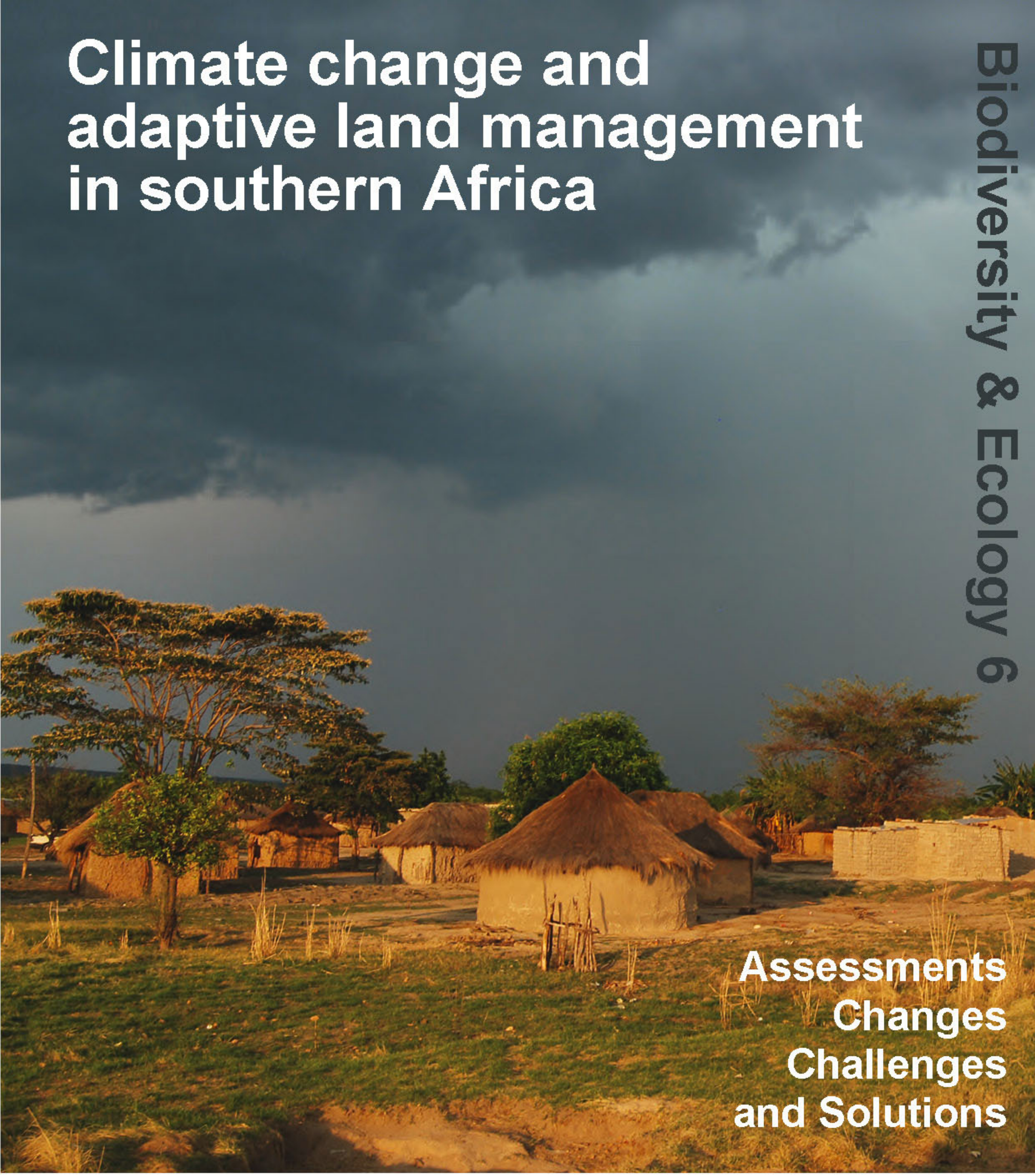
Climate change and adaptive land management in southern Africa

Biodiversity & Ecology 6



Assessments
Changes
Challenges
and Solutions

Product of the first research portfolio of

SASSCAL 2012–2018

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

SPONSORED BY THE

Federal Ministry
of Education
and Research

Klaus Hess Publishers
Göttingen & Windhoek
www.k-hess-verlag.de

ISBN: 978-3-933117-95-3 (Germany), 978-99916-57-43-1 (Namibia)

Language editing: Will Simonson (Cambridge), and Proofreading Pal
Translation of abstracts to Portuguese: Ana Filipa Guerra Silva Gomes da Piedade
Page desing & layout: Marit Arnold, Klaus A. Hess, Ria Henning-Lohmann
Cover photographs:
front: Thunderstorm approaching a village on the Angolan Central Plateau (Rasmus Revermann)
back: Fire in the miombo woodlands, Zambia (David Parduhn)
Cover Design: Ria Henning-Lohmann

ISSN 1613-9801

Printed in Germany

Suggestion for citations:
Volume:
Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J. & Jürgens, N. (eds.) (2018) Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions. *Biodiversity & Ecology*, **6**, Klaus Hess Publishers, Göttingen & Windhoek.

