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Himangana Gupta *Editors*

Climate Change, Food Security and Natural Resource Management

Regional Case Studies
from Three Continents

 Springer

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Mohamed Behnassi • Olaf Pollmann
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About the Publishing Institution



The Center for Research on Environment, Human Security and Governance (CERES)

The CERES, previously the North-South Center for Social Sciences (NRCS), 2008–2015, is an independent and not-for-profit research institute founded by a group of researchers and experts from Morocco and other countries. The CERES aims to develop research and expertise relevant to environment and human security and their governance from a multidimensional and interdisciplinary perspective. As a think tank, the CERES aspires to serve as a reference point, both locally and globally through rigorous research and active engagement with policy-making processes. Through its research programme, the CERES aims to investigate the links between environmental/climate change, their implications for human security and the needed shifts to be undertaken in both research and policy. The CERES, led by Dr. Mohamed Behnassi and mobilizing a large international network of researchers and experts, aims to undertake original research, provide expertise and contribute to effective science and policy interactions through its publications, seminars and capacity building.

Preface

The world is facing increasing challenges due to climate change, resource shortage, food insecurity and resulting land use conflicts. The impact of climate change is multi-sectoral, and it could significantly increase resource conflicts and debilitate the condition in many developing countries across Africa and Asia. Many researchers assume that Africa will be among the regions hardest hit by climate change – although this continent causes the least damage to the climate. Certainly, climate change is taking place – and even progressing faster than expected. We have to acknowledge that climate change is influencing all aspects of human life – the environment, biodiversity and even the security of life.

Twenty-five years after the trend-setting “United Nations Conference on Environment and Development” (UNCED) also known as Rio de Janeiro Earth Summit or *Rio-Conference*, climate research has acquired an extremely political connotation. No doubt, climate research in general has been a crucial factor for the adoption of the *Paris Agreement (Accord de Paris, December 2015)*. More than 55 countries accounting for more than 55% of global emissions have ratified the Paris Agreement. The Agreement entered into force on 4 November 2016 just before the commencement of COP-22 in Marrakech. This timeline is particularly remarkable considering that the ratification of the *Kyoto Protocol* took more than 7 years.

It is worthwhile to note that many important countries have ratified the agreement, not only China and the USA but also emerging economies such as India and Brazil. The USA, however, has decided against the world to step out of the globally significant agreement to curb climatic change. There is hope that US decision will galvanize the world community further, as Paris Agreement is an ambitious effort to limit global warming well below 2 °C.

Warming of the climate system is unequivocal, and the impacts of unchecked climate change will be disastrous. Therefore, purposeful and rapid climate action from all states is necessary and efforts have to be stepwise tightened. For this, States will have to revise their contributions to the agreement every 5 years as a part of the global stocktaking exercise. The stocktake will show the progress towards target fulfilment in terms of climate protection, adaptation, capacity building, technology transfer and finance. Science will provide the indicators that can be used to measure global progress.

With the Paris Agreement in place, it is essential also to discuss the directly linked Sustainable Development Goals (SDGs). Since the adoption of the SDGs, considerable efforts are being made to achieve them. This volume contributes to the on-going debates in climate and SDGs including “Zero hunger” (Goal 2), “Good Health and Well-being” (Goal 3), “Clean Water and Sanitation” (Goal 6), “Responsible Consumption and Production” (Goal 12), “Climate Action” (Goal 13), “Life on Land” (Goal 15) and “Partnerships for the Goals” (Goal 17). It explores the linkages between environmental change and food security as well as the relevance and need to consider the management of natural resources, especially water, soil and forest.

The research on climate change and food security nexus has gained prominent importance in the recent years, but there is still much gap in assessing the local and regional conditions that result in failure of certain policies. Rather, it leads to a reduction in the adaptive capacity of indigenous peoples. Compared to other relevant publications on the subject, this book brings to us the solutions for the gravest problems in the most vulnerable region. It brings together case studies from different regions, particularly Asia and Africa, and discusses the local level implementation of celebrated policies. The document follows an interdisciplinary approach linking science to policy making. Forty-one authors have contributed their research to this volume giving useful insights into their region explaining present and possible problems and their innovative solutions.

