SASSCAL

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

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ANNUAL REPORT
2016 - 2017

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The Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) is a joint initiative of **Angola, Botswana, Namibia, South Africa, Zambia, and Germany** in response to the challenges of global change.

Vision, Mission and Strategic Objectives

Vision

To be a leading regional centre in integrated climate change and adaptive land management science services for improved quality of life in southern Africa.

Mission

To strengthen the regional capacity to generate and use scientific knowledge products and services for decision making on climate change and adaptive land management through research management, human capital development and services brokerage.

Strategic objectives

- to manage and coordinate research in adaptation to climate change and for sustainable land management
- to provide products, services and information for decision-making
- to contribute to the creation of a knowledge-based society through academic and non-academic capacity development programmes

Message from BMBF

Prof Rene Haak

Since the formation of SASSCAL, together with our African partners, we have made tremendous progress and are proud of the achievements in the field of Capacity Development, Research and Services provision. We wish to congratulate the Board and the Executive Management for the hard work, passion and dedication in ensuring SASSCAL remains a relevant strategic player in the fight against the effects of Climate Change in the southern African Region.

As the unique funder of SASSCAL, the German Federal Ministry of Education and Research has invested more than 40 Million euros in research, capacity building and infrastructures to bring the southern African region in the position to conduct this regionally focused fight against the effects of climate change. When we look today at the success stories, it gives us great hope to be proud of our engagement and our commitment to Africa as a platform where German and African scientists together as equal partners work for a better future of our planet. The results have been phenomenal. This constitutes for us an additional motivation to continue our engagement for the next years by allocating new funds to SASSCAL 2.0 in its consolidation phase.

SASSCAL 2.0 has been uniquely tailored by our African partners through a rigorous consultative process to address the developmental needs of the region. It will build on the successes of SASSCAL 1.0 to address future climate change and adaptive land management challenges. As a result, SASSCAL will transform from research management entity into an integrated services provider, creating a platform for service provision and an investment in the production of a new generation of knowledge workers.

The Southern African Region remains one of the most affected regions in the world as far as the negative effects of climate change is concerned and is one of our research priorities in the policy of Internationalization of Research at the German Federal Ministry of Education and Research. Therefore, it seemed right to address climate change by developing regional scientific cooperation and collaboration, as we are doing now in the framework of SASSCAL.

We look forward to a brighter future ahead, with even greater success stories. The German Federal Ministry of Education and Research is still committed to providing the necessary support for this initiative. Let me take this opportunity to once again thank the entire Governing Board of SASSCAL, all our partners both in Africa and Germany for their dedication exhibited over the years. SASSCAL is an African institution which must be owned by our African partners who must assume the financial sustainability of it. We as funding partner can only help for a limited period.

Assuredly, I know that SASSCAL is on the right path to transition into an international organisation which my ministry has immensely contributed to establish. This transforming opens up more opportunities to ensure SASSCAL's long-term sustainability. I wish everyone associated with SASSCAL a great success in their endeavours in 2018 and beyond.

Thank you.

Message from the Chair of the Governing Board

Mrs Jane Mubanga Chinkusu

SASSCAL has grown from strength to strength, not only as an institution but also in terms of scientific impact and increasing ownership by the African partner countries. From the humble beginnings of a German-funded project, SASSCAL has developed within only 6 years into a fully-fledged African institution that is nationally owned, regionally operated and internationally recognized.

SASSCAL has been developed into a Centre that has a governing and advisory structure, assured financial resources, human capital and material resources. Its scientific knowledge products enable it to provide advise to decision makers facing the challenges posed by climate change and unsustainable land management practices.

Steadily, more and more highly specialised African scientists work in teams on transboundary environmental issues in an attempt to find local solutions for African problems. The German Government, through the Federal Ministry of Education and Research (BMBF) is financing the research and capacity development projects and German scientists provide welcome backstopping and technical capacity. On behalf of SASSCAL, I, in my capacity as Chair of the Governing Board, wish to thank the German people for their most generous support to address a global issue at the regional level.

Message from the Executive Director

Dr Jane M. Olwoch

"If you want to walk fast, walk alone. If you want to walk far, walk together"

My team and I stand at a point of opportunity to close SASSCAL 1.0 and to usher in SASSCAL 2.0. While applied transboundary and transdisciplinary scientific research will continue unabated, the new phase will also concentrate on translating the knowledge gained from the 88 tasks of the first research portfolio into tools that will enable decision makers in southern Africa to address the issues related to climate change and sustainable land use management. SASSCAL will continue its capacity development efforts. As opposed to the initial capacity development component that was embedded in the research projects, the second phase will strengthen SASSCAL's contribution to the creation of a new generation of innovative knowledge workers through institutionalised capacity development instruments and the Alumni network will be rolled out and the Regional Integrated Water Resources Management (IWRM) Graduate School will also be started. SASSCAL will support non-academic training in collaborating institutions and establish centres for knowledge generation and brokerage. Graduate Programmes in specialised fields will be started in the second phase.

To ensure long-term sustainability of the institution, the SASSCAL team at the Regional Secretariat has been strengthened to include highly qualified coordinators in Research, Human Capital Development and Open Access Data Centre. Together with existing staff, renewed efforts are in place to broaden the resource base of the institution by soliciting contributions from partner countries, preparing grant applications, participating in calls for proposals and by forging new partnerships with comparable organisations. SASSCAL will increase its visibility by producing regionally relevant services that include, by way of illustration, maps that portray threats to regional conservation areas (Angola), diagnostic analysis of shared water resources to identify the most cost-effective remedial and preventative measures to address areas of transboundary concern (Botswana), by developing and making available computer-based applications that use remote-sensing technologies (Namibia), collation of the climate change impacts for key sectors for the SADC region have been undertaken as input for the development of climate modelling activities (South Africa), and the digitization of weather data (Zambia and Botswana).

The sustainable management and regional expansion of the WeatherNet, currently consisting of 150 Automatic Weather Stations, is of importance to the future of SASSCAL. This truly regional network of sophisticated gauging instruments is one of the pillars of SASSCAL's investments as it serves decision makers and the scientific community from a multitude of academic disciplines. The climatic data obtained, research data harvested from own and related research programmes, combined with the latest remote sensing and earth observation technologies, will enable SASSCAL to offer the services that are expected from a regional science service centre of an international standing.

Lastly, it is my conviction that institutions are not a function of buildings and furniture but of teams of people who understand and share a vision and work towards a common goal. Team work and recognition of each and every member's contribution will be my priority. We have walked this far because we have walked with you all our valued stakeholders.

"If you want to walk fast, walk alone. If you want to walk far, walk together"

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Acronyms

BCA	Botswana College of Agriculture
BGR	Federal Institute for Geosciences and Natural Resources (Germany)
BL	Budget Line
BMBF	German Federal Ministry of Education and Research
BMS	Botswana Meteorological Service
BUAN	Botswana University of Agriculture and Natural Resources
CBNRM	Community-Based Natural Resource Management
CERED	Centre for Environment Research Education and Development (Zambia)
CLIENT	Programme to support international partnerships in climate, environment and energy (BMBF)
CSIR	Council for Scientific and Industrial Research (South Africa)
DAAD	German Academic Exchange Service
DBG	German Botanical Society
DEA	Department of Environmental Affairs (Namibia)
DLR	German Aerospace Centre
DLR-PT	German Aerospace Centre – Project Management Agency
DWD	German Weather Service
ED	Executive Director
EO	Earth Observation
EU	European Union
FEWSNET	Famine Early Warning Systems Network
FOR	Forest Department (Zambia) (own acronym)
FSUJ	Friedrich Schiller University Jena
GERICS	Climate Service Centre Germany
INAMET	National Meteorology and Geophysics Institute (Angola)
ISCED	Centre for Biodiversity Studies and Environmental Education (Angola)
ISOE	Institute for Social-Ecological Research (Germany)
ISPT	Instituto Superior Politécnico Tundavala (Angola)
ISP	Integrated Science Plan
KAZA	Kavango Zambezi
KfW	German Development Bank
MAWF	Ministry of Agriculture, Water and Forestry (Namibia)
MET	Ministry of Environment and Tourism (Namibia)
MUU	Mulungushi University (Zambia)
NBRI	National Botanical Research Institute (Namibia)

NCRST	National Commission on Research Science and Technology (Namibia)
NEA	National Executing Agency
NGO	Non-Governmental Organisation
NNF	Namibia Nature Foundation
NRSC	National Remote Sensing Centre (Zambia)
NUST	Namibia University of Science and Technology
OADC	Open Access Data Centre
ORI	Okavango Research Institute (Botswana)
RS	Regional Secretariat
RSSC	Regional Science Service Centre
SAC	Scientific Advisory Committee
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management
SIG	Spatial Informatics Group
SPACES	Science Partnerships for Assessment of Complex Earth System Processes (BMBF)
SUN	Stellenbosch University (South Africa)
TEVETA	Technical Education, Vocational and Entrepreneurship Training Authority (Zambia)
TRAFFIC	Wildlife trade monitoring network of the WWF
UAN	Agostinho Neto University (Angola)
UB	University of Botswana
UCT	University of Cape Town
UHH	University of Hamburg
UJES	Universidade José Eduardo dos Santos (Angola)
UKZN	University of KwaZulu-Natal (South Africa)
UMAR	University of Marburg (Germany
UNAM	University of Namibia
UNDP	United Nations Development Programme
UNZA	University of Zambia
UT	University of Trier
UWC	University of the Western Cape (South Africa)
WA	Withdrawal Application
WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use
WP	Work Package
ZARI	Zambia Agriculture Research Institute
ZASTI	Zambia Air Services Training Institute
ZAWA	Zambia Wildlife Authority
ZMD	Zambia Meteorological Department

Meet the Governing board

Mrs Jane Mubanga Chinkusu
Governing Board member and Chairperson
Zambia: Director – Ministry of Higher Education

Hon Anna Shiweda
Governing Board member and Vice-Chairperson
Namibia: Deputy Minister- Ministry of Agriculture, Water and Forestry
Alternate - Mr Abraham Nehemiah
Deputy Permanent Secretary – Namibia Ministry of Agriculture, Water and Forestry

Prof Gabriel Luis Miguel
Governing Board member
Angola: General Director for the National Technology Center-Ministry of High Learning, Science, Technology and Innovation

Mr Felix Monggae
Governing Board member
Botswana: Deputy Permanent Secretary
Ministry of Environment, Wildlife & Tourism
Alternate - Mr Balisi Gopolang
Meteorologist - Department of Meteorology

Prof Rene Haak
Governing Board member
Germany: Head of division 723 BMBF "Global Change"
Federal Ministry of Education & Research

Dr Yonah Seleti
Governing Board member
South Africa: Chief Director: Science Missions -Department of Science and Technology
Alternate - Mr Dumisani Mthembu
Senior specialist Multilateral Relations - Department of Science and Technology

Scientific Advisory Committee

Prof Moses Chimbari	Chairman - Botswana
Dr Domingos da Silva Neto	Member – Angola
Prof Dr Georg Teutsch	Member - Germany
Prof Dr Heiko Paeth	Member - Germany
Mr Panduleni N Hamukwaya	Member - Namibia
Dr Mary Seely	Member - Namibia
Dr Jane M Olwoch	Member – South Africa
Dr Sally Archibald	Member – South Africa
Dr Elijah Phiri	Member - Zambia

SASSCAL Executive Directors in Pictures

Dr Henry Mwima
October 2013 to May 2016

Dr Yonah Seleti
(interim ED)
June 2016 to December 2016

Dr Jane M Olwoch
January 2017 to date

SASSCAL Management

Dr Henry Mwima	October 2013 to May 2016
Dr Yonah Seleti	June 2016 to December 2016(interim ED)
Dr Jane M Olwoch	January 2017 to date
Dr Joerg Helmschrot	Director of Science and Technology
Priscilla Mudzingwa	Director of Administration and Finance
Christoph Schumann	Director of Marketing and Fundraising
Chipilica Barbosa	National Director Angola
Casper Bonyongo	National Director Botswana
Peter Erb	National Director Namibia
Peter Shisani	National Director South Africa
Indie Dinala	National Director Zambia

Our History

2007

Prof Norbert Jürgens discussed with the German Chancellor Angela Merkel and former Minister for International Cooperation Heidemarie Wieczorek-Zeul the idea of assisting in the establishment of regional science service centres in Africa. This was during the Chancellor's state visit to South Africa in October 2007 to meet the then President Thabo Mbeki and the Nobel Peace Prize Laureate Nelson Mandela. The Chancellor and the former Minister for International Cooperation visited BIOTA projects in Cape Town. The initiative was well received.

Figure 1: Chancellor Angela Merkel, Heidemarie Wieczorek Zeul and Prof Dr Norbert Jürgens

2009

Initial discussions between the German Federal Ministry of Education and Research (BMBF) and African ministries on establishing an institution that would respond to regional challenges of climate change.

2010

Angola, Botswana, Namibia, South Africa and Zambia joined the Regional Science Service Centre (RSSC). The RSSC initiative together with German representatives agreed to start research and capacity development programmes in five thematic areas: agriculture, biodiversity, forestry and water, with climate as a cross-cutting theme.

BMBF supported a similar initiative in West Africa with the establishment of the sister organisation WASCAL (West African Science Service Centre on Climate Change and Adapted Land Use).

Figure 2: SASSCAL and WASCAL Countries

2011

The RSSC was renamed, Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL). A preliminary Research Portfolio with 151 projects was established using a participatory and bottom-up approach.

2012

Angola, Botswana, Namibia, South Africa and Zambia representatives signed the Joint Declaration in Windhoek. The partner countries followed the proposal of the Bali Action Plan of the UNFCCC (COP13) to have a regional focus when addressing climate change, and implemented the recommendation of the African Union (8th session, Addis Ababa) to have a coordinated network of regional climate service institutions.

BMBF approved funding for the research projects. The University of Hamburg (UHH) was tasked with the thematic and financial coordination of the research programme.

2013

The SASSCAL Governing Board was instituted. Each board member represents a member state. The first Executive Director, Dr Henry Mwima, was appointed. The Regional Secretariat (RS) and National Nodes were established. In October, the SASSCAL RS was registered as a non-profit Section 21 Company in Namibia with a long-term plan to transform SASSCAL into an international organisation. In order to afford legal status to SASSCAL offices in the member states, the below-mentioned National Executing Agencies (NEA) were assigned as implementing entities:

- Universidade José Eduardo Dos Santos, Angola
- Department of Meteorological Services, Botswana
- Agronomic Board, Namibia
- National Research Foundation, South Africa
- National Remote Sensing Centre, Zambia

A series of thematic workshops marked the beginning of the research activities in the 88 projects.

2014

The Open Access Data Centre (OADC) was established in Windhoek, with the concept to be rolled-out to the member countries.

2015

The Scientific Advisory Committee (SAC) was instituted as a sub-committee of the SASSCAL Governing Board.

2016 First year of full operation

The research portfolio in the southern African region is managed by the SASSCAL Regional Secretariat with the assistance of the National Nodes in Angola, Botswana, Namibia, South Africa and Zambia.

2017

The new Executive Director (ED), Dr Jane Olwoch, was appointed to office in February 2017.

Figure 3: The Africa SASSCAL Member Countries

Our work

The ability of countries in southern Africa to jointly respond to climate challenges with scientifically informed and evidence-based actions and policy decisions remains low due to limited scientific research capacity and inadequate research funding in the region. Given this inadequate expertise at academic and non-academic level, SASSCAL 1.0 also focused on the development of capacity at institutional and individual levels to influence economic development.

