SPACES II

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

Research Programme Newsletter

Welcome to our fourth Newsletter!

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

We held one of our main events, the SPACES II Midterm Meeting, virtually last month. With over 120 participants, opened by ministry keynotes from Namibia, South Africa and Germany, we enjoyed a day of intensive discussions ranging from the impacts of Covid-19 to the science-policy interface. Some reflections on the meeting, regarding especially the future perspectives of SPACES collaborations, can be found within this issue.

You can also read the SALLnet team's report of the first online course of the SPACES II training programme on page 6. Furthermore, check out some research highlights from our SASSCAL partners, as well as an invitation to a new virtual climate lecture series hosted by ACCESS.

The publications section that highlights recent research papers has turned out to be popular, and will become a permanent feature in future issues. Please keep further ideas and suggestions coming.

Thanks for your contributions and enjoy reading!

Mari Bieri (SPACES II Board/External Communications)

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fona.de/en/spaces

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DAAD

THÜNEN

ACCESS Conversations on Climate Change, 24th November 16:00-17:30 SAT (15:00-16:30 CET)

ACCESS Conversations on Climate Change is a new series of live online conversations that will take place periodically. It is focused on significant global scale issues and events related to climate change. Topics will include considerations of issues such as Wildfires in California, Australia, South Africa and the artic, Ice Melts in Greenland, the arctic circle and Antarctica and the climate change impact on biodiversity as expressed in several recent global reports.

The second Conversation on Climate Change takes place on the 24th of November at 16:00 SAT. Panellists Dr Hugh Safford (Regional Ecologist, US Forest Service, Pacific Southwest Region) and Prof Sally Archibald (Fire Ecologist at the Centre for African Ecology, Wits) are discussing on:

Wildfires are intensifying globally. Are they? How and what do we attribute this to?

Register here for this event or email Dr Neville Sweijd (nsweijd@access.ac.za) to be notified directly of this and other events.

Biennial Africa Climate Smart Agriculture Stakeholders Conference, 1-2 December 2020

The central objective of the conference is to foster continental and national Climate Smart Agriculture readiness to advert the negative effects of climate change and ensure sustainability of agriculture, food and nutrition security, taking a food system approach.

For further information click here.

Landscape 2021: Diversity for Sustainable and Resilient Agriculture , 20-22 September 2021

Landscape 2021 will bring together scientists from across disciplines with key actors to explore whether and how diversity and diversification can contribute to a more sustainable and resilient agriculture.

We call for sessions, masterclasses, and presentations of products about social science and natural science analysis on diversification in cropping and grassland systems; farming systems; landscape management systems; public and private governance systems; food systems; and cross-scale systems.

Call for papers opens in January! Read more here.

SALDi EGU 2021 Land degradation Session proposal accepted – **Call for contributions**

SALDi team members and collaborators successfully proposed an Inter- and Transdisciplinary Session (ITS) under the overall theme 'The role of the Geosciences in the UN Sustainable Development Goals' at the vEGU21: Gather Online EGU General Assembly. The title of the ITS2.9/SSS3 session is 'Land degradation in savanna environments – assessments, dynamics and implications. The SALDi coordinator Dr. Jussi Baade (FSU Jena, Germany) is the convener of the session with Dr. J.J. Le Roux (University of the Free State, RSA), Dr. T. Morgenthal (DALRRD/DAFF, RSA) and Hilma Nangula Nghiyalwa (ECS, DAAD Ph.D. student, FSU Jena Germany/Namibia) serving as co-conveners. The EGU organizing committee acknowledged the fulfilling of the principles of equality, diversity and inclusion (EDI) in the composition of the convener's team.

The aim of the session is to explore the wide range of methodological approaches to assess land degradation, its dynamics over all spatial and temporal scales as well as the implications for society and the interaction with the different spheres of the Earth including the anthroposphere, atmosphere, biosphere, hydrosphere or the pedosphere. Contributions to this session can be based on field work, remote sensing approaches or modelling exercises, they can also focus on specific physical and socio-economic aspects of land degradation like land management, land cover change or soil erosion or discuss land degradation in a broader societal context. The full session abstract is available here.

We are looking forward to receiving a number of abstracts from the wider SPACES II community. Actually, this is an unique opportunity for all young scientists for a fist serving. The ultimate deadline for abstract submissions is 13 January 2021 at 13:00 CET. But we are happy to receive abstracts as well in advance. A special issue in the journal Earth Surface Dynamics (ESurf) is being considered as an outcome of this session.

Global Forum for Food and Agriculture: How to Feed the World in Times of Pandemic and Climate Change? 18-22 January 2021

The 13th Global Forum for Food and Agriculture (GFFA), the international conference on key issues regarding the future of the global agri-food industry, hosted by the German Federal Ministry of Food and Agriculture (BMEL), will be held on 18 – 22 January 2021, and for the first time in a virtual format.

For the Think Aloud! GFFA Science Slam which will also take place once again this year, the organisers welcome applications from creative and innovative scientists from around the globe.

For further information click here.

SPACES II Terrestrial Project Workshop in Jena, 8-9 October 2020

For two full days, 11 terrestrial project representatives met in person at the Friedrich Schiller University Jena (under full consideration of protection and hygiene measures) and were joined by further 4 virtual participants. Main purpose of the meeting was to strengthen collaborations during the on-going project period, as well as to envision potential future synergies and objectives. Discussions involved Covid-related difficulties and matching approaches to solutions – including the South African perspective, further data exchange and long-term access and availabilities, and also capacity building endeavours during the pandemic. Preparation of the Mid-term Meeting with special attention to inclusion of young researchers and the African reviewers was an agenda item, as well as clarifications on the detailed structure of the envisaged Springer-book publication. A vision was drafted for a meta-modelling approach as a concrete framework to enable collaborations from all projects. The meta-model should accommodate both, trends and events and incorporate SDGs better. Future capacity building shall further strengthen the "2-way knowledge exchange" concept to be fully aligned with local needs.

***Figure**. SPACES II Terrestrial Project participants on Jena's University Abbe-Campus. From left: Hans-Peter Kahle, Steven Higgins, Jan-Henning Feil, Reimund Rötter, Jussi Baade, Christiane Schmullius, Dirk Lohmann, Maik Veste, Mari Bieri, Jonathan Sheppard, and Marcel Urban. In addition, we were joined by several members virtually.*

ORYCS Annual Meeting 2020 – online but all fine

Dirk Lohmann, Katja Geißler, Niels Blaum

On October 5th and 6th, just a couple of days before the SPACES II MTM, ORYCS held its first annual meeting after the project kick-off workshop in 2019. Originally, this meeting was planned to take place this summer at the University of Potsdam in Germany. But given the circumstances, it had to be postponed and go online – like almost everything else.

After a rather exhausting meeting on COVID implications and adaptations earlier in the year, our idea for the 2020 annual meeting was to focus on the fun parts of our work, on research results and constructive research planning. And that is what we did:

All ORYCS PIs and a whole lot of students from Namibia and Germany gathered for two half days and presented their results and exchanged ideas. After all we were surprised how enjoyable the meeting – although online – still was and how much of the team spirit did come across during this pandemic-style event. However, we also all agreed that we're really looking forward to the next physical meeting which is scheduled for May 2021 in Namibia. Hopefully it will take place after some successful months of joint field work in the beautiful Namibian savanna.

ORYCS in the German newspapers Der Tagesspiegel and Potsdamer Neueste Nachrichten

26. SEPTEMBER 2020 WISSENSCHAFT IM ZENTRUM PNN B II

Das Schwinden der Savanne

Können Wildtiere die Verbuschung ganzer Landstriche stoppen? Potsdamer Forschende untersuchen, ob gutes Tiermanagement Namibias Grasland-Ökosystem retten kann

VON MATTHIAS ZIMMERMANN

Auf weiten Ebenen platzieren sich malerisch Baumgruppen, große Wildtierherden ziehen vorbei, wachsam belugt von Löwenrudeln und begleitet vom Zirpen der Zikaden. Doch die Savanne ist in Gefahr. Das afrikanische Grasland droht zu verarmen. Der Klimawandel setzt ihm zu, und weidende Rinder, Schafe und Ziegen verdrängen die Wildnis. Wie sich die Landnutzung auf die empfindlichen Ökosysteme auswirkt und wie man sie steuern kann, untersuchen Forschende der Universität Potsdam gemeinsam mit Kollegen aus Berlin und Frankfurt am Main sowie mit Partnern in Namibia.

Im Projekt „Optimus" haben sie seit 2014 nach den Ursachen dieser Entwicklung gesucht – und nach Wegen, wie sie sich aufhalten und bestenfalls umkehren lässt. „Die flächendeckende Landdegradierung in Namibia hat Farmer und Wissenschaftler an einen motivierter Wandel, ganz neue Ausgangsbedingungen zu schaffen. Eine Grundlage dafür bildet das Konzept der „Communjetzt mit ihren deutschen und namibischen Partnern untersuchen, ob sich ein gutes Wildtiermanagement für eine nachhaldern, messen Wasserhaushalt und Biomasse auf abgesteckten Arealen, führen Experimente an unterschiedlichen Vegetat-Verbuschung in Grenzen zu halten oder gar zurückzudrängen. Da die Wildtiere in den Conservancies von Menschen ange-

Springbock und Forscher. *Ein Team der Universität Potsdam untersucht in Namibia, wie das Management von Wildtieren die Savanne vor der Verbuschung schützen kann.* Fotos: Niels Blaum (3), Robert Hering

Von Matthias Zimmermann

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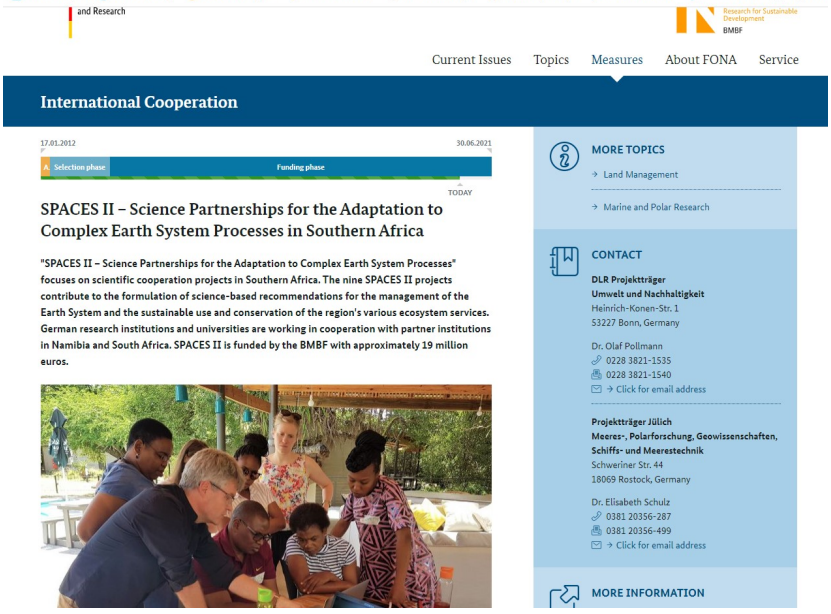
ORYCS project leader Niels Blaum and project PI Katja Geißler have been interviewed by the newspapers Der Tagesspiegel and Potsdamer Neueste Nachrichten for their feature "Wissenschaft im Zentrum" („spotlight on science"). In this nice article they wrap up ORYCS project goals and the issue of wildlife based management in Namibian savannas. You can find the article (in German language only) here.

New BMBF FONA SPACES II Website launched

New website (both German and English versions) on SPACES II was recently launched under the BMBF's FONA (Research for Sustainable Development) Framework Programme.

The website presents the background and aims of SPACES II, and gives a brief overview and a link to the homepage of each of the nine projects. It also links visitors to our newly launched SPACES II Brochure (final versions are in the making), and the training programme website.

The short version of the website link, to add to your project websites and other materials, is: fona.de/en/spaces (or the German version) fona.de/spaces.



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Research for Sustainable Development BMBF

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17.01.2012 30.06.2021

A Selection phase | Funding phase

TODAY

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

"SPACES II – Science Partnerships for the Adaptation to Complex Earth System Processes" focuses on scientific cooperation projects in Southern Africa. The nine SPACES II projects contribute to the formulation of science-based recommendations for the management of the Earth System and the sustainable use and conservation of the region's various ecosystem services. German research institutions and universities are working in cooperation with partner institutions in Namibia and South Africa. SPACES II is funded by the BMBF with approximately 19 million euros.

