SPACES II

Science Partnerships for the Adaptation to Complex Earth System Processes in Southern Africa

Research Programme Newsletter

Welcome to the third SPACES II Newsletter!

Our Newsletter welcomes short news, announcements and articles from all SPACES II projects, associates and stakeholders.

As a special theme within this issue, many SPACES II researchers share their Covid-related challenges and how they have overcome them; from preparing field sites for an unexpected quiet season, to testing instruments at similar sites in Germany.

In this lockdown issue, we also included a new section on virtual conferences, highlighting presentations from different projects. Another new section, SPACES II in media, brings attention to our various contributions in public media. We also introduced a new section to highlight some of the recent scientific publications by SPACES II researchers.

Similarly to the previous issue, we start with short announcements on up-and-coming events and funding calls (check out the open DAAD call for climate post docs!), followed by courses, field trips, research highlights and other longer contributions.

Enjoy reading and keep well!

Mari Bieri (SPACES II Board/External Communications)

INSIDE THIS ISSUE:

VISIT US ONLINE

https://www.fona.de/en/measures/funding-measures/science-partnerships-fo-the-Assessment-of-complex-earth-system-processes.php

https://www.spaces-training.org/

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SPACES II Virtual Midterm Meeting, October 2020

Similar to most events, the SPACES II MTM will be organised as a virtual meeting this year. Date in October will be set soon. All projects are invited to present their progress, and meet on a virtual platform. We will compile the agenda and establish a conference website for the sharing of materials, links and information; ideas and suggestions are welcome. Contact: mari.bieri@thuenen.de

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SPACES II Final Meeting, Future Africa Centre, University of Pretoria, South Africa, 17-20 May 2021

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The dates for SPACES II Final meeting were recently set by voting. The final meeting was scheduled for 17-20 May 2021, subject to meeting and travel restrictions being released. The meeting is hosted by Prof, Dean Barend Erasmus of the University of Pretoria. We expect the format of the meeting to follow the initially planned agenda of the MTM, with two-day student workshops on SPACES topics followed by two days of core meeting.

Call for applications in DAAD climapAfrica program: Postdoctoral fellowships for Africans in Climate research (13.07.2020-14.09.2020)

DAAD

SASSCAL
Southern African Science Service Centre for Climate Change and Adaptive Land Management

WASCAL
West African Science Service Centre on Climate Change and Adapted Land Use

The DAAD climapAfrica program, in cooperation with the climate competence centers SASSCAL and WASCAL, aims to foster application- oriented research results to tackle climate change in southern and western Africa. The program funds postdoctoral research projects and offers a platform for collaboration in thematic working groups composed of postdoctoral fellows and African alumni of German funding initiatives with expertise in the field of climate research. Fellows and Alumni experts will increase their research impact and output through a comprehensive training and support program, including general skills training, science policy advising and science management. The working groups serve as a platform to connect with peers, regional and international experts and practitioners and to build a growing professional network across Africa.

Learn more: https://www.daad.de/en/the-daad/what-we-do/sustainable-development/funding-programmes/climapafrica/

Apply here: https://www2.daad.de/deutschland/stipendium/datenbank/en/21148-scholarship-database/?detail=57516492

Ecological Society of America (ESA) Virtual meeting: Harnessing the Ecological Data Revolution, 3-6 August

The Ecological Society of America (ESA) will be holding a virtual Annual Meeting this year August 3–6 in response to the pandemic. The meeting will focus on the chances and challenges of big and diverse data.

The 105th annual meeting encourages contributions that address these issues or that employ novel and integrative approaches to harnessing the data revolution to address pressing issues in ecology.

Deadline for registrations: **23 July** https://www.esa.org/saltlake/.

American Geophysical Union (AGU) Fall Meeting, San Fransisco: Shaping the Future of Science, 7-11 December

AGU FALL MEETING
San Francisco, CA | 7–11 December 2020

American Geophysical Union (AGU) Fall Meeting will be mostly virtual and remain the global convening meeting for the Earth and space sciences community.

Fall Meeting sessions will include:

- COVID-19, from lessons learned in Earth and space sciences to ideas for what to do to advance research when one can't be in the field or in the lab.
- Actions the Earth and space sciences should take to remove discrimination and eliminate racism to improve diversity and inclusion.
- How to better communicate your science to policymakers, reporters, voters and other key audiences.

Deadline for abstract submissions is **29 July** https://www.agu.org/fall-meeting.

ICOS Science Conference 15-17 September: Free registration offered to virtual conference!

The theme of this year's ICOS Science Conference is "Knowledge for shaping the future—understanding the Earth's biogeochemical processes". Virtual science conference is free to attend, but requires registration:

https://www.icos-cp.eu/sc2020/registration

SALLnet Online Training Workshop APSIM and aDGVM, 24-28 August

SALLnet

This course teaches advanced modelling of agroecosystems services for sustainable rural development under global change. Participants will learn the principles of process-based crop simulation-models (CSMs) and dynamic vegetation models (DVMs), with practical case studies and applications.

The course will be held online, registrations are now closed. Find further information on the SPACES II Training Programme website:

https://www.spaces-training.org/courses/july-september-2020/training-workshop-apsim-advanced-and-dynamic-vegetation-modelling/

Anja Linstädter on bushfires in Australia

SALLnet Principal Investigator Dr. Anja Linstädter (vegetation ecologist at the University of Bonn – Grassland Ecology & Grassland Management Group) was recently interviewed by the newspaper Bonner General-Anzeiger. On the occasion of severe recent wildfires in Australia, Dr. Linstädter commented on the links between human-induced climate change, extreme ecological events, human disturbance, and joint impact of these factors on ecosystems. She also explained why such natural disasters will become more frequent in many terrestrial ecosystems, including African savannas.

The interview, conducted in German, was published in print as well as online on the website of General-Anzeiger Bonn.

Sina Weier, Valerie Linden and Peter Taylor on Bats versus macadamia crop pests

SALLnet researchers Dr. Sina Weier, Dr. Valerie Linden and Prof. Peter Taylor (University of Venda) would like to share their research on bats in Quest. Science for South Africa, which concludes that "bats appear to be of utmost importance for insect pest control" preventing macadamia crop loss from insect pest damage. "Unfortunately, bat populations keep declining at an alarming rate and about one quarter of all bat species are currently threatened with extinction. This decline is mainly attributed to the loss and fragmentation of habitats, roost sites and feeding opportunities, caused primarily by agricultural intensification − more and more natural areas being turned into farmland." The authors offer recommendations on how to help promote bat activity and the biocontrol provided by them. Read more.

EMSAfrica
Ecosystem Management Support for Climate Change in Southern Africa

Photo: Johannes Arlt/DER SPIEGEL

Thomas Clemen on crisis preparation in the German Newspaper Der Spiegel

EMSAfrica PI Prof. Thomas Clemen (Hamburg University of Applied Sciences) was recently interviewed for one of the main German newspapers, Der Spiegel. Thomas and his team specialise in multi-agent modelling and simulation, providing EMSAfrica project with solutions of decision support, data integration and management, as well as stakeholder involvement. His experience in advisory roles for national security and the work he does in simulating human behaviour in public spaces during crisis situations give him an important role in the current pandemic. In this interview, Thomas also draws links between climate change, resilience, and pandemic crisis preparation.

ORYCS Master tandem on Elephant movements

Ronja Kraus[1], Ivonne Makando[2]

University of Vienna, Austria, and ISOE & Institute for Social-Ecological Research in Frankfurt, Germany

Namibia University of Science and Technology (NUST), Windhoek, Namibia

Ivonne Makando (NUST) and Ronja Kraus (ISOE) are Namibian-German tandem master students within the research project ORYCS. Both are working on elephant telemetry data provided by the Ministry of Environment and Tourism of Namibia (MET).

While Ivonne assesses the relationship between elephants and their natural environment, Ronja analyses the influence of land management and game-proof fences on the landscape connectivity for elephant movement. Ivonne is funded by ORYCS and Ronja has successfully applied for a scholarship from her university. Together, Ivonne and Ronja conducted interviews with farmers living with elephants in the study area in 2019. Both have already presented preliminary results of their studies to stakeholders like at the Annual General Meeting of the Namibia Professional Hunting Association (NAPHA) and to researchers at the 3rd Multi/Interdisciplinary Research Conference in Windhoek. This demonstrates how the tandem master program within ORYCS facilitates the exchange of knowledge and experiences between Namibian and German students and enables their collaborative research.

***Photo**: Master students Ivonne Makando (left) and Ronja Kraus (right) during their field work.*

TRACES welcomes new team member

The iSimangaliso Wetland Park, South Africa's first UNESCO World Heritage Site in KwaZulu-Natal, holds the largest estuary of South Africa, i.e. the greater Lake St. Lucia system (Figure 1). It is highly diverse in terms of both flora and fauna, but susceptible to climatic change and anthropogenic impacts such as mining operations in coastal dunes, agriculture and expansion of roads and living space. Hence, it is imperative to gain a better understanding of the paleo-ecological impacts of past climate change and anthropogenic activities to better predict the environmental response of this sensitive area.

Figure 1 (left) *TRACES members taking samples at the iSimangaliso Wetland Park.*

Figure 2 (below) *Angela Effiom at work at the Evolutionary Studies Institute (ESI) of the University of the Witwatersrand.*

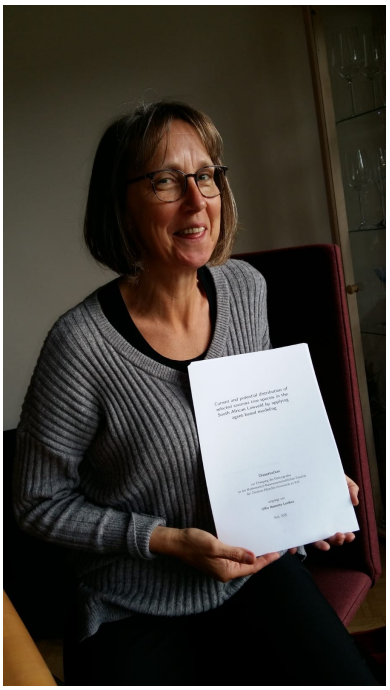
To address this critical issue and broaden the existing available expertise, TRACES is happy to introduce Angela Effiom (Figure 2) as a new associate member in TRACES. Angela is located at the Evolutionary Studies Institute (ESI) of the University of the Witwatersrand, South Africa where she conducts her PhD under supervision by Dr. Frank Neumann. Her research interests focus primarily on the reconstruction of past vegetation and inference of past climate changes using pollen and spores. Another field of research is the application of pollen and spore morphology, foliar and floral epidermal anatomy in plant taxonomy.

