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Book review

Climate Variability Impacts on Land Use and Livelihoods in Drylands

Edited by Mahesh K. Gaur and Victor R. Squires

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Introduction

Climate Variability Impacts on Land Use and Livelihoods in Drylands provides regional up-to-date information on the challenges facing the estimated billion people who use the drylands (also referred to as aridlands) that make up around half the world's land area. Drylands are characterised by being water-limited, commonly with high annual evapotranspiration, and a level of rainfall that is not only low (<200mm per year) but highly variable from year-to-year. The challenges for both industrialised and developing regions are projected to increase against the background of global changes. The term global change is used to encompass not only anthropogenic climate change but ongoing socio-economic changes relating to trade (geopolitical and economic patterns), shifts in market economies and demographic factors (including population growth, urbanization and re-settlement). Effects of these climatic, economic and cultural factors are increasingly being felt in society today.

This 362 page book published by Springer in both hardcover and electronic formats is a collection of 16 contributions that combine analyses of purely biophysical effects of natural climate variability and global change on the productivity of drylands with a systematic look at the socio-ecological dimensions of their ecosystems and human inhabitants. Taking this broader perspective enables assessment of the water-dependent, low productivity of drylands to be placed in the context of management that considers geographical and geopolitical differences, including differences in the degree of aridity, climatic variations, success (or otherwise) of historic adaptation by communities, biodiversity, land use practices, culture and governance. Much of the data and information have not previously been published. The analyses provide new insights into the possible impacts of climate change and socio-economic development for pastoralists and smallholder farmers across the world's drylands including in Australia, Argentina, India, North America, China, Mongolia, North Africa, Central Asia and Southern Africa. Impacts vary regionally but are arguably of more immediate significance in regions occupied by the most vulnerable groups of society.

Climate Variability Impacts on Land Use and Livelihoods in Drylands is edited by Dr Mahesh Gaur from ICAR-Central Arid Zone Research Institute, India, and Dr Victor Squires, Visiting Fellow in the East West Center, Hawaii. Dr Gaur is a specialist in aridland geography and the application of technologies such as remote sensing for natural resources mapping, management and assessment. He also has expertise in socio-economic aspects of drought, land degradation and desertification and the use of indigenous knowledge systems for land management. Dr Squires is a world-renowned expert in rangeland ecology. He has previously held several prestigious positions and research associations including at University of Adelaide and CSIRO in Australia, and has received a number of awards and honours for his research on management and conservation of rangelands and on dryland livestock production. The 16 papers have been assembled into five parts: (I) Background and Settings; (II) Aridlands Under a Global Change Regime; (III) Northern Hemisphere Aridlands: Selected Examples; (IV) Southern Hemisphere Aridlands: Selected Examples; and (V) Summary, Synthesis and Concluding Remarks. Each Part starts with a short (around one page) overview of the content and goals of the section, which helps to set the context and introduce the papers.

Overview

Part I: Background and Settings

Part I contains three contributions that together provide the scope and setting for the remainder of the book. They describe the extent and defining characteristics of drylands and explain why these regions deserve special attention in current and future land management for climate variability.

Chapter 1 by *Mahesh Gaur* and *Victor Squires*, describes the global distribution and diversity of drylands (cold arid, hot

dry, semiarid and dry subhumid regions) and key aspects of their geography, climatology, and population patterns regionally across the globe. The authors present drylands as a vast mosaic of diverse and contrasting landscapes and species that have supported human populations for centuries – indicating a degree of resilience over the long-term. An ecological balance between pasture, livestock, and people that depends on a complex form of low-pressure natural resource management has enabled these livelihoods to endure, supported by essential ecosystem services (nutrient cycling, flood regulation and biodiversity). The authors suggest these ecosystem services are now under threat from sources such as urban expansion, mining, and unsustainable land uses. Fragile soils are already becoming increasingly degraded and unproductive.