MORE TOPICS

→ Land Management

→ Marine and Polar Research

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MORE INFORMATION

What next for SPACES? Reflections from the virtual Midterm Meeting

Mari Bieri, Thünen Institute of CSA & Guy Midgley, University of Stellenbosch

During the past six years of SPACES and SPACES II, we have built strong collaborations within a strategically varied set of projects, and have begun to develop new initiatives within and across the current project set. The current status and future potential of these collaborations and initiatives was one of the main discussion themes at the midterm meeting, particularly as this relates to SPACES objectives on translating science into advice for stakeholders, and ultimate implementation. Consideration of this objective was a major motivation for inviting a diverse group of reviewers, to share valuable guidance and criticisms on SPACES progress and plans, based on their experience in different southern African institutions.

Steve Higgins and Finn Viehberg presented collective ideas from the projects regarding future joint initiatives (see also p. 3, this issue). The notion of a "meta-modelling" project, integrating the various existing modelling work across different project, gained wide support in the discussions that followed—and was seen to offer promising means of combining the terrestrial and marine realms. Based on strong partnerships, it was suggested that the next stage for SPACES could move beyond the tandem model, where individual expertise from German partners is matched with similar expertise from southern African partners, with the aim of implementing a "complementary expertise" approach instead.

Furthermore, many SPACES II partners were involved in the proposals of SAEON's new EFTEON landscape-level research platforms, whose outcome will be announced soon. These were seen to provide a concrete starting point for the development of a range of joint activities. On the marine/coastal side, the sister platform SMCRI offers similar opportunities, as pointed out by one of our reviewers, SAEON's Tommy Bornmann.

For our capacity building programme and training efforts, we are continuing efforts to develop web-based and blended learning courses. The use of a shared portal and advertising helped us to reach a wide audience and exchange best practices among the projects (see also Jon Sheppard on p. 8, this issue). Regarding science-policy interface, we will better engage policy-makers in future courses. We also have initiatives and ideas to further improve the linkages between SASSCAL, ACCESS and SPACES II—such as the ACCESS discussion exchange sessions, as well as past and future courses.

According to feedback, the flash presentation session organised by the SPACES II early-career researchers was a particular highlight at our meeting. The ability of the young researchers to self-organise this high-quality scientific session, as well as a social evening and virtual networking, also shows that there is plenty of potential in developing further activities for the multinational network of our gifted young scientists.

Finally, our SPACES II projects had a unique opportunity to acquire information from adaptation to droughts and global pandemic. The lessons learned could be used in the planning of future work. Focusing on adaptation, answering the critical questions in society "ahead of the curve", while also realising our own blind spots, risks of misinterpretation, and external pressures affecting us, would serve as good starting points for the envisioned next stage for SPACES collaborations. At the end of the day, SPACES II MTM participants were treated to a variety of valuable insights from our reviewer group, who emphasized the importance of effective science for decision making (evidence based policy making). In particular, timeous production of information with sufficient reliability, rather than perfect information that takes too long to emerge, was stressed. Direct linkages with regional and national initiatives on reporting commitments, such as National Biodiversity Assessments, were identified, and the potential role of SASSCAL as a purveyor of information was highlighted.

***Figure**. Word cloud compiled of the Midterm meeting public chat. Names and connection words were removed.*

SALLnet workshop on APSIM advanced and dynamic vegetation modelling

Simon Scheiter & Mirjam Pfeiffer, Senckenberg Biodiversity and Climate Research Centre, William Nelson & Gennady Bracho Mujica, TROPAGS, University of Göttingen

From the 24th to the 28th of August 2020, the South African Limpopo Landscapes Network (SALLnet) hosted a workshop entitled APSIM advanced and dynamic vegetation modelling. This was coordinated and run by scientists from the TROPAGS working group, Georg-August-Universität Göttingen (TROPAGS), and the Senkenberg Biodiversity and Climate Research Centre (SBiK-F), Frankfurt. Twelve participants from almost as many countries, including South Africa, Zambia, Zimbabwe, Guinea, Morocco and Germany to name just a few took part in the workshop that was originally designed to have all participants physically present in Göttingen. However, travel restrictions meant the workshop format shifted to an online workshop, using a variety of mediums such as video conference seminars, and screencast presentations.

The aim of the workshop was to familiarise participants with different modelling approaches that include and represent characteristic features of croplands and savanna rangelands. Although theoretical components laid the foundations of the course, a clear focus was on hands-on, practical sessions that got participants applying the model to their own individually devised landscape use questions. The workshop focussed on a process-based crop simulation model (CSM) for the first two days (APSIM) led by TROPAGS scientists, followed by two days of the savanna and rangeland vegetation model aDGVM, led by SBiK-F scientists. The final day was comprised of participant presentations that highlighted links between the model frameworks used.

The exchange between tutors and participants proved to be a great experience despite the shift in format due to travel restrictions. The tutor-team is already devising a follow-up workshop to complement this success.

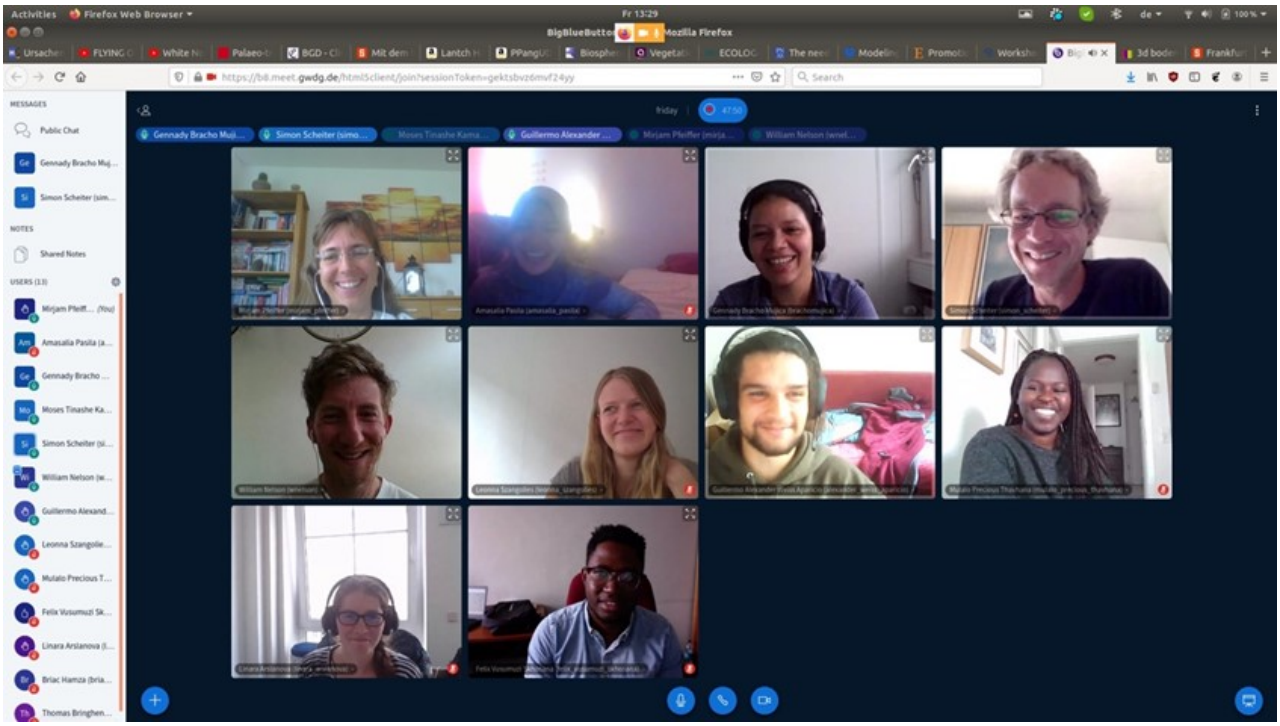


Figure. *Course participants in Zoom.*

Capacity building in COVID times, an opportunity not a threat

Jonathan Sheppard, University of Freiburg

A major focus and output of the Agroforestry in southern Africa (ASAP) project is to promote capacity building in the southern African region, especially in the ASAP partner countries of Zambia, Mozambique, Malawi, Namibia and South Africa. To this end, both short term scientific missions and a training school were planned to be undertaken in 2020 where African and German students had the opportunity to travel in order to learn and undertake research. Nevertheless, the similar as all other projects at this time, both internal and external to the SPACES II programme; the coordination team was compelled to postpone and then subsequently cancel the planned events due to ongoing social distancing and international travel restrictions.

All the same, our remit to provide capacity building opportunities in the region remains. Drawing on the wide range of expertise within the ASAP project we have pooled ideas and intend to reformulate both the training school and STSM concepts into COVID-19 compliant events. Such a reformulation now has the potential to impact a greater audience on a more flexible timeframe with a wider range of opportunities.

ASAP Training School 2.0

The training school will take place as an online event, utilising African partners as hubs for local COVID-19 compliant activities meeting online as a larger group to discuss activities and to listen to, and interact with invited speakers. Aimed at participants who have basic natural sciences and land management knowledge, the concept remains focused on an introduction into agroforestry systems in temperate and dryland ecosystems. The course aims to introduce agroforestry systems as an innovative and flexible approach to sustainable land management and to train competences in the analysis and critical evaluation of their potentials and limitations especially for rural livelihoods under climate change pressures. As an outcome, participants will be able to recognise and assess various examples of agroforestry systems. To be able to identify the components and interactions between them and to gain a basic understanding of their composition and management in order to study them to understand their dynamics, and the interactions that occur between tree, crop and/or livestock in both ecological and social realms. Moreover, by interacting with big players in the field, we intent that students will have the opportunity to ask questions and to formulate their own opinions and position on the utilisation of this innovative land management practice inspiring continued learning within this field of research.

The 12 successful applicants from the 1st training school call will have the opportunity to fully participate in the revised programme. Details will be disseminated soon and posted on the project website once finalised.

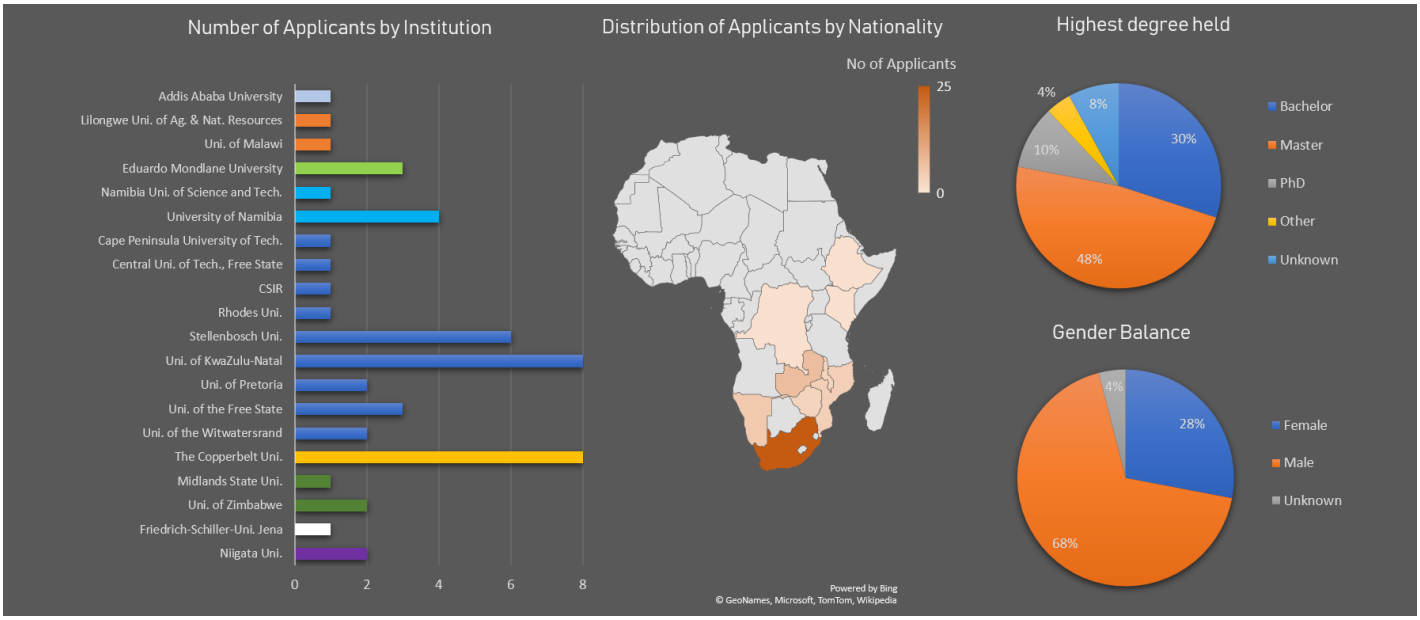


***Figure**: Descriptive statistics for the applications received for the original ASAP training school concept (n=50)*

Capacity building in COVID times, an opportunity not a threat

Short Term Scientific Missions (STSMs)

