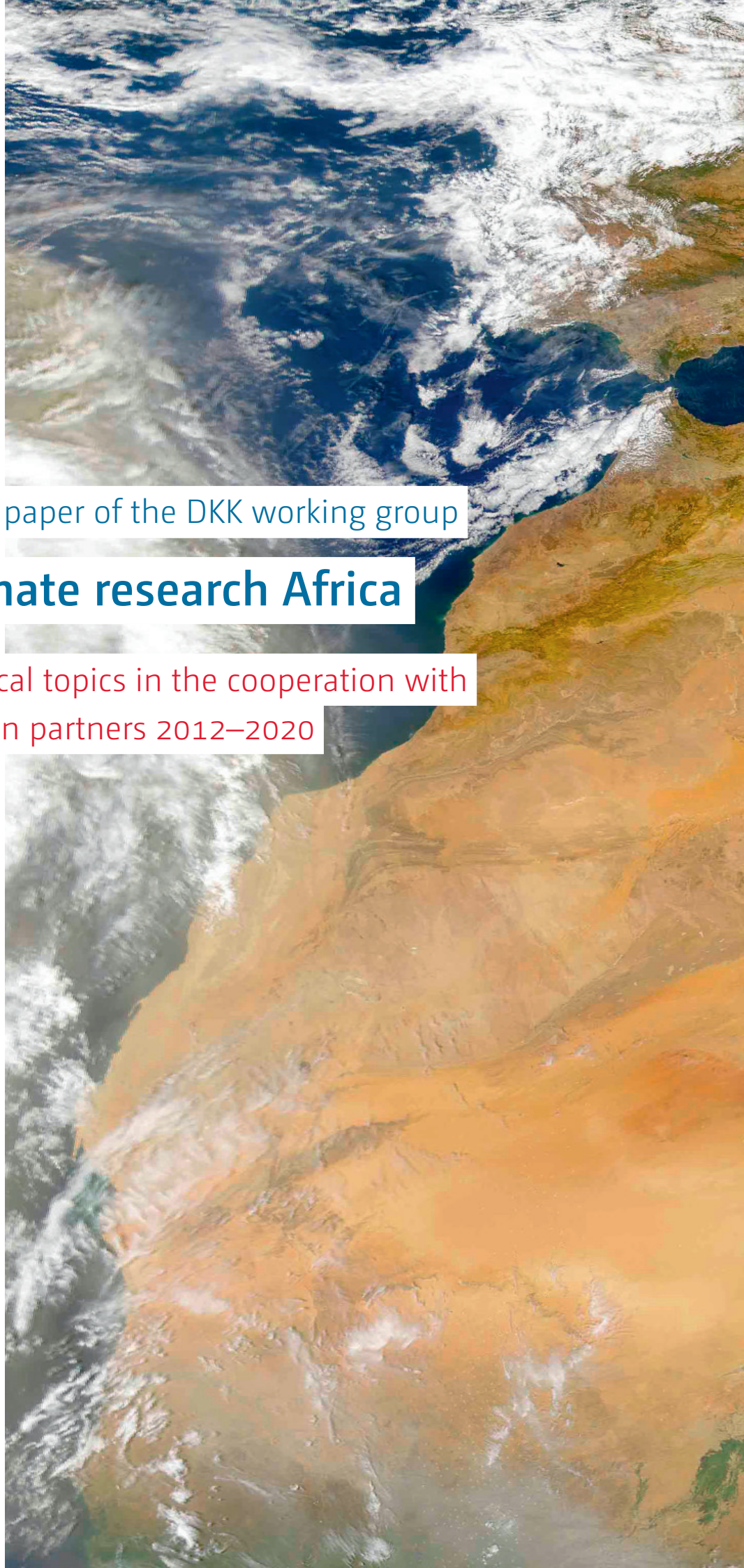
Deutsches Klima Konsortium



Issue paper of the DKK working group

Climate research Africa

on focal topics in the cooperation with African partners 2012–2020

Index

The German Climate Consortium aims to concentrate the competence of German institutes working in the field of climate and climate impact research

This issue paper provides a summary of perspectives in German climate research to assist in the thematic design of partner research and capacity programmes in cooperation with African countries. Since the beginning of 2011, climate scientists regularly convene in Berlin for an exchange of ideas. Through presentations and workshops participants discuss how German interdisciplinary climate research in collaboration with African partners can contribute to the development of climate protection and adaptation measures and capacities.

Berlin, September 2011

Tanja Fröhlich
DKK Managing Director

I. Introduction

Twenty-two research institutes and one association are part of the DKK working group on Africa. The group aims to support important and promising research initiatives in African countries through cooperation. We consider collaboration with Africa partners a particular responsibility, as the continent contributes least to greenhouse gas emissions yet will bear the greatest burden of their impact.

