Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH (ed.)

Running dry?

Climate change in drylands and how to cope with it

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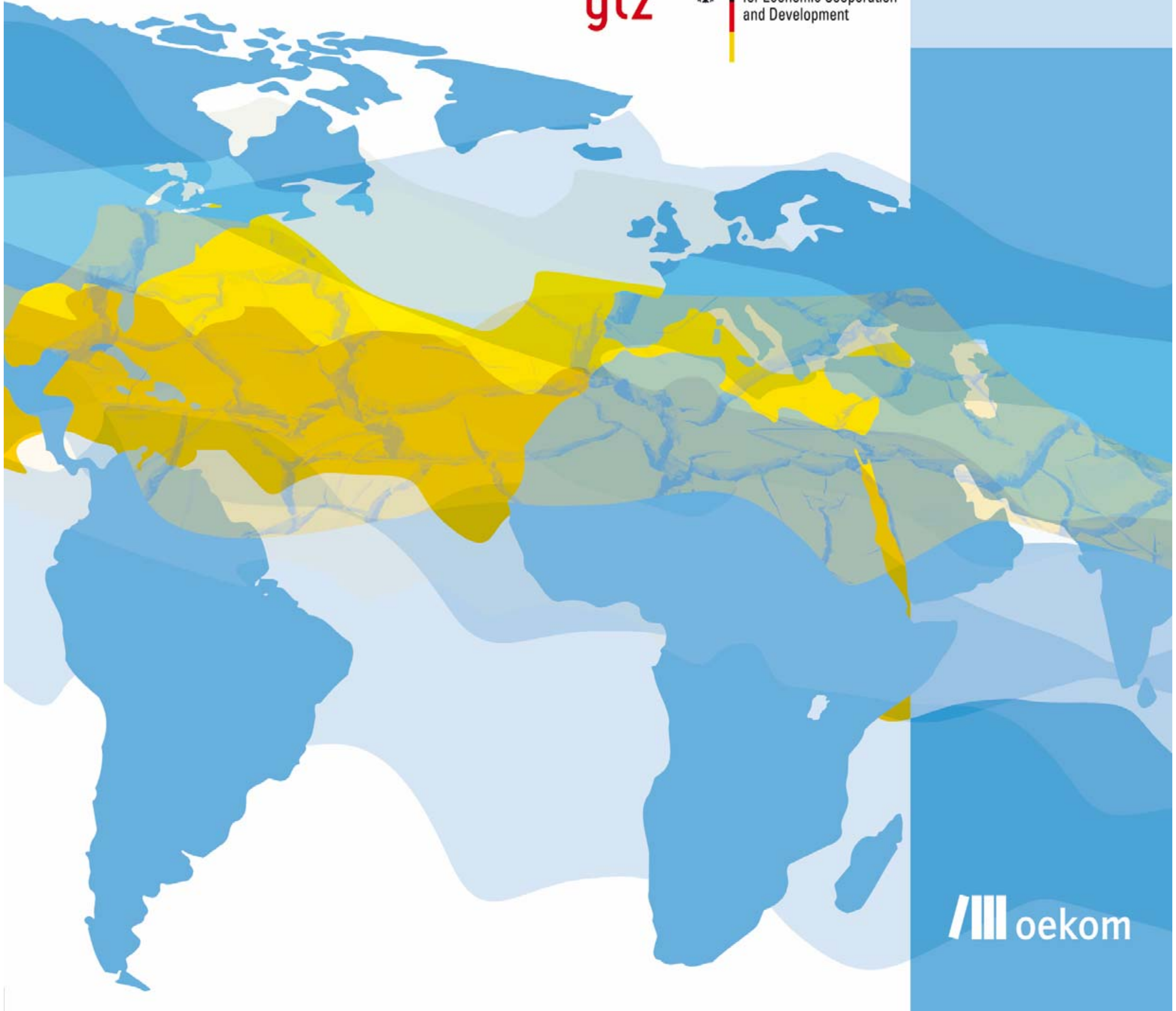
On behalf of
Federal Ministry
for Economic Cooperation
and Development



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Foreword

Dear reader,

The risks associated with climate change have been a topic of discussion since the Earth Summit in Rio de Janeiro in 1992. However, for the following 15 years, the climate and land community have largely ignored one another. Moreover, the issue of land degradation was not included in the Kyoto Protocol or other climate change negotiation fora.

However, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), 2007, has brought about a rebound in mutual understanding. We have learned that climate change and land degradation are not only twin threats to sustainability of life on earth, but that they exacerbate one another.

Today, we know that the world's soils hold more carbon than the atmosphere and vegetation combined. Additionally, we know that land degradation is essentially symptomatic of soil carbon loss. Already, croplands, pastures, and forests in drylands are exposed to threats from climatic variability. Furthermore, we know that drylands account for the most vulnerable ecosystems to climate change. In the long run, climate change impacts, such as changes in temperature, shifts in growing seasons, storms, floods, droughts, and changed rainfall patterns, risk the livelihood of drylands populations. Therefore, adaptation to the adverse effects of climate change through sustainable land management is a crucial, though simultaneously challenging, task.

In order to make climate change endeavors more effective, we need a thorough understanding of how global and regional change are inter-related. We also need a more detailed account of the effects of climate change in drylands that are already underway. Finally, we need meaningful information on how sustainable land management in developing countries can contribute to the mitigation of climate change.

This publication provides a thorough overview and analysis of scientific results regarding climate change in drylands. This includes information on the inter-linkage between climate change and land degradation and the potential mitigation and adaptation measures. We hope the publication helps these crucial issues gain their rightful place within climate-change discussions.

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Introduction

Drylands cover more than one third of the world's terrestrial area. Land degradation in these regions is a driver of climate change. Conversely, dryland ecosystems and populations are among those most affected by the adverse effects of such change.

Recent international climate policy debate and negotiation processes have put the spotlight on the interplay between land use, climate change mitigation and adaptation. This has raised the profile of drylands. New analyses and research produced in preparation for the 2nd National Communications to the United Nations Framework Convention on Climate Change are giving an ever clearer picture of the country-level impacts of climate change. As yet, however, no comprehensive presentation of the linkages between land degradation in drylands and climate change – and of the solutions in the realm of sustainable land management – has been available.

This book is the first to give a full overview of the state of affairs and science in this complex issue area. The analyses are supplemented by case studies of experience gathered in German development cooperation. The publication does not, however, lay claim to being a blueprint for future policy.

It is organised in six thematic chapters. Chapter 2 sets out the contribution drylands make to climate change. In Chapter 3, the perspective is switched, with an overview of recent and projected climatic changes in dryland regions, followed up by a discussion in Chapter 4 of the impacts of global climate change in such regions. The next two chapters highlight a range of approaches towards tackling the challenges that ensue, in terms of mitigating climate change through sustainable land management and adapting to climate change impacts in drylands. Finally, Chapter 7 explores linkages between mitigation and adaptation.

This book will provide a compendium for all scientists, development practitioners and policymakers with an interest in the major global environmental challenges: desertification and land degradation, biodiversity loss and climate change.

1 Executive Summary

The contribution of drylands to climate change

Agriculture and forestry are responsible for around one-third of the total global greenhouse gas (GHG) emissions. As agricultural activities play a dominant role in the world's drylands, such areas also contribute to global warming. Furthermore, desertification, through soil and vegetation loss, amplifies carbon dioxide (CO_2) emissions. To date, no quantitative information on the combined human-induced GHG emissions from drylands is available. The largest uncertainties in the global carbon budget attach to land use as a carbon source.

Dryland soils have lost a significant amount of carbon to the atmosphere due to degradation and desertification. It is estimated that desertification has caused a carbon loss of 20–30 Gt (billion tonnes) up to now, and that a further 0.23–0.29 Gt of carbon are lost to the atmosphere from drylands every year as a result of desertification and related vegetation destruction, through increased soil erosion and the reduced carbon sink.

Besides their contributions to global climate change through GHG emissions, drylands contribute to local and regional climatic changes through land use and land-use change. The resultant changes in physical factors affect surface temperatures and modify soil moisture, precipitation and wind speed. Vegetation cover declines and subsequent desertification processes lead to reduced precipitation. However, it remains difficult to quantify the feedbacks between the land surface and the atmosphere, and projecting the potential outcomes of future climatic effects due to land-cover change remains challenging. As a result, regional climate-change scenarios that exclude land-cover change remain at a low level of confidence.

In Africa's drylands, climate change is driven by a further force: in addition to anthropogenic GHG emissions and land-use and land-cover change including desertification, variations in sea-surface temperatures and atmospheric circulation have been identified as another driver of regional climate change. This combination makes it especially challenging to project future climate change for Africa.

