side Events

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Details</th>
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| 16:00 – 17:00 | Side Event E | Evidence-informed policymaking (EIPM) in South African government departments  
Convener: Ms Mapula Tshangela, DEA  
Venue: Maharani – Tugela Room |
|               | Side Event F | LTAS  
Convener: Mr Vhalinavo Khavagali, DEA  
Venue: Elangeni – Suites 1-4 |
|               | Side Event G | SANCOR  
Convener: Ms Carmen Visser, SANCOR  
Venue: Elangeni – Small Ilangas |
|               | Side Event H | Climate, Water and Agriculture  
Conveners: Prof Roland Schulze, UKZN, and Prof Hannes Rautenbach, SAWS  
Venue: Maharani – Umgeni and Congella Room |
|               |          | To share and exchange lessons from various government departments on EIPM in South African government departments. |
|               |          | Long term adaptation scenarios: research and strategy. |
|               |          | Global Change in a Marine and Coastal Environment. |
|               |          | This session will include a presentation on the South African Farmers’ Handbook on Adaptation to Climate Change: Context, Content and Communication on Climate Smart Agriculture – Roland Schulze. |

### 19:00 – 23:00

**GALA DINNER**  
*Venue: Elangeni Hotel - Great Illanga*
| Session 9A: Ecosystem Services  
Chair: Lawrence Obidike  
*Venue: Elangeni – Small Ilanga* | Session 9B: Health  
Chair: Mavhungu Muthige  
*Venue: Maharani – Umgeni and Congella Room* | Session 9C: Marine and Coastal  
Chair: Kendyl le Roux  
*Venue: Elangeni – Great Ilanga* | Session 9D: Terrestrial Ecology  
Chair: Marc Burman  
*Venue: Maharani – Tugela Room* |
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<tbody>
<tr>
<td>Holistic regional management of multiple water quantity, quality and other stressors in Africa using PROBFLO – <em>Gordon O’Brien</em></td>
<td>Climate variability as a driver of infectious disease incidence – <em>Neville Sweijd</em></td>
<td>The role of pioneers as indicators of biogeographic range expansion caused by global change in southern African coastal waters – <em>Alan Whitfield</em></td>
<td>The effect of Vachellia karroo size on mortality and compensatory responses following herbivory – <em>Lavinia Perumal</em></td>
</tr>
<tr>
<td>Assessing the potential of community science engagement in improving ecosystem services restoration – <em>Nobuhle Mweli</em></td>
<td>Socio-economic determinants of malaria transmission in a province with low malaria incidence employing a Bayesian modelling approach – <em>Osadolor Ebhuoma</em></td>
<td>Seasonal variation of invertebrate diversity in rock pools and emergent rocks along the Wild Coast of South Africa – <em>Zizipho Mnyaka</em></td>
<td>Rainfall variability and its influence on wildlife. Case study: Wonderkop Nature Reserve, South Africa: Limpopo Province – <em>Paulina A. Phophe</em></td>
</tr>
<tr>
<td>Beach Governance and Willingness to pay as an Economic Instrument for Coastal and Marine resource use, protection and management – <em>Simbarashe Ndhleve</em></td>
<td>Climate Change, Migration and the geographical distribution of incident cases of malaria in the Eastern Cape Province, South Africa – <em>Christian L. Lokotola</em></td>
<td>Morphological characterisation of two non-territorial patellid limpets along the Wild Coast – <em>Omega Ndongeni</em></td>
<td>Future-proofing food: Linking sustainable food production with national conservation targets – <em>James Pryke</em></td>
</tr>
<tr>
<td>Developing a methodology to estimate the water use of South African natural vegetation using remote sensing – <em>Manish Ramjeawon</em></td>
<td>Climate change, climate variability, local seasonality, and cerebrovascular disease in central Africans – <em>Longo B. Mbenza</em></td>
<td>Decreasing freshwater supply reduces the productivity of estuaries and nearshore marine environment – <em>Ursula Scharler</em></td>
<td>Can positive biotic interactions mediate climate-driven range shifts? A case study from the sub-Antarctic – <em>Morgan Raath</em></td>
</tr>
<tr>
<td>Increase in apparent temperature (Tapp) and respiratory disease deaths in Cape Town during 2006-2010 – <em>Malebo Makunyane</em></td>
<td>Too hot to handle? Thermal tolerance and the potential effects of climate change on coastal and estuarine organisms in the Kariega estuary and adjacent intertidal coastline – <em>Kerry-Ann van der Walt</em></td>
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<td>Functional response of Blechnum penna marina in tundra environments – <em>Marius Rossouw</em></td>
</tr>
</tbody>
</table>
### SESSION 10: Plenary

**Theme:** Big Global Change Issues  
**Chair:** Dr Luthando Dziba, Council for Scientific and Industrial Research  
**Venue:** Elangeni - Great Illanga

- Land degradation as a global change process - Prof Bob Scholes - 20 mins  
- Resource requirements of future urbanisation - Prof Mark Swilling - 20 mins  
- The footprint of climate change from genes to biomes to people - Dr Wendy Foden - 20 mins  
- Reflections and Q and A

### SESSION 11: Parallel Side Events

| Side Event I: Geo-economics/Engineering/Mimicry and Earth Stewardship  
Convener: Prof Maarten De Wet, NMMU & AEON  
Venue: Elangeni – Small Illanga |
| Side Event J: South African Risk and Vulnerability Atlas  
Convener: Ms Asiphe Sahula, NRF  
Venue: Maharani – Umgeni and Congella Room |
| Side Event K: Opportunities for research partnerships - the European Union Research and Innovation Programme H2020  
Convener: Ms Kogilam Govender, DST  
Venue: Maharani - Tugela Room |
| Side Event L: Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) and Science Partnerships for the Assessment of Complex Earth System Processes (SPACES) as Platforms for innovative Research in Southern Africa  
Convener: Dr Yonah Seleti, DST/SASSCAL  
Venue: Elangeni – Great Illanga |

Engagement with students interested in the Value of Natural Resources.  
Round table discussion session: The South African Risk and Vulnerability Atlas: Decision support tools and user requirements.  
Engagement with students and researchers sharing opportunities and modalities that would support their participation in this large scale programme.  
An introduction to the ongoing and forthcoming research programmes of SASSCAL and the SPACES initiative
### Closing Plenary

**Chair:** Dr Chris Moseki, Senior Specialist, Department of Water and Sanitation  
**Venue:** Elangeni - Great Illanga

- Conference highlights and outcomes (reports from sessions) - GC Science Committee (Chair) - 60 mins
- Awards - 15 mins
- Closing Remarks – Conference organisers (DST/NRF) - 10 mins
- Vote of Thanks – Host (UKZN) - 5 mins
- Closure

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### Closing

**16:00**

**CLOSURE**
<table>
<thead>
<tr>
<th>FIELD TRIP 1: MARINE</th>
<th>Organiser: SEAWORLD/USHAKA/ORI</th>
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<tbody>
<tr>
<td>07.30  Departure</td>
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<tr>
<td>Oceans and climate change, including an introduction, coral lab work, guided aquarium tour, Q&amp;A, and optional dolphin presentation. ORI discussion of sea level rise and engineering issues (a walk along the promenade) with an introductory presentation.</td>
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<td>LUNCH</td>
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<tr>
<th>FIELD TRIP 2: UKULINGA GRASSLAND TRIALS</th>
<th>Organiser: UKZN GRASSLAND SCIENCE</th>
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<tbody>
<tr>
<td>07.00  Departure</td>
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<tr>
<td>UKZN's long-term mowing and burning trials and veld fertilisation trials which were initiated in 1950 and are still being maintained today for grasslands research, with increasing international reach.</td>
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<td>LUNCH</td>
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<tr>
<th>FIELD TRIP 3: NEWLANDS MASHU RESEARCH SITE</th>
<th>Organiser: UKZN POLLUTION RESEARCH GROUP</th>
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<tbody>
<tr>
<td>07.00  Departure</td>
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<tr>
<td>The Newlands Mashu Agricultural Hub situated in Newlands was established in 2010 and functions as a biointensive vegetable production hub, following the agricultural service delivery model of promoting household food security, enabling people to create commercially sustainable economic opportunities through agriculture, and the redressing of imbalances. Training is provided on-site to members of the community in agricultural aspects. It is a site for integrated research on sanitation, decentralised wastewater treatment, nutrient recovery and recycling, and agricultural trials, and resulted in the establishment of the Newlands Mashu Research Site.</td>
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<tr>
<th>FIELD TRIP 4: BUFFELSDRAAI COMMUNITY ECOSYSTEM REHABILITATION</th>
<th>Organiser: UKZN/eThekwini</th>
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<tr>
<td>07.00  Departure</td>
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<td>In November 2008, a ‘reforestation’ project aiming to offset approximately 42,000 tons CO2 equivalent was established as a natural carbon sink. The total offset is expected to be achieved over a 20-year period, and will take place in the buffer zone of the Municipality’s Buffelsdraai Regional Landfill Site. All reforested areas were previously either farmland (under sugarcane), with limited productive capacity, or infested with invasive alien plants.</td>
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<tr>
<th>FIELD TRIP 5: TWO STREAMS CATCHMENT MANAGEMENT PROJECT</th>
<th>Organiser: UKZN/SAEON</th>
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<tr>
<td>07.00  Departure</td>
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<tr>
<td>The Two Streams catchment provides essential ecosystem services to many users of the catchment. SAEON researchers are using the site to investigate impacts of various land uses and crops on the catchment’s water resources. Begun in 1999, this is a long-term site providing important data for the management of water resources.</td>
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Keynote Lecture

Reflecting on Climate Change Adaptation Science from a Developing Country Perspective

By

DR SALEEMUL HUQ

Director of the International Centre for Climate Change and Development, Bangladesh

Biography:

Dr Saleemul Huq is a Senior fellow on Climate Change at the International Institute for Environment and Development (IIED). Before joining IIED he was the Executive director of the Bangladesh Centre for Advanced Studies.

Dr Huq is an expert on the links between climate change and sustainable development, particularly from the perspective of developing countries. He was the lead author of the chapter on Adaptation and Sustainable Development in the third assessment report of the Intergovernmental Panel on Climate Change, and was the lead author of the chapter on Adaptation and Mitigation in the IPCC’s fourth assessment report.

His current focus is on supporting the engagement of the Least Developed Countries in the United Nations Framework Convention on Climate Change. He is researching the least developed countries’ vulnerability to climate change and the impact of adaptation measures. He is also the director of the International Centre for Climate Change and Development (ICCCAD) in Bangladesh.

His expertise is centred on the links between climate change and sustainable development, and particularly the perspective of developing countries in Africa and South Asia. He is currently working on building negotiating capacity and supporting the engagement of the Least Developed Countries (LDCs), including negotiator training workshops for LDCs, policy briefings and support for the Adaptation Fund Board, and conducting research into vulnerability and adaptation to climate change in the LDCs.
ORAL PRESENTATIONS – ABSTRACTS

Session 2A: Risks and Vulnerability

ANALYSIS OF EXTREME WEATHER EVENTS OVER THE LIMPOPO/BOTSWANA REGION: AN ATTRIBUTION STUDY ON HEAT WAVE EVENTS AND EXTREME HOT DAYS

Peliwe Jubase, University of Cape Town
peliwejubase@gmail.com

This paper evaluated the inter-annual variability of climate indices across the Limpopo River Basin, with a specific focus on heat wave and extreme hot events and their associated atmospheric circulations. Extreme weather impose stress on livelihood, wildlife, agriculture and infrastructure of which all result to a socio-economic crisis. The purpose of this paper is to strengthen the literature of extreme weather events in Southern Africa and encourage collaboration between scientists, decision-makers and stakeholders in understanding the impacts of climate change on the historical and future trends of extreme hot events and heat waves. It also has the potential to inform the disaster and risk management sector on heat wave mortality, and is useful for the water management of the Limpopo River Basin as this area requires a thorough inspection for its demand and supply to the surrounding population considering the climate change progression.

The analysis of extreme events adopted a research tool developed by the Expert Team on Climate Change Detection and Indices (ETCCDI) which performs a statistical analysis of climate indices at individual stations. This research tool allowed for the definition, detection and analysis of climate indices in a standardised way, making it possible to compare results of different places and obtain coherent climate trends. Thereafter, Self-Organising Maps methodology was employed to investigate and visualise the atmospheric circulations associated with heat wave and extreme hot events during austral summer. A warming and less cooling local climate was evident, with increases in the percentage number of days being part of the sequential heat wave events, increases in the percentage number of extreme hot days/nights, and rapid decreases in the percentage number of extreme cold days/nights. Heat wave and extreme hot events were mainly characterised by dominant high-pressure systems existing alone and co-existing with a mid-latitude low pressure.

THE VULNERABILITY OF COASTAL COMMUNITIES IN SOLOMON ISLANDS TO CLIMATE CHANGE

Lead Author: Willem Malherbe, Rhodes University
wilfredmalherbe@gmail.com

The impacts of climate change are disproportionally felt across the planet, with small island developing states some of the countries most at risk. Furthermore, climate change may compound existing problems such as over harvested resources, leading to knock-on effects on national economies. Both direct and indirect stressors may impact communities differently based on their level of exposure to stressors, their intrinsic sensitivity to these stressors, and their ability to adapt to stressors.

A series of 83 indicators of vulnerability was used to determine the social, economic, and ecological vulnerability of five coastal communities in Solomon Islands.

As is expected of small island states, exposure presents the biggest threat to coastal communities. Within this category, environmental changes and personal exposure from shoreline erosion and safety at sea
provide evidence of high vulnerability. Within the sensitivity category, the cultural importance of fishing, as well as attachment to place and fishing, renders communities more vulnerable. Simultaneously, local ecological knowledge and economic dependence on resources other than fishing proved to be resilient attributes by decreasing vulnerability. Low vulnerability scores for the adaptive capacity category were achieved by communities where physical capital, such as community infrastructure, was evident. A lack of both institutional support and bridging of social capital were attributes which contributed to community vulnerability.

This study has identified key attributes that have both positive and negative effects on the vulnerability of Solomon Islands communities. Having done this, it has also attempted determine the drivers that renders some attributes more vulnerable than others. It is acknowledged that the drivers of all key attributes of vulnerability is required to determine areas where adaptation plans will be most effective. Importantly, drivers of high vulnerability should not be considered as the primary focus of adaptation planning, but also the drivers of low vulnerability, such as community cohesion, which provide resilience within communities.

RISKS AND VULNERABILITIES IN RURAL JUNIOR SECONDARY SCHOOLS IN THE EASTERN CAPE PROVINCE: IMPLICATIONS FOR SCHOOL MANAGEMENT

Lead Author: Noloyiso Nongalo, Walter Sisulu University
nongalonoloyiso@gmail.com

Rural schools are continuously subjected to various risks ranging from natural disasters, man-made and those that are related to the physical environment of school’s infrastructure. These adversely affect teaching and learning. Teaching and learning can only take place in a safe and secure school environment. Creating safe and secure learning environment requires the management to lead all the stakeholders. However, the art of creating safe school environment in disorganized school environments full of risks and vulnerabilities poses great challenges to school management. To address this problem, an inquiry using a qualitative approach was undertaken to ascertain the implication of these risks and vulnerabilities for school management. Data was generated through interviews from twelve School Management Team members who were purposefully sampled in the Libode-Mega District schools. Data were analyzed using NVivo 10 to identify common patterns which led to thematic analysis. Findings revealed that learners were vulnerable to climate related risks, like floods and tornados. Learners in rural schools emerged as more vulnerable and this has implications for effective school management. The study concludes by suggesting strategies to deal with these risks and vulnerabilities in rural areas.
Key words: School Management Team, climatic risks, man-made risks, infrastructure, strategies

FIRE DANGER RATING IN SOUTH AFRICA UNDER PROJECTED CLIMATE CHANGE SCENARIOS

Lead Author: Stefanie Schütte, University of KwaZulu-Natal
Schuttes@ukzn.ac.za

As climates become hotter, altered fire regimes are likely to affect the South African natural landscapes. Wildfires are caused mainly by the interaction of flammable vegetation that can support combustion and the prevalence of hot, dry and windy spells which predispose these landscapes to burn whenever there is a source of ignition and when biomass and soils are dry.
The emphasis was not on short-term forecasting, but rather on outlining factors affecting fire regimes under natural vegetation for both historical and climate changed conditions, in regard to fire intensities, seasonality, frequency, type and spatial distributions. The temperature-relative humidity based Angström fire danger rating index used was modified in regard to fuel load, vegetation wetness, soil wetness and wind factors. A spatial overview across South Africa of vulnerability to fire was provided, using the South African Quinary Catchments database of 5838 spatial units, with daily historical (1950-1999) and projected daily future (2046-2065) climates, from four downscaled GCMs, assuming natural vegetation.

Major differences emerge between the historical and climate change scenarios for all four fire danger categories assessed, but particular for the “very likely” fire category, with increases in numbers of days per annum projected virtually everywhere across South Africa, in places by up to 40 – 60%.

Future climate conditions point to significant increases in fire risk in many fire-prone areas, and in areas presently not considered fire prone. Changes in fire regime can compromise vegetation stability to fire even in highly resilient natural vegetation types. Adaptation to future conditions is thus vital.

**REDUCING DISASTER RISKS FROM WILDLAND FIRE HAZARDS ASSOCIATED WITH CLIMATE CHANGE IN SOUTH AFRICA**

Tessa Oliver, Kishugu NPC
coord@fynbosfire.org.za

The Global Environment Facility Special Climate Change Fund has granted US$3.5m to South Africa for a three-year project to implement integrated fire management programmes in the Fynbos biome. This project aims to reduce the risk to life, the economy and the environment caused by unwanted wildland fires associated with climate change.

The number and intensity of unwanted wildland Fires in South and Southern Africa has increased significantly during the past several years. Many of these fires have been either major or catastrophic fires which have resulted in deaths, loss of livestock, impacted negatively on the environment and burned uncontrollably at an enormous cost to the South African economy. The Fynbos Biome, which is a fire-dependent ecosystem, is particularly vulnerable to risks from unwanted wildland fire triggered by climate change and scientific research shows that this risk will increase in future. Effective co-ordinated sustained wildfire management to reduce this risk is, therefore, imperative.

In the past, wildfire management was heavily dependent on fire suppression. But factors such as changing climate patterns, an increased wildland-urban interface and greater pressure on natural resources, have become increasingly more significant. It is clear that a change in approach is essential and to achieve this, an effective, co-ordinated wildfire management strategy which earns enthusiastic support across economic, social and demographic lines must be developed. Integrated Fire Management (IFM) provides a framework upon which to build a balanced, workable, and sustainable tool that will meet the fire-related demands of ecosystems and people with minimum harm to the environment. IFM has been defined as a series of actions that include: fire awareness and prevention, risk mapping, hazard identification, prescribed burning, resource sharing and co-ordination with fire detection, fire suppression and fire damage rehabilitation also playing a crucial role.
Session 2B: Freshwater

FROM POWER STATION EMISSIONS TO ECOLOGICAL IMPACTS IN STREAMS; FIRST RESULTS FROM THE ACIDWATER BILATERAL NRF-SANCOOP PROJECT

Lead Author: Christopher Curtis, University of the Witwatersrand
christopher.curtis@wits.ac.za

In South Africa, very few studies into the ecosystem effects of acid deposition have been published, and have focused mainly on the Highveld regions of relatively high sulphur and nitrogen deposition, corresponding with the location of most of the country’s coal-fired power stations. Here we present the first results of the AcidWater study, including co-located deposition and hydrochemical measurements in three regions, across an assumed deposition gradient; the Highveld (high deposition), Waterberg (moderate deposition) and South West Cape (low deposition). All three regions are found to contain acid-sensitive streams with low pH, low conductivity and very low acid neutralizing capacity, most notably in the SW Cape and the Waterberg. These regions are also extremely important for aquatic biodiversity and home to endemic species of invertebrates and fish – and in some cases undescribed species. Precipitation chemistry indicates that acidic deposition occurs in all study regions. The key challenge is to derive regionally-relevant critical load models linking deposition inputs to ecological effects. Work is ongoing to derive critical chemical criteria linking macroinvertebrate response to measures of acidity and deposition. Derivation of regional critical loads will provide an evidence-based approach for developing policy to mitigate power station emissions for ecosystem protection.

MONITORING WATER QUALITY USING SATELLITE REMOTE SENSING: A CASE STUDY OF THE VAAL DAM, SOUTH AFRICA

Keneilwe Hlahane, University of Cape Town
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South Africa is a water stressed country with limited surface freshwater resources. Surface freshwater resources such as rivers, lakes and dams are becoming degraded as a result of poor water quality. Eutrophication is one of the water pollution problems affecting the water quality of freshwater resources. Eutrophication is defined as the process of enrichment by nitrogen and phosphorus nutrients in water bodies. It is associated with the growth of cyanobacteria and algal blooms species, which can be detected using satellite remote sensing. Current methods used for monitoring eutrophication are by collecting biogeochemical data using in-situ methods. These methods are costly, and they lack to provide enough spatial coverage and temporal consistency. Satellite remote sensing is an alternative method that can be used to monitor eutrophication. This study aims to monitor eutrophication in the Vaal dam, by using The Medium Resolution imaging spectrometer (MERIS) satellite remote sensing data products. MERIS satellite images were obtained over the Vaal Dam, South Africa for the period 2002-2012. The images were processed using the maximum peak height (MPH) algorithm to obtain estimates of chlorophyll-a and detect cyanobacteria. The study presents a time series analysis of chlorophyll a (a proxy for eutrophication) and cyanobacteria in order to determine the status, seasonality and trends of eutrophication. The results indicate the trophic status of the dam as being eutrophic to hypertrophic. Seasonality analysis indicated that cyanobacteria blooms increased in production during the summer period, and decreased in winter. Trend analysis indicated that eutrophication and cyanobacterial blooms both worsened and improved in severity over the time period. Satellite remote sensing is a reliable and affordable method that can be used to detect and monitor the quality of freshwater resources.

Keywords: Chlorophyll-a, eutrophication, remote sensing, time series analysis, water quality
RIVER POLLUTION CHANGES RELATED TO DIVERSE LAND-USE PATTERNS AND SEASONAL CHANGE.

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With water resources becoming such a concern in South Africa, a need has developed to understand what processes may affect these valuable resources. The Western Cape is rich in small stream sized rivers forming part of the water resources. These rivers are thus affected by the surrounding environments and continuous development around the rivers could affect river health adversely. Diverse land-use patterns contribute to a wide range of pollutants with different characteristics. Agricultural fields are sources of nutrients and Industrial areas produce high amounts of heavy metals. In some cases point source pollution, like waste water treatment plants, also affect the health of these rivers. However, pollutant concentrations are not only related to the surrounding land-use patterns but are subject to change based on weather patterns. The Western Cape has Mediterranean climate patterns with dry hot summers and wet winters. The transport of pollutants from the source to the rivers are primarily based on surface run-off which in turn is predominantly dependent on the precipitation of the region. Processes like surface run-off, together with first flush events and concentration dilution, mainly control the pollution concentrations in these stream sized rivers. Physicochemical parameters, major agricultural nutrients and industrially produced heavy metals all react differently to these processes. Analysing these parameters allow for quantifying the effects that these processes have on the land-use produced pollution in these rivers and how weather changes facilitate the processes. Thus providing an insight into the effects continuous development and climate change have on water as a national resource.

USING STREAM FLOW CHANGES AND NUTRIENT ENRICHMENT TO DETERMINE THE EFFECTIVENESS OF MACROINVERTEBRATES AS BIOLOGICAL INDICATORS OF RIVER HEALTH

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Water is an important resource for the survival of all living organisms on earth, and the functioning of all ecosystems depends entirely on this resource. Freshwater available for human use is a finite resource and has overtime become a scarce linked to the growing pressures from humans. Rivers are among the main sources of freshwater, however a number of human activities have had negative impacts on the ability of rivers to provide freshwater adequately, many of these problems linked to decline in freshwater quality. This has led to the establishment of ways to monitor the conditions of rivers, biological monitoring which uses indicator species to assess changes in river health is one of them. This study aimed to investigate if shifts in communities of macroinvertebrates which are considered good biological indicators can be used to detect changes in stream flow and nutrient enrichment in rivers. This was done by comparing macroinvertebrates communities found in sites of poor nutrients with those of enriched nutrients and sites with altered flow and those with no altered flow. Results showed that differences in nitrates, velocity and conductivity were linked to high presence of Hydropsychidae in the enriched nutrient site compared to the nutrient poor site. It was also found that differences in the velocity and pH were linked to high presence of Naucoridae species in the altered flow site compared to the non-altered flow site. Finally, the results reported that changes in the conditions of the reference site associated with plantation of maize were linked to an increase in the abundance of Chironomidae species. We concluded that macroinvertebrates can be used to detect changes in the flow and nutrient regimes in rivers, however composition of species needs to be taken into consideration and not just the abundance of the identified species.

Keywords: Biological monitoring, macroinvertebrates, nutrient enrichment, stream flow.
Anthropogenic CO2 emission has received a considerable attention as it is linked to global warming. As a result we experience drastic climate changes which threaten the economy, ecology and living conditions on the planet. Currently, mitigation of CO2 emissions remains a scientific challenge. Various recovery processes have been proposed, amongst them the CO2 capture and sequestration (CCS). CCS has a high potential at reducing CO2 emissions, from stationary and mobile point sources. CCS technologies include CO2 capture by adsorption, absorption, and membrane processes.

The most mature and applied technology in CCS process involves the absorption of carbon dioxide on amine based solvents. However, this process has several drawbacks such as low chemical stability and high energy required to strip off the absorbed CO2 when regenerating the solvent. This presents an opportunity for the development of zeolite membranes for CO2 capture. For instance, SAPO-34 zeolite membranes were found to have high chemical and thermal stability. Previous studies have shown that the separation of CO2 can be achieved with high selectivity at low temperatures using thin-film SAPO-34 membranes (thin layers on supports) because CO2 adsorbs strongly on the membranes than the other components in flue gas. In the thin-film membranes supported on ceramic or sintered stainless steel, thermal expansion mismatch may occur at higher operating temperatures resulting in loss of membrane selectivity due to cracks formation.

A new method is required to overcome the aforementioned problems, thereby enhancing the separation application of the membranes at higher temperatures. In this study a fairly new synthesis method, the Pore-plugging hydrothermal synthesis, was explored to produce nanocomposite SAPO-34 membranes for post-combustion CO2 capture. The physico-chemical properties of the as-synthesized membranes were checked with XRD, TGA, FTIR and SEM. The quality of the as-prepared membranes was evaluated using basic desorption quality test and permeation experiments.

The current abnormal concentration of carbon dioxide (CO2) in the atmosphere is responsible for climate change. The primary anthropogenic sources of CO2 emission are the burning fossil fuels such as gas, oil and coal. The majority of electricity created in South Africa is from Eskom coal-fired power stations. In addition, in order to respond to the actual energy crisis in South Africa, Eskom has planned to import more coal to supply the new power plants built in Mpumalanga and Limpopo. Emission of CO2 is therefore expected to increase in the next decades as it is unlikely that South African government will switch to a clean source of energy in the years to come. As is the case in many developed countries, the underground storage in geological formations of CO2 has been considered as one of the solutions for climate change. This research investigates the risks related to geomechanical processes which might cause the CO2 to leak out on surface during CO2 storage. The main objectives are: to predict the expected land vertical uplift, to predict the risk of fault reactivation in the storage complex and in the
caprock and to investigate the integrity of the caprock during injection. In addition, the results obtained in this project will be critical to address confidently the public concerns regarding the possibility of contamination of the water table and occurrence of seismic events during the storage of CO2. To reach the objectives mentioned above, a 3D geological, 3D geomechanical and a flow model will be constructed. The flow and the geomechanical model will be coupled.

**SUSTAINABLE USE OF COAL FOR ENERGY PRODUCTION IN SOUTH AFRICA WITH LESS CO2 EMISSION: CO2 CAPTURE AND STORAGE A PROMISING OPTION**

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The global atmospheric concentration of anthropogenic gases such as carbon dioxide has increased substantially over the past few decades due to the high level of industrialization and urbanization occurring in developing countries like South Africa. This has escalated the challenges of global warming. In South Africa, carbon capture and storage (CCS) from coal-fired power plants is attracting increasing attention as an alternative approach towards the mitigation of carbon dioxide emission to encourage sustainable use of coal as source of energy in South Africa. Therefore, innovative strategies and process optimization of CCS systems are essential to improving the efficiency of CCS technology in South Africa. Retrofitting CCS to the existing South African coal-fired power plants could ensure sustainable use of coal for energy production with less negative impact on the environment. This study evaluates the use of solid adsorbents like metal organic frameworks and its behaviour during CO2 capture. It also examines various CCS processes that could be used in capturing CO2 from the existing coal-fired power plants. The outcome of this study will suggest a possible adsorbent and most viable technology for CO2 capture that could possibly be implemented in the South African coal-fired power plants to cut down on the high amounts of CO2 emissions from this energy sector.

Keywords: CO2 capture, Coal-fired power plants, Climate change, Sod-ZMOF/Chitosan

**Session 2D: Food Production**

**PHYTOCHEMICAL DISTRIBUTION IN WHOLE SEED (UNDEHULLED) AND COTYLEDON (DEHULLED) OF BAMBARA GROUNDNUT (VIGNA SUBTERRENEA) SEEDS AND THEIR CONTRIBUTION TO ANTIOXIDANT ACTIVITIES**

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The objective of this study was to evaluate the distribution of phytochemical and their contribution to antioxidant potentials in the different varieties of Bambara groundnut (undehulled and dehulled) seeds obtained from Limpopo Province of South Africa. Methanolic extract of the of Bambara groundnut seeds (BGN) were assessed for their total polyphenolics, flavanol, flavonol and anthocyanin contents as well as oxygen radical absorbance capacity (ORAC) and ferric reducing antioxidant power (FRAP). The methanolic extract of the whole seeds exhibited significantly higher in vitro antioxidant activities than the cotyledon with the black seed variety showing the highest ORAC and FRAP 244.89 ± 5.79 μmol TE/g and 84.44 ± 5.25 μmol AEE/g respectively for whole seeds, while 138.77 ± 8.87 μmol TE/g and 35.64 ± 2.42 μmol AEE/g respectively for the cotyledon. The total polyphenolics contents of the extracts ranged from 11.01 ± 0.37 to 3.56 ± 0.10 mg GAE/g (whole seed) and 3.19 ± 0.20 to 2.71 ± 0.28
mg GAE/g (cotyledon). Hence, the BGN whole seeds had stronger in vitro antioxidant potentials than the cotyledon (dehulled).

THE FARMER FIELD SCHOOLS APPROACH TO PROMOTING SMALL-SCALE FARMERS’ KNOWLEDGE, AND PRODUCTION IN Nkonkobe Local Municipality

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This study aims to investigate the impact of the Farmer Field Schools approach on the knowledge, agency and production of small-scale farmers. Farmer Field Schools (FFS’s) were devised in the 1970s by the Food and Agriculture Organization on the UN as a form of adult education in agriculture. It is a group-based approach in which a facilitator meets with farmers on a regular basis and sets in motion a process by which farmers ‘learn how to learn’, whether from themselves or from one another. In 2015, the University of Fort Hare and the Nkonkobe Farmers Association initiated a number of FFS’s in the Alice area. The paper presents the findings from initial research into the impact of these FFS’s, mainly based on interviews with FFS participants.

Key words: Farmer Field schools approach, Agency, Production

CONSERVATION AGRICULTURE WITH ACACIA AND MORINGA IN AGROFORESTRY SYSTEM FOR FODDER PRODUCTION IN LIMPOPO PROVINCE

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The concept of integrating crop-friendly woody perennials species in conservation farming systems is being promoted as an affordable, science-based approach and climate change mitigation and adaptation strategy to improve crop and livestock productivity in arid and semi-arid environments. Woody perennial species are often resilient to drought and when well integrated in crop-livestock systems, can serve as a reliable source of feed. Conservation agriculture with trees (CAWT) involves the integration of crop friendly woody perennial species into crop-livestock system in combination conservation agricultural (CA) practices. CA promotes minimum soil disturbance, increase soil cover and enhance agro-biodiversity. Despite the reported advantages, widescale adoption of CAWT has been suboptimal in South Africa compared to many countries in the African continent. Our current research focused on exploring the benefits of integrating encroached Acacia karroo and Moringa oleifera into mixed cropping/pasture/livestock systems in the Limpopo province. Specific objectives were to access the nutritional value and palatability of Acacia karroo and also that of moringa, its biomass production in response to cutting and planting density as well as its moisture use.

Preliminary findings reveals that: Acacia karroo leaves have a potential of being a protein feed for ruminants and its inclusion in diet increased intake by goats regardless of the higher condensed tannin and phenolic levels; moringa crude protein content exceeded that of Acacia karroo and this was influenced by location and regrowth. Reduced density in moringa resulted in greater loss of soil moisture compared to those established under higher stands with the loss was primarily due increased evaporation rather than transpiration.

In conclusion, the incorporation of Acacia karroo and Moringa oleifera in farming system could improve feed supply for livestock.

Key words: Fodder, acacia, moringa, crude protein, stomatal conductance.
RESPONSE OF YELLOW QPM INBRED LINES TO DROUGHT STRESS TOLERANCE AT SEEDLING STAGE

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Drought stress continues to be one of the most important abiotic stress factors that negatively affect growth and development of maize at all stages. In this study, 18 yellow QPM inbred lines were screened for drought stress tolerance at seedling stage. The experiment was conducted in the growth chamber at the University of Fort Hare, Botany Department. The experiment was laid out in a 6 x 3 Randomized Incomplete Block Design (RCBD) and replicated three times. Maize seedlings were exposed to drought stress treatment by growing them at 20% field capacity. As for the control, the seedlings were grown at 80% field capacity throughout the duration of the experiment, which was three weeks. Different morpho-physiological traits were recorded. Inbred lines exposed to drought stress differed significantly (P<0.05) for all recorded traits except for sub-stomatal carbon dioxide concentration. Under well-watered conditions, no significant differences (P>0.05) were observed for canopy temperature and sub-stomatal carbon dioxide concentration only, while significant differences were observed for the rest of the traits. Generally, lines L2, L7 and L17 performed better under drought stress for most of the parameters that were measured. Additionally, results obtained showed an increase in proline content under drought stress as compared to well-watered conditions. Inbred lines that produced higher amounts of proline than the control were depicted as drought tolerant. This included inbred lines such as, L34, L7, L24, L13 and L2. Preferably, L7 and L2 can be selected as the best performing inbred lines since they produced high proline concentration and performed better for most of the parameters measured under drought stressed conditions.

THE VICIOUS CYCLE OF SOIL EROSION IMPACT AND AGRICULTURE IN SOUTH AFRICA: IMPLICATIONS FOR CLIMATE CHANGE AND VARIABILITY

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The relationship between agriculture and soil erosion is one of a vicious cycle. Agricultural activities impact on the soil as soil erosion, and other soil degradation processes, soil erosion in turn impacts on the agriculture through various processes, including climate change and variability. The goal of this study was to explore how soil erosion impacts on the agricultural potential of South Africa, using the farming situation of Upper and Lower Areas of Didimana, Eastern Cape as a case study. Agricultural activities in the study were measured as plant and crop quality, as well as crop quantity (yield). Also, soil erosion impact was measured in the form of its impact on agricultural enterprise and livelihoods of farmers, change in crop planting, food security, crop loss, and crop sold by farmers, et-cetera. According to findings, plant quality related positively significant with farmers’ livelihood and food security in the study area at p<5% level of significances. Also, the quality of crop produce related positively significant with food security and cost of production, both at 5% and 10% respectively, but negatively with food available for the home. Finally, crop quantity or yield related positively significant with change in crop planting due to soil erosion, but negatively with crop sold for profit, both at 5% level of significances. The implication is that as agricultural activities increases, soil erosion increases, which impacts on climate change and variability. The suggestion therefore is that adequate educational campaign and appropriate measures should be ensured by all stakeholders to control soil erosion. This is because, soil erosion impacts on the agricultural potential of an environment through various means like food insecurity, low farm income, hunger and poverty, and climate change, while agricultural activities in turn impact on soil erosion in an unending cycle.
The summer of 2015/16 was associated with record-breaking temperatures across the southern African region, and in some provinces of South Africa, with devastating drought. In fact, 2015 was globally the warmest here ever recorded, and the first year during which the global average surface temperature increase exceeded the critical 1 °C threshold (compared to the pre-industrial state). Over southern Africa, for December to February, the surface temperature was in the order of 2 °C higher than observed, with staggering monthly temperature anomalies in the order of 6 °C observed in parts of South Africa during this time. These regional and also global temperature extremes were the result of a very strong El Niño event in combination with systematic global warming.

This paper reviews the impact of both El Niño and La Niña events on South African climate, as recorded since 1901. Using state-of-the-art climate models, the attributes of these events under climate change are subsequently explored. The analysis of El Niño and La Niña amplitudes and frequencies is performed for a 1 °C global world (that is, our current world where the global surface temperature is about a degree higher than in the pre-industrial world), a 1.5 °C world (the Paris agreement aspires to keep the global temperature increase below this threshold), a 2 °C world and a 3 °C world (the latter case implies a low-mitigation future). The consequences of a low-mitigation future for southern Africa in terms of droughts and floods that result from El Niño and La Niña events are subsequently discussed, and it is shown that a generally drier future with more El Niño -type droughts is likely. The results emphasise the importance of successful implementation of the Paris Agreement towards achieving ambitious global mitigation targets, towards avoiding dangerous regional climate change in southern Africa.

AN ASSESSMENT OF WATER SECURITY AND HYDROLOGY RESOURCES IN THE FACE OF CLIMATE VARIABILITY: THE CASE STUDY OF NKONKOBÉ LOCAL MUNICIPALITY, EASTERN CAPE, SOUTH AFRICA

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South Africa is regarded as a semi-arid and water scarce country due to its low annual precipitation with a mean annual rainfall of 490mm. This study seeks to assess the effects of water security in the face of climate variability on hydrological resources in Nkonkobe Local Municipality, Eastern Cape, South Africa. The main objective of the research was to investigate climate variability parameters affecting water security in the Nkonkobe Local Municipality. The variability and trends in rainfall and temperature were analysed using descriptive statistics. Bivariate (Pearson) Correlation analysis was used to describe the effect of rainfall distribution and reservoir’s holding capacity. A vulnerability index model was applied to determine the water security status in the study area. The Binfield Reservoir has high resilience to climate variability, but the magnitude of impact could be managed as it falls under Type IV where there is Low Impact. Kat River and Binfield reservoirs faces great exposure or sensitivity, this is evidenced by the reservoir holding capacity that is in the Type I of the vulnerability index. The vulnerability index showed that the in reservoirs water security is highly vulnerable. One of the key findings of this research was that vulnerabilities to form and function can be linked. For example, where reservoir level fluctuations change in response to the change in the climate variabilities, this affects the water security of the reservoirs. The findings illustrate the importance to enhance
adaptation efforts both at the micro (Nkonkobe Local Municipality) and macro (national) levels, particularly for communities where the reservoirs are more vulnerable to climate variability.

Keywords: Nkonkobe Municipality, Climate variability, water security, rainfall, temperature and vulnerability

**IMPROVING THE UNDERSTANDING OF WATER AND CLIMATE RELATED HAZARDS THAT POSE A RISK TO THE AGRICULTURAL SECTOR IN THE UPPER THUKELA CATCHMENT**

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Several climate change studies have predicted a global increase in the frequency of the occurrence of extreme hydro-meteorological events (IPCC, 2013). These events have been documented to have negative impacts on humans, the environment and the economy (Kusangaya et al., 2014). Southern Africa has been argued to be the most vulnerable regions to the impacts of climate change, particularly the agricultural sector. Given this, the impacts of extreme hydro-meteorological events on the agricultural sector in the Upper Thukela Catchment is to be investigated. This study will (i) identify the extreme events of concern for the Upper Thukela region and their current impact on agriculture; (ii) determine the potential changes in the occurrences and magnitudes of these events in the future and the associated impact through hydrological modelling, and (iii) suggest possible adaptation and coping strategies. As part of the adaptation component, the study will include a critical review of the early-warning and forecasting systems used in the Upper Thukela region, and suggestions will be made to improve the use and/or efficiency of these systems.

**RELATIVE RISK ASSESSMENT OF THREATS TO THE WELLBEING OF THE SOCIO-ECOLOGICAL ENDPOINTS OF THE AMATIKULU/NYONI CATCHMENT, KWAZULU-NATAL**

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To manage our ecosystems, Risk Assessments are used as an analytical tool to describe the relative risk that multiple stressors or threats have on the ecological structures that are being managed and to inform management decisions. A Regional Risk Model (RRM) is an example of a tool used to help manage the problem of the stressors/threats on the ecosystem and show possible impacts of the stressors on the ecosystem and identify possible threats to the ecosystem. We conducted a study on the Amatikulu/Nyoni Catchment which was considered to be in a moderately good ecological condition in the past, however there has been the growing demand to utilize the resources provided by the catchment resulting in the degradation of the system as a whole. Limited research on the condition of the catchment has been conducted on the lower Amatikulu/Nyoni region and is needed to inform future management decisions. The RRM tool was applied to the Amatikulu/Nyoni Catchment to determine the overall risk to biotic and abiotic endpoints within the catchment. The results obtained from this study should become a vital part of the adaptive management process of the Amatikulu/Nyoni Catchment.
The lowlands of the Cape Floristic Region have long been recognized as priority areas for conservation due to the major reduction in extent from severe transformation of the landscape, but the remnants face many additional threats. Climate change is expected to be a major driver of change over the coming decades, but it is its interaction with landscape transformation that’s likely to be truly devastating. For instance, landscape transformation leads to fragmented habitats that are isolated within an unsuitable matrix, constraining species’ abilities to track shifting climates. The aim of this paper is to quantify the threat of climate change for Cape Lowland fragments and the species they harbour, and the extent that landscape transformation and fragmentation have exacerbated this threat. Specifically we: 1) explore the climatic heterogeneity and stability of lowland vegetation types under future climate scenarios and the degree to which these have been reduced by landscape transformation; 2) explore topographic heterogeneity as a potential fine-scale buffer against climatic change, how topography varies between vegetation types and how it has been affected by landscape transformation; 3) explore the degree to which the distribution of lowland species is constrained by climate and their dispersal potential, relative to upland species. This research will contribute to our understanding on how Cape lowlands might respond to interacting global change threats.
LAKE SIBAYI VARIATIONS IN RESPONSE TO CLIMATE CHANGE IN NORTHERN KWAZULU-NATAL, SOUTH AFRICA

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The spatial distribution of inland surface water bodies—including fresh and saline lakes, rivers, and reservoirs and their changes over time are central to many agricultural, environmental and ecological issues and are critical factors to terrestrial ecosystems and human enhancement. Such as the small lakes in northern KwaZulu-Natal which are unique ecosystems, important for touristic attractions in South Africa. Recent studies indicate strong variations in water balance of one of the lake, Sibayi. For example, inflows into the lake are less than the outflows resulting in a negative change in storage. The negative change in storage implies that the lake level is continuously shrinking. So the expansion and shrinkage of this lake is critical to the water cycle, ecological and environmental systems and consequently the tourism industry and other forms of livelihoods in general. The relationship of the lake with other environmental elements should be understood if we are to achieve optimal management of natural resources. For optimal management of environmental and ecological resources, remote sensing techniques using multi-temporal and multi-sensor images for change detection purposes have become very important in this regard. In this paper, surface areas of Lake Sibayi is extracted based on a topographic map from 1980 and landsat MSS, TM and ETM satellite images from 1985 to 2014. Then a multivariate correlation analysis is conducted to examine the relationship between the changes in surface areas and the changes in climatic variables including precipitation, evaporation and sunshine duration. Initial results are supported by field experiences indicating a decline in surface water. Annual time series reveal a positive SPI between 1987 and 1991 as well as capturing the 1999/2000 El-Nino years. Mann-Kendall tests indicate a decline in rainfall and minimum temperature which is an indication of warming in the last 20 years. This work has important implications to water resources management and monitoring. Most importantly, changes in surface water areas will impact on the development of tourism and other related livelihoods.