Articles (example):
Archer, E., Engelbrecht, F., Hänsler, A., Landman, W., Tadross, M. & Helmschrot, J. (2018) Seasonal prediction and regional climate projections for southern Africa. In: *Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions* (ed. by Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J. & Jürgens, N.), pp. 14–21, *Biodiversity & Ecology*, **6**, Klaus Hess Publishers, Göttingen & Windhoek.

Corrections brought to our attention will be published at the following location:
http://www.biodiversity-plants.de/biodivers_ecol/biodivers_ecol.php

Biodiversity & Ecology

Journal of the Division Biodiversity, Evolution and Ecology of Plants,
Institute for Plant Science and Microbiology, University of Hamburg

Volume 6:

Climate change and adaptive land management in southern Africa

Assessments, changes, challenges, and solutions

Edited by

Rasmus Revermann[1], Kristin M. Krewenka[1], Ute Schmiedel[1],
Jane M. Olwoch[2], Jörg Helmschrot[2,3], Norbert Jürgens[1]

1 Institute for Plant Science and Microbiology, University of Hamburg
2 Southern African Science Service Centre for Climate Change and Adaptive Land Management
3 Department of Soil Science, Faculty of AgriSciences, Stellenbosch University

Hamburg 2018

Please cite the article as follows:

Revermann, R. (2018) About the book: An introduction. In: *Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions* (ed. by Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J. & Jürgens, N.), pp. 8-10, *Biodiversity & Ecology*, **6**, Klaus Hess Publishers, Göttingen & Windhoek. doi:10.7809/b-e.00294

About the book: An introduction

Dr Rasmus Revermann

This book showcases research results obtained during the SASSCAL research portfolio 1.0 from the years 2012–2018. It offers assessments of the region's values and resources, gives information on the direction and intensity of environmental changes, and evaluates the risks and challenges involved. Further, it proposes pathways towards improved management tools and instruments for climate change adaptation and sustainable land management.

The SASSCAL Research Portfolio 1.0

The scoping process organised during the initial phase of SASSCAL was a large bottom-up, participatory process. It brought together a very wide range of stakeholders from all involved countries: Angola, Botswana, Germany, Namibia, South Africa, and Zambia. The aim was to create a robust joint vision of the most important research needs and to identify achievable research approaches within a regionally integrated portfolio. Interestingly, all African countries involved developed similar views regarding the most important needs and demands, in part based on pre-existing National Development Plans. The most important decision was to unpack what began initially as three main thematic areas—'Climate', 'Water', and 'Land'—into the final five thematic areas: 'Climate', 'Water', 'Forestry', 'Agriculture', and 'Biodiversity'. At the same time, almost all countries voted for a broad call for bottom-up proposals from local research institutions. This initiated a team spirit among the researchers involved that still guides and supports the activities today.

The book structure

Some of the fruits of this five-year-long journey are presented in this book. It is structured according to thematic key areas. To allow a deeper exploration of these huge thematic complexes, the five thematic areas of SASSCAL have been arranged in eight thematic chapters: 1. Climate, 2. Water resources, 3. Risk management, 4. Rangelands, 5. Food security, 6. Forest resources, 7. Land cover dynamics, and 8. Biodiversity. The first article of each chapter introduces the topic, gives an overview of recent findings in the respective areas, and defines common concepts. The subsequent articles present original research findings of the SASSCAL tasks. Infoboxes add to this by providing summaries of certain aspects or by presenting newly developed (software) tools or databases, amongst other supplements.

We hope to present a book that offers scientific information for a wide audience and that is also useful for both interested stakeholders and scientists from other disciplines. As such, the articles do not focus on details of the applied methodology, but instead concentrate on the relevant outcomes. However, references to more detailed descriptions of how the studies were done or how the data were analysed are provided. In order to ensure high scientific quality, all articles underwent a peer-review process in which all articles were checked by two experts in the field. This iterative process clearly improved both the clarity and quality of the submitted papers.