The volume is divided into 3 parts with 17 chapters. To develop an understanding of the basic problems and the nexus between each sector, soil, water and forest, an interconnectedness between the three parts has been maintained. While the *first* part of the volume talks about food security versus environmental and socio-economic dynamics, the *second* part follows with the linkages between the three sectors. The text in these two parts flows from examining the implications of climate-, water- and food-Nexus for policy making, research and business, including examples and case studies from Yemen, Casablanca, Saudi Arabia and India. It finds solutions for realizing food security through sustainable agriculture or ensuring food security through increasing water productivity. A variety of case studies in part II provide examples of how climate change impacts water supply systems and water requirements and how can water security be assured, also mentioning about impacts of soil degradation on agricultural production. The *third* part focuses on the forestry aspects, the maintenance of which is central to climate adaptation, soil health, agricultural diversity and water health. The detailed structure and approach adopted in this contributed volume is as follows:

Part I “Food Security Versus Environmental and Socio-economic Dynamics”

In Chap. 1, Mohamed Behnassi analyses the links between energy, water and food within a climate perspective and their implications for policy-making and governance. As these three interdependent resources are under growing pressure across the world (rising demand, overexploitation and pollutions, climate change, etc.), with many risks of insecurity especially for vulnerable communities in the Global South, it is increasingly imperative to address these resource systems simultane-

ously. The author focuses on the concept of the water-energy-food (WEF) nexus which has become widely used to help understand the complexities of these interdependent systems and how they can be managed sustainably and equitably to meet growing demand. In addition to addressing conflicts or trade-offs among the water, energy and food sectors, this approach to planning and resource management emphasizes the need to improve efficiencies in resource use to reduce environmental degradation and maximize the social and economic benefits of increasingly scarce natural resources.

In Chap. 2, Baig et al. focus on sustainable agriculture as a means to realize food security in the Republic of Yemen. According to the authors, agricultural extension can play a critical role in addressing the issues faced by the agricultural sector and help in enhancing food supplies. The chapter provides in-depth analyses of the issues and challenges that render the National Agricultural Extension Services (NAES) ineffective and inefficient in the country. The authors say that if appropriate measures are taken in letter and spirit to improve the National Extension Service, it can help the country realize sustainable agriculture.

Mouchrif et al. in Chap. 3 consider increasing water productivity and cereal yields forecasting as major tools for ensuring food security in Casablanca. The chapter is essentially oriented towards the study of water productivity (WP) of rain-fed wheat as an indicator of agricultural development related to water management, and winter soft wheat yields forecasting in the rural commune of Ouled Saleh. The results indicate that water productivity is low and has to be improved.

Chapter 4 focuses on the wastage of food as one of the primary causes of food insecurity in the Kingdom of Saudi Arabia. Al-Zahrani et al. mention that about 78% of food purchased in Kingdom of Saudi Arabia (KSA) and United Arab Emirates (UAE) is thrown in the garbage and food leftovers make the single-largest component of the landfills. The chapter examines the factors responsible for food wastage in the Kingdom, besides determining the implications for extension education to reduce such wastage.

In Chap. 5, Baig et al. focus on innovation extension as a means to realize food security in Egypt. The chapter examines the present functioning of extension system and identifies the constraints faced by the agriculture sector and the shortcomings of the agricultural extension department. The authors suggest improvement measures and viable development strategies for improving the working of extension system. Such a case has also been presented for Yemen (Chap. 2), and the results are comparable.

Chapter 6 presents an interesting case in which the food production is increasing but the per capita availability of food is declining. Pal et al. analyse the state of declining foodgrain availability in India despite record agricultural production and rising food subsidy. The authors find that the availability of food declined consistently from its peak of 186.19 kg per person in 1991 to the bottom of 146.51 in 2013. The study also found that the correlation coefficient of per capita net availability with subsidy was low at 0.19 but the correlation of subsidy with agricultural production was high at 0.91. The authors focus on the present government policies and resolutions for food management and the reasons as to why the present policies have not been able to address the problem of food availability in the country.

Finance is also an important player in ensuring food security. Podrzensik and Pollmann in Chap. 7 investigate the importance of the European Union (EU) as an important player in global food security. The chapter gives an overview of the processes of designing and implementing initiatives, building cooperation with governments and participation in partnerships to facilitate change in developing countries, as well as measures taken with the help of financial instruments at EU-level. According to the authors, food security should be guaranteed through investment, training, research and balancing local, regional and global markets and trade. Interestingly, the chapter also focuses on the responsibility of recipient countries.