Knowledge about local climate change impacts in African countries is a precondition for developing adaptation and climate protection strategies. Also, the research results are of practical relevance for Germany. Besides advancing the understanding of global climate change and its impacts on Germany, the issues of security of supply, migration, and potential markets for German products are also important. Knowledge transfers in both directions can help strengthen sustainable cooperation. As well as a high level of expertise in different areas, German climate research has high interdisciplinary potential and many years of experience in the cooperation with African partners.

The basis for our recommendations of thematic focal points is given by national and international agreements and priorities. They are in particular the various initiatives of the German government, together with 'Africa's Science and Technology Consolidated Plan of Action' of the African Union, the 'Climate Change and Natural Resource Management Programme' of NEAP (New Partnership for Africa's Development) and the shared Africa-EU strategy. This issue paper, however, is the result of intensive consultation with our African research partners, their important local expertise as well as shared practical experience in the field.

The themes in this paper are developed on the following guiding principles:

- **Research that does justice to the climate change agenda and specifically to the African but also German interests.**
- **Cooperative support for the development and extension of human capacity in science and research.**
- **Cooperative support in the development and extension of long-term funding of local infrastructure / support for infrastructure.**
- **Transparency in the activities of German climate science both internally and externally.**

II. Summary of recommendations for research and research funding/support

Our recommendations to promote African-German cooperation are subdivided into four thematic topics for climate and climate impact research in Africa.

Topic 1
Feedbacks and tele-connections in the Earth system

This includes fundamental research on the earth-atmosphere system, results of which are the basis for climate impact research.

Further need for research

- **Improvement of our ability to forecast the climate in Africa on seasonal, decadal and longer time scales (climate models) considering the broad spectrum of regional characteristics and the ocean dynamics in the climate system.**
- **Reduction of the uncertainties in the knowledge of the dynamics of the Atlantic Ocean and the upwelling of nutrient-rich water to improve the understanding of the marine ecosystem.**
- **Improvement of our understanding of the changing water cycle and its impact on water availability, human health, and the security of the food supply.**
- **More intense research on extreme weather phenomena in Africa to counteract the impact of flooding and dry periods.**
- **Improvement of our understanding of the interaction between climate change, land use, coupled carbon and nitrogen cycles, mineral dust aerosol, and combustion of biomass.**

Topic 2
Climate change and human habitat

Climate impacts cannot be analysed without considering the complex interactions with other factors such as demography, urbanisation and economic markets. Thus, this topic includes the Global Change, adaptation to climate change and climate protection.

Further need for research

- **Research is needed on land use dynamics, urbanisation, adaptation of farming and agriculture and adaptation of infrastructures and**
- **in regard to regional potential and resources for climate protection.**
- **Interdisciplinary and cooperative research is needed to establish adaptation and climate protection strategies.**

The research approach should be broad enough to involve inclusion of regional data on climate change impacts as well as to enable a comprehensive analysis of socio-economic, legal, technological as well as institutional profiles of a region and its interaction on national and international levels using the same research frame.

Studies of this sort will support the establishment of strategies which help to improve the adaptation to climate change impacts, to enhance efficient use of resources and to protect the climate.

Topic 3
Development of databases and methods

Parallel to research there is a need for the development and extension of research structures. Central components are more extensive databases and methods. The focus should be on the userorientated applications.

Further need for research/structural adaptation

Thus, the main tasks relevant to all areas of climate and climate impact research mentioned in this issue paper are:

- **support in defining data structures and formats and in the digital long-term archiving and creation or extension of necessary structures;**
- **the digitisation of data only available on paper;**
- **the linking of in situ observations with the relevant satellite data and the derivation of information for the databases;**
- **the organisation and implementation of field campaigns and transfer of the information to the databases;**
- **carrying out regional 'Ensemble calculations' of climate models, the interpretation of their results and the storage in databases.**

Topic 4
Human capacity, infrastructure, knowledge transfer

Cooperation in the development and extension of 'human capacities, infrastructure and knowledge transfer' aims at supporting African countries in the further development of the knowledge base in order to strenghten the shaping of the future under conditions of climate change.

Further need for structural adaption

Requirements for structural adaption in the fields of human capacity, infrastructure and knowledge transfer include:

- **support of education and further training for scientists in climate and climate impact research and training of specialist staff and technicians, e.g. in the field of application-oriented research;**
- **the establishment of research groups;**
- **the establishment of graduate schools;**
- **practical assistance in data management;**
- **the establishment of an additional Regional Science Service Centre on Climate and Land use (RSSC) in East Africa additional to the existing ones in Southern and Western Africa;**
- **the establishment of a South-North network in climate and climate impact research;**
- **the establishment and further development of the observational infrastructure for climate-relevant data;**
- **the establishment and support of farms for agricultural training and research and of sustainable aqua-/mariculture facilities;**
- **exchange and cooperation with African partners to promote enhanced public awareness of climate research and its results.**

III. Thematic focal points

There are four complementary topics. In the following, the related research needs are described in detail.