Climate change in dryland regions

During the last century, regions containing large dryland areas have experienced strong drying trends (especially in Africa), precipitation increases (e.g. in northern Asia) or unclear trends in rainfall patterns (e.g. in Central Asia) – hence, no uniform picture of recent precipitation changes in drylands can be drawn. However, it is evident that drylands are already experiencing the impacts of global warming, including pronounced increases in the intensity, frequency and/or duration of extreme events such as heavy rainfall, heat waves, droughts, severe dust storms and flooding.

As dryland-specific climate information is scarce and not readily available, this study refers to climate projections produced by the Intergovernmental Panel on Climate Change (IPCC) for the sub-continental regions in Africa, Central and South America and Central Asia which contain large dryland areas. Such regions will face warming greater than the global mean. The predictions of future warming are relatively robust. In Africa, warming is very likely to be larger (up to 1.5 times) than the global annual mean throughout the continent and across all seasons, with subtropical regions and semiarid areas experiencing the greatest warming. For all sub-continental regions containing large dryland areas in Asia, Central and South America (except for southern South America) climate models also project greater warming than the global mean.

In contrast to temperature projections, precipitation projections at regional and local levels are difficult to make and involve considerable uncertainty. No uniform and comprehensive projections can be made for drylands; indeed, even the sign of such projections varies. Up to now Global Climate Models do not give robust findings for all dryland regions – e.g. in the Sahel, the Guinean coast and the southern Sahara it is uncertain how rainfall will evolve in this century as the sign of the projections varies among models. In other regions, there is likely to be an increase in mean annual precipitation (e.g. East Africa, Ecuador, northern Peru); this finding is robust across the ensemble of models. However, it has to be taken into account that the increase in temperature causes an increase in potential evapotranspiration that may overwhelm any increase in precipitation and result in reduced soil moisture. In most of the dryland regions situated in the subtropics (except for south-eastern South America), climate models project a robust decrease in annual mean rainfall – for instance in the Mediterranean Basin, North Africa, southern Africa and Chile. For Central Asia, particularly its western parts, north-east Brazil, Patagonia and Central America most models also simulate a decrease in mean precipitation.

Global Climate Models project that drylands will experience increases in intensity, frequency and/or duration of extreme weather events. Warming climates lead to more intense precipitation events, even in those land regions where total annual precipitation is reduced. Heavy rainfall may be associated with flooding events, landslides and soil erosion. Furthermore, droughts will increase in intensity, frequency and/or duration and drought-affected areas will increase in extent. Very dry areas have already more than doubled in extent (from ~12 to 30 percent) since the 1970s. It is estimated that, by the 2080s, the proportion of arid and semiarid lands in Africa is likely to increase by 5–8 percent. Extreme drought-affected terrestrial areas will increase from 1 percent to about 30 percent globally by the 2090s.

It must be kept in mind that climate projections are subject to a certain degree of uncertainty. Limitations to accurately predicting future climate change arise from the inability of climate models to adequately account for the influence of land use, land-cover changes and dust aerosols in future climate. Furthermore, large natural variability and other processes that are not included in climate models (e.g. El Niño Southern Oscillation (ENSO) in Africa) add a further level of uncertainty.

Impacts of climate change on drylands

Drylands are already affected by multiple pressures resulting from human activities. The resilience of many ecosystems is likely to be exceeded during this century by a combination of anthropogenic drivers – notably increased land-use intensity. Climate change thus constitutes an additional pressure to already threatened dryland systems. Given the multiple and interactive human-induced pressures, quantifying the impacts of climate change alone is difficult. Dryland populations already suffer from poverty; together with unsustainable land use, this leads to desertification. Climate change constitutes an additional driver in this process with a potential to exacerbate desertification, for example by more frequent and prolonged droughts, to an extent that we do not yet know.

Dryland populations have a low adaptive capacity to climate change and are therefore faced with severe impacts. Their high vulnerability to the adverse effects of climate change is due to heavy dependence on natural resources along with fragile ecosystems, desertification, a high level of poverty, limited assets and entitlements and a lack of governance and institutions. Furthermore, economic alternatives are scarcely available and safety nets are mostly lacking.