As a first step, Angela works on an overview of significant palynomorph taxa from the Indian Ocean Coastal Belt Biome (IOCB) of Southern Africa. A pollen atlas from the IOCB is not existing so far and will form the basis for more detailed future investigations of the paleoecology in this climatically sensitive region. The second step will be the detailed reconstruction of paleo-ecological changes around Lake St Lucia using palynomorphs. Her data will be supported by organic and inorganic chemical analyses provided by South African and German collaborators in the frame of TRACES. A research visit of Angela to Germany is planned when international travel is again possible. We look forward to a fruitful cooperation within TRACES under the umbrella of SPACES II. Angela is thankful to PAST (Palaeontological Scientific Trust) who support her with a student bursary.

EMSAfrica congratulates Dr Ulfia Lenfers!

EMSAfrica
Ecosystem Management Support for Climate Change in Southern Africa

EMSAfrica project members would like to raise a glass of sparkling to Ulfia Lenfers, who started her PhD during the SPACES I project ARS AfricaE and is gaining her PhD during the SPACES II project EMSAfrica in July. In Ulfia's dissertation, an agent-based model was built to show the impacts of elephants on three different tree species at the Kruger National Park, and the use of these trees by firewood collectors outside the protected area.



As the first step, partial order methods were applied to an existing dataset to get a deeper understanding of the ecological adaptation strategies of the different tree species. Three strategies were identified, each assigned to a representative tree species. *Senegalia nigrescens* invests in the root system for nitrogen production, while *Combretum apiculatum* stores carbon in different parts of the plant as a defense strategy against browsers. *Sclerocarya birrea,* with its large average leaf area and easily digestible leaves, has a high photosynthesis rate and nutrient input due to the longer residence time of large browsers. Other characteristics included ability to withstand drought, fire, and recurrent cutting.

The developed agent-based model, with a simulation period from 2010 to 2050, was built by three agent types: "Tree", "Elephant," and "Firewood collector". The second aim was to include adaptable human behavior into the model. To model human adaptive behavior, a so-called "Goal-Oriented Action Planning" (GOAP) approach for collecting firewood was adapted from game development. The agent-based model approach made it possible to observe individual trees over time and compare different tree species and age groups. Additionally, the two areas were simulated with the RCP 4.5 and RCP 8.5 climate scenarios. Particularly noteworthy is the comparison between the consideration of aboveground biomass (AGB) and the detailed information on age class and species level. Effects such as species shift, loss of adult trees, and scrub encroachment were visible in the simulation results. This is a definite advantage of microscopic modeling. The trends of the model outcome resemble an early warning system for different stakeholder groups in South Africa. Thus, simulation results can be processed directly into the practice of decision-makers on-site in the region.

The combination of computer science and geography and the knowledge transfer within the EMSAfrica group contributed to a reusable methodical workflow and adaptable model elements for the scientific consideration of current and potential distributions of certain tree species in different regions.

Photos © U. Lenfers and T. Clemen

First ORYCS short course on experimental design and data analyses

Katja Geissler & Niels Blaum, Department Plant ecology and Nature Conservation, University of Potsdam, Germany

Twenty-three ecology students from four Southern African countries (Zambia, South Africa, Namibia, Zimbabwe) and Germany participated in the SPACES II ORYCS short course in “Experimental design and Data analysis with R – Tools for ecological savanna research” from 8 to 13 March 2020. The course was organized by Katja Geißler and Niels Blaum from the University of Potsdam and Morgan Hauptfleisch from the Namibia University of Science and Technology. The Otjikoto Environmental Education Centre hosted the event in their great venue close to the Waterberg in northern Namibia.

Every day, a morning lecture introduced the participants to a specific savanna topic, a corresponding case study, the experimental design for it and techniques for data collection. Afterwards the whole group went directly into the field, where the data were collected according to the previously discussed scientific question and experimental design.

Three ecological research topics with respective case studies guided our short course:

- Land use and vegetation: Allometry of perennial grasses
- Shrub Encroachment: Dispersal ecology of shrub encroachers
- Biodiversity: Predation risk of small mammals

The afternoon session was reserved for the statistical analysis of these self-collected data using the open-source statistical software R.

Figure 1 *(left). In the course room.*

Figure 2. *Group picture of the first ORYCS short course on experimental design and data analyses.*

One aim of the short course was making students aware of how important it is to design scientifically robust ecological experiments and monitoring programmes. A second aim was to convince them that after starting with an interesting ecological question they need a sound statistical approach to let their data speak. This should benefit both students moving into academia but also students, which end up working in government or consultancy in a broad range of fields.

Figure 3. *Ailly and Martha measuring tussocks of* Cenchrus ciliaris *in the field.*

According to the feedback from the participants, our short course sessions provided them with inspiring and valuable scientific approaches. In addition, participants developed a variety of new analytical skills. What really thrilled us was the level of engagement of our students. This, we believe, we achieved through the variety of fun and challenging academic activities, including the collection and analysis of own field data. At the last day, our intense course concluded with comprehensive small group discussions of participant's own research plans and data they brought along.

Overall, we were delighted that so many students have grasped the opportunity to attend our short course and improve their statistical skills. It was a fantastic experience to work with them. We would also like to thank the Otjikoto Environmental Education Centre, in particular Mya for opening their doors for us.

International conference on South and Tropical Atlantic climate-based marine ecosystem prediction for sustainable management

TRIATLAS is based on cooperation between Brazil, South Africa and Europe. It is strongly related to SPACES II BANINO as it focusses on marine ecosystems and their future changes in the South and tropical Atlantic. The 1st TRIATLAS (South and Tropical Atlantic climate-based marine ecosystem prediction for sustainable management) conference was supposed to take place in Mindelo, Cabo Verde on May 11-15, however due to Covid-19, this meeting was changed ont an online science conference, which took place on May 12-14. BANINO project participants from South Africa, Angola, and Germany contributed to the conference.

Arthur Prigent (BANINO PhD student) held a talk “Weakened SST variability in the tropical Atlantic Ocean since 2000” in the plenary session. He showed that the interannual SST variability in the eastern equatorial Atlantic featured a strong change in magnitude around the year 2000 (Figure 1). The averaged May–June-July (MJJ) SST standard deviation in the Atl3 region (3˚S–3˚N, 20˚W–0˚, Figure 1) decreased by 31% from 1982-1999 (Figure 1a) to 2000–2017 (Figure 1b).

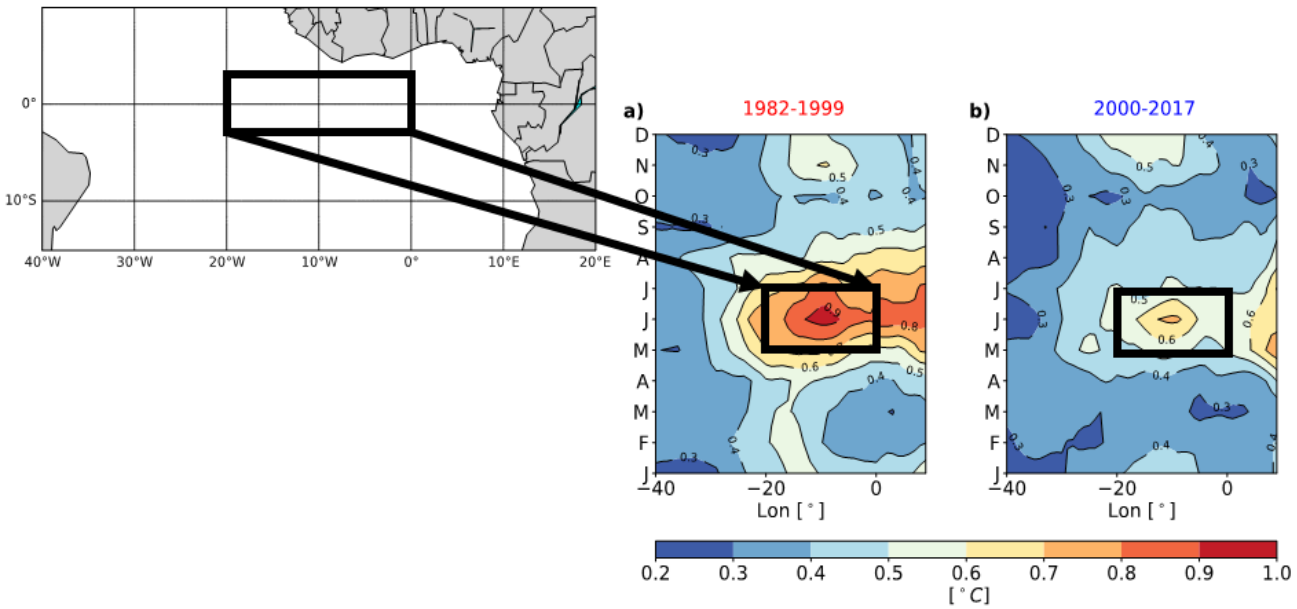


Figure 1. *(a, b) Standard deviation of OI-SST anomalies along the equator and averaged between 3˚S and 3˚N as function of the calendar month for the period 1982-1999 and 2000-2017, respectively (Figure from Prigent et al. 2020).*

In addition, several posters were presented from BANINO partners studying Benguela Niño’s and associated physical processes and long-period variability including, among others:

M.-L. Bachelery (South African BANINO partner) et al.: *How low-frequency Equatorial Kelvin Wave activity and local coastal winds modulate the south-eastern interannual Atlantic variability?*

M. Rouault (South African BANINO partner) et al.: *Impact of El Niño Southern Oscillation on South Benguela seas surface temperature.*

P. Coelho & **C. Ruby** (Angolan BANINO partner): Expansion of minimum oxygen zones in the north of the Benguela current and the tolerance of some zooplanktonic groups.

R. A. Imbol Koungue (PostDoc in BANINO) & **Peter Brandt** (PI BANINO): Angola current variability as observed at 11˚S by moored observations at intraseasonal time scale.

Shunya Koseki & **R.A. Imbol Koungue** (PostDoc in BANINO): Regional atmospheric response to the Benguela Niñas.

