Mohamed Behnassi
Katriona McGlade
Editors

Environmental Change and Human Security in Africa and the Middle East

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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 end of the Cold War signalled the beginning of a process that changed and developed our understanding of the concept of security. Security has now evolved beyond the narrow frame of preventing state conflict into a broader notion that concerns the protection of individuals (MacFarlane and Khong 2006). In 1994, the landmark UNDP Human Development Report (HDR) proposed the concept of 'human security' in recognition of the need to focus on attaining greater societal resilience and improved environmental conditions, especially for the most vulnerable (UN 2006). This more holistic approach encompassed economic, food, health, environmental, personal and community security that should be ensured to protect individuals from negative impacts. Human security inseparably links humans, their social systems and their environments and strives to achieve freedom from fear, freedom from the impacts of natural hazards and freedom from want by reducing natural and social disruptions (Warner et al. 2008). Nevertheless, it is only now, at the beginning of the twenty-first century, that the effects of environmental and climate change– such as extended droughts and extreme hurricanes, disease, decline of natural resources and resulting migration – are beginning to shape a new and more urgent need for the human security paradigm (Ibid: 48).

The human security paradigm has been – and continues to be – debated and informed by many disciplines, by studies using diverse methods of enquiry and by UN institutions, scholars and advocates in every region of the world. The relevance and growing importance of this emerging imperative has been underlined by the Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5), which includes the first systematic assessment across the various dimensions of this concept (Adger et al. 2014). This focus, from a global scientific authority, is evidence that the human security paradigm is increasingly relevant – both in terms of how to define global environmental change and how to address its impacts. The AR5 defines human security, in the context of climate change, as a condition that exists when the vital core of human lives is protected and when people have the freedom and capacity to live with dignity. The AR5 report's authors find that despite the uncertain interactions between multiple factors, there is robust evidence to suggest that human security will be progressively threatened as the climate changes;

climate change undermines livelihoods, compromises culture and individual identity, increases migration that people would rather have avoided and can undermine the ability of states to provide the conditions necessary for human security (Ibid). Despite these findings, the AR5 also makes clear that there is a need for more comprehensive evidence, collected across multiple locations and over long durations, to build and test theories about relationships between climate change and livelihoods, culture, migration and conflict. It is in response to and in contribution to this need that this volume has been conceived.

In recent years, it has become clear that reaching a consensus on the use and meaning of 'security' and 'human security' is not straightforward, particularly as their meaning is constantly shifting in relation to policy debate, media commentary and academic discussion. However, the need to take environmental change seriously and to find practical approaches and solutions undeniably justifies the need to continue these discussions. This volume aims to contribute to these debates, exploring linkages between environmental change and human security as well as the relevance and need to consider human security as a framework for shaping perceptions and action on environmental change.

Contemporary political discussions on environmental change have focused in particular on the question of our changing climate. Yet climate change is a dynamic process that is interconnected with a much wider range of concurrent environmental transformations. A variety of anthropogenic pressures such as rapid deforestation, decimation of fish populations, urbanization, mining, farming and damming of rivers are also causing dramatic changes to our physical world. Pascual et al. (Chap. 4) show how a range of such pressures combine with climate change to produce a particular set of challenges in the Intercontinental Biosphere Reserve of the Mediterranean (Morocco and Spain). Above all, these changes to our environment signify consequences for people, a point highlighted, for example, in Chaps. 1, 7 and 8. Increased exposure and vulnerability as well as a heightened risk to human populations and their security are among the impacts of environmental change that are of increasing concern to academics, civil society and politicians alike and which form the central focus of the contributions to this volume.

The range of issues encompassed by the human security paradigm is reflected in this volume, for example, with focus on health in Chap. 7 and food in Chap. 16, and Part III is dedicated to the particularly pertinent regional problem of water. Indeed, the concept of security has not only been 'stretched' horizontally to embrace a wide range of topical issues but also has a vertical plasticity that embraces both regional and global structures as well as local and individual identities (McIntoch and Hunter 2010). This appearance of human security at different levels is discussed in detail in Chap. 3 which looks at the use of the human security concept at UN and EU level as well as at national level.

Broadening existing national and international security concepts to encompass a wide range of meanings may seem, on the one hand, a simple question of their inclusion. Yet a truly human security-led approach requires, in its fullest articulation, a conceptual realignment of our understanding of human well-being with a profound impact on the organization of our social, ecological and political priorities.