The call for STSM funding will soon be released: the fund is aimed at students who are seeking funding through a short-term scientific mission (STSM) grant in order to undertake agroforestry-based research on a short-term basis. STSMs are essentially exchange visits aimed at supporting researchers' individual mobility, strengthening existing networks and fostering collaboration. But acknowledging current COVID-19 restrictions the fund will now also enable students to undertake local fieldwork for defined goals. The program is designed to facilitate students and early stage researchers to travel in order to:

- Collect data in a specified study region,
- Analyse samples with experts in the field
- Use facilities such as a laboratory, that is not available at a home institution
- Work on a specific task with nominated individuals
- Undertake specific ASAP targeted project work
- Facilitate capacity building

STSMs must be performed within or between ASAP participant countries (Germany, Namibia, South Africa, Mozambique, Zambia and Malawi) or in an area of focus that is affiliated to an ASAP partner's ongoing research in the SADC region. Applicants are encouraged to apply for an STSM grant to facilitate travel and exchange outside the home institution, however, due to ongoing COVID-19 related travel restrictions researchers can also apply for an STSM grant at their home institution in order to collect, analyse and work with data derived in the local or near local area. Applications should observe current COVID-19 travel restrictions and be realistic about the possibility of changes to current regulations. Applications will be reviewed in respect to their achievability in the light of current COVID-19 control measures. We are happy to be able to offer this opportunity and welcome applications in the near future.

For more information please see the ASAP website: www.agroforestry-africa.org, or contact the project coordinator for more information and an application pack: asap@agroforestry-africa.org

Photo credit (Left and Centre: J.Sheppard, Right: R. Maier)

SALDi congratulates Dr. Zhenyu Zhang

SALDi working group would like to congratulate its research member Zhenyu Zhang at the University of Augsburg, for the successful defense of his PhD dissertation in October 2020. In Zhenyu's PhD research, the start-of-the-art coupled atmospheric-land surface-hydrological modeling was adapted to an endorheic basin located in arid and semi-arid zone of Asia, and the joint atmospheric-terrestrial water balance and the land-atmosphere interactions were comprehensively analyzed based on in-situ observations and modeling approach.

Currently, Zhenyu is contributing to the SALDi work-package three which addresses regional land-atmosphere interactions. His work mainly focuses on regional climate modeling, high temporal rainfall simulations, and land-atmosphere interactions assessment. At the regional scale, the Earth System model WRF-Hydro is employed and adapted to southern Africa in very high resolution, aiming at describing the joint atmosphere-terrestrial water cycle and land-atmosphere interactions. Collaborating with Erosion modeling, high spatiotemporal rainfall data from regional climate modeling can represent the convectional intensive rainfall events, thus contributes to investigating soil erosion processes by water. Furthermore, using the selected landscape and degradation scenarios, the impact of land and soil degradation in South Africa on land-atmosphere interactions and on the extent to regional climate will be further investigated in his future research work.

Photo: SALDi member Zhenyu Zhang and dissertation committee at the University of Augsburg

SALDi's DAAD PhD candidate Nangula Hilma Nghiyalwa successfully arrived in Jena after struggling with COVID induced travel issues

My name is Nangula Hilma Nghiyalwa. I am doing a PhD at the Friedrich-Schiller University Jena under the South African Land Degradation Monitor (SALDi) SPACES II project, under the supervision of Professor Christiane Schmullius and Dr Marcel Urban. I arrived in Jena in September 2020, after having been delayed by Covid-19 lockdown measures. Because of that, I had to detour back to Namibia after I initially began my trip to Germany in March through South Africa where I attended the Savanna Science Network Meeting, met up with the SALDi team for field work and in situ instruments set-up such as soil moisture probes set up in SALDi study areas: Kruger National Park in Mpumalanga, Mokala National Park and Benfontein Game Reserve near Kimberley in Northern Cape. I am delighted to finally successfully transfer from Namibia to Jena after some COVID-struggles to start my PhD in SALDi since March. My PhD research is on *"Spatio-temporal mixed pixel analysis of the savanna biome"*. We are using a multi-sensor approach which will jointly apply the optical Sentinel-2 and the synthetic aperture radar (SAR) Sentinel-1 to characterise the semi-arid savanna biome into continuous fields of tree, shrub cover and grassland and seek to understand their temporal dynamics.

Fieldwork resumed: Impact of woody plants' water use on water fluxes and soil moisture content under herbivore pressure

Tim Herkenrath, Kaarina Shilula, Katja Geißler

After Namibia has re-opened its boarders and cases of COVID-19 infection are decreasing currently, we grasped the opportunity to resume our studies at Etosha Heights Private Game Reserve in order to diminish the negative impact of an interrupted field season to the greatest extent possible. A long-term experiment was set-up last year already to measure sap flow densities as a proxy for water use in mopane trees (Colophospermum mopane) under different degrees of simulated leaf browsing. First results provide good evidence that individuals, which have experienced a decent level of herbivory, show a reduced amount of water use (see 3rd Newsletter).

Figure 1. *Giraffe feeding on mopane leaves*

Apparently, a decreased amount of water that is taken up from the ground by plants is likely to affect soil moisture contents. This link will be examined during the next step of our study in more details. Right now, we are installing soil probes that measure sub-canopy soil moisture content in 6 different depths. Even though drilling holes in a dry African Savanna is quite strenuous and sweaty, we are now curious to obtain first promising results as soon as wet seasons begins. Furthermore, we are particularly interested in potential feedbacks between altered soil moisture conditions and germination success of grasses. In addition, the start of the rainfall season will enable us to explore even more aspects of water use strategies of mopane and how these might change in response to herbivorous pressure. Thus, we are keen to conduct a variety of analyses including stomatal conductance measurements, pressure-volume curves and isotopic analyses of xylem water during the following weeks. These results together with sap flow and soil moisture data will provide further profound insights into consequences of mammalian herbivory on tree water use and its relevance for vertical water fluxes and ecosystem functioning at landscape level. Our findings will contribute to the main objective of ORYCS, which aims to assess chances, risks and sustainability of wildlife based land-use in Namibian savannas.

Figure 2 a-c. *PhD student Tim Herkenrath (University of Potsdam) and Kaarina Shilula (former NUST MSc student) installing soil probes to measure moisture content in different depths down to 1 m. (Photo: Tim Herkenrath, Kaarina Shilula)*

In-situ measurements of abiotic and biotic parameters during Meteor cruise 153 in February/Mach 2019

Bettina Martin, André Harmer and Rolf Koppelmann, University of Hamburg

During METEOR cruise 153 in February/Mach 2019 a towed remotely operated vehicle (TRIAXUS) was used to identify physical drivers, nutrients and plankton communities in the northern and southern Benguela Upwelling System. The TRIAXUS was towed at a speed of 8 knots with a horizontal offset out of the vessel's wake. It undulated vertically between 5 and 200 m, depending on the water depth. The gear is connected via optic fibre cable with the ships laboratory where data from different sensors (CTD, Oxygen Optode, Simrad EK60 Echosounder, Laser Optical Plankton Counter, Turner C6 Cyclops sensors for Chl a, Phycocyanin, Phycoerythrin and Turbidity, Video Plankton Recorder, PAR Sensor, Nitrate Sensor) is recorded.

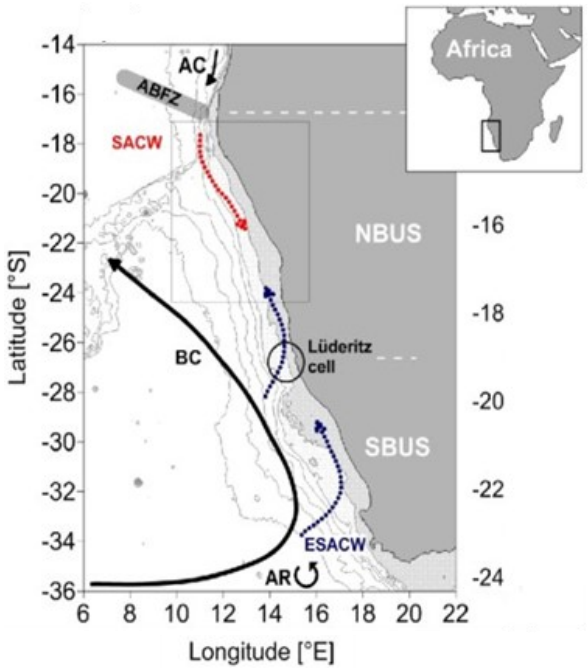
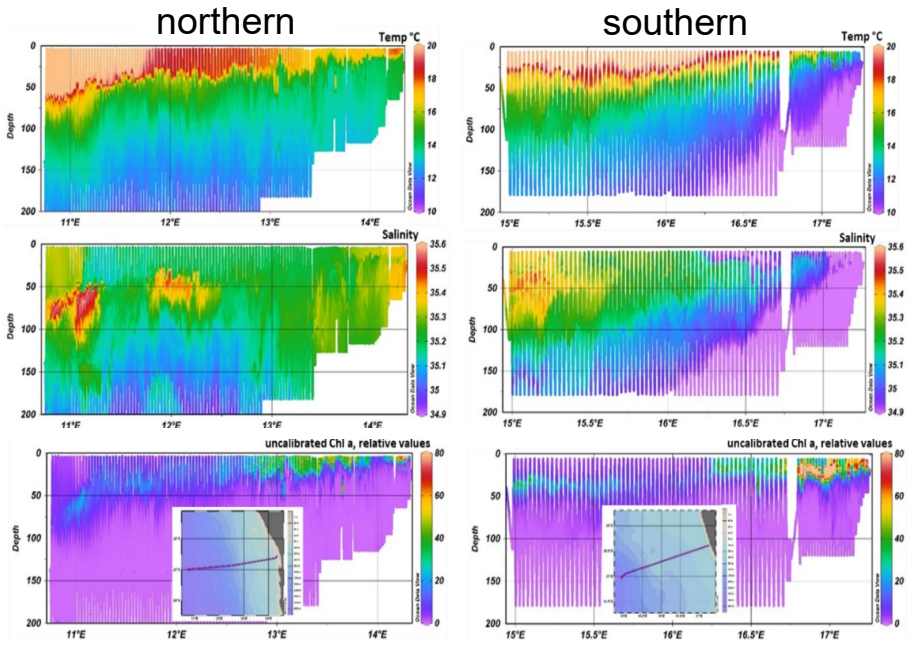


Figure 1. *Map of Benguela Current modified after Flohr et al 2013*

Figure 2 (above). *The TRIAXUS, a towed remotely controlled underwater vehicle.*

Figure 3 (below). *Water mass properties and chlorophyll a distribution on onshore-offshore transects in the northern and southern Benguela Upwelling System indicating upwelling and colder and less saline above the shelf of the sBUS with higher Chl a values.*



In-situ measurements of abiotic and biotic parameters during Meteor cruise 153 in February/Mach 2019

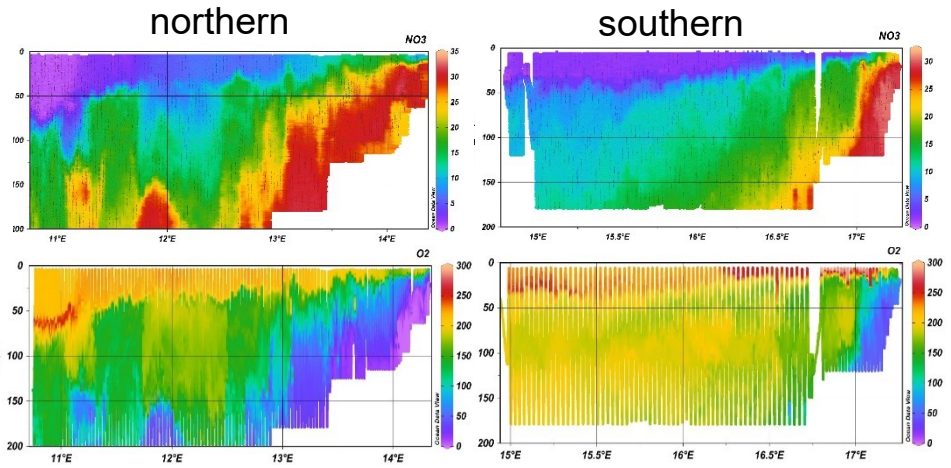


Figure 4. *A higher nutrient load and less O_2 is indicated in the nBUS compared to the sBUS.*

First results confirm different source water masses (SACW in the north, ESACW in the south), and point to stronger upwelling events in the south. Zooplankton pictures were taken with the video plankton recorder. Using the combination of a video plankton recorder and a TRIAXUS allowed for the first time to take pictures of the diazotrophic *Trichodesmium* sp. in the Benguela Upwelling System. This blue-green algae is able to use atmospheric nitrogen for primary production and is assumed to live in oligotrophic areas rather than in high productive upwelling systems.