EMSAfrica at EGU: Understanding carbon dynamics and biome shifts under livestock grazing, climate change and CO_2 fertilization

EMSAfrica employs a multidisciplinary, multi-level approach to study the impacts of climate change and human land use in the dynamics of terrestrial ecosystems in South Africa. At the EGU, EMSAfrica was represented by Oksana Rybchak (Thünen Institute of Climate-Smart Agriculture) and Carola Martens (Goethe University Frankfurt/Senckenberg Biodiversity and Climate Research Centre).

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Oksana Rybchak's presentation focussed on the role of land management and water availability in controlling ecosystem-atmosphere carbon exchange. This study is based on four years of data collected from two eddy-covariance towers that were set up as part of SPACES I in the Karoo dwarf shrub ecosystems (Eastern Cape, South Africa). The sites represent different intensities of livestock grazing but almost identical climatic conditions, allowing investigation of the role of grazing on carbon dynamics. The study shows that CO_2 dynamics in the Karoo are largely driven by water availability and grazing intensity. The grazed site acted as carbon source, while the site that had been rested from grazing was a slight carbon sink.

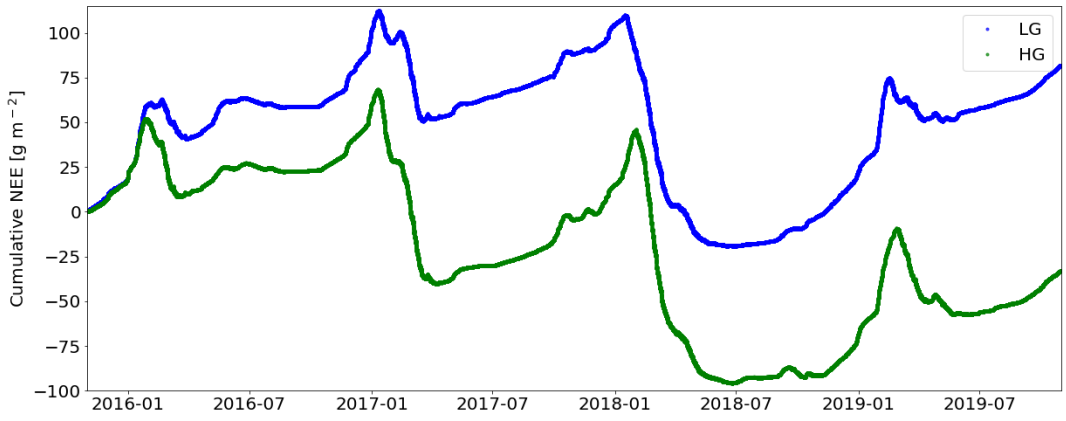


***Figure 1**. Cumulative Net Ecosystem Exchange (NEE) measured at the „Lenient grazed" (blue) and „Highly grazed" but rested (green) site in the Karoo.*

Carola Martens presented her work on modelling the impacts of climate and CO_2 fertilization on carbon stocks and biome distribution in Africa. To quantify the uncertainties related to future changes in climate and increasing atmospheric CO_2, she employed an ensemble of adaptive Dynamic Global Vegetation Model simulations based on downscaled General Circulation Models under two Representative Concentration Pathways (RCP) until 2099. She projected the biggest biome and ecosystem change under strong climatic change (RCP 8.5, Figure 2). With CO_2 fertilisation, woody encroachment associated biome changes lead to increasing carbon stocks of aboveground biomass. When effects of elevated CO_2 were removed, Africa became a carbon source. It was concluded that climate and CO_2 fertilization will cause biome changes in large parts of Africa, but that the magnitude and location of the changes remain uncertain.

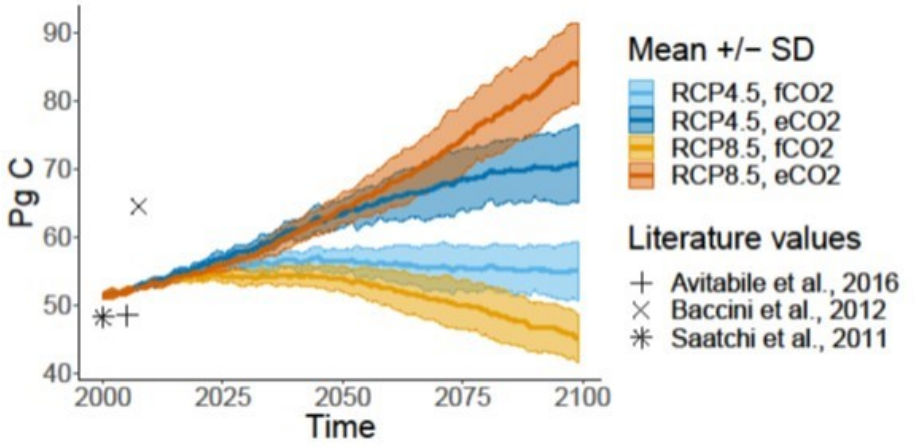


***Figure 2**. Projected carbon stocks of aboveground vegetation under different Representative Concentration Pathways and enabling or disabling the impact of CO_2 fertilization on plants in Africa up until the year 2099.*

SALLnet at EGU: Modelling impacts of climate change and alternative management interventions on farmland multi-functionality

The European Geosciences Union (EGU) General Assembly took place online between the 4th and 8th of May. SALLnet project was represented by Prof. Reimund Roetter and Dr. William Nelson (TROPAGS, University of Göttingen), who showcased the entire SALLnet project, as well as a case study defined for the Limpopo Province, South Africa. The case study investigated the effects of current management practices and an intensification scenario over a longer period of years on soil organic carbon change under rangeland and arable land, potential erosion, productive water use, biomass production, monthly feed gaps, and rangeland habitat quality. The study looked at coupling the output of vegetation (aDGVM) and crop models (APSIM) regionally calibrated with sound ground/ experimental data. This appears promising to provide meaningful insights into the highly complex interconnections of different ecosystem services at a landscape level. Tentative results showed that sustainable intensification closed the livestock feed gap, but further reduced soil organic carbon (Figure 2).

Rötter, R.P., Nelson, W.C.D., Isselstein, J., Scheiter, S., Pfeiffer, M., Hoffmann, M.P., Ayisi, K., Lindstädter, A., Behn, K., Westphal, C., Grass, I., Feil, J.H., Odhiambo, J., Taylor, P., Twine, W., Merante, P., Bracho Mujica, G., Bringhenti, T., Lamega, S., Yazdan Bakhsh, S., Krieger, W., Linden, V., Weier, S., and Erasmus, B. (2020). Modelling impacts of climate change and alternative management interventions on the multi-functionality of agricultural landscapes in southern Africa.

https://www.uni-goettingen.de/de/document/download/53f1cbcd81e1933b372b7a57fc60e485.pdf/SALLnet_pico_egu.pdf

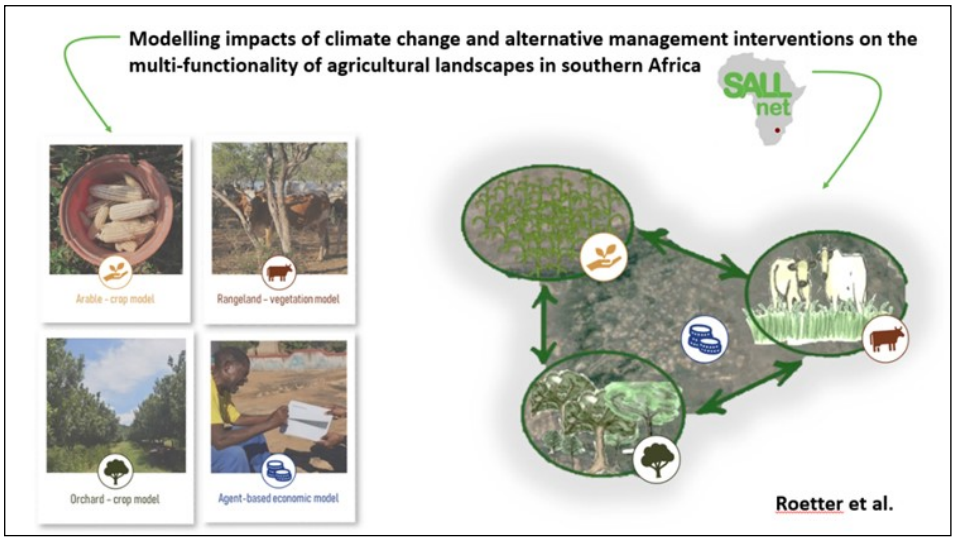


Figure 1. *EGU 2020 SALLnet contribution advertisement.*

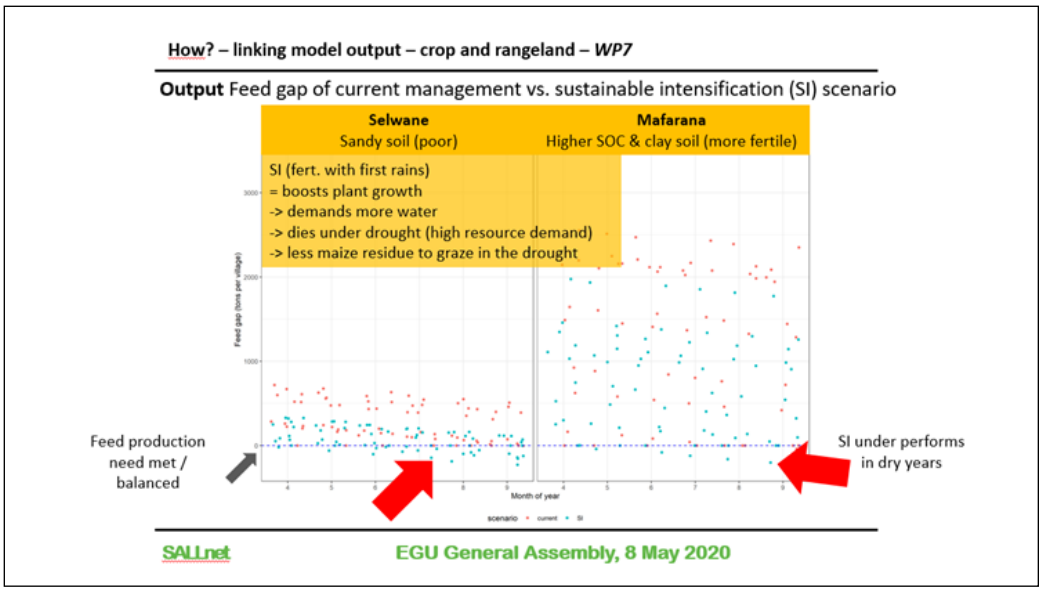


Figure 2. *EGU 2020 SALLnet contribution highlights of model coupling study.*

BANINO at EGU: Understanding Benguela Niño (Niña) through sea surface temperature variability

Fernanda Nascimento of BANINO presented their study on temporal and spatial Sea Surface Temperature (SST) variability off the Southwest African coast. Benguela Niño (Niña) is an Atlantic Ocean event similar to the Pacific Ocean El Niño (La Niña). Like its Pacific brother, Benguela Niño (Niña) also affects local economy, ecosystems and ocean dynamics. Therefore, a better understanding of these phenomena is important. Aiming to better understand how to identify Benguela Niño in observations and how the models can reproduce them, an investigation of sea surface temperature (SST) temporal and spatial variability was done throughout the Southwest African coast. Using SST obtained from satellite observations and from four different numerical models, a coastal strip of 1° width from 8S to 28S was calculated and averaged longitudinally. We assumed that at any given time and space, the coastal strip represents SST in the 1° band. Different analysis methods were taken:(i) power spectrum; (ii) EOFs; and (iii) coherence. However, before statistical analysis, climatology was calculated and subtracted from each latitudinal data point.