SASSCAL adopted a regional approach to conducting research in the areas of climate change and adaptive land management. This approach recognises that our resources and ecosystem functions and services are transboundary in nature. In addition, stressors such as fire and climate change are transverse national boundaries in their origin, development and ultimately response. As such SASSCAL has been established as a leading regional driver in research which is regionally and internationally recognised. SASSCAL utilised a value chain approach to determine its pillars, namely research management, service provision and capacity development. These cornerstones of SASSCAL's operation are based on the value proposition of:

Relevance

SASSCAL provides climate change data and information and services for decision making to reduce risk and improve livelihoods.

Trans-/Interdisciplinary Research

SASSCAL promotes collaboration among scientists and stakeholders from different disciplines and sectors to ensure the implementation of innovative, integrated and divergent research approaches to mutual challenges.

Regional Coverage

SASSCAL research addresses common climate change and land management issues beyond national borders recognising the flow of energy and ecosystems services thereby contributing markedly to regional integration and addressing cross-border challenges.

Scientific Coverage

SASSCAL has a portfolio with a wide spectrum of thematic research areas, physical and human infrastructure and transnational mandates that make the institution an ideal conduit for the cost-effective and efficient channelling and managing of resources made available by external funding agencies.

Institutional Cooperation and Partnerships

SASSCAL actively maintains a wide network of partner universities and research institutions as well as funding and service organisations.

Strategic Objectives

Research Management: Through its research management objective, SASSCAL aims to strengthen its position as a regionally relevant and internationally acknowledged institution This will enable SASCAL to serve the region with scientifically sound information and knowledge related to climate change and adaptive land management.

Capacity development: To prioritise and place emphasis on knowledge management with a view to improve scientific research uptake, research policy linkages and the production of services with an impact on society.

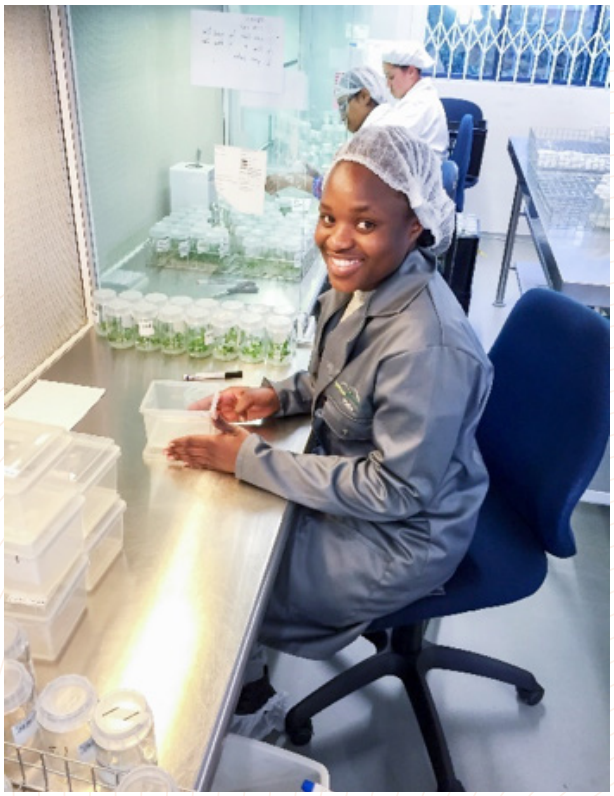
Service provision: To provide SASSCAL's science services that will ensure that the best available science is effectively communicated with relevant sectors, to develop and evaluate adaptation strategies.

Research Management

From 2012 to 2017 SASSCAL implemented and managed a research portfolio of 88 tasks across all member states. It was envisioned that this first research phase will be concluded by the end of 2017. However, the majority of tasks started late due to various challenges. As such, most were granted a no-cost extension until April 2018.

The research projects were designed to integrate research and capacity development. SASSCAL 1.0 research focused on identifying appropriate interventions, opportunities for integration and collaboration and this was achieved though five priority areas:

The outcome of all SASSCAL research is expected to better equip the region with scientifically sound data for decision making processes. Since the research is



demand driven, decision makers from local to regional level will be supported by relevant solutions for their climate change challenges.

Based on the research conducted through SASSCAL 1.0, the service provision component of the first phase has provided information, data and knowledge-based services and products to a broad range of users and practitioners. This is achieved through the Open Access Data Centre (OADC), a core service facility of SASSCAL that was established in 2014.

Operating as a data hub, the OADC provides scientifically verified, harmonised and quality-controlled data, products and information that constitute the basis for the development of demand-driven services. The main objective for the OADC is to provide an information sharing platform that is easily and freely accessible. The OADC receives data from various researchers and adds value to it by for example creating knowledge products and services, and by making these openly available with an online platform. This platform is known as the SASSCAL Data and Information Portal. This is considered to be a very important resource for the region considering that many countries in southern Africa face inadequate infrastructure to provide reliable data and information climate change impact assessments and adaptation strategies. The portal provides a reference point for future and current researchers.

Figure 4: SASSCAL funded research

Human Capital Development

The human capacity development is partly measured in terms of students involved in the SASSCAL tasks, that have completed their studies and successfully received academic accolades. Further, human capacity development activities included specialised training which were offered to various governmental and non-governmental institutions. The SASSCAL funded Regional MSc programme in Earth Observation, GIS and Remote Sensing coincides with technological advancements and developments in earth observation sciences. The use of Earth Observation data from satellites is at the centre of timely and effective environmental monitoring. Furthermore, Africa has prioritized Earth Observation from space through the African Space Strategy and Policy and the formation of the Africa Space Agency and Pan-Africa University of Space sciences. Several African states already have their own Space Agencies; those that do not have them yet have space programmes. In addition, there are several openly and online satellite products, as well as derived products, from our partners in Europe and United States of America such as the Copernicus and Landsat series.

The GMES and Africa Programme is also another key programme that is using Earth Observation data from satellites. The southern African region still lacks the technical capacity and expertise to fully exploit and utilise these earth observation products. To be able to take advantage of these datasets and contribute effectively to our programmes, more remote sensing scientists must be produced to process the data and transform it into useful products for decision making.

Research Thematic Areas

Climate

to understand and project climate well enough to promote sustainable and adaptive management of water, forestry, agriculture and biodiversity in the region

Water

to develop a common water resources information base and analytical methods to further strengthen capacity to implement integrated water resources management strategies for improved transboundary river management and resource use;

Forestry

to conserve forests in southern Africa to ensure continued delivery of vital ecosystem services to the region

Agriculture

to understand resources, drivers and changes of land use and to promote sustainable food production and food security in the region

Biodiversity

to understand patterns, processes and driving forces of biodiversity and to ensure delivery of vital ecosystem services to sustain agriculture, forestry and ecotourism in the region.

Key Achievements of SASSCAL

Research

A total of 88 projects were implemented with a regional focus under the 5 thematic areas under SASSCAL 1.0. These research projects focused on research that is both contextually relevant and based on the most advanced science available and contribute to improving decision making in the southern African region. SASSCAL 1.0 research portfolio contextualised regional scientific integration and services that address:

- the present state and future trends of resources under global change,
- the risks and vulnerabilities of ecosystems, land use systems and social systems, and
- the potential for adaptation and improved management of natural resources and services.

The table below shows the 88 research projects distribution in terms of country of implementation and thematic areas. There is clear evidence of the balance in terms of national coverage and thematic area.

More than 500 individuals and over 80 academic, governmental and non-governmental institutions were involved in these research projects. All these projects carried out demand driven research. SASSCAL 1.0 research proposals were developed in close collaboration with national and regional stakeholders and research agendas.

This was envisioned to ensure that research products would provide policy makers with information to implement informed adaptive land management practices, in the wake of the challenges posed by climate change. Research was commissioned to fill in the knowledge gaps to enable communities to best adapt to climate change through adaptive land management practices.

Thematic Area	Angola	Botswana	Germany	Namibia	South Africa	Zambia	Total
Climate	1	3	3	2	1	1	11
Water	3	2	6	2	2	2	18
Forestry	1	2	2	3	1	3	12
Agriculture	3	2	8	3	1	4	21
Biodiversity	4	3	2	6	1	2	18
Capacity Development	1	2	1	2	0	2	8
Total	13	14	22	18	6	14	88

Table 1: Distribution of the 88 Research Projects

As demonstrated by its scientific output from Phase 1, SASSCAL contributed significantly to the strengthening of the southern African research landscape. More than 100 students are graduating at different levels (Undergraduate and postgraduate) under this research phase. Contribution to peer review journals was also a significant output from SASSCAL 1.0 research portfolio.

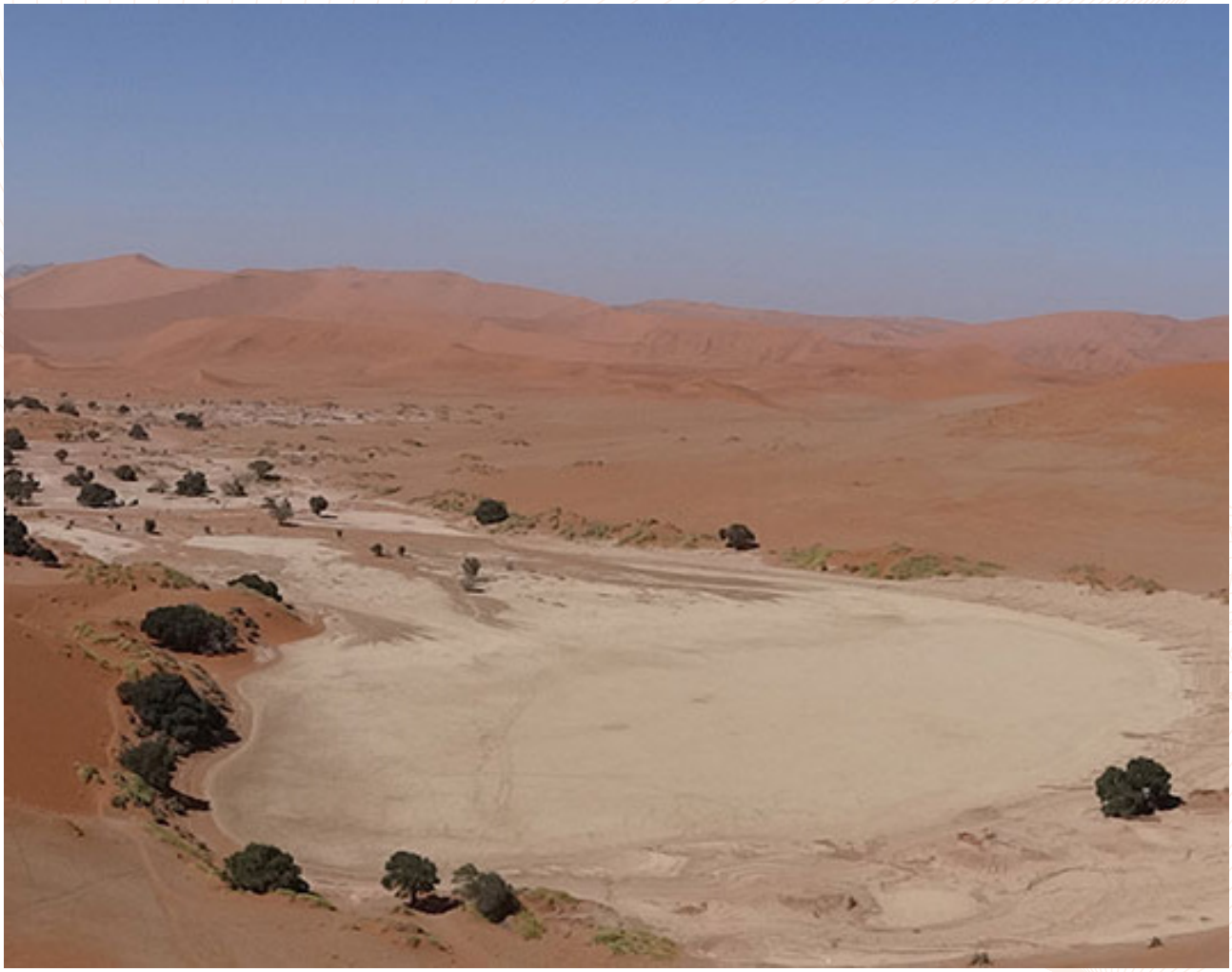
These research publications provide scientifically sound knowledge for decision makers to inform policies. In addition, several Postdoc students finalised their research projects and significantly contributed through their scientific publications to new knowledge generated through their research efforts.

All the research work carried out between 2012 and 2017 under SASSCAL 1.0 culminated in a book. The book is one of the most important research outputs from SASSCAL 1.0 research portfolio.

The SASSCAL Research Book presents the most important findings from the first phase of the SASSCAL research portfolio to the scientific community as well as the public. The SASSCAL Book will be launched at the SASSCAL Symposium in Lusaka in April 2018. The Book is freely available for download: *http://www.biodiversity-plants.de/biodivers_ecol/vol6.php*

Type of Publication	2017	2016	2015	2014	2013
Publications in Journals (peer-reviewed)	47	57	47	15	4
Publications in Journals (not peer-reviewed)	81	6	4	5	1
Scientific Presentations at Conferences		102	122	91	32
Contributions in Books		6	5	1	-
Monographs		11	1	1	1
PhD Thesis	46	2	2	1	-
MSc Thesis	9	32	28	8	1
BSc Thesis	11	18	23	12	-
Software Products		6	12	0	-
Others (policy briefs, newsletter contributions…)		14	26	10	6
Total number of publications	194	254	270	144	45

Table 2: SASSCAL's Scientific Output until December 2017



Research Highlights

Innovative research with a regional focus

SASSCAL supports and manages high-level and innovative research across Southern Africa. This includes regional climate change assessments and projections, hydro-chemical groundwater assessment studies and hydrological modelling in transboundary basins such as the Cuvelai and Zambezi Basins, forest inventory and deforestation research in savannah woodlands, soil quality improvement techniques in Angola, Botswana and Namibia and micro-biological studies in all SASSCAL countries.
For example, SASSCAL supported research on the sustainable improvement of productivity, best practice farming and conservation agriculture. Examples of such studies are shown in the table below.

- SASSCAL supported the development of methods to optimise the germination and growing of various crop seeds in Botswana and identified the potential for optimised rotation practises to increase maize yields in Zambia as well as suitable green fertilisers increasing yields in central Angola.
- Basic and applied research in dryland forests and savannas reveals that research contributes to a better understanding of the woodlands as an economic and environmental resource and provides recommendation to sustainably manage woodlands and savannas in the context of anthropogenic and climate change threats.
- Advanced hydrological assessments and modelling in Botswana and Zambia proved that water stress is caused by environmental and anthropogenic drivers and led to suggestions on improving management in the catchments.
- SASSCAL research in South Africa contributed to the assessment of the strength and magnitude of El Niño in southern Africa and its impact in various regions.

These examples demonstrate that SASSCAL research contributes to the generation of novel and innovative research for which the region receives acknowledgement from the international scientific community.

Climate Variability and Change

SASSCAL focussed on assessing climate variability, change and impact in Southern Africa by improving the data quality through observation and modelling as well as assessment and impact studies in various ecosystems.

Acknowledging the lack of long-term reliable data records, particularly outside of South Africa, SASSCAL together with National Meteorological Authorities in Angola (National Institute of Meteorology and Geophysics INAMET), Botswana (Department of Meteorological services DMS) and Zambia (Zambia Meteorological Department-ZMD) as well as research partners from all SASSCAL countries, supported the increase in climate information by the operation and maintenance of a complementary regional network of more than 150 Automatic Weather Stations (Fig. 5) providing reliable time series of key climatic variables. In addition, a coordinated effort led by the German Weather Service (DFG) was undertaken to rescue and archive historical analogue data sets and ensure their availability for future research and assessments.