Chapter 2 by *Ahmed Sidahmed* summarises current understanding of threats to the world's drylands, including urban expansion, mining, and unsustainable land uses, but identifies climate change and the global response as a key issue. In this chapter, understanding of the text is supported by several boxes containing explanatory material, definitions and case studies. Climate change is described as aggravating the challenges of managing a resource base that has become increasingly degraded and unproductive. However, there is some optimism that new and more sustainable investments and adaptive management choices capable of contributing to improved livelihoods and alleviation of poverty in dryland communities are possible. An ecosystem approach that includes restoration and renovation is seen as an important and urgent initial step in mitigating the impacts of climate change.

In Chapter 3 *Richard Bawden* portrays the world's drylands/aridlands as representing biophysical and sociocultural dynamics in the face of global changes. From a broad, forward-looking analysis, he concludes that these water-stressed biomes are inherently vulnerable to environmental challenges resulting from multiple stresses, and in this way they provide a focus for exploring the nature and magnitude of impacts of global change. He argues that the situation is now so dire that a major change in worldviews and in the global policies and programs they inform is essential. The paper presents a way forward that requires a continuing evolution in the focus of aridlands research from increasing productivity and profitability in agricultural and pastoral enterprises towards a more systematic approach addressing sustainable livelihoods and well-being taking account of their multi-functionality.

Part II: Aridlands Under a Global Change Regime

Part II contains four papers that deal with the nexus between people and the dryland/aridland environment. Three contrasting regions, the cold, arid Qinghai-Tibet Plateau (two chapters), Iran's aridland watersheds and India's arid Thar Desert illustrate the challenges for inhabitants of these diverse and often harsh environments.

Chapters 4 and 5 focus on the cold, arid Qinghai-Tibet Plateau. In Chapter 4, *Victor Squires* and *Haiying Feng* firstly explain what is meant by 'global change' and introduce the theoretical basis for current thinking about how change occurs. The paper discusses the impact of humans on the environment and their role as 'agents of change', taking as an example the way that adaptive practices are implemented by local land users and officials on the cold and arid Qinghai-Tibet Plateau to cope with environmental change. Historical records in this region are being used to trace responses to environmental extremes. The authors conclude that traditional ecological knowledge and shared systems of belief can facilitate collective responses to crises and contribute to the maintenance of long-term resilience of socio-ecological systems. In Chapter 5, *Haiying Feng* and *Victor Squires* explore further the attitudes and responses of herders, agro-pastoralists, and government officials to ecological and socio-economic threats posed by global change. Climate change impacts affecting the Qinghai-Tibet Plateau, particularly glacier melt and permafrost thaws, are a risk to the livelihoods of all land users. The preferred government response is ecological resettlement and relocation of herders and agropastoralists, and this is seen as also beneficial for ecological restoration of degraded lands in the headwaters of the three major rivers in this region.

In Chapter 6, *Hossein Badripour* and *Hamid Reza Soleymani* describe how Iran's National Action Plan for the country's aridland watersheds aims to improve the health of rangeland ecosystems in the catchments of its major rivers. Mitigation and adaptation measures are designed to address projected anthropogenic climate changes.

Chapter 7 by *R. P. Dhir* describes challenges facing management of the Thar Desert region in the northwest arid zone of India, a monsoonal region where the ratio of potential evapotranspiration to rainfall is high, and where population expansion and agricultural intensification during the twentieth century has resulted in degradation of natural resources. Local adaptive capacity is generally low, reflecting indigenous biophysical and social resources. The paper discusses socio-economic and governance issues for ongoing resource rehabilitation to combat the effects of drought and famine in the face of projected climate changes.

Part III: Northern Hemisphere Aridlands: Selected Examples

In Chapter 8, *Victor Squires* analyses examples of problems and opportunities for North American aridlands. Focussing on the problem of water shortages, he examines what understanding can be derived from current competing needs for urban development and food production on irrigated farmlands. A contrasting example used is the serious threat from invasive plants and fire in the desert regions, e.g. the Mohave and the Chihuahuan. The paper describes mitigation and adaptation strategies being developed, but notes the lack of certainty in their outcomes.