In **Part II** “*Climate, Water, Soil and Agriculture: Managing the Linkages*”

In Chap. 8, Karmaoui et al. analyses the impact of climate change on water demand in the Middle Draa Valley of south of Morocco. The study is based on the outputs of two software runs under socio-economical and climate change scenarios. The result predicts increase in mean temperatures from 1.4 °C to 3 °C and decrease in precipitation by approximately 3.9% to 15% in a number of scenarios considered in the study. The authors conclude that the study area will suffer from a lack of water supply due to the impact of climate change and the increase of water demand, which will be accelerated by high population growth.

Alomran et al. in Chap. 9 determine the water requirements by a date palm in Saudi Arabia. The authors provide information on the determination of monthly and annual water requirements by date palm in eight different regions of Saudi Arabia. They report a decrease of the crop water requirement (CRW) in all sites of study to around 8000 m³/ha, which is mainly attributed to percentage of shaded area of date palm tree.

Chapter 10 focuses on the contribution of the Corporate Social Responsibility (CSR) to water protection in the Maghreb region. Abdelhafid Aimar talks about the threat to water security in the region and explains that engineering of a new water approach is crucial to reduce social vulnerabilities, secure safe water supplies and ensure water security in the region. With this background, the author examines whether the involvement of the business sector can abate the threats of water deterioration in the region and how CSR could allocate resources to positively and effectively impact the use of valuable water resources, control water contamination risks and sustain water resource management.

Chapter 11 looks at the impact of soil degradation on agricultural production in Africa. Olaf Pollmann and Szilárd Podrzensik describe the potential of soil quality and soil efficiency to create the linkage between agricultural soil treatment and local economic success on the African market. They conclude that it is important for each African country to establish land use concepts to decouple organic farming of small farmers from bigger commercial communities. This decoupling process could keep the soil fertility for small farming communities while other profit-yielding agriculture will support the regional economy.

In Chap. 12, Hind Mouhanni and Abdelaziz Bendou evaluate the feasibility and effects of the reuse of treated wastewater which contains higher concentration of soluble salts compared to groundwater on plant, soil and leachate. The authors conclude that the use of treated wastewater for irrigation presents a risk of salinization

for the groundwater, and especially in the case of heavy textured soils. Therefore, caution in the management of irrigation intakes to prevent the accumulation of salts in the rhizosphere must be taken into consideration.

In Chap. 13, Sergiy et al. investigate the eco-service role of soil saprophages in the formation of sustainable man-made ecosystems under forest plantations. The authors found that earthworm eco-service activity had positive impact on environmental conditions of remediated soil. Environmental quality of remediated soil enriched in earthworm casts was confirmed to be improved.

Part III “Forest Management from a Climate Change and Sustainability Perspective”

In Chap. 14, Himangana Gupta talks about REDD+ as a multi-sectoral approach and the role of stakeholders in making climate mitigation and adaptation projects a success. The study also integrates expert views of scientists on implementing REDD+ as an effective adaptation mechanism. The author concludes that effective governance, increased stakeholder participation and synergizing the programme with watershed management initiatives can help yield full potential of REDD+.

Chapter 15 captures the conservation aspect of REDD+. Lokesh Chandra Dube analyses the twin objectives of conserving carbon and biodiversity through results based payments coming from the implementation of REDD+ activities in tropical countries. The author has made an assessment of international carbon markets and biodiversity markets to find out the possible ways to amalgamate these two.

In Chap. 16, Lauren Kathleen Sanchez studies the carbon dynamics at Harvard forest and ecological responses to changes in the growing season. The author hypothesized and modelled the phenological and ecosystem function responses to changes in the growing season. The author concludes that both photosynthetic growing season and cumulative ecological degrees were highly correlated to aboveground woody increment, which is an important driver of carbon uptake. Additionally, changes in the growing season were most strongly correlated to soil temperatures below the surface.

Chapter 17 captures the sustainability aspect through participatory governance. Baig et al. talk about ensuring sustainability in forests through the participation of locals. The authors assess the role of forestry extension programmes in educating stakeholders involved in planning, developing policies and undertaking institutional measures aiming at improving the existing forests. They also provide information on the challenges and constraints currently faced by forests and discuss the possible roles of participatory management approach in improving the situation and moving towards a sustainable future.

In a nutshell, this book sheds light on the scientific and policy aspects of the discourse about climate change, food security and natural resource management, and in particular, the perspectives on water, soil and forest. Since the book is a useful collection of case studies from Africa, Asia and Europe, it will encourage cross-continental knowledge sharing. The scope of the book ranges from impacts to mitigation and from in-field experiments to policy implementation. It contributes to the existing knowledge on climate-food nexus and connects climate change to sec-

tors it could impact directly. All chapters and principles in the three parts of this book emphasize local ownership of strategy processes, effective participation from all levels and high-level commitment. They point out the importance of convergence and coherence between different planning frameworks, integrated analysis and capacity development. Besides being relevant for the academicians and scholars working in the field of climate change, forest and agriculture, it aims to catch interest of the policy makers and practitioners to understand ground realities for appropriate action. It is also bound to make an impact on the non-governmental organizations around the world and in the three different continents that this book covers, considering the indigenous and local issues highlighted in this book.