Similarly, although it is crucial to develop specific strategies to directly mitigate and adapt to environmental change, it is a much broader approach that takes economic and societal strategies into account that is necessary if we are to truly address environmental change and the challenges it presents to human security. While acknowledging that full protection of human security may rely on our capacity to rethink conventional governance frameworks, we are not operating with a tabula rasa nor in a vacuum from competing approaches and concerns. Thus, without consideration of the complexity of the existing paradigms and dynamics that govern our socio-ecological systems and decision-making processes, it is unlikely that attempts to promote human security approaches can be sustainable. This is particularly apparent in the discussion in Chap. 3 which demonstrates that while human security can provide a useful conceptual framework, its practical application and connection to other policy areas directly influences its acceptability and adoption.

Based on this background, the approach adopted in this contributed volume is structured as follows:

The contributions to Part I examine the human security dimensions of global environmental change and how these intersect with other strands of action on environmental change such as climate change adaptation, socio-ecological strategies and development policy. In Chap. 1, coeditor Mohamed Behnassi investigates the links between climate change and security by highlighting key biophysical, human, economic and geopolitical impacts of climate change and their security implications, examining the extent to which these implications are currently well-managed and assessing the usefulness of 'climate security' as a framework for boosting climate change policy and governance. The analysis draws the conclusion that if climate security concerns are underestimated, we must expect and find ways to manage future security challenges. In this way, he suggests that a climate security framework helps to adopt preventive and security-sensitive responses to climate risks, with the potential to generate new dynamics within climate policy and governance. In a second chapter, El Fellah and Behnassi discuss the relationship between environmental change and dominant development pathways and demonstrate how the current discourse often disregards the interlinkages between growing social injustice and the ever-increasing environmental crisis. The authors conclude that fighting social vulnerabilities must be at the heart of policy responses to the global environmental change in order to prevent threats to human security. In Chap. 3, McGlade et al. analyse the relevance and usefulness of the concept of human security in the context of climate adaptation policy-making. They find that, while the concept can help frame initiatives and act as a rallying call to action, it is not a prerequisite for effectively ensuring human security. One element of ensuring human security is the physical protection of people from environmental changes, ensuring their health, safety and well-being.

In Part II, a variety of case studies provide empirical examples of how environmental change is impacting human security in the Middle East and African regions, divided into two sections: (1) physical impacts and (2) socio-economic impacts. In Chap. 4, Pascual et al. carry out a multidisciplinary assessment of the potential water vulnerability in the Intercontinental Biosphere Reserve of the Mediterranean

(IBRM) that lies in both Spanish and Moroccan territories. Their assessment of vulnerability includes the use of climate change scenarios, a hydro-ecological model and the participation of stakeholders and local experts. In Chap. 5, an impact assessment carried out by Deafalla et al. uses qualitative and quantitative techniques to map and assess the impact of environmental change on demographical dynamics and land use/land cover (LU/LC) change in the Nuba Mountains of Sudan. Chapter 6 looks at the situation in Nigeria, the most populous country in Africa. Suleiman Iguda Ladan finds that human security is seriously threatened by global environmental change, a situation aggravated by the lack of economic development and institutional capacity to mitigate and adapt to the changes. In Chap. 7, Kahime et al. assess the impacts of environmental change on human health and security in pre-Saharan North Africa. Their focus is on the dynamics and impacts of zoonotic cutaneous leishmaniasis (ZCL), a vector-borne disease widespread in most countries of the Mediterranean Basin including Morocco where it causes a public health problem that is worsening with changes in climate and unsustainable population activities. In Chap. 8, Niklas Baumert and Julia Kloos investigate a hypothetical vulnerability scenario for preventive resettlement as a response to sea level rise (SLR) in low-lying coastal zones (LLCZ). Taking the city of Alexandria in Egypt as an example, the authors argue that SLR-induced preventive resettlement can lead to the severe disruption of the livelihoods of certain social groups who then become vulnerable to displacement, unemployment and homelessness. Baumert and Kloos thus present a conceptual framework to anticipate the need for preventive resettlement and raise awareness of potential vulnerabilities and threats to human security.

In the second section, the broader socio-economic impacts of global environmental change form the focus of chapters by Madhumati Dutta and Nabil Sultan. In Chap. 9, Dutta takes us to India, looking at the rise of consumption in the population and the impacts of consumer behaviour on environmental change and accordingly for human security. Chapter 10 brings us to the Arab Gulf region where the population is heavily reliant on the revenues generated by oil and gas. Here, Sultan examines the emerging interest in shale gas and the social, economic and environmental implications of a changing energy supply.