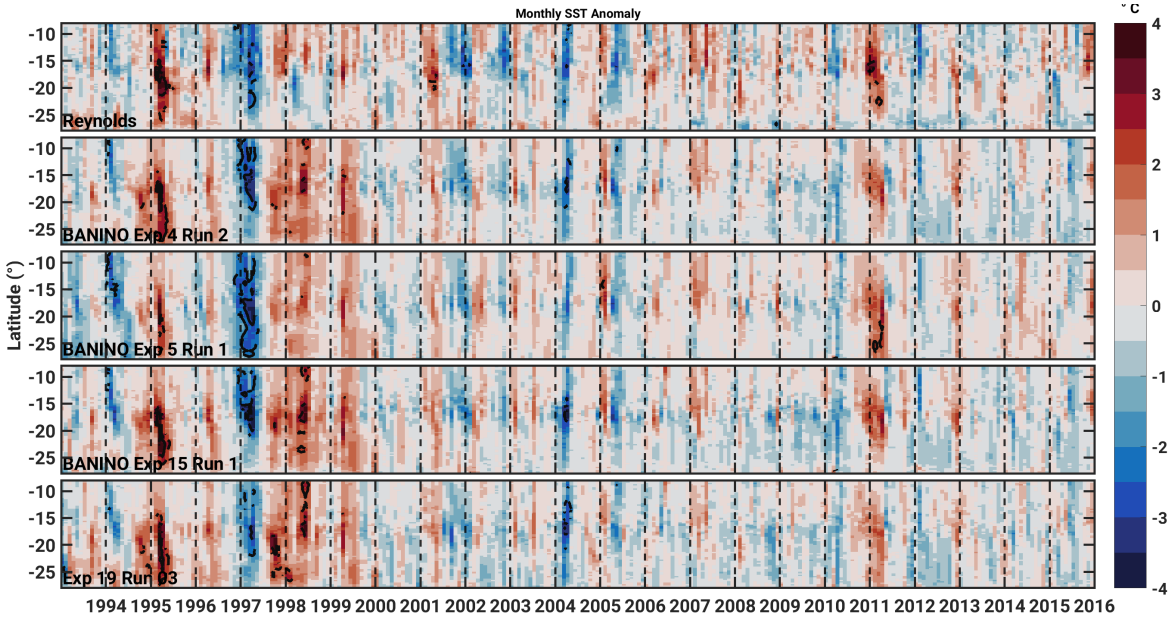


Figure 1. *SST Monthly averaged climatological anomalies. Gray lines represent values above 2 standard deviations.*

Using values of 2 standard deviation as a cutoff limit for anomalous behavior, Benguela Niños and a Niñas were identified in the observations (Figure 1): 1995 and 2011 warmer (> SST anomaly) signals (Niño event); and 1997 and 2004 cooler (< SST anomaly) signals (Niña event). The numerical models were able to reproduce 1995 warm event and 2004 cold event. However, there were over and under estimations in the models: models underestimate lower temperatures, reaching a minimum of ~13°C, while the observations reach ~11°C. Besides, a warm event in 1998 were shown only in the models, and 2011 warm event was not reproduced by them. Interestingly, the models were able to reproduce 1999 warm event (not seen in the observations, and were also able to reproduce 2004 cooler event, even though for this year there is no recorded Niña. In addition to reproducing SST anomalies, frequencies variabilities were also reproduced by the models and at 0.8 cycles per year and high (> 0.1 cpy) frequencies the model is well coherent (> 0.8) with the observations. Therefore, even though models were warmer than the observations, variability seen on observations were reproduced by the models. Highly anomalous warm and cold periods that coincideswith years of Benguela Niño and Niña were found both on observations and in the models, as well as SST weakening after 2000. The same analysis will be done next with Sea Surface Salinity (SSS) and Sea Level Anomaly (SLA).

Nascimento, F. P. S., Schmidt, M., and Mohrholz, V.: Temporal and spatial Sea Surface Temperature (SST) variability off the Southwest African coast, EGU General Assembly 2020, https://doi.org/10.5194/egusphere-egu2020-21321

SALLnet Field Trials in Macadamia Orchards

Most of the planned field trips in SALLnet had to be postponed due to the Covid-19 travel restrictions; mainly only one field trial having started last year already could continue. This field trial serves to create a unique data set that will enable the development of a first-ever eco-physiological macadamia model building on the most suitable modelling concepts. Such model will allow to assess the effects of climate change and management interventions on productivity and water use of macadamia orchards in the Limpopo Province (South Africa).

***All photos** by Thomas Bringhenti.*

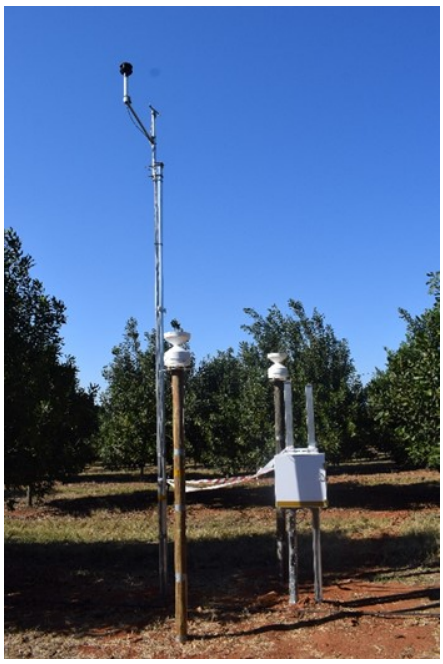
Left: Row of macadamia trees at Neuhof farm.

Below left: Taking soil samples at Neuhof macadamia orchard farm.

Below right: Installing sap flow sensors for estimating tree transpiration.

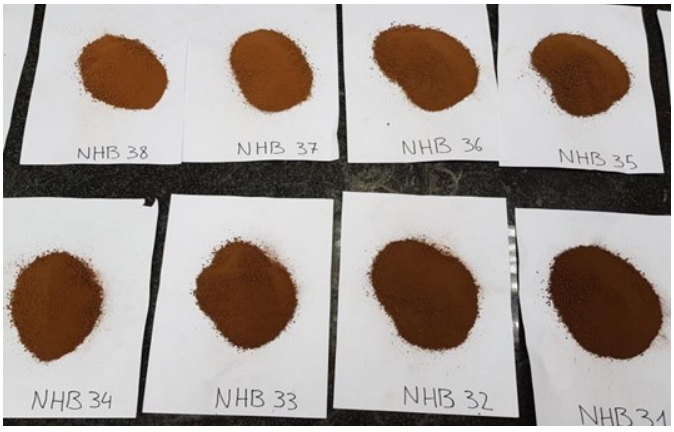
The experiment is carried out by Thomas Bringhenti, PhD student of the Tropical Plant Production and Agricultural Systems Modelling division (TROPAGS) at the University of Goettingen. It was set up in July 2019 on two macadamia farms (Maclands and Neuhof) in Limpopo. In both farms, two orchards containing each one of the targeted macadamia varieties (M. integrifolia 849 and Beaumont) were selected. The experiment includes the detailed measurements of tree eco-physiology with different monitoring intensities and additional measurements related to phenological development, morphology and productivity.

A number of devices were permanently installed for the continuous recording of soil moisture (TDR sensors), weather (iButton loggers for air temperature and relative humidity, tipping rain gauges, PAR sensors for solar radiation and anemometers for wind speed) and plant parameters (sap flow sensors for estimating tree transpiration and daily water use rates). Data collection started from August, coinciding with the macadamia flowering period. In parallel to that, soil samples were taken from all orchards for the determination of soil texture, bulk density, pH, electrical conductivity and organic carbon.



Left: *On-field weather station at Maclands farm.*

Below: *Analysing soil samples at the Soil Lab of the University of Venda.*



Morphological traits and phenological development of the selected trees are monitored periodically in each orchard. A ceptometer is used for the determination of leaf area index (LAI), by measuring light interception of the trees' canopies. Pictures of the trees are taken on every measurement day, along with hemispherical fish-eye lens pictures of the canopy from below.

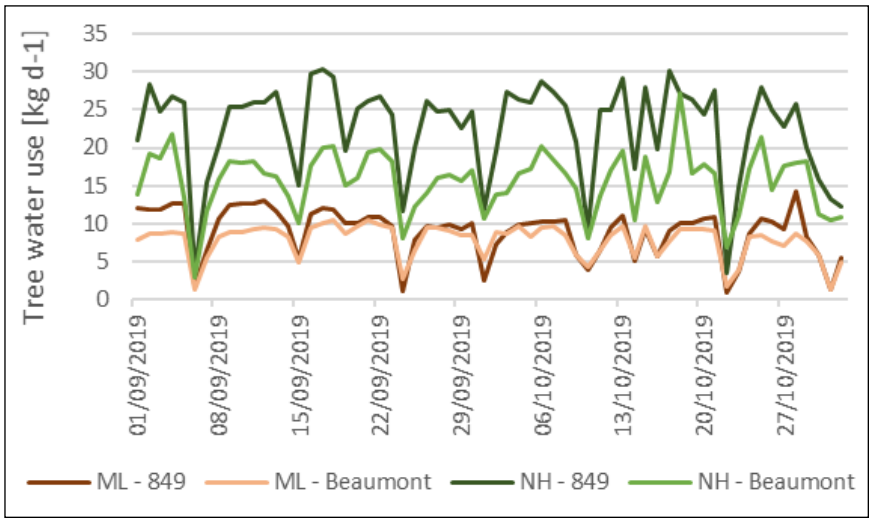


Figure: *Daily water use of the monitored macadamia trees in the selected orchards (ML=Maclands, NH=Neuhof) during the months of September and October 2019.*

Finally, all management activities are constantly monitored in both farms, with special attention given to irrigation frequency and amounts, as well as pruning.