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Acknowledgements

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The content and approach of this volume are mainly based on the empirical research undertaken by the majority of co-editors and chapter’s authors in many parts of the world in relation with the core topics covered by this publication.

I have been honoured to chair the HES2015 and to share the editorship of this volume with my colleagues: Dr. Himangana Gupta (Programme Officer, National Communication Cell, Ministry of Environment, Forest and Climate Change, New Delhi, India) and Dr. Olaf Pollmann (North-West University, School of Environmental Science and Development, South Africa). Their professionalism, expertise and intellectual capacity made the editing process an exciting and instructive experience and definitely contributed to the quality of this publication. The editorial team has managed to ensure the depth, relevance and accuracy of the analysis both theoretically and empirically. Based on this, I wholeheartedly thank them for their trust, perseverance and valuable contribution making the whole publishing process a true success.

The chapters in this volume are also the result of the invaluable contributions made by our peer-reviewers, who generously gave their time to provide insight and expertise to the selection and editing process. On behalf of my co-editors Himangana Gupta and Olaf Pollmann, who actively participated in the peer-review process, I would specifically like to acknowledge, among others, with sincere and deepest thanks the following colleagues: Raj Kumar Gupta (Independent Journalist and

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Agadir, Morocco

Mohamed Behnassi

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Mohamed Behnassi, PhD, is specialist in environment and human security law and politics. After the obtention of his PhD in 2003 from the Faculty of Law, Economics and Social Sciences, Hassan II University of Casablanca for a thesis titled: *Multilateral Environmental Negotiations: Towards a Global Governance for Environment*, he joined the Faculty of Law, Economics and Social Sciences, Ibn Zohr University of Agadir, Morocco, as Assistant Professor (2014). In 2011, he obtained the status of Associate Professor and in 2017 the status of Full Professor. He served as the Head of Public Law Department (2014–2015) and the Director of the Research Laboratory for Territorial Governance, Human Security and Sustainability (LAGOS) (2015–present). In addition, Dr. Behnassi is the Founder and Director of the Center for Environment, Human Security and Governance (CERES) (former North-South Center for Social Sciences (NRCS), 2008–2015). Dr. Behnassi is also Associate Researcher at the UMR ESPACE-DEV, Institute of Research for Development (IRD), France. In 2011, he completed a US State Department-sponsored Civic Education and Leadership Fellowship (CELF) at the Maxwell School of Citizenship and Public Affairs, Syracuse University, USA, and in 2014, he obtained a Diploma in Diplomacy and International Environmental Law from the University of Eastern Finland and the United Nations Environment Programme (UNEP), Finland. Dr. Behnassi has pursued several postdoctoral trainings since the completion of his Ph.D.

His core teaching and expertise areas cover environmental change, human security, sustainability, climate change politics and governance, human rights, CSR, etc. He has published numerous books with international publishers: *Environmental Change and Human Security in Africa and the Middle East* (Springer 2017); *Vulnerability of Agriculture, Water and Fisheries to Climate Change* (Springer 2014); *Science, Policy and Politics of Modern Agricultural System* (Springer 2014); *Sustainable Food Security in the Era of Local and Global Environmental Change* (Springer 2013); *Global Food Insecurity* (Springer, 2011); *Sustainable Agricultural Development* (Springer, 2011); *Health, Environment and Development* (European University Editions, 2011); and *Climate Change, Energy Crisis and Food Security* (Ottawa University Press, 2011). He has also published numerous research papers and made presentations on these at international conferences. In addition, Dr. Behnassi has organized many international conferences covering the above research areas in collaboration with national and international organizations and managed many research and expertise projects on behalf of various national and international institutions. Behnassi is regularly requested to contribute to review and evaluation processes and to provide scientific expertise nationally and internationally. Other professional activities include Social Compliance Auditing and consultancy by monitoring human rights at work and the sustainability of the global supply chain.