Part III focuses on water security, a particular problem caused by environmental change and anthropogenic activity in the Middle East and Africa. It looks at differing regional manifestations of this question and provides evidence that many locations at the subregional level face imminent threats to water and food security, declines in agricultural production and potential socio-economic crises. Chapters in this section examine impacts at both local and global scales and highlight the interplay between policies for water security at both scales of observation. We begin with Antonelli et al. who examine water resources, food security and the role of virtual water trade in the Middle East and North Africa (MENA) region in Chap. 11. The study is the first comprehensive analysis of the virtual water trade phenomenon in the MENA. The authors find that the region is highly dependent on virtual water imports to ensure its water and food security. In Chap. 12, we travel to eastern Algeria, where Abdelhafid Aimar discusses how water scarcity, pollution and

water supply problems are obstructing the region's development, creating social tensions and affecting the quality of life and availability of drinking water. In Chap. 13, Özden Zeynep Oktav surveys Turkey's water policy and relations with its neighbours Iraq and Syria in terms of water scarcity in the Euphrates-Tigris Basin. Oktav finds that shared water resources can act as a source of cooperation as well as of conflict depending on the changing political, economic and security circumstances.

Finally, in Part IV, we present some critical perspectives and approaches for addressing the impacts of environmental change on human security. These chapters outline the need for a shift from both theoretical and practical standpoints and point to areas to be developed in future research. We begin with Chap. 14 by Olivier Barrière where the author investigates the human relationship to the land from a legal perspective and considers it as a human and environmental security challenge. In a context of global change, the human relationship to the land and its natural resources increasingly defines a key challenge to human and environmental security. From this relationship materializes an ecological dimension on which the humanity depends for its existence, well-being, health and development. However, current pressures on land, including the land grabbing phenomenon, that are growing worldwide and particularly in Africa place the land issue at the heart of the human and environmental security (through many problems such as food insecurity and climate change-induced displacements or 'climate refugees'). This issue is even considered as one of the main drivers of many current and potential violent conflicts. The author assumes that the human relationship to the land and its resources, and the resulting consequences, depends on how they are supported by relevant laws. The reason is that land-related laws are not subject to a unique thought since they are plural and diversified worldwide. In Chap. 15, Matsa et al. provide a detailed study of traditional and cultural approaches to food security and features of environmental change in the rural district of Beitbridge, Zimbabwe. They establish that impacts of environmental change on food security are gendered and that indigenous knowledge systems are an essential pillar of ensuring food security.

This volume provides insights from recent research on global environmental change and human security in the Middle East and Africa. These regions face particular challenges in relation to environmental degradation, the decline of natural resources and the security implications that existing and future trends in these areas may present. It touches on the scientific and policy features of the discourse with a focus on the particular regional challenge of climate change impacts on water resources and water security. Through the insights shared in this publication, the editors aim to contribute to the growing academic literature pertained to environmental change and human security while enhancing political discussions and policy agendas on how to address current and future challenges.

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I have been honoured to chair the GECS2012 and to share the editorship of this volume with my colleague Katriona McGlade, a fellow from Ecologic Institute, Germany, whose professionalism, expertise and intellectual capacity made the editing process an exciting and instructive experience and undeniably contributed to the quality of this publication.

The chapters in this volume are also the result of the invaluable contributions made by our peer-reviewers, who generously gave up their time to provide insight and expertise to the selection and editing process. On behalf of my coeditor Katriona McGlade, I would thus like to acknowledge, with sincere and deepest thanks, the following colleagues: Dr. Dania Abdul-Malak (senior environmental researcher, European Topic Centre for Spatial Information and Analysis, University of Malaga, Spain), Christiane Gerstetter (senior fellow, Ecologic Institute, Berlin, Germany), Rodrigo Vidaurre (fellow, Ecologic Institute, Berlin, Germany), Dr. Mohamed Aly Ramady (visiting associate professor, Department of Finance and Economics, College of Industrial Management, King Fahd University of Petroleum and Minerals, Saudi Arabia), Dr. Ian Alcock (research fellow, European Centre for Environment and Human Health, University of Exeter, UK), Dr. Ethemcan Turhan (Mercator-IPC fellow, Istanbul Policy Center at Sabanci University, Turkey), Dr. Prof. Jan Van Heerden (retired head of economics at Pretoria University, South Africa and former president of the African Econometric Society and deputy director of Economic Research Southern Africa) and Dr. Prof. Mohamed Tawfic Ahmed

(Environmental Impact Assessment Unit, Faculty of Agriculture, Suez Canal University, Egypt).