Climate change has negative consequences for dryland biodiversity and ecosystem goods and services. For instance, annual river runoff and water availability are projected to decrease but there are still large uncertainties in modelling. Freshwater scarcity will result in a persistent and substantial reduction in the provision of ecosystem services in drylands, leading to further desertification and posing a risk to livelihoods. Anticipated water scarcity is just one of several factors leading to the projected decline in agricultural productivity in drylands. Here, where crops are already near their maximum heat tolerance, increased frequency of heat stress, droughts and flooding events will reduce crop yields and grassland and livestock productivity even if potentially positive effects from carbon fertilisation are taken into account. The decline in productivity will have severe consequences for food security and further development. More research is needed, e.g. on the relationship between CO_2 fertilisation and the production of agricultural crops at local and regional level.

Climate-change mitigation through sustainable land management

Dryland soils have lost a significant amount of carbon due to degradation and desertification. Therefore, being far from saturation, they harbour great potential for carbon sequestration.

Unfortunately, no global estimates of the overall mitigation potential in drylands are available. It is generally difficult to estimate emissions and removals from agriculture, forestry and other land use (AFOLU). Global estimates for drylands have only been performed with regard to soil carbon sequestration in the forestry and, especially, agricultural sectors, but not for other mitigation categories such as reducing emissions or sources. Worldwide, soil carbon sequestration is the mechanism providing most of the mitigation potential in agriculture.

The large surface area of drylands makes soil carbon sequestration globally significant. Under a range of assumptions, dryland soils could annually sequester 0.9–1.9 Gt C (3.3–6.97 Gt CO_2) if desertification control and land restoration practices are adopted. By way of illustration: in 2008 Germany emitted approximately 831.8 million t CO_2, thus 0.2266 Gt C. However, these estimates have large uncertainties.

Besides its contribution to carbon sequestration, sustainable land management in degraded and non-degraded dryland areas is key to avoiding further carbon loss through desertification. Drylands hold a significant proportion of global soil carbon due to their high percentage of land cover. Sustainable land management is key to protecting this carbon from loss and thus preventing the associated emissions of carbon dioxide. Practices to enhance soil carbon sequestration and to prevent carbon loss in drylands are well-known in sustainable land management – the wheel does thus not need to be reinvented. Mitigation measures in drylands fit into strategies and approaches that have long been advocated and applied to foster sustainable land management and to combat desertification, e.g. improved cropland and grazing land management, restoration of degraded lands, agroforestry or erosion management.

In addition to their positive effect on mitigating climate change, mitigation measures in drylands could generate numerous co-benefits such as conservation of biodiversity, enhanced food security or poverty alleviation. Mitigation measures in the AFOLU sector often have synergies with sustainable development policies and practices, and many explicitly influence social, economic and environmental aspects of sustainability. The main target group for such mitigation measures is made up of small-scale, resource-poor farmers for whom the benefits could constitute an enhancement of their livelihood. Sustainable land management practices that increase soil fertility and soil carbon stocks are therefore of major interest in poor dryland regions.

Thanks to its contribution to climate-change mitigation and its delivery of environmental and socio-economic benefits, sustainable land management could generate major value. Compared to ecosystems in other climatic zones such as tropical rainforests, dryland ecosystems are not highly productive. At low prices for carbon, investment in mitigation measures in drylands may thus not be cost-effective due to the associated transaction costs. Integrating both its contribution to climate-change mitigation and its delivery of environmental and socio-economic benefits into cost-benefit analyses could make sustainable land management more cost-effective than is currently the case.

Despite the high mitigation potential, soil carbon sequestration faces various challenges which have led to its exclusion under the Clean Development Mechanism (CDM). Like avoided deforestation and forest degradation, soil carbon sequestration is not eligible under the CDM in the first commitment period (until 2012) of the Kyoto Protocol. Afforestation and reforestation (A/R) projects are the only AFOLU carbon sequestration project types to be implemented in developing countries that are included – however, only three A/R projects have been registered to date. The eligibility of sustainable land management activities as project activities under the CDM is currently being negotiated by the parties to the UNFCCC.

Research and advocacy are required to overcome the challenges and to capture the value of the various co-benefits of mitigation in drylands. Initiatives like the World Bank's BioCarbon Fund are needed to test and demonstrate how AFOLU activities can generate emission reductions that can be measured, monitored and certified, while contributing to measurable environmental and livelihood benefits.