Topic 1

Feedbacks and tele-connections in the Earth system

The IPCC expects that the 21st century warming of the African continent will be more rapid than the global mean, with the strongest warming in the subtropics. The rapid growth of the population, the disproportionately severe land degradation as well as water and air pollution will make the ecosystems of African countries vulnerable to the effects of climate change. There is thus a need to improve climate forecasting for Africa on seasonal, decadal and longer time scales.

Feedbacks and tele-connections in the Earth system: Consequences for the semi-arid regions

As the oceans warm, enhanced evaporation and moisture transport may strengthen the monsoon rainfall, whereas the arid subtropical regions will likely become dryer. The tropical rain belt is expected to expand, although the consequences for the semi-arid regions remain, however, unclear.

Monsoon dynamics and the Sahel

The African monsoon is directly coupled with the ocean circulation and its evaporation fluxes. These are strongly influenced by the surface temperature of the tropical Atlantic Ocean and the temperature gradient between the Central and Northern Atlantic Ocean. Additionally, the (anthropogenic) aerosol transport to the ocean affects this temperature gradient.

Changes in the monsoon such as the onset and the duration of the rainy season are of essential importance for the agriculture. The need in research is in terms of possible feedbacks between climate change, mobilisation of the Saharan mineral dust aerosols, the monsoon dynamics, and the drying of the Sahel zone.

Land-atmosphere-ocean interactions

The IPCC expects that the climate change will cause a pole-ward migration of the jet streams. In view of the importance of the Indian and Atlantic Ocean circulations and their connections with the Pacific Ocean as part of the global oceanic circulation, coupled atmosphere-ocean models must be improved.

More reliable forecasts of the dynamics of the Atlantic Ocean and the upwelling of nutrient-rich water during climate change can improve the understanding of the impact on fisheries and the entire marine ecosystem.

Trends of the drying of temperate and subtropical regions of Africa are connected with the soil moisture and dynamics of the vegetation. If surface water reservoirs are reduced, the cooling due to evaporation will decrease as well. This can contribute to acceleration of warming and to a prolongation of heat extremes. An improved forecasting of the changing water cycle is of importance for the water availability, flooding, dry periods, human health, and the security of the food supply.

Improvements of the climate models are necessary to predict the impact of changes in temperature and precipitation on terrestrial ecosystems in the semi-arid regions of Africa (➥ cf. topic 3). Furthermore, since there is often no empirical basis of measurements, the observational infrastructure needs to be extended (➥ cf. topic 4).

Biogeochemical cycles and air pollution

The deforestation in sub-Sahara Africa has been enormous in the past decades. The reason for this has been the increasing demand for firewood of a growing population and the worldwide demand for hardwood. In some regions, the tropical rainforests and the afforested savannas have already disappeared. The largest existing rainforest is in the Congo River basin where deforestation rates are high. The loss of biodiversity and the degradation of the carbon reservoir add to rising CO_2 emissions. For the Amazon basin, it has been shown that links exist between forests, water budgets and regional climate. Such studies are also needed for Africa to evaluate any relationships with climate change. Forest fires in Africa constitute the largest emissions of gaseous and particulate air pollutants in the world. Furthermore, while the use of mineral fertilizers in some regions influences the crop yield positively, it is also an important intervention in the coupled carbon and nitrogen cycles.

Africa is also the largest source of desert dust in the world, most of it coming from the Sahara. The mineral dust is rich in nitrogen, iron, and phosphorus. The total amount of the desert dust aerosol is sufficient to influence the climate through cooling of the lower and warming of the upper part of the atmosphere. Furthermore, biomass burning as well as mineral dust emissions significantly reduce the regional air quality.

Further need for research

- **Improvement of our ability to forecast the climate in Africa on seasonal, decadal and longer time scales (climate models) considering the broad spectrum of regional characteristics and the ocean dynamics in the climate system.**
- **Reduction of the uncertainties in the knowledge of the dynamics of the Atlantic Ocean and the upwelling of nutrient-rich water to improve the understanding of the marine ecosystem.**
- **Improvement of our understanding of the changing water cycle and its impact on the water availability, human health, and the security of the food supply.**
- **More intense research of extreme weather phenomena in Africa to counteract the impact of flooding and dry periods.**
- **Improvement of our understanding of the interactions between climate change, land use, coupled carbon and nitrogen cycles, mineral dust aerosol, and combustion of biomass.**

Topic 2

Climate Change and human habitat

Climate change is one of the main drivers for future changes in the African human habitat, particularly due to its impact on available resources. Furthermore, demography, urbanisation and globalisation processes need to be considered in possible climate change mitigation approaches, as they determine the utilisation of land and other resources that are major causes of emissions.

To assess the main drivers and their interaction with principal sources of emissions, as well as the adaptability of the human habitat to climate change, integrative research approaches are essential.

Determinants of land use dynamics

It is common knowledge that climate change, demographic trends as well as increasing urbanisation and market globalisation are and will be crucial for land-use changes in the future Africa. However, specific and precise knowledge about impacts and changes of these factors at regional scale is still lacking. In the context of the market economy this would e.g. be represented by volatility of prices for agricultural products or changes in food production and consumption patterns.