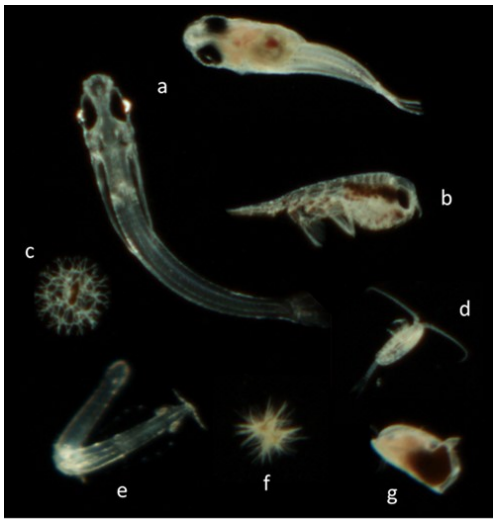


Figure 5 *(above). Examples of individuals detected with the Video-Plankton-Recorder; a) fish larvae, b)* Themisto gaudichaudii *(Amphipoda), c) Radiolaria, d) Copepoda, e) Chaetognatha, f) undefined Trichodesmium-like particle, g) Ostracoda.*

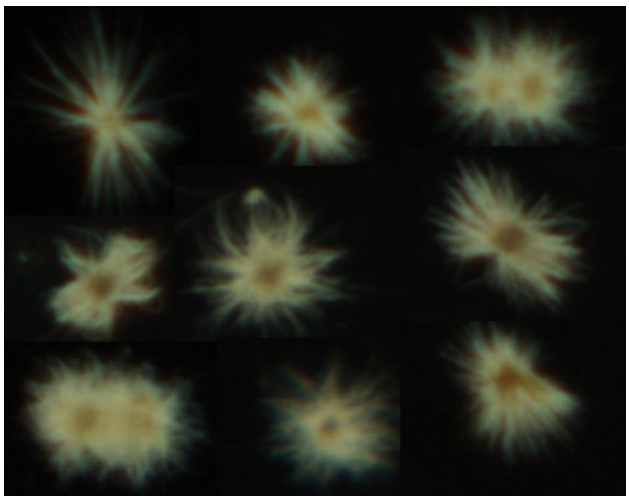
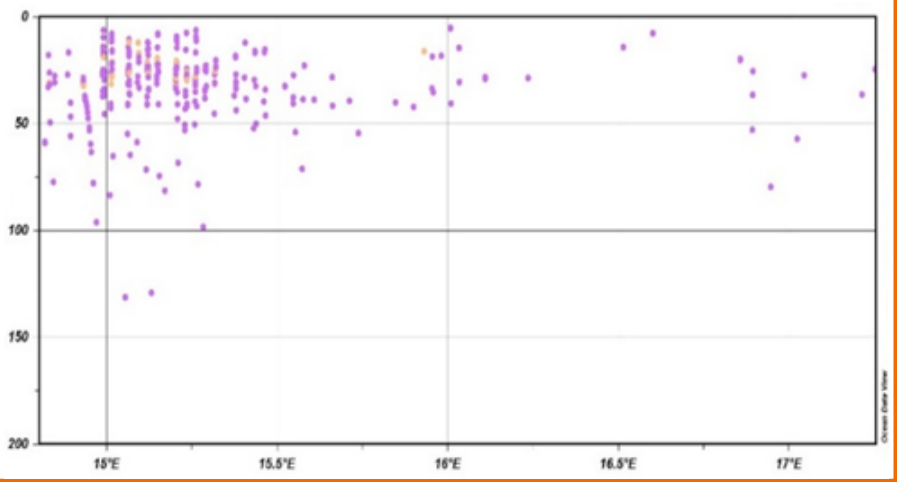


Figure 6 *(above). VPR frames containing pictures of* Trichodesmium *sp. as detected by trained software*

Figure 7 *(right). Presence of* Trichodesmium *sp. on a transect in the southern BUS recorded by VPR. Purple dots show single presence, yellow dots represent two organisms.*



Taking advantage of an interdisciplinary collaboration opportunity to better understand a South African agroforestry system: Preliminary results - water dynamics

Svenja Hoffmeister, Institute for Water and River Basin Management, KIT, Karlsruhe, Germany

Figure 1. *View from Hillcrest Berry Orchards, near Stellenbosch, South Africa.*

With the help of colleagues from Stellenbosch University, ASAP researchers secured the opportunity to undertake an interdisciplinary field study within a windbreak-berry system just outside Stellenbosch, South Africa. The site belongs to the Hillcrest Berry Orchards, owned by Raymond and Betty O'Grady who fully supported us in this endeavour. We were able to take soil samples and install equipment in one of their blackberry plots adjacent to a windbreak consisting of 15-20-year-old Italian alders.

Our joint aim is to quantify the effects of the windbreak trees on cropped area in comparison to a reference outside the influence of the windbreak. Specifically, we are interested in differences in water dynamics, nutrients and erosion. ASAP teams have monitored soil moisture profiles and meteorological variables for a 6-month period and explored the characteristics of the windbreak and the soil in a joint field campaign in 2019.

Even though we are still at an early stage of the data analyses, we can observe differences in the water dynamics between the windbreak-influenced plot and the reference. For instance, while the overall soil moisture is higher at the reference, it seems the alders secure some of their water demand by taking up water from greater depths. Looking at the water balance, it appears that evapotranspiration is the dominant process, drying out the soil throughout the summer months. We also observe different re-wetting dynamics after precipitation events when comparing the windbreak plot to the reference. By adding information about the soil properties, nutrients and the windbreak (such as shading effects or estimated rooting depth) and through collaboration between the different research groups we will put together more pieces of the puzzle to the overall picture of this agroforestry system.

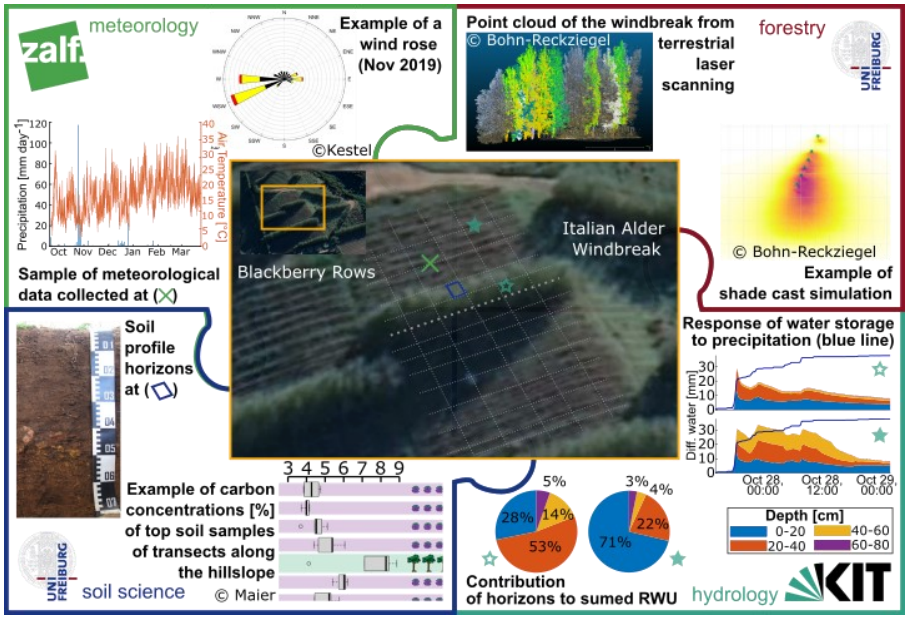


Figure 2. *Overview of the contributions of the ASAP researches included in this study and examples of their data.*

Improving the Research Infrastructure in Africa: The SEACRIFOG Roadmap towards an optimized GHG observation in Africa

Veronika Jorch, Thünen Institute of Climate-Smart Agriculture & Jörg Helmschrot, SASSCAL

The EU-funded SEACRIFOG project, which was recently concluded, addressed the challenge of continental-wide Greenhouse Gas (GHG) Observation in Africa which is mainly limited due to unbalanced technical and human capacities. As a major output, the project consortia developed a roadmap for an optimized, harmonized and feasible GHG-observation infrastructure for Africa and its offshore areas taking existing networks, technical and human capacities and costing into account. By integrating a continental infrastructure inventory, the analysis of protocols, the essential variables concept, a spatial analysis and a cost-assessment, the consortia presented a model for an optimized observation systems for GHGs in Africa which would assist in reducing the uncertainty of GHG fluxes over the continent and support information- and knowledge-based mitigation options. Existing well-maintained networks such as the flux tower network operated by SAEON/EFTEON in South Africa or the SASSCAL WeatherNet providing regional real-time climate data for Southern Africa were acknowledged as model networks and demonstrate that capacities exist to build on. Based on the continental-wide inventory of existing networks, measurement stations and data products, a multi-species optimal network design for reducing uncertainty on main GHG fluxes in Africa has revealed that investments in observation infrastructure should ideally consider a continental-wide approach, but preference should be given to the placement of new tall-tower stations in Africa between 10° N and 25°S (Nickless et al, 2020). However, SEACRIFOG also concluded in its final report that investments in infrastructure are only one building block for the successful and long-term operation of an optimized and harmonized GHG observation. Equal investments in human resources capacity building as well as feasible maintenance strategies, developed and implemented by capacitated African institutions, are required. The winter school on GHG observation , jointly organized by EMSAfrica and SEACRIFOG as a collaboration of various institutes, including SAEON and SASSCAL, as well as the Science Policy Dialogues conducted by ICOS underpinned the need for capacity building across the continent.