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Abbreviations and Acronyms

| | |
|-------|---|
| AAV | Antyodaya Anna Yojana |
| ABHO | Agence du bassin hydraulique d'Ouarzazate |
| ACP | African, Caribbean and Pacific countries |
| AES | Agricultural Extension Service |
| AFED | Arab Forum for Environment and Development |
| APL | Above Poverty Line |
| AREA | Agricultural Research and Extension Authority |
| BPL | Below Poverty Line |
| CACP | Commission for Agricultural Costs and Prices |
| CBD | Convention on Biological Diversity |
| CDM | Clean Development Mechanism |
| CERES | Center for Research on Environment, Human Security and Governance |
| CFRN | Coalition for Rainforest Nations |
| CIP | Central Issue Price |
| COP | Conference of Parties |
| CRW | Crop water requirement |
| CSR | Corporate social responsibility |
| CWD | Coarse woody debris |
| DCI | Development Cooperation Instrument |
| EEAS | European External Action Service |
| ESCAP | Economic and Social Commission for Asia and the Pacific |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| FCI | Food Corporation of India |
| FEC | Food Entitlements Card |
| FIRST | Food and Nutrition Security Impact, Resilience, Sustainability and Transformation |
| FSI | Forest Survey of India |
| FSTP | Food Security Thematic Programme |
| FWD | Fine woody debris |

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| GCC | Gulf Cooperation Council |
| GCMs | Global climate models |
| GDP | Gross domestic product |
| GFI | Goodness of fit index |
| GHG | Greenhouse gas |
| GHI | Global Hunger Index |
| GPGC | Global Public Goods and Challenge |
| GW | Groundwater |
| HCP | Haut Commissariat au Plan |
| ICDS | Integrated Child Development Services |
| ICT | Information and communication technology |
| IFAD | International Fund for Agricultural Development |
| IFPRI | International Food Policy Research Institute |
| INFORMED | Information for Nutrition, Food Security and Resilience for Decision Making |
| INRA | National Institute for Agronomic Research |
| ISO | International Organization for Standardization |
| ITCZ | Intertropical Convergence Zone |
| JICA | Japan International Cooperation Agency |
| KAN | Knowledge-Action Network |
| KSA | Kingdom of Saudi Arabia |
| LAGOS | Research Laboratory for Territorial Governance, Human Security and Sustainability |
| LAI | Leaf area index |
| LTER | Long Term Ecological Research |
| LULUCF | Land Use, Land Use Change and Forestry |
| MAW | Ministry of Agriculture |
| MDGs | Millennium Development Goals |
| MDV | Middle Draa Valley |
| MENA | Middle East and North Africa |
| MIS | Marketing information system |
| MSP | Minimum Support Prices |
| NAES | National Agricultural Extension Service |
| NAPAs | National Adaptation Programmes of Action |
| NASS | National Agriculture Sector Strategy |
| NCWCD | National Commission for Wildlife, Conservation and Development |
| NEE | Net ecosystem exchange |
| NREGS | National Rural Employment Guarantee Scheme |
| NTFP | Non-timber forest Products |
| OCTs | Overseas countries and territories |
| ONEE | Office national d'Electricité et d'Eau potable |
| ORMVAO | Office régionale de mise en valeur agricole d'Ouarzazate |
| PDS | Public Distribution System |
| PRA | Participatory Rapid Appraisal |
| RED | Reducing Emission from Deforestation |

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| REDD+ | Reducing Emissions from Deforestation and Forest Degradation in Developing Countries |
| RIWA | Rationalization of the Irrigating Water in Agriculture |
| RMSE | Root mean square error |
| RMSEA | Root mean square error of approximation |
| RWP | Rainwater productivity |
| SAR | Sodium adsorption ratio |
| SBSTA | Subsidiary Body for Scientific and Technological Advice |
| SDGs | Sustainable Development Goals |
| SDSM | Statistical Downscaling Models |
| SEM | Structural equation modelling |
| SUN | Scaling Up Nutrition |
| TBL | Triple bottom line |
| TPDS | Targeted Public Distribution System |
| TWW | Treated wastewater |
| UAE | United Arab Emirates |
| UGC | University Grants Commission |
| UNDP | United Nations Development Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | United Nation Framework Convention on Climate Change |
| USAID | US Agency for International Development |
| USDA | US Development Agency |
| USGS | US Geological Survey |
| VPD | Vapour pressure deficit |
| WBCSD | World Business Council for Sustainable Development |
| WEAP | Water Evaluation and Planning system |
| WEF | Water-Energy-Food |
| WFP | World Food Programme |
| WP | Water productivity |
| WTO | World Trade Organization |

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