In Chapter 9, *Ajai* and *P. S. Dhinwa* describe the challenges of managing negative impacts of climate change on the extensive aridlands of India and the huge population living there. Plans have been developed to combat the major threat to livelihoods posed by land degradation and desertification. However, recent increases in seasonal climate variability with longer and more severe droughts and water shortages are slowing progress towards adoption of more strategic good management goals. Irrigated agriculture, which is an important practice in the arid regions, is vulnerable to water shortages,

but is at the same time a critical component in adaptive strategies, and more water efficient agriculture is presented as a critical need.

Chapter 10 by *Shiming Ma* examines the drylands of China, which include the extensive Gobi and Taklamakan Deserts as well as numerous smaller deserts. While the problems are large, significant progress by China over the past approximately 60 years towards stabilising mobile sand dunes, reducing dust and sand storms, rehabilitating millions of hectares of degraded lands and lifting millions of people out of poverty is presented as significant cause for optimism for the future.

Chapter 11 by *Ahmed Mohamed* and *Victor R. Squires* focusses on the large tracts of drylands around the shores of the Mediterranean Sea. The WANA (West Asia and North Africa) region and the MENA (Middle East and North Africa) face some common challenges as well as regional differences in implementing programs to mitigate and adapt to climate change. The authors outline the major issues for these regions, and reference similarities and differences confronting countries on the north side of the Mediterranean and their efforts to deal with land degradation, biodiversity loss and threats to livelihood.

Part IV Southern Hemisphere Aridlands: Selected Examples

Chapter 12 by *Klaus Kellner, Graham von Maltitz*, *Mary Seely*, *Julius Atlhopheng* and *Lehman Lindeque* provides a comprehensive overview and analysis of problems and prospects facing the aridlands of Southern Africa (Botswana, Zimbabwe, South Africa and Namibia). Many land users in the arid and semiarid areas of Southern Africa remain highly dependent on natural resources such as soil, vegetation and water for their livelihoods. Compared to the true arid lands, semi-arid areas have higher population densities and more intensive land use practices. As a result, they are more at risk of accelerated land degradation through processes such as loss of vegetative cover, increase in alien and invader species, bush encroachment, change in species composition and loss of habitats. The authors discuss the impact of projected climate change in exacerbating these problems.

In Chapter 13, *Carlos Busso* and *Osvaldo Fernandez* analyse the challenges facing land users in arid and semiarid rangelands of Argentina in the face of current and future climate changes. The authors argue that land use changes are already having negative impacts on vegetation, and the situation is being made worse by climate variability. A change identified as being of particular importance is the increasing colonisation of higher elevations by plant communities as climates warm.

Chapter 14 by *David Eldridge* and *Genevieve Beecham* provides an analysis of issues for the large areas of Australia classified as dryland, which include several true deserts and a large tract of semiarid and dry subhumid land. Climate variability data and model predictions show that increasing climate variability and other changes in climate will affect the viability of rural communities. The analysis indicates climate change will result in decreased production and a reduction in community size, which will generally lead to an increase in social burden and decline in services such as infrastructure and health. Environmental impacts of climate change are expected to include reduced ground-storey plant cover, reduced livestock and crop yields, decline in quality of pastoral land, increased land degradation and soil nutrient loss. The authors conclude that overall, the adaptive capacity of rangeland managers will depend on their financial and social resilience and their ability to innovate and access new information, with government intervention needed to address policy and social constraints to climate adaptation.

Part V Summary, Synthesis and Concluding Remarks

In Chapter 15, *Mahesh Gaur* and *Victor Squires* summarise the challenges and opportunities faced by inhabitants of aridlands/drylands. The characteristics and implications of global changes are discussed using the concept of the water, soil, food, energy nexus as a guiding framework. The long-term future of traditional land uses, especially arid zone pastoralism, are discussed in the light of environmental, economic, social and political changes.

Chapter 16 by *Victor Squires* and *Mahesh Gaur* synthesises the information and analyses in the first 14 contributions in the book. They conclude that the likely impact of global change (including climate change) on the lands and its peoples will be profound. While there may still be time to adapt, the pace of change and the dire circumstances in which many inhabitants now live makes this challenging, especially when coping mechanisms are no longer sufficient and more transformational adaptation become necessary. The authors conclude that the pace of change and existing degradation over much of the world's aridlands raise serious concerns about the future of the land and its peoples over the next 20–50 years. Finally, they identify research priorities and express a fervent hope that various initiatives such as the UNEP Land Degradation Neutrality initiative may achieve their targets.