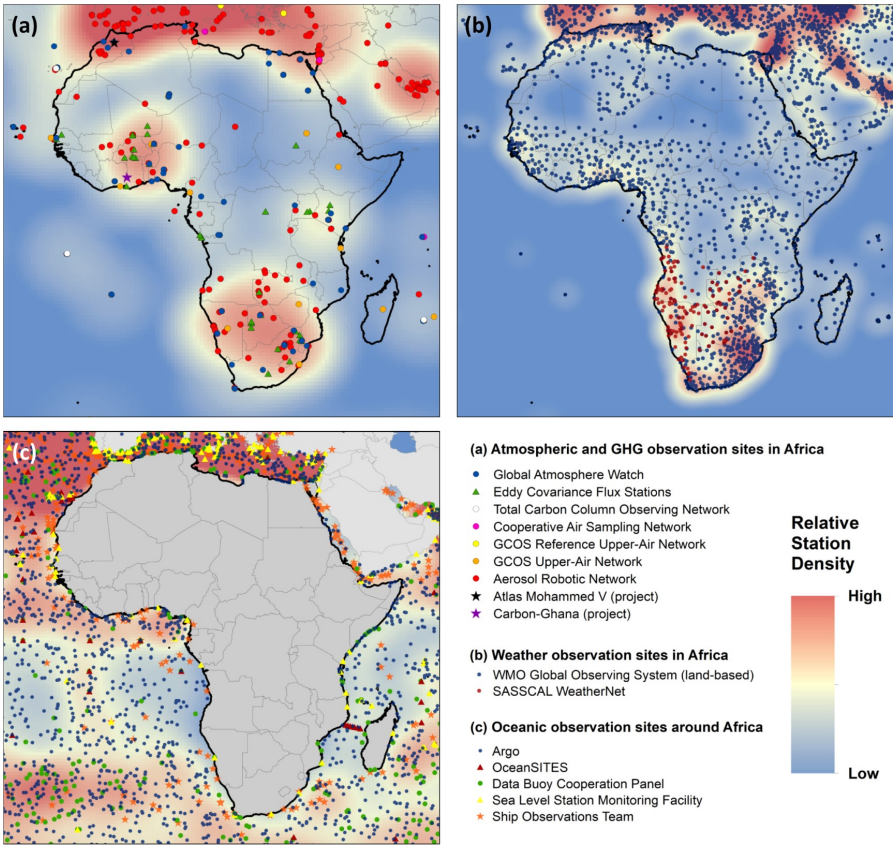


Figure. *Observation stations and density of selected networks, from A. Lopéz-Ballesteros et al 2018*

López-Ballesteros, A., Beck, J., Bombelli, A., Grieco, E., Lorencová, E. K., Merbold, L., et al. (2018). Towards a feasible and representative pan□African research infrastructure network for GHG observations. Environmental Research Letters, 13(8), 085003. https://doi.org/10.1088/1748-9326/aad66c

Nickless, A., Scholes, R.J., Vermeulen, A., Beck, J., López-Ballesteros, A., Ardö, K., Karstens, U., Rigby, M., Kasurinen, V., Pantazatou, K., Jorch V., & Kutsch W. (2020) Greenhouse gas observation network design for Africa, Tellus B: Chemical and Physical Meteorology, 72:1, 1-30, DOI: 10.1080/16000889.2020.1824486

Stakeholder attitudes on wildlife in Namibia's Kunene Region

Ronja Kraus, Robert Luetkemeier, Meed Mbidzo, Morgan Hauptfleisch, Stefan Liehr

Human-wildlife interactions and resulting conflicts within and between stakeholders from agriculture, nature conservation and the economy are of particular importance in Namibia. To gain a better understanding of the underlying reasons for conflicts to emerge, the transdisciplinary research project ORYCS conducted qualitative research in 2019: a workshop with experts and farmers was held, 28 individual stakeholders were interviewed, and a participatory observation of a farmers' meeting concerning human-elephant conflicts was performed. The findings thereof functioned as baseline for a stakeholder analysis within the transdisciplinary research project ORYCS. The comprehensive set of qualitative information was analyzed to frame human-wildlife conflicts from the ecosystem services and disservices viewpoint that integrates both natural and societal components critical to human-wildlife conflict.

Following the empirical work mentioned above, the German-Namibian researcher team selected a comprehensive set of relevant stakeholders (Figure) and evaluated these with regard to their attitude on the expansion or intensification (i) of wildlife conservation in general, (ii) of consumptive use of wildlife and (iii) of conventional commercial livestock farming. Additionally, potential conflicts in the context of human-wildlife interactions were analyzed in light of all the information gathered to provide an understanding of the reasons and dynamics of conflicts in the region. For instance, conflicts might arise around different viewpoints on the use and allocation of resources, ethical and moral considerations, diverging knowledge and differing perceptions of socio-political procedures.

***Figure**. Overview of stakeholder groups and the number of actors evaluated in each of the groups*

Group	Description
Agriculture (7)	Individual and institutional actors of the agricultural sector on the production side (e.g. farmers, unions)
Conservation (13)	International and national institutional stakeholders with non-governmental background related to environmental conservation (e.g. NGOs)
Government (7)	Namibian governmental bodies that are in charge of relevant policy fields (e.g. ministries)
Media (4)	Institutional actors that shape the Namibian media landscape (e.g. newspapers) excluding social media channels
Science (5)	International and national institutional actors from science and research (e.g. universities, research institutes)
Tourism (12)	Individuals and institutional actors involved in the Namibian tourism sector (e.g. tourists, unions)
Trade & Commerce (5)	Institutional actors from the agricultural sector's demand side and retailers (e.g. supermarkets, auctioneers)

As a result, two potential conflict solution strategies were carved out as proposed by the respondents. On the one hand, some stakeholders supported the idea to intensify areas that are spatially separated and reserved either for nature conservation or human utilization. Other respondents, however, favored the narrative of co-existence by integrating wildlife into the landscape. This might be manifested in the shift from conventional livestock farming towards wildlife-based management as wildlife is regarded as being better adapted to drought.

The analysis revealed that different perspectives on wildlife, its utilization and the need for conservation occur amongst the stakeholders. These differing viewpoints trigger conflicts among the societal parties. Findings on both, the overall stakeholder groups and the conflict characterization were contextualized in a social-ecological conflict theory. This theory assumes that conflicts between societal actors emerge when the stakeholders' perceptions are not aligned or in other words, their perceived ecosystem services-disservices ratios on a particular wildlife species differ. This basic assumption now serves the design of an empirical field study in 2021.

Implications of climate extremes for future dam management in Namibia

Sylvia Thompson[1], Aune-Lea Hatutale[2], Andre Mostert[2], Jörg Helmschrot[1]

[1]Southern African Science Service Centre for Climate Change and Adaptive Land Management, Windhoek, Namibia, [2]Namibia Water Corporation, Windhoek, Namibia

In a collaborative study between SASSCAL and the Namibian Water Corporation NamWater on the effects of climate extremes on the dam inflows into Namibian dams, 40 years of CHIRPS 2.0 satellite-based precipitation data for the dam catchment areas of Naute, Omatako and Von Bach dam, three main supply dams of Namibia, were analysed and compared to historic dam inflow figures.

Namibia is the driest country in sub-Saharan Africa and 92 % of the land surface is characterised by hyper-arid, arid or semi-arid terrain. Of the mean annual rainfall of about 285 mm, 83 % evaporates and only 2 % results in ephemeral runoff. The country's interior has no perennial rivers. Namibia consequently relies extensively on harvesting surface water and storing this water for agricultural (71 %), domestic (24 %) and industrial water supply (5 %) in dams.

The pressure to Namibia's increasing water demand is erratic and highly variable rainfall with long intermittent dry spells. The high demand for water, in combination with growing population pressure, requires the country to also resort to treating wastewater and pumping harvested surface water into its aquifers, to minimise evaporation and augment the water supply during the drier seasons. The fine balance of Namibia's water supply and demand equation was tested to its limits in the recent prolonged drought that by the end of 2019, was the worst drought recorded in Namibia in some 90 years, and resulted in the full capacity of the capital's main supply dams depleted to less than 20%.

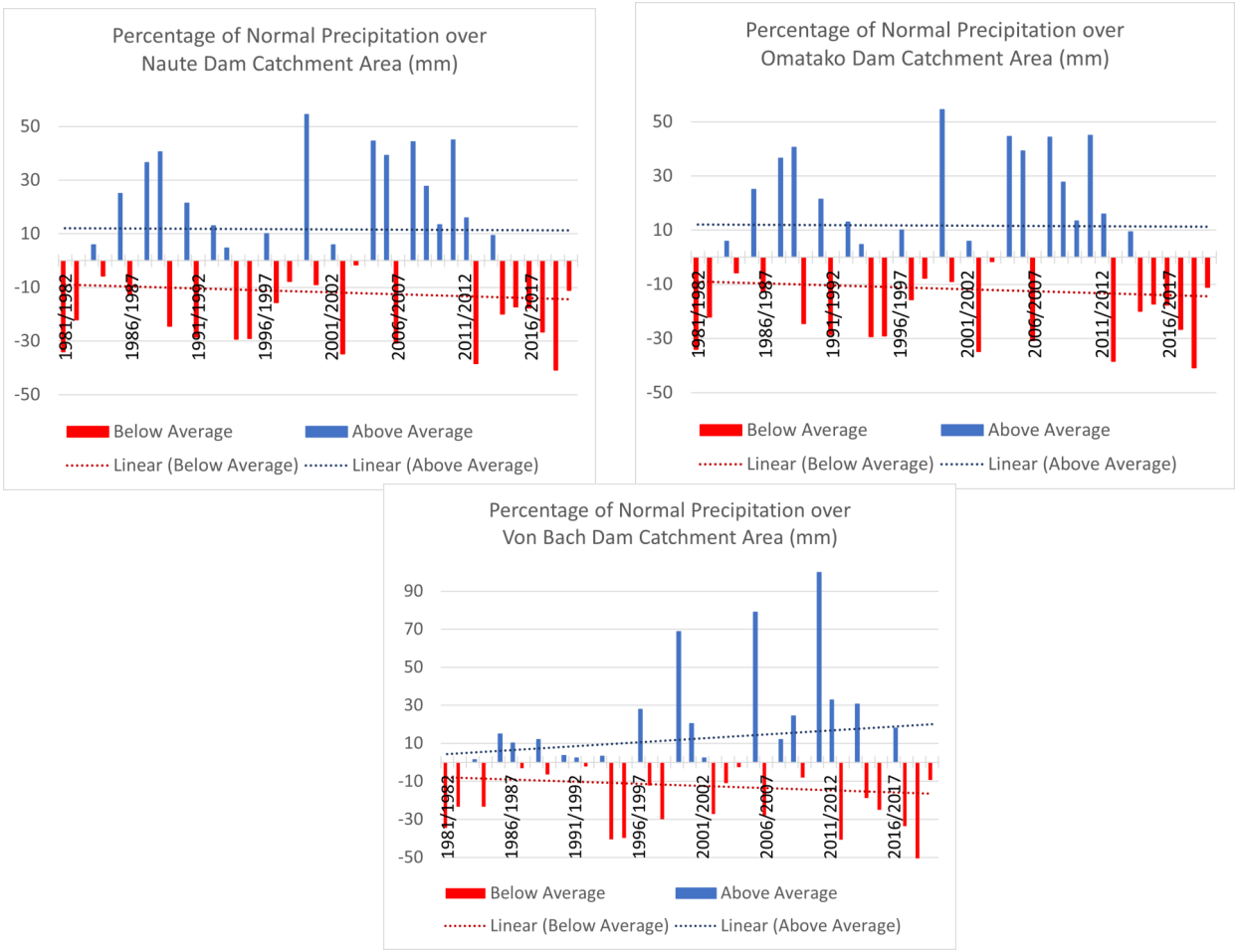
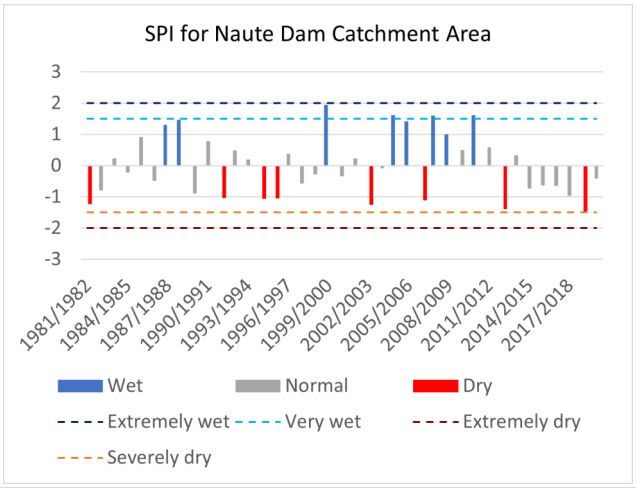


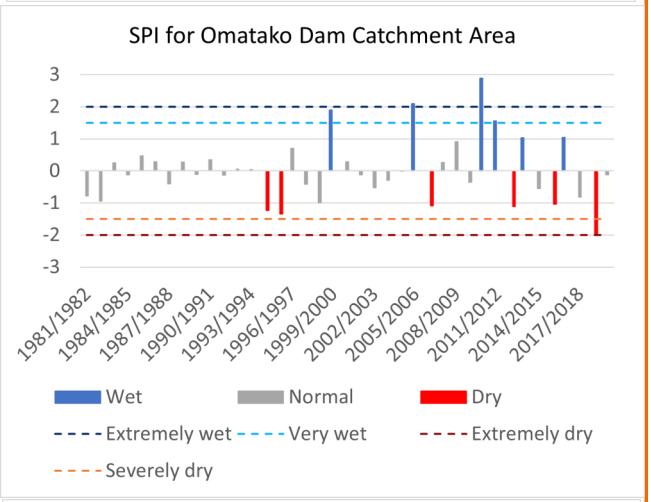
Figure 1. *Graphs of the seasonal percentage below normal precipitation over 40 years for the Naute, Omatako (above) and Von Bach dam (below), clearly showing that the past 10 years had a pronounced dry spell.*

Implications of climate extremes for future dam management in Namibia

A study of CHIRPS 2 precipitation data for the dam's catchment areas show that dry spells in the past ten years have been more pronounced and that periods of below average precipitation last longer than in the preceding 30 years. More extreme high rainfall and drought events are noted in the past 20 years. Dam inflows respond, as expected, to precipitation events, albeit at times with delay and also not proportionally. A temporal and spatial analysis of catchment precipitation versus dam inflows shows that other factors, which can include soils, bush encroachment, farm dams and intensity of rainfall events, may impact dam inflows and these need to be further investigated.