The experiment will continue until June 2021.

Savanna Ecology During the Pandemic: Managing our Sap Flow Measurements in Namibia

Tim Herkenrath, Jonas Roth, Katja Geißler & Niels Blaum

Department Plant Ecology and Nature Conservation, University of Potsdam, Germany

The ORYCS project aims to gain profound scientific insights into consequences of wildlife based land-use in Namibia and to assess, how sustainability can emerge from a wildlife dominated savanna ecosystem from multiple perspectives. From an eco-hydrological perspective, we hypothesize that browsing herbivores are capable to reduce vertical water fluxes through woody plants and consequently, may influence soil moisture conditions. Thus, we believe that herbivores shape their landscape not only by removing biomass and redistributing nutrients but also by altering water availability. Because woody encroachment and soil degradation in water limited ecosystems are partly associated with water availability, we expect browsers to be important drivers of savannas, in particular in the light of climate change.

Currently, we are running an experiment at Etosha Heights Private Game Reserve which measures sap flow in mopane trees under different levels of simulated leaf herbivory (see Figures). It has started in December of last year already (see 1st SPACES II Newsletter) and is suitable to provide long-term measurements. We returned to our study area in March, checked the experimental set-up and retrieved the data collected thus far. Since these data turned out to be very promising, we were enthusiastic to continue with further steps. These include a simulation of dry season herbivory and an assessment of the effect of herbivorous stress on trees' reproductive investment. Furthermore, we were keen to expand our measurements to woody species other than mopane in order to acquire a broad knowledge of tree transpiration under various herbivorous regimes.

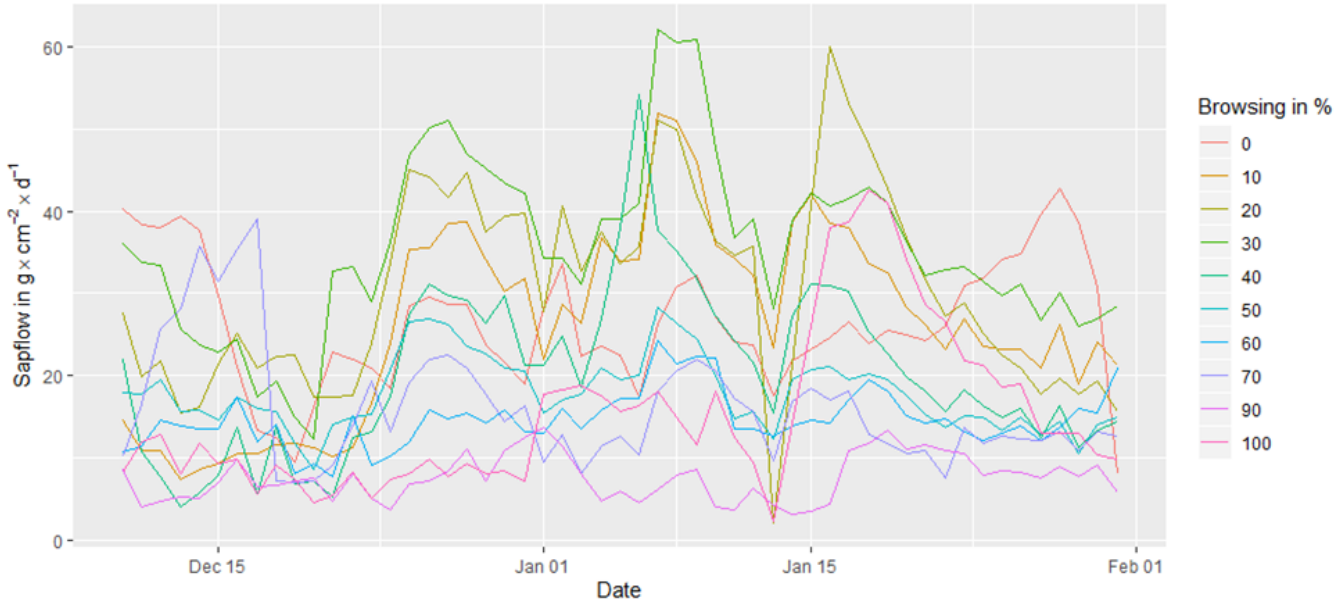


Figure 1. *First results: Sap flow densities in response to different levels of browsing (Jonas Roth)*

Unfortunately, our plans have been thwarted by the unpredictable Corona pandemic that forced us to leave Namibia last minute just before international boarders were completely closed. During these last fast-paced days in the game reserve, we exclusively focused on the protection of our equipment in the field. It was the only thing we could do to ensure an effective continuation of our field work whenever possible.

The weeks after returning to Germany were characterized by many uncertainties. However, we adjusted the plans for our ongoing studies in order to guarantee a high degree of flexibility towards all possible unpredictable future developments. Luckily, our Namibian partners managed to go to our study area in May and provided some much appreciated basic maintenance work. Despite all difficulties, challenges and the loss of an entire field season that emerged from the interrupted research stay, we have recovered our optimism today and are keen to continue with the experiments in the field, which are essential for our studies.

Figure 2. *Dr. Niels Blaum and PhD student Tim Herkenrath maintaining the experimental set-up in Namibia (Photo: Dr Katja Geißler).*

TRACES – new Foraminifera and Ostracoda!

Peter Frenzel[1], Eugene Bergh[2], Olga Gildeeva[1], Silvia Kolomaznik[1], Mauro Alivernini[1]

[1]University of Jena, Germany; [2]South African Museum, Cape Town, South Africa

Foraminifera and Ostracoda are the main bioindicators used by our working group within the TRACES programme in order to document anthropogenic impacts onto brackish water systems. Foraminifera are shell-bearing marine protists and Ostracoda aquatic crustaceans with a calcified bivalved carapace (Figure 1). Both are usually less than 1 mm in size and classical groups of micropalaeontology because of their high diversity, widespread occurrence, easily preservable hard parts and their high value as palaeoenvironmental proxies and guide fossils. Their role in environmental micropalaeontology has grown over the last twenty years and these microfossils are continuing to be increasingly used within this sector.

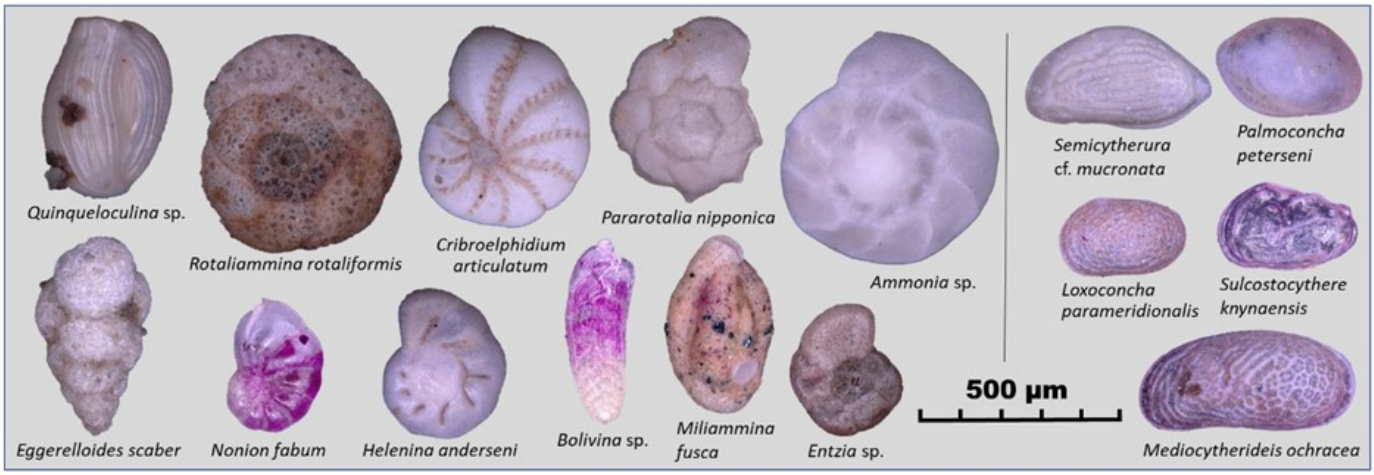


Figure 1. *Selected marginal marine Foraminifera (left) and Ostracoda (right) of the field campaign in 2020*

Our main study areas are Richards Bay Harbour and the estuary of Mlalazi in South Africa, where we carried out detailed sampling campaigns for associations from surface sediments and short cores in 2018. A new campaign was launched in February 2020, just before the Covid-19 lockdown. Mauro Alivernini, a member of the micropalaeontological working group in Jena, applied successfully for an IMPULSE grant by Friedrich Schiller University of Jena enabling this additional expedition. The field work covered a large part of the South African coast between Durban on the east coast and Mossel Bay on the south coast (Figure 2). The fieldwork generated a set of surface sediment samples containing Recent brackish water Foraminifera and Ostracoda.