General Assessment

The 21 contributors from eleven countries to this book together represent a substantial body of experience in the ecology and management of drylands around the world. Their papers provide expert analyses that draw together data and research in disciplines of ecology, agricultural production, sociology and economics to explore the effects of climate variability and global change on productivity and natural resource management in aridlands and drylands across a range of countries and cultures.

This book assesses the challenges of natural climate variability (temperature and amount and reliability of rainfall) in the water-dependent drylands and how they will be exacerbated by global changes. The editors sought to provide a clarity on the key themes of 'drylands' and 'global change' – terms which vary in use in the published literature. Alternative references to drylands and aridlands in different regions and studies was accommodated by the combined term drylands/aridlands. To clarify that global change is a broader term, encompassing socio-ecological and economic concepts as well as climate change, 'global change (including climate change)' is often used. While somewhat awkward and there is some loss

in readability, this approach was reasonably successful in reminding the reader of the meaning and intent.

Several papers provide evidence that regional climate changes are already being experienced, and that they are affecting the culture, health, economies and lifestyles of peoples as well as agricultural productivity. Many of the contributions describing regional examples give little cause for optimism for the future viability of dryland ecology and the communities that depend on these regions for their livelihood. Several authors describe a serious risk that acceleration of environmental degradation under future global change will threaten vital community infrastructure and, in turn, lead to forced displacement and relocation in some areas. With changes such as reduction in precipitation and higher evapotranspiration rates, aridity will increase. As a result, there will be more prolonged droughts, reduced soil moisture, and intensified stress on vegetation and local water sources. These effects, which are already being experienced in some regions, suggest that some agricultural and pastoral production is at risk under projected climate change. Together, the analyses of climate variability in drylands give a concerning picture that existing climate stresses on local livelihoods will be even worse under global change. The accelerating pace at which change is occurring heightens the risk and this, with the already dire conditions in some dryland regions, will seriously challenge the capacity of dryland managers to implement adaptation strategies in time to avoid profound negative impacts. Perhaps the most optimistic example in the entire book comes from China where significant progress has been made in combating degradation and desertification in some of the harshest and most densely populated environments, albeit from a baseline characterised by severe degradation.

A common theme across many of the contributions is the urgency for more comprehensive and proactive policy and governance interventions to guide adaptive management across different socio-economic and cultural circumstances and improve the resilience of the world's drylands. The global importance of the drylands that occupy around half of the land area and support over a billion people emphasises the need for concerted effort to ensure the success of existing initiatives such as Land Degradation Neutrality, and supporting research to facilitate strategies to mitigate future impacts. The social and cultural dimensions, including implications for factors such as food security, water availability and traditional ways of life, are also emphasised. Climate variability and global change threaten not only established practices in industrial farming systems, but also systems relying on traditional knowledge practised by some of the world's most vulnerable peoples.

The world's drylands are extensive and diverse, and a multi-stakeholder approach is undoubtedly needed to address the challenges of climate variability and global change. Too much emphasis on the need for policy and new technology (including climate forecasting) should not delay implementation of actions. The information in this book, including regionally specific examples providing new data and analyses relevant to development of more local strategies, provides a foundation for adaptation to the problems and opportunities identified under climate variability and changes already being experienced. These changes will affect the welfare and livelihoods of the millions of people who live in dryland regions, including some of the most economically disadvantaged peoples of the world. It is perhaps too critical to suggest that the book could have included a stronger focus on identifying mitigation options and next steps to avoid the worst of the projected impacts. Incremental changes now will provide a platform for future sustainability of the production and socio-ecological values, including biodiversity and cultural richness, of drylands/aridlands. Overall, *Climate Variability Impacts on Land Use and Livelihoods in Drylands* represents a valuable collation of knowledge and data across the extensive and diverse dryland for land use change specialists, policy makers and natural resource management agencies.

Conflicts of interest

The author declares no conflicts of interest.

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