The study recommends that an increase in climatic extremes and more pronounced drought events, as well as other factors influencing dam inflows, should be considered and, in the case of impact factors, managed, in the future of dam and basin management to ensure water security.





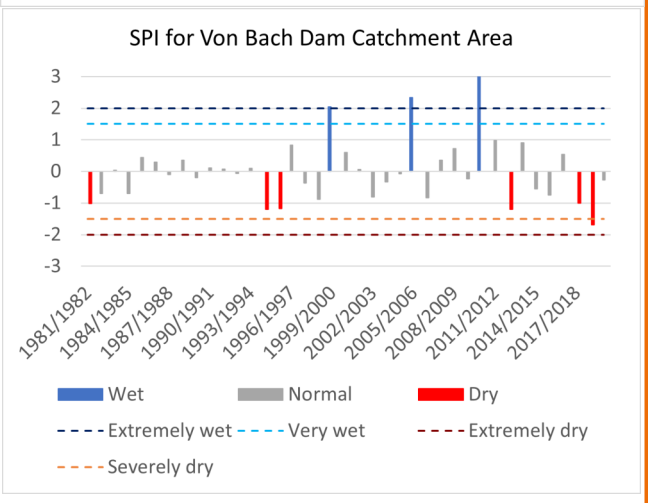
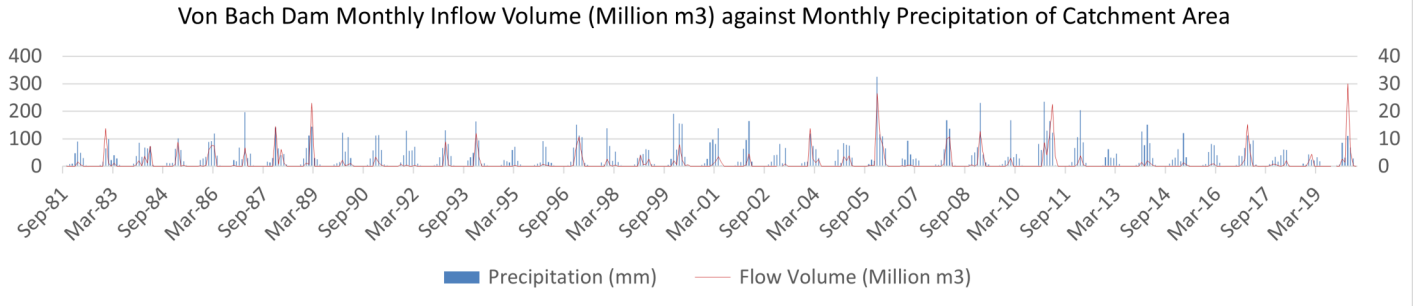


Figure 2 (right). *The graphs of Standardised Precipitation Index (SPI) over the past 40 years demonstrate an increase in extreme events, with highest high rainfall and low rainfall extremes for Omatako and Von Bach being recorded in the past ten years.*

Figure 3 (below). *The graph of inflow volume of Von Bach dam against its catchment precipitation: the inflow response to precipitation is not proportional and sometimes delayed.*



Monitoring Slangbos Encroachment in the SALDi Study Site Mantsopa, Free State

Marcel Urban[1], K. Schellenberg[1], T. Morgenthal[2], C. Dubois[1], A. Hirner[3], U. Gessner[3], Z. Zhang[4], B. Mogonong[5], J. Baade[6] & C. Schmullius[1]

[1]Department for Earth Observation, Friedrich-Schiller-University Jena, Germany, [2]Department of Agriculture, Forestry and Fisheries (DAFF), Directorate: Land Use and Soil Management, [3]German Aerospace Center, Oberpfaffenhofen, Germany, [4]University of Augsburg, Germany, [5]South African Environmental Observation Network (SAEON), Arid Land Node, [6]Department for Physical Geography, Friedrich-Schiller-University Jena, Germany

Increasing woody cover and overgrazing in semi-arid ecosystems are known to be the major factors driving land degradation (Dubovyk, 2017). During the last decades, woody cover encroachment has significantly increased in southern Africa, which led to crucial environmental, land cover as well as land use changes (O'Connor et al., 2014; Stevens et al., 2016). This study focuses on the intensification of the slangbos/ bankrupt bush (*Seriphium plumosum*) in Mantsopa, our SALDi study site in the Free State province. Though being indigenous to South Africa, slangbos has been documented to be the main encroacher on grassvelds in Free State, Western Cape, North West, Mpumalanga, Eastern Cape and Gauteng (Morgenthal, 2018; Mucina and Rutherford, 2006). The goal of this study is to synergistically combine SAR (Sentinel-1) and optical (Sentinel-2) Earth Observation information and use random forest to monitor the slangbos encroachment on arable land between 2015 and 2020. Our preliminary results are promising in terms of detecting slangbos on agricultural fields (see Figure).

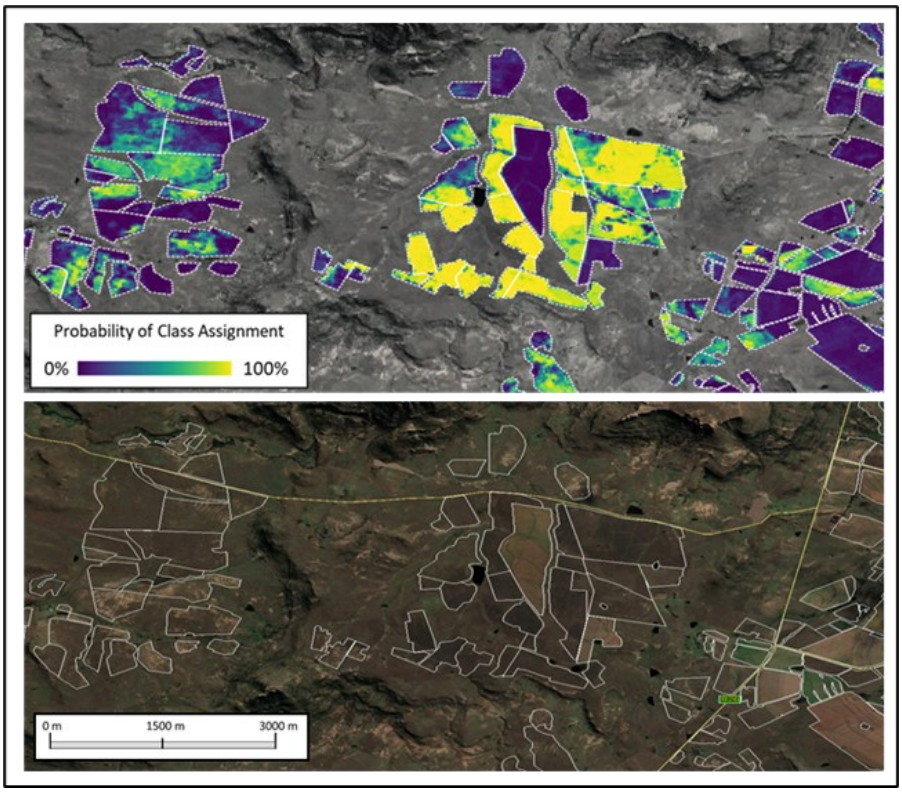


***Figure**. Top: probability measure for the assignment of individual pixels to the class "slangbos" between 10/2017 and 09/2018 for a selected area in Mantsopa, Free State (Latitude / Longitude: -29.36°, 27.24°) (contains modified Copernicus Sentinel data [2017 – 2018]). Bottom: Google Earth high resolution imagery from 2018. The field in the center of the image (low probability for classification as slangbos) is surrounded by fields highly affect by slangbos encroachment visible as darker areas (manuscript in preparation). Map Data: Google, Maxar Technologies.*

Dubovyk, O., 2017. The role of Remote Sensing in land degradation assessments: opportunities and challenges. Eur. J. Remote Sens. https://doi.org/10.1080/22797254.2017.1378926

O'Connor, T.G., Puttick, J.R., Hoffman, M.T., 2014. Bush encroachment in southern Africa: Changes and causes. African J. Range Forage Sci. 31, 67–88. https://doi.org/10.2989/10220119.2014.939996

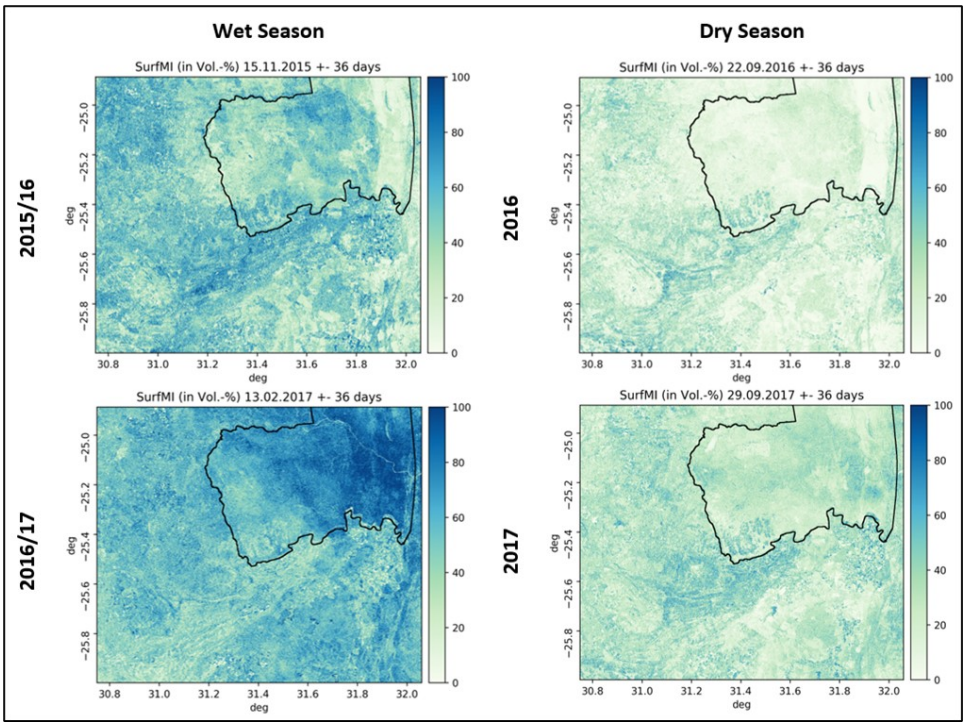
Stevens, N., Erasmus, B.F.N., Archibald, S., Bond, W.J., 2016. Woody encroachment over 70 years in South African savannahs: Overgrazing, global change or extinction aftershock? Philos. Trans. R. Soc. B Biol. Sci. 371, 20150437. https://doi.org/10.1098/rstb.2015.0437

Surface Moisture Monitoring in the SALDi Study Site Ehlanzeni, Mpumalanga

Marcel Urban[1], Tercia Strydom[2], Izak P.J. Smit[2], Jussi Baade[3] & Christiane Schmullius[1]

[1]Department for Earth Observation, Friedrich-Schiller-University Jena, Germany, [2]Scientific Services, South African National Parks, Skukuza, South Africa, [3]Department for Physical Geography, Friedrich-Schiller-University Jena, Germany

Analyzing surface moisture dynamics (e.g. duration of droughts) is of high importance, as it is highly correlated to vegetation and soil respiration, which represents both root and microbial respiration, and is one of the main fluxes of carbon in savanna ecosystems (Makhado & Scholes 2011). Within SALDi we derive surface moisture information from Earth Observation time series (Surface Moisture Index - SurfMI) using the approach by Urban et al. (2018). This method applies a change detection (Wagner et al. 1999, Naeimi et al. 2009) to Sentinel-1 C-band GRD (ground range detected) backscatter time series with high spatial (10 m pixel size) and temporal resolution (12-day revisit). We calculated the rolling median of the SurfMI for three time steps before and after each acquisition, which represents a bi-monthly average. Figure (below) shows the wettest and driest dates within the respective wet (October to March) and dry (April to September) season between 2015 and 2017 for the southern part of the Kruger National Park and the surrounding region, representing the SALDi study site Ehlanzeni.