THE LONG-TERM VARIABILITY ANALYSES OF FLOW AND WATER TEMPERATURE REGIME IN THE LUVUVHU RIVER CATCHMENT

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Stream flow and water temperature are perceived as master variables shaping many fundamental ecological characteristics (processes) of riverine ecosystems. With growing pressure on rivers to provide water directly for drinking, growing food and supporting industries, the alteration of these two master variables is probably the biggest threat to the integrity of rivers and aquatic ecosystems. Assessments of these assemblage responses to flow and temperature variation in the Luvuvhu River catchment will provide an insight into trajectories of ecosystem change in this strategic water resource. This aimed at setting acceptable thresholds (maxima and minimum) for water temperature and flow in the Luvuvhu River catchment, and identify indicator taxa that can be used to monitor these changes. Hydrological and thermal metrics for the Luvuvhu catchment will be derived using the Range of Variability Approach (RVA) and Indicator of Thermal Alteration (ITA) methods respectively. The role of flow, temperature, land use, channel condition, habitat integrity and channel morphology on macroinvertebrate assemblage will be analyzed using multivariate approaches and structural equation modelling.
Freshwater systems are a valuable resource under increasing threat due to pollution. In South Africa, river ecosystem management has shifted from the improvement of water quality to that of the creation of ecological reserves, ecological health and the improvement of biological integrity. This shift has allowed for the increased use of bio-indicators to determine ecosystem health. Macro-invertebrates, riparian vegetation and fish have been used in the suite of bio-monitoring mechanisms. However, there is an increasing need to include periphyton as a tool in river ecosystem monitoring due to their absorptive nature and ability to indicate change environmental conditions.

In South Africa research suggesting algae as bio-indicators has been primarily based on the use of diatoms as a bio-monitoring tool. This study aims to determine patterns and trends in periphyton communities in the summer rainfall region of KwaZulu-Natal, South Africa. This is achieved through five sampling sites aimed at determining the relationship between changes in nutrient and flow regimes on periphyton communities.

Trends and relationships between physico-chemical and algal biomass were evident. Trends indicated the role rainfall played in increasing river depth and velocity which in turn influenced algal biomass growth and species composition and the effect that seasonality changes had on periphyton communities. Peaks in algal biomass were as a result of increases in nutrients within a particular system while decreases in algal biomass occurred due to an increase in invertebrate grazers. Sloughing events resulted due to increases in flow and velocity. General trends at all five sites showed peaks in algal biomass in early summer and a lesser algal biomass peak in early autumn. This research suggests that if better understanding of periphyton patterns and trends are established, periphyton can be used as an important bio-monitoring tool and aid in the creating and setting of ecological reserves.

Estuaries are among the most productive and dynamic ecosystems globally, and have a high ecological, economic and social value. The structure, function, processes and biodiversity of estuarine ecosystems are vulnerable to threats from local and catchment scale land use activities. In South Africa the majority of estuarine ecosystems on the KwaZulu-Natal north coast are threatened by the poor water quality, reduced flows and habitat alterations originating from land use activities as well as changes in climatic conditions. River inflow is one of the important factor controlling estuarine functioning and the mouth state. In the last decade South Africa has been experiencing extreme events of rainfall and drought. In year 2016, South Africa has been experiencing little to no rainfall and KwaZulu-Natal was one of the severely impacted regions. It can be expected that these extreme events will alter the functioning of estuarine ecosystems. The aim of the study was to evaluate variability in invertebrate communities of the uMvoti, Thukela and aMatikulu estuaries to estimate possible effects of climate change and excessive water resource use. The uMvoti Estuary and the upper Thukela were characterised by freshwater macrozoobenthos, while the lower Thukela and the Amatikulu estuaries were dominated by estuarine and/marine macrozoobenthos. Zooplankton abundance was generally higher during the low flow when compared with the high flow sampling sessions. The high diversity of macrozoobenthos and zooplankton observed in the Amatikulu suggests that the system is in a good ecological condition. Water quality states and flows were identified as important drivers that affect the community structures.
significantly. Outcomes highlight the poor ecological integrity state of the macrozoobenthos and zooplankton communities in the uMvoti and Thukela estuaries. The altered state of the environmental variables in the study were attributed to excessive use of the local water resources as well as altered flows.

Session 3C: Oceanography

**OBSERVED EDDY DISSIPATION IN THE AGULHAS CURRENT**

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Analysing eddy characteristics from a global dataset of automatically tracked eddies for the Agulhas Current in combination with surface drifters as well as geostrophic currents from satellite altimeters, it is shown that eddies from the Mozambique Channel and south of Madagascar dissipate as they approach the Agulhas Current. By tracking the offshore position of the current core and its velocity at 30ºS in relation to eddies, it is demonstrated that eddy dissipation occurs through a transfer of momentum, where anti-cyclones consistently induce positive velocity anomalies, and cyclones reduce the velocities and cause offshore meanders. Composite analyses of the anti-cyclonic (cyclonic) eddy-current interaction events demonstrate that the positive (negative) velocity anomalies propagate downstream in the Agulhas Current at 44km/day (23km/day). Many numerical models are unable to accurately represent these eddy dissipation processes, affecting our understanding of the Agulhas Current, which strongly influences our understanding of the regional climate and thus climate change.

**OCEAN DYNAMICS THAT INFLUENCE SEA TEMPERATURE STRUCTURES IN THE ALGOA AND ST FRANCIS BAY REGION**

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Bay-scale currents, thermohaline circulation, upwelling, fronts and mixing in Algoa and St Francis Bay occur over short and long time periods. They play a major role in the primary and secondary production of the region by driving nutrients to the surface or concentrating them in certain areas. These thermal and salinity gradients are driven by the wind and open ocean influences, such as the Agulhas Current, daily and seasonal variations in solar radiation, long and short period waves, air-sea fluxes and fresh water inflow from the land. Internal waves also play an important role in the marine ecosystem of the bays by uplifting nutrient, phytoplankton, copepods and larvae towards the surface at the crests of the waves. The phenomena are poorly understood in the Algoa Bay region, but now with the implementation of SAEON’s continuous monitoring platform (CMP) an opportunity has arisen to study them in detail. The project focuses on the physical ocean dynamics that drive the temporal and spatial distribution of nutrients in the bays and adjacent coastal regions, in order to gain a deeper understanding of the physical functioning of the systems and at the same time supplement the work of the biologists.

Key words: Bay-scale currents, upwelling, fronts and mixing
INVESTIGATING THE REGIME OF THE SOUTH-WEST INDIAN OCEAN CURRENTS AND THROUGH A NUMERICAL MODEL

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The South-West Indian Ocean (SWIO) is a complex system consisting with a particular interest because it includes one of the three major source regions of the Agulhas Current, the East Madagascar Current (EMC). Variability in the EMC is known to influence the timing of ring formation at the Agulhas Retroflection, and ultimately the strength and stability of the Atlantic overturning circulation due to the leakage of water from the Indian Ocean into the Atlantic Ocean. The termination regime of the EMC, after passing the southern tip of Madagascar has not been completely resolved. Whether or not a possible non-persistent retroflection exists, it is however known that nearly symmetric dipolar vortex pairs joins the Agulhas Current from the southern tip. Its variability can also be impacted by the high eddy kinetic energy (EKE) band observed at 25°S, from Australia to Madagascar. Also occurring in this region is the shallow eastward flow known as the South Indian Ocean Countercurrent (SICC) and one of the largest dendroid phytoplankton blooms in the world, the Southeast Madagascar bloom.

This unique system, where variability of the termination regime of the EMC, associated with complex mechanisms of the SICC and mesoscale eddies, will be investigated using a high resolution regional model.

We will discuss the eddy characteristics of the mesoscale eddies in the high EKE band, with a section on its seasonality, as well as the eddy-current interaction which influence largely the variability of the EMC. In doing so, the fate of the termination regime of the EMC could be resolved. We will also analyse how eddies could influence the onset of the South-east Madagascar Phytoplankton bloom. These plankton cells, which bloom at the surface or which are upwelled from the deep chlorophyll maximum, have been shown from a cruise data to be nitrogen-fixers. This study will explore the possibility of nutrient being advected in the bloom area, and the complex mechanisms which cause the phytoplankton cells to use these nutrients, hence triggering the bloom at various spots simultaneously.

GLOBAL SEA-LEVEL CHANGE AND UPLIFT OF SOUTHERN AFRICA FROM DATING ELEVATED MARINE TERRACES

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Global sea level is known to have fluctuated by several hundreds of meters over the past 100 Ma. However, the exact amplitude of these sea-level changes is uncertain and in reality a discrepancy of about 200 m exists between different models. Here, we use strontium (Sr) isotope stratigraphy to date marine fossils from elevated marine terraces preserved along the southeast coast of southern Africa, a subcontinent that has remained relatively stable since the mid-Cretaceous epeirogeny (120-80 Ma). Oysters, shark teeth, sea urchins and corals were collected from local outcrops of Cenozoic limestones of the Algoa Group (the Bathurst and Alexandria Formations) at four localities, between Port Elizabeth and East London in the Eastern Cape. The deposits occur at relatively high elevation, between 140 and 330 m above present day sea level, overlying Cretaceous red bed sediments and deeply weathered Cape quartzites and Karoo dolerites. Pristine domains of the fossils were subsampled, cleaned, leached and subject to Sr separation chemistry. Mass spectrometry was performed at the MIT Radiogenic Isotope Laboratory. 87Sr/86Sr results range between 0.7079 and 0.7084, and between 0.7090 and 0.7142, which correspond to 33-20 Ma and 4-1 Ma, respectively, calibrated using the global marine 87Sr/86Sr curve. These new dates demonstrate at least two episodes of marine transgression, repeatedly at 330 m elevation, during the Oligo-Miocene, and again during the Plio-Pleistocene. Assuming no significant vertical movements of the subcontinent, as supported by cosmogenic studies that indicate <4 m of uplift
over the last 4 Ma, these sea-level high stands suggest a maximum amplitude of sea-level changes of up to 450 m between the Oligocene (33 Ma) and the -120 m low stands of the Middle Pleistocene, a period when people first colonized the emerged southern Cape continental shelf during glaciation, between 20,000 and 140,000 years ago.

MODELLING INTERANNUAL WIND VARIABILITY AS A DRIVER OF THE COASTAL OCEAN INSHORE OF THE AGULHAS CURRENT

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The coastal and shelf waters inshore of the Agulhas current, on South Africa’s southeast coast, are an important spawning and nursery area for several commercially important fish and invertebrate species. Dynamically the region is complex with ocean currents and temperatures dominated by the influence of the Agulhas Current, as well as coastal and wind-driven upwelling cells. Here we compare wind variability from two reanalysis datasets as well as observations over the eastern Agulhas Bank. The inter-annual variability in wind is then compared with Agulhas Current variability in two ocean models to assess the relative impact of both local winds and the Agulhas on changes in the distribution of upwelling and ocean structures on the eastern Agulhas Bank occurring over the last 50 years.

VALIDATION OF HOURLY SST AND CHLOROPHYLL-A USING MULTI TEMPORAL REMOTE SENSING SATELLITE IMAGERY

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Sea surface temperature and chlorophyll-a are crucial climatic parameters in the study and understanding of the dynamics in the oceans. These parameters together with such other variables as wind speed and direction have been used by various personnel in oceans to better understand the environment they are working in. at the same time oceans have been places were territorial wars have been fought due to the valuable species they have that are needed in different areas. The techniques that have been used in calculating both sea surface temperature and chlorophyll concentrations have been found to be cumbersome and thus new ideas will be needed to expeditiously bring the desired maps on time to save lives and sailors in the oceans. Multi temporal remote sensing techniques are suggested as the best techniques as compared to the old system of measuring sea surface temperature. Such imagery from Advanced Very High Resolution Radiometer (AVHRR) instrument aboard National Oceanic and Administration (NOAA) satellite from National Aeronautic Space Agency (NASA), MERIS from Europe Space Agency (ESA) have been used before in monitoring oceanic conditions. However, due to their high temporal resolution the multi temporal instruments are being substituted by instruments with lower temporal resolution and a good spatial coverage. This paper looks at these techniques and offers the best comparison between the old methods and satellite remote sensing methods of SST and chlorophyll measurement with more emphasis on multi temporal satellite remote sensing.
WINE MARKETING STRATEGIES IN RESPONSE TO CLIMATE CHANGE

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The global wine industry is worth billions of rands, however the climate change could have a critical impact. The aim of the study is to explore the global changes in suitability for wine production caused by climate change which may result in substantial economic and conservation consequences. Redistribution in wine production may occur within continents, moving from declining traditional wine-growing regions to areas of novel suitability, as well as from the Southern Hemisphere to large newly suitable areas in the Northern Hemisphere. The actual extent of these redistributions will depend on market forces, available adaptation options for vineyards, and continued popularity of wine with consumers. Even modest realization of the potential change could result in habitat loss to viticulture over large areas. More important to add value, this study provide the possible strategies which are more practical to wine professionals that may adapt and mitigate in both vine, wine production and wine market. The effective adaptation and mitigation of this possible strategies in response to climate change may be the future of the wine industry

Key words: Global wine industry, climate change, wine quality, market strategies.

EFFECT OF THE COMBINATION OF BACILLUS MEGATERIUM, MICRO-DOSING OF FERTILIZATION & LIMING ON MAIZE YIELD TO MITIGATE SOME EFFECTS OF GLOBAL CHANGE ON FERTILIZATION COSTS FOR SMALL SCALE FARMERS

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Global change in fertilizer costs has negative effect to farmers. Small scale farmers do not afford to buy the recommended quantities of fertilizers recommended for their crops. They routinely disregard the recommendations from soil analyses. Some of their soils require huge amounts of lime such as 6 t.ha-1 of lime. The first problem with the farmers is in the logistics of bringing 6 t ha-1 of lime to the field and its application. The aim of the study was to mitigate some effects of global change on fertilization costs to small scale farmers. The field study on maize was conducted in the Eastern Cape farm with soils that had acid saturation of 54% requiring 4.5t.ha-1 of lime and 0.47t.ha-1 of 3:2:3 (34) Fertilizer. The treatments employed were micro-dosing of 2:3:2 (34) fertilizer (5g) per planting hole, micro-dosing of lime (5g) per planting whole, and Bacillus megaterium inoculation. The treatments were tested individually and in combinations. The results showed that the combination of B. megaterium and 2:3:2 (34) fertilizer increased the maize yield significantly in Season 1 and Season 2 by 54.7% and 48.1%, respectively. When this combination was compared to the treatment with 2:3:2 (34) fertilizer alone, it still produced a maize yield increase of 34.51% in Season 2. The combination of B. megaterium and the micro-dosing of 2:3:2 (34) fertilizer and lime was the most effective treatment to increase maize yield by 59% and 55% in season 1 and 2, respectively. The study concluded that a return on investment for small scale farmers is possible since only 54.7% of the recommended fertilizer and only 5.7% of the recommended lime were used together with B. megaterium resulting in an average of 57% maize yield increase.
THE ROLE OF SMALLHOLDER FARMERS’ PERCEPTION ON CLIMATE CHANGE EFFECTS AND VARIABILITY ON CROP PRODUCTION: THE CASE OF FARMERS IN GQUMASHE VILLAGE, IN THE EASTERN CAPE OF SOUTH AFRICA

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Climate is one of the most important factors associated with agricultural productivity and climate change affects agriculture in numerous ways. The aim of this study was to examine farmer’s perceptions on the effects of climate change and variability on crop production using the case of farmers in Gqumashe village, Eastern Cape, South Africa. The survey research design method was adopted for the study, and information collected from 50 respondents form the basis of discussion. According to findings, farmers in the study area claimed awareness (90%) of changes and variability associated with climate in their area, suggesting the ever increasing rate of the problem nowadays, and they perceive it as detrimental to agricultural production in their area. In line with literature view on causes of climate change, 54% population of farmers perceive that natural causes are responsible for climate change and variability, while 44% say human activities are the causes. Amongst all coping strategies with climate change problems, 60% population of farmers suggested that the use of indigenous knowledge is a more pragmatic way of coping with such changes in climate. Examples of coping strategies, as suggested by farmers are: crop rotation; change in time of farm operation; increase of irrigation; promoting climate change awareness and education; working together with other farmers; introducing new crop cultivars; use of different planting dates; as well as the promotion of crop diversification. The suggestion therefore is that, farmers’ education in the study area needs improvement. Also, extension services to farmers need to improve, as 68% farmers claimed no assistance from extension, and 84% rated services from extension as poor. More so, farmers need more education on improved agricultural techniques and technologies that mitigate change and variability, as insufficient knowledge on new technologies is the basic reason why most farmers still prefer their local methods despite availability of more improved techniques for agricultural production.

Key words: Smallholder farmers’ perception; climate change and variability; crop production; Gqumashe village; and Eastern Cape.

EFFECTS OF SCALE AND DIVERSITY OF FARMING ENTERPRISES ON FOOD SECURITY UNDER CLIMATE CHANGE AND CLIMATE VARIABILITY IN SOUTHERN AFRICA

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In sub-Saharan Africa, roughly two-thirds of the population live in rural areas and are dependent on agriculture for their livelihoods; nearly half live in extreme poverty and are undernourished. It is estimated that by 2020 the population of sub-Saharan Africa will grow to nearly 1 billion. Due to Africa’s population rates increasing at a greater rate, productive capacity of the continent’s current food production systems has exceeded. Although agriculture contributes 30% - 50% of the national incomes in sub-Saharan Africa and can continue to generate greater income and stimulate economic growth, population increase will result in agricultural yields to decrease by 7-27% (FAO, 2012, Benton and Doughill 2011). Furthermore, this increase in population will cause a greater demand for food production and pose a major threat to achieving Sustainable Development Goals (SDG), which are aimed among other things at ending hunger, improving nutrition and achieving increased food production. Therefore, there is a need to identify the appropriate scale for intervention and to ensure improved food production within the agricultural landscape (Scherr and McNeely 2008). This study aims to evaluate whether scale and diversity of individual farming systems within a landscape can affect the vulnerability of food production system and the vulnerability to climate change, with increased
variability in climate. There are two objectives to this research, firstly, to investigate the resilience of small-scale and large-scale farming systems to increasing temperature and more variable rainfall. Secondly, to compare the resilience of farming landscapes consisting of diverse farming systems with landscapes dominated by a single farming system, to increasing temperatures and more variable rainfall. There are three possible approaches: firstly, through observation and remote sensing; secondly, multivariate analysis of historical production data, through using the Ricardian Model; and lastly, through developing a farm system economic model.

CLASSIFICATION OF SMALLHOLDER FARMERS FOR EFFECTIVE RAINFALL VARIABILITY MANAGEMENT IN SOUTH AFRICA

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Increased rainfall variability is one of the major challenges facing smallholder farmers in South Africa. The limited adoption of research recommended rainfall variability management research outputs and increased farmer diversity warrants use of the farm typology approach. A household survey was undertaken in Alice and Lambani, Eastern Cape and Limpopo provinces of South Africa respectively. A two-step cluster analysis was conducted using SPSS classifying farmers based on the predominant socio-economic and farming system characteristics. Literature review was conducted to document research recommended rainfall variability management strategies within southern Africa. Strategies were then linked to corresponding farmer typologies based on potential compatibility hinged on resource endowment, labor and literacy. The most dominant farmer types were: (1) Old and resource constrained farmers with less household labour and livestock. They are compatible with labour and cost saving strategies like conservation agriculture (mulching, basins, potholing, rotations etc.) and use of indigenous crop seeds. Intercropping maximises productivity and reduces risk in small landholdings. (2) Young, labour endowed and food insecure farmers with small farm sizes. They can practice inter- and multiple cropping. Organic farming i.e. manure use, altering plant density and cropping dates is compatible with their semi-literacy levels. (3) Formally employed, literate and resource endowed farmers are able to purchase different cultivars, irrigation and chemicals to reduce transpiration. They can access seasonal forecast information through the internet, television and other organisations. Improved literacy enables them to successfully undertake integrated pest and nutrient management. Different farmer typologies exist within South Africa and are differentiated by resource endowment, literacy and labour. Resource endowed farmers potentially utilise strategies that need financial resources e.g. improved seed and irrigation. Labour deficient farmers need labour saving strategies like conservation agriculture. Households with reduced literacy utilise less complex strategies. Use simulation modelling ascertains the impacts of the potential intervention of scenarios.

A REVIEW OF THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY IN ZIMBABWE

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Agriculture plays a critical role in the Zimbabwean national economy as well as rural livelihoods. Like most African countries, Zimbabwean agriculture is climate dependent since most of the crops are grown under rain-fed conditions. Of late, Zimbabwe has witnessed a marked increase in climate variability that is characterised by successive droughts affecting mostly the drier agro-ecological zones. Utilising secondary sources of data from sources such as the World Bank and primary data obtained from 40 households through IDI’s, this paper examines the impacts of climate change on agricultural performance and related implications for the well-being of small-scale producers. The ability to produce
food and earn incomes for their families is being compromised by erratic rainfalls which have been received over the past few years resulting in a shift towards the production of short maize season varieties, small grains and sweet potatoes which require less rainfall. Other strategies widely employed by small producers to mitigate themselves against climate variability include the sowing of seeds at two different intervals as well as the adoption of conservation agriculture. The paper also highlights other climate adaptation strategies employed by agricultural producers and concludes by recommending support for irrigation equipment to farmers and the production of small grains and short-season maize varieties to offset climate variability risks.

Keywords: Climate change, small producers, agricultural production, climate variability, yield potential.
and 6°C/min HR. The molecular components of each of the bio-oil samples indicated the predominant presence of alkanes, alkenes, carboxylic acids and alkyl esters in the bio-oils produced without a catalyst.

The pyrolysis experiments were conducted again at 530°C FT and 6°C/min HR and using 1 wt% and 2 wt% zeolite nano-catalysts. The bio-oil yielded more of cyclo-alkanes and aromatics. A maximum yield of 58% was recorded with 1% zeolite but with lots of coking and gas formation. The viscosities of the bio-oils reduced by 35% and 34% for the 1% and 2% zeolite samples, respectively. The bio-oils with 1% and 2% zeolite resulted in a 32% and 30% reduction in acid value, respectively.

**DARK FERMENTATIVE BIOHYDROGEN PRODUCTION USING SOUTH AFRICAN BIOWASTE EFFLUENTS**

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The dwindling fossil fuels coupled with environmental pollution necessitate the search for alternative energy resources. Hydrogen production is envisioned to play a pivotal role towards the implementation of clean and sustainable energy production, particularly when it is produced from inexpensive processes. In recent years, South Africa has been experiencing a sporadic increase in its biowaste effluents due to the high level of urbanization and industrialization that is occurring in most cities across the country. An estimated 22.9 and 26.2 million tons of biowaste effluents were produced in 2012 and 2014 respectively. These effluents are considered an ideal substrate for dark fermentation because they are abundant and rich in nutritional content. In this study, the feasibility of dark fermentative biohydrogen production from the South African biowaste effluents was investigated. Ten different waste materials consisting of bread, sugarcane, peach, mango, potato, cabbage, apple, kitchen, brewery, and corn-cob were each assessed on biohydrogen production potential using mixed anaerobic sludge. Experimental results showed that effluents rich in carbohydrates are ideal carbon source for biohydrogen-producing spore-forming microorganisms. A maximum biohydrogen yield of 78.36, 68.32, and 55.69 ml H2/g TVS was obtained from cabbage, apple, and sweet potato respectively. The fraction of biohydrogen from the total gas produced was 50.45, 49.86, and 45.69% for cabbage, apple, and sweet potato, respectively. Hence, these results illustrate the potential of biowaste materials for biohydrogen process development and could pave a way for development of a dark fermentation process for the utilization of these wastes for biohydrogen production.

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**Session 4C: Oceanography**

**THE SEASONAL CYCLE OF CO2 IN THE SOUTHERN OCEAN: DIAGNOSING BIASES IN CMIP5 EARTH SYSTEMS MODELS**

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The Southern Ocean forms a key component of the global carbon budget: taking up about 50% (1.0±0.05 PgC yr -1) of the total global oceanic annual uptake of anthropogenic CO2. Despite its importance, it still remains under-sampled with respect to surface CO2 and thus atmospheric inversion and coupled ocean biogeochemical models play a key role in constraining sea-air CO2 fluxes (FCO2) in the Southern Ocean. Recent studies have however, (e.g. Anav et al., 2013), shown that although Ocean Biogeochemical Models (OBGMs) agree in respect of the mean CO2 annual fluxes in the Southern Ocean, they disagree on the amplitude and phasing of the seasonal cycle and compare poorly.
with observations. The seasonal cycle is the dominant mode of variability of ocean biogeochemistry including CO2 in the Southern Ocean (Lenton et al., 2013). In this study, we examine 7 earth systems models from the Coupled Model Intercomparison Project Phase 5 (CMIP5) to explore climate model biases in the Southern Ocean. Here we find that 4 of 7 (ISPL-CM5A-MR, CMCC-CESM, GFDL-ESM2M and CNRM-CERFACS) CMIP5 earth system models show a bias in the influence of temperature-driven pCO2 variability in summer (Dec-Jan) relative to observations. While two of the seven (MPI-ESM-MR and NorESM2) shows a general overestimation of biological driven CO2 uptake (primary production) and thus FCO2 is mostly regulated by biological processes. We find that of the 7 the NCAR-CESM shows a FCO2 seasonal cycle that is relatively comparable to observations across all three basins of the Southern Ocean. We find that this is due to consistency with observations in the seasonal modulation of the drivers of pCO2 i.e. biogeochemical-physical processes and temperature.

SEA LEVEL RISE AND VARIABILITY ALONG THE EAST AND SOUTH COAST OF SOUTHERN AFRICA BASED ON MONTHLY TIDE GAUGE RECORDS

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Sea level rise and variability is of great concern in the coastal areas, where significant part of the population is settled in many countries around the world. Therefore, understanding regional and local long-term sea level variability as well as its trend is critical. How the sea level has varied on different timescales and why, are the key questions for understanding sea level change, and hence crucial for improving future global, region and local projections. The Empirical Mode Decomposition/Hilbert - Huang Transformation (EMD/HHT) method was applied to determine the range of time scales of sea level variability and so identify corresponding drivers. The data consisted of all available tide gauge monthly mean records until December 2015, from seven sites along the east and south coast of southern Africa. The data was obtained from the Permanent Service for Mean Sea Level (PSMSL, http://www.psmsl.org/). Due to our limited knowledge of how sea level is linked to the drivers, it is still challenging interpreting a single oscillatory mode. Therefore, the timescales revealed were grouped as sub-annual, interannual and long-term low-frequency components of sea level variability. The sub-annual component indicates how sea level responds to the weather disturbances in the annual cycle, including seasonal and annual large-scale wind and atmospheric pressure pattern changes. The interannual component indicates an association with El Niño-Southern Oscillation (ENSO) through large-scale sea surface temperature patterns and large-scale wind patterns. Lastly, the low-frequency component may be associated to bi-decadal ocean dynamics or climate variability drivers, such as the 18.6 year lunar nodal cycle. The remaining mode, which is considered as the increasing trend, showed that along the study region sea level is rising at all sites mainly from the 1990s onwards, at a pattern similar to the global mean increase.

CLIMATE CHANGE IN COASTAL WATERS: TIME SERIES PROPERTIES AFFECTING TREND ESTIMATION

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In South Africa 129 in situ temperature time series of up to 43 years are used for investigations of the thermal characteristics of coastal seawater. They are collected with handheld thermometers or underwater temperature recorders (UTRs) and are recorded at precisions from 0.5°C to 0.001°C. Using the natural range of seasonal signals and variability for 84 of these time series, their length, decadal trend and data precision were systematically varied before fitting generalized least squares (GLS) models to study the effect these variables have on trend detection. The variables that contributed most to accurate trend detection in decreasing order were: time series length, decadal trend, variance,
percentage of missing data (%NA) and measurement precision. Time series > 30 years in length are preferred, and though larger decadal trends are modeled more accurately, modeled significance (p-value) is largely affected by the variance present. The risk of committing both type 1 and 2 errors increases when ≥ 5%NA is present. There is no appreciable effect on model accuracy between measurement precision of 0.1°C to 0.001°C. Measurement precisions of 0.5°C require longer time series to give equally accurate model results. The implication is that the thermometer time series in this dataset, and others around the world, must be at least two years longer than their UTR counterparts to be useful for decadal scale climate change studies. Furthermore, adding older lower precision UTR data to newer higher precision UTR data within the same time series will increase their usefulness for this purpose.

COASTAL AND OFFSHORE CO-OCCURRENCES OF MARINE HEATWAVES AND COLD-SPLELS AROUND SOUTH AFRICA

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The shallow water ecosystems found along the coastlines of the world are particularly at risk from changing climates as their temperatures may change more rapidly and dramatically than waters in the open ocean. To this end it is necessary to identify the occurrence of extreme ocean temperature events, referred to here as Marine Heatwaves (MHWs) and Marine Cold-Spells (MCSs), in the nearshore environment. We have taken a recently developed algorithm that defines these extreme events in a novel way and applied it to the in situ time series available for the coast of South Africa. We found that MHWs and MCSs occur along the entirety of the coast of South Africa and with some temporal and spatial agreement between the largest events detected. MHWs occur more often and last longer than MCSs, which have greater mean intensities. The cumulative intensity (°C·days) for most MHWs and MCSs were comparable however, several were much larger and specific areas displayed more extreme events than the coastal average. The largest three MHWs in each of the time series along the coast of South Africa have generally occurred in the second half of the time series whereas the largest three MCSs have generally occurred in the first half. Thus implying that the occurrence of MHWs is on the rise while for MCSs it is declining. These same calculations were conducted for offshore temperatures from 1/4 ° NOAA Optimally Interpolated sea surface temperature (OISST) data at the nearest locations to the in situ stations and it was found that a similar pattern of increasing MHWs and decreasing MCSs existed. The proportion of co-occurrence between in situ and OISST data for each time series ranged from 0.20–0.50 with co-occurrence rates generally higher for MHWs than MCSs.

CYCLIC OR EPISODIC CHANGES TO THE NORTHERN SHORE OF THE THUKELA WAVE-DOMINATED DELTA

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The Thukela River is dominated by a southerly-southeasterly swell which drives a south-north longshore drift, consequently the Thukela Delta is highly asymmetric towards the north. Evidence within the literature indicates that this coast is the only prograding coastline in KwaZulu-Natal [1]. In contrast, at the present time, this coast is in a strongly transgressive phase which has been in place since at least 1997. During this time the high water line has retreated more than 100 m. During this process a linear clastic shoreline (1997) has evolved into a bedrock-controlled, headland bound embayment (2016). Is this a product of Climate Change, or the consequence of dynamic long-term geomorphology?
Extensive field work, electronic and literature research shows that this geomorphological change is not temporally unique and thus cannot be simply assigned to Climate Change. This large-scale coastal morphological change is clearly on a decadal scale and linked to the Thukela River flow regime. The Thukela River discharge is integral with the climate, which itself is linked to global events such as ENSO. Further, South Africa’s rainfall shows a ~18-year wet-dry cyclicity, which may correlate with the 18-year Lunar Nodal Cycle. More recent research suggests that the KwaZulu-Natal river flood flow regime correlates with the Pacific Decadal Oscillation [2]. At present we are trying to uncover these coastal dynamics drivers. However, this geomorphological process clearly masks any aspect of sea-level rise, at this location, and proves that other aspects of coastal change can dominate the coast and that these processes need to be clearly documented and understood.


THE IMPORTANCE OF OCEAN ACIDIFICATION RESEARCH IN SOUTH AFRICA: A CASE STUDY OF EARLY STAGE ARGYROSOMUS JAPONICUS

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Ocean acidification (OA), a product of increasing atmospheric CO2, is gaining research interest on a global scale and numerous studies have documented the negative effects it may have on marine organisms in the future. However, there is currently a large gap in the global understanding of OA in the southern Indian Ocean and Africa and in the interest of achieving a comprehensive understanding of the effects of OA on marine ecosystems there is a need to conduct extensive research in these areas that are data deficient. In order to achieve this, there is a need to develop a comprehensive and coordinated research effort in the diverse coastline of South Africa which addresses the effects of OA on multiple organisms across a range of species, populations and ecosystems.

Current global research in OA has mainly focused on addressing the impacts of OA on calcifying organisms and fewer studies have addressed the effects it has on fishes. Research that has addressed fishes has had a tropical focus and even fewer studies have included temperate species in their appraisals. Fishes, as in many other organisms, are likely to be most vulnerable to changes in seawater chemistry as a result of OA during their early developmental stages due to poorly developed internal pH regulatory systems.

An iconic South African species, Argyrosomus japonicus, which is a popular angling species occurring in coastal and estuarine areas in South Africa was selected as an ideal study organism to begin OA research in South Africa. This temperate species is known to occur in pelagic coastal waters until reaching a size of 20 mm total length at which they recruit into estuarine areas. We examined the effect of OA conditions predicted for 2050 and 2100 on the metabolic rates of larval and early stage A. japonicus using newly designed methods of respirometry for small animals. Preliminary results suggest that there may be a negative effect of OA on metabolic structure at certain life stages creating an ontogenetic bottleneck for optimal development and recruitment at later developmental stages.
CAN THE ENVIRONMENTAL IMPACT OF BEEF PRODUCTION BE REDUCED?

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One of the responsibilities of the livestock industries is to limit the release of greenhouse gases (GHG) and water use, in order to ensure future sustainability. This can be done through improved production efficiency. Improved cow productivity will have a mitigating effect on the production of GHG, as higher productivity will probably lead to higher gross efficiency. The environmental impact of changes in cow productivity is presented. Cow productivity was measured in kilogram calf weaned per Large Stock Unit (LSU) calved. The three component traits that influence productivity are (1) weaning weight of the calf, (2) feed requirements of the cow to raise the calf (the cow LSU was used since it is linked to daily feed intake); and (3) the frequency at which a calf is produced, using inter-calving period (ICP). The definition of the LSU used in this study is the equivalent of a 450 kg ox gaining 0.5 kg/day on pastures with a mean digestible energy of 55% (75MJ metabolizable energy/day). In South Africa the enteric methane emissions factor (MEFenteric) of a LSU is approximately 94 kg methane/year for beef cattle. The changes in the Afrikaner cattle breed over 33 years indicated that weaning weight increased by +20.4 kg, cow weight decreased by 8.3 kg and ICP decreased by 19.7 days, resulting in an increase of 18.3% in cow productivity. The MEFenteric was 1 kg methane/kilogram calf weaned/LSU mated in 1980 and it decreased to 0.88 kg MEFenteric in 2013, a reduction of 12%. This demonstrates that the improvement in cow productivity can reduce the carbon footprint, and thus the environmental impact of beef production. This information can be used by the Department of Environmental Affairs in their effort to develop an emissions baseline for the Agriculture, Forestry and Other Land Use (AFOLU) sectors.

NITROGEN FERTILIZER AND BIOCHAR APPLICATION RATE EFFECT ON SOIL PHYSICOCHEMICAL PROPERTIES AND GRAIN YIELD OF MAIZE

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Biochar (BC) is a carbon-rich material that can improve crop growth, yield and soil physicochemical properties but this improvement has varied over a wide range of soils, crop and BC feedstock used. In addition, the effect of BC properties on crop growth and yield is little understood. The effect of Nitrogen (N) and BC application rates on maize productivity and soil physicochemical properties was evaluated on a sandy soil under dryland and irrigated conditions. Four rates of N (0, 50, 100 and 150 kgN/ha) in a main plot were combined with four levels of BC (0, 5, 10 and 15 t/ha) in a subplot in a split-plot arrangement with four replications. The results showed that N fertilization had no effect on pH, bulk density (Bd) and water holding capacity (WHC) while BC had a significant effect under both conditions. Maize grain yield responded to N fertilizer only under irrigated condition and it increased quadratically with increasing N fertilizer application rates whereas it was completely non-responsive to BC application under both conditions. Furthermore, there was no significant interaction effect of N fertilizer and BC on grain yield of maize. Overall, the improvement of soil physicochemical properties and maize grain yield with N and BC application was more pronounced under irrigated condition when compared to dryland condition. This may suggest that N and BC application on sandy soils has the potential to improve maize productivity under well-watered conditions. This may also serve as a viable strategy for improving soil physicochemical properties while simultaneously improving maize productivity. However, further research is still needed to determine optimum application rates of BC either as a sole organic amendment or in conjunction with fertilizers for field grown maize.

Key words: Nitrogen fertilizer, Biochar amendment, soil physicochemical properties and maize grain yield
STOMATAL BEHAVIOUR OF COWPEA GENOTYPES GROWN UNDER DROUGHT CONDITIONS

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Low water availability is one of the major limitations to growth and productivity of crops world-wide. Plants lose most of their water through the stomata thus, the stomata play an important role in controlling transpiration and photosynthesis. The objective of the study was therefore to assess the behaviour of stomata of cowpea grown under water stress. Four cowpea genotypes were grown under four different moisture levels under hot semi-arid conditions. Stomatal conductance was then measured at 47, 54, 70 and 77 days after planting (DAP). The results showed that stomatal conductance was significantly influenced by genotypes and moisture levels. Genotypes varied in stomatal conductance early in the growth stages, that is at 47 and 54 DAP but no significant differences were observed at 70 and 77 DAP. Genotype TVu4607 had significantly higher stomatal conductance under severe stress conditions at both 47 and 54 DAP. Moisture level on the other hand, did not influence stomatal conductance at 47 and 77 DAP but strongly influenced the stomatal conductance at 54 and 70 DAP. Higher stomatal conductance was observed under well water-watered conditions and significantly decreased with decreasing moisture level. The correlation between biomass at flowering and stomatal conductance at 47DAP was only positive and significant under severe stress and not under well-watered conditions. In conclusion, the results showed that cowpea genotypes respond differently to water stress and that they differ more at the early growth stages. In addition, the study suggests that cowpea genotypes that show higher stomatal conductance early in their growth stage yield more biomass. These findings could be useful in adapting cowpea to drought conditions.

THE POTENTIAL OF LOCALLY PRODUCED BIOCHAR AS AN ALTERNATIVE REMEDY FOR THE IMPROVEMENT OF NUTRIENT DEPLETED SOILS IN THE EASTERN CAPE

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Biochar, is a carbon-rich product and a soil amendment produced by heating biomass such as waste (green, wood and papermill), seaweed, rice and animal manure feedstock, under limited supply of oxygen and low temperatures. Recently, there has been much interest shown in the use of biochar as a soil amendment, and in certain regions of the world. However, biochar technology is not well known in South Africa. Biochar is documented for its significant contribution in the improvement of soil physico-chemical properties, thereby increasing crop yields. The renewed interest is based on the fact that biochar has been demonstrated to be the most stable soil amendment for resource poor farmers. It provides an economical way to sequester carbon and increases nutrient availability beyond fertiliser effect and helps increase agricultural productivity in degraded and low fertility soils. In the Eastern Cape, nutrients from exposed manures in open kraals are lost through volatilization, leaching and run off. These large amounts of manures that are packed inside or outside kraals can be used in biochar production. In addition, this review work is aimed sensitising the farming community that biochar technology can be used locally to improve crop yields grown on local nutrient depleted soils and as means to mitigate global climate change. There is a gap in research when it comes to producing biochar with specific nutrient composition, and in verifying the exact conditions of pyrolysis which affect nutrient properties. Further research is needed to bridge this gap to enhance the potential of biochar in agricultural production, under resource-poor farmer’s conditions.

Key words: Biochar, manure, soil fertility
ADAPTATION TO THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURE IN ETHEKWINI: A LITERATURE REVIEW

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The eThekwini Municipality has shown strong innovative strategies and activities on climate change adaptation. Putting the improvement of the quality of life of its urban poor remains the main goal in the official planning systems of the municipality and its counterparts. In this era of the changing climate affecting agricultural activities across the world, both small-scale and commercial farmers are adjusting their practices.Commercially, farming has had to adapt to diversified land use plans as well make choices of inputs which would be resilient and work within forecasted conditions. There is also evidence of shifting public policy to adapt to forthcoming changes. The Municipality has designed a food security strategic plan that intends to complement its climate change policy documents. Certainly, the Municipality’s food security vision declaration aims to guarantee that eThekwini population has a strong and resilient food security status. Urban agriculture is one of eThekwini’s policies supporting urban agricultural programmes and activities, although this policy is complemented with the rural agricultural policy (under the rural area-based management). These include the organic and sustainable agricultural initiatives, essential food sovereignty, food security, economic empowerment and environmental sustainability for eThekwini residents and the Municipality’s green leadership, which is mainly responsible for implementing approaches to aid poor citizens to adapt to climate change.