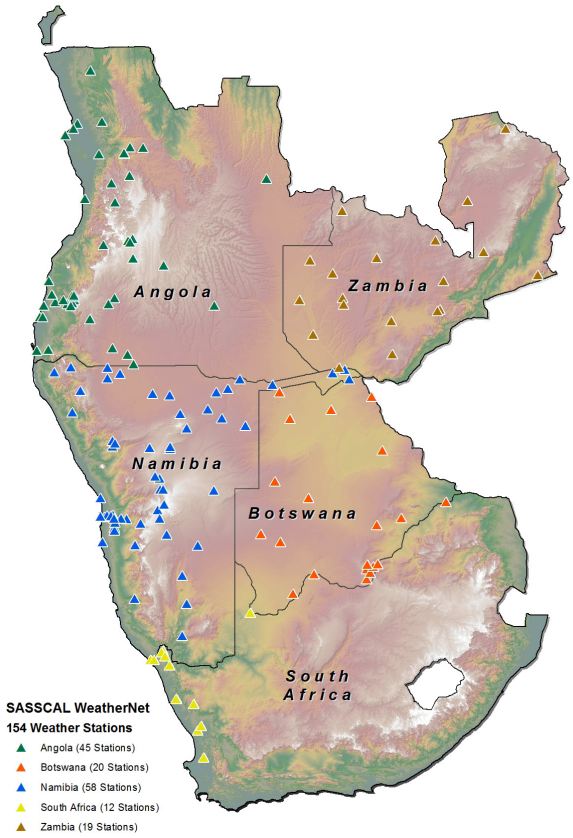


Figure 5: The distribution of the SASSCAL WeatherNet Automatic Weather Stations

Figure 6: Example of a SASSCAL Automatic Weather

To enhance understanding of fog occurrence and non-rainfall fog precipitation across the coastal Namib Desert and to increase capacities in understanding fog dynamics, Gobabeb, in collaboration with research partners from South Africa, USA, Israel, Germany and Switzerland, has designed and established N-S and E-W transects across the Namib Desert (Fig. 7). Collecting fog data and maintaining a database in order to build capacity in terms of climatological measurement will help to investigate potential correlations between Benguela sea surface temperatures and behaviour in relation to fog occurrence which is a key variable to understand the adaptation potential of the desert ecosystems under extreme conditions. The scientific value of the meteorological arrays has already been underscored too, both by contributing to new knowledge and understanding of weather dynamics, in particular fog, as well as the academic discourses that are emerging. An initial result was that the earlier work, which the station network was to support and confirm, was an excellent start but not comprehensive enough. The altered and improved understanding is that wind direction is an important consideration for explaining the source of fog on the Namib coast. Independent research on the isotopic signature of different types of fog, which implies different origins and life cycles, is generating additional interest to understand the dynamics of Namib fog. Independent research that was taking place concurrently, focussing on microbial and soil invertebrate diversity and distribution, on the isotopic signature of different types of fog, and on vegetation associations and physiological responses to fog, confirmed the validity of the overall purpose to develop reliable, high quality long-term data on fog dynamics.

Figure 7: Fog Station in the Namib Desert

In a coordinated effort by Council for Scientific and Industrial Research (CSIR) and Climate Service Centre Germany (GERICS), the most recent and prominent global circulation models (GCM) projections were downscaled to 50 km resolution over Africa for the period of 1961 – 2010 and for three different representative concentration pathway scenarios (RCP 2.6, 4.5 and 8.5). The analysis of these data sets have shown that temperatures over southern Africa have been increasing rapidly over the last five decades, at a rate of about twice the global rate of temperature increase. Further drastic increases, in the order of 6°C by the end of the century relative to the present-day climate (Fig. 8), may occur over the central and western interior regions under low-mitigation futures. Moreover, southern Africa is projected to become generally drier under low-mitigation climate change futures. Such changes will leave little room for adaptation in a region that is already characterised as dry and hot. Impacts on crop and livestock farming may well be devastating, and significant changes may occur in terms of vegetation cover in the savannas, particularly in the presence of human-induced land degradation. Under modest to high mitigation, southern Africa will still experience further climate change, but amplitudes of change will be reduced, potentially leaving more room for adaptation.

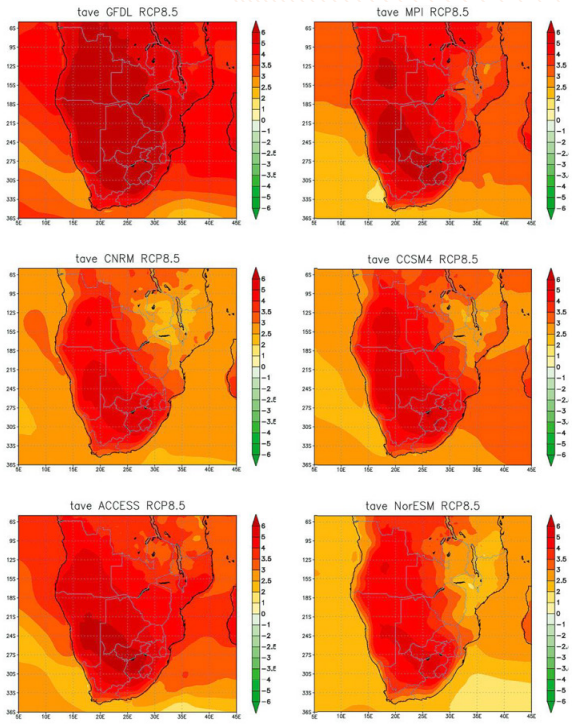


Figure 8: Climate change projections CCAM projected change in the annual average temperature (°C) over southern Africa at 50km resolution, for the time period 2080-2099 relative to 1971 – 2000. The downscalings were obtained from six different CMIP5 GCM projections under low mitigation (RCP8.5) (Archer et al 2018)

Furthermore, an analysis of the long-term precipitation data for the Kgalagadi district in Botswana for the years 1979 to 2015 revealed that summer rainfall has started later every year, indicating a shift of summer rainfall towards autumn/winter. Winter rain patterns, on the other hand, showed a stronger variability with more frequent and longer periods of drought without any precipitation. The shift of summer rainfall creates problems for the farmers regarding sowing and harvesting dates.

Other studies show that the previous prevailing drought in the winter rainfall areas of the SASSCAL region showed for the first time ever drastic effects on vegetation. This was the first time, diversity and composition of species on the biodiversity observatories in the winter rainfall regions of South Africa showed a marked decline in density and vegetation cover. Such changes in vegetation have not been observed since the start of measurements in 2001. Observation on site and preliminary data show that particularly very old plants with a lot of biomass suffer from the drought, while fully grown but younger plants are currently still surviving.

Forest Ecosystem Impact Studies

There was a strong focus of SASSCAL research on human and climate change impact on various types of ecosystems in the region. Remote sensing studies have analysed the state of the Miombo forest stands for the Bailundo Municipality in Angola. The studies have shown that just 7.5% of surface area in the study region is covered by dense Miombo stands, while 29% are open Miombo stands, 37.6% agricultural land and 24.6% grassland. The denser Miombo forest stands are limited to regions with higher altitudes. The different forest types could represent different stages of forest degradation.

Monitoring deforestation in Huambo province from 2002 - 2015 aimed at using modern technologies for continuous forest monitoring, such as remote sensing, to provide information on the current state of the forest in the central highlands of Angola, specifically the province of Huambo; to analyse the change of the forest during the period from 2002-2015 and through this, to examine the rate of deforestation, caused mainly by the charcoal exploitation in the region. Research by the Universidade José Eduardo dos Santos (UJES) has shown a significant decrease in Miombo woodland area:

- In 2002, there were about 2,596,536 ha of

the Miombo forest covered surface, that corresponded to 78 % of the total Huambo province area.

- 13 years later, in 2015, the Miombo forest covered area has decreased to 1,597,621 ha corresponding to 48 % of the total Huambo province area.

These numbers demonstrate an alarming loss of Miombo forest during the last 13 years of observation. It is assumed, that the main factors contributing to this loss are basic needs such as firewood collection, charcoal production, expansion of agricultural fields and urban development.

The main loss of Miombo land cover can be attributed to the conversion of forest into agricultural land (792,204 ha) and thereafter, the conversion of forest into urban land or bare soil. This information was shared with local communities and authorities by providing information material in various languages and formats (Fig. 9).


13 Years of DEFORESTATION in HUAMBO
2002
78%
2015
48%
Between 2002 and 2015 Miombo forests were reduced by the equivalent of
30%
of the Huambo area
Causes
Uncontrolled Exploration
Inefficient Agriculture
Wild fires
Unsustainable Production of Charcoal
Consequences
Global Warming
Biodiversity Losses
Desertification
Economic Losses
At this rate
In 18 Years there won't be forests left in Huambo
Every Day an area of forest the size of 200 Football fields is cut down
More than ONE MILLION people depend on Huambo forests to survive
SASSCAL
Task 137
UJES
Did you know...
Mount Môco is not only the highest point in the Country but also the refuge to one of the most important and threatened forests hosting several unique animal species?

Similar trends were found in the Zambezi region in north-eastern Namibia and south-western Zambia, where a significant increase in farmland was noted in the period from 2002 to 2013, which reduced dry forests by 24%. In addition to the extension of arable farming, urbanisation and mining also lead to deforestation processes in some areas: As such, progressing deforestation because of urbanisation and mining has been quantified in the Cubango province in north-western Angola, for instance, using remote sensing methods. The area taken up by mining has more than quadrupled between 2010 and 2015 from 0.3% to 1.3%, and the surface area built up because of urbanisation increased from 0.9% to 1.4% over 10 years. Sociological research in Botswana has shown that the expensive and in particular unreliable power supply in urban areas has led to a massive increase in charcoal demand. However, this has only contributed to increased deforestation to a limited degree. According to the study, the higher demand for fuel is largely met with charcoal that has already been produced because of agricultural expansion. The sociological study therefore related deforestation to the expansion of farmland and not to the shortfalls in power supply.

SASSCAL research regarding the management of woodlands has found that regular resewing of the valuable tree species *Baikaea plurijuga* can lead to good regeneration in the stands and sustainable use of this key species. The stands thus showed positive and continuous growth of young plants. SASSCAL researchers also tried to improve the germination rate of valuable tree species in order to increase their regeneration potential. Germination trials with the Pterocarpus angolensis and Strychnos cocculoides species showed that germination in tissue culture served to significantly reduce the time to germination and significantly increased the germination rate of the seeds. This method is thus preferable for targeted reforestation when compared to the conventional cold frame method.

A team of Namibian researchers has prepared a report on the legal framework regulating timber trade between Angola, Namibia and Zambia as a basis for an administrative and legal set of rules to control cross-border trade and its implementation. The report also informs on the use of the wood species of timber charges found at border crossings to the neighbouring countries as well as the challenges related to their use. An electronic version of the report was provided to the Directorate Forestry in Windhoek as well as to customs officers controlling the border crossings in northern Namibia.

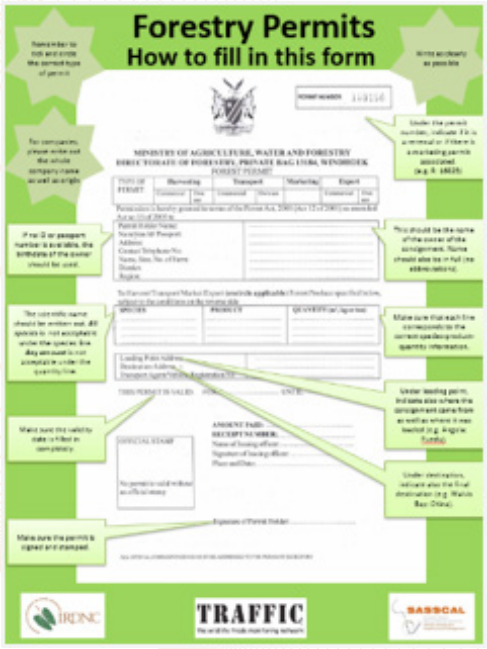


Figure 10: Timber trading and information sheets for handling permits

In the agricultural thematic area, research focused on adaptation studies, improving agricultural productivity and human-wildlife conflicts.

As summarised by Chimwamurombe and Munsanje (2018) , the effect of improved practices on soil fertility, water stress, pests and diseases, weeds, and yield was measured and compared to conventional farm practices such as disc harrowing, planting densities, weeding and chemical fertiliser application. Studies in Angola have shown that conservation farm management practices improved soil fertility by reducing soil acidity and improving the nutrient status of the soil through inputs of organic matter. In some soils, the acidity was reduced from pH 4 to pH 5.6 by the third season of adopting practices that increased soil organic matter from less than 1% to above 2%. This resulted in overall improvement in yields and productivity, demonstrating how conservation agriculture has the potential to improve the food security situation in these farming communities. Notably, the best outcome was achieved

when all principles of conservation agriculture (minimum tillage, residue retention/soil cover, crop rotation with legumes, intercropping with legumes, and improved fertiliser use efficiency, planting dates and selection of improved varieties) were adhered to.

Studies on climate-adapted farming in Zambia reported very good success with the reproduction of selected, locally-adapted maize and cowpea species as seeds. The farmers involved generated excellent yields, and the seeds harvested were officially certified as seeds, so that the farmers were now able to market them commercially. The selected and reproduced local maize species had excellent characteristics in the fields of drought resistance, cob size, corn size and weight as well as resistance of the seeds to storage pests. The cowpea species, which had also been reproduced successfully, had positive characteristics with regard to seed size and harvest yield, even with low levels of precipitation.