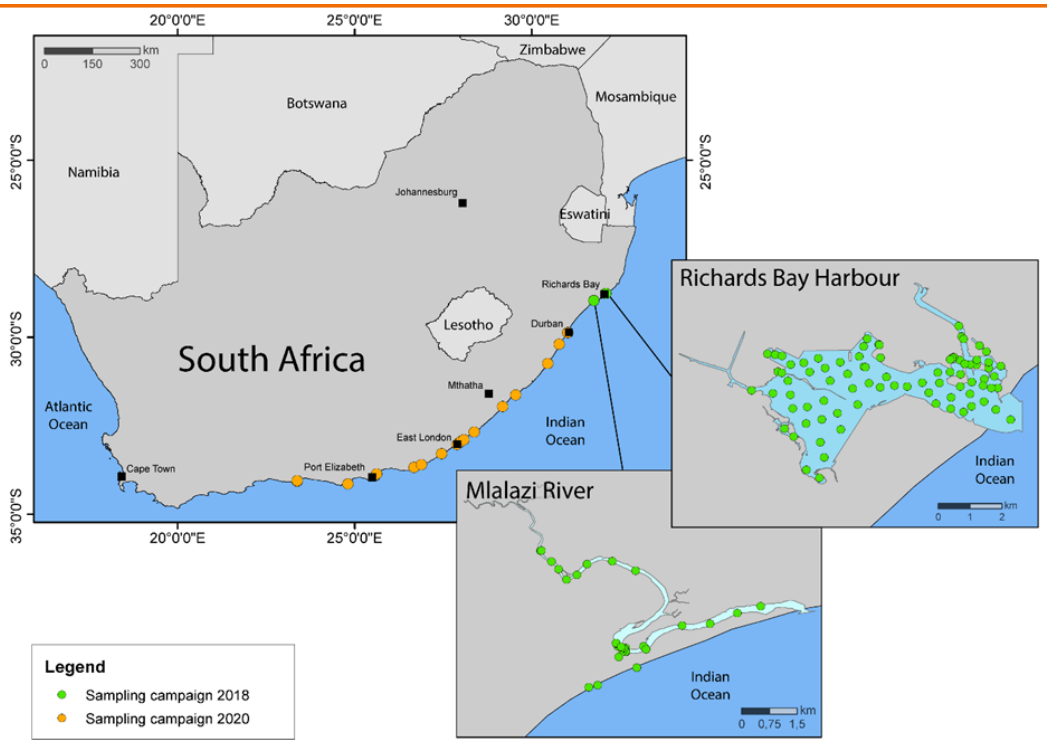


Figure 2. *Maps of study areas of the brackish water project within TRACES. The focus lies on Richards Bay Harbour and Mlalazi estuary. The new campaign of February 2020 provided a set of reference samples (orange circles) from other estuarine systems of the eastern South African coast.*

The micropalaeontologists Mauro Alivernini, Peter Frenzel, Silvia Kolomaznik and Eugene Bergh (Figure 3) took part in the expedition 2020 and were supported by our cooperation partners Jemma Finch and Trevor Hill from the University of KwaZulu Natal in Pietermaritzburg. The new samples and their microfossil associations will serve as references for comparisons of Richards Bay with other estuarine systems and harbours of different pollution levels. The first analyses of the microfauna are under way within a Bachelor thesis by Silvia Kolomaznik and will be studied in more detail within the PhD thesis of Olga Gildeeva in Jena. Geochemical and sedimentological analyses, including a microplastic screening, will be carried out by our cooperation partners in Greifswald and Bremen.

We are glad being able to continue our research despite the complicated situation brought on by the Covid-19 pandemic.

Figure 3. *Staining and labelling sediment samples for later recognition of living Foraminifera. From left to right: Eugene Bergh, Silvia Kolomaznik and Mauro Alivernini.*

Research in the time of Covid-19, travel bans and home offices

Maik Veste, Centrum für Energietechnologie Brandenburg (CEBra)

Ecological research lives from personal outdoor experiences. Intensive measurements and the exchange with local scientists are important for the scientific understanding of the ecological systems. But what to do suddenly when the research work is interrupted by COVID-19? No research on site and staying at home is now the motto. Home office for the scientific devices?

Using the positive effects of trees in agroforestry systems for agriculture and promoting biodiversity in southern Africa are the main goals of the ASAP project, while the associated CLIENT II project FarmImpact develops optimized water solutions for agriculture. In this context, Lower Lusatia and northern Saxony on the doorstep of Cottbus offer interesting opportunities for a real laboratory for testing our measuring instruments and scientific concepts. Drought, water shortage, high temperature and high wind erosion are also of ecological importance in the adjacent open-cast mines - in fact the Brandenburg desert on site. Even today, German agriculture is going through its third consecutive year of drought, something we experienced in southern Africa a few years ago.

Figures. *Testing measuring instruments and scientific concepts on German sites for later application in South Africa. Microclimatic research in apple orchards (above), and vineyards in a post-mining site in Lusatia, Wolkenberg (below).*

Simulating savanna vegetation

Leonna Szangolies, Dirk Lohmann, Florian Jeltsch

Department Plant Ecology and Nature Conservation, University of Potsdam, Germany

A savanna vegetation model is part of ORYCS work-package one. We simulate grass and woody biomass as fodder for antelopes and to get insights about their impact on the vegetation. A dynamic landscape arises from the vegetation model. Different processes influence the vegetation. Having identified the most important of those for our model, we can now generate the first results. Without grazers and browsers the trees are very likely to become dominant in the savanna. Many fires can suppress this dominance. However ,also animal effects like biomass consumption and trampling play an important role in the stability of the savanna ecosystem. That is why we finally joined the wildlife model and the vegetation model! Results coming soon!