Furthermore, analyses to differentiate the influence of management and climate change on ecosystem services such as soil fertility are still missing.

In order to reduce Africa's contribution to climate change and to introduce adequate adaptation activities in time, the focus of future research activities should be on closing the listed knowledge gaps.

Agricultural production from small-scale farmers is in this context an important factor as they represent the majority of African population. Agriculture is still the major income sector as, despite increasing urbanisation, the majority of the population still lives in rural areas.

The future behaviour of rural dwellers and their adaptability to changing conditions results in different land-use trends and therefore different approaches to tackle climate change.

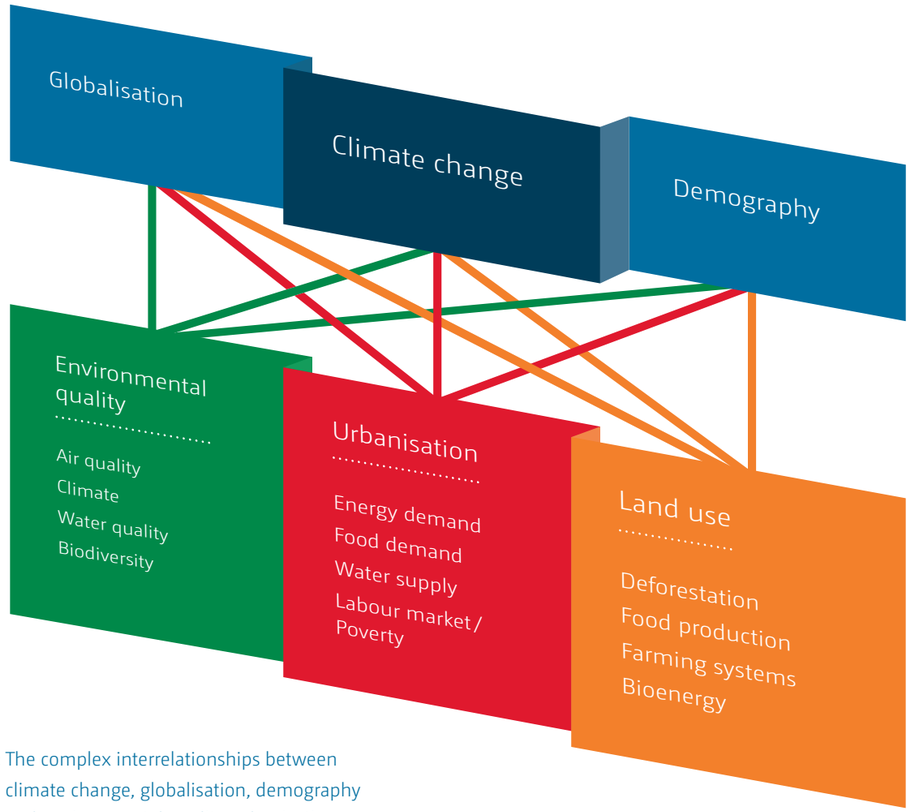


Abb.: The complex interrelationships between climate change, globalisation, demography and environmental quality, urbanisation and land use.

Agricultural adaptation

Beside land use dynamics, adaptation in the management of agricultural areas plays an important role. Recurrent famines, as in 2011 in the Horn of Africa and Kenya, point out how vulnerable food security still is in many places. Weather variability and the increase of weather extremes due to climate change can lead to drastic decreases in arable land and food production. In some areas a rapid depletion of water resources can be expected in the long term, not least through uncontrolled deforestation. Adaptation (and increase) of agricultural production is essential in order to achieve long-term food security and with it political stability in many regions.

In this context, cooperation and effective knowledge transfer should strengthen regional research initiatives for the development of adapted agro-technologies.

Combining regionalised knowledge of the natural-scientific context and socio-economic interactions will be a key factor for the success of efficient adaptation strategies.

Adaptation of energy supplies through energy efficiency and sustainable energy supply

Traditionally, biomass has been the main energy source in most African countries. As a result of population growth much more firewood and charcoal are needed. This causes massive deforestation and heavy losses in natural habitats. Erosion of fertile soil and desertification are two of the consequences. Finally farmland is destroyed. Moreover, deforestation accelerates climate change. Strategies for adaptation and climate protection therefore must include measures for more efficient usage of exiting bio-energy resources as well as develop other regenerative types of energy. This is seen also a key factor for the economic development of any region.

A variety of measures are available which, however, need to be adapted to regional conditions. A large number of relevant projects have already been realized. Important measures include knowledge transfer to regional populations and relevant stakeholders on the topic of efficient energy use, technology transfer, and the improvement or development of central energy-related infrastructure. For a sustainable implementation of resource use on the local level several factors are essential. Amongst them, capacity building is indispensable to improve knowledge about key factors such as institutional requirements, human capital, marketing, investment environment and others.