The content of the book

Long term monitoring and data availability

Research on climate change and adaptive land management requires a strong data foundation to come to scientifically sound conclusions, upon which recommendations for management can be based. However, in many areas, appropriate data is scarce or unavailable, or the necessary lengths of time series are not given. Thus, various tasks addressed these shortcomings in the different thematic areas. As such, a huge success of the first years of SASSCAL was the implementation of the SASSCAL WeatherNet, involving the installation, maintenance, and online database creation of 154 automatic weather stations [1.6]; how the newly gathered data can be used for improved water management is illustrated in [1.8] and various other studies make use of climate data produced by the WeatherNet. The scope of the activities in the thematic area 'Climate' also included reactivating and archiving historic climate data [1.1]. Looking a step ahead, the new SEACRIFROG initiative is presented [1.7], which will embed SASSCAL initiatives in the global research context on climate change. For an excellent review of how climate change may affect southern Africa, refer to the overview article climate [1.0].

Similarly to climate change studies, research on biodiversity also requires long time series to monitor changes and the factors inducing these changes. This need led to the establishment of a network of biodiversity observatories that has become a crucial research infrastructure [8.0]. The network has been continued and expanded in SASSCAL 1.0. and data on the 57 Biodiversity Observatories can be found online in the SASSCAL ObservationNet [8.7]. Article [8.8] provides very detailed insight into the temporal changes of the vegetation at the Soebatsfontein Observatory based on 17 years of annual monitoring and nicely illustrates the value of long-term ecological time series data. In [8.6], first insights into the functioning of the social-ecological systems of the newly established Cameia National Park Observatory are presented. An important function of SASSCAL for the future will be the storage of data and making data sets available for future research in the SASSCAL Information and Data Portal [2.7].

Water quantity and quality above and below ground

The recent water crisis in southern Africa has made the general population very aware of the immense value of water. The overview article [2.0] nicely summarises the activities carried out in the thematic area 'Water' and highlights perspectives for better management. Similarly, the subsequent article [2.1] reviews the activities dealing with groundwater research in southern Africa and focuses particularly on the inspiring discovery of semi-fossil, deep aquifers in northern Namibia and southern Angola. Following up on this topic, [2.2] provides an in-depth analysis of water quality and the available water sources on the local level in the Cuvelai-Etosha Basin. In the same region, the vulnerability to drought on the household level was investigated [3.5]. Studies on water quality were also carried out in wetland ecosystems that remain rather pristine: the Barotse floodplain in Zambia [2.5] and the Okavango Delta [2.6]. These studies collected baseline data to monitor potential impacts of developments in the upper reaches of each region. Examples of how hydrological modelling tools can be used to provide support for management decisions are given in the studies presented in [2.4] and [2.8].

Management risks

A conceptual approach to risk management and the corresponding terminology are provided in the overview article, [3.0]. The subsequent articles deal with different phenomena related to 'risks', such as floods and droughts [3.1]; present an index for extreme climate events [3.2]; and investigate presumably inactive gully systems in the Swartland region of South Africa [3.3]. A topic often overlooked, with hardly any scientific coverage, is the impact of mining in remote northeast Angola. The study presented in [3.4] mapped the impacts of both artisanal and industrial mining activities in the border region to the Democratic Republic of Congo, spotlighting their dramatic effects on the ecosystems.

Providing food and maintaining ecosystem services

In most parts of southern Africa, smallholders are the backbone of food security. However, yields are often far below the land's potential and in some cases are even declining [5.0]. The agriculture tasks in the SASSCAL 1.0 research portfolio have explored new and sometimes unconventional ways of closing the yield gap, such as using rhizobia as biofertilizer [5.3] or making use of legumes for intercropping [5.4]. Similarly, wild legumes have been analysed for their forage quality and their potential is discussed as supplementary foods in rangelands for times when other available food sources for herbivores are not available [4.2, 4.3 and 4.5]. To aid adaptation to increasing droughts and shortened growing seasons due to climate change, germplasm of landraces of maize and cowpea has been evaluated [5.5] and drought-resistant varieties were identified [5.6]. The conflict between land use and wild animals is examined in a Game Management Area in eastern Zambia and solutions on the farm level discussed [5.2]. As pointed out in article [5.7], a holistic approach to landscape management is needed to reconcile food security on the one side and conservation needs on the other.