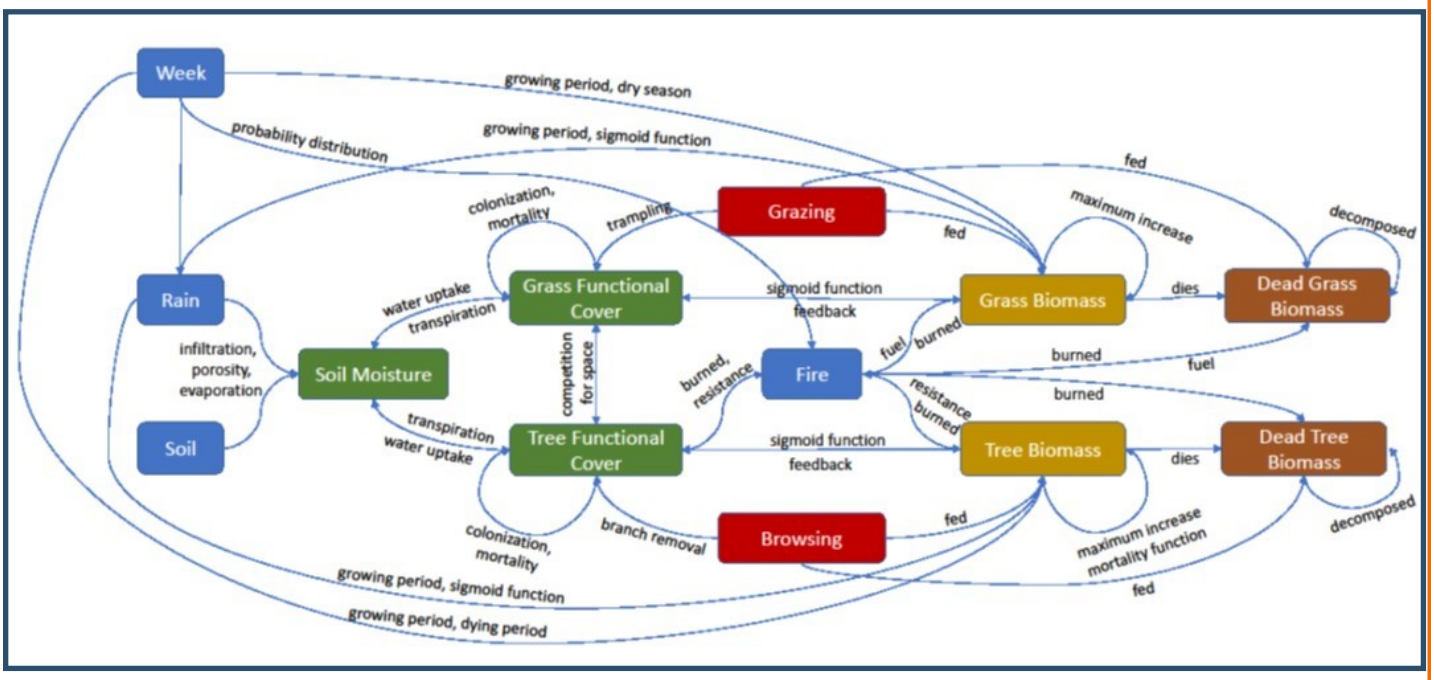


Figure 1. *The mindmap of processes influencing vegetation.*

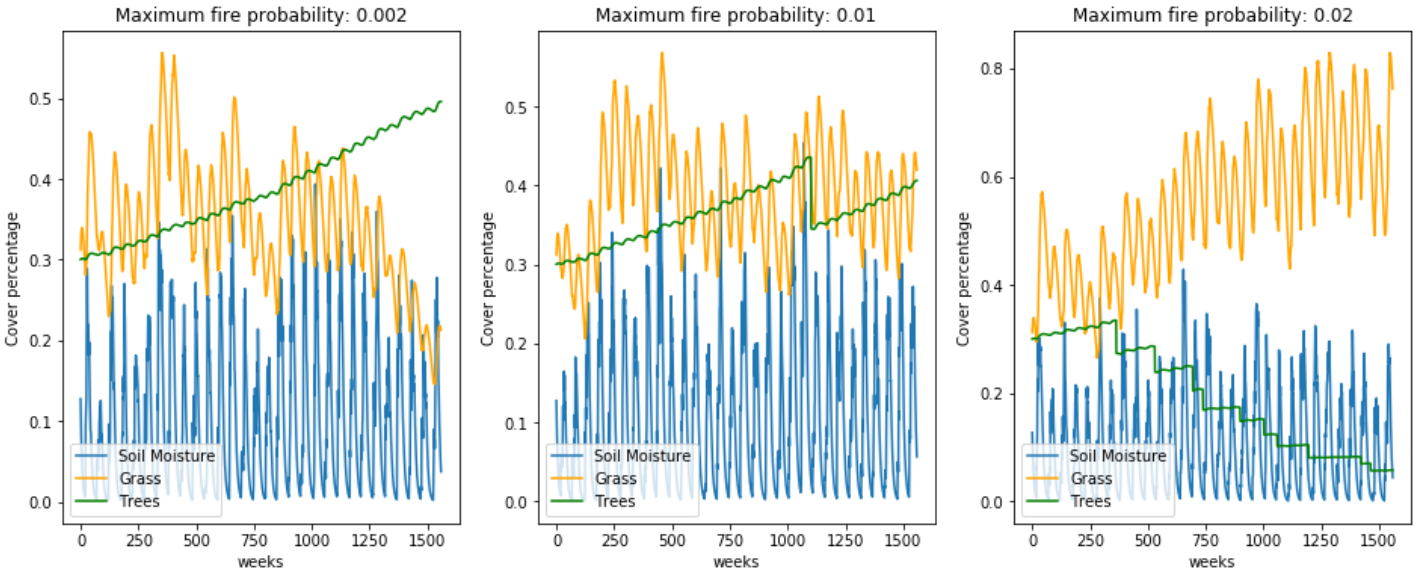
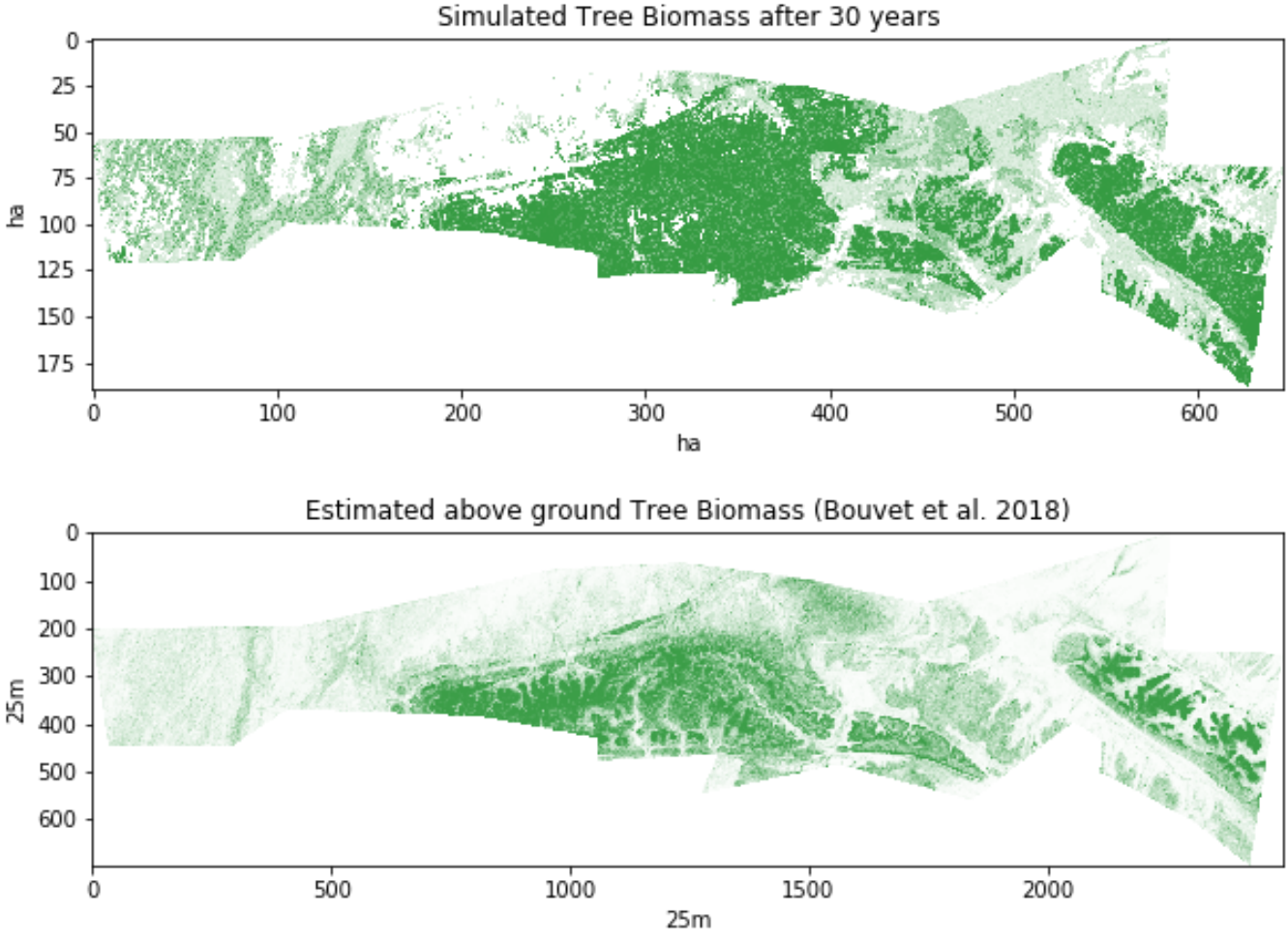


Figure 2. *30 years functional cover dynamics with different fire probabilities, fires also depend on grass biomass, seasonality, neighbouring cells, starting Cover 30 % Grass, 30 % Trees.*

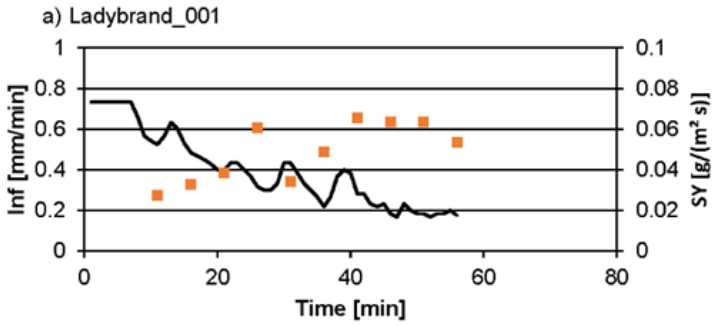
The properties of the total simulated biomass on Etosha Heights after 30 years do already match biomass ratios estimated by remote sensing (Bouvet et al. 2018).



SALDi rainfall simulation experiments for soil erodibility assessment

Andreas Kaiser, Michael Geissler, Jay Le Roux, Marike Stander & J. Baade

One aim of the South African Land Degradation Monitor (SALDi) is to advance current soil degradation process assessment tools for soil erosion by introducing a physically based erosion model to South Africa. Any model needs some kind of experimental adaptation to local conditions, e.g. soil properties. An often-used approach to determine infiltration rates and soil erodibility are rainfall simulation experiments. Within the framework of SALDi we used the mobile Rainmaker manufactured by UGT in Müncheberg, Germany to conduct experiments e.g. close to Ladybrand in the eastern Free State. The instrument allows to simulate the impact of rainfall events on a surface of 3 m². We used a constant rainfall intensity of 40 mm/h. By measuring runoff and sediment concentration (Fig. 1) one is able to determine infiltration rates, assess ground water recharge and surface runoff generation as well as soil erodibility.



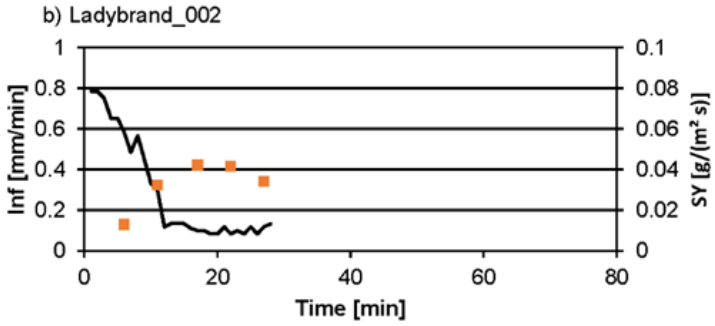


Figure 1 *(left). Measuring runoff and sediment concentration at an experimental plot during a rainfall simulation experiment close to Ladybrand, Free State (Photo: J. Baade 2019).*

Figure 2 *(above). Infiltration and sediment yield for two experimental runs at the Phama experimental site in Ladybrand.*

Figure 2 shows the results of two experimental runs on the Phama experimental site north of Ladybrand conducted in cooperation with our colleagues from the University of the Free State. The first run (Fig. 2a) was conducted on intensively used grazing land and the second run on strongly eroded bare ground (Fig. 2b). The constant, high infiltration rate at the start of the first run indicated complete infiltration and no surface runoff. About 5 min after the start runoff commences, but it takes about 40 min to reach steady state conditions for the surface runoff. The mobilization of soil particles (soil erosion) starts when surface runoff starts and reaches steady state conditions similarly to runoff. On the bare ground plot (Fig. 2b) surface runoff and soil erosion started instantaneously. Within about ten minutes the runoff to rainfall ratio reached > 85 %. But due to the already strongly eroded surface sediment yield was lower than on the other plot. These results of experiments conducted on different soils and under different management conditions are fed into the physically based erosion model EROSION 3D.

Rainfall and grazing in the eastern Karoo

EMSAfrica
Ecosystem Management Support for Climate Change in Southern Africa

EMSAfrica field design is based on three focal areas along an aridity gradient in South Africa. The driest, semi-arid research area, is located in eastern Karoo, and managed by Dr Justin du Toit. It hosts two EMSAfrica eddy covariance flux towers and a variety of long- and short-term experiments.

The Karoo is a desert-like biome occupying much of the western interior of South Africa, characterised by a wide variety of dwarf-shrubs. The area is used primarily for livestock production, particularly sheep which graze the relatively sparse shrubs and grasses. The ingress of these animals into this environment in the 17 and 1800s, which had thus far remained relatively un-grazed owing to the lack of surface drinking water, resulted in a rapid decline of vegetation biomass, especially of grasses and palatable shrubs. Severe droughts in the early twentieth century resulted in dramatic collapses in agricultural output, and it was recognised by farmers, scientists, and the authorities that management practices that would optimise animal production while protecting the vegetation needed to be developed. In the 1930s and 1940s various grazing experiments in the eastern Karoo, at the Grootfontein College of Agriculture, were established to test the effects of various grazing systems on vegetation composition and animal production. Early on it was recognised that season of grazing was important, particularly in that grasses (very valuable in the Karoo) declined when grazed in the summer, and that repeated summer grazing should be avoided (Fig 1).

Figure 1. Influence of seasonal grazing in the eastern Karoo Winter-only grazing (left) and summer-only grazing (right).

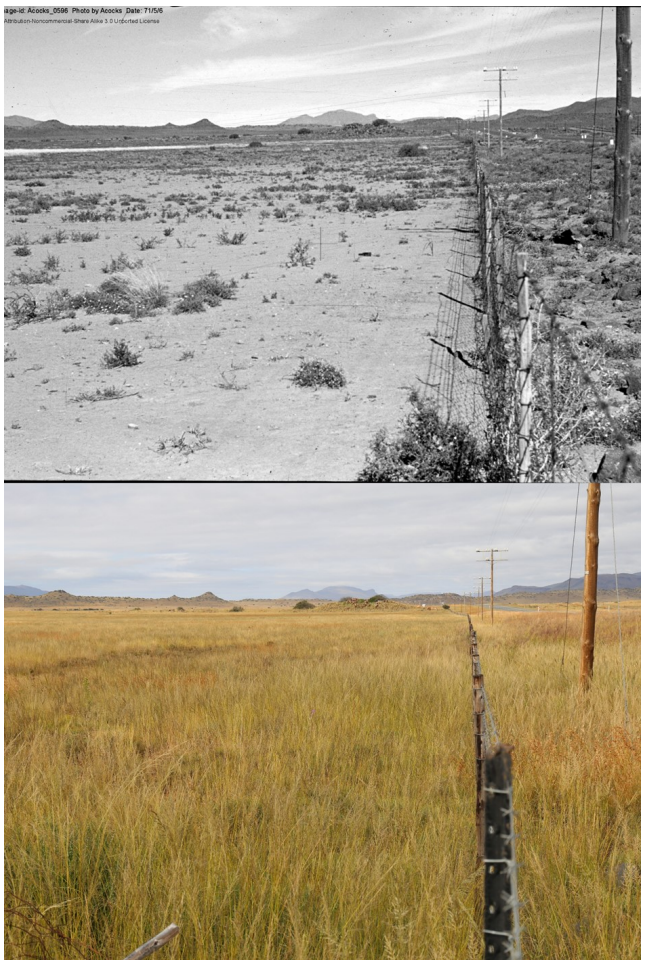


Figure 2. Long-term changes in cover, 1971 and 2016. (Top photo JPH Acocks, other photos Justin du Toit).