Figure: charcoal in Morogoro, Tanzania

Adaptation of infrastructure

As a result of climate change it is expected that in Africa weather extremes such as storms, droughts, and floods will increase. This will strongly affect the existing infrastructure. Improvement and further development of infrastructure components are therefore considered an essential part of a basic adaptation strategy. Urbanisation also plays an important role in this context, especially with respect to fast-growing megacities and their regions. Both cities and their hinterland must be part of an integrated planning approach, not least to improving resource use efficiency.

As well as energy-related infrastructure issues, water storage is also becoming a more and more important topic.

In most African regions a dramatic reduction of (fresh) water availability is expected. This will affect the whole economy including the crops of small farmers at the one end and the large water-storage systems of megacities at the other. Raising sea levels and flooding events of increasing frequency and extent are other challenges for the infrastructure designed to protect urban settlements and farming land.

Africa as a player in international climate protection policy

There is great potential in Africa for reduction of greenhouse gas emissions and for carbon sequestration. Sustainable use of wood as a main energy source is one reason, and also current farming methods offer big potential for more efficient crop production. Making better use of soils may improve their capacity for carbon sequestration.

However there is lack of knowledge on a variety of topics such as biomass and carbon storage in regional vegetation, efficient regeneration of soils after clearing of woods, or agro-technical measures for carbon storage in farmland. But this kind of knowledge is indispensible, if African countries are to become partners in climate protection actions. It supports the application of mechanisms such as REDD+, which means reduction of emissions caused by deforestation and damage of forests plus nature conservation. In summary, the strengthening of regional research institutions and (forest) administration practices are essential features.

Further need for research

- **Research is needed on land-use dynamics, urbanisation, adaptation of farming and agriculture and adaptation of infrastructures and**
- **in regard to regional potential and resources for climate protection.**
- **Interdisciplinary and cooperative research is needed to establish adaptation and climate protection strategies.**

The research approach should be broad enough to involve investigations into regional data referring to climate change impacts as well as enable a comprehensive analysis of socio-economic, legal, technological as well as institutional profiles of a region and its interaction on national and international levels using the same research frame. Studies of this sort will support the establishment of strategies which help to improve adaptation to climate change impacts, to enhance efficient use of resources and to protect the climate.

Topic 3
Development and improvement of databases and methods

In situ and remotely sensed measurements are essential to record and project future climate change in Africa. The observation density of scientific data concerning meteorology, hydrology, land cover and use as well as socio-economic data is relatively sparse in Africa. An important pre-condition for climate and climate impact research is thus given by the development of active data-bases.

Development and improvement of active databases

Active databases require new data sources to be exploited, new data collected, quality-controlled, standardised, spatially and temporally combined, and digitised where data are only available on paper. An important element in the creation of datasets is the interlinking of in situ and satellite observations. Specifically in Africa, this is of great importance as the ground-based observational network does not cover some regions and only sparsely covers others. An innovative combination of remotely sensed and in situ data can lead to significant improvements in observation density.

To fully capture the impacts of climate change and adaptation to changed climatic conditions, socio-economic data is also needed, such as data on climate-related migration of people and on land and energy use.

These measures and securing their sustainable maintenance affect all areas of climate and climate impact research and are necessary conditions for successful interdisciplinary research.

Support with user-orientated application of data

The long-term aim in regard to the acquired data is their integration into preferably freely accessible databases and their user-orientated application. In some African countries, there is a need for advice and methods of advice for decision makers, the linking of data users and continuity in implementing these tasks. Hence, the processing and provision of information for interested users (e.g. in the education sector) are the most important tasks in this regard. This will affect the training of personnel and the improvements in infrastructure including the IT sector. Support for more user-orientated applications of the data could for example be delivered in the form of advice and examples of good practice. These user-orientated applications should serve the adaptation to climate change and protection (➥ cf. topic 2) and should support the development of these sectors in African countries.

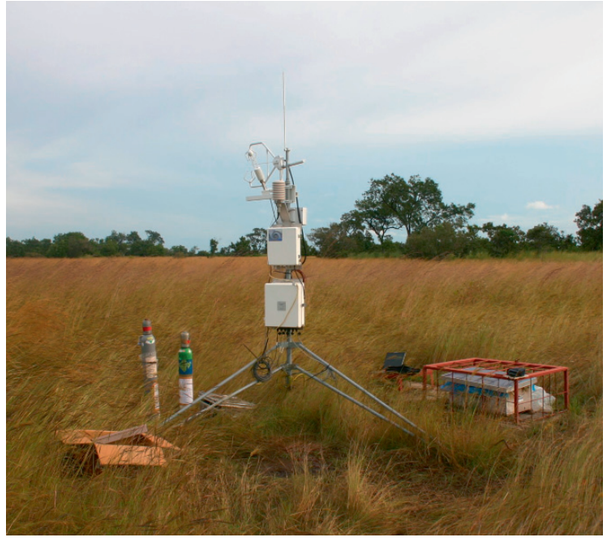


Image: field campaign in Burkina Faso

Climate models: more regional climate simulations, quality assurance, further development of models

Besides the provision of observational data, forecasts of future climate change on regional and local levels are necessary for regional planning projects. These forecasts are made possible by interpreting results from climate models. For many areas in Africa, only few simulations are available on a regional scale. This is especially true for 'Ensemble calculations', which are repeated model runs showing the uncertainty of the projections. Additionally, simulations of the recent climate for regions with sparse observational coverage are of great importance both to quantify current climate change and identify its causes and impacts (➥ cf. topic 1).