South African SALDi Land Degradation Monitor

***Figure**. Bi-monthly average of the SurfMI for the wettest and driest dates during 2015 and 2017 for the southern part of Kruger National Park and surrounding regions (unpublished work) (contains modified Copernicus Sentinel data [2015 – 2017]).*

These radar-retrieved surface moisture maps represent the water content of vegetation and/or soil surface, whatever cover dominates the respective pixel. Hence, when interpreted jointly with optical products on canopy cover and phenology, identification of biophysical versus geophysical spatio-temporal patterns become possible. During 2015/16, South Africa experienced one of the most severe meteorological droughts since the start of climate recording. The highest surface moisture in the wet season 2015/16 is found in November 2015, while it was February 2017 in the following wet season 2016/17. The lowest surface moisture is found in September for both dry seasons (2016 and 2017). However, 2016 reveal much dryer conditions than in 2017.

Makhado, R.A.; Scholes, R.J., 2011. Determinants of soil respiration in a semi-arid savanna ecosystem, Kruger National Park, South Africa. Koedoe, 53, 1–8.

Wagner,W.; Lemoine, G.; Rott, H., 1999. A method for estimating soil moisture from ERS Scatterometer and soil data. Remote Sens. Environ. 70, 191–207.

Naeimi, V.; Scipal, K.; Bartalis, Z.; Hasenauer, S.;Wagner,W., 2009. An improved soil moisture retrieval algorithm for ERS and METOP scatterometer observations. IEEE Trans. Geosci. Remote Sens. 47, 1999–2013.

SALDi Data Cube

Jonas Eberle[1], M. Thiel[2], S. Hill[2], A. Mlisa[4], N. Mashiyi[4], A. Hirner[1], U. Gessner[1], M. Urban[3], C. Schmullius[3] & J. Baade[5]

[1]German Aerospace Center, Oberpfaffenhofen, Germany, [2] Department of Remote Sensing, University of Würzburg, [3]Department for Earth Observation, Friedrich-Schiller-University Jena, Germany, [4]South African National Space Agency, South Africa, [5]Department for Physical Geography, Friedrich-Schiller-University Jena, Germany

SALDi is setting up an Open Data Cube infrastructure, which will enable a detailed analysis of land degradation in the six SALDi focus regions based on time series of satellite data (Figure 3). The Data Cube integrates ready-to-use data of the European optical Sentinel-2 and radar Sentinel-1 satellites, as well as derived information such as biophysical variables and indices. This Earth observation infrastructure is based on the Open Data Cube project (Open Data Cube contributors, 2020), which facilitates efficient time series analysis by providing uncomplicated data access for method development, flexibility and standardization in data management and dynamic working tools for research teams and users. The interactive notebook interface of the Open Data Cube platform will effectively introduce users to open science and cloud-based Earth observation techniques. The SALDi Data Cube will be located at Leibniz Supercomputing Centre (LRZ) managed by the Technical University of Munich and will allow standardized access to data and processing for SALDi scientists and partners in Germany and South Africa. In this context, SALDi is in close contact with colleagues from the South African National Space Agency (SANSA) where a complementary Data Cube based on data from the SPOT satellites is currently established.

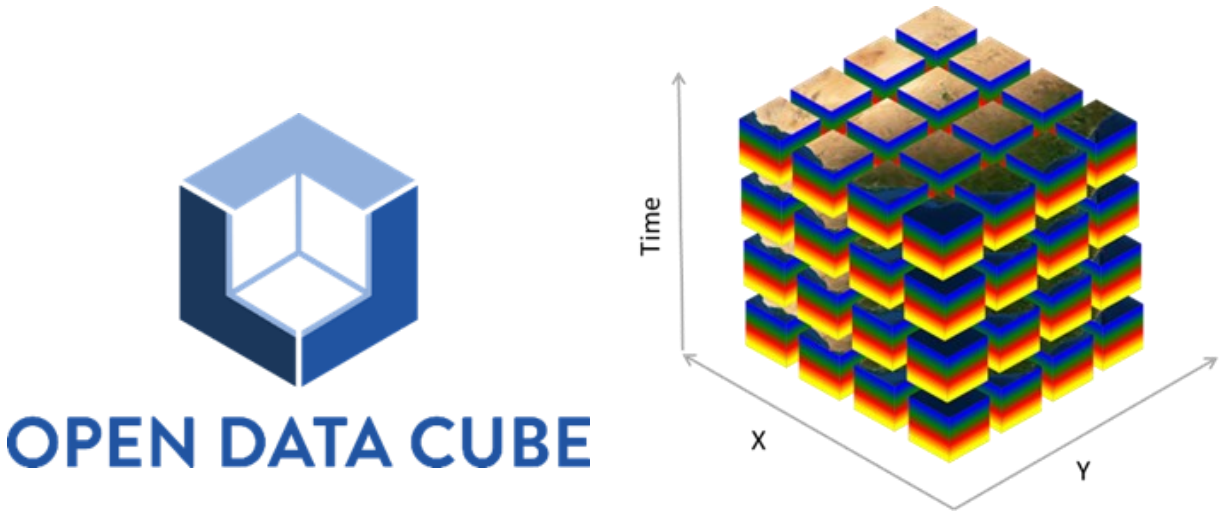


***Figure**. The Open Date Cube project is an open source geospatial data management and analysis software project supported by numerous organizations including the USGS and CEOS. It is a framework for creating data cubes. Here a conceptual representation indicates a multi-dimensional stack in space, time and type of spatially aligned pixels.*

Open Data Cube contributors (2020). The Open Data Cube (ODC) Project. URL https://www.opendatacube.org

Woody Cover Map of Kruger National Park – Revisited

Andreas Hirner[1], U. Gessner[1], M. Urban[2], C. Schmullius[2] & J. Baade[3]

[1]German Aerospace Center, Oberpfaffenhofen, Germany, [2]Department for Earth Observation, Friedrich-Schiller-University Jena, Germany, [3]Department for Physical Geography, Friedrich-Schiller-University Jena, Germany

SALDI's Earth observation group explores the synergistic use of novel radar and optical satellite time series to improve mapping of surface parameters with relevance to degradation assessments in South Africa. In the last SPACES II newsletter (07/2020), a wall-to-wall woody cover map of Kruger National Park was presented produced from Sentinel-1 radar scenes (Urban et al., 2020) which was trained on airborne LiDAR data provided by SANParks (Smit et al., 2016). This approach is now complemented using optical data from the Sentinel-2 (S2) satellite constellation with a spatial resolution of 10-20 m (Figure). Based on the same LiDAR input data set, the German Aerospace Center (DLR) devised an approach to account for one challenge that is typical for optical satellite data, namely observational gaps caused by cloud cover. This problem is especially prevalent in those parts of the national park that are closer to the Drakensberg segment of the Great Escarpment.

Nine established remote sensing-derived indices (NDVI, RVI, EVI, DVI, REIP, SAVI, MSAVI, TSAVI, NDWI) of all S2 scenes were calculated, masked for clouds and stacked. In order to minimize gaps, multi-annual monthly composites spanning four years for each index were constructed from the stack and subsequently used in combination with lidar-derived reference data to fit a random forest (RF) model (Breiman, 2001). Accuracy assessments revealed a Root Mean Squared Error (RMSE) of 14.6% for this optical woody cover product with a spatial resolution of 10 m.

There is great potential for a combined optical-radar data fusion exercise to further increase accuracy. We are planning to use both data sets in a common classification approach using open source software and host it on the SALDi Open Data Cube environment currently set-up. This will allow us to provide a cloud-based service accessible to all project partners and stakeholders in South Africa.

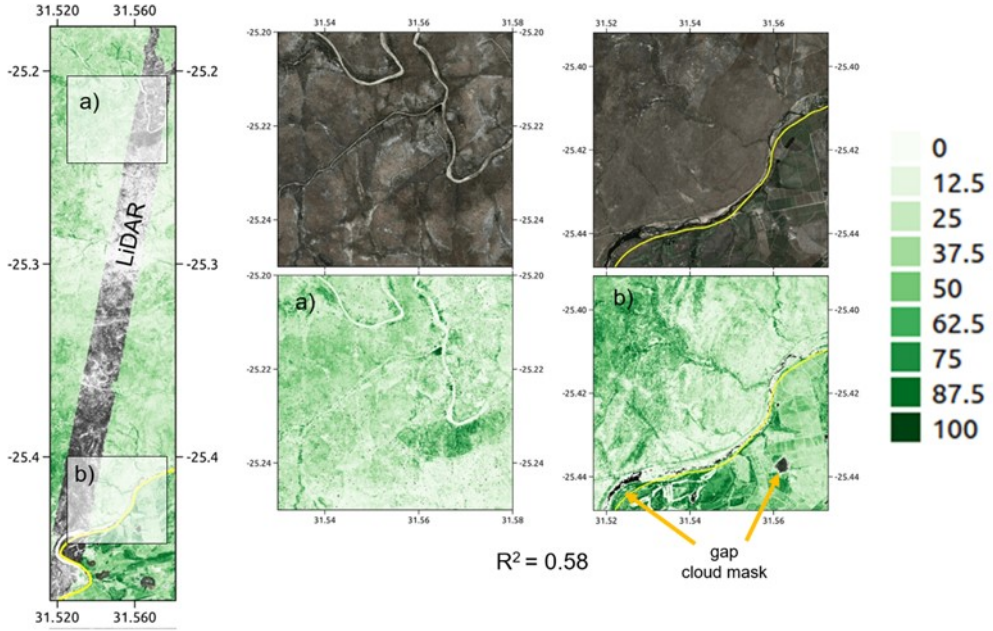


***Figure**. Random forest regression results deriving woody cover (in %) using the multi-annual monthly composites in the southern portion of Kruger National Park. Left: overview with indication of LiDAR strip in shades of gray and RF regression in green. Right: detailed comparison of Bing Map imagery and regression results.*

Urban, M., Heckel, K., Berger, C., Schratz, P., Smit, I., Strydom, T., Baade, J., & Schmullius, C. (2020). Woody cover mapping in the savanna ecosystem of the Kruger National Park using Sentinel-1 C-Band time series data. Koedoe, 62(1), 1-6, https://doi.org/10.4102/koedoe.v62i1.1621

Smit, I.P.J., Asner, G.P., Govender, N., Vaughn, N.R. & Van Wilgen, B.W. (2016): An examination of the potential efficacy of high-intensity fires for reversing woody encroachment in savannas. J. Appl. Ecol. 53, 1623–1633. doi:10.1111/1365-2664.12738

Agroforestry: an appropriate and sustainable response to a changing climate in Southern Africa?

The recent review publication authored by ASAP researchers outlines and discusses the utilisation of an agroforestry-based strategy (the combination of trees and crops and/or animals on the same landholding) as a suitable reaction that can be used both for the adaptation to and the mitigation of climate change effects. The article forms a baseline discussion of the state of the art in the southern African region.

Agroforestry systems: a complete solution or a useful tool in our toolbox?

The paper discusses the multiple benefits bestowed by agroforestry systems, drawing examples and discussion from the recent literature. These include agroforestry's facilitation of increased ecosystem services, influence over crop production and positive impacts on rural livelihoods through provisioning and income generation. Nevertheless, the paper acknowledges that knowledge gaps remain. Outstanding questions are highlighted, requiring further investigation. These include for example the interplay between trees and crops and their combination within agroforestry systems, and their potential benefits. Likewise, deficiencies are identified in the institutional and policy frameworks that underlie the adoption and stimulus of agroforestry systems in the southern African region.

The article evokes that agroforestry systems should not be viewed as a one-size-fits-all standardised solution, but rather a recipe with many ingredients that can be individually applied to bake the cake that is appropriate for the occasion. Efforts directing the implementation of agroforestry systems should be directed towards tackling individual issues and local differences on the composition and management of particular land management strategies that are suited to individual circumstances.