In the rangelands of the semi-arid areas of southern Africa, bush encroachment and erosion are severe problems affecting large areas, negatively impacting the carrying capacity for wild and domestic herbivores [4.0 and 4.7]. The study in [4.1] presents a long time series of monitoring soil water content in cleared and bush encroached sites. The authors are able to show the differences in ground water recharge which is negatively related to the woody cover above ground. In [4.8] the authors give food for thought on how rangelands can be rehabilitated using simple methods requiring landscape literacy and material available in the surrounding area.

Fire

Disaster and tool at the same time, fire is an omnipresent feature of many landscapes in southern Africa and can have a profound impact on ecosystems. Various studies presented in the book address this topic. The impact of fire on small mammal communities is investigated in the Busanga Swamps in Zambia [8.10]; [6.5] examines its effect on the structure and composition of the Baikiaea woodlands. A study of different fire treatments on the Waterberg analyses the impacts on various organismic groups such as insects, large herbivores, and plants, as well as on soil properties [4.6]. In the overview article on land cover dynamics, the observation of spatial and temporal fire patterns using satellite imagery is discussed [7.0].

Woodland ecosystems and their usage

The more mesic parts of southern Africa—appearing mainly in the countries of Angola and Zambia, but also the northern parts of Namibia and Botswana and, to some extent, in northeastern South Africa—are covered by dry tropical forests and woodlands [6.0]. While they provide livelihoods and important ecosystem services to a large population, deforestation and forest degradation due to charcoal production [7.2] and agricultural expansion [6.2] is advancing. The conversion of woodlands to agricultural area leads to a reduction of organic carbon and nutrients in the soil [5.1].

The dry tropical forest and woodland biomes have received much less attention in scientific studies than the tropical rainforests. Forest inventories are indispensable for understanding these woodland ecosystems. Based on data recorded on vegetation plots and in forest inventories, the spatial patterns of above-ground biomass and its environmental drivers were investigated [6.1]. Furthermore, the 'Biodiversity' chapter presents two studies investigating spatial patterns of vegetation composition, one in the Katleng District, Botswana [8.3], and the other in Huíla Province, Angola [8.5].

Moreover, the 'Forest Resources' chapter has much to offer on how to better manage woodland resources. As such, the impact of fire on woodlands is discussed [6.5] and findings are presented on how native tree species, including several of interest as timber species, can be propagated [6.3]. An economic analysis on the return from forest farm lots is provided [6.6], showing that these can be economical even on marginal sites. A good example of how to integrate perspectives from very different disciplines is presented in article [6.2], in which the authors combine ground-based anthropological studies with remote sensing data and discuss perceptions of deforestation in Zambia.

The bird's eye perspective

The chapter 'Land Cover Dynamics' will be of interest to many scientists and stakeholders alike; here, authors with different disciplinary backgrounds showcase how remote sensing technology can be used to monitor social-ecological systems and to detect occurring changes. The overview [7.0] presents analyses based on the full Landsat archive for the SASSCAL region and showcases several applications based on other types of satellite imagery—a great source of inspiration for researchers from all disciplines. In the following articles, the use of new techniques is presented and used to illustrate how they can facilitate monitoring of woodlands in the future: airborne LiDAR data can be combined with satellite imagery to estimate woody cover of large areas [7.1], and unmanned aerial vehicles (UAVs) can aid very detailed analysis of woodland cover and structure on the local scale [7.4 and 7.5].

Biodiversity

Southern Africa harbours an enormous diversity—much of it still barely documented. Within SASSCAL, several studies aimed at closing this knowledge gap. While [8.1] documented the herpetofauna at one particular area on the Angolan escarpment, finding new species never documented in the country before, [8.2] compiled a comprehensive checklist of the cockroach and termite species to be found in Zambia. The concluding article of the book, [8.11], tells the story of Lake Liambezi and its rise and fall as a hub of fish diversity and fisheries. Subsequent years of high rainfall led to the filling of the lake and gave rise to large fish stocks. However, as the waters receded a few years later, both fish populations and, consequently, the fisheries collapsed again. The detailed observations allowed the authors to derive concrete recommendations for better management for the next time Lake Liambezi starts to refill.

Capacity development

Finally, we have two contributions that illustrate a very important pillar of the SASSCAL approach: capacity development. In two short contributions, two newly established master's courses at universities in the SASSCAL region are presented, filling important gaps in the academic curricula: one on dryland forestry [6.4] and the other on remote sensing [7.3].

Further reading

Obviously, not all outcomes of such a large initiative such as SASSCAL can fit in one volume. Thus, we included a 'further reading' section at the end of the book where information regarding further studies produced by SASSCAL, many of them freely available online, can be found. This section also contains a list of the numerous theses that have been completed in the context of SASSCAL.