The quality of climate model results is under constant scientific scrutiny. To reduce present shortcomings, continuous further model development is required. Improved data availability and progress in understanding the underlying processes are essential for the quality assurance of the models. This makes field studies and the extension of the present ground-based observation network necessary.

When further developing the underlying methods of climate models, a next step is to enable them to make decadal and seasonal predictions. Climate changes on a decadal scale are often more relevant to the decision makers who implement adaptation measures than very long-term projections. Seasonal forecasts are of great importance to rain-fed agriculture, as found in many parts of Africa.

Further need for research / structural adaptation

Thus, the main tasks relevant to all areas of climate and climate impact research mentioned in this issue paper are:

- **support in defining data structures and formats and in the digital long-term archiving and creation or extension of necessary structures;**
- **the digitisation of data only available on paper;**
- **the linking of in situ observations with the relevant satellite data and the derivation of information for the databases;**
- **the organisation and implementation of field campaigns and transfer of the information to the databases;**
- **carrying out regional 'Ensemble calculations' of climate models, the interpretation of their results and the storage into databases.**

Topic 4

Human capacity development, infrastructure, knowledge transfer

Joint research means research based on partnership to obtain excellent results. However, in many African countries, the know-how, human capacity, and infrastructure are insufficient to sustain joint investigations between partners in climate and climate impact research on an eye-to-eye level. The German Federal Government and the German climate research in general already support capacity-building through involvement in several projects. However, more effort is needed to create a sustainable base for climate research in Africa.

Human capacity

In many African countries, there is a strong need to build up a critical mass of scientists engaged in climate and climate impact research. The education and promotion of young scientists play a role as well as further training for senior scientists. There is a need of the following provisions.

- **Establishment and extension of climate-relevant programmes at African universities;**
- **Foundation and scientific advice of (interdisciplinary) research groups;**
- **Education and further training in the observation and evaluation of climate-relevant data and the skills in the application of climate models;**
- **Establishment of graduate schools for, e.g., urban and regional management, or land use under climate change.**

Furthermore, there is a need for skilled technicians for the maintenance and operation of scientific measurement instrumentation and for agricultural test farms. The necessary skills could be taught in the frame of intensive training courses.

Knowledge transfer, networking, competence centers

The situation in terms of ground-based measurements has to be significantly improved to obtain a higher density of observational sites in the different climate zones, providing continuous climate-relevant data. National institutions such as local weather services need to be involved to jointly develop tools for quality assurance as well as data management and policy.

The initiative of the BMBF (German Federal Ministry of Education and Research) to establish climate competence centres in Africa (Regional Science Service Centers) is a suitable tool to cooperatively build up scientific networks and to increase the human capacity and knowledge transfer in Western and Southern Africa in the frame of climate and climate impact research. Due to demands in research as well as due to practical experiences of DKK institutes, there is likewise a need to have an additional competence centre for East Africa.

Furthermore, the DKK suggests establishing a North-South network for climate and climate impact research, comparable to the European ERA-NET.

The knowledge transfer should also include cooperation in strategies, concepts and actions to convey the findings of the climate and climate impact research understandably to the public.

Infrastructure

An improvement of the observational infrastructure in Africa is necessary because measurements are used to analyse trends and to validate and improve climate models. These measurements contribute also to fulfilling the requirements of the United Nations Framework Convention on Climate Change (UNFCCC) to monitor aerosol properties and greenhouse gas concentrations and emissions. Finally, such infrastructure is also valuable in improving access to global programmes and satellite data. Cooperation is also needed on the establishment or further development of measurement sites with scientific instrumentation, information technology, and satellite communication technology.

Overall, there is a huge demand to support the establishment or further improvement of computer capacity to generate user-oriented scientific and socio-economic data for climate and climate impact research.

We suggest cooperation to establish and support agricultural training and research farms, which serve for applied research and/or education of the users. These farms are excellent tools to test strategies of land use and to develop guidelines of best practice in the different climate zones of Africa.

We encourage cooperation to establish and support sustainable aqua-/mariculture facilities for raising aquatic organisms in the different climate zones of Africa to reduce the insecurity of food supply caused by climatic variability.

Overall, existing training centres, research facilities, and universities are excellent points of contacts. The German government is already involved in numerous infrastructure projects, capacity building, and knowledge transfer in African countries. These projects can also provide platforms for training and education programmes and projects. Individual and cooperative programmes should be developed in partnership and by taking specific national or local characteristics into consideration. The goal should be the cooperative use and the further development of existing African infrastructure.