In Angola, studies of ISCED have shown that adding rhizobia increases the cowpea yield compared to fertilization with compost, mineral fertiliser and micro-organisms. The Botswana University of Agriculture and Natural Resources (BUAN) worked on the identification, reproduction and implementation of local rhizobia strains to improve crop yields under changing climate conditions. Different rhizobia strains were identified, which showed very good growth at a temperature of 40° C. These strains are currently tested with regard to their behaviour when they are exposed to even higher temperatures, as they might successfully be used to inoculate crops at extreme locations. As shown by collaborative studies by BUAN, NUST, University of Bremen, UHH and National Botanical Research Institute (NBRI) (Pule-Meulenberg et al 2018), wild drought-tolerant nitrogen-fixing plants with heat-tolerant bacterial symbionts might be a source for mitigation,

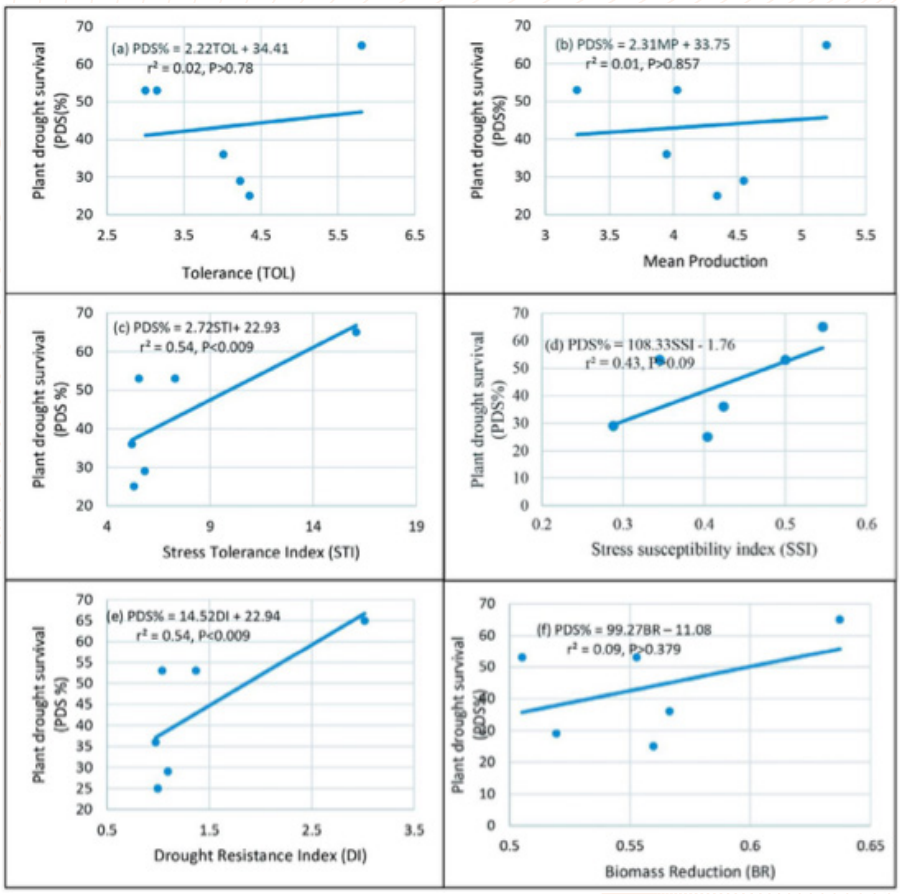


Figure 11: Relationship between drought tolerance and plant survival (%) in the field Plants were exposed to drought stress for 11 days and drought tolerance indices were calculated (Utlawang et al 2018)

nutrient-rich grazing grounds, and soil fertility. Herbaceous legumes show potential to be used as forage plants that are resilient to climate change effects. Therefore, the purpose of these studies were to assess the diversity of wild herbaceous legumes in the north-western and eastern parts of Botswana, northern parts of Namibia, and Northern Cape of South Africa. They were assessed for nodulation and insect damage, root nodule bacteria were isolated, and some were identified and authenticated on their homologous hosts. In Namibia, rhizosphere bacteria were isolated and characterised. The bacteria isolated were typical plant growth–promoting bacteria mostly belonging to the Bacillus and Brevibacillus genera, with fewer rhizobial species. Such bacteria may be valuable inoculants for pulses and cereals, respectively.
Taken together, the results of this study highlight the potential for herbaceous legumes in mitigating climate change effects through the use of inoculants as biofertiliser and through use in intercropping that modulates pest infestation, leading to low usage of chemical pesticides.

In most studies, farmers were involved in developing the research design and informed about research outputs allowing them to better understand the possibilities of innovative management practices.

Figure 12: Rufunsa District. Stakeholders a group of farmers involved in participatory evaluation of maize germplasm accessions on farm at one of the three sites in Rufunsa District.

As shown by SASSCAL research undertaken by the University of Botswana and Copperbelt University, agricultural production of smallholder farmers can be significantly impacted by wildlife activity, especially during the dry season. Based on surveyed data in the Lumimba Game Management Area in Lundazi District, Eastern Province of Zambia, the researchers concluded that crop damages are most frequent close to protected areas and decrease with increasing distances from these areas. As people invade habitats originally reserved for wildlife in order to cultivate food crops to support the growing human population, farmer-wildlife conflicts are likely to occur.

According to Zambia's Copperbelt University, crops most impacted by wildlife were ranked as maize, rice, cotton, cassava and pumpkin, whilst both University's research teams established elephants as the most destructive herbivore, raiding crops virtually daily. Apart from conflicts over crops, local farmers illegally kill wild animals for bushmeat for economic reasons. A combination of counter measures against crop damages may be effective at the farm level, but were reported to be ineffective in the case of elephant habituation, where electrical fencing, funded through joint venture or private-community funding was considered more effective.

Figure 13: Some products used as elephant deterrent in Northern Botswana, 30% of farmers believe in the effectiveness of chilli pepper, whilst others believe in hanging mutton cloth and dangling tins as effective deterrent against elephant

Figure 14: Interview session with a household head

Water Research in SASSCAL 1.0

Since the impact of climate change on water resources in southern Africa is already being experienced, the SASSCAL research focused on the better understanding and management of limited water resources in the region by addressing various spatial and temporal scales. The main objective of the water tasks is to develop reliable hydrological, hydro-climatic and hydrogeological baseline data, along with a set of analytical methods to strengthen the research capacity of the water sector of the southern African region. Thereby the SASSCAL programme aims to contribute to the implementation of integrated water resources management strategies for improved transboundary river management and resource usage in the context of global climate and land management changes.

The research activities within the water theme can be summarised in three key research areas:

- baseline data observation/monitoring in Angola (new monitoring infrastructure establishments in the Rio Giraul Basin), Botswana (expansion of existing monitoring infrastructure in the Notwane Basin), Namibia (expansion of monitoring coverage in the Cuvelai-Etosha and Zambezi basins) and South Africa (continuing and extension of long-term observations in four catchments);
- basic research in the fields of water quantity and quality assessments and modelling (with strong focus on the Barotse floodplain, Zambia and the Okavango Delta), erosion and sedimentation assessments and land use/climate change impacts in selected river basins across the region; and
- integrated and interdisciplinary research in the fields of groundwater mapping; water quality and quantity assessments and use; flood mapping; monitoring; risk assessments; large-scale drought impacts; as well as analyses of water demand and water-related vulnerabilities of households.

In agreement with tasks from the other thematic areas, five regional hotspots were identified as locations for water research in the SASSCAL research portfolio (Fig. 15), while some studies used Earth-Observation (EO)-based products to monitor floods and droughts for the entire region. These locations were:

i) Northern Namibia/southern Angola (e.g. Cuvelai-Etosha Basin, Cunene Basin, Rio Giraul Catchment)

ii) Central Angola (Lusaka Province, Kwanza River Basin)

iii) The broader Kavango–Zambezi (KAZA) transboundary region, including the upper Zambezi River Basin, upper Congo River Basin, Okavango River Basin, Chobe River Basin

iv) Southern Botswana (Notwane River Basin and upper Limpopo River Basin)

v) South Africa (Heuningnes, Verlorenvlei and Sanspruit catchments in the Western Cape Province, Cathedral Peak in KwaZulu-Natal Province and Letaba in Limpopo Province).

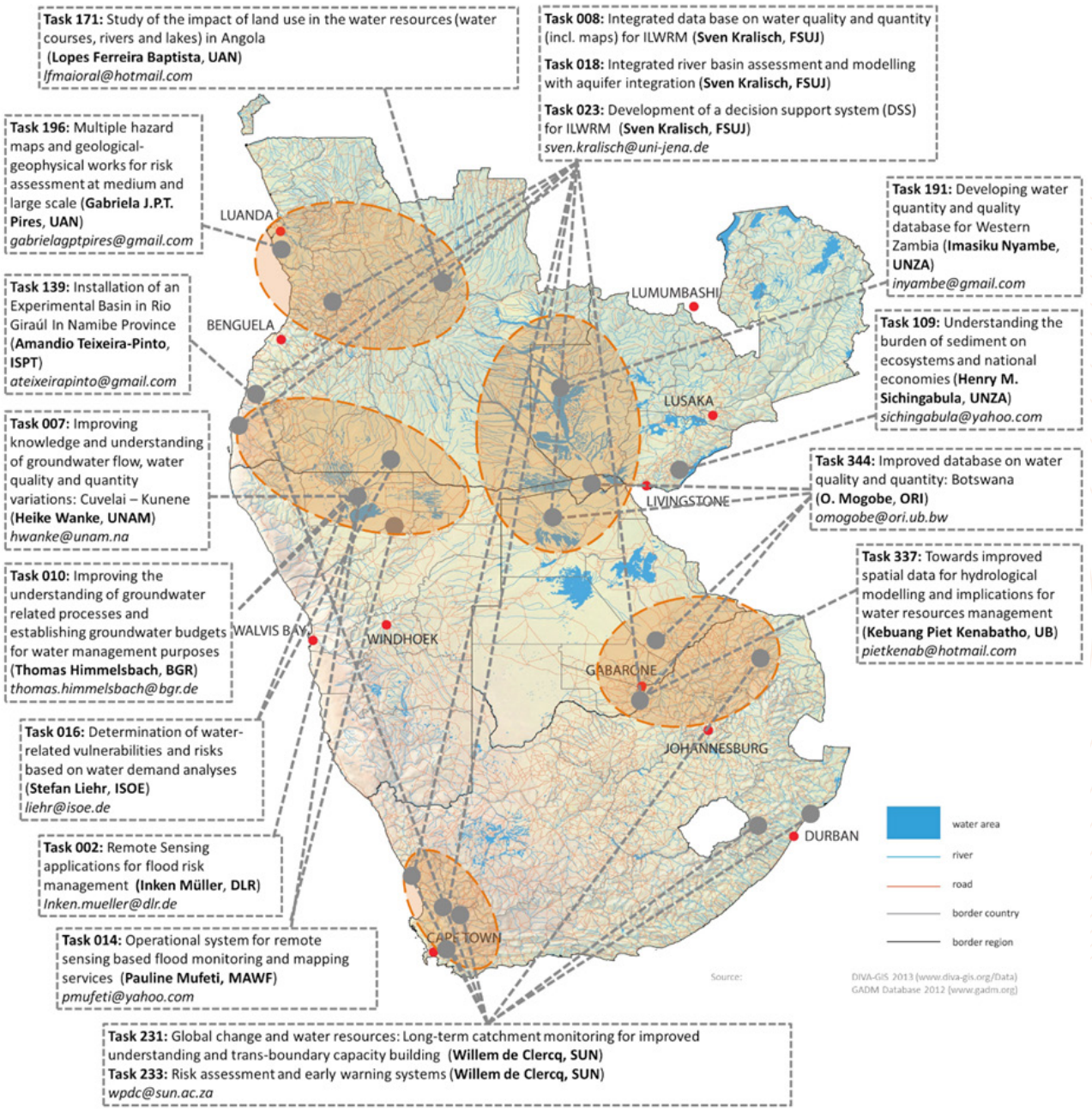


Figure 15:The locations of the SASSCAL water research sites

Figure 16:Some effects of artisanal mining landscape showing the environmental damage due to artisanal mining along the Tchiumbe River, Angola (Newsletter 2/1 March 2017)

Through SASSCAL research it was found that mining is a major driver of environmental impact, severely affecting surface water and groundwater quality, but also changing landscape features through deforestation, erosion and sedimentation dynamics. It also affects the flora and faunal biodiversity, all leading to environmental changes including altered flow conditions and groundwater recharge mechanisms. A study in Angola has showed that replanting of vegetation, the construction of sedimentation basins for capturing mining waste, as well as waste water treatment facilities may reduce the environmental impact of mining in the region.

The Okavango Delta in Botswana is one of the most famous wetland systems in the world and is mostly protected, but land use and population growth around the delta impacts on water quality
The SASSCAL research conducted by the Okavango Research Institute provided much-needed monitoring equipment and data to better understand the level of water pollution in the Upper Okavango Delta. The researchers continuously monitored water quality between 2014 and 2017 with physio-chemical parameters. A positive research outcome of acceptable ionic composition shows that wetland systems have thus far been successful in keeping the Delta's water quality at acceptable levels, in spite of the human impact from diversifying land uses in the Upper Okavango Delta.

The Notwane catchment in Botswana was setup as a strategic catchment for water resources in Botswana. Gaborone's water supply is primarily based on water from the Gaborone Dam, which receives its inflow from the Notwane catchment. The continuous water supply to Gaborone and surrounding areas is a concern to water managers, given the variability of rainfall in the catchment and uncontrolled water uptake in tributary areas. It has experienced declining water levels in recent years due to, among others, effects of climate variability and change. Furthermore, there are more than 300 farm dams located upstream of Gaborone dam for which the impact on water flow mechanisms is investigated by the University of Botswana.

In Namibia, where groundwater is considered the major water source, SASSCAL contributed to a better understanding of groundwater dynamics and usage. The Federal Institute for Geosciences and Natural Resources (BGR) focused their research on exploring deep aquifer systems in Namibia in an attempt to improve the responsible use of groundwater resources in this country. The deeper, semi-fossilised systems present a more secure source of water for human use, but studying these is as complex as accessing them for use. With their research, BGR provides valuable insights into the methodology for groundwater prospecting in southern Africa.

UNAM conducted an integrated assessment of the

surface and groundwater quality and quantity in the Cuvelai-Etosha Basin between 2013 and 2017. Hydrological and microbiological sampling and analyses have shown that water quality and quantity in this region is highly variable, both in space and time. Knowledge on recharge conditions and recharge rates are indispensable key parameters for resources management, but only a few methods are applicable in arid environments. The complex interrelation of vegetation, soil structure, microclimate and spatio-temporal heterogeneity were described as main regulators that govern deeper infiltration and net water fluxes. Both studies make practical recommendations for the implementation of corrective measures at a local scale that will improve water security in the region.

Figure 17:Extraction of shallow groundwater by wells with grazing livestock affecting groundwater quality, Cuvelai region, Namibia

In the same area, the Institute for Sociol-Ecological Research adopted a social-ecological perspective on water and food security and assessed the sensitivity of households to drought in the Cuvelai-Basin in Namibia. They conducted structured socio-economic surveys in 2014 and 2015 among 461 households in urban and rural areas to assess seasonal water and food consumption patterns. The study found significant alterations of people's consumption patterns that serve as an entry point for drought sensitivity analyses. These insights contribute to an enhanced decision-base for integrated drought risk management in both countries.

The Hydrology Division in the Ministry of Agriculture, Water and Forestry in Namibia uses a variety of systems for early flood warning and monitoring. These systems include telemetry gauges for rainfall and river levels, weather and rainfall forecasting systems, remote sensing for rainfall and river flow estimations and satellite images for flood mapping and rapid assessments – all combined in empirical flood forecasting. Integrating (EO) technologies and hydrological and hydraulic modelling build the scientific basis for the implemented monitoring and observational systems to determine surface water balances and conduct flood risk and vulnerability mapping in the target basin and floodplains. Results were combined in a scientifically sound flood model for the Cuvelai-Etosha Basin and the Namibian Zambezi floodplains. This was supported by field studies that analysed the target communities' vulnerability to floods caused by the possible impacts of increased climate variability and change. During the rainy season, early warning and flood forecasting information is disseminated through the Daily Flood Bulletin which is provided to more than 600 stakeholders (Fig 18).