The agro-ecology programme is another important initiative that aims to promote appropriate and sustainable approaches to agricultural planning and implementation. Six innovative agricultural hubs have been developed in the following areas: Northdene Agroecology Research and Development Centre, Newlands-Mashu Permaculture Centre, Inchanga, Scorpio Place in Mariannridge, Mariannhill Monastery and Umbumbulu. Durban’s Botanic Gardens comprises educational and interactive exhibitions that address challenges associated with climate change, embracing the value of biodiversity, water conservation, food security, and renewable energy.

The extent and magnitude of climate change shows that it is a multi-governance issue. Thus eThekwini Municipality adaptation strategies are linked with the national, provincial and local structure.

AN EXAMINATION OF SMALL-SCALE FARMERS' RESPONSE TO GOVERNMENT’S AGRICULTURAL POLICIES AFFECTING AGRICULTURE AND DEVELOPMENT IN ETHEKWINI MUNICIPALITY

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In 2000, eThekwini Municipality was demarcated with 67% of the spatial footprint falling in ‘rural’ zones that include the peri-urban areas. These areas are characterised by low service and fragmented service delivery by different spheres of government, high levels of poverty and diseases, low levels of sustainable income and low economic opportunities. Acknowledging these problems in the municipality, eThekwini saw it fit to respond through policies and strategies including the use of agriculture as a means of alleviating poverty, promoting food security and integrated rural development. One of the implementations was the development of Rural Agricultural Services and Marketing Hubs in eThekwini. This study examines how small-scale farmers within eThekwini Municipality are responding to government agricultural plans (National, provincial and local government) that affects agriculture and development in ways that co-operatives resists and subvert original intentions and indigenous knowledge. Data was collected through the use of qualitative methods by conducting interviews with 5 co-operative gardens and from 4 Hub Managers.
In South Africa, both commercial and small-scale farmers have been affected by a change in climatic conditions. In response to a changing climate, some farmers (particularly small-scale farmers) have altered their cultivation methods by shifting away from using chemicals and fertilisers to employing organic ways to preserve the quality of the food at affordable prices. Contradictory governmental policies are observable from the Department of Agriculture and the Municipality, where municipal extension officers advocate for organic cultivation and The Department of Agriculture promotes the use of fertilisers. The study found that different production methods advocated by the two government spheres (Provincial and Local Municipality) has created perplexity among the farmers growing small-scale which has led some gardens engaging in organic farming because of the quality and flavorsome of their produce and others pretending to adopting ways promoted by the provincial department in order to receive benefits and resources such as tools.

Keywords: agriculture, small-scale farmers, extension services, government policies

Session 5A: Food Production

THE INTERACTION BETWEEN DEVELOPING LIVESTOCK PRODUCTION SYSTEMS, INCREASED PRODUCT DEMAND AND POTENTIAL CLIMATE CHANGE IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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Livestock production systems in developing countries are changing rapidly in response to a number of drivers. The human population is expected to increase from 7.4 billion currently to 9.2 billion in 2050. The African component of this increase is estimated to be in the region of 1 billion. Rapid urbanization is expected to continue in developing countries, resulting in an increased demand for livestock products. The demand increase is driven by urbanization, population growth and increased incomes. The demand for meat alone is expected to double from the 1999 level of 229 million tonnes to 465 million tonnes in 2050. This increase in demand can only be met through increased livestock numbers, more efficient production systems or a combination thereof. It will be a challenge to meet the predicted increase in demand under known and stable climatic conditions. However, the reality is that this will have to be achieved in the face to changing climatic conditions which may, in all likelihood, impact negatively on livestock production. Livestock production systems in South Africa and more so in the Eastern Cape region, is characterized by two distinctly different production sectors (commercial and developing/communal), with the commercial sector being highly productive and the developing sector being substantially less productive. Both these sectors contribute to drivers of climate change as well as being negatively affected by climate change. The inefficiencies of the developing sector will, on the one hand, aggravate drivers of climate change and on the other be exposed by the effects of climate change. In order to limit these effects, serious attention will have to be given to the development and maintenance of the natural resource, genetic merit of animals, specie selection and improvement of production output/throughput. The Eastern Cape Province, with its livestock production dynamics, and by adopting appropriate climate-responsible technologies, ought to play a significant role in meeting these demands within the South African context.
The "Limpopo Living Landscape" project is part of the German - South African initiative SPACES and is funded by the BMBF, Germany. It aims at understanding and predicting the combined effects of land use and climate change processes on vegetation, biodiversity and rural livelihoods. It identifies farm and policy level intervention strategies that support rural livelihoods and the natural resource base on which people depend. Methodology includes socio-economic assessment of the current and future livelihood options for rural communities. In parallel, on-farm experimentation aims at understanding crop and rangeland productivity under highly variable climates. The project makes also use of remote sensing technology and predictive models.

Strong collaboration between German and South African Universities as well as knowledge transfer to stakeholders and capacity building is achieved since the start of the project in 2013. The presentation shows examples of activities in all of the four subprojects, modelling of vegetation and rangeland dynamics, functional biodiversity, remote sensing and livelihoods and farming systems, and demonstrates the linkages between these research activities.

Modelling activities focus on the feedback mechanisms between grazing, browsing, fire, wood extraction and savanna degradation in the Limpopo Province using a Digital Global Vegetation Model. The objective is to define "optimal" livestock, fire management and fuel wood extraction strategies for the rangeland in Limpopo that will contribute to define sustainable rangeland management practices at regional level for current and future conditions. Numerous activities focus on the role of fauna in pollination and pest control including, among others, beetles, birds, ants in small holder farms and in plantations. From the so-called "Drought Act Experiment", management decisions are derived for farmers about how to lower the drought impact on vegetations. In parallel, remote sensing information is coupled with ground truth data on land-use and its spatial and temporal variability, including responses to extreme climate. Remote sensing based estimates are also used to determine functional habitat structure and from that to derive spatial distribution of avifauna. For arable crops, data from field experiments in Limpopo are used to calibrate dynamic growth models and to predict the impact of climate change on the availability of food and feed under future climate.

The presentation concludes on the interlinked effects and responses on human activities and climate. It finally defines options for ongoing and future research opportunities in collaboration with South African partners.

RESEARCH AND DEVELOPMENT TO SUPPORT CLIMATE SMART LIVESTOCK PRODUCTION IN THE ERA OF CLIMATE CHANGE

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Over the last 40 years food production has undergone a revolution and is now globalised in a free market economy. In spite of the large-scale, intensive and extensive, industrial systems of livestock production in the developed countries, 70% of world food is still produced by several billion commercial, small-scale, subsistence or communal farming families in Africa, Asia and Latin America. These continents will be more vulnerable to climate change, and therefore research and development to support climate smart livestock production is essential. The following aspects, that are related to livestock production and climate change are important (1) restoring the value of grasslands/rangelands, (2) pastoral risk management and decision support systems, (3) improved production efficiency (4) global warming and sustainable livestock production, (5) the disentanglement between food and nutritional needs, focusing
on nutrient rich core foods, (6) greenhouse gas emissions from livestock and carbon sequestration, and (7) water and waste management. Through research, development and management interventions, methods or innovative ways must be developed or put in place to mitigate the effects of climate change on livestock production and to reduce the greenhouse gas production from livestock. No single entity in South Africa can perform this research and implementation the outcome, on its own. The establishment of a (virtual) centre of excellence in climate smart livestock production, with the objective to conduct research, share research expertise and information and capacity building, should be a priority.

**MULTISCALE DRIVERS OF SUGARCANE EXPANSION AND IMPACTS ON WATER RESOURCES IN SOUTHERN AFRICA**

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The reality of sugarcane expansion and intensification across Southern Africa is one that requires greater scrutiny than is currently the case, particularly considering the impacts of this activity on water resources in this region. This study makes use of a frequency analysis approach to ascertain the multiscale proximate and ultimate drivers of sugarcane production as reported in a complement of 87 case studies across the uMngeni, Uhomme and Kilombero Catchments. Further, using a relationship between observed sugarcane yields and future low, medium and high production scenarios, this study develops water use estimates for rainfed and irrigated sugarcane over six production cycles, viz. 2013/14 - 2019/20. Results indicate that ultimate drivers such as foreign direct investment and increased local and international demand for sugar play the most dominant role in the expansion of sugarcane production regionally and within each catchment. Water use may be anticipated to increase in response to increased production intensity, particularly in the medium and high growth scenarios, though this may be mitigated by increased water use efficiency and the development and adoption of improved cane crop varieties. More detailed water use modelling studies are required to account for critical aspects related to crop water use such as changes to temperature, total evaporation and carbon dioxide concentration as a consequence of climate change and increased climate variability. This will provide useful policy advice for regional agricultural development initiatives.

**INTEGRATING INDIGENOUS KNOWLEDGE WITH SCIENTIFIC SEASONAL FORECASTS FOR SMALL SCALE FARMERS: A REVIEW**

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Small scale farmers are highly vulnerable to the impacts of climate change due to the increase in extreme weather event which have a devastating effect on agricultural productivity. Access and use of climate forecast information has a potential to reduce vulnerability to climate risks. Climate forecast information is useful for effective agricultural activities and food security. To enhance the use of climate forecasts by small scale farmers, a multi approach is required which includes the use of indigenous knowledge together with scientific weather forecasts. By reviewing literature on indigenous knowledge and climate change science, this article suggests for an integration of indigenous forecasts with scientific seasonal forecasts. This approach will enable local communities and small scale farmers realize adaptation strategies to a changing climate that are relevant to their localities. Having access to climate forecast information will reduce exposure of small scale farmers to climate risks.
Strengthening Science-Policy-Practice Interface in a World Characterised by Rapid Change

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The impact of climate-change disasters poses significant challenges for South Africa, especially for vulnerable rural households. In South Africa, the impact of climate change at the local level, especially in rural areas, is not well known. Rural households are generally poor and lack resources to adapt to and mitigate the impact of climate change, but the extent of their vulnerability are largely not understood. This study looked at the micro-level impact of climate change, evaluated household vulnerability and assessed alternative adaptation strategies in rural areas. The results indicate that climate change will hit crop yields hard and that households with less capital are most vulnerable. These households consist of the elderly and households headed by females. Households that receive remittances or extension services or participate in formal savings schemes in villages are less vulnerable. The results suggest that households need to move towards climate-smart agriculture, which combines adaptation, mitigation and productivity growth.

Session 5B: Climate Modelling

A Systems Approach to Understanding Complex Estuarine Functioning during Increased Climatic Variability through Ecological Network Analysis

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Extreme climatic events and climatic variability are predicted to intensify in the future. The response of estuaries to these events are a growing management issue. Estuaries are among the most productive water ecosystems, providing valuable ecosystem services with high ecological and anthropogenic importance. Estuaries are highly dynamic systems and experience regular environmental variations caused by tidal, seasonal and climatic conditions. On many occasions, human induced perturbations have exacerbated the effects of these changes and created a whole new range of environmental stresses. Estuarine organisms are exposed to highly variable environmental conditions from variable river flows during dry and wet seasons, and from tidal influence. Changes in estuarine food webs such as abundance, biomass and diversity of various groups brought on by drought and flood events can differ over spatial and temporal scales. Food webs are central to understanding many ecosystem questions such as productivity and resilience to disturbances such as drought. Ecological Network Analysis is a systems-orientated methodology to analyse within system interactions and to identify holistic properties that are otherwise not evident. The aims of this study are to develop an ecological network analysis framework to understand complex estuarine food web functioning. This tool will be applied to case studies along the KwaZulu-Natal coast. The biomasses and trophic exchanges of various biotic species and abiotic components will be estimated and used to establish ecological networks using the Linear Inverse Modelling approach. Ecological Network Analysis will be used to calculate several explanatory ecosystem indices, and direct and indirect effects. Food webs will be investigated from a hierarchical approach, understanding the network from a system level to how individual components interact. Drought and flood scenarios will then be modelled to assess changes to the estuarine food web functioning under these conditions. The model will describe the vital components e.g. species groups affecting energy transfer within the estuarine ecosystem. The modelled drought and flood scenarios will indicate how the functional dynamics of the ecosystem may change, such as a decrease in abundance of key ecosystem components affecting the energy transfer within the system. No results will be available to present at the time of the conference.
Towards an Improved Understanding of the Influence of Raingauge Design, Slope and Aspect on Rainfall Measurements: A Cross-Calibration Study

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Recording raingauges in South Africa have decreased over the past two decades. The monitoring in two important research catchments, has been re-established at Cathedral Peak and continued at Jonkershoek, due to the long term data records available for the catchments, which makes them vital for long term monitoring of global change. Raingauges were upgraded from Snowdon manual monthly raingauges, to modern Davis tipping-bucket and Texas high intensity raingauges. This creates in homogeneities in the data record. A cross-calibration between the historical and modern raingauges is required. Literature suggests that overall across the sites, the historical raingauges should record more rainfall. With 26 months of data from Cathedral Peak and 10 months of data from Jonkershoek, the preliminary analysis shows that for both sites the historical raingauges are recording more rainfall. However, the difference between the raingauges is small. Compared to the ground level raingauge, both raingauges record less rainfall by approximately 10%.

The Sensitivity of Simulated Temperatures in Climate Models to Aerosols over Southern Africa

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Atmospheric aerosols can impact climate directly, through interacting with solar radiation, as well as indirectly by modifying clouds. The Intergovernmental Panel on Climate Change (IPCC)'s fifth Assessment Report (AR5) stated that the level of scientific understanding of aerosols radiative forcing is medium to low. Southern Africa has high levels of aerosol loading, especially during the biomass burning season, However few climate modelling studies focus on this region. An understanding of the impact of aerosols on southern Africa surface temperature will provide an important baseline for regional climate patterns and variability. The current study focuses on using Goddard Institute for Space Studies Global Climate Model (GISS-GCM) that uses the CMIP5 emissions and spatial resolution of 2 × 2.5° for 1979-2012. Two scenarios where ran, one with aerosols scheme on and one without aerosols to investigate the sensitivity of the simulated surface temperature on the presence of southern Africa aerosols. As the first step, the study evaluated GISS-GCM by comparing the simulated surface temperature to Climate Research Unit (CRU) observations over the southern African region about 10° N to 50° S and 0° W to 60° E. The model captured the temporal and spatial pattern of surface temperature reasonably well. A warm bias of 0.8 °C is pronounced over the western part of southern Africa during JJA and SON season. The sensitivity study is achieved through comparing surface temperature from model runs with and without aerosols. In general, the “aerosol on” scenario, surface temperatures are cooler in many parts of study domain compared to the “aerosol off” run. The purpose of the presentation is to show the simulated climatology of surface temperatures as compared to CRU observations and monthly and seasonal average sensitivity of surface temperatures to aerosols across full period.

Keywords –Aerosol particles, Climate, Surface temperature
IMPACTS OF SPECTRAL NUDGING ON THE SIMULATION OF PRESENT-DAY RAINFALL PATTERNS OVER SOUTHERN AFRICA

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Regional climate models (RCMs) provide finer-scale simulations than those of Global climate models (GCMs), whilst being forced by the output of the host GCMs. In this study, we examine the influence of various strengths of spectral nudging on the simulation rainfall patterns in Southern Africa. We use the Conformal-Cubic Atmospheric Model (CCAM) as RCM to downscale ERA-interim reanalysis data to a resolution of 50 km in the horizontal over the globe. A scale-selective filter (spectral nudging technique) is used for nudging the CCAM simulations. The filter is applied at length scales of 9000 km, and 4500 km, 3300 km, 2250 km. Simulations are also performed without using any atmospheric nudging (only sea-surface temperatures and sea-ice provided in this case). The filter is applied at six-hourly intervals and from 900 hPa upwards. The model simulations of rainfall are compared against CRUTS3.2. Use of this spectral-nudging technique ensures that observed synoptic-scale circulation patterns are represented with increasing realism as the length-scale at which the filter is applied decreases. The model simulations of rainfall are compared against CRUTS3.2 observed monthly rainfall data, and the merits of the different length scales of nudging are discussed.

ATMOSPHERIC RESEARCH AT UKZN, DURBAN

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In the present context of global changes, atmospheric and climatic research should be more organized in the framework of international collaborations and research networks. During recent years, the importance of systematic monitoring of the atmospheric structure, dynamics and composition has been confirmed by numerous satellite and surface observations. Together with land use change, the aerosol burden perturbs the surface/atmosphere radiative balance, as well as cloud properties, ensuing regional climatic impacts. Over Southern Africa and the neighbouring oceanic regions of the Indian Ocean, these regional impacts are influenced by dynamical variability and play an important role in global climate change. The quantitative characterization of these anthropogenic regional factors and their relative climatic impact are still uncertain. In this domain, the improvement and the use of integrative climate modelling tools is a necessity for environmental management and climate change mitigation (International Panel on Climate Change, 2007). Compared to developed regions of the northern hemisphere, the tropical and austral regions of the southern hemisphere are poorly documented even though they are important components of the global atmosphere. Thus, it is important to understand the structure and dynamics of the atmosphere (especially in Southern Africa). In this talk, we shall present the overview of atmospheric research team activity at UKZN, Durban and showcase some of the recent results.

IMPACT OF SPATIO-TEMPORAL VARIABILITY OF THE MASCARENE HIGH ON WEATHER OVER SOUTHERN AFRICA

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Subtropical highs form over the subtropical belts for both the Northern Hemisphere (NH) and Southern Hemisphere (SH). They influence weather and climate variability in many regions around the world. The study focuses on investigating the spatio-temporal variability of Mascarene High on (anomalous)
weather over southern Africa at intraseasonal, seasonal, interannual and event time-scales. Mascarene High location is over the Southwest Indian Ocean (SWIO) within 25-35°S, 40-110°E boundaries. The Mascarene High appears to play a vital role in day-to-day weather and climate patterns conditions over southern Africa. Typically, the movement and distribution of the Mascarene High is the main attribute that influences weather and climate conditions over southern Africa. Spatio-temporal characteristics of the Mascarene High investigated in this study span for the period 1985-2100 using NCEP-NCAR reanalysis I datasets for the present period and the Conformal-Cubic Atmospheric Model (CCAM) for future projections. The present climate investigation of the Mascarene High over the SWIO is for the period 1985-2014.

Identification of the Mascarene High is done using mean surface sea level pressure (MSLP) extracted from ECMWF ERA-interim monthly reanalysis field data via KNMI archives and compared with MSLP from NCEP-NCAR reanalysis I. The data is also subjected to Principal Component Analysis, depicting eastern and southern parts of the South Indian Ocean to be dominant regions. This assisted in illustrating variations of spatial dominance and seasonal positioning of the weather system over the SWIO. The Mascarene High migrates south (north) in austral summer (winter). Event scale analysis is also employed for investigating Mascarene High blocking and induced anomalous weather. It appears that Mascarene High blocking leads to anomalous rainfall events over southern Africa and South Africa is severely affected. Types of weather events that contribute to anomalous amount of rainfall during this occurrence include tropical cyclones, cut-off lows and northwest cloud bands. Analyses done indicate a significant geographical variability of the Mascarene High development, distribution and movement in the SWIO at the different time-scales. Subsequently, the future of the Mascarene High is projected to have a shift in mean position as a result of a projected expansion. The study showed that circulation of the Mascarene High is projected to expand in the future. The expansion of the Mascarene High is expected to shift tropical cyclone trajectories equatorwards, with the baroclinic structure of cold fronts expected to shift polewards affecting changes in the pattern of weather and climate over southern Africa. This finding is important as it illustrates expected changes in weather and climate conditions over southern Africa in a changing climate.

Keywords: Subtropical highs, Mascarene High, SWIO, Southern Hemisphere, Spatial dominance, Seasonal positioning.

**Session 5C: Urban Ecology**

**IMPLEMENTING THE GREEN CITY POLICY IN MUNICIPAL SPATIAL PLANNING: THE CASE OF BUFFALO CITY METROPOLITAN MUNICIPALITY**

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The term “eco-city,” and similar concepts such as “green” and “sustainable” cities, has evolved over time concurrent to the development of the understanding of social change and mankind’s impact on environmental and economic health. Most of the world’s Green House Gases (GHG) emissions are ultimately attributable to cities, which are centers of economic activity. With the advent of climate change impacts, modern economies developed the green city policies to create sustainable urban development, low emission, and environmentally friendly cities.

Spatial planning, which contains strategies and policies for urban development, should be directed to the efforts to reduce GHG in transport, urban design and development, waste management, renewable energy, environmental health and water resources. A green city should incorporate policies, measures, technologies, and operational strategies to increase all aspects of environmental, social, and economic health; narrowly, these goals should be accomplished primarily through spatial planning.
In South Africa municipalities, including Buffalo City Metropolitan Municipality (BCMM) have been tasked to develop and implement the green city policy. However, BCMM has adopted a climate change response strategy but has not developed implementation plans. In addition, it is yet to develop the green city policy that clearly articulate how the municipality will reduce its GHG omissions in its spatial planning designs and economic development.

Against this background, this research reviews and analyses green policy landscape in Metropolitan Municipalities. It is envisaged that the research will provide the basis for the development of a comprehensive implementation of green policy strategies and programmes for the local transition to action in Buffalo City Metropolitan Municipality, in the Eastern Cape Province.

Key words: Climate change, policy, municipalities, green city, South Africa


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This City of Tshwane has undergone some significant spatial expansion over the past 15 years. In this project, how the land use as well and land cover over the area of Tshwane will be monitored to precisely track done all the changes that have occurred within this spatial area. With the use of GIS and Remote sensing data of the highest resolution, the land cover can be synthesised using various imagery over the period of 2001-2011. The City of Tshwane’s population increased from 2.1 million people in 2001 to 2.9 million in 2011. This significant increase was due to the incorporation of the Metsweding region and its local municipalities since the year 2011. The aim of this research project is to examine the changes that the former city of Tshwane underwent after the incorporation of the Metsweding District Municipality in 2011. The changes will be tracked and analysed using the ArcMap 10.4 software as well as spatial data for the years 2001 and 2011. LandSat images of the land cover from the United States Geological Survey (USGS). Changes related since the absorption of the Metsweding Municipality have resulted in the City of Tshwane being the largest Metropolitan Municipality by land mass, covering a surface area of 6 368km² of Gauteng’s 19 055km². The merging of the two municipalities has led to a framework that provides the residents of Tshwane with better infrastructure, service delivery yielding better economic growth as well as better quality of life.

PLANNING FOR A LOW CARBON, CLIMATE RESILIENT CITY; THE LINKAGES BETWEEN MITIGATION, ADAPTATION, AND URBAN DEVELOPMENT

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The new urban agenda is focused on the importance of urbanization as a tool for development and advancing the Sustainable Development Goals (SDGs). The majority of urban growth is projected in sub-Saharan Africa and, with urban expansion and land use changes, are expected to increase greenhouse gas emissions and vulnerability to climate change impacts, thus the need for low carbon, climate resilient development is urgent. Identifying opportunities to integrate climate change mitigation and adaptation responses in urban spatial development is increasingly recognized to maximize policy synergies, in light of municipal resource deficits and challenges, to create win-win situations.
The research presented examines and synthesizes peer-reviewed literature on climate change mitigation and adaptation in sub-Saharan African cities, relating to urban land use/cover change planning and policies. Results are presented according to several themes, including the stimulus behind the interventions, the funding mechanisms, and the realization of co-benefits, discussed in relation to the international mitigation-adaptation integration discourse. The use of (i) earth observation imagery, to assess the rate and extent of urban features and land use changes, (ii) urban modelling, to assess policy scenarios, and (iii) future projections of climate change are lacking, hindering decision-making and integration of climate change responses in development. The study presented is part of a project aimed at integrating climate change responses in urban development for South Africa by assessing the impacts of climate change on future urban development and the potential responses of municipals to these impacts.

**PATTERNS OF RESIDENTIAL DENSIFICATION IN JOHANNESBURG, 1996-2011**

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In South Africa, urban densification is seen as one of the main tools for achieving resilient, efficient cities, and a means to enhance urban economic opportunities, social cohesion, and restructuring the apartheid urban form (NPC, 2012; GPG, 2016). The patterns through which residential densification occurs, however, significantly vary between cities, and within different parts of urban areas, thus requiring targeted understanding and policy approaches.

This paper presents the findings of a data-led approach that explored patterns of residential densification in Johannesburg, South Africa. The data presented stems from the preliminary phase of a broader study on resilient densification in Johannesburg (Todes, Harrison, & Weakley, 2015). It used publicly available datasets, most notably the 1996, 2001 and 2011 population censuses, as well as private, proprietary data on Johannesburg’s changing urban form to draw its conclusions.

This detailed look at the changing trends in household sizes, types, tenure, and dwelling needs provided insight into the different forms through which densification has been occurring in the city over the past two decades. From these, four dominant models of residential change were identified: the rise in formal and informal backyarding, especially in former township areas; the development of formal townhouse in the outskirts of the City; the conversion and infill in older suburbs; and interior densification without notable change in the exterior built form.

The paper will discuss this process, findings, gaps and lessons that emerged from this exercise. It then reflects on the opportunities and potential utility in applying demographic and spatial data analysis in understanding the changing urban form and in targeted policy making.
Session 5D: Ecosystem Services

WHAT CAN WE LEARN FROM GEO-BIOSPHERE-FEEDBACKS FOR SUSTAINABLE
SAVANNA RANGELAND MANAGEMENT?
FIRST INSIGHTS FROM AN ARID NAMIBIAN SAVANNA

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Savanna ecosystems are probably unparalleled in their dependence on the functioning of complex feedbacks between the geo- and biosphere, i.e. climatic conditions, atmospheric CO2 levels, water availability, vegetation dynamics, soil-water dynamics and land use. Disrupting the regulating functions of these feedbacks may lead to irreversible, discontinuous transitions and to a catastrophic change of the ecosystem including changes in the sustainable provision of a variety of ecosystem services (e.g. water supply, forage production, tourism). This provision is under extreme threat due to climate and CO2 changes as well as increasing land-use pressure.

We will present an on-going Namibian-German SPACES project (OPTIMASS) that links field measurements, experiments and process-based models to analyse how key geo-biosphere feedbacks in arid savannas qualitatively and quantitatively depend on land use, climate change, and increasing CO2 levels. In particular, we aim at quantifying specific feedbacks between land use, biodiversity, soil properties, plant available soil moisture, plant physiology and vegetation cover. The feedbacks in the field were analysed along land use induced degradation gradients that may affect feedbacks in different levels and directions. Shrub cover (mainly Acacia mellifera) was used as proxy for past land use intensity.

First results show the relevance of integrating geo-biosphere feedbacks in predictive modelling approaches that aim to develop sustainable savanna rangeland management strategies.

SPATIOTEMPORAL RURAL SAVANNA DYNAMICS FOR SUSTAINABILITY

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The food-energy-water nexus is a conceptual framework that is often used to untangle causality in complex social-ecological systems (SES). In the rural savannas of the Bushbuck Ridge municipality in Mpumalanga, we used a combination of remotely sensed data and detailed field studies collectively spanning 50 years, to understand the dynamics of energy and food security. This presentation will synthesize the findings of 13 years of research, and explore the policy and management implications from these long-term spatiotemporal studies on ecosystem services associated with vegetation structure and -function in this rural savanna. Widespread use of fuelwood, insects as a common source of protein, increasing household wealth, decreasing fertility rates, increased food security and complex land- based livelihood strategies, all in the face of unsustainable natural resource extraction, calls for a different narrative of the stereotypical African smallholder farmer. Without a critical examination of the adaptation space of these farmers, effective responses to global change challenges remain elusive.
CLIMATE VARIABILITY AND POPULATION GROWTH: IMPLICATIONS ON WATER RIGHTS AND FUTURE WATER DISTRIBUTION IN MTHATHA RIVER CATCHMENT

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This study modelled catchment water security situations based on annual population growth and the volatility of the monthly cubic meter flow of the Mthatha River as well as identifying factors that are responsible for the volatility of the flow of the river. Minimum required 25 litres/person/day was used to simulate water needs and available water, while the ARCH/GARCH model was used for variance analysis to identify the inherent predictability and the factors influencing the flow pattern of the Mthatha River. The results show cases of water insecurity as the population grows as only 2% of the population could get required per capita water per day. It also identified climate variability and previous month flow pattern as important influences of future predictability of the river. River flow could lose more water during a high temperature regime than gains through rainfall. We recommend strategies for the reduction of high evaporation of surface water as the environment becomes warmer through Managed Aquifer Recharge and Storage of wet period excess water in the subsurface to avoid evaporation as well as institutional arrangement (human and infrastructure) for sustainable water distribution through timely warning to stakeholders about possible shocks (future decline and smart water usage) and awareness in the Mthatha River catchment area.

IS THERE A RELATIONSHIP BETWEEN THE COLOUR OF SAMPLE WATER AND DISSOLVED ORGANIC CARBON (DOC) IN MOUNTAINOUS CATCHMENTS UNDER CONTRASTING LAND USES AT THE CATHEDRAL PEAK RESEARCH SITE (CPRS), DRAKENSBERG?

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Literature suggests that the amount of DOC being transported from watersheds is increasing as a result of climate change. Little is known about the effects climate change will have on the storage and release of carbon. In this study, results from the analysis of monthly and episodic water samples for DOC and absorbance at wavelengths 254nm, 360nm, 400nm and 546nm; were used in order to detect whether there is a relationship between absorbance and DOC. The use of simple absorbance measurements as a proxy for DOC is not only easier but also cheaper. In gaining a better understanding of the hydrologic pathway of these organic carbons, it was then be possible to understand whether land use has an impact on their concentrations, since a comparison was made between catchments with contrasting land use histories. With the onset of climate change, it is necessary to understand the impact of storm events in mountainous catchment areas such as CPRS which have historical and current monitoring instrumentation. There is a need for understanding event scale mechanisms that are controlling particulate and dissolved matter fluxes in streams which may vary seasonally. It was expected that the DOC fluxes calculated for the first major storm of the rainfall season would be significantly higher than the succeeding storm events. This is because the first rainfall event flushes a large amount of solutes from the ground into the streams. It was tested for in order to get an idea of the changes in concentration from the first rainfall event moving forward.
IMPACTS OF CLIMATE CHANGE WATER AVAILABILITY IN RURAL CIBENI VILLAGE, EASTERN CAPE, SOUTH AFRICA

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Majority of rural Eastern Cape villages of South Africa households do not have access to safe water supplies and infrastructure. Due to changes in climatic conditions for example declining rainfall levels, these sources become unreliable in supplying adequate and safe water to the population. These rural populations due to the drying up of water sources have to find other alternative ways to get water. Climate change has an impact on the reliability of water sources and this has an impact on rural communities. Rainfall data from the year 1985 up to 2016 is analysed to map the rainfall variability. This study seeks to establish what alternative ways do people use when affected by unfavorably conditions like less rainfall. The study also seeks with the aid of questionnaires to investigate any local and provincial intervention in the provision of water to the village when the water sources become unreliable. Interventions can be in the form of programmes or initiatives that involve water supply, climate change adaptation and mitigation strategies and water conservation strategies.

KEYWORDS: rural water sources, climate change, rainfall patterns, improved sources, unimproved sources, alternatives.

Session 7A: Livelihoods and Poverty

OPERATION PHAKISA AND THE BLUE ECONOMY: EMERGING OPPORTUNITIES FOR YOUNG RESEARCHERS

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The Operation Phakisa (OP) Oceans Economy Lab, led by the Department of Environmental Affairs, was initiated in July 2014. The lab brought together a number of individuals from a variety of private, public and government organisations engage for 6 weeks on a strategy to develop the ocean economy of South Africa. This saw South Africa not only developing roadmaps for growing high value economic sectors (e.g. oil and gas, transport) but also developing marine protection and ocean governance programmes. This is in line with the idea of a Blue Economy which seeks to uncouple economic growth from environmental degradation. This paradigm has been around for a while but has only recently been gaining recognition. SA is being proactive about developing the ocean industries by looking holistically at the ocean environment for developing it in a sustainable way while being economically inclusive.

The main focus areas of OP Oceans Economy are:

- Marine transport and manufacturing activities (such as coastal shipping, trans-shipment, boat building, repair and refurbishment);
- Offshore oil and gas exploration;
- Aquaculture;
- Marine protection services and ocean governance;
- Small Harbours;
- Marine and Coastal Tourism.

Each of these areas has a skills working group, with marine protection and ocean governance having identified a list of 200 potential occupations for the country to invest in and develop. There are therefore a number of opportunities and career paths which may become available for young researchers as these
initiatives develop. This presentation will provide feedback, supplied by the Oceans Economy Secretariat and the South African International Maritime Institute (SAIMI), on progress on the focus areas as well as progress on training initiatives and opportunities which have already commenced.

GENDER DIMENSIONS OF CLIMATE CHANGE AND IMPLICATIONS FOR AGRICULTURAL PRODUCTION. THE CASE OF NKONKOBVE LOCAL MUNICIPALITY

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Climate change increasingly affects the livelihoods of people, and poor people experience especially negative impacts given their lack of capacity to prepare for and cope with the effects of a changing climate. Among poor people, women and men may experience these impacts differently. This review presents and tests two hypotheses on the gender-differentiated impacts of climate change on women and men in developing countries. The first hypothesis is that lack of access in assets and resources affects agriculture production negatively under the fluctuation of temperatures and Extension services are adequately funded and poorly distributed to rural household. The second hypothesis is that climate-related shocks affect women more negatively than men. With limited evidence from developing countries, this review shows that climate change affects women’s and men’s assets and well-being differently in six impact areas: (i) impacts related to agricultural production, (ii) food security, (iii) health, (iv) water and energy resources, (v) climate-induced migration and conflict, and (vi) climate-related natural disasters. In the literature reviewed, women seem to suffer more negative impacts of climate change in terms of their assets and well-being because of social and cultural norms regarding gender roles and their lack of access to and control of assets, although there are some exceptions. Empirical evidence in this area is limited, patchy, varied, and highly contextual in nature, which makes it difficult to draw strong conclusions. Findings here are indicative of the complexities in the field of gender and climate change, and signal that multidisciplinary research is needed to further enhance the knowledge base on the differential climate impacts on women’s and men’s assets and well-being in agricultural and rural settings, and to understand what mechanisms work best to help women and men in poor communities become more climate resilient.

Key words: Gender, role, agriculture, production, constraints

ASSESSING AND MAPPING THE ADAPTIVE CAPACITY OF RESOURCE-POOR HOUSEHOLDS TO CHANGING CLIMATE: A CASE STUDY OF NKONKOBVE LOCAL MUNICIPALITY

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This paper provides an empirically based assessment that we conducted to ascertain the adaptive capacity of resource-constrained villages in Nkonkobe Local Municipality in the Eastern Cape Province of South Africa. We did this via overlay analysis of equally weighted demographic indicators that were extracted from the Statistics South Africa (StatsSA) 2011 Census data. The assignment of weights to different indicators comprising water access, income levels, age profiles and literacy levels for conveniently selected villages was objectively determined by running an automated geoprocessing Python script after which adaptive capacity was mapped on a low-medium-high scale. A Kruskal-Wallis H test on demographic data for water access revealed that the demographic results are independent of choice of data acquired from different data providers ($\chi^2(2) = 1.26$, $p = 0.533$, with mean ranked population scores of 7.4 for ECSECC, 6.8 for Quantec and 9.8 for StatsSA). The lowest adaptive capacity was observed in 14 villages from a total of 146 villages within the municipality. These results
suggest that automated geoprocessing scripts provide a robust and dependable way of assessing adaptive capacity especially for areas with a high numbers of villages. The generic insight discernible from this initiative is that adaptive capacity can be mapped and used to spatially depict villages with low copying capacity in order to guide the formulation of climate policies that are potentially capable of enhancing the coping and adaptation capacities of resource poor villages. We therefore urge those interested to consider using the approach presented in this paper in attempting to address challenging issues on adaptation to climate change and disaster management in order to reduce community vulnerability to natural hazards today and in the future.

SMALLHOLDER AGRICULTURAL COMMERCIALISATION AND MARKET RISK IMPLICATIONS ON AGRICULTURAL DEVELOPMENT

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The need for economically rewarding food and fibre production under subsistence systems is well researched and documented. Market orientation of smallholder farmers is also well documented and emphasised by international, continental and national agricultural organisations and departments. Increasingly, farmers, firms and governments at global, continental, regional national or provincial scales are realising that agricultural production and marketing is risky. This review dwells on scholarly articles that have investigated smallholder agriculture and market risks implications to agricultural development. The review revealed that recent increases in globalisation; emergence of new technologies with unequal distribution and access; climate change linked frequency of natural disasters have significant effects on food and fibre price volatility. Market risks generated from price volatility effects have profound implications for food security, economic development, and sustainable natural resources management policy-making for smallholder agriculture development. While smallholder agricultural commercialisation is a driver for increased productivity, more efficient resource utilisation and economic development, top-down approaches in such programmes has not achieved desired impacts in South Africa. Based on the review, farmer perceptions of market risks are inadequately researched yet vital in bottom-up approach to smallholder agricultural commercialisation. There is therefore need to improve management of agricultural risks and their perceptions in pursuit of more productivity to meet growing global population demands through smallholder agricultural commercialisation. More important are agricultural supply chains which are affected by market risks perceived by farmers with critical threats to conventional rain-fed smallholder agricultural systems, opportunities for conservation agriculture and risk management oriented agribusiness.

SOIL NUTRIENT DEPLETION: A HIDDEN THREAT TO RESOURCE-LIMITED FARMERS OF THE EASTERN CAPE IN AN ERA OF GLOBAL CLIMATE CHANGE

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Soil is the most basic of all natural resources. It is a three dimensional layer of the earth’s crust capable of supporting plant and animal life. Eastern Cape farmers with, limited resources, make use of their gardens and fields to produce crops without proper soil management practices. These practices include the use of application of limited fertilizers, both chemical and organic or no fertilizer application at all. Poor nutrient supply is known to be a major yield-limiting factor in rural areas that are dominated by small-scale farmers. In selected rural areas of the Province a mean application of 15.45 kg NPK ha⁻¹ annum⁻¹ was found in gardens. The average proportions in which the nutrients were supplied were approximately 7N: 8P: 5K. In fields, the quantities of N, P and K supplied as organic or chemical fertilizers were less than in gardens, amounting to a mean of 8.72 kg ha⁻¹ annum⁻¹, and the average
proportions in which the nutrients were supplied were approximately 3N: 5P: 2K. The resulting depletion of nutrients from soils leads to declining crop yields. Soil nutrient depletion refers to all nutrient losses from a soil through both natural and human-induced processes. Nitrogen and potassium losses primarily arise from leaching and soil erosion. Phosphorus is mainly lost through crop removals, adsorption and fixation by clay colloids. Soil nutrient depletion has caused serious decline in maize yields in the Province. Some minerals that used to be abundant in food 50-100 years ago, are now in minute quantities or not there at all. This nutrient depletion crisis calls for drastic measures aimed at mitigating the situation especially within the context of climate change/variability.

Key words: farmers, nutrients, soil nutrient depletion, fertilizers, maize yields

Session 7B: Climate Change Adaptation & Mitigation

PROGRESS IN TRANSITIONING TO THE GREEN ECONOMY WITHIN LOCAL GOVERNMENT: FOCUS ON GREEN ECONOMY PROGRAMMES: A CASE STUDY OF SELECTED DISTRICT MUNICIPALITIES

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Studies highlight that there has been a lot of commitment at the national level to ensure that the country is able to take forward the priorities of the green economy transition. As such the concept of the green economy is regarded as a framework for addressing the country’s major socioeconomic and environmental challenges through stimulating economic activity and employment. Despite efforts to accelerate implementation of this transition, it is however pointed out that progress on these commitments has been somewhat uneven to date. According to Stats SA while significant strides have been made in improving access to basic services, there is however still a lot to be done in terms of improving livelihoods of people. These, and other functions are some of the areas whereby municipalities as local governments have an important role to play. Hence in addition to the triple challenge of poverty, inequality and unemployment, the role of local governments in driving the implementation of objectives as highlighted in national green economy policies and programmes is recognised in the study. Consequently it is acknowledged that municipalities have a myriad of issues to deal with. While this is true, it is also highlighted that a lot of work undertaken and implemented by municipalities has not been comprehensively documented. As such, a gap is identified in terms of gathering, storing and sharing information as evidence record for the transition. The study therefore seeks to establish progress made in facilitating the objectives of the green economy transition particularly within local government. The study will employ a qualitative approach whereby 20 district municipalities are selected as case studies. The intention is also to track the programmes in place and the impact they make in driving the green economy. The focus will be on the nine prioritised areas of the green economy and the challenges and successes thereof. Findings of this study will be used as evidence for green economy policy and be used to inform in terms of the institutional reforms necessary to improve the implementation of green economy programmes.

FINANCING GLOBAL CHANGE: THE CASE FOR GREEN BONDS

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Green bonds apply environmental labelling to traditional bonds for financing green and climate projects. The green bond market has grown rapidly in recent years, and shows promise for furthering climate
action. Multilateral development banks have been most active in issuing green bonds to support their environment and development agendas, but corporations and municipalities are also beginning to issue green bonds. To what extent can green bonds provide finance for climate action in developing countries? Emerging economies are becoming more active in the green bond market. The case of Johannesburg, the first city in an emerging country to issue a green bond, is examined for potential replication. Challenges and opportunities relating to green bond demonstration and governance, de-risking, and green integrity are also explored.