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Agadir, Morocco Mohamed Behnassi

Contents

List of Abbreviations and Acronyms

AEA	ASEAN Energy Awards
AET	Actual evapotranspiration
ANOVA	Analysis of variance
AR	Assessment report
BWTC	Bahrain World Trade Center
CAPMAS	Central Agency for Public Mobilization and Statistic
CCI	Climate Change Initiative
CDM	Clean Development Mechanism
CERES	Center for Research on Environment, Human Security and Governance
CFSP	Common Foreign and Security Policy
CGIAR	Consultative Group for International Agricultural Research
CLICO	Climate Change, Hydro-conflicts and Human Security
CNG	Compressed natural gas
COP	Conference of the Parties
CRED	Centre for Research on the Epidemiology of Disasters
CSDP	Common Security and Defence Policy
CSP	Concentrated solar power
CVD	Cardiovascular disease
DEAP	District Environmental Action Planning Programme
DFDR	Development-forced displacement and resettlement
EHSP	Environment and Human Security Program
EMA	Environmental Management Agency
ENEC	Emirates Nuclear Energy Corporation
ENVSEC	Environment and Security Initiative
EPHD	Errachidia Provincial Health Delegation
ERDAS	Earth Resources Data Analysis System
ESA	European Space Agency
ESS	European Security Strategy
EU	European Union
FANR	Federal Authority for Nuclear Regulation
FAO	Food and Agriculture Organization

GAP	Great Anatolian Project
GCC	Gulf Cooperation Council
GCMs	Global Circulation Models
GDP	Gross national product
GEC	Global Environmental Change
GECHS	Global Environmental Change and Human Security
GECS	Global Environmental Change and Human Security Conference
GED	Gender, Environment and Development
GHG	Greenhouse gases
GIS	Geographical information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GMES	Global Monitoring for Environment and Security
GNEII	Gulf Nuclear Energy Infrastructure Institute
GOLD	General Organization for Land Development
GOPP	General Organization for Physical Planning
HDR	Human Development Report
HEPP	Hydro-electric power plants
HSU	Human Security Unit
HVAC	Ventilation and air conditioning
IAEA	International Atomic Energy Agency
IBRM	Intercontinental Biosphere Reserve of the Mediterranean
ICBA	International Center for Biosaline Agriculture
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
INDH	National Initiative for Human Development
IPCC	Intergovernmental Panel on Climate Change
IRD	Institute of Research for Development
KACARE	King Abdullah City for Atomic and Renewable Energy
LAGOS	Research Laboratory on Territorial Governance, Human Security and Sustainability
LLCZ	Low-lying coastal zones
LPG	Liquid petroleum gas
LU/LC	Land use/land cover
MAB	Man and the Biosphere Programme
MDG	Millennium Development Goals
MENA	Middle East and North Africa
ML	Maximum likelihood
MMES	Middle East and Sahel
MPCE	Monthly per capita expenditure
NAPA	National Adaptation Programmes of Action to climate change
NASA	National Aeronautics and Space Administration Agency
NATO	North Atlantic Treaty Organization
NCD	Noncommunicable diseases

NDVI	Normalized difference vegetation index
NESTA	National Earth Science Teachers Association
NOAA	National Oceanic and Atmospheric Administration
NRCS	North–south Center for Social Sciences
OCHA	UN's Office for the Coordination of Human Affairs
OECD	Organisation for Economic Co-operation and Development
PACJA	Pan African Climate Justice Alliance
PCA	Post-classification analysis
PCD	Post-change detection
PET	Potential evapotranspiration
QEWC	Qatar's Electricity and Water Company
QST	Qatar Solar Technologies
ROI	Return on investment
SDG	Sustainable development goals
SLR	Sea level rise
SOER	State of Environment Reporting
SWAT	Soil and Water Assessment Tool
TERRA	Spaceborne Thermal Emission and Reflection Radiometer
TM	Landsat Thematic Mapper
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNTFHS	United Nations Trust Fund for Human Security
UNU-EHS	United Nations University, Institute for Environment and Human Security
USAID	United States Agency for International Development
USGS	United States Geological Survey
VOCs	Volatile organic chemicals
WCED	United Nations World Commission on Environment and Development
WDI	Water deficit index
WFP	World Food Programme
WGBU	German Advisory Council on Global Change
WHO	World Health Organization
WMO	World Meteorological Organization
ZCL	Zoonotic cutaneous leishmaniasis