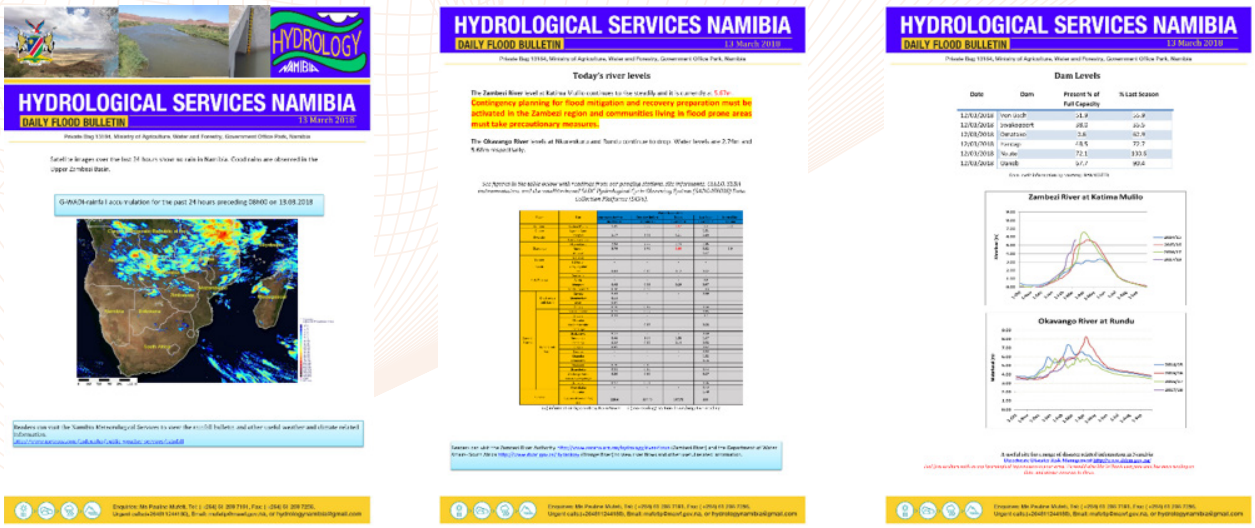


Figure 18: Daily Flood Bulletin of the Hydrology Division, Ministry of Agriculture, Water and Forestry, serving more than 600 subscribers (MAWF, 2018)

The SASSCAL water research in South Africa covers two domains, which were both embedded in the idea of continued hydrological research related to long-term monitoring and advances in methodology to better the prospects of being a living laboratory and enhance the prospects of modelling related to the idea of twinning. The major research locations in South Africa were Cathedral Peak in KwaZulu-Natal Province, Sandspruit, Verlorenvlei and Heuningnes catchments in the Western Cape Province, and lastly, continued monitoring of the Klein-Letaba system in the Limpopo Province. These catchments were chosen primarily because long-term monitoring of some water components is already taking place and because they are located in climatically different regions of the country. Data on climate, streamflow and groundwater depths were collected in the catchments.

University of Stellenbosch studied the complex interaction between recharge rates, salinity and suitability of use of groundwater in the Verlorenvlei area on the West Coast of South Africa. Using groundwater and weather measuring equipment and applying groundwater modelling, the researchers provided an improved understanding of the interdependence of domestic, agricultural and ecological water requirements. The improved understanding of hydrology of the West Coast supports planning for climate change impacts and the lessons from this work will now be applied beyond this area.

Water research in Zambia focused on surface water quality of the upper Zambezi, the resilience of floodplains along the Zambezi River, and the role and economic implications of sedimentation in wetlands and reservoirs in central and southern parts of Zambia. University of Zambia, through SASSCAL, set out to determine the seasonal variation in water quality parameters in the Barotse Floodplain, through which inferences could be made into spatio-temporal variation. Water samples were collected across the floodplain and tested for their physical, bacteriological and chemical characteristics. Sediment samples were tested for their chemical elements. Through the analyses of these samples, the surface water quality and sediments of the Barotse Floodplain were characterised during low and high flows. The researchers found that the floodplain may play a critical role in being a natural sink of some elements, although a high spatio-temporal variability of parameters was observed. It was concluded that the mechanisms and drivers for the variability and varying loads could be attributed to anthropogenic and natural processes. Anthropogenic effects resulting from deforestation and increased agricultural production in the surrounding areas of the floodplains led to high sedimentation and high nutrient loading, low dissolved oxygen and bacteriological contamination of water, especially in settled water courses.

Nyambe et al. (2018) expect that future economic pressures in western Zambia due to population growth and limited resource availability may exacerbate these effects. With their results, the researchers emphasise that ensuring proper management of the floodplain is essential to ensure climate change resilience and thereby protect this system for its economic value. The work was supported by modelling studies undertaken by University of Jena in the Luanginga catchment, which revealed that a decrease in rainfall and higher temperatures cause lower water quantities, resulting in a reduction of flood extent (35%) and duration, and thus, alteration and damage to the highly productive and valuable wetland ecosystem. This research concludes that this will increase risks and vulnerability for the people depending on the flooding pattern in the wetlands.

A second study focused on mapping and quantifying the extent of sedimentation and erosion in Lusaka and southern provinces of the country. This exercise focused on storage capacity of small reservoirs and sedimentation from agricultural fields and its impact on ecosystems and the economy of the agricultural and water sectors at national level. The aim was to approach rural communities to raise awareness regarding sedimentation and the problems that it creates, and to provide guidance on optimised land and farm dam management. The study provided bathymetric surveys and mapped more than 500 farm dams. This is the most thorough inventory of man-made dams and reservoirs in SADC. This research was supported by studies determining sedimentation rates and its effects on four small reservoirs in eastern parts of the Lusaka district. The results showed that reservoir capacity storage losses were in two to three orders of magnitude, indicating how serious sedimentation was on small reservoirs. The study called for dam owners to begin to regularly dredge the deposited sediment, which will increase storage capacity and ensure sustainable use of the water resources in small reservoirs for local communities. The status of sedimentation on small

reservoirs in central Zambia is not different from that in southern parts of the country. SASSCAL research determined concentration levels and the distribution of selected physico-chemical parameters of water in the Makoye reservoir and their implications on livestock. The result was that chemical sedimentation might be detrimental to reservoir water quality but may still be useful to domestic animals given that most analysed chemical and physical parameters were found to be within acceptable limits recommended for livestock watering. Integrating observed data, assessment and modelling tools and an advanced understanding of hydrological systems, allowed some projects to focus on transboundary basin assessments. Research was conducted on the Gabarone Dam Catchment in Botswana and South Africa, the Okavango Basin in Angola, Namibia and Zambia and the Luanginga Catchment in the upper Zambezi River Catchment in Angola and Zambia utilizing advanced modelling techniques, to develop the basin assessment and model hydrological process dynamics in these catchments. Overall, results of this research showed that climate is the dominant driver of change for runoff generation in the investigated basins. Consequently, management actions need to focus on improved water distribution and water-use efficiency.

Biodiversity and Conservation

Southern Africa is rich in biodiversity and this biodiversity provides a significant economic and intrinsic value to the region. Population growth and accelerated climate change, coupled with consequent land use changes and often aggravated by poor land use management practices, are threatening the region's biodiversity.

SASSCAL research therefore addressed the threats to the region's biodiversity and ecosystem processes, by establishing clear baselines of the current states of these systems, by identifying changes to these systems, and by enhancing the understanding of the impacts of climatic challenges on these biodiversity systems that are facing the region. Moreover, SASSCAL research aims at ensuring sound land management processes by facilitating informed decision-making processes.

In order to continually assess and monitor changes to the SASSCAL region's biodiversity, a biodiversity observation network of 47 biodiversity observatories and 10 auxiliary observatories has been established throughout Angola, Namibia, Zambia and South Africa (Fig 19) .

Figure 19: Location of the 57 Biodiversity observatories in the SASSCAL region

Notably, these long-term observations report that some observatories in Namibia and South Africa have already been monitored for between 17 to even up to 30 years , providing invaluable insight into the complexity of these biodiversity systems. In this line, 17 years of research in the Succulent Karoo of the South African Namaqualand landscape demonstrated, to what extent and at what pace the vegetation could recover after long-term pressure from extensive commercial farming. Twenty plots showed a strong division of the species composition between 12 lowland and 8 upland plots . The research further suggested not only a habitat-specific response of vegetation to land use change, but also a plot specific response.

The openly accessible online SASSCAL ObservationNet endeavours to facilitate the sharing of information on research infrastructure and has been developed by the UHH. However, before a biodiversity observatory or any ecosystem can be monitored, and changes to the system can be detected, a baseline inventory of the system has to be established that ascertains the existing species composition, richness and distribution of that area. In spite of historical and early scientific exploration in southern Africa (e.g. Baum 1903; Dinter, 1927; Pole Evans, 1948), the region still hasn't established a holistic overview of its biodiversity status . In this line SASSCAL funded research projects that aimed at establishing biodiversity baselines in fauna and flora, and ensuring the establishment of inventories, with the use of database systems:

- At the NBRI, the BRAHMS database system was established, and some 90.000 herbarium collections were inserted. Extensive data quality control procedures were applied to the data in the system and flora intensity maps were derived.
- Ravaged by centuries of political unrest, very little baseline data is available for Angola. ISCED, in Angola, surveyed around 98% of the Huila province land surface and made this information available to the BiotaBase . In addition, a vegetation map was derived from MODIS data. In Tundavala, in the southern part of the African Great Escarpment, a species list of 13 species of frogs, 12 species of lizards, and 9 species of snakes were recorded. ISCED further ensured the digitisation of historical literature, documents and museums and compiled these with available online resources into zoological databases and catalogues. These collections include 40.000 Ornithological records, 5.000 Meso and Micromammal specimens, 34.600 records on birds, and a mammal collection of almost 4.000 records.
- The BCA created an inventory of all tree, shrub and grass species in the Kweneng, Kgatleng and Central districts of Botswana and consequently derived a distribution map of tree, shrub and grasses of those districts, in addition to producing a field guide of grasses for Botswana.
- The University of Zambia compiled an annoted checklist of cockroaches and termites . Field surveys confirmed 7 cockroach and 2 termite species, where all species of the Blattodea in Zambia are registered as non-evaluated in the IUCN Red List.
- The NNF documented and photographed 49 fish species in Lake Liambezi during the course of their research work, which is speculated to be only half of the total number of fish species known to exist in the neighbouring Upper Zambezi floodplains.

Figure 20: Some of the species identified in Tundavala (Anchieta's treefrog, Ansorge's whip snake and Hoesch's skink)

A number of SASSCAL funded research projects deployed innovative cutting-edge technologies to ensure that they meet their objectives efficiently:

- NUST acquired and deployed the eBEE drone to ensure that the 21 Namibian observatories can be annually monitored.
- The Botswana University of Agriculture and Natural Resources analysed Landsat 8 and Operational Land Imager imagery to derive a vegetation map for Kgatleng district .
- ISCED processed a time-series from 2001 to 2013 of MODIS imagery to derive major vegetation units for Huíla Province .
- The Okavango Research Institute of the University of Botswana developed a detailed vegetation/habitat map of northern Botswana using remote sensing products.

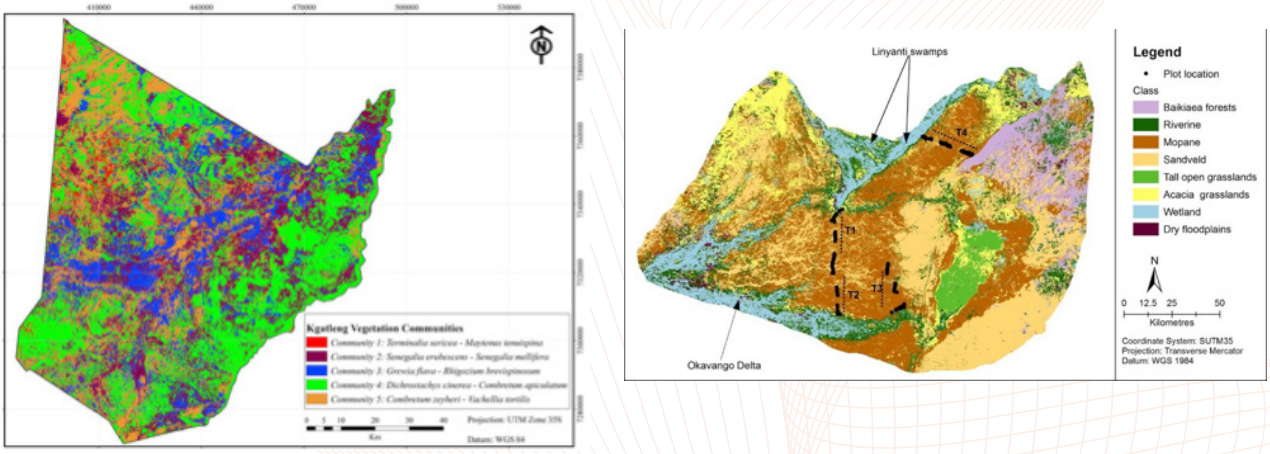


Figure 21: A vegetation map derived for Kgatleng district and the vegetation map of Northern Botswana

Capacity Development

The main capacity development component was embedded in the 88 research projects within the five thematic areas and included training of emerging scientists (at Postdoc, PhD, MSc level) and technical personnel (technicians and other non-academic staff) as well as training on the use of the scientific equipment that is required for the scientific research.

Various capacity development activities focused on developing or expanding existing or new teaching curricula, executing subject-specific workshops (within SASSCAL and/or with stakeholders), training in subject-specific methodologies, jointly supervising student theses (BSc, MSc, PhD, Postdoc) as well as publishing the achieved results. At a non-academic/ technical level, training of technicians was conducted by way of short tailor-made courses at technical training institutions, collaborating governmental departments and NGOs. For example, technical staff of national weather authorities in Zambia, Angola and Botswana were trained in weather monitoring systems and technologies as well as in data management in applying GIS in their daily operations.

SASSCAL 1.0 thus developed capacity at institutional and personal levels. In collaboration with qualified research institutions, SASSCAL developed and accredited the following MSc programmes:

- MSc Geographic Information Systems and Earth Observation (accredited for University of Zambia, Namibia University of Science and Technology, University of Botswana, and Cape Peninsula University),
- Applied and Environmental Geology (collaboration between University of Namibia and the Federal Department for Geosciences and Natural Resources),
- Dryland Forestry at University of Stellenbosch (in cooperation with University of Namibia and University of Botswana), and
- Diploma courses on Meteorology and Climatology as well as on Climate Change awareness at the Zambia Air Services Training institute (approved by TEVETA in 2016).

As a result of the academic training supported by SASSCAL, 153 students graduated within the SASSCAL research projects by the end of 2017. In addition, several postdoctoral students finalised their research projects and significantly contributed to new knowledge generated. Around 270 students were registered with SASSCAL by the end of 2017 (SASSCAL and Non SASSCAL funded). There is evidence that the SASSCAL programmes have a great sustainability potential beyond SASSCAL funding. This is due to the 151 non-SASSCAL-funded students at all graduate levels that were involved in SASSCAL research projects.

TYPE OF STUDENTS	NUMBER OF GRADUATES WITHIN SASSCAL PROJECTS	NUMBER OF REGISTRATIONS	NUMBER OF NON-SASSCAL FUNDED STUDENTS IN PROJECTS	TOTAL NO. OF STUDENTS
BSc Students	53	10	49	112
MSc Students	69	38	55	162
PhD Students	5	42	24	71
Post-Doc Students	-	33	23	56
Total	137	123	151	401

Table 3: Number of Students Involved in SASSCAL Research Projects by End of 2016

Figure 22: Josefina Hamutoko proudly presents her NCRST Award

Figure 23: Paulina Zigelski: best botanical MSc thesis award recipient

The joint supervision of student theses by international mentors and supervisors from the African Countries and Germany is an important component of capacity development. In 2015, 13 jointly supervised Bachelor theses, 21 Master theses and one PhD thesis were completed. 40 PhD students, 77 MSc students as well as 24 BSc students were enrolled at African and German universities in 2015. In 2016, 10 BSc Hons and BSc students, 27 MSc students, and 5 PhD students completed their studies. In 2017, 13 BSc Hons, 9 MSc and 4 PhD students graduated with SASSCAL support. Two students have been awarded special prices in recognition for their outstanding research performance: Ms. Josefina T Hamutoko, PhD student in Task 007, has won the annual Award of the National Commission on Research, Science and Technology (NCRST), Namibia, in the category Best Young Scientist.

- For her MSc thesis "Molecular biogeography of the Syzygium guineense complex: How environment and genetics push suffrutication in Africa's Miombo region" (Task 159) Paulina Zigelski was awarded the prize for the best botanical MSc thesis at UHH in 2016 by the German Botanical Society (DBG). Paulina is now pursuing her PhD studies that look at dwarf shrubs, (geoxylic suffrutices), with massive underground woody structures; commonly known as („underground trees") - Since very little is known about diversity, ecology and evolution of geoxylic suffrutices in the tropical regions of Angola and Zambia, Paulina hopes to get insight into their ecological adaptation and possible forms of competition. By use of a multifaceted approach of genetic, morphological, microclimatic and experimental fire studies, this study may give us some very useful answers to those complex questions on long term adaptation and possible evolution.