DOMESTIC WATER CONSERVATION ACTIONS AS LINKED TO ACCESS TO INFORMATION, MOTIVATION AND CAPACITY ACROSS A SOCIOECONOMIC GRADIENT IN GEORGE, SOUTH AFRICA

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Clean freshwater is a natural ecosystem service resource vital to the well-being of nations worldwide; it is vital to all living species, including humans. Freshwater systems constitute 0.01% of the water on earth and provide habitats to a great diversity of fauna and flora. Humans require water for their basic needs, including food production, industrialisation and urbanisation. Since the 1950s, the human population has increased exponentially from 3 to 7 billion. This has inflicted unsustainable pressure on freshwater ecosystems, as water is constantly affected by factors like dynamic climate variations, invasive alien plant species, pollution and over-utilisation. Sustainable management of freshwater resources is therefore necessary to ensure proper ecological function and a supply of freshwater for future users. This study investigates the enforcement of such management practices at a domestic level by looking at factors that might influence human behaviour toward water conservation. The factors include access to information (knowledge and awareness), motivation (drivers toward enforcing action) and capacity (having the tools required to implement action) in relation to sustainable water utilisation in the household. The study is conducted in two residential areas along the Kat and Malgas Rivers in George, Western Cape. It takes socioeconomic contexts into consideration by sampling across a sliding-scale of inequality in socioeconomic conditions at a neighbourhood level. We use a mixed methods research methodology that consists of two phases: Phase one inculcates a qualitative approach, whereby data is collected using interviews with local residents, and is subsequently analysed using the statistical software package, ATLAS.ti to derive themes. The themes are used to structure a questionnaire for the second phase to gather further data. This second data-set is analysed through the statistical programme, STATISTICA. The results of both phases are integrated for final interpretation to analyse how socioeconomic gradients reflect different domestic water conservation strategies.

CLIMATE CHANGE RESPONSES: SYNERGIES AND TRADE-OFFS

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Increasingly there is evidence to suggest that there are likely to be synergies and trade-offs to interventions implemented in response to climate change challenges. This is especially relevant in developing countries, where there are likely be significant advantages to capitalizing on synergies in climate change mitigation and adaptation in terms of supporting sustainable developmental growth. As such there are likely to be synergies and trade-offs among current or planned climate change interventions within the Agriculture, Forestry and Other Land Uses, and Infrastructure sectors that can be optimised. Whilst these synergies and trade-offs can be understood in a qualitative way the opportunities for optimising synergies between these strategies often lack empirical evidence, inhibiting support of investment in alternate interventions. In this paper, international and local lessons on the
development of integrated assessment models (IAMs) for mitigation and adaptation are used to provide insights on the challenges and opportunities to empirically quantify synergies and trade-offs. Initial results of a project that aims to develop a platform to quantify synergies and trade-offs in South Africa cities is also presented, highlighting an integrated approach to addressing developmental growth in light of projected climate impacts and associated risks in South Africa.

AN ASSESSMENT OF L-BAND ALOS 2 PALSAR 2 DATA FOR ABOVEGROUND BIOMASS MONITORING IN DIFFERENT FOREST ECOSYSTEMS

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The mapping of forest aboveground biomass (AGB) stocks is critical for understanding the terrestrial carbon budget. This study investigated the potential of multi-seasonal, dual-polarized L-band ALOS 2 PALSAR 2 data sensor to model woody biomass across different forest types in South Africa. We used the Random Forest algorithm to determine the extent to which (i) PALSAR 2 backscatter intensity, (ii) SAR image textures, and (iii) polarization ratios could be used to model AGB in each of the forest types. All three image variables (backscatter intensity, image textures, and polarization ratios) were first used independently then jointly in the modelling process so as to determine the predictive strength of each variable as well as to investigate whether the joint use of these variables yielded improved results. We also sought to establish the best season to acquire imagery for AGB retrieval. Our results showed that backscatter intensity exhibited good relationships with AGB with the best performing model yielding high accuracies ($R^2 = 0.78$ and 15.3 t/ha). A comparative analysis of the two PALSAR 2 bands showed that the HV channel performed slightly better than its HH counterpart. Polarization ratios also exhibited equally impressive results whereas texture parameters showed the least correlation to AGB. However, with the use of the recursive feature elimination (RFE) method we were able to select only the relevant texture features and produce a much more improved texture model. The use of the three image variables together in a single model showed good sensitivity but was unable to exceed the performance of backscatter/image ratios when considered singularly. Furthermore, PALSAR 2 data acquired during different stages of the dry season proved to be the best suited for biomass modelling. Overall, the study demonstrated the potential of PALSAR 2 data to monitor AGB stocks in different forest ecosystems.

Session 7C: Urban Ecology

PRELIMINARY ESTIMATES OF CITY SCALE ANTHROPOGENIC HEAT FLUX IN SOUTH AFRICA

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The Anthropogenic Heat Fluxes (AHF) from buildings, transport and people are an essential component of the urban climate within cities. Presently limited information on the AHF in South African cities exists. This study used the LUCY (Large scale Urban Consumption of Energy) model to provide an initial estimate of the AHF in South African settlements. The results indicate that cities in South Africa are important sources of waste heat emissions. The inclusion of the comparison between the AHF mean on a ‘hot day’ versus a ‘normal day’ highlights the sensitivity of the AHF to temperature change. Waste heat emissions in cities contribute to increasing urban temperatures and in turn higher urban temperatures contribute to increasing waste heat production. Waste heat is an unwanted product of energy consumption and under future scenarios of development and climate change in South African cities; the AHF within South African cities is likely to grow and thus impact on the development or
intensification of urban heat islands. As a consequence; waste heat emissions will become an important trade-off for cities to account for in climate change policy. AHF is an essential factor in city-scale atmospheric circulation and surface temperature and as such, there is a need to improve our ability to quantify the AHF in South African cities. Future work towards improving the parameterisation of building, transport and human sources of waste heat emissions within these cities is therefore envisaged. The input of such data into Urban Climate Models (UCMs) will help support research into urban heat island effects in South African cities under a changing climate.

ESTIMATION OF URBAN SURFACE TEMPERATURES USING REMOTE SENSING IN ETHEKWINI MUNICIPALITY

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Urban Heat Islands (UHI's) are an increasingly common phenomenon within urban areas around the world. These heat islands may lead to a variety of negative effects, such as health impacts on urban inhabitants and disruption of the functioning of surrounding natural environments amongst others. The best method of determining the presence and magnitude of UHI’s is through remote sensor thermal imaging. However, due to differing resolution characteristics, certain remote sensors would be better equipped at determining Land Surface Temperatures (LST's) and from it inferring UHI’s. The aim of this study was to determine the presence and magnitude of UHI’s across eThekwini municipality using Landsat 8 and MODIS remote sensors for each season over the period of a year. An additional aim included checking the accuracy of these sensors in determining LST’s. MODIS LST products were obtained directly from the EROS data centre (EDC) and converted into degrees Celsius. Landsat 8 images were also obtained from the EDC and LST’s were obtained through an algorithm developed by Stathopoulou and Cartalis, (2007). Accuracy results showed that MODIS had an RMSE of 7.04 °C while Landsat 8 had an RMSE of 2.92 °C. MODIS also had an R2 value of 0.65 while Landsat 8 a R2 value of 0.93. Based on these results, Landsat 8 was considered a more suitable remote sensor to determine LST in the case study area. Differences in temperature between highly urbanised and non-urban areas were around 2 - 6 °C warm, confirming the presence of UHI’s within eThekwini municipality. In other areas, the cooling effects of vegetation could be clearly observed suggesting possible mitigation methods.

EFFECTS OF SOCIO-ECONOMIC PARAMETERS ON HOUSEHOLD SOLID WASTE GENERATION AND COMPOSITION AROUND UMTATA REGION

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Household solid waste management problems are a growing environmental challenge in South Africa and many other developing countries. Household solid waste in Mthatha has been reported to be one of the problems facing the city and is overwhelming local authorities, as it is beyond the environment and management capacity of the existing waste management system. Understanding household solid waste characteristics and rate of generation will help evolve appropriate waste management strategy based on the principle of reduce, re-use and recycle. Over 240 sample households were selected for the study using stratified random sampling that seeks to categorise households according to informal settlement, low income households, middle income households and high income households. Data on household waste generation, composition, awareness, and household waste management practices was gathered through mixed methods and analysed against various socio-economic factors. The results revealed that waste generation rate increases as you move up the socio-economic groups. Waste bags of waste per week with the mean number of bags of by 1.92±1.276, 2.29 ±1.43, 2.33 ±1.221 and 2.79 ±1.355 for
informal settlement, low income households, middle income households and high income households; respectively. Household socio-economic status emerged as a significant factor (P < 0.05) affecting waste generation, recycling and reuse across the entire four socio-economic strata. The results highlighted discriminate difference in refuse removal provided by the municipality favouring middle and high socio-economic groups (door to door refuse collection at least once a week) while their counterparts, informal and low socio-economic statuses do personal removal which include skip bin disposal, open space disposal and/or burning of waste.

Key words: Awareness, characteristics, disposal, refuse, recycling, influence.

TREE BARKS AS BIO-INDICATOR OF ATMOSPHERIC POLLUTION: EVALUATION OF HEAVY METALS CONCENTRATION

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The release of various types of gaseous, volatile organic and inorganic pollutants into the atmosphere has constantly brought about steady deterioration of the world’s air quality, giving rise to numerous cases of illness and even death, depletion of ozone layer, acid rains, global warming, greenhouse effect and physiological problem.

The study seeks to investigate the suitability of Terminalia catappa, Azadirachta indica, Gmelina arboreae, Mangifera indica, Glyricidia sepium, Petiforum species and Moraya species tree barks as suitable bio-indicators of environmental pollution: degrees of temporal heavy metals contamination around anthropogenic activities, such as: industrial, high traffic commercial, residential high and low traffic volumes areas of Ibadan, Nigeria. Concentrations of Pb, Zn, Cd, Cu, Co and Cr in the dry-ashed bark samples were evaluated using atomic absorption spectrometry (AAS).

The mean concentration (dry weight, mg/kg) of heavy metal in samples from industrial zone was observed as follows; Pb‒3.67 ± 1.97, Cd‒0.10 ± 0.07, Zn‒30.96 ± 32.05, Cu‒7.29 ± 5.17, Co‒0.91 ± 0.58, Cr‒2.61±1.84. The trend of average metal concentrations at high traffic commercial zone gave the order: Zn > Pb > Cu > Cr > Co > Cd. Residential high traffic zone investigated showed the following concentrations (mg/kg): Pb‒6.70 ± 3.52, Cd‒0.06 ± 0.05, Zn‒22.24 ± 12.93, Cu‒6.97 ± 3.78, Co‒0.95 ± 0.27, Cr–3.35 ± 1.16, with the trend as Zn > Cu > Pb > Cr > Co > Cd. Relatively strong positive correlation between heavy metals at (ρ < 0.05), such as Zn versus Cu (r = 0.79) and Co versus Cu (r = 0.77) was observed. The results of the study suggest that tree bark samples investigated could potentially serve as bio-indicators for Zn, Pb, Cu, Cr, Co but may be inadequate in monitoring Cd.

Session 7D: Terrestrial Ecology

HOW WILL CLIMATE CHANGE IMPACT THE GEOGRAPHICAL EXTENT OF C3 GRASSLAND IN THE KWAZULU-NATAL DRAKENSBERG?

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Global climate change is the major challenge of the 21st century with global surface temperature increases having been recorded and projections predicting further temperature increases towards the end of the 21st century. The C3 and C4 photosynthetic pathways in vegetation respond to temperature increase and CO2 increase in two contrasting ways – increasing temperature is predicted to favour C4
range expansion, with increased CO2 to favour C3 range expansion. The ecological interplay between C3 and C4 grassland in the Kwazulu-Natal Drakensberg leads to the potential for an increase or decrease in C3 grassland extent depending on if these grasslands are climatically limited or CO2 limited. The aim of this paper is to determine if each of a subset of six common C3 grasses in the KZN Drakensberg is climatically limited. This would suggest a future C3 range contraction that would be in opposition to potential future range expansion under the influence of increasing atmospheric CO2. The environmental domains of these six species were determined using an ensemble of five correlative species distribution modelling algorithms using the Biomod package in R. Early results suggest the current distribution of individual C3 grass species is related in part to climatic factors, but local landscape-level distribution suggests some of these species may be expanding to lower elevations and onto northerly facing slopes in the KZN Drakensberg. This suggests future C3 range expansion as atmospheric CO2 concentrations rise which has implications for Drakensberg water supply, plant diversity and fire regimes as relatively homogeneous C3 grasslands invade and crowd out more species rich C4 grasslands.

COMPLEX PHENOLOGICAL CHANGES IN EUROPEAN BARN SWALLOWS IN SOUTH AFRICA FROM 1987 TO 2012

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Climate change, habitat loss and agricultural intensification have together probably caused the population declines observed in many European bird species since the 1970s. Increasing Northern Hemisphere temperatures from 1970 to 2000 have been linked to phenological changes in a wide range of species. Over this period, European spring phenological phases, such as the start of plant growth, bird arrival and start of breeding, shifted earlier in the west and later in the east. Phenological change can expose populations to different or new environmental pressures, causing them to change in size or move in space. Migratory birds are exposed to different climate changes at their breeding and non-breeding grounds, potentially increasing their vulnerability to other pressures. We investigated phenological changes in the European barn swallow Hirundo rustica rustica, an iconic and still abundant long-distance migratory species that breeds in the Palearctic, at its South African non-breeding grounds. Reports indicate that barn swallow migratory timing in South Africa changed with geographic variability from 1987–2011, with moult estimated to end later in the Free State. Based on these reports, we analysed country-wide variability in primary moult and pre-migratory weight gain phenology in South Africa, using citizen science ringing data. Mean start of moult shifted a week earlier in Gauteng and a week later in the Free State, with smaller shifts elsewhere. Changes in mean start of weight gain were largely consistent with changes in moult timing, and were generally consistent with other reported changes in barn swallow phenology in South Africa. However, some changes were in conflict, suggesting a possible change in breeding strategy in some populations. Migratory connectivity estimates were used to relate these patterns to phenological change in the Palearctic. Our results provide further evidence that Palearctic climate change can cause ecological changes in the Southern Hemisphere.

MEASUREMENT AND MODELLING OF NET PRIMARY PRODUCTIVITY IN A SOUTH AFRICAN SAVANNA SYSTEM

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It has become essential to accurately monitor and estimate the emission and uptake of atmospheric carbon dioxide (CO2) in various ecosystems around the globe. Atmospheric CO2 plays a central role in the Earth’s atmospheric, ocean and terrestrial systems and it has been recognised as the greatest
contributor to the anthropogenic greenhouse gas effect. The exchange of CO2 between the atmosphere and land/ocean surface constitute the largest component of the global carbon cycle on which other perturbations are overlayed. Understanding the changing driving forces of climate change and their ecological consequences requires long-term measurements of CO2 gas exchange and the utilisation these measurements to develop our modelling ability. The Council for Scientific and Industrial Research (CSIR) has been operating two eddy covariance flux towers within the Kruger National Park at Skukuza and Malopeni since 2001 and 2008 respectively. Carbon dioxide flux data from these measurement sites for the period of operation will be presented and compared with output from the Community Atmosphere Biosphere Land Exchange (CABLE) model, run in an offline mode using input data collected on site or dynamically coupled to the Conformal-Cubic Atmospheric Model (CCAM). The model skill in predicting the exchange of CO2 between the land surface and the atmosphere will be presented for the diurnal, seasonal and interannual time periods.

PLANT FUNCTIONAL TRAITS AND RESOURCE PARTITIONING MEDIATE WATER RELATED FEEDBACKS IN A SEMIARID AFRICAN SAVANNA

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Shrub encroachment is considered as the most threatening form of rangeland degradation in African savannas. The key drivers are highly unpredictable climatic conditions and unsustainable livestock management, which affect ecological and eco-hydrological processes responsible for germination, establishment, growth and mortality of plants. The main objectives of this SPACES-OPTIMASS project were to reveal causes and consequences of shrub encroachment from an eco-hydrological perspective and to obtain reliable relationships between habitat and vegetation characteristics. From a plants perspective, a promising approach is the use of traits that are associated with higher competitive ability related to water. This seems especially important in the light of savanna degradation. Several studies indicate that rarely occurring climatic conditions like droughts or series of good rainfall years trigger the dieback of desirable grasses or facilitate mass recruitment events of encroacher species, respectively. Other traits comprise the ability of different plant types to withstand environmental extremes like droughts or traits that feedback to important ecosystem services, such as livestock production. The variability of these water and grazing related traits of savanna plant species and the influence of soil characteristics modified by land use are still widely unknown.

A field survey has been conducted along precipitation gradients in the Kalahari savanna rangelands in Namibia. We quantified the plasticity in plant specific wilting points, the nutritional value of aboveground biomass, the use of different water sources and other water related traits for different stages of the life cycle of the main encroacher woody species Acacia mellifera, the two perennial grasses Stipagrostis uniplumis and Aristida stipitata and the annual grass Schmididia kalahariensis. Predawn leaf water potentials, isotopic composition of potential water sources and soil moisture has been measured concomitantly to estimate resource partitioning.

POLITICAL CHANGES AND PROTECTED AREA MANAGEMENT

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The DRC has undergone dramatic political changes throughout its history. These changes have significantly affected protected area management and biodiversity.
During the colonial era, creation of protected areas was mainly political and economic motivated, though ecological reasons were publically presented. Despite the gazettement of these areas, access to resources was granted to some people with negative impact on wildlife. After the independence, these protected areas were upgraded both in sizes and status. Although the main purpose was protection of biodiversity and critical ecosystems, it was used by the government to foster support from the international community. During this era, more protected areas were created with limited resources which led to their degradation.

With the political and financial crisis and the incoming of the democracy and collaborative approaches in conservation, international NGOs and donors were integrated into protected area management as partners. This brought changes in conservation interventions. Protected area management had to shift from purely fortress conservation to collaborative management. Given the gap between field interventions and the existing national legal provisions, recently the country adopted new conservation laws that with different governance and management approaches. These approaches promoted protected area management with external stakeholders and communities at different levels. Furthermore, although old fashion protected areas were solely created by the central government, current laws provide different multiple layers to create protected areas and design management strategies and governance.

Although these changes are happening, little have been done to involve local stakeholders into the governance of protected areas. This paper shows that political context and changes can drive shift in conservation practices. Thus, it impacts positively or negatively conservation outcomes. Moreover, this paper identifies political changes as an opportunity for changes from traditional conservation practices to multi-stakeholders approaches.

INTERACTIVE EFFECTS OF DISTURBANCES ON GRASSLAND SOIL AND VEGETATION

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Disturbances by alien plant species pose a significant threat to indigenous plant biodiversity and associated ecosystems. Similarly, large herbivores can often act as disturbance agents, in a sense that their actions can kill or displace mature plants; modify resource availability and physical soil properties. The purpose of this study was to gain a greater insight into how the two potential disturbance agents interactively affect soil and vegetation characteristics. Twenty sites will be selected for sampling at both Rietvlei Nature Reserve (Gauteng) and cattle trampled areas in the Eastern Cape. The twenty sites will ideally consist of: 1) five sites with dense populations of alien plants, but untrampled or only slightly trampled, 2) five sites with moderate or heavy trampling but minimal invasion by alien plant species, 3) five sites with moderate or heavy trampling and alien plant invasion and, 4) five untrampled or only slightly trampled sites with minimal alien plant invasion. Subsequently, from each site, sub-plots of 2x2 m will be selected in which biotic and abiotic data were collected. The results exhibit that undisturbed sites had higher vegetation cover, however these results proved to be antagonistic in nature rather than synergistic.
Session 8A: Livelihoods and Poverty

A REVIEW OF POVERTY REDUCTION WITHIN LOCAL CLIMATE CHANGE INITIATIVES: A CASE OF ETHEKWINI MUNICIPALITY

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This paper presents the results of research carried out to investigate how climate change policy has supported poverty reduction and human development in eThekwini Municipality. Globally, recognition of climate change impacts upon people, particularly the most vulnerable, and how these impacts can be moderated through climate change adaptation-focussed policy interventions, has grown. EThekwini municipality, South Africa, is at the forefront of implementing a community- and ecosystem-based adaptation (CEBA) approach, whereby projects incorporate biodiversity, water, mitigation, climate protection and human elements with local economic development and poverty reduction benefits. This paper reviews 104 climate change projects implemented within eThekwini Municipality. The findings are based on document and content analysis pertaining to the 104 projects to assess whether, how and to what extent the projects engaged with concepts of poverty reduction. The study revealed that climate change projects, which previously revolved around ecological systems, are today spending substantial effort in identifying synergies and mutual links between human development and natural biodiversity systems. Furthermore, the research findings further show that eThekwini Municipality has co-produced policy and projects which simultaneously target the poor or unemployed, primarily using job creation and livelihood generation as a proxy, and climate change adaptation. The research approach uses the opportunity presented by climate change to address key national priorities whilst conserving the country’s rich ecological heritage. Such examples within this city’s climate change portfolio could be useful and in some cases, replicated by other municipalities throughout Africa that wish to expand their climate change efforts, driven by low-carbon, climate appropriate development.

COMPETING KNOWLEDGE SYSTEMS IN CLIMATE CHANGE DISCOURSE: A REVIEW OF PERSPECTIVES FROM ETHEKWINI MUNICIPALITY

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Perhaps the greatest claim in climate change discourse is the idea that most people know or (at least) ought to know the term “Climate Change”. Of course, the claim is possibly true given the plethora of information available on the subject in various platforms. However, a group of people mostly in poor communities grapple to understand what is meant by the term “Climate Change” due to language limitations. The purpose of this paper is to examine the problem of translating the term within the semantics of IsiZulu language. Furthermore, the paper seeks to challenge the place where Climate Change related debates are located, the knowledge system that underpins such engagements, and the way concepts are communicated. The paper is based on a broader study on poverty reduction co-benefits in climate change adaptation projects conducted in KwaMashu, Quarry Heights, Paradise Valley and Umlazi in eThekwini Municipality. The study used a qualitative approach by conducting a series of semi-structured individual and focus groups interviews with members of co-operatives participating in projects in the above mentioned areas. The study revealed a challenge on the respondents’ part to make a distinction between climate and weather, thus treating the two as synonymous (“Isimoyo sezulu”) in the climate change question. Discourses on climate change are dominated by those from the formal education sector where poorest people are systematically marginalized. Strategic intelligence relies on Indigenous Knowledge system to try and make sense of foreign concepts. Most respondents understood climate change to be a foreign construct. However, given the natural calamities associated with the phenomenon, respondents seemed to relate to the experiences once the association was introduced.
differently. Therefore, this paper argues that a local ontology of climate change needs to be recorded and translated to communicate with mainstream discourse, so as to bridge the existing knowledge divide.

CLIMATE CHANGE ADAPTATION AND POVERTY REEDUCATION CO-BENEFITS: EVIDENCE FROM THE SIHLANZIMVELO PROJECT IN ETHEKWINI MUNICIPALITY

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Climate change poses a real existential threat to humanity. Against this backdrop, adapting to the impacts of climate change continues to gain traction (albeit sluggishly) in local government planning. Since the poor are the most affected by the consequences of climate change, there is a growing recognition of the significance of embedding poverty reduction co-benefits in climate change adaptation projects in holistic policy. This study examines the Sihlanzimvelo Project in eThekwini Municipality to determine how far it incorporates elements of poverty reduction. The Sihlanzimvelo Project is an initiative of the Roads and Stormwater Maintenance Unit of the Municipality to clean rivers so as to reduce flooding "ecosystem services such as improving water quality, assurance of supply and the ecological reserve. It covers approximately 138 in Umlazi, Inanda, Ntuzuma and KwaMashu townships of the 800km of rivers, streams and canals in eThekwini. The Project is implemented mainly through local co-operatives that are sub-contracted by the Municipality. Using the qualitative research paradigm comprising of seven focus groups and two expert interviews, the study found that although the Sihlanzimvelo Project was geared towards reducing urban flooding by clearing river bodies, it was also underpinned by the intention of reducing poverty. Those employed in the project cited various benefits arising from the project, including access to regular income, capacitation through skills acquisition, attainment of accredited certification, access to open spaces, and better understanding and appreciation of the ecosystem. However, despite these benefits, the project is also bedevilled by a number of challenges including illegal dumping on cleaned rivers, free-riding by cooperators, the ‘swapping in’ of workers at extremely low pay, and the lack of appropriate tools and clothing for the work. Participants in the focus groups also cited the lack of transparency in the management of cooperatives’ finance and differences in remunerations across project sites as further challenges. In light of these challenges, this paper recommends that the municipality plays a more active oversight role in the implementation of the project in order to enhance transparency and accountability. Indeed the workers themselves motivated forcefully that they be employed directly by the Municipality. Additionally, cooperatives should be provided with all the necessary safety equipment to protect them from becoming ill as they sometimes work in highly contaminated water bodies.

AN ENVIRONMENTAL INJUSTICE TO THE RURAL POOR: CLIMATE CHANGE AND DROUGHT

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The Eastern Cape Province is one of the poorest provinces in South Africa. It is predominantly rural and faces a plethora of development challenges. The central feature of this development impasse is the increasing number of households that lack food and employment opportunities. The stark reality and growing evidence that climate change has affected some of the rural communities cannot be ignored. The lack of food and other developmental challenges that continue to plague the province have its origins in colonialism and the legalised apartheid regime.
Effects of climate change are felt more by the poor in the rural areas more than those who are not poor. Subsistence agriculture is the most common livelihood option despite the grants that are given by the government where they could live by until the month ends. The poor rural areas face core challenges including vast land that is laying fallow, lack of farming equipment, high soil erosion, impact of environmental changes, and these results to poverty. These challenges made communities to no longer slot in in agricultural activities at household level. An environmental injustice to the already poor people is playing havoc especially in terms of food security. At the household level data for evidence based policy making for environmental injustice that has bedevilled the community’s needs a lot of investigation especially when there is evidence showing environmental changes as one of the cause of lack of food, dying livestock and disease because the rivers are drying up.

It is against such a background that the paper will argue using secondary data as well as primary data obtained from Goboti village in the Eastern Cape. The paper will explore the environmental injustice faced by poor rural households.

**CLIMATE CHANGE, FOOD INSECURITY, AND THE IMPACT OF NUTRITION SUPPLEMENTATION PROGRAMME ON CHILDREN’S GLOBAL MALNUTRITION SEVERITY IN MQANDULI, EASTERN CAPE, SOUTH AFRICA**

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Background: South Africa(SA) in general and high lands of Mqanduli areas from Eastern Cape, poorest province of SA, are continuously facing climate change consequences such as drought, food insecurity/acute malnutrition(AM) and chronic malnutrition(CM.). The aim of this study was to evaluate the impact of the Nutrition Supplementation Program (NSP) on Global malnutrition (GM = AM+CM) among children under the age of 5 years.

Methods: A longitudinal intervention study was conducted with two components-quantitative and qualitative designs in Mqanduli areas. A quantitative design was conducted in all records of children enrolled on the NSP during 24 months period and a qualitative design among all nurses running the NSP in each health facilities between 2013 and 2014 (mild, moderate, and severe) were defined by Z-scores for anthropometric measurements.

RESULTS: Nurses considered that NSP components were excellently implemented within health facilities (score=92.3%). At the baseline test of these underweight children 51% (n= 25), 22.4% (n= 11), and 26.5% (n= 13) had mild, moderate, and severe underweight levels, respectively. The proportions of converted to normal weight were significantly higher in females than in males. Thus, efficiency of reduction of GM was 88%, 76%, and 100% in all children, males, and females respectively. CONCLUSION: Mitigation in front of drought and Integrated NSP might reduce 100% of GM in all and males. Clinical Governance must continue with satisfaction and Nutritional Therapy among Nurses and Information about Climate Change Vulnerability.

Keywords: Climate Change, Food Insecurity, Poverty, Global Malnutrition, Children, Supplementation,
One of the aims of climate change adaptation and mitigation projects is the enhancement of the livelihood conditions of beneficiaries. Using the case study of the Paradise Valley, this study examines the extent to which climate change mitigation and adaption projects have improved access to clean water. This paper is based on research which reviewed the Paradise Valley project, which aimed to address social issues through locals acquiring skills, clearing of alien plants and attracting tourists to participate in leisure activities in the Valley. In this study a qualitative data research method was employed with data collected through individual interviews and focus group discussions (FGDs). We used a qualitative research design to collect data from fourteen interviews and one focus group which had seven participants. Data from the empirical research was triangulated with project related documents. Findings from the individual interviews and FGDs revealed that prior to the implementation of the project, the area was characterized by a shortage of clean water due to climate change. Water shortages led to limited drinking water for human and livestock, crop failure, and an increased financial burden due to purchasing fruits and vegetable from supermarkets. Participants in the study noted that the removal of alien plants resulted in increased water levels thus alleviating the previous water constraints experienced in the area. Additionally, participants’ have become more conscious of the consequences of their actions for the environment. Despite these benefits, the lack of long-term employment, low income, and illegal dumping remain some of the challenges associated with the area. The paper concludes that a holistic approach which combines adaptation with poverty reduction has improved wellbeing in Paradise Valley.

Keywords: Vulnerable, Climate Change, Water, eThekwini Municipality

Session 8B: Climate Change Adaptation & Mitigation

TRANSDISCIPLINARITY WITHIN SOUTH AFRICA’S GLOBAL CHANGE RESEARCH: HOW (WELL?) ARE WE DOING?

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The Global Change Programme (GCP) of the Department of Science and Technology (DST) of South Africa is one of the ‘Grand Challenge’ programmes that comprise a 10-year Innovation Plan (2008–2018), which aims to transform South Africa into a greater knowledge-based economy through stimulating transdisciplinary research to resolve, inter alia, specific energy, economy, society and technology needs. Meeting these challenges epitomises the necessity of effective transdisciplinary research, which can be defined as research specifically orientated to resolve ‘real-world’ (i.e. encompassing policy-driven research toward societal benefit) problems that are too complex and multidimensional to be answered by singular research disciplines. We present a first-order evaluation of the transdisciplinary capacity building within the GCP programme at its halfway stage, with an aim to test its effectiveness.

We base our analyses of transdisciplinarity after calculating the level of transdisciplinary research across the various themes presented at the 2nd Biannual Conference for Global Change (CGC), held in early December 2014, at the Nelson Mandela Metropolitan University in the Eastern Cape. Our model evaluates links created between the research papers to the overarching themes of the conference by considering key words/phrases within each research paper. These links are inculcated within this model.
to establish the network of interconnectivity across the conference research themes and its success in catalysing transdisciplinarity research amongst young graduate students in South Africa.

We specifically highlight non-linkages between themes that are known to be important to meeting Global Grand Challenges. Non-linkages are also related to shortfalls in accelerated policy development and implementation of important facets relating to the Innovation Plan. We show that an analysis of this nature helps to highlight the need to re-direct some of the key research links to better facilitate the aims of South Africa’s Grand Challenges.

CITIZEN SCIENCE IN THE KAROO: TOOL FOR COMMUNITY ENGAGEMENT AND CITIZEN STEWARDSHIP

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Scientists across the world are increasingly aware of the need to engage actively with the public to improve communal knowledge and understanding through active community participation in science and technology projects. Moreover, engagement with local communities will increase collaborative socio-ecological decision making about public projects, and ensure efficient national policies. In this context the African Earth Observatory Network (AEON) Karoo Shale Gas Baseline Study group is building a working relationship with local Karoo communities to explore relevant theory and practice of the baseline science and of the study. To date, the baseline study covers five main interactive projects: groundwater monitoring and analysis; gas flow detection; surface and critical zone changes; monitoring of seismic events; and socio-economic and health risk analysis. Communities are learning about the consequences of an absence of baseline studies. Lack of such knowledge and clarity about risks and stakeholdership of potential shale gas extraction, especially during public consultation and engagements with companies and or government, usually results in unhelpful emotional debates around environmental and human ethics. We report on preliminary results from one of the selected Eastern Karoo communities and AEON-facilitated round-table workshops, showing how principles of citizen science can be applied to the design of a framework for the capacitation of the Eastern Karoo communities prior to the proposed shale gas exploration, especially in groundwater monitoring by community groups. The framework and objectives of AEON’s studies form a basis for planning and evaluation procedures to ensure future sustainability of such citizen science programs through community trust. Citizen science will ultimately play a fundamental role as an element of self-help, community engagement and development of citizen stewardship in the Eastern Karoo.

Keywords: Karoo citizen science, community engagement, community participation, capacity building, baseline research

MORINGA OLEIFERA PHYSIOLOGICAL PRODUCTIVITY AND SOIL ORGANIC CARBON FOR CLIMATE CHANGE MITIGATION

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Moringa is a multipurpose plant that is difficult to overlook in current battle with the climate change, due to its fast growing and adaptability to grow under harsh conditions where many plants cannot
survive. This study was aimed to evaluate the response of Moringa biomass yield, physiological productivity and soil organic carbon to four plant spacings at populations of 1 250; 1 667; 2 500 & 5 000 plants ha-1, with constant inter row spacing of 2 m. Naturally growing Mopani and Marula tree species were used as a control. The treatments were arranged in a randomized complete block design and replicated eight times. Data for stomatal conductance (gs), sub-stomatal CO2 (Ci), photosynthetic rate (A) and transpiration rate (E) were measured from the 3 tree species. Leaf biomass was sampled from a net plot of 12 m2 during harvesting. Soil at 0-30 and 30-60 cm were sampled prior to planting and at harvest for physical and chemical properties. Data were analysed using Statistix 10.0 software and the means were compared by Least significant difference (LSD) at p<0.05. Planting density showed no influence on Physiological productivity of Moringa tree but this was higher compared to the other tree species. However, soil organic carbon was significant prior planting and at harvest. Biomass was significant during first harvest (216.5-445.4 kg ha-1) and non-significant during second harvest. Results showed that Moringa can grow under harsh environmental conditions provided nutrients (e.g compost) are applied to avoid yield loss and affecting microbial activities. The tree has potential to mitigate climate change due to its high potential for photosynthetic productivity all year round.

Key words: Climate change, Moringa, Plant population, Soil carbon

CLIMATE CHANGE AND SEASONALITY: INVESTIGATING HOW THE PERCEPTIONS OF FARMERS IN KWAZULU-NATAL (MSHWATHI) RELATE TO THE CLIMATE RECORDS

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Various studies have shown that climate change has very different effects on crop production based on geographic location. There is evidence that the particular context of small-holder farmers in the KwaZulu-Natal region has stressors that challenge adaptive capacity. Small-holder farmers are said to be vulnerable to climate change since most tend to rely on rain-fed crop systems. This project aimed to: look at how farmers’ perceptions influence climate change adaptation strategies, determine how seasonality affects the way farmers in Mshwathi cope with climate changes and explore the relationship between farmers’ perceptions and the climate records. The method is informed by a Socio-ecological systems approach. Interviews with 30 farmers were conducted. The responses are compared with climatological data in the form of temperature and rainfall data over time. One of the primary questions the results seek to answer is: How does seasonality affect the way farmers in Mshwathi cope with climate change?

Key words: Farmers, Risk perception. Seasonal Coping strategies, Conservation Agriculture, Adaptation

SHOULD WE REST DURING DROUGHT? FIRST RESULTS FROM THE DROUGHTACT EXPERIMENT, LIMPOPO, SOUTH AFRICA

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Livestock farming is the dominant land-use practice in southern African drylands and has tremendous importance for livelihood security in the region. Under projected climate change scenarios, the functional integrity of savanna rangelands in South Africa’s Limpopo region is threatened by more frequent and severe droughts. Modelling studies suggest that resting during and after drought years might be beneficial for rangeland health. We used an experimental approach to elucidate whether resting
during a centennial-scale drought has beneficial effects on ecosystem functioning and ecosystem service, thereby gaining a better understanding of grazed ecosystems’ resistance to drought. Specifically, we compared grazed and rested vegetation under drought and non-drought conditions for two seasons. Rangelands were in a good state prior to the implementation of treatments, and the grass layer was dominated by perennial grasses such as Themeda triandra. We assessed treatment effects on multiple soil-mediated and vegetation-mediated ecosystem functions and services, including aboveground net primary production and plant functional trait responses. We found that one season rest both under drought and non-drought conditions stimulates plant production, whereas longer resting results in an accumulation of moribund material. This in turn leads to self-shading, reduced plant fitness and individual production. We conclude that resting periods need to be attuned to rangeland condition, even in drought years.

THE ESTIMATION OF A SATELLITE BASED SPATIALLY DERIVED DROUGHT INDEX FROM HYDROLOGICAL SYSTEM DRIVERS: RAINFALL AND EVAPOTRANSPERSION

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South Africa is naturally water scarce hence has become particularly prone to recurrent droughts which impact all facets of society and the environment. Since, droughts are a natural hazard of South Africa's climate, and it is expected to worsen with climate change projections, it is vital that the country prepares for this natural phenomenon. Evapotranspiration (ET) is an important component of the hydrological cycle, crucial for assessing human-induced and climate effects on natural and agricultural ecosystems as well as for better planning of water resources and disaster reduction plans. The overall aim of this research study is to investigate the different types of droughts over differing timescales. Earth observation in particular is seen to be an important tool in ET estimation over various spatial and temporal scales. An objective of this research is therefore; to apply and evaluate a satellite derived Evaporative Drought Index (ETDI) in South Africa. The option of forecasting reference Evapotranspiration will also be explored using global numerical weather forecast datasets. The forecasted reference Evapotranspiration together with a modelled forecasted actual Evapotranspiration will then be used to calculate a forecasted ETDI. This will thereafter be used to forecast drought conditions in South Africa.

t is envisaged that the results from this research study highlight the potential of utilizing satellite earth observation data as a data source to monitor droughts, assist in water resources and disaster management in South Africa.

Session 8C: Marine and Coastal

INTERROGATING POWER POLITICS IN A TRANSDISCIPLINARY RESEARCH GROUP DESIGNING A PARTICIPATORY PROCESS IN COASTAL MANAGEMENT

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Participatory processes have become an integral part of development programmes. In spite of the idealised aim of participation to open up spaces of inclusion, there are implicit notions of power relations that become a barrier to meaningful participation such as knowledge regimes that inform development trajectories. Participants who hold more knowledge have power to mobilize influence and
are more likely to assert their views in the company of passive participants. Acknowledging the pitfalls of participatory processes, the Council of Scientific Research and Industrial Sciences (CSIR) partnered with the University of KwaZulu-Natal, School of Built Environment and Development Studies on a project entitled the Negotiation of Knowledge for Coastal Governance that was funded by the Society and Sustainability Research Programme of the Department of Science and Technology’s Global Change Grand Challenge (GCGC). This project proposed a radical way to generate knowledge used in coastal governance. The institution that is proposed for the knowledge generation is what is known as a “competency group” that intends to eliminate some of the issues inherent in participatory processes. The concept of a competency group is founded on the notion of recognizing all knowledges as equal and relevant to coastal management as opposed to having scientific knowledge as the main contributor to coastal knowledge.

The use of competency groups in coastal management participatory processes was a new concept that needed to be designed carefully. To achieve this, a group of scientists from different knowledge regimes and disciplines were responsible for designing competency groups in order to recognise tacit knowledge, and ‘slowing down’ dominant discourses that ordinarily inform coastal management. This paper seeks to investigate the power politics in transdisciplinary research team.

This study takes a post-positivist approach to investigating the research team and employs three methodologies: dramaturgy, discourse analysis and deliberation. Data collection was done using participant observation and semi-structured interviews. Findings from the study suggest that time needs to be invested in ensuring that transdisciplinary research team share the same understanding of concepts before working together.

RELATIVE SEA-LEVEL RISE AND THE POTENTIAL FOR SUBSIDENCE OF THE SWARTKOPS ESTUARY INTERTIDAL SALT MARSHES, SOUTH AFRICA

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Salt marshes are coastal wetlands that are highly productive and biologically diverse ecosystems. These systems are under threat from rising sea levels which are predicted to accelerate in the future. Salt marsh habitats within the Swartkops Estuary was examined to determine their structure along an elevation gradient and how this structure has changed over the past six decades, what the primary drivers of this structure were and whether the salt marsh surface is stable, rising or declining relative to current and future sea level rise. Relative sea-level has been rising by 1.86 mm.y-1 over the past 46 years, but this rate has accelerated in the past five years to 6.49 mm.y-1. It was found that the subtidal, intertidal and supratidal salt marsh habitat occupy the elevation zone between -0.5 to 3 m AMSL. GIS analyses showed that during the last 60 years, losses of floodplain, intertidal and supratidal saltmarsh are mainly attributed to developmental pressure. The main environmental drivers for the salt marshes were shown to be soil moisture and elevation. Elevation dictates tidal inundation periodicity and frequency, and thus acts to influence all edaphic factors driving vegetation distribution. Rod Surface Elevation Table results over the past 6 years indicate that the salt marsh surface elevation is keeping pace with historic relative sea-level rise (RSLR), but at an accelerated RSLR of 6.49 mm.yr-1, only two of the eight RSET stations show an elevation rate surplus. These results should be interpreted with caution though because of the short time-series and the high likelihood that the current ratio of sediment deposition will be accelerated in response to the increased sea level rise.
WHAT CAN WE LEARN ABOUT GLOBAL CHANGE FROM CORALS IN INTER-TIDAL ROCK POOLS?

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Corals are among the fauna most vulnerable to the effects of global change, since they thrive within narrow thermal ranges, are susceptible to impacts of acidification, pollution, storms and disease. Coral cover on reefs has decreased steeply in the last few decades and global bleaching events have severely impacted global coral populations at least three times since 1998. Despite this, coral assemblages persist in unfavourable habitats, including in intertidal pools. Understanding the roles of acclimation, adaptation and life histories in the ability of corals to survive in adverse conditions will help to predict future population trajectories and plan conservation strategies.

Our studies show that corals in intertidal pools of KZN can tolerate higher and more variable temperatures than conspecifics from shallow subtidal habitats. Corals from intertidal pools withstand temperature swings of up to 10° C in a single tidal cycle and high variability, especially in summer. In contrast, in winter they may have to compensate for low levels of light, especially towards the southern limits of their distribution. Intertidal corals retained higher numbers of algal symbionts and higher concentrations of chlorophyll a per symbiont than those from subtidal reefs when exposed to thermal stress. Differences in numbers of symbionts and concentration of chl a were also apparent among species, possibly depending on their ability to use lipid reserves and heterotrophy to subsidize nutrients obtained from symbionts. Further studies on variation in clades and physiology of the algal symbionts among habitats and species will help to understand their role in the tolerance of corals to thermal stress.

BEACH WEBCAMS AS TOOLS FOR MONITORING AND UNDERSTANDING COASTAL CHANGE: AN APPLIED CASE STUDY OF CHAIN ROCKS BEACH, AMANZIMTOTI

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Beach webcams are a useful tool for monitoring beaches. Apart from providing consistent live and up-to-date information on beach conditions for beach users, webcams can provide information on rip currents, which is useful for bather safety; and beach change over various time scales, which is useful for beach management. Short- to long-term imagery can be gathered for analysing temporal changes that aerial or satellite imagery cannot provide. Changes in coastal morphology can be examined over hourly, semi-diurnal, diurnal, synoptic, seasonal and inter-annual time periods.