Adaptation to climate change

Due to the stock of GHGs already accumulated in the atmosphere, climate change cannot be avoided entirely and therefore adaptation has become imperative. Drylands will suffer particularly. Their populations and ecosystems are among the most vulnerable to such change, which constitutes an additional human-induced pressure on already stressed systems. Dryland populations have a low adaptive capacity. Their livelihoods are severely threatened and adaptation to the adverse effects of climate change is therefore crucial.

In drylands, there is a huge need for enhanced flexibility and strategic approaches, as scarce and scattered information on climate change stimuli and impacts leads to high levels of uncertainty. Planning in drylands thus needs to be more flexible in the face of uncertainties and risks; it must become more strategic and should cover longer time horizons. Such adaptive management requires flexible responses to a more variable environment. In this context, the identification of incentives and options for the diversification of livelihoods is crucial to achieve greater independence from climatic factors.

Adaptation to climate change is intrinsically linked to sustainable development. Development approaches cannot be sustainable unless they are climate-resilient. Adaptation measures, in turn, will only be successful if they are embedded in development approaches designed to tackle the root causes of vulnerability.

Adaptation strategies need to focus on strengthening the adaptive capacity of societies and ecosystems, reducing their vulnerability to climate change and correcting policies that lead to mal-adaptation. The well-known practices of sustainable land management make an important contribution to adaptation in drylands, as they reduce and manage existing problems of desertification and drought. However, 'business as usual' measures do not suffice. Anticipation of and preparedness for climate change call for a radical change in mid- to long-term development planning. To cope with the high level of uncertainty, measures must respond to existing risks related to climate variability while at the same time improving mechanisms to cope with anticipated climate extremes.

Furthermore, adaptation to climate change needs to encompass more than technological measures. Vulnerability to the adverse effects of climate change is determined by social and political factors. Therefore, adaptation measures should not focus on technical solutions but rather on the societal factors that compromise the capacity to cope with the effects of climate change. A multi-level approach for adaptation is required that also encompasses policy-driven responses.

Moreover, climate change demands adjusting best practices of sustainable land management. Familiar approaches and instruments need to be revised and adjusted in the light of climate change. Traditional strategies to cope with climate variability can be a good starting point for adaptation. However, they may be overstrained when climate change results in more intense and frequent extreme weather events. Therefore, supplementary and innovative approaches are needed.

On country level adaptation policies cannot be governed separately from other global environmental problems. The multilateral environmental agreements need to ensure consistency between their mechanisms and encourage the integration of their respective planning processes. Countries' capacities to use the instruments of the Rio Conventions in a complementary way need to be strengthened.

Resources for adaptation available through current international financial mechanisms are marginal when compared to the need for adaptation funding and can only be effective when embedded in coherent climate-resilient development policies. The costs of adaptation are difficult to assess accurately. They include the costs of adaptive measures on the ground, the costs of capacity development and the costs of 'climate-proofing' development strategies. Some international mechanisms have been put in place under the United Nations Framework Convention on Climate Change (UNFCCC) in order to support the adaptation efforts of developing countries. Development cooperation plays a crucial role in financing adaptation as the majority of such funding is assured by official development assistance.

Linkages between mitigation and adaptation

Both adaptation and mitigation are essential to reduce the expected impacts of climate change and to achieve sustainable development objectives. They should thus be considered (and implemented) in tandem. However, exploiting synergies between both policy areas is often challenged by asymmetries in their characteristics – specific adaptation and mitigation options operate at different spatial, temporal and institutional scales. Furthermore, adaptation and mitigation activities can influence each other's effectiveness. Investments in mitigation may have positive and negative consequences for adaptation and vice versa. This has to be taken into account in planning and implementation processes. However, information on interactions between adaptation and mitigation at regional and sectoral levels is scarce and their exploration has only just begun.

Sustainable land management yields benefits for both climate change mitigation and adaptation. Many existing traditional and contemporary management practices, such as agroforestry, help prevent desertification, mitigate climate change and adapt to its adverse impacts. There are thus significant opportunities for mitigation and adaptation while at the same time delivering further environmental and socio-economic benefits.

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Convention Project to Combat Desertification
The GTZ Convention Project to Combat Desertification (CCD Project) is acting on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). It provides 'down-to-earth' advice for UNCCD implementation in international fora and on the ground and supports solutions for better integration of sustainable land management and climate-change aspects in practice.

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