SASSCAL also supported exchange programmes to allow researchers to collaborate with other institutions and benefit from these interactions. The UHH supported a DAAD (German Academic Exchange Service) application of a PhD candidate from Zambia for a research visit to analyse data sets in Hamburg. The Federal Institute for Geosciences and Natural Resources (BGR) enabled a PhD student from the University of Namibia (UNAM) to attend a two-month laboratory internship at BGR. With support from the United Nations Development Programme (UNDP), twelve additional students were included in the first year of the new diploma course in Meteorology.

Figure 24: The launch of the SASSCAL-sponsored Master of Geoinformation Science and Earth Observation in Zambia

SASSCAL Alumin

To ensure SASSCAL researchers are nurtured, SASSCAL will establish an engaged, and supportive alumni network. Some of the SASSCAL supported students are pictured below.

Training Events

To facilitate the exchange of knowledge within the SASSCAL community, a number of specialised training workshops and training events were conducted in 2016 and 2017. Special training opportunities for students or staff members in the fields of operating technical meteorological and hydrological equipment, data handling and processing, climate and water assessment, advanced remote sensing techniques, data processing and conservation farming measures help to further develop capacity within the SASSCAL countries.

Recognising the limited research infrastructure in SASSCAL countries and the urgent need to strengthen the southern African research capacities, investment in research infrastructure was another success of SASSCAL 1.0. This infrastructure and equipment include greenhouse laboratories (e.g. at ISCED-Huila, Lubango, Mulungushi University, Zambia), experimental research sites, herbariums and gene banks (e.g. ISCED-Huila, Lubango) as well as a substantial weather observation infrastructure. In addition, the procurement of IT infrastructure (hard- and software) as well as field- and transport equipment was supported in most of research projects in SASSCAL 1.0.

Training	Trainer	participants	Venue	Dates	Number of participants
Weather appreciation training for high school students	Zambia Air Services Training Institute	High school students	ZASTI, Lusaka, Zambia.	6 sessions per year since January 2014 and ongoing	960
Quality seed production	Seed Control and Certification Institute (SCCI) and Zambia Agricultural Research Institute (ZARI)	Rufunsa District, Zambia.	Local farmers	15 - 16 July 2014	16
Quality seed production	SCCI and ZARI	Shibuyunji District, Zambia.	Local farmers	22 - 23 July 2014	15
Bathymetric Survey Using Coden Remote Controlled Hydrographic Boat	CODEN Manufacturer, Japan.	Task 109 staff	University of Zambia, Lusaka, Zambia.	20 September 2014	20
Community sensitisation on key drivers of deforestation and forest degradation	Centre for Environmental Research, Education and Development (CERED)	Local Communities	Chirundu, Siavonga, Livingstone, Kazungula, Mwandi, Sesheke and Mumbwa districts	September 2014 to October 2015	320
Training workshop in hyperspectral remote sensing	South African National Space Agency	National Remote Sensing Centre, University of Zambia and Zambia Agricultural Research Institute staff	National Remote Sensing Centre, Lusaka, Zambia.	25-27 November 2014	9
Diploma in Climatology	ZASTI	In-service and direct entry students	ZASTI, Lusaka	January 2015 to December 2017	20
Data Collection	Zambia Community Based Natural Resource Management Forum	Department of National Parks and Wildlife community scouts	Mumbwa, Zambia	15-30 February 2015	20

Grass-root community training-Beekeeping technologies Sharing workshop	Mulungushi University	Bee Keepers from Central Province	Mulungushi University, Kabwe, Zambia.	30 May 2015	40
Data Collection	Zambia Community Based Natural Resource Management Forum	The Nature Conservancy (TNC) community scouts	Mulobezi, Zambia	10-25 June 2015	30
Questionnaire and interview administration	Department of National Parks and Wildlife	Enumerators from within the Lumimba Game Management Area	Lumimba Game Management Area, Zambia.	12-24 June 2015	30
Grassroot community training - beekeepers stakeholders workshop	Mulungushi University	Bee Keepers from Central Province	Mulungushi University, Kabwe, Zambia.	19 June 2015	40
Certificate in Para-ecology and Certificate in Community Based Natural Resource Management	Zambia Forestry College	Community members from GMAs around project sites	Zambia Forestry College, Kitwe	1 January to 30 December 2016	40
SASSCAL Short Course Regional Climate Change Assessment and Uncertainty Analysis	GERICS, CSIR, University of Zambia, CSAG/ UCT and Stellenbosch University	Technical staff and scientists from SASSCAL partner countries	University of Zambia, Lusaka, Zambia.	19-22 April 2016	17
SASSCAL Short Course Hydrological Modelling with JAMS/J2000	Friedrich Schiller university of Jena	Technical staff and scientists from SASSCAL partner countries	University of Zambia, Lusaka, Zambia	25-29 April 2016.	
Advanced hydrological data processing and modelling	University of Jena, University of Zambia,	Staff at University of Zambia	University of Zambia, Lusaka	25 to 28 April 2016	
Forest resource assessment as a tool for preparing management plans	BUAN	Chobe Enclave communities and of the Makomoto Woodland Management Trust	Kavimba, Botswana	28 April 2016	15
MOMS training workshop	University of Botswana	Kgetsi ya Tsie-women organisation	Lerala, Botswana	17-18 May 2016	23

Regional Science Workshop (contributing to the development of the SASSCAL 2.0 Science Plan)	SASSCAL	Windhoek, Namibia	27 institutions, 9 universities and 5 government institutions,3 members from the SASSCAL Governing Board and 2 members from the SASSCAL Scientific Advisory Committee, as well as the Director of WASCAL	21-23 June 2016	
Data Management	DMS	Technicians-DMS	Gaborone, Botswana	July 2016	6
Advanced Climsoft and Data management	Institute for Meteorological Training and Research (IMTR)	Department of Meteorological Services (DMS)	Botswana	August 2016	2
Graduate Supervision	UB UNZA UKZN	Early career researchers	Johannesburg,	October 2016	10
Post-graduate Training Workshop	University of Botswana	Students from Universities in South Africa and Botswana	Johannesburg	17 – 20 November 2016	10
Laboratory technician's training	Zambia Bureau of Standards (ZABS)	Mulungushi University Laboratory Technicians	ZABS, Lusaka, Zambia.	Spread across 2016	2
Capacity building workshop (cultivation, food processing and the marketing of foods developed from climate smart indigenous veldt products)	BUAN	farmers and small & medium enterprises	Kaudwane, Botswana	9-10 February 2017	152
Leadership & Group dynamics	BUAN	Community Based Organisations, Conservation Committee members and Extension Workers from Agriculture and Forestry department	Kavimba, Botswana	13-17 February 2017	15

Climate modelling and assessing large climate data sets for climate change assessments	GERICS,CSIR, University of Zambia, CSAG/ UCT and Stellenbosch University	Botswana and South African SASSCAL staff, CSIR SASSCAL PhD/ Post doc students, BITRI staff and University of KwaZulu Natal PhD students	Stellenbosch	20-24 February 2017	14
Manuscript Writing	University of Zambia (UNZA), University of Botswana (UB) and University of KwaZulu-Natal (UKZN)	Graduate students	Francistown, Botswana	Feb 2017	23
Capacity building workshops (cultivation, food processing and the marketing of foods developed from climate smart indigenous veldt products)	BUAN	farmers and small & medium enterprises	Malwelwe	16-17 March 2017	118
Fire Management	Forestry Department	Local community members	Sesheke, Zambia	13-16 April 2017	38
Theory and applications of 'Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES)	Okavango Research Institute and Botswana International University of Science and Technology	Department of Water Affairs, Water Utilities Corporation, BCL mine, Department of Waste Management and Okavango Research Institute.	Maun, Botswana	22-23 May 2017	17
OADC Strategic planning	SASSCAL	Johannesburg, South Africa	All OADC staff and SASSCAL management	22-24 May 2017	6
Capacity building workshop (cultivation, food processing and the marketing of foods developed from climate smart indigenous veldt products)	BUAN	farmers and small & medium enterprises	Shaikarawe, Botswana	6-7 July 2017	152
Training workshop on data analysis for ecologists in R	University of Hamburg	Copperbelt University and Department of National Parks and Wildlife Researchers and staff	Copperbelt University, Kitwe, Zambia	10 - 25 July 2017	13

Management Oriented Monitoring System (MOMS training workshop)	D.G. Ecological Consulting, Namibia	Department of Wildlife & National Parks (DWNP) District Botswana Wildlife Training Institute (BWTI)	Maun, Botswana	11-12 July 2017	40
Fire Management	Forestry Department	Local community members	Kaoma, Zambia	3-7 November 2017	42
Interconnecting Cisco Network Devices (ICND) Part	IT-IQ Botswana	Department of Meteorological Services	Gaborone, Botswana	20-24 November 2017	6
Sustainable Utilisation and value addition of tree resources	BUAN	Chobe Enclave communities and of the Makomoto Woodland Management	Gaborone, Botswana	27 Nov - 1 December 2017	15
Graduate Thesis Writing Workshop	UB UNZA UKZN	Graduate students	Gaborone, Botswana	December 2017	50
Review the current operational status of the SASSCAL WeatherNet, and further, to develop a strategy for its long-term sustainability	SASSCAL	Windhoek, Namibia	representatives from the meteorological services of all SASSCAL member countries, collaborating regional and German universities and institutions	4-6 April	30
Using the easy-to-use regional climate model EasyREMO in combination with an introduction to climate model data analyses and regional climate change assessment	GERICS, Germany	Regional Secretariat, Windhoek Windhoek, Namibia	SASSCAL students and scientists	24-27 October	9 participants from Angola, Botswana, Namibia and Zambia
Data collection and processing		Various municipalities	Botswana	2 days	24
Introduction to R software	UHH & Copperbelt University	Ecologists from Task 189 Department of National Parks and Wildlife, Zambia	Copperbelt University,	2 days	
Agrometeorology and climate change training workshop	ZASTI	Department of Agriculture and related institutions	ZASTI, Lusaka		20
Weather observers' refresher course	ZASTI	Zambia Meteorological Department (ZMD) and aviation staff	ZASTI, Lusaka		20

Installation repair and maintenance of automatic weather stations (AWS)	ADCON, Austria	ZMD staff	ZMD, Lusaka, Zambia		5
Data digitisation	IEDRO	ZMD staff	ZMD, Lusaka, Zambia		10
Planning and construction of farm dams	NUST	Farmers and extension workers	Farm Krumhuk, Namibia		30
Distribution of reptiles, amphibians and small mammals on 4 different fire regime areas based on standardised pitfall traps on the Namibian Waterberg Plateau	UHH and NUST		Namibia		20
AWS programming, sensors, data format and transmission	Campbell Scientific, South Africa	DMS technical staff, Botswana	DMS, Botswana	3 days	10
Training on how to divert rain water off-farm roads and use cattle to trample down gully heads	NUST	Rangeland Management students,	Farm Krumhuk, Namibia		28
ArcView	UB		Botswana		16
Identification of Poaceae	NBRI		Namibia		
Identification of hymenoptera			ISED-Angola		
Photogrammetry and advanced remote sensing techniques, on ERDAS IMAGINE software		Staff at the Hydrology Division MAWF	Namibia		
Flash Flood Forecasting (EF5)		Staff at the Hydrology MAWF	Namibia		
QGIS		staff of the NBRI	Windhoek		
collection and handling of small vertebrate specimen	UHH and ISCED		Angola		
Citizen science techniques	Zambia CBNRM Forum	Local stakeholders	Zambia		
Inoculant use that proved to increase yields		Rundu, Namibia			

Training events in pictures

Figure 25: Participants at a Climate Modelling workshop in Lusaka

Figure 26: Dr Iain Darbyshire demonstrating dissection of Acan-thaceae flowers to WIND staff at the NBRI , Foto: Erin Tripp

Figure 27: Students being trained in the field on the Waterberg Plateau in Namibia

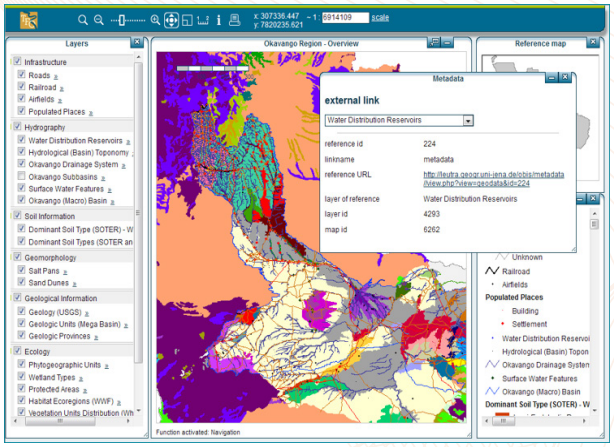
Figure 28: NUST_students_construct_a_suspended_filter_at_Krumhuk

Figure 29: Participants of the Regional Science Workshop in Windhoek

Services and Products

The OADC aims to address data, services and information needs for innovative and effective solutions that inform decision making processes. The OADC is a data hub for archiving, assimilating, documenting, safeguarding and finally making available the deliverables produced by the SASSCAL 1.0 portfolio.

Operating as a data custodian for the SASSCAL-funded research activities, the OADC provides scientifically verified, harmonised and quality-controlled information, data and products that constitute the basis for the development of reliable, demand-oriented services and products. Since the start of SASSCAL, various services and products were implemented through the OADC.



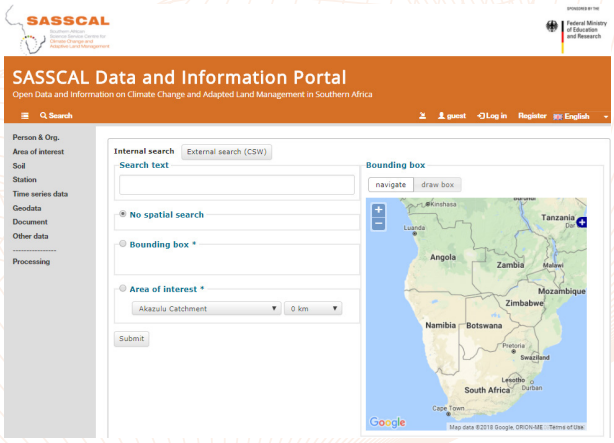


Figure 30: Information data portal

The SASSCAL service flagship is the WeatherNet that has been established to increase climate data availability for the SASSCAL countries. It has been developed in a collaborative effort from national weather authorities, cooperating data providers and researchers under the leadership of UHH. The SASSCAL WeatherNet provides easy and open access to climate information for over 150 Automatic Weather Stations for southern Africa. Information about climate variables like rainfall, air and soil temperature, wind speed and direction, solar radiation among others is provided. There are currently more than 150 active weather stations on WeatherNet. The SASSCAL WeatherNet provides near real-time weather data, as well as:

- hourly, daily and monthly values
- Continuous time series, partly from 2010
- Export functionality as MS EXCEL files.

SASSCAL 1.0 research contributed to the provision of services and decision support at local, national and regional level. Besides the data and service provision through the OADC, SASSCAL has developed data sets, tools and services that are either fully implemented or under consideration as prototypes. All these products serve the region with reliable and scientifically sound data and information.