The CoastBusters Research Group has been opportunistically collecting freely available webcam imagery for various beaches in South Africa since early 2010 in order to build up a reference database of the coast. Information on erosion and deposition cycles at Chain Rocks Beach, a headland-bound bay in Amanzimtoti, is presented as an example of what information can be gleaned from this database as a tool to understanding beach change over time. Daily low tide images were closely monitored during Spring 2014, during which four high swell (Hs>3.5m) events induced significant morphodynamic changes on the beach. During this time there was approximately 30 m beach loss and the erosion focus moved 100’s of metres northward in concert with southerly-to-easterly swell propagation direction changes. Positional and orientation changes in the longshore surfbar were concomitantly noted.

A widespread monitoring system of dedicated beach webcams is essential to provide a long-term repository of beach imagery to enable scientific analysis and understanding of beach change over time, especially considering the postulated effects of Climate Change and Sea-Level Rise. This information
can then be added to the beach management toolkit. The best evidence of global change on beaches can be supplied by webcams.

**EFFECTS OF FLOOD EVENTS ON ESTUARINE FISH COMMUNITIES**

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Rivers in southern Africa and Australia are already subject to more extreme flood behaviour than those elsewhere in the world. Downscaled regional climate models indicate the likelihood of increased heavy/extreme precipitation events along the South African East Coast. This will have implications for the fauna inhabiting estuaries. The effect of flooding on the fish communities in four permanently open estuaries (Kariega, Great Fish, Mbashe and Thukela) were examined and were found to be dependent on the type of estuary and the intensity and duration of the flood. In the freshwater dominated Great Fish and Thukela estuaries flooding was found to decrease both the abundance and diversity of species. In the Mbashe Estuary although flooding also resulted in a temporary decrease in species richness and abundance, it played an important role in scouring sediment from this system, which receives enormous quantities of fluvial sediment during the summer months. In contrast, a large episodic flood into the normally marine-dominated and at times hypersaline Kariega Estuary allowed for the development of a normal horizontal salinity gradient and an increase in both species richness and abundance. The results of this study demonstrate the effects of floods on the fish communities of four different permanently open estuaries.

**THE INFLUENCE OF ENVIRONMENTAL VARIABILITY ON THE ABUNDANCE OF CHOKKA SQUID OFF THE SOUTH COAST OF SOUTH AFRICA**

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Due to depleted finfish stocks, the socio-economic importance of cephalopod fisheries is increasing. These cephalopod fisheries display high variabilities in abundance which lead to increasing difficulties in developing sustainable management strategies. The South African chokka, Loligo reynaudii, fishery is one such fishery. The fishery has been in place since 1985 and has been managed utilising total allowable effort methods. The effort levels have not changed in the past 30 years, however, in 2012 and 2013 the fishery experienced a crash. This crash was hypothesised to be environmentally driven. The relationship between the environment and chokka squid abundance has been extensively studied. However, the relationship is yet to be quantified. This study aimed at quantifying the relationship between chokka abundance and several environmental parameters including temperature, wind activity, pressure changes, chlorophyll-a concentrations and large scale climatic indices (Antarctic Oscillation and El Nino Index). This relationship was then used to construct a predictive model which could assist with future management strategies. A GAM analysis of the data defined a strong ($r^2=0.707$) environment-abundance relationship which explained 81.2% of the deviance in the data. However, when the predictive ability of this relationship was tested, it was found to fail. The predictions made by the GAM predicted a similar trend in catches until 2005, after which it decayed. Possible causes of the failure of the model were then discussed.
INVASIVE SPECIES REPRODUCTIVE ADVANTAGE: OBSERVATIONS AND PREDICTIONS IN A HETEROGENEOUS WORLD

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Climate change and invasive species jointly threaten natural systems. Predicting their consequences is difficult given our poor understanding of how climate change will affect ecological interactions and better descriptions of the mechanisms by which these threats affect individual-level processes are essential. A general functional trait contributing to invasive species’ success is their generally high reproductive potential (invasive reproductive advantage, IRA). Against this, local biological and physical conditions in the recipient community (context), can offer resistance. The introduced Mediterranean mussel Mytilus galloprovincialis threatens the native Perna perna on South African rocky shores. The two co-exist on the south coast, Mytilus dominating the high- and Perna the low mussel zone, with overlap in the middle. While Mytilus exhibits IRA, its distribution may be disadvantageous through limited food availability and more extreme temperatures on the high-shore. Given differences in their thermal sensitivities, it is unclear whether climate linked increases in temperatures will influence these species differently. We first tested for IRA, explicitly considering environmental context (within-shore distribution). Second, based on Dynamic Energy Budget (DEB) modelling and projected temperatures based on 95 year IPCC scenarios, we simulated reproductive potential for both species. At three sites we found that, despite Mytilus displacement to high shore and its resulting small size, its aggregate reproductive potential is greater than for Perna. Interestingly, however, DEB simulations suggest that climate change would improve Perna reproductive potential more than that of Mytilus. Anticipating winners or losers in a climatically changing world is challenging given multiple interacting drivers and predictive frameworks should consider environmental context along with physiological adaptations.

DETERMINING VEGETATION AND WATER USE MODELLING PARAMETERS FOR A NEW HYDROLOGICAL BASELINE LAND COVER IN SOUTH AFRICA

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The combination of both natural and anthropogenic activities have caused significant changes to the natural land cover, which have impacted on the hydrological responses. The assessment of the magnitude of these land use change impacts on the hydrological response is important for sound water resource management, and is largely dependent on the baseline land cover used. The development of an updated natural vegetation map of South Africa by SANBI (2012), together with improved field based measurements of natural vegetation water use in recent studies, has led to the assessment of this map as a new hydrological baseline for South Africa. The proposed new baseline provides an opportunity to address the concerns raised about the current Acocks’ (1988) baseline used in South Africa. The aim of the project is to estimate the vegetation and water use parameters for the proposed new baseline in order to have a relatively reliable baseline against which global change may be assessed. The refined parameterisation of the baseline will be based on review of measured values from past literature, new analysis and where necessary, on expert knowledge. The ACRU agrohydrological model will be used to generate the hydrological response under the proposed new baseline land cover.
THE CONTRIBUTION OF OCBIL THEORY TO SOUTH AFRICAN CONSERVATION STRATEGIES: ANALYSIS OF THE LEVEL OF ENDEMISM IN PLANT SPECIES ON OCBILS AS COMPARED TO YODFELS IN THE CAPE FLORISTIC REGION

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The rate at which biodiversity is declining is alarming, and calls for researchers to determine effective conservation methods. Many surrogates have been defined as being best for conservation, however they all have gaps. Thus it is still of relevance to explore different avenues in terms of the best methods that would better represent the diversity that we have, and do so effectively taking into account all aspects of conservation. The OCBIL theory has the potential to provide the solution to the issues of conservation by providing an integrative framework of understanding of conservation of OCBIL biota. This study evaluates one of the hypothesis proposed by Hopper, (2009), comparing level of endemism between Old climatically buffered infertile landscape (OCBIL) and young often disturbed fertile landscapes (YODFELS). The data used was collected in three sites within the CFR, Orange Kloof valley, Orange Kloof East and Jonaskop Peak. The data sources were online peer reviewed journals (Releve data). To assess endemism, the species were grouped according to their distribution from local, Regional, Southern Africa, Continental and widespread. It was discovered that OCBILS had almost twice more local and regional endemics than YODFELS in two out of three sites which showed to have more continental and Southern Africa species. There was however one exception in the overall trend, observed in Orange Kloof East, where OCBILS had less local and regional endemics than YODFEL site. These results proved to be in support of hoppers hypothesis, and can be linked effectively to the OCBIL theory. To implement the OCBIL theory in the CFR for conservation further research is needed to assess validity of the remaining 6 hypotheses. It can be concluded that the OCBIL theory has great potential in contributing to SA conservation of OCBILS, which as this study shows have many endemic plants worth conserving.

FORAGING BEHAVIOUR RESPONSES DURING THE HEAT OF THE DAY IN CAPE SUGARBIRDS: SEX-SPECIFIC VARIATION IN FLOWER VISITATION RATES

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Body size determines an animal’s energy and water demands for thermoregulation. Sexual size dimorphism is common across many species, but its physiological consequences (e.g. energy and water demands) are poorly understood. We predicted that the smaller sex should show greater foraging effort during the day, especially during extreme weather, to meet their higher mass-specific energy and water demands. In this study we determined if a Fynbos endemic, the Cape Sugarbird (Promerops cafer)–males are up to 15% larger than females, show sex-specific foraging patterns. We compared flower visitation rates between male and female Cape Sugarbirds at different times of the day, and among days that varied in maximum air temperature. Despite the higher energy demands of female Cape Sugarbirds, males generally dominated flower resources throughout the day. These results suggest that female Cape Sugarbirds will be more prone to energy and water stress hot and dry summers in the Fynbos region. Endemic birds, such as the Cape Sugarbird, warrant a conservation priority, especially since they are the dominant pollinator of the Proteaceae in the Fynbos biome. The findings of my study will provide insights into population persistence of Cape Sugarbirds in response to predicted rise in global temperatures.
Invertebrates constitute the bulk of diversity in terrestrial ecosystem. However, their distribution, abundance and sensitivity to habitat change is largely unknown. Inventory programs are of particular importance if we are to improve the conservation status of invertebrates and thereby understand their way of life. Ants were sampled using pitfall traps across seven different habitat types representing grazed, ungrazed, burnt, unburnt, woodland, open grassland and alien invaded sites. We aim to provide a checklist and baseline data for monitoring the response of ants to various disturbance i.e. fire, grazing and alien invasive. The first survey yielded a total of 55 ant species in 22 genera and five subfamilies. The most diverse and abundant subfamily was Mymicinae with 29 species and 86% of the total abundance in the study. Inventory completion based on six different richness estimators varied from 52 to 95% in different sites, however it was general higher for most sites and therefore indicating that most species were sampled. The invaded habitat type had the highest species richness (25 species) and was the most abundant site i.e. 32% of the total abundance while the ungrazed habitat type had the lowest species richness (17 species). The highest abundance was in disturbed sites (burnt and grazed sites) and lowest in control sites (unburnt and ungrazed), while open habitat sites (open grass) also had a less ant abundance as compared to closed habitat sites (woodland and invaded site).

Keywords: Ant (Formicidae), Richness, Abundance, Grazing, Burning, Disturbance
Results: The regional TRF (first AFREF static coordinates) based on seven days continuous GNSS data adequately supports regional studies within static models of the Earth. However, kinematic and geodynamic models are better represented within sixty days (or more days) solution.

Conclusions: At lower costs and readily available, permanent GNSS stations should be promoted until better density and/ or additional space geodesy techniques are densified on the continent.

Session 9A: Ecosystem Services

HOLISTIC REGIONAL MANAGEMENT OF MULTIPLE WATER QUANTITY, QUALITY AND OTHER STRESSORS IN AFRICA USING PROBFLO

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Best practice principles of Integrated Water Resource Management (IWRM) in Africa includes the need for robust holistic frameworks that address the risk associated with multiple stressors to social and ecological objectives on regional, trans-boundary scales. Recent rapid increases in water resource developments throughout Africa has resulted in widespread ecological impacts with associated socio-economic consequences. With regional regulators we have developed a regional IWRM Environmental flows framework that gives adequate consideration to non-flow stressors to describe the risk associated with sources in a holistic context. This regional scale ecological risk assessment approach incorporates Bayesian Networks to model the probable relationships between the flows and other driver variables, and socio-ecological indicators by assigning magnitudes and probabilities of adverse impacts of hazards to endpoints. In this paper we demonstrate the application of the PROBFLO approach in the Lesotho Highlands Water Project (Phase II) which includes the construction of the large Polihali Dam on the Senqu River, Lesotho and South Africa, and highlights from the Mara River application of PROBFLO as a part of the Water Allocation Plan for the Mara River Basin, Kenya and Tanzania. These case studies includes the establishment of Resource Quality Objectives for both case studies, the use of existing evidence, specialist solicitations and data generated through biophysical assessments to the study area. Outcomes included the establishment of a transparent, adaptable socio-ecological model to represent the risk relationships between sources, stressors, receptors and endpoints. A series of alternative management options and associated trade-offs were evaluated in the form of a range of scenarios with associated socio-ecological consequences. Scenarios were presented to stakeholders representing society who with the risk assessment outcomes contributed to the establishment of management plans for the use of the water resources. A range of mitigation measures were identified to minimise ecological consequences and monitoring. And adaptive management measures were designed to contribute to the implementation of the management plans. The PROBFLO approach has successfully allowed water resource use regulators to develop holistic plans to manage water quality, quality, habitat and other stressors on regional scales in Africa.

NATURAL AND ANTHROPOGENIC FACTORS INFLUENCING WATER QUALITY IN DEVELOPING COUNTRIES: A REVIEW

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Influence of natural and anthropogenic activities on spatial and temporal variations in water quality is a cause of concern in rivers. Point and non-point contamination sources release physical, chemical and microbiological pollutants which pose immense challenges for water resource management.
Nevertheless information on the influence of natural factors and human activities on water quality is still thin. In this paper we therefore review literature on effects of human and natural factors on spatial and temporal distribution of water quality. The review will add into available literature on the subject.

**ASSESSING THE POTENTIAL OF COMMUNITY SCIENCE ENGAGEMENT IN IMPROVING ECOSYSTEM SERVICES RESTORATION**

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Many valuable ecosystem services which humans depend on are provided by grasslands, including South Africa’s primary water catchment systems. When grasslands are degraded, these processes break down leading to poor grass cover (less forage) and high rates of soil erosion. Economically, this translates to increased monetary inputs required to dredge dams, purify water and restore degraded catchments. The northern Drakensberg is no exception. Due to poor land management such as cattle over grazing, the catchments have undergone excessive degradation which impacts water quality. During erosion, sediment runs into streams and dams. Silt that accumulates affects water quality which means that all regions that rely on the Tugela-Vaal water supply get sediment laden water which has adverse economic effects.

Community participation is imperative in solving degradation issues and the success of this depends on how it is done. Some programs aim to reduce rural poverty by ensuring job creation. However, their benefits are not often measured and may require internally motivated sustained effort to reap true benefits. Empowering communities to monitor different rehabilitation responses provides a platform for learning and may motivate them to sustain and improve land management practices.

The aim of this project is to assess a science engagement community monitoring programme in Okhombe, a rural ward in the Upper Thukela region as a model for entrenching good land management practices. With the key question, “Can we rehabilitate degraded environments to improve ecosystem services through community participation?” the study will be conducted in 3 sites: Oqolweni, Sigodiphola and Enhlanokhombe in Okhombe. A veld condition assessment at different altitudinal gradients and a comparison of formal (scientific methods) and informal (citizen science methods) will be done. In addition, payment for ecosystem services indicators (basal cover, rainfall, surface runoff) will be determined.

**BEACH GOVERNANCE AND WILLINGNESS TO PAY AS AN ECONOMIC INSTRUMENT FOR COASTAL AND MARINE RESOURCE USE, PROTECTION AND MANAGEMENT**

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Globally, marine and coastal ecosystems provide food, cultural, recreational and ecosystem regulatory services that are important for the economic livelihoods of inhabitants living along coastal zone. However, these valuable ecosystems are being subjected to a range of human pressures, comprising pollution, excess nutrients (causing eutrophication), overfishing and destructive fishing practices, loss and degradation of habitats. In South Africa, the Wild-Coast of the Eastern Cape has long been identified as having a great potential for the development of the province. Focusing on Eastern Cape’s Wild Coast, this study reviews current mechanisms for the governance and management of the coastal and marine environment highlighting the challenges faced by the communities in managing their coastal
and marine resources for sustainable beneficiation. The study seeks to investigate the willingness of users of Wild Coast coastal and marine resources to contribute towards the costs sustainable utilisation. The originality of this paper is that it provides one of the first analyses of the influence of socio-economics and social capital parameters and respondents’ willingness to pay (WTP). The findings have substantive public policy implications for coastal management. It set a scene for effective appraisal of coastal resource use and recommendations for improved management and scientific support.

DEVELOPING A METHODOLOGY TO ESTIMATE THE WATER USE OF SOUTH AFRICAN NATURAL VEGETATION USING REMOTE SENSING

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The scarcity of water is a growing concern throughout the world. The changing climate and land uses require improved estimates of total evaporation (ET) to better assess the impacts of change and manage water resources. In arid and semi-arid regions, water use from natural vegetation play a critical role in the availability of water. There are a number of in-situ methods available to estimate ET however, these methods cover small spatial areas, do not cover land surface heterogeneity well and are expensive and time consuming at times. The application of remote sensing energy balance models overcome these restrictions. The focus of this study was to develop an approach to estimate ET for natural vegetation throughout South Africa using remote sensing. The Surface Energy Balance System (SEBS) model in conjunction with Landsat 7 ETM+ and 8 OLI/TIRS images was first used to validate point-based ET from various biomes across the country. The results from the study indicate a fair comparison between the in-situ ET data and the evaporation estimates produced using the SEBS model with coefficient of determination value of 0.69 being achieved. Following the validation of the in-situ and SEBS ET, the SEBS model was setup to model ET for a year. For this investigation, cloud free Landsat 8 OLI/TIRS images were obtained for each biome for the period between 1 July 2014 to 31 June 2015. The highest ET value of 8.7 mm/day was obtained from the Forest biome on the 12 January 2015 and the lowest ET estimate of 0.09 mm/day was on the 17 January 2015 from the Nama Karoo biome. The Forest biome recorded the highest mean ET value of 4.9 mm/day whilst the lowest mean ET value was 0.71 mm/day attained from the Nama Karoo biome.

Session 9B: Health

CLIMATE VARIABILITY AS A DRIVER OF INFECTIOUS DISEASE INCIDENCE

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While the climate drivers of the incidence of infectious diseases are known, the precise relationship between these two ends of the disease transmission system is not well documented in South Africa. Given our natural range of climate zones, and useful information on the range of disease incidence in both the public and private health systems, we are now in a position to examine this on a range of time and space scales. The project underway is attempting to map and quantify the relationship between climate variability and the variability of incidence of diarrhoea and pneumonia (the biggest killers of children in South Africa). The goal of the project is to use these relationships to develop both operational forecast systems for climate related public health risks and also to make longer term climate change related predictions based on scenarios. In particular the study compares these relationship on an annual and inter-annual basis in the Western Cape with that of Gauteng and Limpopo and also investigates the impact of the 2015/2016 El Nino event. In the case of diarrhoea, significant differences in the proportion
of disease incidence as well as the annual cycle of diseases incidence is mediated by rainfall surfing summer in Gauteng and Limpopo, whereas this effect is absent in the Western Cape. Anomalous incidence outbreaks are caused by rainfall reduction in Gauteng (or perhaps by importation of disease from neighbouring countries). The positive impact on disease incidence of the recent El Nino is also evident. The presentation concludes with some recommendations for further research and a discussion on the intermediary variables that explain the transmission patterns.

CLIMATE CHANGE, EL NINO SOUTHERN OSCILLATION AND MALARIA IN KINSHASA

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Background:
We hypothesized that an appropriate use of variables and methods could contribute to show a close association between climatic conditions and outbreaks of malaria particularly during the 1997/98 year El Nino associated with higher temperatures, heavy rainfall and flooding in Kinshasa, DRC, as well as among under five years children.

The aim of this study was to analyse the relationship between precipitations, temperatures, El Nino anomalies of temperature of the surface of tropical Pacific Ocean, and the number of outpatient malaria cases in Kinshasa.

Methods:
In this retrospective analysis, the epidemiologic file included malaria and non-malaria admissions according to the results of investigations of blood smears carried out between May 1st, 1997 and March 30th, 2000, at LOMO MEDICAL CENTRE Kinshasa CONGO. El Nino anomalies of temperature of the surface of tropical Pacific Ocean (SSTs) were obtained from the United States of America Space Administration.

Results:
During the year 1997/1998 known as El Nino year, the number of malaria cases remained higher than the mean of the study period as indicated in the figure by the values above zero, whereas the year 1999/2000 called La Nina was defined by a lower number of malaria cases in comparison with the mean of the study period.

Under 5-year children presented the most marked sensitivity to malaria onset during El Nino phenomenon, whereas the malaria cases fluctuated with the variation in local climatic conditions among outpatients aged ≥5 years.

There was a partial correlation coefficients identified by the regression model between the anomalies of SSTs (Nino 1, 2), precipitations and malaria prevalence with the following equation: \( Y = a + b_1x/c + b_2x \).

Conclusion: The Early warning System is needed to control malaria in Kinshasa.

Keywords: Malaria, Climate change, El NINO, DR CONGO Africa
Malaria disease is widely linked to poor socio-economic status. South Africa (SA) in general and KwaZulu-Natal (KZN) in particular have made significant progress over the past two decades in reducing malaria disease caused by plasmodium falciparum. SA aims to achieve zero malaria transmission in 2018; thus an in-depth understanding of the socio-economic factors that influences malaria risk is vital because it will guide towards creating polices and strategies that will concurrently help combat malaria transmission and improve socio-economic conditions. However, limited information is available that highlights the influence of socio-economic factors on malaria risk. The aim of this study was to analyse the influence of socio-economic factors on malaria transmission in KwaZulu-Natal (KZN), South Africa (SA) employing a Bayesian modelling approach. We obtained confirmed malaria case data from the malaria control program of KZN between 2000 to 2014. The socio-economic status (age, gender, education, source of water, type of toilet facilities, type of dwelling, energy source/fuel for lighting, annual household income) used in this study were obtained from the department of statistics, SA. The dependence of reported cases of malaria with socio-economic factors in KZN after employing different Bayesian models via Markov Chain Monte Carlo (MCMC) identified the zero inflated binomial model as the best fit model for our dataset. It also showed that gender, education and annual income were significant socioeconomic determinants of malaria transmission in KZN.

BACKGROUND: Malaria significant global burden, its spatial distribution and seasonality activity are sensitive change in climatic conditions and socio-demographic factors such as migration and internal population movements. In the Eastern Cape Province, South Africa, remarkable change in climate, migration flow and trend of malaria within the last decade from health facilities case reported raise questions on local transmission of the disease.

OBJECTIVE: To assess the impact of climate change and migration on emerging malaria transmission in the Eastern Cape Province.

METHOD: Descriptive and correlational analysis and retrospective secondary data review from the Department of Health of the Eastern Cape Province between 2010 and 2014 were performed. Analysis of variance (ANOVA) compares means in terms of gender, age, nationality, residence, origin/destination, year onset, season’s onset and variability of El Nino La Nina years.

RESULTS: The highest number of malaria cases was observed during cold seasons predicted by increased temperature of previous seasons. However, significance association was observed between migration flow and risk of transmission. Malaria cases were commoner in autochthone patients (South African citizens) than in migrant patients (other African nationalities) with significant P-value (P < 0.001).
CONCLUSION: The interaction between climate change and migration flow has positive accounts for predictors of emerging local transmission of malaria in the Eastern Cape Province, South Africa. This requires a public health response to better understand the local epidemiology of malaria in the province and bring strong policy to control its onset.

KEYWORDS: malaria, climate change, migration and Eastern Cape Province, South Africa

CLIMATE CHANGE, CLIMATE VARIABILITY, LOCAL SEASONALITY, AND CEREBROVASCULAR DISEASE IN CENTRAL AFRICANS

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Introduction: The significant impact of seasonality and climate change on stroke-related morbidity and mortality is well established, however, some findings on this issue are conflicting. The objective was to determine the impact of gender, ages, seasons, years of admission, temperatures, rainfall and El Nino phenomenon on ischemic and hemorrhagic strokes and fatal cases of stroke.

INCREASE IN APPARENT TEMPERATURE (TAPP) AND RESPIRATORY DISEASE DEATHS IN CAPE TOWN DURING 2006-2010

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Several studies have associated weather with mortality, but there is a need of such studies in developing countries such as South Africa. The study’s objective was to investigate if there is significant association between the daily outdoor Tapp and daily respiratory disease (RD) deaths in Cape Town. Confounding by air pollution (PM10, NO2 and SO2) was investigated. The time-stratified case-crossover and time-series epidemiological designs were used to investigate the association. Mortality, meteorological and air pollution data were obtained from Stats SA, SA Weather Service and the Department of Environmental Affairs, respectively. In total 10914 RD deaths occurred in Cape Town. The association between the 2-day cumulative average (CA2) of Tapp and RD deaths is linear, thus no smoothing splines were used. Per IQR (7°C) increase in the CA2 of Tapp, an insignificant 0.2% increase in RD deaths was observed for the >=65 age group, after adjusting for PM10. An insignificant 0.8% and 2% increase in RD deaths was observed for all ages and the >=65 age group, after adjusting for SO2. Per IQR (6°C) in CA2 of Tapp, an insignificant 0.2%, 0.1% and 0.4% increase in RD deaths was observed for the respective age groups, after adjusting for NO2. Results show that the >=65 age group appears to be more susceptible to Tapp increases.
Session 9C: Marine and Coastal

THE ROLE OF PIONEERS AS INDICATORS OF BIOGEOGRAPHIC RANGE EXPANSION CAUSED BY GLOBAL CHANGE IN SOUTHERN AFRICAN COASTAL WATERS

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The South African coastline is just over 3000 km in length yet it covers three major biogeographic regions, namely subtropical, warm temperate and cool temperate. In this presentation we review published information to assess the possible role of climate change in driving distributional changes of a wide variety of organisms around the subcontinent. In particular we focus on harmful algal blooms, seaweeds, eelgrass, mangroves, salt marsh plants, foraminiferans, stromatolites, corals, squid, zooplankton, zoobenthos, fish, birds and crocodiles. The role of pioneers or propagules as indicators of an incipient range expansion are discussed, with mangroves, zoobenthos, fishes and birds providing the best examples of actual and imminent distributional changes. The contraction of the warm temperate biogeographic region, arising from the intrusion of cool upwelled waters along the Western Cape shores, and increasingly warm Agulhas Current waters penetrating along the eastern parts of the subcontinent, are highlighted. The above features provide an ideal setting for the monitoring of biotic drivers and responses to global climate change over different spatial and temporal scales, and have direct relevance to similar studies being conducted elsewhere in the world. We conclude that, although this review focuses mainly on the impact of global climate change on South African coastal biodiversity, other anthropogenic drivers of change such as introduced alien invasive species may act synergistically with climate change, thereby compounding both short and long-term changes in the distribution and abundance of indigenous species.

SEASONAL CHANGES IN THE SALT MARSH TERRESTRIAL BOUNDARY VEGETATION

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The sea-land estuary interface is occupied by diverse and specialized plant habitats such as salt marshes. At this interface future sea level rise translates into a modification of salinity and inundation effects. An understanding of the effect of these environmental factors on plant growth and survival is required to predict, manage and adapt to climate change. Seasonal changes in the salt marsh-terrestrial boundary were investigated at Swartkops Estuary. Long-term monitoring plots were established to track changes in plant and sediment characteristics of this ecotone habitat. Plant cover abundance as well as sediment characteristics were measured. In addition, laboratory studies were used to assess the morphological response of selected ecotone plant species Disphyma crassifolium to different salinity and inundation states. This was done using a 3 x 5 controlled experiment of three inundation levels (tidal, waterlogged and drought) and five salinity levels (0, 8, 18, 35, 45 ppt). The transect surveys identified three distinct zones along the boundary i.e. Drosanthemum parvifolium, Sarcocornia pillansii and D. crassifolium distributed along an elevation gradient. During winter the vegetation changed and the sedge, Isolepis sp. was dominant in the ecotone habitat in response to low electrical conductivity during winter. Laboratory studies showed that the ecotone species grew best in the drought treatment at a salinity of 8 ppt. There was a cessation of growth in the waterlogged conditions and steady growth in the tidal treatments in high salinities (> 18 ppt). Plants in the drought treatments were more succulent than the tidal and waterlogged-treated plants. These results indicate that D. crassifolium is sensitive to high
salinity and waterlogging and wouldn't survive complete submergence with seawater. Therefore, sea level rise will result in growth reduction of ecotone plants.

SEASONAL VARIATION OF INVERTEBRATE DIVERSITY IN ROCK POOLS AND EMERGENT ROCKS ALONG THE WILD COAST OF SOUTH AFRICA

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The rocky intertidal zone is a biodiversity rich interface between land and sea whereby interlocking habitats create a mosaic of heterogeneous habitats for different organisms. With varied tidal levels organisms are exposed to physical and physiological stresses that then govern their distribution on shore. However, the occurrence and diversity of invertebrates is also influenced by annual seasonal changes. This study thus aimed to quantify whether different habitats and seasons influenced the invertebrate community structure along the Wild Coast. Invertebrate species richness and diversity was computed in rock pools and emergent rock outcrops across six sites (Dwesa-Cwebe, Silaka and Huleka Nature Reserves and Nqabarha, Presley’s Bay and Mngazana) over a 12 months period. This was all conducted during a day time low spring tide. The results showed that Mngazana rocky shores had the highest invertebrate diversity (H=0.914) on the high shore, during summer, compared to the high shore of the other sites in summer. The lowest value was recorded in Silaka during winter (H=0.444). The highest diversity for limpets was found in Presley’s Bay during the spring season. As a result, there were no significant correlations between the low, mid and high shores across the sites over the various seasons. Seasonal variations were more pronounced on the emergent rock than inside rock pools.

Keywords: Distribution, habitat, wave action, exploitation, zonation, temperature.

MORPHOLOGICAL CHARACTERISATION OF TWO NON- TERRITORIAL PATELLID LIMPETS ALONG THE WILD COAST

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The Patellidae family comprise four genera that consist of more than 39 limpet species globally. Limpets in this family are either migratory (i.e. non-territorial) or resident (i.e. territorial) and are characterized by different features. This study thus aimed to describe the morphological characteristics of two non-territorial limpets, Scutellatra granularis and S. natalensis. Thirty individuals were collected per species in each of the four sites studied along the Wild Coast. Shell length (SL), shell width (SW), shell height (SH), shell mass (SM), meat mass (MM) and total body weight (BW) were measured. Thereafter: condition index (CI), shell conicity and shell ellipticity were calculated. Results showed that S. granularis had a higher SL (2.27±0.11 cm), SW (1.63±0.09 cm), SH (0.91±0.07 cm), SM (1.19±0.17 g), MM (0.81±0.11 g) and BW (2.03±0.29 g) compare to S. natalensis SL (1.94±0.03 cm), SW (1.41±0.02 cm), SH (0.71±0.04 cm), SM (0.61±0.04 g), MM (0.37±0.02 g) and BW (1.07±0.09 g). Ellipticity was similar in both species while S. natalensis was less conical (0.37±0.02) than S. granularis (0.39±0.01). The CI was similar, and there were positive correlations between shell length and body weight, in both species. These two species therefore share more common, than different, morphological features.

Key words: Aperture, correlation, distribution, nodules, shell morphology, size variation
DECREASING FRESHWATER SUPPLY REDUCES THE PRODUCTIVITY OF ESTUARIES AND NEARSHORE MARINE ENVIRONMENT

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Estuarine functioning is dependent on adequate freshwater inflow and inlet opening regimes for their high productivity. The productivity depends on conducive environmental conditions, and the exchange of biota with the nearshore environment. Ecological networks of several estuaries along the KwaZulu-Natal coast have been investigated for their standing stocks, productivity and resilience under various environmental conditions, foremost depending on seasonal rainfall and drought conditions. Clear differences in standing stock, productivity and network resilience could be attributed to freshwater availability. Not only are estuaries dependent on riverine input. Also the oligo- to mesotrophic KwaZulu-Natal Bight, the provinces most important shelf area within the 200 m isobath, depends on terrestrial influence delivered via KZN’s rivers. The food web of the KZN bight has been found to substantially depend on riverine detritus input for its energy requirements. In addition, as a closed inlet precludes juvenile prawns from using the nursery area the impact of several scenarios of nursery area availability and fishing effort were investigated by virtually closing and opening such areas (e.g. St. Lucia) and quantifying the impact on the prawn fishery and the ecosystem of the KZN-Bight. In conclusion, the disruption of adequate freshwater supply to the nearshore environments has serious consequences not only for biodiversity, but also for habitat availability, thus impacting on productivity and nursery areas along the coast.

TOO HOT TO HANDLE? THERMAL TOLERANCE AND THE POTENTIAL EFFECTS OF CLIMATE CHANGE ON COASTAL AND ESTUARINE ORGANISMS IN THE KARIEGA ESTUARY AND ADJACENT INTERTIDAL COASTLINE

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Climate change occurs at global, regional and local levels and causes extensive effects on ecosystems. Temperature is one of the primary factors controlling physiological and life history functions in aquatic organisms. Presently, temperature changes are evident, yet not similar, on all continents and in the oceans and is responsible for causing shifts in aquatic organisms phenologies, physiological and behavioral traits, geographic ranges, productivity, and the disruption of diverse species interactions. Therefore, understanding the physiology of differential climate change effects (i.e. change in temperature) on organisms is one of the many urgent challenges faced by contemporary science.

In various volumes, ecological and evolutionary physiologists have pointed out the increasing importance of studying the physiological responses of organisms to climate change including tolerance limits to environmental change. Thereby, by incorporating several taxonomic groups to thermal tolerance studies, one may be able to understand which community components are more vulnerable to climate change. Furthermore, it has been suggested that research into climate change in the marine environment should focus on coastal and estuarine environments, as these environments are shallow and highly dynamic, being a good indicator of climate change.

Therefore, the main aim is to determine thermal tolerance of various warm-temperate, cool-temperate and tropical fish and invertebrate species from different habitats occurring in the warm –temperate Kariega estuary and adjacent intertidal environment. This results in hypothesizing that marine organisms inhabiting coastal intertidal habitats are more vulnerable to thermal warming compared to marine organisms inhabiting estuarine habitats and also that tropical and cool-temperate marine organisms are more vulnerable to thermal warming compared to warm-temperate marine organisms.
This will contribute important knowledge on predicting impacts of climate change on estuarine and coastal fish and invertebrates as well as to provide new information on temperature tolerance of estuarine and marine fish and invertebrates in South African coastal waters.

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THE EFFECT OF VACHELIA KARROO SIZE ON MORTALITY AND COMPENSATORY RESPONSES FOLLOWING HERBIVORY

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Savannas of the Eastern Cape are being encroached by woody vegetation and one of the major contributors is Vachellia karroo (Acacia), hence the aim of this study was to investigate how survival and growth of this common African savanna species are influenced by its age and size. We conducted field and greenhouse trials to determine the effect of plant age and size on the survival and compensatory responses of V. karroo seedlings and saplings following simulated browsing under controlled and natural conditions.

Age interacted with repeated browsing and negatively influenced seedling survival and regrowth. Older seedlings (16 and 30 weeks old) had greater survival with higher browsing frequencies resulted in greater mortality and reduced growth. The threshold age after which seedlings become more tolerant to herbivory occurs at an age of 28 weeks. Seedlings less than six weeks old experiencing intense (100% defoliation) browsing had a very low probability (33%) of survival following just a single defoliation. Interestingly, all 16 week old seedlings regrew most of their foliage following a moderate (50%) defoliation with some plants overcompensating for leaf loss. Among field plants there were two distinct demographic stages (< 9 mm and > 9 mm stem basal diameter (SBD)) which differed markedly in their rates of regrowth in response to defoliation – regardless of defoliation intensity.

An increase in tree cover requires successful transitions of seedlings into saplings. The results of this study suggest that in semi-arid savannas, browsing can impact tree cover through imposing a recruitment bottleneck for tree seedlings and, to a lesser extent, saplings. Moreover this research suggests that there is a “browse trap” where V. karroo seedlings, specifically seedlings less than 28 weeks old or have a SBD less than 9mm, have increased vulnerability to repeated intense browsing.

HOW CAN WE MODEL CLIMATE CHANGE AND LAND USE IMPACTS ON DIVERSITY OF AFRICAN SAVANNAS?

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Grass-tree dynamics in semi-arid savanna ecosystems are characterized by the interaction of precipitation, grazing and fire. These factors affect plant community composition, structure and dynamics, and regulate the balance between woody vegetation and grasses. Climate change combined with increasing land use pressure make savannas prone to degradation processes. Overgrazing and excess fuelwood extraction may result in degrading pasture quality, loss of productivity, shrub encroachment, loss of functional diversity, and alteration of habitat structure. These processes may adversely affect the capacity of savannas to support humans, their domestic animals, and wildlife diversity. In order to attempt mitigation of adverse effects on savannas under changing climate and land use regimes, a quantitative understanding of savanna vegetation dynamics and its underlying processes.
is required. Dynamic vegetation models are excellent tools to simulate vegetation shifts due to environmental changes, but most state-of-the-art DGVMs have trouble to adequately represent detailed changes in functional diversity. Therefore, we developed aDGVM2, an individual- and trait-based model that specifically focuses on a more detailed representation of savanna ecosystems. It allows to model process-based vegetation dynamics as a function of environmental conditions (climate, soil) and community-scale interactions (resource competition between plant individuals), and generically selects for plant individuals with traits that allow adaptation to prevailing conditions. The aDGVM2 distinguishes annual and perennial grasses, single-stemmed trees, multi-stemmed shrubs, and simulates fire and grazing disturbance. Case studies for South African savannas using aDGVM2 show that (over-)grazing causes a shift from predominantly perennial to more annual grasses, while fire and increasingly arid conditions promote dominance of shrubs over trees. Based on our results, we aim to identify best-practice land management guidelines for stakeholders to preserve and promote productivity, functional diversity, desirable structural composition as well as vegetation community composition in savanna ecosystems.

RAINFALL VARIABILITY AND ITS INFLUENCE ON WILDLIFE. CASE STUDY: WONDERKOP NATURE RESERVE, SOUTH AFRICA: LIMPOPO PROVINCE

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The climate of the world varies from one decade to another, and a changing climate is natural and expected. Rainfall is one of the most important environmental factors; its effects directly determine animal distribution as well as their productivity. However, there is a well-founded concern that the unprecedented human and industrial development activities have caused changes over and above natural variation which led to low amount of rainfall received during dry seasons (July to September) in Wonderkop Nature Reserve. This lead to high mortality rate as a result of insufficient grazing and water supply. Seasonal to inter-annual rainfall variability in Africa demonstrate how the society is under serious threat due to increasing natural disasters linked to climate variability and change. This research used quantitative research method. The population data collected in the study were mainly through field observation and field survey and climate data were collected from South African weather focus and also from the reserve. Road trip observation was conducted in order to identify common place where animals usually gather or prefer to graze. This was done to check if animals preferred certain places to others. The road trip observation was also used to check any dead animals in the preserve if they had died out of starvation or out of being preyed by other predators. The data were collected on two different places (Southern and Eastern Section) within Wonderkop Nature Reserve. There are dramatic climatic changes in the period of 2003 to 2012 and those changes had negatively impact in term of loss water and food availability for wildlife. This resulted to high mortality rate during dry seasons as a results of food competition and insufficient food. This shows relationship between rainfall variability and population dynamics at Wonderkop Nature Reserve.

FUTURE-PROOFING FOOD: LINKING SUSTAINABLE FOOD PRODUCTION WITH NATIONAL CONSERVATION TARGETS

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With increasing pressures on food production and concern over maintenance of biodiversity and delivery of ecosystem services, there is an urgent need to future-proof food production while maintaining the natural environment for future generations. In South Africa, there is a significant lack of information on how agricultural production influences ecosystems and natural processes, or its
consequences to the long-term sustainability of agricultural systems that depend on these natural resources. The future-proofing food programme aims to assess, and more importantly, to make recommendations on ways to produce food in South Africa within the framework of the National Biodiversity and Strategic Action Plan. Specifically, we research actions which maintain ecosystem processes through biodiversity conservation within production landscapes, and minimize environmentally harmful practices, while meeting agricultural production targets. This involves researching ways in which the agricultural sector can improve the conservation of biodiversity in and around production areas, and thereafter, to link these production areas into larger conservation networks. We also aim to re-invigorate current agricultural practices by ensuring sustainable use of precious and irreplaceable resources and help to produce field crops using production techniques that minimize the use of external artificial energy inputs (fertilizer) while maximizing the use of natural inputs (soil fertility, sunlight, water) and natural populations (biodiversity) in order to be economically and ecologically sustainable. The programme has two prongs: original research, and synthesis. Research was performed on very strategic and urgent needs, while at the same time existing research and citizen knowledge was combined and synthesized. Original research in the forestry sector has focused on validating and applying fundamental design and management principles for biodiversity conservation within South African production landscapes. This technology has now been transferred to the Western Cape agricultural sector with a strong emphasis on ecosystem function.