This was against a backdrop of a highly variable climate and, though only realised later, unusually dry period of time spanning several decades. Thus the results that emerged from the 1930s to the 1960s tended to discount the effect of drought and amplify the effects of grazing systems. After the mid-1970s increased, and the overwhelmingly important influence of rainfall became clear (Fig 2). We studied plant compositional data from the 1940s through to the 2010s and presented our findings in the following papers:

Du Toit, J.C. & O'Connor, T.G. 2020. Long-term influence of season of grazing and rainfall on vegetation in the eastern Karoo, South Africa. *African Journal of Range & Forage Science*:1–13.

DuToit, J.C.O., Ramaswiela, T., Pauw, M.J. & Connor, T.G.O. 2018. Interactions of grazing and rainfall on vegetation at Grootfontein in the eastern Karoo. *African Journal of Range & Forage Science* 35:267–276.

Simulating medium-term effects of cropping system diversification on soil fertility and crop productivity in southern Africa

Crop diversification is perceived as a strategy to achieve high productivity and maintain environmental sustainability. Utilizing the capability of agro-ecosystem models to quantify the interactions of crop productivity with management and environmental variables, the APSIM model was evaluated against six and an eight-year field trial datasets comprised of different crop rotations and fertiliser rates under two contrasting agro-ecological conditions in South Africa.

After evaluation, the model was applied over a ten-year simulation period with rotation treatments, fertiliser levels, and residue management for the two sites. Maize monoculture treatments with residues removed reduced yields strongly (>1000 kg/ha). On commercial, fertilised cropping systems, allocating land to cultivate crops other than maize reduced the simulated total yield performance. This diversification disadvantage has to be considered against the benefits of increased SOC and yields in the medium-term. For the commercial systems, maize intercropped with delayed sown oats or cowpea appeared promising.

This study provided the first-ever evaluation of continuously simulated output from a crop model against medium-term field trial data in southern Africa. The simulation experiment suggests intercropping is a promising option for cropping system diversification. Simultaneously, it underlines the critical role of fertiliser and residue management when farmers diversify in maintaining soil fertility (indicated by SOC and Nmin levels), stabilising yields in the medium-term. Overall, the usefulness of model applications for the design of suitable cropping systems in southern Africa, addressing various dimensions of sustainability is illustrated.

M.P. Hoffmann, C.M. Swanepoel, W.C.D. Nelson, D.J. Beukes, M. van der Laan, J.N.G. Hargreaves, R.P. Rötter European *Journal of Agronomy,* April 2020

Figure 1 *(left) Intercropped maize and cowpea field of a smallholder farmer in the study region.*

Figure 2 *(right) Maize monoculture of a smallholder farmer in the study region.*

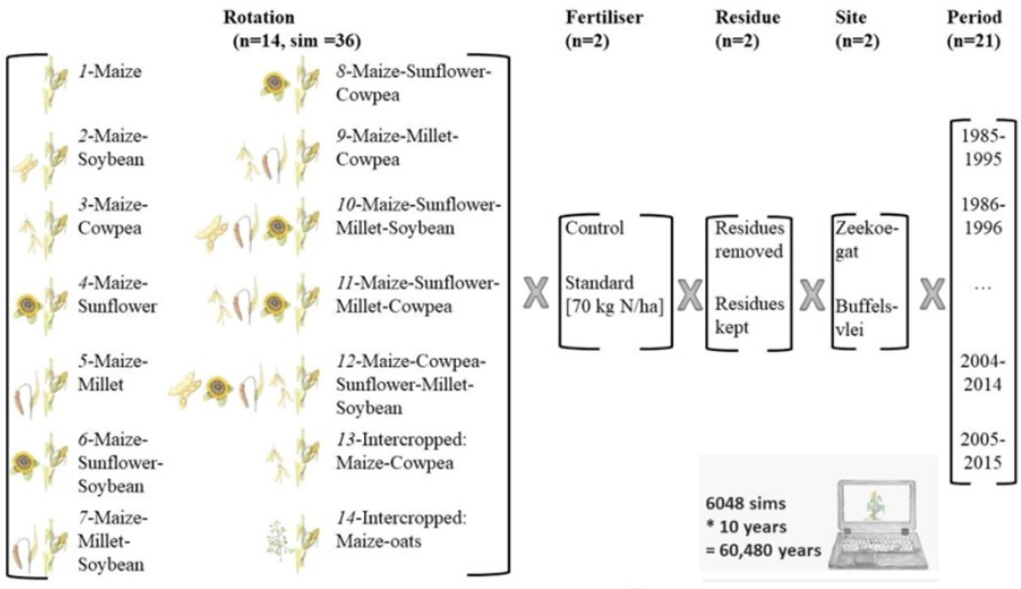


Figure 3*. Overview of the different factors taken into account for the simulation experiment, i.e. the overall cropping system; rotation, fertiliser, residue management, plus the environment characterised by site and simulation period; in brackets, the number of levels. For rotations with a temporal sequence of crops, simulations were conducted with each crop as the starting crop; resulting in, for instance a rotation including five crops, five different independent simulations.*

Wall-to-wall woody cover map of the Kruger National Park for the years 2016/2017

Within SALDi, the Jena Earth Observation group supported by SANParks Scientific Services personal produced a wall-to-wall woody cover map for the Kruger National Park (KNP), utilizing data from European Space Agency's (ESA) Copernicus Sentinel-1 radar satellite (C-Band). A high-resolution Light Detection and Ranging (LiDAR) data set (Smit et al. 2016) was reclassified to produce woody cover percentages and consequently used for calibration and spatial-cross validation. Woody cover estimation for different spatial resolutions (10m, 30m, 50m, 100m, Fig. 1) was carried out by fitting a random forest (RF) model. Model accuracy was assessed via spatial cross-validation and revealed an overall Root Mean Squared Error (RMSE) of 22.8 % for the product with a spatial resolution of 10 m, 15.8 % for 30 m and 14.8 % for 50 m and 13.4 % for 100 m (Urban et al., in press).

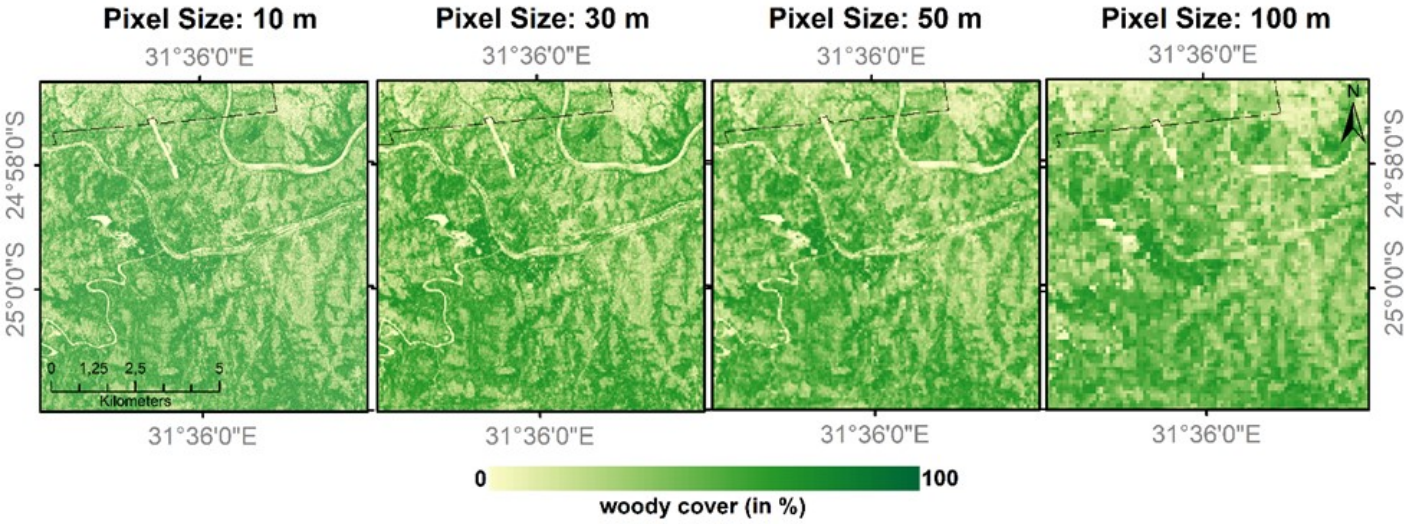


Figure 1. *Details of the wall-to-wall woody cover map of the KNP for the years 2016/17 (Urban et al. in press) showing the vicinity of Skukuza and Skukuza airport in a spatial resolution of 10 m (left) to 100 m (right).*

The methodology is designed for savanna vegetation structure mapping based on height estimates using open-source software and open access data in order to allow for a continuation of woody cover classification and change monitoring in savanna ecosystems. The programming code (statistical software R), Sentinel-1 and LiDAR training data as well as data sets for model prediction of three selected regions in the KNP are freely available via the following DOI: https://doi.org/10.5281/zenodo.3728186

Urban, M., K. Heckel, C. Berger, P. Schratz, I.P.J. Smit, T. Strydom, J. Baade & C. Schmullius (in press): Woody Cover Mapping in the Savanna Ecosystem of the Kruger National Park Using Sentinel-1 C-Band Time Series Data. Accepted by Koedoe.

Smit, I.P.J., Asner, G.P., Govender, N., Vaughn, N.R. & Wilgen, B.W. van, 2016, 'An examination of the potential efficacy of high-intensity fires for reversing woody encroachment in savannas', Journal of Applied Ecology, 53(5), 1623 –1633.