Resulting from the studies undertaken within the SASSCAL research portfolio, various services and products were developed and implemented during the first phase of SASSCAL:

- the Plant Photo Guide providing ecological and environmental information on species within the southern African region,
- the SASSCAL Information System (SASSCAL-IS) providing more than 650 data sets of hydrological relevance for the region,
- a prototype dashboard providing the public with data and information relevant to agriculture
- ObservationNet providing information on 45 long-term biodiversity observatories established in the region,
- a RainfallApp for rainfall data collection from participating partners, and
- the GeoTool for online visualisation and analysis of geodata.

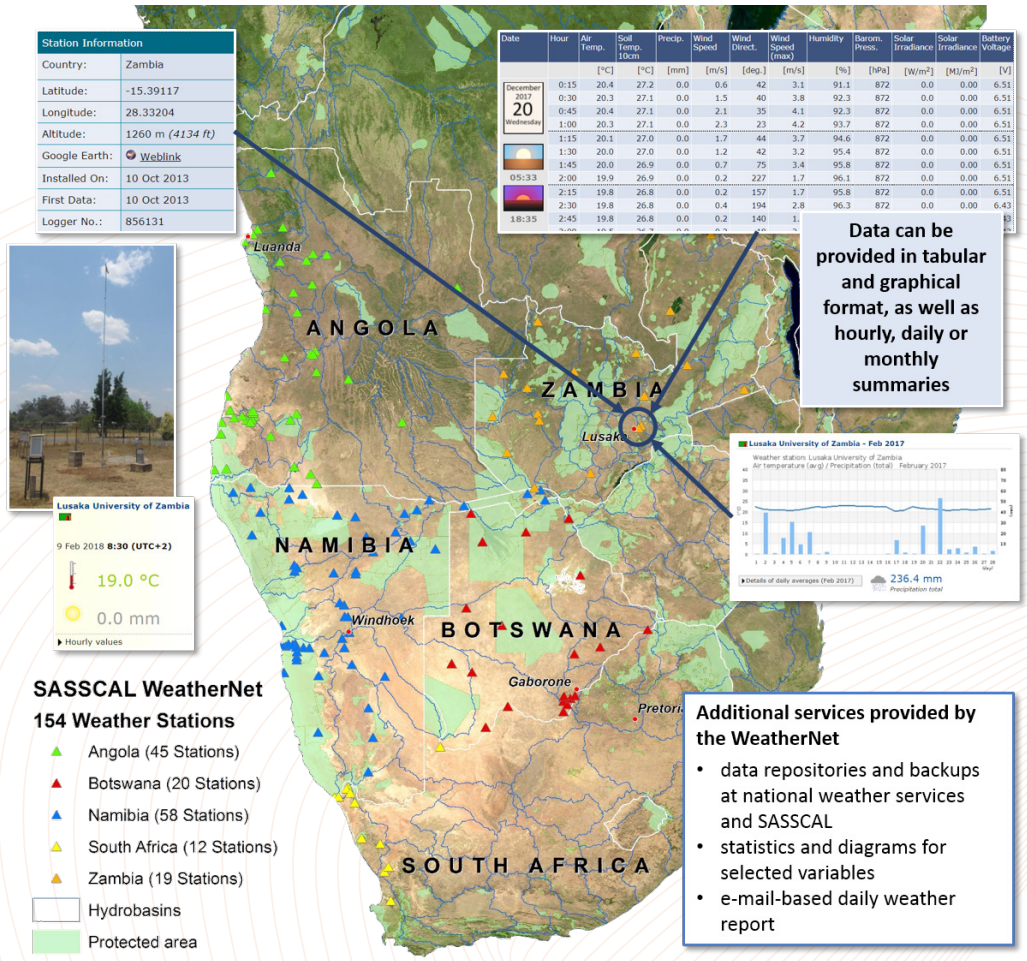


Figure 31: Distribution of AWS

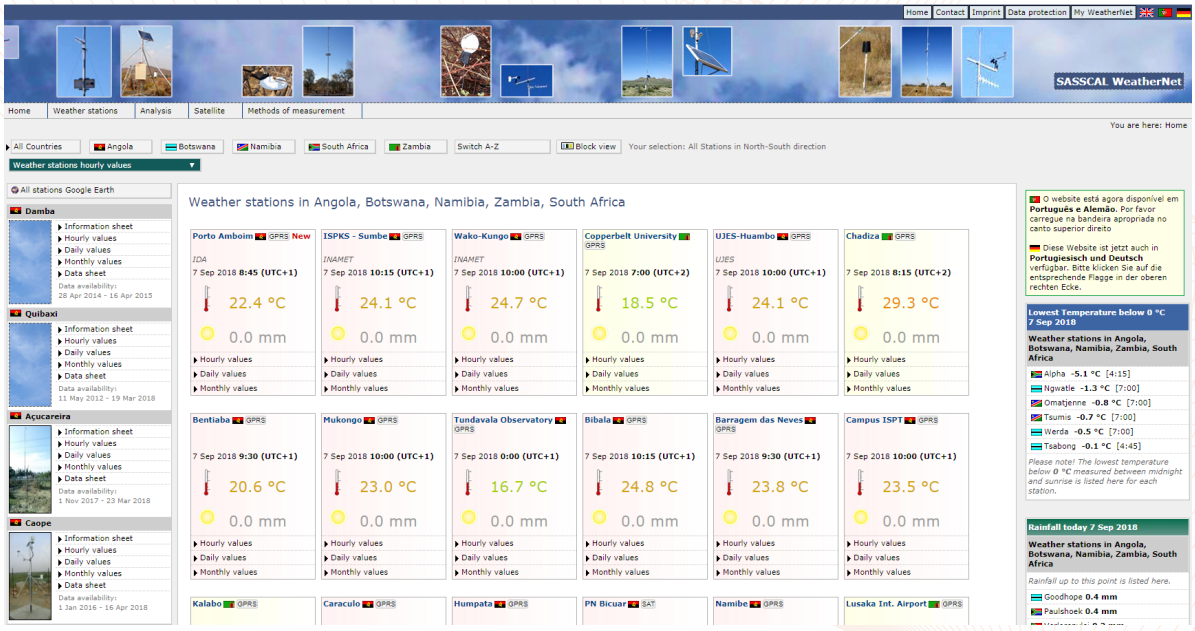


Figure 32: Some of the data captured by AWS

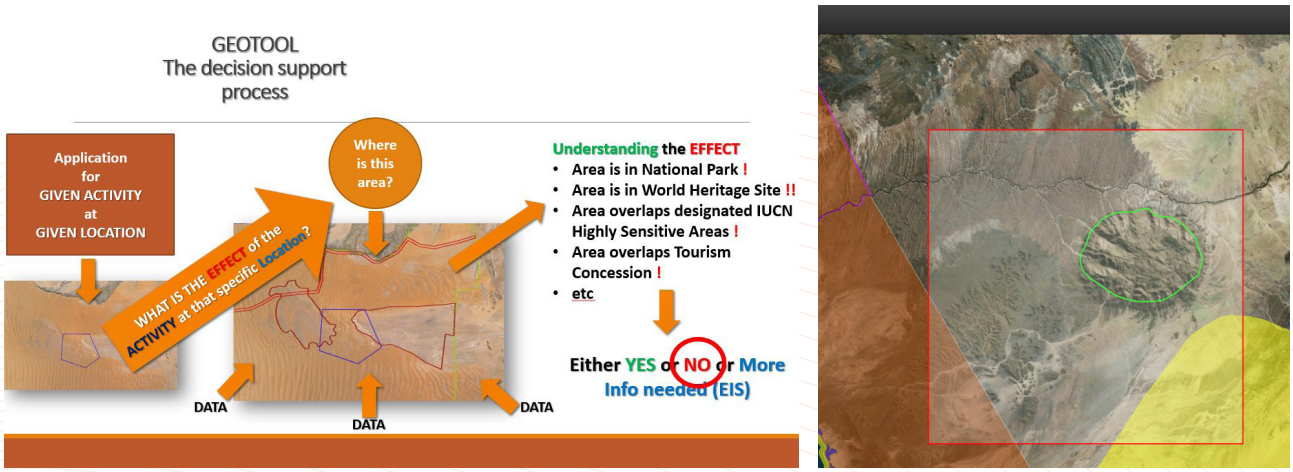


Figure 33: Screenshot from Geotool

For decision support, SASSCAL researchers drafted a significant number of reports and management plans that are provided to the respective decision-making authorities. For example, the Zambia Wildlife Authority completed a management plan for land use options with regard to the reduction of conflict between anthropogenesis use and fauna for the Lumimba Game Management Area. It was based on a survey of 120 households in the research area. The management plan has been submitted for review to the Zambia Wildlife Authority (ZAWA) and presented the plan to the Ministry for Tourism and Arts.

Global Partnerships

SASSCAL acknowledges the importance of global partnerships and external parties for joint actions for mutually beneficial actions and purposes. These hinge on relationships where all parties contribute to the output and the achievement of the objectives rather than a solely financial relationship. Our partnerships have been coiled in a spirit of common understanding, accountability and equality, requiring mutual respect and transparency irrespective of size and power. In pursuit of our goal of being an international organization we are have established and continue to pursue strong, lasting and mutually beneficial partnerships.

Our partnerships have strengthened and enhanced our innovation capabilities through knowledge exchange for the promotion and production of products for decision making. Global partnerships assist in unlocking some strategic funding opportunities through collaborative project funding pursuits. Selected partnerships are described below:

1. Supporting EU-African Cooperation on Research Infrastructures for Food Security and Greenhouse Gas Observations (SEACRIFOG)

<table>
<tr><td rowspan="2">Supporting EU-African Cooperation on Research Infrastructures for Food Security and Greenhouse Gas Observations (SEACRIFOG) Project Partners: Thünen-Institute of Climate-Smart Agriculture; SASSCAL; Euro-Mediterranean Center on Climate Change (CMCC); Integrated Carbon Observation System (ICOS ERIC); International Livestock Research Institute (ILRI); University of the Witwatersrand; Trinity College Dublin; South African Environmental Observation Network (SAEON); Geomar Helmholtz Centre for Ocean Research Kiel; Leibniz Institute for Tropospheric Research; University of Bergen; Uni Research; CzechGlobe; Lund University; Cape Verde National Fisheries Development Institute; West African Science Center on Climate Change and Adapted Land Use (WASCAL)</td><td>Greenhouse Gas Observation & Climate-Smart Agriculture

Project Period: March 2017 – February 2020
Funded by: European Union (EU) Horizon 2020 Research and Innovation Programme</td></tr>
<tr><td>The objective of theSEACRIFOG project is to design a pan-African observation network for greenhouse gases and food security.</td></tr>
<tr><td rowspan="2">SASSCAL is contributing to the SEACRIFOG project through various tasks which provide fundamental information for the appropriate design of a tailored network. In a first step, SASSCAL leads the identification of a set of essential variables to be observed in the context of SEACRIFOG. Building on the resulting variable set, SASSCAL then carries out an assessment of the status quo in terms of relevant observational infrastructure and data products across the continent in order to assess corresponding opportunities, gaps and needs. This work will feed into the detailed design and costing of an appropriate network of research infrastructures.</td><td>The objective of theSEACRIFOG project is to design a pan-African observation network for greenhouse gases and food security.</td></tr>
<tr><td>SASSCAL is developing an Excel-based tool (Fig 34) to integrate the various project tasks and capture and visualize corresponding information in order to collate and integrate information on existing GHG-related observation in the African continent.</td></tr>
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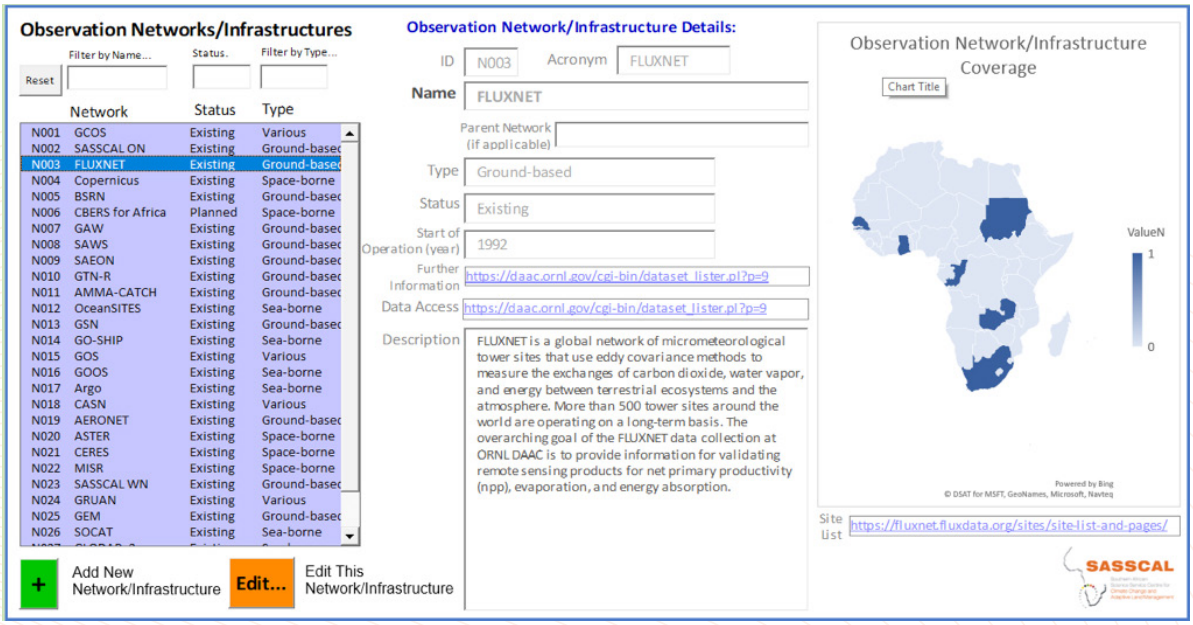


Figure 34: Screenshot of the Excel-based inventory tool to capture information in line with SEACRIFOG developed by SASSCAL in 2017

2. SASSCAL-Miombo collaborating Project

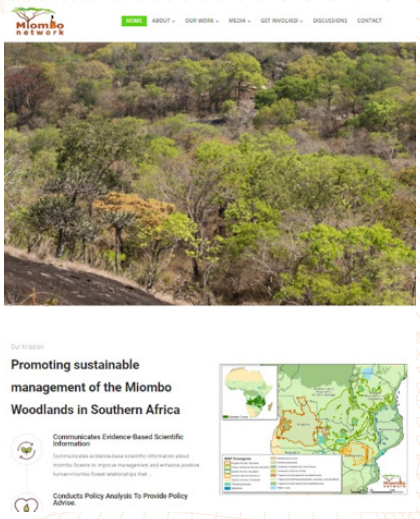


Figure 35: Miombo network policy briefs cover

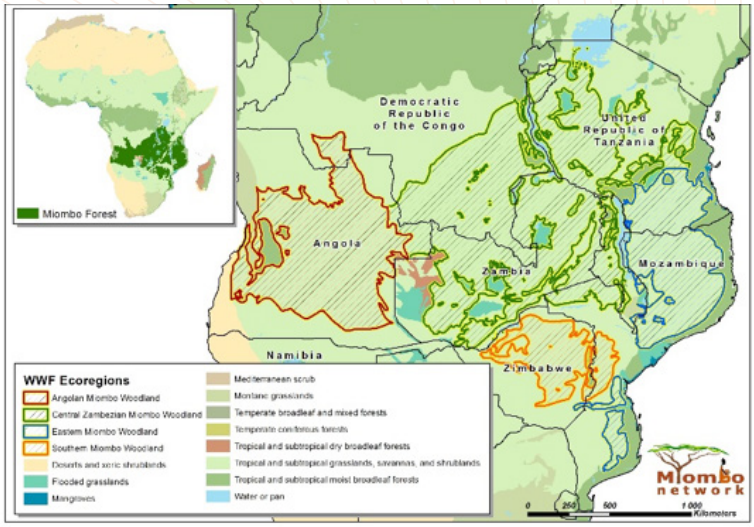


Figure 36: Map of the Miombo Ecoregion

Miombo Network
Project Partner: Miombo Network
Project Period: 2017 - 2018
Funded by: World Bank

In the context of the MoU that SASSCAL signed with the Miombo Network and with support from World Bank, SASSCAL provides the Miombo Network with technical support in strengthening the institutional structure, dissemination and outreach. In this line, SASSCAL has created a Miombo Network website (http://miombonetwork.org/) and has furthermore supported the group by creating a Miombo Network logo, a Miombo woodlands map with the associated data set, and by providing the layout, formatting and graphic components of two policy briefs.