CAN POSITIVE BIOTIC INTERACTIONS MEDIATE CLIMATE-DRIVEN RANGE SHIFTS? A CASE STUDY FROM THE SUB-ANTARCTIC

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The importance of plant-plant interactions in predicting community responses to climate change has gained recognition in recent years. However, the majority of studies have focused on the impact of negative (e.g. competitive) interactions on community dynamics and species distributions, while positive (e.g. facilitative) interactions have rarely been considered. In alpine systems, cushion plants (i.e. compact, low-growing, hemispherical plants) create more favourable microhabitats for other species compared to the surrounding environment by ameliorating disturbance and stress. Cushion plants therefore have the potential to facilitate the upward migration species in response to climate warming. This study examines whether fine-scale facilitative interactions scale up to shape plant species distributions, and uses Azorella selago, a widespread cushion plant, and the rest of the vascular flora of Marion Island as a model system. We assess if the elevational distribution of vascular plant species differs when growing in association or away from A. selago. The upper distributional limits of most species did not differ significantly in the presence and absence of A. selago. However, A. selago had a strong positive effect on the upper range limit of one species, Colobanthus kerguelensis (+119.38 m) and a marginally significant positive effect on another, Lycopodium saururus (+30.82 m). Therefore, even though A. selago strongly impacts the fine-scale occurrence and performance of some species, these local impacts only scale up to shape the distribution of some vascular plant species. Thus, positive plant-plant interactions have the potential to mediate climate-driven range shifts by expanding species’ upper distributional limits, although the influence of these interactions may be species-specific.
Ferns are a fascinating group. They have their origin in the Carboniferous, while most modern taxa only stared to radiate during the late Cretaceous. They have been out-competed by Angiosperms in high productivity environments and rarely dominate ecologically. One exception of this is on Marion Island, where Blechnum penna-marina has the highest biomass of any vascular plant, as well as covers the largest area up to 300 meters above sea level. Blechnum penna-marina and other ferns are also some of the species that are moving up-slope at higher rates than most of the indigenous angiosperms. This raises some interesting questions; like why do these ferns out-compete angiosperms in most habitats? And why are ferns and fern allies moving up-slope better than other taxa? Another aspect of Marion Island is that it is quite similar to the environment of the Last Glacial Maximum (with low temperatures and high rainfall). Could this island and its climate give us an idea of how ferns and other taxa coped with the Last Glacial Maximum? I will try to address these questions by using nutrient data, climactic and physiological data collected the past few years.
MITIGATING GREENHOUSE GAS EMISSIONS ON SMALLHOLDER DAIRY FARMS

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Poor quality dairy cattle diets have low nutrient use efficiency and contribute to high rumen methane production. Management of feeds and feeding systems is important in reducing the carbon footprint of dairy cattle especially on forage based systems. Four forage: concentrate diets supplied to pregnant and lactating dairy cattle on smallholder farms were evaluated. The forage: concentrate ratios were 73:27 (HD1: -60 pre-partum); 67:33 (HD2: -30 pre-partum); 60:40 (LD1: 1-30 days in milk (DIM) and 42:58 (LD2: -30-60 DIM). Acid detergent fibre (ADF) and crude protein (CP) content of these diets range from 291 to 342 and 120-127 g/kg DM respectively. Animals’ body condition was scored for every stage and daily (AM) milk production was taken for up to 60 DIM. All diets were poorly degraded with mean DMD and effective degradability of 550 g/kg and 620 g/kg DM respectively. There was an inverse relationship between dry matter disappearance and ADF ($r= 0.99; P<0.01$) but positive correlation with CP content. Mean BCS and AM milk yield were low and ranged from 2.0 to 2.75 and 6 to 14 kg/cow respectively. Diets ADF was higher than 170-210 g/kg DM recommended for lactating small dairy breeds (NRC, 2001). Dietary forage was low in CP and available NDF and affected body gain. All diets for pregnancy and lactating cows were poorly degraded ruminally. This is an indication that nutrients in both fed low and high concentrate diets did not stimulate growth of both structural and non-structural carbohydrates due to energy and protein insufficiency. High concentrate diets that are low in available carbohydrates result in loss of carbon and hydrogens toward methane synthesis.

ASSESSMENT OF THE PROPERTIES OF TORREFIED SUGARCANE BAGASSE RELEVANT TO GASIFICATION

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Sugarcane bagasse was torrefied to improve its quality in terms of thermal and physical properties prior to gasification. Torrefaction of sugarcane bagasse was undertaken at 300 °C in a chemically inactive atmosphere of nitrogen, and at 10 °C/min heating rate. A residence time of 5 minutes allowed for the rapid reaction of the material during torrefaction. The torrefied sugarcane bagasse was characterized to determine its suitability as feedstocks for gasification. Results showed that torrefied bagasse showed reduced ration of oxygen to carbon as well as increased higher hydrogen to carbon ratio with a heating value of 20.19 MJ/kg. SEM results also revealed a fibrous structure and pith in the micrographs of torrefied bagasse, indicating that the material is carbonaceous in nature, and exhibiting a more permeable structure with larger surface area that depicts features of the material which favours gasification. The gasification process of the torrefied material relied on computer simulation to establish the impact of torrefaction on the conversion efficiency of the process. Optimum conversion efficiency achieved during gasification of torrefied bagasse was 60%, which was due to a number of factors that included the slightly modified properties of the material.
PRELIMINARY RESULTS OF A MULTI-PARAMETER AIRBORNE 
GEOPHYSICAL SURVEY IN THE JANSENVILLE AREA, EASTERN CAPE

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We report on the preliminary results of a new high-resolution geophysical survey flown in the southern Karoo in the Eastern Cape. This aeromagnetic and radiometric survey complements other surveys in the area looking at different aspects of the subsurface. Since different geophysical survey methods are suited for different features there is value in surveying a given area using a variety of methods, even if these surveys are not time-continuous, since most geological features are not likely to change on a human time-scale. The parameters of a survey of the same method also have a large influence on the usefulness of results.

We will provide the preliminary results of the current aeromagnetic survey, and compare these to regional historical aeromagnetic data and features identified using other methods in the same area.

The data (being collected at the time of submission) will be used to improve our understanding of the subsurface architecture of the southern Karoo Basin in the vicinity of Jansenville, which may provide insights to movement of groundwater by mapping the distribution of small-scale features in the near-surface. This understanding is important to the development of evidence-based policies regarding future land and resource use in the area, especially given that the area is already heavily reliant on groundwater, and will become more so given current projections. In tandem with other work taking place in the area, such as groundwater testing, the observations will also feed into potential shale gas development in the Karoo by providing an indication of how inter-linked any detected groundwater pathways are.

SOCIO-ECONOMIC IMPACTS OF LAND RESTORATION PRACTICES ON 
RURAL COMMUNITIES IN THE UMZIMVUBU CATCHMENT, SOUTH AFRICA

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South Africa’s communal rangelands are grappling with black and silver wattle invasions. Wattle invasion contributes to soil erosion, reduction in grazing areas, stream flow reduction and reduces the capacity of indigenous plants to reproduce. An area of almost 6 720 km2 out of a total area of 167 398 km2 in the Eastern Cape has been invaded by alien plants including black and silver wattle. Working for Water Programme was designed to reduce the rate of unemployment by employing members of rural communities while eradicating alien invasive plants. This study aims to investigate the impacts of wattle clearing on the stream flow. Data will be collected through in-field assessments, questionnaires, interviews with the project managers, farmers, Department of Environmental Affairs and some extension interviews with the NGOs with regards to the future use of cleared areas. Increased water yields after clearing wattles will be estimated by applying the formula: Stream flow reduction (mm) = biomass (g/m2) × 0.0238. Some contingent valuation method will be undertaken by asking people how much they are willing to pay for certain environmental assets and all the other activities that are likely to affect stream flow.

Key words: invasive alien species, black and silver wattle, agriculture, Working for Water Programme, water yields.
SHELL MORPHOLOGY AND REPRODUCTION OF SCUTELLASTRA LONGICOSTA IN THE WILD COAST

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Reproduction in limpets occurs through spawning and type of spawning depends on the body size. Growth and reproduction is often affected by seasonal changes in the wild. Reproduction in South African limpets has been understudied and this study thus aimed to describe gonadal development and sex differentiation by histology. Individuals of Scutellastra longicosta were collected in Dwesa marine protected area, along the Wild Coast. Shell dimensions such as shell length, shell width and shell height were measured. Wet weight, somatic mass, visceral mass and gonad weight were weighed. To determine the shape of S. longicosta shell conicity and shell ellipticity were calculated, while gonad somatic index (GSI) was calculated for reproductive output. Results showed that females had a higher SH, SW, WW, GW and GSI, SC than males and neuters. The gonads varied in sizes, females were larger, males were medium and neuters were smaller indicating that this species is truly protandrous.

Keywords: Shell morphology, histology, spawning, gonad index, size variation, limpets.

SCREENING OF YELLOW QUALITY PROTEIN MAIZE (QPM) INBRED LINES FOR BASAL AND ACQUIRED THERMOTOLERANCE

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Maize is the most important cereal crop in Africa. However, its production is under serious threat due to the increasing occurrence of abiotic stress factors such as drought, salinity and most importantly, heat stress. In this study, 18 yellow QPM inbred lines were screened for tolerance to heat stress using the water bath and growth chamber techniques at the University of Fort Hare. A randomized incomplete block design with three replications was used for each experiment. Total biomass was used to compute three stress indices; heat susceptible index (HSI), heat tolerant index (HTI) and tolerance (TOL), which were used to determine the response of all genotypes to heat stress. Based on the water bath study, there were highly significant differences (p < 0.001) in coleoptile growth, which was used to calculate heat tolerance index for basal thermotolerance, and line 17, 24, 32, 33 and 12 proved to be tolerant. In a separate growth chamber study, lines 3, 16 and 18 exhibited acquired thermo–tolerance based on the HTI and HSI calculated. While basal thermotolerance is useful prior to emergency, acquired thermotolerance is effective after crop emergency. Combining these mechanisms of tolerance in single genotypes is highly recommended. Furthermore, these inbred lines should also be evaluated under field conditions to ascertain their thermotolerance at later stages of growth. Nevertheless, the thermotolerant genotypes identified in this study will be useful in plant breeding programs aimed at developing heat tolerant varieties.

ENVIRONMENTAL DRIVERS OF DIATOM BIOGEOGRAPHICAL PATTERNS ALONG THE COAST OF SOUTH AFRICA

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Marine botanical biogeography has been extensively documented in South Africa with a specific focus on macroalgae (seaweed). The knowledge of patterns in the geographic distribution of diatom flora is
limited and the diversity of marine benthic diatoms along the coast of South Africa remains unknown. Due to changing ocean temperatures and increased anthropogenic impacts, there is a degree of change with respect to species distribution in the marine ecosystem. Despite temperature being identified as the main determinant of biogeographical patterns and ecosystem processes, the aim of the research is to determine the biogeography of marine littoral diatoms along the coast of South Africa by determining the main environmental drivers responsible for such geographic patterns. Diatoms are excellent bioindicators of their environment, and once the diversity, biogeography and environmental drivers are known, species can be used to detect change in the marine environment. The main hypotheses to be tested are: a) seawater temperature is the main environmental driver of marine benthic diatom biogeography and b) marine benthic diatoms exhibit the same biogeographic patterns as the intertidal macroalgae around the coast of South Africa.

MAPPING THE ZONATION PATTERN OF BOTH LIMPETS AND SEAWEEDS IN HLULEKA MARINE PROTECTED AREA

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The Wild Coast is a transition between the warm subtropical East Coast and the cold temperate West Coast of South Africa. As such, this area comprises some species with both cold temperate and subtropical affinities. Therefore, changes in sea surface temperatures will lead to a dominance of either cold species or subtropical species. Research has shown that global warming will lead to increased sea temperatures, which will result in dominance of subtropical species in areas formally occupied by temperate species. The purpose of this study was therefore to locate, identify and map the distribution of limpets and seaweeds in Hluleka MPA. The study also aimed to quantify the effects of habitat heterogeneity on limpet and seaweed diversity. Vertical line transacts were laid from high shore to low shore and species were identified. Species diversity and density were recorded. All data were mapped and analysed using QGIS. Rhodophytes such as Jania verrucosa, Hypnea spicifera and Arthrocardia carinata were found co-existing in mixed habitats from mid to low shore. Brown crustose algae such as Ralfsia verrucosa and R. expansa occupied emergent rocks on the low show but preferring mixed habitats in the midshore. Fissulera natalensi and Cellana capensis were the most abundant limpet species in rock pools and mixed habitats. Overall, the zonation pattern and species diversity of Hluleka MPA was determined mostly by habitat types. Species with temperate affinities dominated this MPA while no species of subtropical affinities were found. This study was an ideal baseline study for monitoring species shift and replacement due to global warming in future.

Key words: abundance, density, distribution, diversity, habitats, rocky shores.

DRIFTER TRAJECTORIES IN THE AGULHAS SYSTEM – DOES DEPLOYMENT POSITION MATTER?

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It is hypothesized that a surface drifter’s ultimate trajectory through the Agulhas System is related to its release position relative to the Agulhas Current’s inshore front. Modelling studies suggest that a drifter deployed inshore of the core of the current is likely to propagate westwards into the South Atlantic via the Benguela Current, whilst a drifter deployed offshore of the core is more likely to propagate eastwards into the Indian Ocean. To test these theories, five SVP drifters were deployed along the Agulhas System Climate Array (ASCA) at 34° S. Soon after deployment the three drifters deployed...
closest to the Agulhas Current core completed at least one rotation around a trapped cyclonic eddy on the south eastern edge of the Agulhas Bank. After which the first drifter was caught in the Agulhas Retrofection before propagating into the South Atlantic, the second drifter propagated into the South Atlantic after completing a series of sub-mesoscale rotations on the western edge of the Agulhas Bank and the third drifter was trapped on the Agulhas Bank. Drifters four and five, deployed furthest from the Agulhas Current Core, were expelled into the Indian Ocean after interacting with an anti-cyclonic eddy. Sub-mesoscale features identified in this study are important processes for both cross shelf and inter-ocean exchange and are further investigated using a method developed by Lumpkin (2016) which identifies looping characteristics in surface drifter trajectories. Enhanced understanding of fine scale current characteristics around South Africa will broaden knowledge on how these dynamics are modified over time and whether these dynamics are being exacerbated by changes to the global climate.

AIR POLLUTION STUDIES IN DURBAN, SOUTH AFRICA: A REVIEW

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Air pollution is a major problem of the new millennium and it has become increasingly clear that human activities are playing an important role in the cycling of trace gases in the atmosphere1.

Poor air quality can affect health and the wider environment, particularly in urban areas where the majority of people live and work.

Due to their abundance and substantial health impacts, pollutants chosen with direct relevance to this investigation include: CO, NO2, SO2, O3 and particulate matter (PM 2.5 and PM 10). Their health and environmental impacts are briefly outlined below:

• CO: Excessive exposure results in headache, dizziness, vomiting, and nausea. At high concentrations loss of conscious or death can occur2.

• NO2: It is a known respiratory tract irritant in mammals and is implicated in the corrosion of metals3.

• SO2: It is linked to adverse effects on the respiratory system such as broncho-constriction/ increased asthma symptoms4.

• O3: A reactive oxidant gas playing a key role in the photo-chemistry of air pollution and atmospheric oxidation processes2.

• Particulate matter (PM) is associated with cardiovascular disease, lung cancer and asthma. Impacts of these materials also include effects on visibility and climate5.

South Africa has been identified as a source of industrial pollution significant on a global scale6. The South Durban area has a basin-like topographical configuration that facilitates the accumulation of air pollution as well as being the location of petrochemical refineries and chemical industries7.

A principle by-product of industrial processes is SO2 and it is often used as an ‘indicator pollutant’8. Measurements of SO2 levels in Durban began in 1958 and it is therefore the pollutant with the longest record of near continuous monitoring. A comprehensive review of air pollution studies in Durban from 1990 to the present is presented for the species listed above.
LAND COVER MONITORING IN THE KEISKAMMA CATCHMENT OF THE EASTERN CAPE PROVINCE OF SOUTH AFRICA USING REMOTE SENSING TECHNIQUES

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Countries around the world are faced with land use and land cover change due to various factors such as rapid population growth, increased demand for agricultural productivity, and change in climatic characteristics. Land cover change is therefore a serious problem that needs to be addressed through careful monitoring and management. Automated geographical analysis offers a powerful tool for monitoring and detecting land cover and land use change over time and space. This study was conducted in the northern Keiskamma catchment of the Eastern Cape province of South Africa. Although the catchment hosts a high level of biodiversity in both flora and fauna, there is lack of empirical data showing the land cover dynamics of the area. The aim of this research was to quantify land use and land cover dynamics in the area using Landsat imagery between the years 2000 and 2016. Five images were acquired at an interval of approximately four years. Six land cover classes were generated by classifying the multispectral and normalized difference vegetation indices (NDVIs) of each date. An unsupervised classification was adopted for the classification in this study, since an in-depth knowledge about the land cover types of the area was lacking. Accuracy assessment of the classification based on the latest image was evaluated using reference data interpreted from Google Earth image. The multi-temporal classes were subsequently compared in a post-classification change detection analysis. The overall accuracy of the study in comparison to the reference data was 72%. The change detection analysis revealed a 16% decrease in dense forest, while grasses, bush and bare soil/built-up area, water bodies increased 9%, 5%, 2% and 2% respectively. Cultivated lands proved to be the most stable class only registering an increase of 1%. These findings show that bush encroachment and deforestation are the leading causes of forest degradation in the area.

POTENTIAL IMPACT OF CLIMATE CHANGE ON EXTREME RAINFALL EVENTS AND AFRICAN EASTERN WAVES OVER WEST AFRICA

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The uncertainty in the future characteristics, intensity and frequency, of Extreme Rainfall Events (EREs) and its impact on the socioeconomic of West Africa remains a source of concern to inhabitants, researchers and policy makers. This study examines the relationship between African Easterly Waves (AEWs) and EREs over West Africa and investigates how climate change could alter the relationship in the future. Satellite observations, reanalysis data and regional climate model (RCA4) simulations (forced with eight global climate simulations) were analyzed for the study. The study used the 95th percentile of daily rainfall as a threshold to identify extreme rainfall events, and applied spectral analysis to extract 3-5 day and 6-9 day AEWs from 700hPa meridional wind component over West Africa. RCA4 captures the link between the structure of AEWs and rainfall pattern over West Africa, and shows AEWs contribution to EREs over the region ranges from 20 to 60% as depicted by reanalysis data. Nonetheless, the ensemble mean simulations indicate no significant changes in the contribution of AEWs to EREs under RCP4.5 and RCP8.5 emission scenario. This suggests that the increase in the frequency and intensity of the EREs may not be attributed to the changes in AEWs. The study’s applications is in understanding the future impact of climate extremes over West Africa and also help inform policy makers in their decision making in mitigating future EREs over the region.

Keywords: Extreme rainfall events, African Easterly Waves, Climate change, Dynamical downscaling, West Africa
MODELLING DISPERSAL AND CONNECTIVITY OF BROADCAST SPAWNING CORAL IN THE WESTERN INDIAN OCEAN

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Connectivity, or the exchange of individuals among marine populations, is of great importance to meta-population dynamics, population persistence, and species expansion. The small size of larvae coupled with the vast and complex marine environment they occupy hamper our ability to quantify dispersal and connectivity. For many marine species, population connectivity is determined largely by ocean currents transporting larvae and juveniles between distant patches of suitable habitat. Here, a biophysical model driven by high resolution ocean currents derived from Regional Ocean Modeling System is applied to evaluate connectivity between Western Indian Ocean (WIO) reefs and incorporating individual trait variability. The results suggest that larval transport between reefs in the WIO region show the quasi-chaotic nature driven primarily by large-scale circulation and mesoscale features. There is strong dependence on particle release location and season, reflecting annual circulation patterns. There is clear differences (ANOVA, F = 4.78, p = 0.0114) in larval recruitment among spawning seasons with increased dispersal of reef larvae in JJA and SON. There is also significant differences (ANOVA, F = 7.04, p = 0.002) in self-recruitment for the different seasons but is higher in DJF and MAM. This point to the importance of constant larval retention for reef populations with some level of seasonal variability.

ESTUARINE ZOOPLANKTON COMMUNITY DYNAMICS IN THE FACE OF GLOBAL CHANGE

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Estuaries are a prominent feature along the South African coastline and play a number of ecological and economical functions including the cycling of nutrients, enhance coastal production, nursery and breeding sites for aquatic organisms, sources of food and sites for recreation and tourism. An important factor influencing the functioning of estuaries is the flow rate. In KwaZulu-Natal, estuaries fall into the subtropical bioregion where there are two distinct seasons with each season having marked impacts on the rainfall of the area which in turn influences flow rates of freshwater into estuarine systems. With increasing human development and forecasted changes associated with Climate change (more intense droughts and rainfall periods), the integrity of ecological systems are at risk. In order to ensure the health and viability of these systems, good management practices need to be implemented. Zooplankton have been shown to respond quickly to changes in their environment and are thus good indicators of ecosystem health. This study evaluated zooplankton community dynamics in the Mlalazi and Mdloti estuaries and related them to potential drivers in their respective environments. The Mlalazi zooplankton community was characterized by the typical marine and estuarine components with abundances varying on a seasonal basis. The Mdloti estuary was dominated by a freshwater community (cladocerans, cyclopoids and rotifers) with no seasonal differences being detected in the preliminary results. A possible contributing factor structuring the Mdloti zooplankton community is the influence of the Hazelmere dam which reduces freshwater inflow into the system. A compounding factor is the prolonged drought which further reduced the flow rates into the Mdloti estuary. A consequence of the reduced flow rates of the Mdloti is the closure of the estuary from the sea which in turn inhibits sea water flow into the system resulting in the system becoming fresh and in turn impacting the zooplankton species composition of the estuary.
QUANTIFYING RIPARIAN TOTAL EVAPORATION THROUGH THE USE OF SATELLITE EARTH OBSERVATION TECHNOLOGIES

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Knowledge regarding the water use of riparian vegetation and their associated impacts on groundwater and streamflow transmission losses in South Africa remains fairly limited. The use of satellite imagery for the estimation of spatially representative ET has been well documented and represents a suitable approach for the estimation of riparian ET. In this study two techniques, to estimate ET at both a moderate spatial and high temporal resolution were evaluated. The Surface Energy Balance System (SEBS) Model was used to derive daily ET from satellite imagery. The Kcact and output downscaling with linear regression approaches were evaluated by comparing their respective estimates against the original SEBS ET estimates and Eddy covariance (ECET) measurements at two separate locations, along the Groot Letaba River in the semi-arid north eastern South Africa. The ET estimates obtained using the Kcact approach and downscaling with linear regression compared favourably to the original SEBS ET values, producing RMSE values of 0.69 and 1.41 mm d⁻¹, respectively. Comparisons between ET estimates acquired using the Kcact approach and downscaling with linear regression against ECET was fairly poor, yielding RMSE values of; 1.88 and 2.57 mm d⁻¹ and 1.10 and 2.39 mm d⁻¹ for transects 1 and 2, respectively.

THE ROLE OF ENSO ON CHARACTERISTICS OF EXTREME AND HEAVY RAINFALL OVER SOUTHERN AFRICA

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Southern Africa is highly vulnerable to extreme and heavy rainfall, which can significantly impact its economy, society and environment. Rainfall variability in Southern Africa is largely moderated by the El Niño Southern Oscillation (ENSO), an ocean-atmosphere phenomenon which results in circulation and precipitation anomalies worldwide. Previous studies have identified eight distinct patterns of ENSO, based on sea surface temperature anomalies across the tropical ocean basins, and explored their influence on circulation and monthly precipitation anomalies over Southern Africa. This paper investigates the role ENSO plays on characteristics of extreme and heavy rainfall over Southern Africa, using GPCP daily rainfall data for the period 1996 to 2011. Extreme rainfall events were defined as days which exceeded the upper 95th percentile of the rainfall distribution and heavy rainfall events as three consecutive days which exceeded the upper 80th percentile. The annual and seasonal spatial distribution of extreme and heavy rainfall events over Southern Africa was plotted. Time series plots of the inter-annual and seasonal variability of percentage land area experiencing extreme and heavy rainfall during different phases of ENSO were also created. The results generally indicated that La Niña patterns experienced more extreme and heavy rainfall events than the El Niño patterns. The LN4 pattern indicated the highest occurrence of extreme rainfall events, thereby possibly producing more severe weather. The EN2 pattern indicated the lowest occurrence of extreme rainfall events, whilst the EN4 pattern indicated the highest out of the El Niño patterns. There appeared to be discernable differences between the ENSO patterns when comparing the spatial distribution of extreme rainfall events. However, when comparing the spatial distribution of heavy rainfall events, the patterns are fairly similar to each other. The GPCP daily rainfall data has a narrow temporal range, therefore future research would benefit from accessing a more comprehensive dataset.
DURBAN'S SOLAR CLIMATE
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Assessment of the solar resource is a key factor for the planning of efficient solar energy systems. The variable nature of solar energy at ground level is primarily due to clouds.

Due to high cloud cover, the Durban area has the lowest average solar radiation in South Africa of approximately 6000-6500 MJ/m² annually [1]. In addition, being a coastal location with sub-tropical climate, Durban receives relatively variable solar irradiance at ground level due to the dynamic cloud patterns.

Analysis of minute ground-based solar irradiance data shows that Durban’s climate can be grouped into five classes. These classes can be identified as sunny, cloudy, sunny morning-cloudy afternoon, cloudy morning-moderately sunny afternoon and random. Durban’s solar climate can be explained by having the largest percentage of sunny days, followed by the second largest percentage of cloudy days. Mixed days occur with almost equal frequency and random days are fairly rare.

This characterization of the solar radiation received at Durban will provide useful information for design and implementation, which is essential if the penetration of solar energy systems is to be increased.


INVESTIGATION OF STRATEGIES EMPLOYED BY RURAL HOUSEHOLDS TO IMPROVE FOOD SECURITY IN NKONKOBIE LOCAL MUNICIPALITY: A CASE OF ZIHLAHLENI LOCATION IN MIDDLEDRIFT, EASTERN CAPE PROVINCE
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Eastern Cape is one of the provinces which experiencing a rapid increase in food prices while household income is increasing at a slower rate. This aggressive state is locating ordinary Eastern Cape Province, at present striving to meet their basic household requirements and become more vulnerable to food security. The objectives of the study are to investigate strategies used by rural households to improve food security in Nkonkobe Local Municipality and to assess assets and resources of rural households to make use of strategies for enough food in Eastern Cape Province of South Africa. Data were collected from 100 households using a questionnaire as the main instrument. Analysis of data used was simple a descriptive statistics to describe household food security. Most households interviewed were male headed (50.3%). Unemployment level was high with 73.6% of the interviewed households being unemployed. The average household heads was 59 years. Most of the households owned home gardens and had access to arable land but they did not cultivate them. Furthermore most household perceive lack of capital as the main cause of food security and they depend on government grant. Access to enough food is affected by gender of head of household, household size, education level of household head, agricultural training and monthly total income. Most of the interviewed household heads depend mostly on food purchases rather than their own production. Therefore government should however continue fostering its agenda of improving agriculture in rural households though it does not contribute to it directly.

Keywords: Food security, household income, Agriculture
SLIPPERY CUSTOMERS FOR CONSERVATION: FRESHWATER EELS AND RIVER MANAGEMENT

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In southern Africa, Anguillid eels are a socio-ecologically important group of species that are poorly understood, poorly protected and potentially highly threatened and/or exploited. Temperate eel populations have declined dramatically to the point of endangerment during the last few decades. Tropical eels also face increasing threats due to global change, namely growing exploitation demands, habitat loss and development of water resource management schemes. The latter is particularly concerning along the east flowing rivers of South Africa.

Despite their socio-economic and ecological importance, the level of understanding regarding their occurrence, abundance, diversity and ecology still remains poor. Without this knowledge we are unable to adequately conserve these flagship species and the services they generate and ultimately, manage the rivers they occur in.

Two projects have been initiated to compare their historical and current distribution in KwaZulu-Natal (KZN), as well as assessing their genetic diversity. Within this framework, 20 sites have been sampled in the major rivers of KZN and DNA samples from 18 individuals and 3 species have been collected. The second project aims at evaluating the potential to use freshwater eels as a tool to monitor ecological changes in the uMgeni River using both remote and manual telemetry. A scoping survey was conducted in winter 2016 but no eels were actually recorded.

This PhD project then aims to address the knowledge gap in understanding these species by generating information regarding their distribution, population diversity and wellbeing. Consequently, this will aid in promoting biodiversity and river conservation for the benefit of all users.

RESPONSE OF SOIL MACROINVERTEBRATES IN DIFFERENT DISTURBANCES IN THE SANDSTONE SOURVELD IN KWA ZULU-NATAL

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Soil macroinvertebrates are used as bioindicators to assess the state of the environment and how the environmental conditions change over time as a result of anthropogenic and natural forces. There is no data on the effect of different disturbances on soil macroinvertebrates diversity and assemblages in different vegetation types in the sandstone sourveld, which is a species-rich and threatened grassland that is restricted to the interior of KwaZulu-Natal (KZN) Province in South Africa. The aim of this study is to develop a bioindicator tool for monitoring ecological conditions of the KZN sandstone sourveld by determining the relationship between habitat conditions to soil macroinvertebrates assemblages. Disturbed and undisturbed sites will be identified and sampled for soil macroinvertebrates in the dry and wet season using pitfall traps in sandstone sourveld grassland. Vegetation characteristics and composition will be measured using plot based methods. Preliminary results of soil macroinvertebrates and vegetation dynamics will be discussed in terms of abundance, diversity, composition and vegetation cover in less human impacted (undisturbed) and strongly human impacted (disturbed) site.
GREENHOUSE GAS EMISSION PROFILES OF NEIGHBOURHOODS IN DURBAN, SOUTH AFRICA - AN INITIAL INVESTIGATION

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There is increasing attention to climate change mitigation with developmental co-benefits, especially for cities in low and middle-income nations. Research on the links between emissions, spatial planning, and sustainable urban development are emerging. Greenhouse gas (GHG) emissions inventories lack integration with strategic spatial planning, which is critical for place-based mitigation strategies. In response to this gap, a bottom-up emissions inventory study was undertaken to identify high emission zones and development goals for Durban metropolitan area (eThekwini Municipality). The study presented is the first attempt at creating a spatially resolved emissions inventory for key sectors due to increasing motivation for emissions reduction from key activities in the region. This is particularly significant for cities in developing countries because there are limited resources to focus on emissions reduction from all activities. The total emissions calculated for Durban in 2013, was 12.22 MtCO2e (Mega tonnes carbon dioxide equivalents), of which the road transport sector contributed 43%, followed by industry electricity consumption (30%). Furthermore, the industrialized spaces in the city were responsible for up to 12 times more emissions than the lowest emitting neighbourhood and the per capita emissions from affluent neighbourhoods are comparable to cities in high income countries. Three high emission zones were found characterized by industry electricity use in (i) south Durban and road transport in the (ii) central business district (CBD) and (iii) north Durban. The lowest emissions were found on the rural periphery of the city which have low levels of access to services and economic opportunities. The emissions profiles of the three zones provide valuable information to assist the municipality in tailoring mitigation efforts for the transition to a low carbon city.

EXPLORING AND DEVELOPING GRADE SEVEN LEARNERS’ ATTITUDES AND BEHAVIOURS TO RECYCLING IN A PUBLIC PRIMARY SCHOOL IN PINETOWN, KWAZULU-NATAL

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The study worked with Grade Seven learners in exploring and developing their attitudes and behaviours to recycling in a public primary school in Pinetown. Data were collected using questionnaire and interview as research tools. Prior to intervention learners confused recycling with waste management. This resulted in a high percentage of learners responding that they do practise recycling when they were asked this question “Do you recycle?” whereas they in fact were not practising it. Activities such as crocheting caps and making rings and necklaces from plastics were introduced to assist in developing their attitudes and behaviours. Videos on the effects of dumping litter were also used to help learners understand the global impact of littering. A study of this nature, where learners’ attitudes and behaviours were developed using such activities, has not been conducted before. A high percentage of learners thought that recycling was for females only. Future research should focus on addressing misconceptions learners have about recycling.
The estimations of design rainfall and design floods are required for the design of hydraulic structures and to quantify the risk of failure of these structures. With more than 10 years of additional rainfall data available since Smithers and Schulze (2003), there is potential for updating design rainfall estimation in South Africa.

Previous studies in South Africa have assumed a stationary climate. However, due to climate change, the frequency and magnitude of extreme rainfall events has possibly increased, resulting in increased runoffs in some areas (Bates et al., 2008). These changes in rainfall and runoff impact on the estimation of design floods. Thus the potential impact of non-stationary data, e.g. as a consequence of climate change, on design rainfall needs to be quantified to evaluate the impact on design flood estimation (Smithers, 2012).

Another need to update the estimation of extreme rainfall events is the estimation of Probable Maximum Precipitation (PMP), which is required for the design of large dams in South Africa. Results of investigations by Görgens et al (2007) suggest that the PMP curves (HRU 1/72) may no longer represent the upper limit of design rainfall and may be underestimating extreme rainfall in many regions in South Africa. Thus, there is a need to update and modernise PMP estimation techniques.

The aims and objectives of the study to be conducted from 2016 to 2019 include:

- Updating design rainfall for all durations
- Identifying trends in climate change and extreme rainfall events
- Developing a method to account for the impacts of non-stationary data on design rainfall estimation
- Developing a method to estimate extreme design rainfall events, including the PMP, in a changing environment.

SHRUB EXPANSION-A GLOBAL PHENOMENON

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Several scholarly articles have suggested that the encroachment of woody species is a world-wide problem. This is despite the fact that most of these studies are based on the shrub coverage change of a single location.

A total 66 scholarly papers on shrub expansion published from 2000-2016 were studied and an in-depth analysis was done through a reselection process of the papers that specifically and directly dealt with shrub coverage change. This review selected and investigated only those studies that revealed absolute change and/or relative change over time with coverage computed through the use of remote sensing methods and field surveys. A stringent selection criterion was followed and it excluded amongst others, experiments and simulations. Most importantly, most of the world biomes affected by shrub expansion in one or the other way were represented.

We used multivariate analysis tools and the R-statistical software for data analysis. Induced herbivory increase/overgrazing and temperature increase were the main drivers of shrub expansion in this study. Our results showed clearly that bush encroachment leads to mainly rangeland quality decrease and
climate warming. Nonetheless, our results show that the quantification process of shrub expansion is not the easiest because it is based on predictions and estimations of shrubification done through numerous different study methods. Also, bush encroachment may not be documented in certain parts of the world even though it is being experienced and this may lead to biased results. We conclude that bush encroachment is a world-wide feature which is more pronounced in certain parts of the world than others.

ENVIRONMENTAL FACTORS AFFECTING MILK PRODUCTION TRAITS IN THE GUERNSEY POPULATION OF SOUTH AFRICA

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Milk production is mainly affected by factors such as management, age of animal and season, which are classified as environmental factors. Environmental variance, albeit not transferable from parent to offspring, plays an important part in the performance of dairy cattle. Thus, environmental factors tend to obscure the animal’s true genetic ability. Knowledge of non-genetic factors helps in standardizing management of the breeding animals. Breeds such as the Guernsey produce high milk yield of good quality, while well-adapted to harsh climatic environments. The objective of the current study was to evaluate different environmental factors affecting milk production traits in South African Guernsey cattle. Data were obtained from South African Guernsey herds participating in the National Milk Recording Scheme (NMRIS). A total of 7526 records (305-day) for milk (MY), fat (FY) and protein yields (PRY) was extracted from the Integrated Registration and Genetic Information System (INTERGIS). The General Linear Model (GLM) procedure of the Statistical Analysis System (SAS, 2012) was used to determine the effect of the environmental factors on the production traits. The model fitted consisted of the fixed effects of contemporary group, parity, days in milk and age at calving. Contemporary groups were created by concatenating herd, year and season of calving. Contemporary group, parity, days in milk and age at calving had significant effects on the milk production traits (P < 0.001). The environmental effects, as shown by the R2 explained 0.67, 0.70 and 0.69 of the variation for milk, fat and protein yields, respectively. Trends for the milk production traits increased up to parity 3. It can therefore be concluded that milk, fat and protein yields are affected by the contemporary group herd-year-season, parity, days in milk and calving age. These results underline the need to adjust for environmental effects when performing genetic evaluations in the Guernsey population.

Key words: Guernsey cows, milk yield, milk composition, non-genetic factors, least square means

POLITICAL CHANGES AND PROTECTED AREA MANAGEMENT IN THE DEMOCRATIC REPUBLIC OF CONGO

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The DRC has undergone dramatic political changes throughout its history. These changes have significantly affected protected area management and biodiversity.

During the colonial era, creation of protected areas was mainly political and economic motivated, though ecological reasons were publically presented. Despite the getting of these areas, access to resources was granted to some people with negative impact on wildlife. After the independence, these protected areas were upgraded both in sizes and status. Although the main purpose was protection of biodiversity and critical ecosystems, it was used by the government to foster support from the
international community. During this era, more protected areas were created with limited resources which led to their degradation.

With the political and financial crisis and the incoming of the democracy and collaborative approaches in conservation, international NGOs and donors were integrated into protected area management as partners. This brought changes in conservation interventions. Protected area management had to shift from purely fortress conservation to collaborative management. Given the gap between field interventions and the existing national legal provisions, recently the country adopted new conservation laws that with different governance and management approaches. These approaches promoted protected area management with external stakeholders and communities at different levels. Furthermore, although old fashion protected areas were solely created by the central government, current laws provide different multiple layers to create protected areas and design management strategies and governance.

Although these changes are happening, little have been done to involve local stakeholders into the governance of protected areas. This paper shows that political context and changes can drive shift in conservation practices. Thus, it impacts positively or negatively conservation outcomes. Moreover, this paper identifies political changes as an opportunity for changes from traditional conservation practices to multi-stakeholders approaches.

**POTENTIAL FUTURE CHANGE TO ESTUARINE RUNOFF LIKELY TO INFLUENCE ADJACENT SUBTIDAL MACROBENTHIC COMMUNITIES**

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Riverine outflow is anticipated to change in the future as the effects of increased water abstraction for anthropogenic use and climate change occurs. Climate change driven rainfall patterns will result in increased drought periods reducing runoff and in shorter and wetter than normal rainy seasons increasing it on the east coast of South Africa. The implication of altered freshwater flow on estuaries is surmised, but the potential impact of river plume size change on the nearshore macrobenthic communities present has not yet been explored.

Previous studies have noted the importance of estuaries and coral reefs in structuring the adjacent macrobenthic environment; but their relative importance has not been assessed. Nearshore unconsolidated benthic environments are highly heterogeneous and play an important role in maintaining the functioning of the marine environment through filtration and the recycling of detritus and nutrients back up the food web.

Our study undertaken at Sodwana within the iSimangaliso Wetlands Park assessed the impact of an estuary and coral reef on the macrobenthic communities present. In this oligotrophic area of limited anthropogenic impact, estuaries, even small ones such as the Mgobozeleni, have a significant impact, potentially more so than large structures such as coral reefs. Increased abundance and biomass was found nearest the estuary decreasing with distance, which can primarily be attributed to increased food availability originating in the estuary. Should future riverine flow reduction occur due to anthropogenic or climate change related influences, this may result in a change in presence and functioning of these macrobenthic communities, which highlights the importance of appropriate integrated management of marine environments from river catchments to oceans themselves.
PERFORMANCE OF BONSMARA AND NGUNI CATTLE ON DIFFERENT DIETS

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Global warming is making the optimum use of indigenous breeds in all production systems increasingly important. The Nguni, an extensive production breed, does not perform as well as the exotic breeds in the feedlot due to their smaller frame. There are suggestions that Nguni cattle tend to have improved performance on a lower energy diet compared to the high energy diet fed in the feedlot. The aim was to determine if there is a difference in the performance of the Nguni on a low versus a high energy diet in the feedlot and to compare these results with the Bonsmara’s results. Twenty Nguni and 20 Bonsmara (10-12 months) bulls were divided into two groups with one group receiving a low energy diet (11.0 ME MJ/kg) and the other a high energy diet (12.5 ME MJ/kg) for 120 days till slaughter. The Nguni on the low energy diet had a higher P8-fat, ribfat, eye muscle area and marbling compared to the Nguni on the high energy diet. However, the Nguni on the high energy diet had a higher live weight, slaughter weight and ADG. The Bonsmara on the high energy diet had a higher live weight, slaughter weight, ADG and eye muscle area than the Bonsmara on the low energy diet. A higher fat deposition can be seen in both breeds when fed the low energy diet. The results for ADG, ribfat, P8-fat and marbling were significantly different (p < 0.05) between the diets. The Nguni did not grow more when fed the lower energy diet, but the eye muscle area was larger. A further study is being done on the gene expression of the Nguni and Bonsmara on a low and a high energy diet to identify growth related genes that are expressed differently between the breeds and the diets.

USING GIS TO MAP THE FINE-SCALE ZONATION PATTERN OF LIMPTS AND SEAWEEDS IN SILAKA NATURE RESERVE

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The rocky shore is a coastal interface between land and the sea, therefore rocky intertidal species are exposed to both marine and terrestrial climatic conditions. Recent studies have demonstrated that seaweeds and limpets are ideal for studying the effects of climate change since they are sessile and sedentary. As a result, the distribution of these species is expected to shift from the cool East Coast towards the cold West Coast of South Africa due to increased sea surface temperatures. It is therefore imperative to record and document the current positions and zonation pattern of the East Coast species for future monitoring programs. This study thus aimed to identify and map the fine-scale zonation pattern of both seaweeds and limpets in Silaka Nature Reserve, Eastern Cape. Line transects were laid from the high-shore to the low-shore. Species diversity and density were recorded at 1 m intervals along each transect. A total of 29 seaweeds and 9 limpet species were recorded in different habitats. Cellana capensis was the most abundant limpet species, while Corallina officinalis, Gelidium pristoides and Ralfsia verrucossa were the most abundant seaweeds on the shore. Habitat heterogeneity resulted in Siphonaria concinna occupying mixed habitats while S. serrata and Helcion concolor were mostly found in rockpools and mixed habitats. Phymatolithon foveatum and R. verrucossa seemed to occur together and were mostly found in rockpools, while G. pristoides was found in furrows. Hypnea spicifera, H. rosea and Ptilophora pinнатifida were found only in the low shore zone. The presence of the tropical Padina boryana seaweed was indicative of cool temperate water infiltration by tropical species. This study showed that there is a habitat shift in some species, with some species expanding to new habitats while the others become restricted to specific habitats.

Key words: abundance, density, distribution, diversity, habitats, rocky shores
APPLICATION OF MARINE EPIFAUNA IN ECOSYSTEM CLASSIFICATION, ASSESSMENT AND MARINE PROTECTED AREA DESIGN IN SOUTH AFRICA

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Ecosystem classification and mapping are foundational steps for biodiversity assessment and conservation planning, which in turn support integrated ocean management. Systematic conservation planning provides a framework to identify areas where actions can be effective in integrated ocean management implementation. The aim of this study is to support ecosystem classification and mapping for improved biodiversity assessment and management in KwaZulu-Natal. Benthic habitats of the KwaZulu-Natal shelf were verified using epifaunal data quantified from seabed imagery. Seabed images were collected using a Remotely Operated Vehicle (ROV), on reef, unconsolidated sand and mixed substrate sites with depth range between 48 and 85m. Epifauna were identified using taxonomic guides and assistance from expert taxonomist. PRIMER v6 with PERMANOVA software package was used to perform multi-variate analysis and identify characteristic and distinguishing taxa. Two existing habitat classifications (national and regional) were tested using quantified epifaunal data. Eight reef sites, 4 mixed substrate sites and 5 unconsolidated sites were assessed representing two habitat types in each of the habitat classifications. As expected, epifaunal species occurring in unconsolidated sites were significantly different to both mixed and reef substrates (P=0.007, t=2.45 and P=0.0008, t=3.00). Interestingly epifaunal species occurring on mixed substrates were also significantly different to those occurring on reef (P=0.0019, t=1.9). Neither of the habitat types represented in the habitat classifications tested were significantly different in terms of epifaunal communities (national: P=0.6, t=0.83 and regional: P=0.5, t=0.95). The results from this study provide empirical information to support refinement of existing habitat classifications for the Southern KwaZulu-Natal region. Further investigations are underway to assess drivers of ecological differences observed.