Further need for structural adaption

Requirements for structural adaption in the fields of human capacity, infrastructure and knowledge transfer include:

- **support of education and further training for scientists in climate and climate impact research and training of specialist staff and technicians, e.g. in the field of application-oriented research;**
- **support of the digitalisation and use of historical data on paper;**
- **practical assistance in data management in the frame of existing facilities such as weather services;**
- **the establishment of an additional climate competence centre (RSSC) in East Africa;**
- **the establishment of a South-North network in climate and climate impact research;**
- **the establishment and further development of the observational infrastructure for climate-relevant data;**
- **the establishement and further development of computational capacity;**
- **the establishment and support of agricultural training and research farms and of sustainable aqua-/mariculture facilities in different climate zone in Africa;**
- **exchange and cooperation with African partners to promote enhanced public awareness of climate research and its results.**

IV. Geographic overview of current projects and activities

(as of June 2011)

The German climate research community has been cooperating in Africa for many years. DKK institutions are involved (often as members of international research clusters) in 130 climate projects across 33 African countries. This highlights Africa's significance in the global climate research community. Nevertheless, this commitment is only a 'drop in the ocean' in view of the huge demand for information, specifically about regional and local climate impacts and appropriate adaptation measures.

The largest number of cooperation projects are currently taking place in western Africa (53), followed by southern Africa (31) and eastern Africa (23), northern and central Africa.

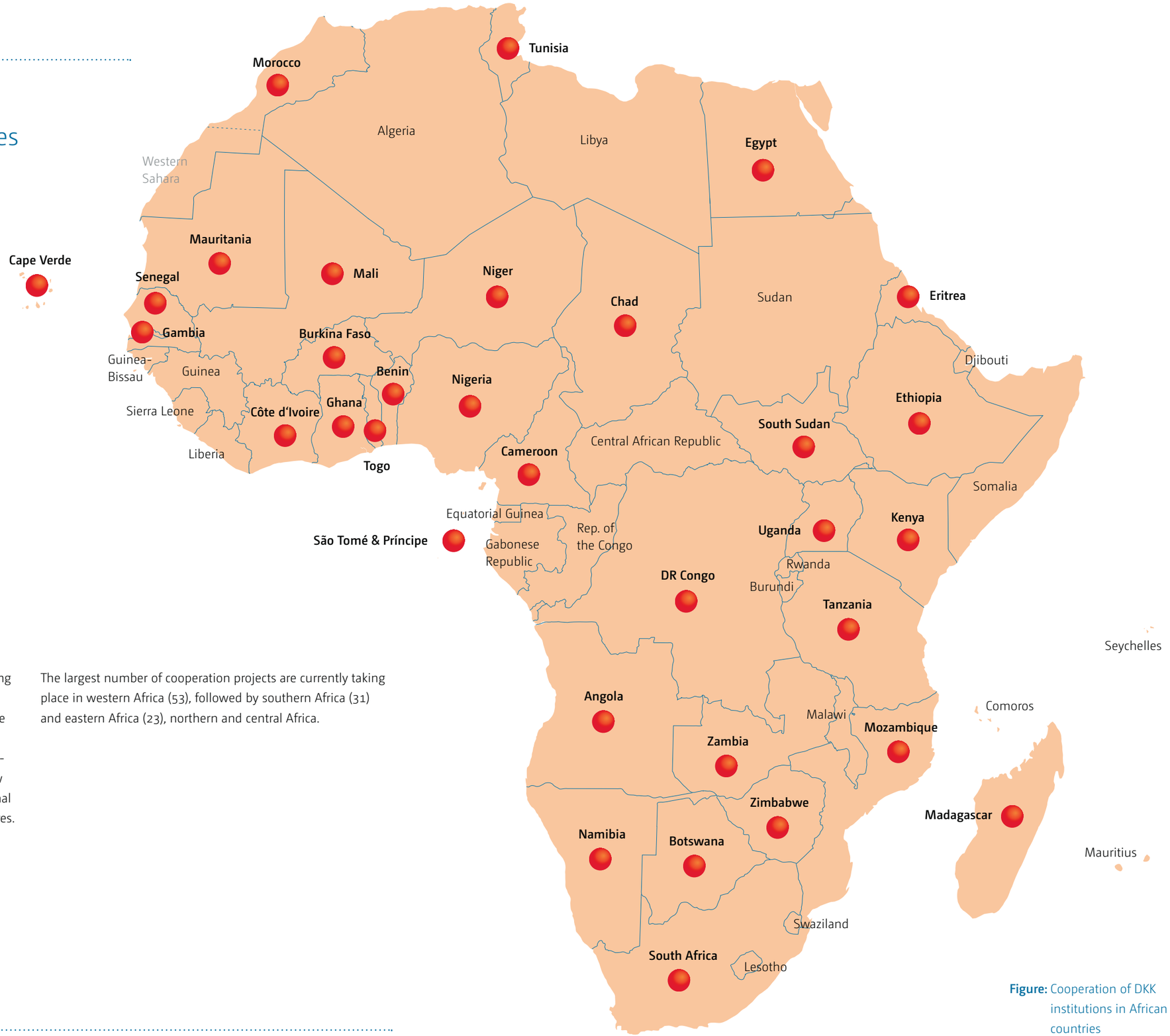


Figure: Cooperation of DKK institutions in African countries

V. Participating institutions and contact persons with Africa-relevant expertise

Here we list all participating institutions with their Africa-related topics or areas of expertise, together with contact persons for Africa:

High-resolution regional climate modelling; Estimation of the impact of climate change on water resources
Dr Andreas Hänsler, E-mail: andreas.haensler@hzg.de

Regional climate modelling, Advice and support for establishing and operating observing systems, Digitisation of historical data, Remote sensing
Stefan Rösner, E-mail: stefan.roesner@dwd.de

Remote sensing, analysis of climate relevant atmospheric parameters, chemistry and material cycles, hydrology, climate reconstructions, Global Change Observatory
Dr Torsten Schmidt, E-mail: tschmidt@gfz-potsdam.de

Legal issues implementing REDD+, carbon balance simulation of forests, understanding the complex changes of earth and environment, urban vulnerability
Dr Andreas Marx, E-mail: andreas.marx@ufz.de

Ocean-Atmosphere-Interaction, Marine Biogeochemical Cycles and Ecosystems, Oceanrelated Climate Protection Potential, Climate Simulation
Prof. Arne Körtzinger, E-mail: akoertzinger@ifm-geomar.de

Measurements of aerosol emission and pollution, cloud measurements, aerosol remote sensing, and meso-skale aerosol and cloud modelling
Prof. Alfred Wiedensohler, E-mail: ali@tropos.de

Economic and ecological aspects of land use and energy supply strategies; climate policy; migration; poverty
Prof. Gernot Klepper, E-mail: gernot.klepper@ifw-kiel.de

IGUA/KIT: Climate and land use change, hydrology, floods, droughts, coupled model systems, measurement networks
Prof. Harald Kunstmann, E-mail: harald.kunstmann@kit.edu

Changing large marine ecosystems in the Eastern Boundary Currents, biogeochemical cycles
Dr Volker Mohrholz, E-mail: volker.mohrholz@io-warnemuende.de
Dr Martin Schmidt, E-mail: martin.schmidt@io-warnemuende.de

Relevant expertise of the fifteen KDM members in the field of marine and polar sciences as well as of coastal research
Prof. Detlef Stammer, E-mail: detlef.stammer@zmaw.de

Water cycle, interaction soil-atmosphere, mineral dust, land cover, ensemble regional climate projection and decadal climate prediction
Dr Hans-Jürgen Panitz, E-mail: hans-juergen.panitz@kit.edu

Hydrologic cycle, Paleoclimatology, modeling of interactions between ocean circulation and multidecadal droughts
Dr Stefan Mulitza, E-mail: smulitza@uni-bremen.de

Interactions biogeochemistry-climate, atmospheric trace gases, quantification of sources and sinks
Prof. Martin Heimann, E-mail: martin.heimann@bgc-jena.mpg.de

Measurements and modeling of trace gases and aerosols
Prof. Jos Lelieveld, E-mail: lelieveld@mpch-mainz.mpg.de

Remote sensing, (observational) data-assessment, (atmospheric) radiative transfer
Dr Stefan Kinne, E-mail: stefan.kinne@zmaw.de

Model systems/data for hydrology, rainforest, biogeochemical cycles, desertification/erosion, monsoon, land use
Dr Fred Hattermann, E-mail: hattermann@pik-potsdam.de

Center for Earth Systems Research and Sustainability (CEN): Feedback processes between land surface and atmosphere with application to climate simulations in the presence of land surface changes.
Prof. Martin Claußen, E-mail: martin.claussen@zmaw.de

Evaluation of resource management and climate protection potentials of infrastructure related technologies. Technology transfer for waste and water management.
Dr Konrad Soyez, E-mail: konrad.soyez@uni-potsdam.de.

Water resources, climatology
Prof. Heiko Paeth, E-mail: heiko.paeth@uni-wuerzburg.de

Long-term monitoring of trace gas fluxes between eco systems and the atmosphere, ecological assessments for land use change
Dr Werner L. Kutsch, E-mail: werner.kutsch@vti.bund.de

Gender and Sustainability, Sustainable Energy Systems in Africa (main Focus West-Africa)
Selly Wane, E-mail: selly.wane@wupperinst.org

Scientific analyses of sustainable agro-landscape use in newly developing and developing countries
Dr Stefan Sieber, E-Mail: stefan.sieber@zalf.de

Climate induced changes in coastal zones, resource management of coastal inhabitants, upwelling systems in southern Africa, carbonate sediments as climate archives
PD Dr Hauke Reuter, E-Mail: hauke.reuter@zmt-bremen.de

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