Figure37: Miombo network policy briefs cover

Policy Briefs "Land use planning: a tool to minimize the environment and social impacts of agricultural expansion in southern Africa" and "Promoting sustainable timber harvesting in Miombo through improved silviculture"

3. Extreme Climate Index Visualization Tool

Extreme Climate Index Visualization Tool	**Project Partners:** SASSCAL, Council for Science and Industrial Research (CSIR), Africa Risk Capacity (ARC) / Extreme Climate Facility (XCF) **Project Period:** April 2017 – June 2018 **Funded by:** Africa Risk Capacity
SASSCAL designed, implemented, hosts and deploys an online tool (prototype link: http://ecidemo.sasscal.org) to be used in disseminating information and provide data visualizations for the Extreme Climate Indices for the African continent, calculated by CSIR. . The tool is meant to support the current efforts of Africa Risk Capacity in spreading awareness about their Extreme Climate Facility financial mechanism. The tool was developed for the entire continent Africa region and will therefore strengthen SASSCAL as a service and product provider of useful science backed knowledge products in the climate change related decision-making field. The platform is in the final internal testing phase with contributions by stakeholders from CSIR, SASSCAL and ARC/ XCF. The 1st public testing is due in August 2018.	

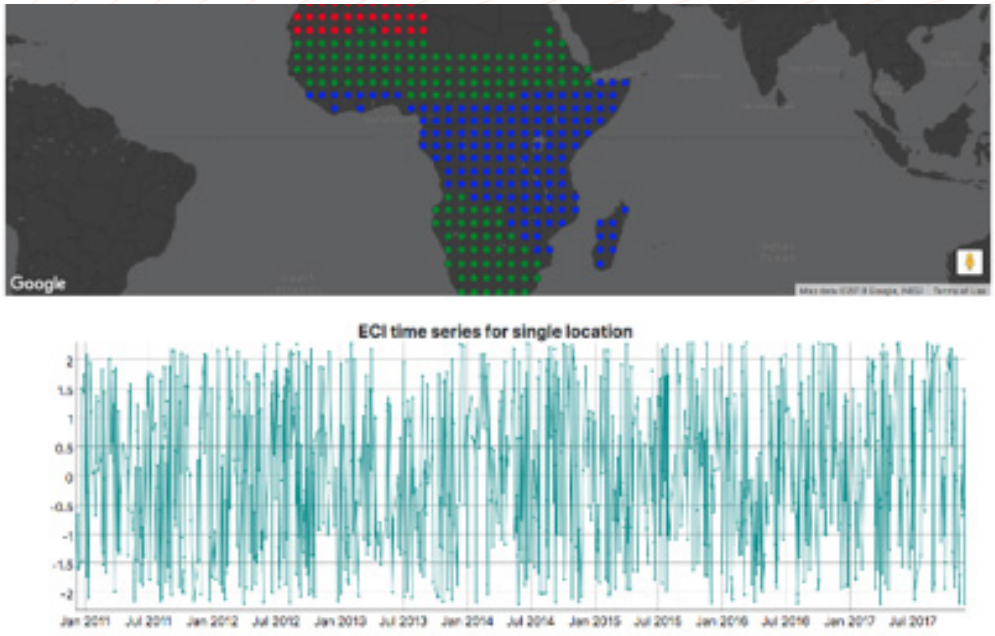


Figure38: An online visualization platform that enables stakeholders to view Extreme Climate Index data.

Figure39: Presentation of the continental ECI and linked records

4. WeMAST - Wetland Monitoring and Assessment Service for Transboundary Basins in Southern Africa

WeMAST - Wetland Monitoring and Assessment Service for Transboundary Basins in Southern Africa Project Period: July 2018 – June 2021 Funded by: GMES Africa (AU and EU)	Project Partners: University of Botswana; University of Western Cape, South Africa; South African National Space Agency; University of Zambia; Midlands State University, Zimbabwe; National Remote Sensing Centre, Zambia
The service component will be designed as a 3-tier-architecture with data collated at SASSCAL and SANSA, services jointly designed to address stakeholder needs and accessed through the webportal (Fig 39).	

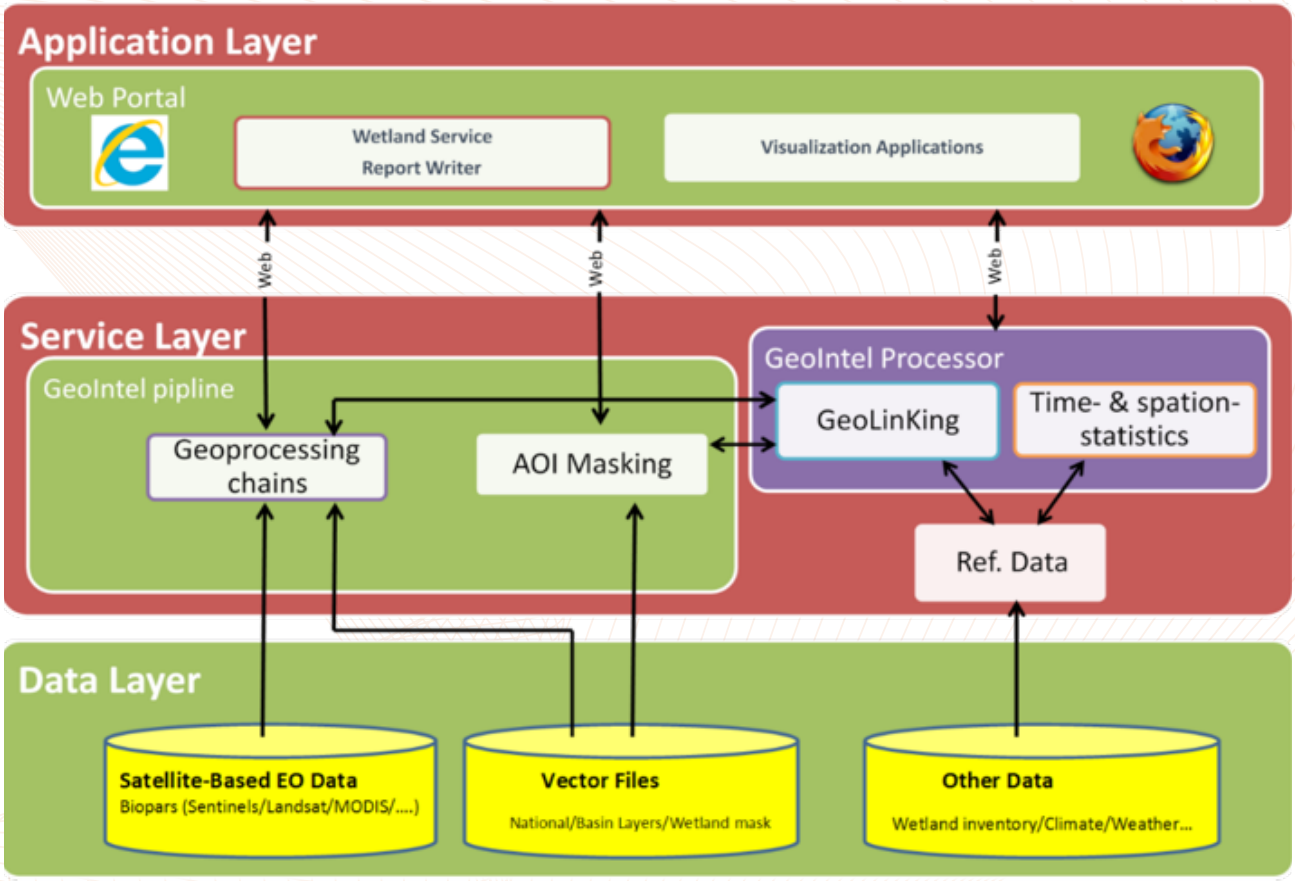


Figure 40: WeMAST Service Architecture

Finance

2016 Financial report

STATEMENT OF INCOME AND PAYMENTS FOR THE PERIOD ENDED 31 DECEMBER 2016

	NOTES	2016	2015
INCOME		**€**	**€**
From KfW		3,716,592	2,519,614
Exchange gain on translation		0	
Total Income		**3,716,592**	**2,519,614**
PAYMENTS			
Personnel Cost		1,141,566	677,530
Travel & Subsistence		93,530	102,738
Workshops & Meetings		131,749	114,277
Board Meetings		51,577	60,617
Consumables		21,797	23,163
Services & Utilities		208,045 1	68,814
Rent & Rates		117,027	160,557
Training & Capacity Development		1,736	3,065
Landscaping		347	0
Furniture & Equipment		8,306	62,855
Transport		61,154	265,615
Hardware & Software		13,144	47,599
Bank Charges		11,762	7,229
Administration Fees		80,089	26,884
Research		2,740,712	0
Total Expenditure		**4,682,541**	**1,720,943**
Deficit/Excess of Income over expenditure		**-965,949**	**798,671**

2017 Financial report

SOUTHERN AFRICAN SCIENCE SERVICE CENTRE FOR CLIMATE CHANGE AND ADAPTIVE LAND MANAGEMENT (SASSCAL)

STATEMENT OF INCOME RECEIPTS AND PAYMENTS FOR THE PERIOD ENDED 31 DECEMBER 2017

	NOTES	2017	2016
INCOME		€	€
From KfW		4,051,984	3,716,592
Exchange gain on translation		0	0
Total Income		**4,051,984**	**3,716,592**
PAYMENTS			
Personnel Cost		1,193,766	1,141,566
Travel & Subsistence		45,610	93,530
Workshops & Meetings		107,746	131,749
Board Meetings		37,084	51,577
Consumables		19,942	21,797
Services & Utilities		155,544	208,045
Rent & Rates		101,863	117,027
Training & Capacity Development		23,548	1,736
Landscaping		0	347
Furniture & Equipment		3,495	8,306
Transport		-13,871	61,154
Hardware & Software		7,937	13,144
Bank Charges		12,383	11,762
Administration Fees		54,164	80,089
Research		1,160,620	2,740,712
Total Expenditure		**2,909,831**	**4,682,541**
Deficit/Excess of Income over expenditure		**1,142,152**	**-965,949**

SASSCAL in 2016

1st quarter 2016

Jan 2016
Dr Henry Mwima is the Executive Director of SASSCAL

Jan 2016
SASSCAL offers GIS Training for Conservation and Wildlife Resource Management

Feb 2016
SASSCAL OADC Technical Strategy Meeting in Gaborone

Feb & Mar 2016
3 Applied Geology courses handed over to UNAM

Apr 2016
SASSCAL Short Course on Climate & Water, Lusaka

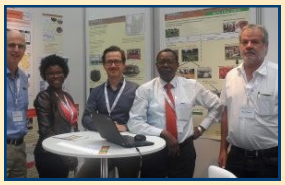
Mar 2016
SASSCAL offers GIS Training for Hydrologists

2nd quarter 2016

May 2016
SASSCAL launches its first SASSCAL Newsletter

May 2016
OADC GIS Training/ Workshop

May 2016
Adaptation Futures 2016, Rotterdam



May 2016
SASSCAL in Botswana holds National Thematic Workshops

May 2016
SASSCAL Angola awarded GBIF grant

Jun 2016
SASSCAL appoints Director of Science & Technology, Dr Jörg Helmschrot

Jun 2016
SASSCAL offers GIS Training for Water Resource Managers

Jun 2016
SASSCAL Regional Science & Capacity Development and Service Brokerage Workshops

3rd quarter 2016

Jul 2016
Dr Yonah Seleti starts as Acting Executive Director of SASSCAL

Jul 2016
SASSCAL offers GIS Training for Vegetation Mapping

Jul 2016
Namibia National Node hosts Namibia Land Management Dashboard

Sep 2016
SASSCAL Zambia End-of-Task Workshop

Sep 2016
SASSCAL ED visits Zambia

Sep 2016
SASSCAL 2.0 Strategy is drafted

Sep 2016
SASSCAL funded student Josefina Hamutoko wins Young Scientist of the Year Award

4th quarter 2016

Nov 2016
Launch of Master in EO & RS in Namibia with first 14 students receiving scholarships

Nov 2016
BMBF field visit to Namibia

Nov 2016
SASSCAL ED visits Angola

Nov 2016
SASSCAL launches new SASSCAL Website

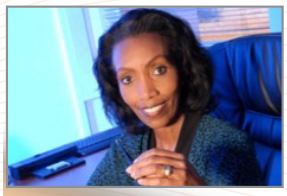
Dec 2016
SASSCAL WeatherNet is presented at the Southern Africa Regional Climate Services Workshop

Dec 2016
SASSCAL is awarded Science Forum South Africa Science Diplomacy Award for 2016

SASSCAL in 2017

1st quarter 2017

Jan 2017
Dr Jane Olwoch joins SASSCAL as the new Executive Director



Jan 2017
SASSCAL participates in Tree Planting in Zambia

Feb 2017
Regional climate change assessment and impact analysis workshop, Stellenbosch

Feb 2017
Scientific Workshop on Vegetation Mapping & Monitoring of Biodiversity, Zambia

Feb 2017
SASSCAL @ 2016/17 National Tree Planting launch of ZAMBIA

Feb 2017
SASSCAL at the Fifth International Conference on Climate Services (ICCS5)

Mar 2017
SASSCAL @ International Council for Science (ICSU) Meeting, Lusaka

2nd quarter 2017

Apr 2017
SASSCAL Agriculture Workshop

Apr 2017
SASSCAL WeatherNet Workshop, Windhoek

May 2017
SASSCAL OADC Workshop, Jo'burg

May 2017
Regional Stakeholder Coordination Workshop on the delivery of Weather, Water and Climate Services in Africa

May & Jun 2017
SASSCAL/WASCAL Workshops

Jun 2017
International Symposium on Remote Sensing of the Environment (ISRSE-37)

Jun 2017
6th Zambia Water Forum and Exhibition

3rd quarter 2017

Jul 2017
SASSCAL & UNDP sign MoU

Jul 2017
NUST presents SASSCAL Projects Information

Jul 2017
SASSCAL Information Sharing Session: European Climate Diplomacy Week

Jul 2017
MSc UNZA Launch

Aug 2017
SASSCAL at Zambia Agricultural Show

Aug 2017
Mulungushi University in Zambia hosts SASSCAL

Sep 2017
SASSCAL at Windhoek Industrial and Agricultural Show

Sep 2017
Participation at AMCOMET Africa Hydromet Forum

4th quarter 2017

Oct 2017
International Climate Change Conference, Windhoek

Oct 2017
Regional climate model EasyREMO Training

Nov 2017
SASSCAL & WASCAL World Café at COP23, Bonn

Nov 2017
SASSCAL & Miombo Network sign MoU

Nov 2017
SASSCAL awarded at GMES & Africa Award

Nov 2017
SASSCAL Data Portal Workshop

Dec 2017
SASSCAL @South African Science Forum

Notes

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

Annual Report 2016 and 2017

Compiled by: SASSCAL Team

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