DETECTING SPATIAL CHANGES OF PROTEA GLEN SETTLEMENT BETWEEN 2000-2015 USING SATELLITE IMAGERY

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Urban spatial growth is a phenomenon that occurs due to rapid urbanization and increased populations in the area, and mostly occurs in developing countries. This spatial growth infringes into the hinterland causing land degradation, land use change and land cover change particularly the transformation of agricultural land to residential land and industrial land and a problem arises when such occurs. The new urban fabric needs to be analysed in order to detect and document the changes that urban growth and urbanization have brought. The detecting and documenting would assist in finding out the direction that spatial growth is headed, understand urban infrastructure expansion in a South African suburb and assist government in planning future service provision in the area. The main aim of the research is to quantify urban infrastructure expansion in Protea Glen, Soweto, Gauteng from 2000 to 2015, by using the Normalized Difference Built-Up Index (NDBI) change detection index on Landsat imagery, a Tasseled Cap transformation approach of remote sensing and displaying the changes using Geographic Information System (GIS). With this approach the findings show how there has been spatial growth in the area over time, there has been an increase in the number of roads and houses in the area. The spatial growth of the study area has extended outwards next to mining areas that are adjacent the area. The findings conclude how the increase in urban infrastructure has had an impact on service provision in terms of urban infrastructure and transport to Johannesburg from Protea Glen that has to be provided by the municipality.
BIOGEOGRAPHICAL DISTRIBUTION OF THE
ESTUARINE MACROZOOBENTHIC FAUNA OF SOUTH AFRICA

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After a century of estuarine research, an analysis on the biogeographical distribution of estuarine macrozoobenthos is finally possible. By the late 1990s, less than 50 estuaries had been quantitatively studied for their macrozoobenthic fauna and over the last two decades this has grown to ~90 estuaries. Macrozoobenthic fauna comprises all organisms that live in or on the sediment in aquatic systems such as estuaries. The South African coastline of approximately 3000 km comprises 300 estuaries which are unevenly distributed into three biogeographical regions (i.e. cool temperate, warm temperate and subtropical bioregions). The analysis of the macrozoobenthic fauna in South African estuaries however, groups this fauna into two assemblages (i.e. a temperate assemblage and a subtropical assemblage). There was no significant difference in the assemblages of the cool and warm temperate bioregions. The macrozoobenthic fauna of the subtropical bioregion further separates into two assemblages with the macrozoobenthic fauna from the temporarily open/closed estuaries forming a distinct group. This is not evident from the fauna that is found in the temperate bioregions. This pattern is potentially biased by the sampling effort. The majority of estuaries that has been studied for their macrozoobenthic community are in the subtropical bioregion. Studies on the distribution of organisms at different scales, as presented in this study, can assist environmental managers with the formulation of conservation priorities or efforts.

CROSS SHORE TRANSPORT OF INVERTEBRATE LARVAE ON THE
SOUTH-EAST COAST OF SOUTH AFRICA

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Offshore and onshore transportation of invertebrate larvae is a process that is studied and used by researchers predict larval settlement and the abundance of species in a particular region. In order to understand the population dynamics of marine communities, studies of both the pelagic and benthic stages must be conducted, and understanding the different larval life stages and behaviour will play an important role in population dynamics and enables conservationists to predict future adult populations. The aim of this project is to investigate the cross-shore distribution of invertebrate larvae in two sites along the South East Coast (Kenton-on-sea Canon rocks). Collected samples will be identified up to species level in order to determine the type of adult populations of that region. Samples were collected and identified up to species level using an electron microscope in order to determine the type of adult populations of that region. Such studies ensure that important marine species can be conserved from the larval stage due to the high threats from over-exploitation by fishing industries. Results from this study will inform Marine protected Areas (MPA’s) design in the area and allow the specific identification of larval hotspots for protection from over-exploitation.

Keywords: marine invertebrates, larvae, settlement, distribution, conservation, exploitation.
INVASIVE SPECIES DIFFER IN KEY FUNCTIONAL TRAITS FROM NATIVE AND NON-INVASIVE ALIEN PLANT SPECIES ON MARION ISLAND

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Non-indigenous species are a major conservation threat in the climatically harsh and unique ecosystems of the Sub-Antarctic Islands. The small size and low diversity of these islands render them vulnerable to biological invasions. However, what determines whether alien arrivals become successful invaders or not has not been well-explored for the region. We used a trait-based approach to understand whether the success of invasive plant species can be explained by differences in functional traits between indigenous and alien plant species. Average values for a number of functional traits of all alien and indigenous higher plant species on Sub-Antarctic Marion Island were collected from across the island. To test whether the traits of invasive species differ from those of native and non-invasive alien species, a phylogenetic generalized least square model was performed. Our findings showed that invasive species are characterized by traits that indicate enhanced resource acquisition, competitive vigour, increased growth rate and a short lifespan (i.e. smaller leaves, high specific leaf area, high leaf nitrogen and phosphorus concentration, high specific root length, and low root diameter) relative to native and non-invasive alien species. This may explain the invasion potential of alien plants on Marion Island. Compared to invasive species, native species displayed physically tougher leaves and more resilience against freezing. However, traits such as leaf toughness and frost tolerance may become less important for continuing fitness as conditions become milder due to climate change, placing the native flora at a disadvantage to the alien flora. As temperatures are expected to increase into the future, the invasion problem on Marion Island as with the rest of the Sub-Antarctic Islands is expected to aggravate with climate change. In summary, understanding which functional traits favour invasion success and potential may provide a useful tool to minimize future invasions in the changing ecosystems and climates.

ANT AND SPIDER DIVERSITY IN A RURAL LANDSCAPE OF THE VHEMBE BIOSPHERE, SOUTH AFRICA

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Land use changes are therefore among the most immediate drivers of species diversity. Arthropods show measurable behavioural responses to changing land mosaics at the smallest scale and heterogeneous environments are therefore predicted to support more complex and diverse biological assemblages. Ants are premier soil turners, channelers of energy and dominates insect fauna, while spiders are a mega-diverse group that can regulate other invertebrate populations. This study aims to quantify the response of these two taxa in a rural-urban mosaic of a rapidly developing communal area. The study took place in and around two villages in the north-eastern corner of South Africa. Two replicates for each of the dominant land use categories, viz. urban settlements, dryland cultivation and cattle rangelands, were set out in each of the villages and sampled during the dry and wet seasons for a total of 2 villages × 3 land use categories × 2 seasons = 24 assemblages. Ant richness was not affected by land use but local scale variables such as vertical vegetation structure (+) and leaf litter cover (+), although vegetation complexity at lower levels was negatively associated with ant richness. Spider species richness was mostly affected by land use and local conditions highlighting their landscape elements. For both ant and spider assemblages the constrained ordination explained 18% of variation in these taxa. Three environmental variables (leaf litter cover, active carbon and rock cover) were important in explaining ant assemblage structure, while two (sand and leaf litter cover) were important for spider assemblage structure. This study highlight the importance of disturbance (land use activities) and leaf litter with the associated effects on ant and spider assemblages across the study area.

Keywords: Ants, spiders, diversity, assemblages, land use, Biosphere, urbanization
VARIABILITY OF TROPICAL CYCLONE HEAT POTENTIAL AND BARRIER LAYERS IN THE SOUTH INDIAN OCEAN

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Track and intensity are key aspects of tropical cyclone behaviour. Intensity is related to tropical cyclone heat potential (TCHP) and barrier layer thickness (BLT). Here, the variability of TCHP and BLT in the South West Indian Ocean and their relationships with tropical cyclones is investigated.

It is shown that cyclone intensification is influenced by large TCHP values, deep barrier layers and the presence of anticyclonic eddies in the upper ocean. TCHP and BLT time series across the Seychelles-Chagos thermocline ridge (SCTR) are correlated with ENSO, $r = 0.57$ (4 month lag) and 0.53 (2 month lag) respectively. Large BLT fluctuations overlay with large positive TCHP values during the summer ($r = 0.78$, November-March) and are modulated by westward propagating Rossby waves. In particular, TCHP is enhanced along the Rossby wave path which may lead to positive rainfall anomalies across the SCTR. After the 1997-1998 El Nino, a warming trend in the TCHP was observed over most of the basin, except across the SCTR which may be associated with changes in the regional atmospheric circulation. Increasing SST and frequency of Category-5 tropical cyclones also occurred. An analysis of the ocean response to Category 5 Tropical Cyclone Bansi that developed over and east of Madagascar during January 2015 is performed. Its unusual track was found to be linked with the strengthening of the monsoonal north westerlies while its rapid intensification from Category-2 to Category-4 was linked to a high-TCHP region, associated with a warm core eddy and large BLT.

COMPARING BIOMASS AND COMMUNITY COMPOSITION OF EPHEMERAL WETLAND MICROALGAE IN FIELD VERSUS MICROCOSM STUDIES

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Fauna and flora of Ephemeral wetlands are adapted to rapid wetting and drying cycles. For instance, many algal species in these habitats possess adaptations that allow for survival in dry conditions, producing cysts and spores that germinate following inundation. Algae have been used as proxies for wetland health, as different species are associated with water quality and inundation states. Therefore, conducting microcosm laboratory experiments to simulate inundation can allow us to determine how robust microalgae in ephemeral wetlands are to different conditions. The aim of the study was to compare microalgal biomass and community composition using a field and a lab experimental approach. Physicochemical and biological variables were collected every 4 days over a 28-day period in both the field and experimental over an inundation period. Physicochemical data showed a gradual increase over the inundation period for both the field and experimental data. Experiment phytoplankton biomass peaked (21µg/L) on day 12 with a second peak (23µg/L) on day 24. In contrast, field phytoplankton biomass peaked (17µg/L) on day 24 post a rainfall event. Over the entire monitoring period, there was no significant difference ($p>0.05$) between the field and the experiment phytoplankton biomass. Microphytobenthic (MPB) biomass reached a peak of 115 µg/m² on day 28 of the experiment, whereas in the field, biomass remained low (22.5µg/m²) throughout the inundation period. In contrast to phytoplankton biomass, there was a significant difference ($p<0.05$) between field and experiment MPB biomass. Experimental data showed a clear shift in biomass from a phytoplankton to an MPB dominated system, whereas this pattern was not apparent in the field data. Euglenophytes dominated the phytoplankton community (60 %) in the field within the first 16 days, whereas in the experiment chlorophytes were the dominant group (70 %). In the MPB community, the diatoms were the dominant group (65 %) in the field and chlorophytes in the experiment (40 %). There is a slight difference in the development of microalgae in the field compared to the experiment, which could be as a result of a container effect. From the study we can conclude that there are similar patterns of algal biomass between
the field and experiments which can help give an overall understanding of the response and development of the algal community to inundation. Knowing that baseline field and lab experiments produce similar patterns in algal biomass and community we can be confident that lab manipulation experiments would reflect field conditions.

STRUCTURAL COMPARISON OF CARBON FINE PARTICLES PRODUCED FROM GAS PURIFICATION IN THE DOWNDRAFT GASIFIER SYSTEM AT MELANI VILLAGE

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The process of biomass gasification does not only produce syngas, but also some by-products as well, amongst them is soot (carbon fine particles). Soot is a black, carbon rich material produced from power plants and engines as a result of incomplete combustion. During the gasification process, an immense variety of contaminants are generated as the syngas is produced. A contaminated gas is known to cause fouling problems in the system; therefore it is of great importance to ensure that the produced gas contains minimum contaminants and for this reason purification of the gas comes into play. Carbon fine particles will be collected from the cyclone and from the pond consecutively. The comparison of the mentioned carbon fine particles will contribute positively towards decision making on which carbon fine particles to be used for a specified application. The structural characteristics of the two will be investigated through the employment of FTIR, Calorimeter, SEM and CHNS. The FTIR preliminary results showed some similarities in their functional groups. The full paper will present results obtained.

RESPONSE OF SPARTINA MARITIMA INTERTIDAL SALT MARSH TO INUNDATION AND SALINITY STRESS RELATED TO PREDICTED SEA LEVEL RISE

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Salt marshes are some of the most productive ecosystems in the world, however, they are particularly sensitive to changes in sea levels. Sea level has been rising for centuries and the rate of sea level-rise has been anticipated to increase as a result of global warming. Considering the present predictions of sea level rise, it is very likely that the frequency and magnitude of high tide level will increase which will expose intertidal salt marsh vegetation to prolonged submergence. The S. maritima in the Keurbooms Estuary is limited only to the lower Bitou tributary, the confluence and a few patches in the Keurbooms tributary. The S. maritima population in the confluence and Bitou tributary often grow on muddy waterlogged substrate while the Keurbooms tributary population grow on a sandier substrate. The S. maritima plants on waterlogged muddy substrate were shorter and showing more evidence of below-ground vegetative reproduction than those on sandy substrate. The mean chlorophyll fluorescence PSII (FV/FM) for S. maritima in the Keurbooms Estuary ranged from 0.694 ± 0.023 to 0.773 ± 0.006. Plants in the waterlogged conditions of the Bitou marsh had significantly lower PSII values than other plants indicating signs of photo-inhibition. Tidal inundation experiment showed reduced PSII values when the sediment surface of the plants was completely submerged during high tide but increased to normal values during the outgoing tide indicating highly adaptability of the S. maritima species to short-term submergence conditions. These results suggest that tidal inundation themselves do not prohibit plant growth of this species but prolonged submergence will. To ensure survival in the face of rising sea levels, the salt marsh will have to accrete sediment at a rate equal or more than the rising sea levels.
NON-VOLANT MACRO-INVERTEBRATE RICHNESS AND DIVERSITY IN DISTURBED KWAZULU-NATAL SANDSTONE SOURVELD

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Invasive alien plants (IAPs) alter the functioning of the invaded ecosystems such as nutrient cycling, thereby affecting the long-term stability of ecosystems. Invertebrates, particularly non-volant soil macro-fauna are most affected by drastic changes and disturbances such as IAPs in the environment due to their limited dispersal abilities. The Sandstone Sourveld found in the KwaZulu-Natal province of South Africa, is a threatened ecosystem with a substantial disturbance caused by land transformation and IAPs. The impact of IAPs on non-volant macro-invertebrates in this ecosystem is poorly understood. Therefore the aim of this study was to assess non-volant macro-invertebrate diversity along the disturbance gradient (low, medium and high invasion) and to understand the impact of IAPs on non-volant macro-invertebrates diversity. Sampling was done in Springside, Tanglewood and Giba Gorge Nature Reserves. Pitfall traps were used to sample non-volant macro-invertebrates across sites in June 2016. Vegetation structure and species composition were also assessed. Species diversity indices, namely, species richness, Simpson’s evenness and Shannon-Wiener diversity indices were compared within the site along the disturbance gradient. This study will provide a comprehensive understanding on the biodiversity of non-volant macro-invertebrate in relation to IAPs in the Sandstone Sourveld. This knowledge would be useful to guide the necessary IAPs management interventions that would enhance non-volant macro-invertebrates diversity to create a more functional and stable ecosystem.

Key words: Disturbance, ecosystems, invasive alien plants, species diversity

SOUTH ATLANTIC VARIABILITY DUE TO AGULHAS LEAKAGE

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Role of Atlantic Meridional Overturning Circulation (AMOC) on global water cycle has long been demonstrated particularly in North Atlantic Ocean. In recent years, the South Atlantic Ocean has attracted more interest, with sampling being carried out along 34.5°S between the shelf of South Africa and the Greenwich Meridian (0°E). Thermostalinograph data collected during austral spring in 2013-2015 showed substantial variability in surface temperature and salinity with notable meso-scale features. During September 2013, surface temperature ranged between 16 °C and 17°C, but in September 2014, it had decreased to 15-15.5°C, and in September 2015, it varied between 15.5°C and 16.5°C. Salinity was 35.4-35.6psu in September 2013, 35.3-35.6psu in September 2014, and 35.3-35.5psu in September 2015. The variability in surface temperature and salinity were associated with changes in current speed and direction, as measured by a ship-board Acoustic Doppler Current Profiler. Satellite altimetry showed that, overall, positive sea level anomalies dominated along the transect during all cruises. Satellite sea surface temperature showed that northward advection of Subantarctic water dominated the offshore part of the transect, while Agulhas leakage through filaments dominated closer to coast. Both in-situ and satellite data concur that Agulhas leakage play a substantial role in modification of the south Atlantic. Satellite data also shows that interaction of Subantarctic water with the Agulhas water by the retroflection region plays a role in the route of the Agulhas leakage into the Atlantic Ocean.
THE IMPACTS OF DROUGHTS ON THE HYDROLOGY OF THE ORANGE RIVER BASIN, SOUTHERN AFRICA

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The impact of climatic variability on discharges in the Orange River Basin was analysed using monthly data of two climatic drought indices, the standardised precipitation index (SPI) and the standardised precipitation evapotranspiration index (SPEI), and an index for discharge, over the period 1918 to 2012. As a result of the regulation of hydrological variables in the basin, which are likely to disrupt the climatic-hydrology relationship, the study focused on two sub-basins and a gauging station located close to the source of the River, where a strong climate-hydrology relationship is likely to be maintained. The climatic drought indices were considered over the two sub-basins and discharge over the gauging station. The analysis was conducted at the 6-, 12-, 24-, and 48-month time scales (accumulation periods).

Both climatic drought indices, the SPI and SPEI, effectively identified dry conditions in the sub-basins, and the indices showed the same evolution of climatic droughts in the sub-basins at all time scales analysed. This was attributed to the dominant influence of precipitation on droughts in the sub-basins.

Cross-correlation analysis showed a strong, positive relationship between the discharge and climatic drought indices; at all time scales analysed, maximum correlation coefficients were above 0.8. Analysed at the 6-, 12-, and 24-month time scales, the maximum correlation between the discharge and climatic drought index occurred at a lag of 1 month, and at the 48-month time-scale, the maximum correlation occurred at 0 lag. This indicates the high sensitivity of discharge to climatic variability (particularly precipitation) in the sub-basins, and the response was similar when measured by either the SPI or SPEI.

At all time-scales analysed, wavelet coherence showed that the relationship between the discharge and climatic indices remained strong almost throughout the whole study period, with only a few events where the correlation dropped. This was likely the result of water management and regulation (non-climatic factors) in the basin, which disrupted the control of climate over discharge.

THE AGULHAS SYSTEM CLIMATE ARRAY: DEVELOPING LONG-TERM MONITORING OF THE AGULHAS CURRENT

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In order to understand global change and the impacts on South Africa, the establishment of sustained measurements of key biomes are essential. Of focus here is a long-term time series within the offshore marine environment of the Agulhas Current, the strongest western boundary current in the Southern Hemisphere. The Agulhas Current directly impacts weather and climate both over Southern Africa and in to the Northern Hemisphere through the transport of heat and salt, and is also itself impacted by global change, and in turn propagates these altered dynamics, creating a feedback loop that is not fully understood.

The Agulhas System Climate Array (ASCA), consists of seven tall and three shelf moorings with Acoustic Doppler Current Profilers (ADCP), single-point current meters and microcats, and five Current- and Pressure-Inverted Echo-Sounders (CPIES), has been established on the east coast of South Africa (34° S) to monitor this heat and salt transport. The array of moorings, along with surveys of Conductivity, Temperature and Depth (CTD) stations and ship-borne ADCP transects, has begun to provide a time-series of the Agulhas Current. This provides the baseline on which changes to flow dynamics, volume transport and mesoscale variability can be studied.
It has been suggested that monitoring the Agulhas Current is like “having your finger on the pulse of climate change” hence a comprehensive understanding through sustained detailed observations is a minimum requirement to developing knowledge of a changing planet. Ideally, ASCA would need to be successfully deployed for a minimum of ten years to begin addressing key questions, with the first five years for establishment, to build scientific and technical capacity within South Africa and produce results from the acquired data. ASCA is a multi-institutional program and provides a platform for South African researchers and students keen to study global change within the Agulhas Current.

WIND VARIABILITY ALONG THE SOUTHERN COAST OF SOUTH AFRICA

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A study conducted by Schumann (1992) revealed an abrupt change in wind speed and direction over the south coast of South Africa after one of the strongest El Ninos in 1982/83. Schumann carried out a wind analysis over a 38 year period (1950-1988), with the change identified being represented in the last five years of the timeseries. This study seeks to see if the change discovered by Schumann was permanent or not by reconstructing the timeseries and extending it to 2014. Changes in wind speed and direction from a station in Cape Town, provided by the South African Weather Service, are analyzed from 1960-2014. The wind direction analysis shows a statistical significant positive trend while the wind speed analysis shows a relatively weaker positive trend. There is a great deal of variability associated with both wind variables. This variation is partly explained by the direct or indirect effect of El Niño Southern Oscillation (ENSO) events and another mode of atmospheric variability, the Southern Annular Mode (SAM). It is observed that in most strong El Nino events, the wind decreases in magnitude and changes in direction. The opposite is true for La Nina events. The understanding of the tendency of winds to move towards or away from the equator during the various phases of SAM appears to be significantly responsible for the modification of winds in this area. However, it also be taken into consideration that over this period, changes in the location of the station and instruments used to measure winds occurred. These changes were reflected in the data and need to be considered during the analysis. Changes in winds over this area have an impact on the Benguela upwelling system, an important area with regards to fisheries as well as, for example, local pollution dispersion. In addition to this, disentangling the complex nature of global change and clarifying where the variability is an artifact of instrumentation is essential in order to grasp long term trends and improve forecasts.

GRAZING MANAGEMENT IMPACTS ON GRASS AND SOIL LAYER IN A SAVANNA ECOSYSTEM OF EASTERN CAPE, SOUTH AFRICA

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Very few studies have been conducted in the Eastern Cape region of South Africa to examine the impact of grazing management on range vegetation and soil. In addition, studies on the impact of grazing management on carbon (C) and nitrogen (N) storage are not sufficient. The objective of this study is to evaluate the grazing management impacts on grass, soil and C-N pools production potential of rangelands. This study aims to focus on neighbouring communal lands, rest-rotate commercial farms, and Holistic Planned Grazing (communal and commercial). Eight farms will be selected; each farm will be divided into major landscape positions. At each landscape, three grazing enclosures will be fenced in each farm for long-term monitoring and biomass estimation. Vegetation measurements include species composition, diversity, basal and litter cover, available biomass and annual net primary production. Soil measurements include pH, soil minerals, organic matter, total C, N, particle size, bulk density, penetration resistance, aggregate stability and water infiltration. Monitoring data will contribute
to the development of a guideline to evaluate farms for carbon trading, and ecosystem services maintenance.

LIVELIHOOD DIVERSIFICATION THROUGH A RURAL NON-FARM ECONOMY: EMPOWERING WOMEN SMALLHOLDER FARMERS IN EASTERN CAPE, SOUTH AFRICA: A CASE OF NKONKOBÉ MUNICIPALITY

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Agriculture is the main source of livelihood for many rural communities in Southern Africa. However, the sector has faced a lot of challenges due to issues such as climate change, poor soils, lack of new technologies, poor rains and lack of credit amongst others. I believe this paper will contribute in identifying the various challenges faced by women smallholder farmers in Eastern Cape. This is because women are mainly involved in agriculture in the province. To add, I also believe that the researcher will benefit from attending the conference. This is due to the various strategies that are to be discussed by various researchers from different fields that may be taken into consideration in the drafting of this paper. Drawing on the integration of the Sustainable Livelihoods Approach (SLA) and the Gender and Development (GAD) framework, the paper adopted the theories that are relevant to agriculture and food security. The issues of food security are of concern and should be considered when discussing about global issues. Since women’s involvement in agriculture will contribute to food security thus also ensuring sustainable development. This study proposes that the empowerment of women smallholder farmers holds the key to creating food security and poverty eradication in the rural areas of South Africa. The empowerment of women will not only assist the country’s food security but their capabilities in tackling many issues related to farming will be addressed.

OPTIMIZATION & KINETICS STUDY OF GREEN SOLVENT PRETREATMENT OF NON-EDIBLE LIGNOCELLULOSIC BIOMASS FOR BIOENERGY, BIOFUELS & BIO COMMODITIES PRODUCTION

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Increasing concerns over environmental and geo-political issues on sustainability have driven the industries to shift their efforts to produce chemicals from renewable biomass. This was due to rapid increase in fuel & chemical demand which influenced climate change and depletion of resources. Lignocellulosic materials are the most promising feedstock as natural and renewable resource essential to the functioning of modern industrial societies. A considerable amount of such materials as waste by-products are being generated through agricultural practices mainly from various agro based industries. A significant amount of corn cobs wastes is discarded annually in South Africa after 14.5 million tons of maize grains per year is processed to various food products.

This corn cob contains energy content of 18.4 -18.7 MJ/kg and (30-45% cellulose) which can be used to produce bioenergy, biofuels & biochemicals without expanding the amount of agriculture land. In order to produce these commodities from biomass, the pretreatment stage must be applied wherein the accessibility of the cellulose polymers is improved. Enzymatic cellulose hydrolysis is then applied to ferment the sugars by means of cellulase enzyme. These fermentable sugars are converted into either biofuels such as bioethanol & biodiesel or biochemical such as bio-succinic acid. The solids can be used in direct combustion or gasification for energy production.
The research objectives are to determine and evaluate the best solvent to pre-treat corn cob using a technique that should expedient the production of the mentioned commodities. Investigate the effect of pretreatment parameters on the yield of cellulose and hemicellulose and study the kinetics of the pretreatment method towards developing a conceptual process design for the dissolution process.

The results obtained so far indicate that almost all tested solvents have the ability to reduce the recalcitrance of biomass to a certain extent depending on the operating conditions. Fourier-transform infrared spectra (FTIR) spectra indicate that the IR crystallinity index of cellulose decreased, and the structure was disrupted after pretreatment due to the effective removal of the amorphous zone. The molten hydrate salts have proven to be the promising pretreatment solvents due to their sugar recovery, non-derivatization effect and environmental benign.

Keywords: Corn cob, Enzymatic cellulose hydrolysis, Fermentation, Lignocellulosic biomass, recalcitrance

A TRAIT-BASED APPROACH IN UNDERSTANDING ANT COMMUNITY ASSEMBLY IN THE SOUTPANSBERG MOUNTAIN, SOUTH AFRICA

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Understanding how communities are assembled and structured is central to ecology and conservation science. A number of conceptual advances suggests that the use of taxonomic diversity alone is insufficient to understand biodiversity patterns and processes and incorporating functional diversity provides additional insights into species assemblages. Trait-based approaches have become important tools for understanding species assemblage and their responses to climate change. Ants are an ideal study system because they are geographically widespread and their change in abundance will have consequences for ecosystem processes. Here, we aim to quantify thermal tolerance and water loss for dominant ant species along an elevational gradient in the Soutpansberg Mountain in Southern Africa, use this to predict response to climate change and quantify functional diversity of all species previously collected across this gradient. Ant species will be collected using bait for thermal tolerance assays while their behavioral niches will be driven from previous studies. Morphological traits will be measured for all species previously collected while other behavioral and life history traits will be derived from the literature. Generalized Linear Mixed Models (GLMMs) will be used to analyze the response of functional diversity to habitat type, elevation and aspect. Multiple linear regressions models will be used to analyze the relationship between thermal tolerance, thermal niche and timing of activity. We expect that functional diversity will decrease with elevation but will also be significantly affected by habitat. Thermal tolerance ranges of dominant ant species will relate to their timing of activity as well as distribution across the mountain, larger thermal tolerance will result in larger distribution ranges and thermal range will increase with elevation. Species with higher water content will have broader thermal tolerance ranges while habitat will play a significant role in affecting thermal tolerance.

Keywords: Climate change, ants, functional diversity, thermal tolerance, body size, functional traits.
ANALYSIS OF THE 2015/16 EL NIÑO DROUGHT: METEOROLOGICAL STRUCTURE AND IMPACTS IN LIMPOPO PROVINCE

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Whilst the 2015/16 El Niño was virtually tied to the 1997/98 event, its evolution and impacts in southern Africa are not comparable. Temperature, rainfall and circulation anomalies that characterized the 2015/16 drought season are analyzed using station and reanalysis data. Composite analysis is used to analyze the drought impacts at monthly, sub-seasonal and seasonal timescales. Positive SST anomalies (>2°C) spread toward the eastern equatorial Pacific season between June and September 2015 reaching a peak (>3°C) during December. Repeated heat wave conditions characterized much of the Limpopo with the land surface temperature anomalies of >10°C. The failure of ridging anticyclones over the southeast coast resulted in the westerly wind anomalies and reduce a moisture flux from the SW Indian Ocean. The Prevailing surface winds were therefore continental, dry and warm. As typical with an El Niño season, tropical cyclone activity was subdued with no landfall or cyclogenesis in the Mozambique Channel. The land under cultivation was significantly reduced and most of the early crops wilted. Despite the negative impacts of the 2015/16 drought, the 1991/92 event remains the most severe drought to have affected the region. Results of this study contribute to the understanding impact of El Niño induced droughts and how affected communities may build resilience and adapt to a changing climate.

Key words: Drought, heat waves, ridging highs, El Niño, south

EFFECTS OF RAINOUT SHELTERING ON SOIL MOISTURE AND SEEDLING NUMBERS OVER A GROWING SEASON IN A SELECTED CAMP OF NEUDAMM FARM, NAMIBIA

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Soil moisture is fundamentally important to many hydrological, biological and biogeochemical processes and it affects ecological process considerably in the semi-arid ecosystems. Thus, lack of soil moisture is a cause for concern to the farmers in Namibia especially, particularly during the unpredictable climate change-induced droughts. Rainout shelter is a useful tool for experimental manipulations of rainfall patterns that can demonstrate how water availability affects ecological processes in semi-arid ecosystem affected by climate change. Therefore, the objective of this study was to determine the effect of reduced precipitation by the use of rainout sheltering on soil moisture and the survival of seedlings at a research site with a mean annual precipitation of about 350 mm. The study was conducted at the farm Neudamm near Windhoek using 20 sheltered and 20 unsheltered (controlled) plots of 5 m × 5 m. Soil samples were collected from all the plots once every week for 9 weeks. Smaller quadrats of 20 cm × 20 cm were used, 5 quadrats were under 5 natural sheltered plots and another 5 quadrats were on 5 unsheltered plots and individual seedlings were counted once every week from each quadrat. Seedlings in each quadrat were identified and categorized in three different growth forms, namely grass, forb and woody. The results of this study showed that sheltering of plots does not have effects on soil moisture (χ²=2.55, df =1, P>0.05). However, the number of seedlings depended on the amount of water in the soil (R²= 0.280, y= 0.657x+3.756, p<0.05). Because the study was only carried in the central of the country, it is recommended that further studies along a precipitation gradient are conducted in order to assess the overall relationship between soil moisture, seedling number and seedling survival using rainout sheltering experiment.
MITIGATING THE URBAN HEAT ISLAND: CONSIDERATIONS FOR SOUTH AFRICAN CITIES

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Urbanisation in South Africa is expected to increase to 71.3% in 2030 and reach nearly 80% by 2050, with the City of Johannesburg projected to surpass the 10 million population mark and emerge as a megacity by 2030. Urbanised cities generally have replaced natural land surfaces with materials that retain heat, as well as have waste heat from buildings, motor vehicles and industries. In altering the local environment, this can result in local environmental stresses. Rapid urbanisation coupled with climate change could amongst other issues, increase the local urban heat island (UHI) effect. The UHI, a phenomenon where a temperature difference between the built-up environment and the surrounding (natural) environment exists, is of increasing concern given that more people are moving to cities each year. This contributes to the intensity of the UHI increasing and the number of people affected by it. Limited studies have previously been undertaken to characterise the UHI in African cities, and more recently, studies have been undertaken in Johannesburg, eThekwini (Durban, KwaZulu-Natal), Buffalo City and Nelson Mandela Bay in South Africa. There are still gaps in understanding how these temperatures will change in the future under climate change and greater urbanisation, and how anthropogenic factors could influence the magnitude of the UHI in South African cities. The impacts of the UHI and key interventions, including benefits and unintended consequences of these strategies, were shown. The relevance of the UHI in the context of South African cities were discussed in terms of limited UHI studies and considerations for cooling strategies in cities, as well as the appropriateness of these strategies in terms of planned long-term development goals and climate change.

CLIMATE CHANGE COPING MECHANISMS AND ADAPTATION STRATEGIES IN COMMUNITIES SURROUNDING QUEEN ELIZABETH NATIONAL PARK

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The sustainability of livelihood systems in natural resource based communities has been threatened by climate change. Observed climate-associated catastrophes including floods, landslides, and droughts have led to reduced resource diversity and crop production, water scarcity, soil erosion, creating vulnerabilities for communities with least capacity to adapt. With particular interest in communities surrounding Queen Elizabeth National Park, the study applied a holistic approach to explore how communities confronted with climatic changes are coping and adapting to such changes. Climate change has complex differentiated implications on households. At the household level, 43.2% of the respondents stated diversifying their primary livelihood activities to other activities such as transport especially motor cycle “boda-boda”, merchandise trading; petty grocessaries, food vending and tourism guides. These according to the focused group discussions and responses from the questionnaires are the most common activities carried out by respondents most especially in times of poor harvest, less fish or limited salt mining. This means that households may not be able to sustain these economic activities when climate change impact persists. The results also indicated that 21.2% of the respondents reported temporarily shifting to fishing or salt mining in times of long dry spell and drought so as to economically sustain their households. 13.3% of the women use shallow salt pans and 16.2% of the men use protective gear (condoms) to protect their reproductive organs when carrying out salt mining. Lastly, 4.6% of the respondents reported shifting to agriculture when fishing and salt mining had become a health risk. Often salt miners, especially those who have not fully recovered from the reproductive illness or respiratory infections, opt for farming. From the findings, respondents seem to shift from fishing to salt mining or agriculture. However, these are also affected by climatic changes. Therefore, communities should be assisted in terms of adaptive capacity to handle long term climatic changes.
TROPICAL CYCLONE TRACKS AND THE OCCURRENCE OF EXTREME WEATHER EVENTS OVER SOUTHERN AFRICA (1983-2013)

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Approximately 9-12 tropical cyclones form every year in the SW Indian Ocean tropical cyclone basin; however, less than 5% of them make landfall over Southern Africa. The main aim of this study is to investigate tropical cyclone tracks originating from the Southern Indian Ocean and producing extreme weather events over southern Africa (1983-2013). Tropical cyclones that had prolonged westward and southward tracking are investigated via composite analysis. Storm tracks, rainfall circulation and thermodynamics fields are analyzed using the NCEP reanalysis data. Extreme weather associated with strong winds and heavy rainfall caused by tropical cyclones affect mainly the eastern coastal and adjacent interior of Southern Africa. Other than causing heavy rains and flooding, prolonged droughts are experienced over Mozambique, Zimbabwe and some parts of South Africa because of tropical cyclones being quasi stationary in the Mozambique Channel. The results of the study contribute to the understanding of extreme weather events associated with tropical cyclones, which made landfall in the interior of southern Africa and help communities for future awareness and adaptation.

Keywords: tropical cyclone, tracks, landfall, floods, drought

CONTACT METAMORPHISM IN THE KAROO BASIN: HIGH RESOLUTION SCANNING OF CONTACT AUREOLES

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Sedimentary basins go through various stages of metamorphism once the sedimentation processes have ceased. The Karoo Basin is unique because of basin wide dolerite intrusions that were emplaced within the sedimentary successions of the basin during the break up of Gondwana ca 182 Ma. These hot intrusions caused various metamorphic reactions in the host rocks that are preserved as hydrothermal vent complexes associated with over-heating and hydrothermal circulation of meteoric water in the uppermost formations of the Stomberg Group, and vent complexes that were created by overheating and dehydration of organic rich shales of the Ecca Group. The purpose of this research is to study contact metamorphism of Karoo sedimentary rocks at various depths with the intent to ascertain the maximum temperature at different zones of the contact aureoles and to study the effects of excess heat on the porosity and permeability of host rocks. SOEKOR boreholes that were drilled in the Karoo Basin in the 1960’s were logged and samples were selected in close proximity to dolerite sill intrusions. We present high resolution QEMSCAN and MAPS images of drill core samples from AB 1/65 and QU 1/65 boreholes. The data presented indicates mineral dehydration reactions and crystallization of metamorphic chiastolite, muscovite, and increased illite crystallinity. High resolution MAPS images show that the porosity of host rocks is altered reduced significantly in host rocks that are close to a dolerite sill compared to those away from a sill.

Keywords: Karoo Basin, dolerite intrusions, contact metamorphism
CLIMATE CHANGE AWARENESS AND PERCEPTIONS ON COMMUNAL AGRICULTURAL PRACTICES: A CASE OF UMZIMVUBU CATCHMENT, SOUTH AFRICA

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In South Africa, climate change is set to hit the agricultural sector the most severely and cause suffering, particularly for the poor who rely highly on agriculture for their livelihoods. One such case is the UMzimvubu which is composed of warm and temperate climate with less rainfall in winter than in summer. The area is of rural nature. To protect themselves against potential losses, farmers need to recognize the changes already taking place in their climate and undertake appropriate adaptation strategies. Sound public knowledge and awareness especially among farmers is required to reduce climate change impact. The study will assess the farmer’s perceptions and awareness on the impact of climate change on their farming activities. Random sampling technique will be used to select farmers to be interviewed. A pre-tested questionnaire will be administered to the farmers, focusing on matters relating to climate change awareness, employed adaptation strategies and problems related to their coping strategies. Non-formal interviews with the extension officers and NGOs will be used to be enlightened on the role they play to reduce climate change impact. Descriptive statistics will be applied to analyse and describe the data. Meta-analyses will be employed to compare secondary data and primary data to understand the perceived differences. Information on climate change awareness should be disseminated well to ensure that it will attract the attention of the farmers’ especially communal farmers.

Keywords: Farmers; Coping strategies; Adaptation strategies; knowledge.

EXTENT AND ROLE OF WASTE SALVAGERS IN WASTE MANAGEMENT IN THE O.R. TAMBO DISTRICT MUNICIPALITY, EASTERN CAPE

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Recycling is broadly acknowledged as a sustainable municipal solid waste management strategy. Studies have explained that it is possible to improve waste management services provided the municipalities realize the importance of informal recycling. The aim of the study is to investigate the extent and role of waste salvagers in waste management in the ORTDM. The study seeks to investigate how waste picking contributes towards waste management, to explore the socio-economic factors that influence waste picking activity, and investigate the municipality bye-laws of waste management. The data was collected through observations and open-ended questionnaires. In addition to the primary data collected, secondary data were also collected from scientific journals, books, internet and unpublished papers and the data was analysed on the SPSS version 23. Results revealed that the work done by waste pickers forms a significant link between the formal economy and the informal sector because they supply raw materials essential for manufacturing goods and commodities needed by the formal economy. The risks to the health and safety of waste pickers within O.R Tambo District Municipality are compounded by poverty and a lack of resources to purchase proper food, personal protective equipment. Coming from the lowest social level, waste pickers in all cultures traditionally have a bad reputation. To promote the integration process, which can only proceed in step with public opinion, the widespread public idea of waste pickers as vagabonds and criminals must be changed into a perception of them as environmental agents and valued partners, acting together towards common goals.

Key words: Recycling, economy, waste management, health and safety, bi-laws.
ABBIOTIC DRIVERS OF ROCK POOLS ASSEMBLAGES ALONG THE EAST COAST OF SOUTH AFRICA

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Rock pools dynamics are largely mediated by the harsh environmental gradient imposed on intertidal life. As such, rock pools provide an ideal setup to test and understand the vulnerability of intertidal systems to climate change. This study aimed to explore the influence of environmental parameters on the assemblages of benthic invertebrates in tidal pools at two marine reserve (Dwesa-Cwebe and Hluleka) and two non-reserve sites (Nqabara and Presley’s Bay) on the east coast of South Africa. Variability of assemblages due to time and shore height was also considered. Physico-chemical properties (pH, temperature, salinity, conductivity, turbidity and dissolved oxygen) were measured in nine rock pools at each site in each season (summer, winter, autumn and spring). Species composition of the assemblages was also determined. Multi-dimensional scaling on the variability of the environmental parameters in relation to time suggested the highest pH values during summer and spring at low shore and during summer and winter at high shore. Canonical analysis of principal coordinates was used to investigate possible links between the environmental parameters with time and shore height to invertebrate species distribution. Results revealed a link between pH and the abundance of Gastropoda, Anthozoa and Echinoidea, while salinity was mostly associated with Gastropoda, Cirripedia, Anthozoa, Holothuroidea, Asteroidea and Polyplacophora. Temperature was associated with the abundance of Anthozoa and Gastropoda. Overall, specimens of these seven families mostly occurred on the middle shore at all sites. This study suggests a link of pH and temperature in structuring rock pools assemblages and highlights the potential vulnerability of South African warm temperate rock pools to the current and predicted environmental change.

Key words: marine protected areas, exploited areas, intertidal, shore height, climate change.