Any questions or comments can be directed to the corresponding author, who would be happy to discuss this publication further: jonathan.sheppard@iww.uni-freiburg.de

Sheppard, J.P.; Bohn Reckziegel, R.; Borrass, L.; Chirwa, P.W.; Cuaranhua, C.J.; Hassler, S.K.; Hoffmeister, S.; Kestel, F.; Maier, R.; Mälicke, M.; Morhart, C.; Ndlovu, N.P.; Veste, M.; Funk, R.; Lang, F.; Seifert, T.; du Toit, B.; Kahle, H.-P. Agroforestry: An Appropriate and Sustainable Response to a Changing Climate in Southern Africa? *Sustainability* **2020**, 12, 6796.

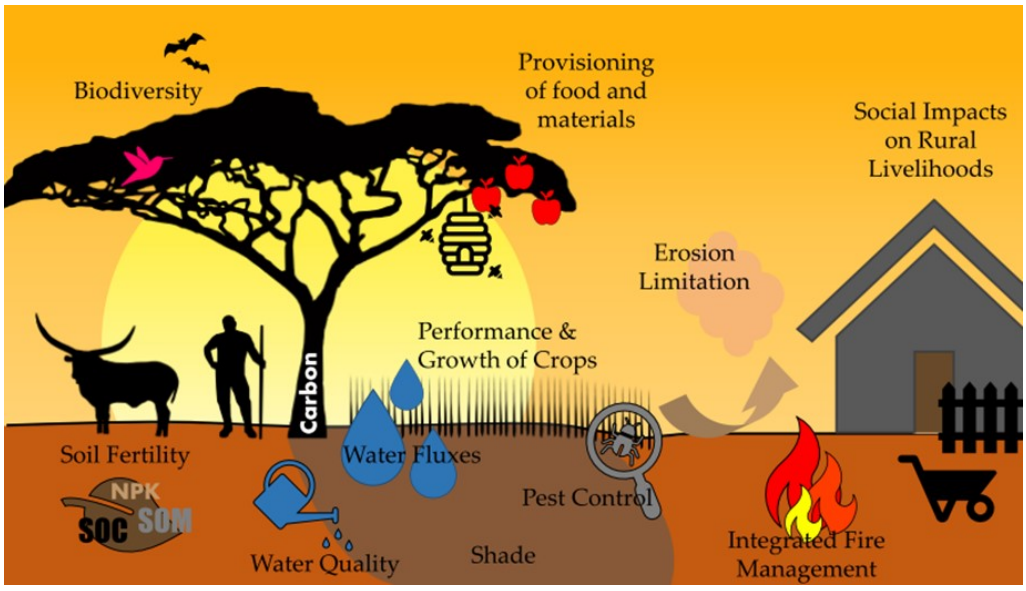


Figure. *On- and off-site benefits of agroforestry systems in the southern African region for direct and indirect mitigation of predicted climate change impacts.*

Large uncertainties in future biome changes in Africa call for flexible climate adaptation strategies

In a joint effort of South African and German scientists and a collaboration between SPACES II projects EMSAfrica and SALLnet, we found large uncertainties in projections of future biomes in Africa. Climate change and elevated CO_2 are expected to drive vegetation changes in Africa. We used an ensemble of dynamic vegetation model simulations with the adaptive Dynamic Global Vegetation Model (aDGVM) to assess impacts of these drivers on carbon stocks and biomes until 2099. Downscaled high-resolution climate data from six general circulation models (GCMs) for two mitigation scenarios (representative concentration pathways, RCPs 4.5 and 8.5) from the Council for Scientific and Industrial Research in South Africa (CSIR) were used for these simulations. We assessed the direct effects of climate change and elevated CO_2 on vegetation change and its plant-physiological drivers.

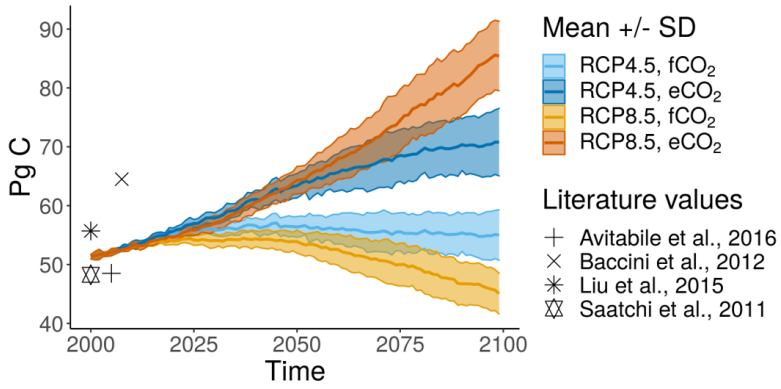
Climate change and elevated CO_2 led to an 18 to 61% increase in carbon stocks, which was primarily driven by CO_2 fertilization (Fig. 1). Associated biome changes are likely across Africa, especially woody encroachment with changes from savanna to forest (Fig. 2). Disabling CO_2 fertilization resulted in a -22 to +11% change in carbon stocks. Direct effects from elevated CO_2 were associated with substantial increases in water use efficiency, primarily driven by photosynthesis enhancement. At the ecosystem level, interactions between fire and woody plant demography further promoted woody encroachment.

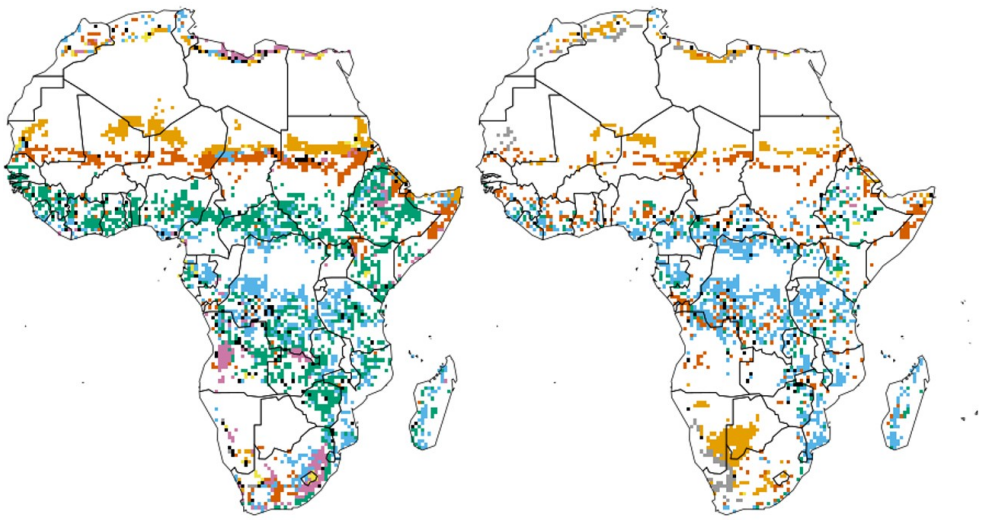
We conclude that substantial future biome changes due to climate and CO_2 changes are likely across Africa. The large uncertainties in future projections imply that adaptation strategies need to be flexible and that focused research on CO_2 effects is necessary.

Martens C, Hickler T, Davis-Reddy C, Engelbrecht F, Higgins SI, von Maltitz GP, Midgley GF, Pfeiffer M and Scheiter S (2020) *Global Change Biology*. doi:10.1111/gcb.15390

Figure 1 (right). *Carbon in aboveground biomass in Africa from 2000 to 2099.*

Figure 2 (below). *Biome changes under RCP8.5 from 2000-2019 to 2080-2099 under climate change with elevated CO_2 (left) and CO_2 fixed at 400ppm (right).*





Disentangling Drought and Grazing Effects on Soil Carbon Stocks and CO_2 Fluxes in a Semi-Arid African Savanna

In a collaborative study of the SALLnet project, scientists from the University of Limpopo, South Africa, and the University of Bonn, Germany found that drought can reduce CO_2 fluxes and increase carbon storage in the soil. The study was conducted within the "DroughtAct" experiment, which combines grazing and centennial-scale drought treatments.

Our study sought to disentangle joint effects of long-term drought and grazing on soil carbon stocks and CO_2 fluxes, focusing on a semi-arid African savanna grassland. Information on joint grazing and drought effects are limited, despite the wide distribution of dryland grasslands and their importance for ecosystem service provision. We installed 32 CO_2 chambers in the DroughtAct experiment (Fig. 1) which measured CO_2 fluxes over one growth period.

Figure 1. Measuring CO2-Fluxes from the soil. Photo: L. Munjonji

We found CO_2 fluxes to strongly respond to the 5-year experimental drought (Fig. 2). Extreme drought reduced CO_2 emission rates by 32% compared to ambient conditions. CO_2 fluxes averaged 5.7 mg $m^{-2}min^{-1}$ under drought compared to 8.3 mg $m^{-2}min^{-1}$ under ambient conditions. CO_2 fluxes were however not influenced by grazing. At the end of the growth period, grazed plots under ambient rainfall had released 16.3 tons of CO_2 ha^{-1} which was 58% higher than observed on grazed plots subjected to severe drought. Soil carbon stocks were higher under drought conditions due to slower decomposition rates (Fig. 3). Our study revealed that long-term extreme drought may be favorable in terms of preserving the existing soil carbon stocks through reduced CO_2 release. This finding is critical for understanding future soil carbon dynamics in dryland grasslands in the face of climate change.

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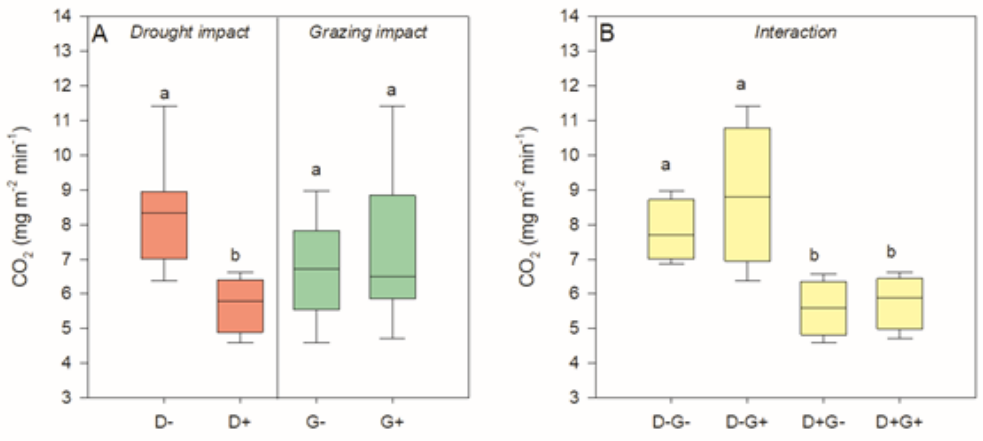

Figure 2. *Effect of drought and grazing on CO_2 fluxes over one growth period. (A) Impact of drought (D+) and grazing (G+) in comparison to ambient rainfall (D-) and no grazing (G-); and (B) combined effects of drought and grazing on CO_2 fluxes. Different lowercase letters indicate significant differences among treatments ($P < 0.05$).*

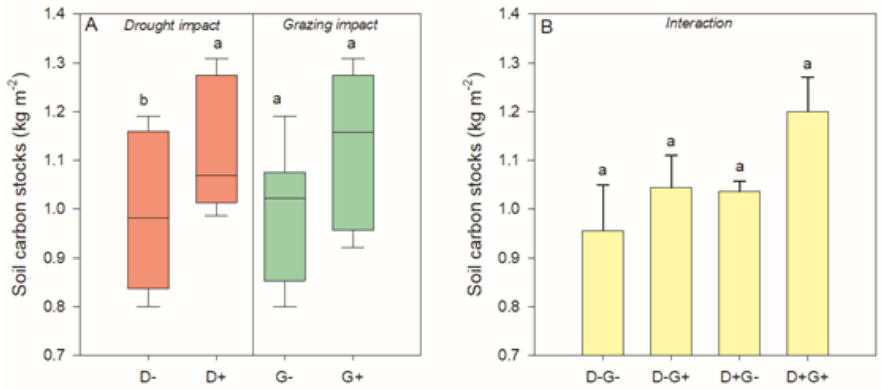

Figure 3. *Effect of drought and grazing on C stocks. (A) The impact of the main effects (drought (D+) and grazing (G+)) on soil carbon stocks in comparison to ambient rainfall (D-) and no grazing (G-); and (B) combined effect of drought and grazing on soil carbon stocks. Different lowercase letters indicate significant differences among treatments ($P < 0.05$).*