SALINITY TOLERANCE OF MARSH CRAB, PARASESARMA CATENATUM (BRACHYURA: SESARMIDAE), IN MNGAZANA ESTUARY, EASTERN CAPE

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Salinity is considered an ecological key factor in estuaries. Estuarine organisms are generally well adapted to a wide range of salinities that may be influenced by unpredictable rainfall and flooding events that result in altered freshwater inflow. This study examines the salinity tolerance of the Sesarmid crab Parasesarma catenatum with the aim of understanding the physiological responses to a range of salinities. The influence of salinity on the distribution of P. catenatum is not properly addressed. Sub-adult to adult P. catenatum (carapace width: 13.55 ± 1.85 mm) were randomly collected from Mngazana Estuary and exposed to six salinity treatments (0, 4, 8, 15, 30 and 60) over 96hrs. Before exposure, crabs were initially acclimated to a salinity of 30 for 2hrs and were then acclimated down or up at a salinity change of ≤5 every 2hrs until the test salinity was reached. For each replicate, 10 crabs were individually exposed in ~200ml of water, at room temperature (24.3 ± 1.3°C). Crabs were monitored at regular intervals for signs of stress and/or death. Preliminary results showed P. catenatum is euryhaline, tolerating salinities between 4 and 60 with the highest survival (≥80%) measured at a salinity range of 8 and 30. The highest mortality was observed at 0 (100% mortality) and 4 (50% mortality). All crabs exposed to freshwater (salinity of 0) died within 4hrs of exposure. The preliminary observation supports the distribution of P. catenatum along the estuary where salinities range between 4 and 35. No mortality was recorded at the salinity of 30 suggesting that this is a preferred salinity that may be associated with low energy costs. Further investigation to assess the metabolism of these crabs using respiration as a
proxy for fitness will establish the potential resilience of the marsh crab under a scenario of climate change.

**CAPTURING CLIMATE CHANGE KNOWLEDGE OF PASTORALISTS IN SEMI-ARID RANGELANDS OF SOUTH AFRICA**

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Despite facing various social, biological, economic, political and management challenges, resource poor farmers have proven to be resilient in withstanding all the above challenges, including harsh environmental conditions. With the projected increases in temperatures and rainfall variability, climate change impacts to be experienced by farmers in the dry are to intensify. Thus there is a need to know how people understand and perceive the climate change in order to understand its impacts. The aim of this study was to assess the understanding of South African communal pastoralist’s knowledge on climate change and to assess where this knowledge is derived from for adaptation purposes. Two communal areas namely, Leliefontein and Steinkopf in Northern Cape served as study sites. A case study approach, with triangulation of focus groups and semi-structured interviews were methods used. The focus group was aimed at drawing up a seasonal calendar where 10 livestock farmers from Leliefontein participated and 14 from Steinkopf. The focus group discussions were followed by in-depth semi-structured interviews, where a total of 20 farmers from Leliefontein and 21 from Steinkopf were interviewed. While various other studies highlight the lack of awareness and understanding of climate change among communal farmers, this study found that 90 % and 55 % of the interviewed Steinkopf and Leliefontein farmers had an understanding of the term. The interviewed farmers referred to the term climate change as “seasonal shifts” that they have been experiencing. For these descendants of the Nama-khoi, livestock farming is a tradition that is passed on from generation to generation, and this has led to inter-generation knowledge transfer as the main source of information. Apart from inter-generation knowledge transfer, media sources contributed as alternative sources of information. The basic but, wealthy knowledge of farmers informs them of potential climate change impacts and possible adaptation strategies.

**CHARACTERISING HISTORICAL LAND COVER CHANGE, AND UNDERSTANDING TRENDS IN THE GOUKOU CATCHMENT, WESTERN CAPE, SOUTH AFRICA**

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The greater demand for goods and services across the globe drives land cover change, due to human pressure which in turn grows the unsustainable consumption patterns of natural resources and compromises the environment and ecosystem service delivery. The main focus of this study was to document the types, geographic distributions, rate of land cover changes and understand the motive behind these changes and consequences of the land cover change by looking at land use change, ecosystem services, water quality and quantity, impacts of land cover change on climate change and ecological infrastructure. Understanding impacts of land cover change requires robust understanding and documentation on the characteristics that cause change. Land cover change observation and monitoring rely on remotely sensed data coupled with field observations which assist in describing social, economic and physical dimensions of land cover change. This study was conducted by using advanced GIS tools and Remote Sensing technologies. Two sets of data were used on this study: Colour Infrared Images (CIR) and black and white aerial photographs. CIR images were analysed by using on-
screen digitising. Black and white images were analysed using several steps: projection, geo-referencing, mosaic, subset, textual analysis which comprises: running filters over kernel window sizes. Filters: variance, skewness, kurtosis, and Mean Euclidean Distance and kernel window sizes were 3x3, 5x5, 7x7, 13x13 and 25x25. Results were then stacked and Principal Component Analysis was performed to eliminate redundancy. Then supervised and unsupervised classification was performed. Results show that there is a rapid increase of cultivated fields over the years followed by an increase in disturbed areas, aliens and dam construction. Natural vegetation and wetlands are diminishing; this is due to conversion of natural area to agricultural fields. These results are of primary concern for the negative impacts of increasing land use activities to the delivery of ecosystem services, water quality and quantity and climate change in Goukou catchment.

**BIOLOGICAL TREATMENT OF PALM OIL MILL EFFLUENT (POME) USING FUSARIUM SPP, ASPERGILLIUS NIGER AND UREA**

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The Palm oil mill effluent (POME) causes serious environmental hazard due to its high biological oxygen demand (BOD) and chemical oxygen demand (COD) if disposed of without proper treatment. The effect of microbes (fungus) and urea (nutrient) in the biological treatment of POME was investigated in this study. Four samples were prepared (sample A, B, C, and D). From the result obtained, there was a decrease across the samples (A, B, C & D) in all parameters considered, such as: pH from 3.00 to 8.30, dissolved oxygen from 0.52 to 2.15mg/L, suspended solids from 56 to 17mg/L, BOD from 3584 to 70mg/L and COD from 2708 to 110mg/L. Sample D was found to be efficient in the treatment of POME among other samples (A, B, & C) used in this study, and it promises to be a good alternative for sustainable management of the effluent/waste.

Keywords: Palm oil mill effluent, Biological oxygen demand, Chemical oxygen demand

**QUANTITATIVE ANALYSIS OF THE ENVIRONMENTAL IMPACT OF A LOW-COST HOUSE**

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The residential sector in South Africa is the third-largest energy consumer and CO2 emitter. The poor thermal performance of low-cost housing due to the use of inferior building materials, results in excessive energy consumption to achieve thermal comfort. Consequently, increasing the carbon footprint of the country. Considering that coal-fired power plant is the major source of energy production. The aim of this study is to quantify the emitted greenhouse gases in generating the equivalent energy requires to maintain indoor thermal comfort of a low-cost house. Meteorological conditions of the house were monitored for a year. These conditions include indoor and outdoor temperature, indoor and outdoor relative humidity, solar radiation, wind speed and direction. Inner and outer surface temperatures of the house thermal envelope were also measured. The house thermal energy consumption was estimated using the degree-hours method. While the greenhouse gas emission was calculated using the UNFCCC methodological tool. With a reference temperature of 20°C and 24°C, respectively, winter season with 90.30 kWh/m2 was found to have the maximum thermal load. The thermal energy consumed during the same period was 3740.41 kWh. The annual thermal energy consumption was estimated at 988.47 kWh. To produce the equivalent amount of energy from a coal-fired power plant, 9785.84 kg of CO2, 78.39 kg of SO2, 41.42 kg of NOx gases will be emitted into the atmosphere per annual. The environmental impact of poor thermal housing performance was revealed
in this study. Energy efficient design in low-cost housing will not only reduce greenhouse gases emission, it will also provide a cost-effective year round thermal comfort for the occupants.

MORPHOMETRIC ANALYSIS OF SELECTED DRAINAGE BASINS SUBJECT TO DIVERSE GEOTECTONIC CONTROLS

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Changes in landscape take place as a result of the interaction between natural and man-made forces. The impact of human forces on the landscape became prevalent in the last century due to urbanisation, accessibility and globalisation.

Changes in Landscape development arise by natural or man-made activities impacts on the society, hence there is the need for adaptive management methods to mitigate and control landscape evolution now and in the future.

This paper through the use of GIS and remote sensing evaluate and access how tectonics and structural control influences the evolution and development of landscape using two basins with diverse geotectonic controls.

The main objective was to access the broader suitability of morphometric analysis in characterization of ancient landscape, this will then assist in the understanding of the process of landscape evolution, the extent of geological controls and therefore provide knowledge that can be used in geo-hazard identification, land-use management, and mapping of high flood potential and erosion prone areas.

A combination of knowledge of Geology, Physical Geography, and Geomorphology was used to explain landscape characterization and basin development.

Geological data sets at scales 1; 250,000 and 1,1,000,000 and the digital elevation model, (DEM) at 30M spatial resolution were used for the analysis, using ArcHydro in Arc GIS 10. DEM data were used to derive the morphometric parameters, while the geological datasets were used to carry out Morphostructural analysis.

It was determined that as the erosional development of the area by the stream progressed, the lithology has a major influence in the drainage development of the basins and also there exist an interrelationship between the drainage basin morphology and the structural geological markers.

Landscape changes respond to internal and external forces, our understanding of this forces is very vital in providing information for promoting sustainability and adapting land-use management practices.

POPULATION DYNAMICS OF ELAND (TAUROTRAGUS ORYX) IN THE DRAKENSBERG: CURRENT STATUS, TRENDS, GROUP COMPOSITION AND DISTRIBUTION

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Long-term population dynamics of eland (Taurotragus oryx) in the Drakensberg has not previously been assessed. Previous research on eland in the Berg was conducted >30 years ago. This study analyses historical data obtained through annual aerial and ground surveys conducted by Ezemvelo KZN
Wildlife. Survey data includes population numbers and, in more recent years, group composition (age and gender structure). In addition, grid numbers where eland are present are recorded. The aim of this study is to examine the population components of eland in the Drakensberg to get a better understanding of their current status, population trends, group composition and distribution in relation to global change. The current eland population in the Berg is 1404 individuals (2015 survey), with an overall increasing trend from 1942 to 2015 ($\lambda = 1.33$). However, in recent years (2003-2015), the population has been declining ($\lambda = 0.76$). With regard to group composition, adults constitute 59.12% of the population, while sub-adults and calves account for 18.78% and 19.06% respectively. Adult females specifically, make up 45.95% of the total group structure. The ratio of adult males: adult females: sub-adults: calves is 1: 3.66: 1.48: 1.5. Past and present distributions of eland are compared to determine shifts in habitat use. Results show a reduction in the area that eland utilise in the past decade. The decreasing eland numbers in recent years and the reduction in their distribution is a major cause for concern. Findings of this study will contribute to updated management plans for eland in areas managed by Ezemvelo KZN Wildlife. The updated mammal population database will assist Ezemvelo KZN Wildlife with on-going monitoring of eland populations in the Berg.

Keywords: distribution, Drakensberg, eland, global change, group structure, population status, trends

THE EFFECT OF COLOPHOSPERMUM MOPANE LEAVES ON PRODUCTIVITY, MEAT QUALITY AND METHANE PRODUCTION OF BEEF CATTLE IN SOUTH AFRICA

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Livestock production in communal land depends on pasture for sustainability with less concentrate supplement due to costs effective. Therefore, the use of browse trees has been considered as supplementary feed as it evidently showed a significant improvement of performance in ruminants. Evaluation of the effect of Colophospermum Mopane leaves for improvement of production was conducted in Botswana. The findings revealed Colophospermum Mopane leaves significantly improved average dry matter intake, average daily gain and cold dressed carcass weight of cattle. Studies reported an observation of minimal fat percentage on goat and sheep meat supplemented with browse trees than those fed on a different diet. Juiciness, tenderness and flavor of the meat were also improved $p<0.05$. However, in this study, the level of leaves inclusion in the diet was not specified. Further studies need to be conducted to determine the quantity, method followed and period of feeding the leaves. Other research findings also reported a comparison of Acacia karoo leaf-meal (AF) supplement and pasture grass fed to Nguni steers in South Africa. The results showed AF fed cattle had highest meat redness ($17.3 \pm 0.29$) values than steers on control diet. Similarly, higher meat protein content was also observed in steers supplemented with AF ($22.4 \pm 0.08\%$) ($P>0.05$) than those subjected to a different diet. Evidently, browse trees containing saponins and tannis have also shown potential to reduce the flow of microbial protein in rumen and increase efficiency of feed utilization and also decrease methanogens. In a study of comparing C4 and C3 grasses with legumes for reduction of enteric methane (CH4) emission in cattle showed that animals fed legumes produced 20% less CH4 than those subjected to grasses. Conclusion of research studies corroborates on how browse trees effectively improve production in livestock as well its effect on reducing the level of enteric CH4 emission. However, how much level of CH4 output from ruminants fed browse trees is produced and the quality of meat produce is unknown. The purpose of this study is to determine the effect of production, meat quality and enteric CH4 emission of cattle fed Colophospermum Mopane leaves.
ASPECTS OF THE ECOLOGY OF FERAL CATS IN URBAN PIETERMARITZBURG, SOUTH AFRICA

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Feral cats (Felis catus) are considered one of the world’s worst invasive species with expanding populations in urban areas. The effects of changing land use, especially urbanisation can alter the distribution and behaviour of feral cats. They are negatively implicated in preying on native wildlife, harbouring and spreading infectious zoonotic diseases and being a public nuisance. We investigated aspects of the ecology of feral cats in the urban mosaic of Pietermaritzburg, South Africa. Home range and habitat use were determined using telemetered feral cats (n = 11) with Global Positioning Satellite-Cellular transmitting collars. Mean home ranges of feral cats were small in urban areas with Minimum Convex Polygon 5.97 ± 1.49 ha. Feral cats showed individual variation in home ranges in the urban mosaic. Generally supplemental resources were the primary driver of feral cat home ranges as these feeding sites where within the core areas of the feral cats. Feline Immunodeficiency Virus (FIV) and Feline Corona Virus (FCoV) are common viruses leading to infectious diseases and fatality in feral cats. Feral cats (n = 42) were sampled for disease prevalence to determine the influence of sex, age, and location on prevalence in 2014-2015. Overall prevalence of disease in feral cats was generally low with incidences of FeLV and FIV 28.6% and 7.1%, respectively. There was a significant effect of location for FeLV prevalence. There was no documented occurrence of FCoV in this study. The results obtained contribute to recommendations for strategies and practices in the management of feral cat populations in an urban landscape.

IDENTIFICATION AND MAPPING OF WATER SOURCES USED IN THE MATATIELE LOCAL MUNICIPALITY, EASTERN CAPE, SOUTH AFRICA

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Globally, water is currently a point of focus and is scarce. South Africa is a water scarce country, the country makes many efforts on water provision for people. In the process of water provision, water security is not given much attention. This then becomes a problem especially in rural areas because of various reasons one of them being economic factor which may hinder these people from getting well secured water for basic uses. The aim of the study was to assess the state of water sources mostly used in the Matatiele Local Municipality. This was achieved by identifying and mapping the water sources mostly used in the study area. The study area was categorized into rural, peri-urban and urban areas. Distances between water sources and households were measured and compared to the acceptable distance which is 200m as stated by the National Water Act No 36 of 1998. ArcGIS v10.3 was used to map all identified water sources. Global Positioning System (GPS) was used to measure distances between households and water sources in the study area. Results revealed that there is a significant difference in acceptable distances among these categories. The longest distance travelled was 1.8km, 0.896km and 0.005km rural, peri-urban and urban area, respectively. There is a significant difference in types of water sources used between these groups. The dominant water sources were taps, wells and mix of the two in urban, rural and peri-urban, respectively. This highlights a need municipality and other authorities to comply with the acceptable distances of the water sources from the household in rural area.

Keywords: distances, taps, boreholes, rivers, tanks, wells, dams
ENHANCING FOOD SECURITY THROUGH CABBAGE PRODUCTION BY LOCAL FARMERS IN NKOKOBE MUNICIPALITY

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Subsistence farmers practice farming for survival while commercial farmers produce to feed themselves and larger society with the motive to achieve highest profit. These types of farmers are characterised by growing what they eat, live without making regular purchases in the markets. The main objective of subsistence/peasant farmers is to ensure food security at household level. Cabbage is a crop that has been identified to have vital food nutrient sources like Vitamin A, B and C, protein, calcium, iron and antioxidative compounds beneficial for preventing cancer. This paper therefore, looks at the potential that cabbage production has in enhancing household food security and also the challenges encountered by these cabbage producers. Primary data was obtained from 50 respondents and linear regression model was used to analyse the data used. Income was used as food security measure. The results showed that three variables were statistically significant and they are gender (10%), Education (5%) and household size (5%). Meaning that these are variables that influenced cabbage production by these households and it also affects their food security status since income is affected.

Keywords: subsistence farmers, food security and cabbage.

UNDERSTANDING THE MACROFAUNA COMMUNITY STRUCTURE OF THE MDLOTI ESTUARY

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Estuaries are some of the most productive systems. There are 270 estuaries along the South African coastline and a majority of these estuaries (73%) are temporarily open/closed estuaries (TOCEs). The Mdlozi estuary is an example of a temporarily open/closed estuary (TOCE). This system is impacted by anthropogenic activities such as pollution, siltation and reduced freshwater inflow by the Hazelmere Dam (leading to prolonged mouth closure). The prolonged mouth-closure was further amplified by the recent drought resulting in oligohaline conditions. Macrofauna are benthic organisms that play an important role in ecosystem functioning as primary and secondary consumers and an important food source for secondary and tertiary consumers. Additionally, macrofauna contribute to nutrient recycling and bioturbation, and make effective indicators of estuarine health. With climate change being predicted to increase the intensity and frequency of droughts and rainfall, knowledge of the effects of oligohaline conditions on macrofauna communities is important. This is particularly critical for the implementation of good management practices in the Mdlozi estuary. This study aims to investigate the temporal and spatial dynamics of the macrofauna community structure in the Mdlozi estuary. Preliminary results show that recent conditions have yielded a shift in taxonomic abundance. Previous studies (2002/2003 and 2007/2008) found that polychaetes, oligochaetes and amphipods dominated the system, with chironomid fly larvae having higher abundances in the fresher regions. As the estuary became more oligohaline, these studies found that amphipod and isopod abundances decreased. With the system being currently oligohaline, freshwater taxa are dominant, with chironomid fly larvae and cladocerans having some of the highest abundances in the system. A shift in benthic species composition in a system can lead to a disturbance in biological interactions as a result of bottom-up effects. This could modify the diversity of the system (with some estuarine taxa declining) and thus the functioning of it.
THE EFFECT OF HIGH FREQUENCY ATMOSPHERIC VARIABILITY ON LAGRANGIAN TRANSPORT IN THE SOUTHERN BENGUELA

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This study analyses the physical mechanisms that impact on Lagrangian transport in the southern Benguela upwelling system, an environment in which currents are key components of many important ecological processes, including the dispersal of marine larvae. Our study wishes to disentangle the combined roles of mesoscale turbulence, highly present in the region, and of short-period (less than 10 days) wind variability.

A validated interannual simulation of the region, using ROMS, over the period 1990-2010, provides the mean dispersal patterns. Sensitivity of these patterns to the atmospheric variability and to the synoptic oceanic circulation is considered by carrying a series of simulations with different initial conditions and low-passed time-filtered atmospheric forcing. Results highlight the contribution of high frequency atmospheric forcing on the variability of larval transport from the south coast to the west coast of South Africa.

THE INFLUENCE AND MANAGEMENT OF THE INVASIVE SPECIES CHROMOLAENA ODORATA IN BUFFELSDRAAI LANDFILL SITE

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Invasive alien plants are known to cause huge threats to biodiversity conservation and ecosystem services provision, invading both human and non-human modified landscapes. The invasion of alien plants at Buffelsdraai’s Community Reforestation Programme is a major threat to reforestation success. This study seeks to determine the influence that a woody shrub Chromolaena odorata has on the tree growth dynamics of replanted indigenous trees at the Buffelsdraai Landfill Site, and to assess the efficacy of cutting height and frequency in mechanical control of C. odorata. We investigated the competitive responses of three tree species: Acacia nilotica, Brachylaena discolor and Erythrina lysistemon by measuring branch length and diameter growth when grown in areas where C. odorata was present or removed. We expect greater growth of the trees with neighborhoods where C. odorata was removed than C. odorata-intact areas. For management purposes of C. odorata, we will assess the effect of three cutting frequencies on two heights of cutting on the species’ ability to resprout and persist after mechanical clearing.

GENOTYPE BY ENVIRONMENT INTERACTION OF SOUTH AFRICAN HOLSTEIN COWS

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Recently South Africa has been faced with challenges of drought along with high temperatures. These challenges motivate breeders to select animals adapted to the changing climatic conditions and water shortages. In this study genotype by environment was investigated for milk production in South African Holstein cows producing in pasture or total mixed ration (TMR). The aim of this study was to consider the possibility of genotype by environment interaction in three lactations of South African Holstein cows on milk production. The data was received from two South African research institutions namely; Agricultural Research Council (ARC) and South African Studbook for the first three lactations. Data
was recorded from 1985 to 2015. After data editing number of the records used for both environments were 218,679 and 71,952 for pasture and TMR respectively. To determine heritability and genetic correlation for both environments a multivariate analysis fitting an animal model using Wombat software. Both environments shared most common sires. Milk production was treated differently in each environment (pasture or TMR). Fixed effects included in the model were: herd-year-season, age at first calving and year of calving x feeding systems. Results from this study show high genetic correlation across environments (>0.64). The heritability’s estimates for milk production in pasture was 0.35 (0.018), 0.29 (0.018), 0.24 (0.019) and 0.31 (0.011), 0.21 (0.012), 0.17 (0.013) for TMR for lactations one to three respectively. The correlations for sires with more than twenty-five daughters ranged from 0.83-1. Bull dams were ranked and the best 1% of dams were selected. These correlations of their estimated breeding values in the environment ranged between 0.22-0.98 for bull dams. This result gives a good indication of the importance of genotype by environment in South Africa.

ENVIRONMENTAL FLOW REQUIREMENTS AND RESPONSE OF MACRO-INVERTEBRATE POPULATIONS IN THE LUVUVHU RIVER BASIN

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Stream flow alteration and rising water temperatures shapes fundamental ecological behaviors of aquatic organisms in riverine ecosystems. An understanding of an organism’s hydrological and thermal sensitivity or tolerance is therefore of importance in determining the likely effects of changes in flow and water temperature regimes on aquatic ecosystems, and also in the development conservation tools for aquatic ecosystems. Extreme events such as high and low flows exert pressure on aquatic organisms and dictate the success or failure of different species and their variation in distribution patterns. The long-term biomonitoring assessment of assemblage responses survey over time in the Luvuvhu River Catchment provides insights into trajectories of ecosystem change in this strategic water resource area. The responses of two aquatic organisms to two contrasting disturbance events (a major flood event and the long-term cumulative effects of land-use changes) were assessed in the period of time between 1999 and 2012 by quantifying variation and change in abundance of functional groups based on flow rate sensitivity, water quality and metrics of ecological condition. Results indicated that all metrics recovered to pre-flood conditions within seven months after the flood event. Similarly, cumulative impacts of land use effected significant decreases in some but not all metrics. Indices that did not change, including SASS total score and ASPT, were the result of insufficient consideration of the decrease in the abundance of sensitive taxa specifically, and the abundance of all taxa in general. Following the same trend, another biomonitoring assessment has been commenced with the aim to assess changes to assemblage structures of freshwater macroinvertebrate fauna due to thermal and hydrological variability over time in the Luvuvhu River Catchment (selected sites), and also to recommend a baseline flow required to sustain a range of macro-invertebrate species occurring in this strategic component of the Vhembe Biosphere Reserve.

A NUMERICAL SIMULATION OF TROPICAL STORM CHEDZA OVER SOUTH-EASTERN AFRICA

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Widespread flooding over parts of Malawi, Mozambique, and Madagascar occurred in January 2015. An impact assessment by the World Bank indicated huge damage to property, infrastructure, and agriculture over several regions in south-eastern Africa. The flooding was associated with tropical storm
Chedza that developed in the Mozambique Channel on 11 January 2015. This study investigates the atmospheric circulation and potential mechanisms responsible for the heavy rainfall event that occurred between 11 and 17 January over Mozambique and Malawi using the Weather Research and Forecasting (WRF) model, the Global Forecast System atmospheric reanalysis, satellite derived rainfall and wind data, and station rainfall data. Tropical Rainfall Measuring Mission rainfall estimates and rainfall station data indicated that southern Malawi and northern Mozambique experienced the majority of rainfall during the early stages of tropical storm Chedza while Madagascar experienced heavy falls when tropical storm Chedza tracked over the island on 17 January 2015. Furthermore, analysis of the station data revealed that the heavy rainfall over Mozambique occurred between 11 and 13 January with some stations recording about 80% of their total January 2015 rainfall as resulting from this event. The WRF model run of the event indicated a low level easterly to southeasterly onshore flow over southern Mozambique that interacted with a northwesterly monsoonal flow along the northern flanks of the storm in the northern Mozambique Channel, leading to surface moisture flux convergence in the regions of heavy rainfall. Furthermore, moisture from the southwest Indian Ocean was advected into the region during the heavy rainfall. It is suggested that multiple favourable factors which included strong moisture fluxes from the southwest Indian Ocean and equatorial South Indian Ocean, near surface convergence over the areas of heavy rainfall, and strong uplift acted together to create favourable conditions for the development of tropical storm Chedza and the associated heavy rainfall.

FISH HEALTH AND DIVERSITY OF PARASITES FROM KWENA DAM, MPUMALANGA PROVINCE, SOUTH AFRICA

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Health and quality of aquatic systems are affected by human activities through the introduction of pollutants and invasive species. Fish found in the aquatic systems suffer due to the pollutants which make the fish to be susceptible to parasitic infection infections and invasive species can introduce new pathogens to water bodies. Kwena Dam forms part of the Crocodile River System in Mpumalanga Province. The research project was aimed to evaluate the fish health of selected fish species and the diversity of parasites seasonally. The fish species sampled included Mozambique tilapia, sharptooth catfish and common carp (invasive species). Fish were collected using gill nets during autumn (April) and winter (July). The fish were weighed, measured and examined for endo- and ectoparasites. All parasites were fixed and preserved according to standard methods for each parasite group. To evaluate the health of fish the Health Assessment Index (HAI) and Parasite Index (PI) were used. Parasites that were found included Trypanosoma sp., monogeneans, Diplostomum sp., Contracecum sp. larvae, Procamallanus, Gryporhynchid cestode larvae, Atractolytocestus huronensis, Dolops ranarum, Argulus japonicus and acanthocephalans. Water quality results showed that the water was of good quality. The fish showed to be in harmony with their environment as there were few deformities recorded with low HAI scores. Results of this study forms part of evaluation of freshwater ecosystems also provide information on new distribution and host records of fish parasites in South Africa and can be implemented in the management and conservation of fish species at the dam.
STUDY OF THE AEROSOL OPTICAL PROPERTIES OVER DURBAN USING THE AERONET SUN PHOTOMETER WITH COMPARISONS MADE WITH THE SKUKUZA SUN PHOTOMETER, SOUTH AFRICA

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The Aerosol Optical Depth (AOD), Angstrom Exponent (α440–870), Volume size distribution, Single Scattering Albedo, Asymmetry parameter were downloaded for Durban and Skukuza, in order to compare and validate the preliminary results from the Durban sun photometer with the well-established Skukuza sun photometer. High AOD was noted for both regions in August, this was attributed to it being the onset of the biomass burning season. The AE also displayed similar trends, with low values (suggesting coarser aerosols) from January to July, with increases in AE in August. The SSA and ASP values for Skukuza showed strong seasonal variability. Higher SSA values noted for summer and autumn, thus alluding to an increase in scattering type aerosols during these months. The SSA for Durban was only given for winter and the values were similar to the values noted for Skukuza’s winter, suggesting, biomass burning, urban industrial (mixed aerosol loads) present during the winter months.

Key Words: Aerosol optical depth, Angstrom Exponent, Volume size distribution, Single Scattering Albedo

CLIMATE CHANGE AND PEST EPIDEMICS: LESSONS FROM THE 2013 ARMYWORM OUTBREAK IN THE EASTERN CAPE PROVINCE

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The African Armyworm, Spodoptera exempta W (Noctuidae), is a sporadic pest whose population size is affected by factors such as micro- and macro- climatic conditions, food quality and supply, predation and parasitism. Complete crop loss on cereals like maize have been reported during endemics and/or pandemics. During the 2013 outbreak, in the Eastern Cape, more than 12000 ha of maize, pastures and beans were infested and damaged resulting in significant losses, with some farmers recording 100% loss. Most political and even technical personnel are unaware or not familiar with the environmental factors that trigger the gregarious phase of armyworm development and outbreaks. Consequently, farmers and decision makers are not adequately prepared to deal with a climate-change-induced pest outbreaks. South Africa experienced major armyworm outbreaks in 2001, 2003 and 2013. Over the past 30 years, two major outbreaks were recorded in the Province, with the first said to have occurred in the early eighties and the second in 2013. This calls for a collaborative and concerted approach for the continuous monitoring of climate variability and changes that may influence pest outbreaks, at provincial, national and the Southern African region. The 2013 epidemic provided important lessons that may help in developing management and control strategies for future epidemics. These include the need for the creation and adoption of nation- and provincial-wide state of preparedness through the development of appropriate contingency plans, trained personnel, relevant equipment acquisition, farm awareness programmes and campaigns and capacity building, before outbreaks occur. This will significantly reduce the devastating potential and effect of armyworm outbreaks, post drought periods, on the socio-economic conditions, livelihood and outlook of small-scale farmers and communities who are most at risk.

Key words: Epidemics and endemics, lessons learnt, Armyworm outbreak, Eastern Cape Province
THE SACTN AND YOU
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The availability of quality data is a constant issue plaguing all fields of research. Long term monitoring and data collection for environmental systems in South Africa has been limited and the temporal and spatial resolution of most datasets are sparse. This negatively affects the efficacy of any attempts at management of these systems. To this end our research team has aggregated all of the coastal in isitu seawater temperature time series available along the coast of South Africa so as to aid in the accurate data driven management of our coastal systems. These data are made freely available to all managers and researchers. The ease of access to these data is currently being improved by hosting them on the SAEON data access portal. Detailed on this poster one may find the meta-data for the South African Coastal Temperature Network (SACTN) and examples of the research already conducted with these data.

EFFECT OF TEMPERATURE ON OXYGEN CONSUMPTION OF SUBTROPICAL ESTUARINE MACROFAUNA
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Estuarine habitats have naturally high variable physico-chemical and biotic conditions. Moreover, human activities can intensify this natural variability leading to unpredictable extreme disturbances. Disturbed areas are generally characterized by the presence of more opportunistic species with higher physiological plasticity. Very little is known about the metabolic rates and physiology of subtropical estuarine macrofauna. The present study aimed to quantify and compare the oxygen consumption rates of eight macrobenthic species at four different temperatures. To evaluate the hypothesis that the metabolism of macrobenthic species varies according to their habitat conditions, four species were sampled in the temporarily open/closed Mdloti Estuary subjected to strong anthropic pressure, and four species were collected in the permanently open Mlalazi Estuary located in a natural reserve representing a good health index. Oxygen fluxes were measured in the laboratory at an individual level with high-precision optical oxygen sensors. The respiration rates were measured at four different temperatures showing significant increases with temperature for all the studied species. Species from the Mdloti Estuary showed higher metabolism resilience to temperature variation than the species collected in Mlalazi Estuary suggesting that the species from perturbed estuaries can better adapt their physiology to suit variable environmental conditions.

MUNICIPAL SOLID WASTE MANAGEMENT IN SOUTH AFRICA: SOCIAL NORMS AND ATTITUDES
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The communities of Khayelitsha face critical problems with regard to managing waste. Increase on the generation of solid waste in the households accompanied with the use of packaged goods by the members of the community, far exceeds the township ability and capability for safe disposal. Littering in the township is a persistent problem, despite various clean-up and anti-litter promotional campaigns and programs run by local government, private organizations and other community interest groups. The persistent problem of litter and mismanaging of solid waste in the household need to be addressed, the study investigated the continuous litter and mismanage of waste in Khayelitsha. The rationale and
assumption underpinning this study was that waste management problems are related to social norms and attitude of the people of Khayelitsha. To investigate this phenomenon, the head of households residing in Khayelitsha for more than 5 year were surveyed; the head of household were purposeful selected till the researcher achieved a trash hole of 300 samples in order to collect rich data that provided an insight of their lived experience in waste management. Findings arising from the analysis were validated by means of focus group session with 8 waste management operators.

THE IMPACT OF GLOBAL CHANGE ON WATER QUALITY AND THE HEALTH OF SELECTED FISH SPECIES AT TZANEEN AND MIDDLE LETABA DAMS, LIMPOPO, SOUTH AFRICA

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Freshwater resources in South Africa are under severe pressure from existing anthropogenic impacts. Global climate change is likely to exacerbate this pressure. The Letaba River System is contaminated by metal and organic materials due to activities taking place in the catchment. An increase in pollution levels at the Tzaneen Dam and Middle Letaba Dam will affect the ecosystem health and therefore the aquatic biota in the systems. Water samples were collected twice (high flow and low flow) and analysed for selected water constituents. Fish were collected using gill nets, weight, measured and examined for parasites. Each fish was visually examined to identify any parasites and the Health Assessment Index (HAI) and Parasite Index (PI) were determined. All water constituents fell within the target water quality range (TWQR) for aquatic ecosystems throughout the study. However, phosphate was below detection at Tzaneen Dam during low flow. Eleven different parasite species (both ecto- and endoparasites) were recorded, from Clarias gariepinus and Schilbe intermedius. Higher HAI values were recorded for Clarias gariepinus than S. intermedius indicating that Clarias gariepinus was in better health than S. intermedius. Although in this study the results may be affected by low number of S. intermedius collected only at Tzaneen Dam while C. gariepinus was collected from both dams. Fish can be used as bioindicators because the accumulated metals in the fish tissues are indicative of the bioavailability of metals in both dams. These accumulated metals coupled with global climate change pose a great challenge to humanity and ecosystems. Considering the finite nature of water, its deteriorating quality and our increasing demand for it, the need to protect and manage freshwater resources is crucial.

DISTRIBUTION AND ABUNDANCE OF MACROBENTHIC INVERTEBRATES IN RELATION TO ENVIRONMENTAL PARAMETERS

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Habitat loss and sea level rise are the two major components of global change. In combination, they pose a severe threat to low lying habitats, particularly the intertidal areas of estuaries and lagoons. Before development of a harbour, Durban Bay was a sheltered lagoon with totally exposed sandbanks and deeper channels with extensive mangrove and swamp areas and two vegetated islands near the centre. Much of the soft substrate in has been lost due to development, but the Bay is still ecologically important. However further development and sea level rise could further degrade the ecological integrity of the Bay. We studied the macrobenthic invertebrate in intertidal and subtidal communities and correlated them to the physicochemical and environmental properties of the areas, to help in understanding their status and inform development decisions. There were significant difference between species composition on both intertidal and subtidal sandbanks which correlate with microphytotobenthos distribution and the type of sediments. The little lagoon community was significantly different from all
other areas both on intertidal and subtidal sandbanks. Chalichirus kraussi and nemerteans contributed to differences in intertidal and subtidal sandbanks respectively. Tidal level is an important determinant of intertidal assemblages and the importance of soft substrata generally to diversity. On subtidal sandbanks all seasons were significantly different from each other apart from spring to summer. Our results emphasize the importance of the intertidal macrobenthos and substrata general to ecosystem function. Further development, aligned with sea level rise may eradicate intertidal habitat and substantially alter the structure and functioning of the subtidal soft sediment cascading effects on fish and avifauna. Similar habitats around the country may be equally vulnerable to these pressures.

AN ISOGLOSSA WOODII UNDERSTOREY INFLUENCES COASTAL FOREST REGENERATION IN SOUTH AFRICA

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Understorey vegetation has been mooted as an ecological filter that shapes the density and species composition of tree regeneration. We examined the effect of a woody herb Isoglossa woodii and associated herbivory on tree seedling emergence and establishment in coastal dune forest. Nineteen 10m × 10m plots were established and each subdivided into herbivore-protected (fenced) and herbivore-unprotected (unfenced) sub-plots of 5m × 10m. The herb stratum was removed from half of each sub-plot. Once a year (2001-2008) we measured the seedling size and species composition in 10 permanent 1m² quadrats located in each sub-plot. The height and stem density of I. woodii in each sub-plot were also measured. From February 2005 to February 2007, soil samples were collected from all sub-plots for measurement of fertility (Ca, Cu, exchangeable acidity, Mg, Mn, pH, P, K, total C, total cations, Zn, and total N) and moisture content during 2005 and 2006. The herb and herbivore treatments had no effect on any of the measured soil parameters. The herb also had no effect on soil moisture. The density and species composition of tree seedlings, and herbivory, were greater in the cleared than beneath the intact understorey. The effect of the herb understorey on reducing seedling density and species richness was greater than the effect of herbivory. The magnitude of these differences and effects increased with time. We argue that I. woodii is a strong ecological filter that affects the establishment of woody seedlings and hence tree dynamics in subtropical dune forests. The herb filter combines several interacting mechanisms, but low light is the main limiting determinant of seedling establishment and survival in these forests. Gaps in I. woodii cover provide opportunities for regeneration of tree species that are sensitive to deep shade.

SHRIMP COMMUNITY CHANGES DURING EXTENDED MOUTH CLOSURE OF ST LUCIA, INDICATORS OF RESILIENCE AND RECOVERY?

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Penaeidea and Caridea in Lake St Lucia, the largest estuarine system in southern Africa, have received little attention since mouth closure in 2002. Closure was associated with changes in mouth management strategy, increased freshwater abstraction, decreased rainfall and high evaporation rates, resulting in hypersaline conditions and low lake levels. A six month marine connection in 2007 was observed along with various back channel connections from the Mfolozi Estuary, with which St Lucia previously shared a mouth. Samples were collected biannually (spring/autumn) from six sites, two in each of the North Lake, South Lake and Narrows regions, between November 2004 and May 2012 using seine nets. Seven Penaeidea and seven Caridea species were recorded, of which Palaemon pacificus, P. peringueyi, Penaeus indicus and Metapenaeus monoceros dominated abundance. The decline in species recorded and densities of freshwater, estuarine and marine species during the initial closed period (2004–2007)
was linked to increased salinity, lack of recruitment and reduced estuarine surface area. Cyclone Gamede opened the mouth in March 2007 resulting in recruitment of marine species, predominantly P. indicus, followed by a decline in densities after re-closure (August 2007). Increases in marine and freshwater species were evident after Mfolozi flooding connections during 2008, 2009 and 2010. Highest densities were recorded after breaching (2007) and flood connections, highlighting the importance of a marine link for maintained recruitment of penaeid species.

THE VULNERABILITIES OF COASTAL RESORTS TO THE IMPACTS OF CLIMATE CHANGE. A CASE STUDY OF SELECTED AREAS ALONG THE WILD COAST, EASTERN CAPE, SOUTH AFRICA

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Climate change is a global phenomenon with major impacts on coastlines, leaving coastal areas vulnerable to conditions such as sea level rise, flooding as well as storm surges which will result in increased damage to or loss of coastal property and infrastructure. The study examined the vulnerability of the Eastern Cape’s Wild Coast resorts to the impacts of climate change. The study employed both qualitative and quantitative methods aided by questionnaires and GIS mapping to identify vulnerable settlements as well as their impacts. A meta analysis of the identified vulnerabilities was studied and strategies employed to reduce the impacts was also done. Results of the study indicate that almost 80% of the Wild Coast resorts occur within the low lying areas of the Coast and these areas are mostly affected by impacts such as sea level rise, heavy rainfall and floods accompanied by storm surges. Another alarming challenge faced by the local municipality is controlling unplanned developments within these low lying zones of the coast. Based on the findings of this research, it is recommended that relevant departments provide awareness in ensuring people understand the risk of climate change on low lying areas as well as mainstreaming climate change in long term development planning. This research promotes the monitoring of coastal environments vulnerable to the impact of climate change along a South African Coastline.

Key words: risk, sea level rise, floods, low lying zones

AN ANALYSIS OF VEGETATION REDUCTION VERSUS URBAN GROWTH/URBANIZATION BETWEEN 1997 AND 2014 IN KING WILLIAMS TOWN, EASTERN CAPE, SOUTH AFRICA

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Simply defined as the shift from a rural to an urban society, urbanization is an essential corollary of industrialization that goes hand in hand with the role of human settlements as engines of growth in the economy and as promoters of scientific, socio-cultural and technological development. Urbanization is the outcome of the social, economic and political development, it is also a factor of development associated with modernization and is a means of and consequences of modernization and has a positive and accelerating effect on development. An urban area is often regarded as a place with spatial concentration of people whose lives are organised around non-agricultural activities. They are typically dominated by built up and artificial land with impervious surfaces. A consequence of this is the accompanying shrinkage in vegetation and an increase in impermeable surfaces. Hence basically urbanization together with urban expansion exerts pressure on land resources causing environmental and social problems in the process. Tackling these impacts of urban expansion requires knowledge of the spatial phenomena of landscape components including vegetation dynamics this can be achieved
through spatio-temporal analyses methods, remote sensing and GIS techniques have become an efficient tool to carry out such analysis. This study is aimed at mapping and through various forms data also quantify the dynamics in vegetation cover and urban expansion from 1997 to 2014 in King Williams Town, Eastern Cape province.

COMMUNITY CONSULTATION APPROACH ON REHABILITATION PROGRAMME AT NTABELANGA DAM CATCHMENTS, EASTERN CAPE, SOUTH AFRICA

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Ntabelanga is a rural area with a small population located in Mhlontlo Local Municipality in the Eastern Cape Province, South Africa. It is perceived to be undeveloped in terms of agriculture and water resource infrastructure due to soil erosion along the Ntabelanga Dam catchments. In view of this, the Department of Environmental Affairs intends to undertake a catchment rehabilitation program aiming at restoring the composition, structure and functions of these catchments. However, it is crucial to undertake community consultation approach in the planning and decision making of the project.

This research study therefore seeks to investigate the perception and experiences of the public. This is in keeping with Bernard (1999) who states that “community consultation is becoming a prerequisite for rehabilitation programs” as well the South African Constitution requires proper consultation to be held before the onset of a project according to Environmental Conservation Act of 1989.

Three directly affected sites (ward 16, 21 and 22) were selected for the study. The research methods used include qualitative methods such as individual and focus group Interviews as well as non-participant observation. Geographic Information Systems (GIS) and Statistical Package for the Social Science (SPSS) software were used as tools to analyse and present data.

Keywords: Community Consultation, Soil erosion, Land Restoration and Rehabilitation, Natural Resources, Catchments