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About the Editors and Contributors

Editors

Mohamed Behnassi, PhD specialist in environment and human security politics, is associate professor, director of the Research Laboratory for Territorial Governance, Human Security and Sustainability (LAGOS), and ex-head of Public Law Department (2014–2015) at the Faculty of Law, Economics and Social Sciences, Ibn Zohr University of Agadir, Morocco. He was the founder and director of the North–south Center for Social Sciences (NRCS) from 2008 to 2015 and is currently director of the Center for Research on Environment, Human Security and Governance (CERES). Dr. Behnassi is member of the Moroccan Association for Regional Sciences (AMSR) and active member of the National Council for Climate Change, Sustainable Development and Leadership (NCCSD), India. He is also senior social compliance auditor (practising consultancy by monitoring human rights at work and the sustainability of the global supply chain).

Dr. Behnassi obtained 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'. 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 PhD.

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 such as 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 also 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 institutions such as the Royal Institute of Strategic Studies (IRES) in Morocco (Food and health security face to climate change in Morocco), GIZ (Mainstreaming climate risk in local development planning), Carrefour Associatif and UNICEF (University Social Responsibility).

Katriona McGlade, MSc in international development, is a fellow and coordinator for International Development at the independent, not-for-profit think tank Ecologic Institute in Berlin, Germany. Katriona works on European environmental and international development policy, leading and contributing to a range of research and consultancy projects, both for the EU (European Commission, European Parliament) and for the German government (Federal Ministry of Education and Research, Federal Environment Agency, GIZ).

From 2010 until 2012, Katriona was engaged in a 3-year European research project funded under the European Commission's seventh Framework Programme (FP7). The Climate Change, Hydro-conflicts and Human Security (CLICO) project examined the impacts of climate change on water resources in the Mediterranean, Middle East and Sahel region and the consequences for conflict and human security. Katriona's other research has included analysis of governance and policy in the areas of climate adaptation, marine and freshwater environments, biodiversity, sustainability and international development. Her particular research interests include the interactions and trade-offs between sectoral policies, the impact of EU policies beyond European borders and the use of participatory processes to produce legitimate and equitable policy outcomes.

Katriona is involved in a number of activities that foster exchange and dialogue on environmental issues, and teaches visiting students from Mexico at the ITESM Summer School on Environment and Sustainability. She is responsible for coordinating Ecologic Institute's role in the British-German Environment Forum (BGEF), which facilitates exchange and discussion on issues of common environmental concern between the two countries. She has also coordinated stakeholder involvement

in Cooperation Across the Atlantic for Marine Governance Integration (CALAMAR), a transatlantic dialogue process on marine governance between the EU and the USA and is a member of the Ecoscholars Network that fosters regular professional and academic exchange on international environmental policy issues.

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Part I
Global Environmental Change as a Human Security Issue

Chapter 1
Climate Security as a Framework for Climate Policy and Governance

Mohamed Behnassi

Abstract There is growing evidence that the impacts of climate change have the potential to trigger or amplify many risks and vulnerabilities with the possibility of increasing the likelihood of tensionsand conflicts in many fragile countries. This may also undermine the ability ofsomegovernmentsto provide the conditions necessary for human security. Such evidence has recently pushed numerous actors from political, academic and public spheres toward framing climate change as a security issue due to the perceived advantages of establishing such a link. In line with this trend, this introductory chapter aims to address the linkages between climate change and its multiple security implications and the different benefits of mainstreaming climate security in key responses to global warming. After presenting the key economic, human, and geopolitical impacts of climate change and their security implications, this chapter discusses the extent to which these impacts are currently well-managed. Following this, the usefulness of 'climate security' as a framework for improvingclimate change policy and governance is examined. The analysis leads to the conclusion that if we underestimate climate-security concerns, new security challenges – in addition to existing challenges –are to be expected and must be appropriately managed. Therefore, a climate security framework can help to adopt preventive and security-sensitive responses to climate risks, thus creating a new dynamic within climate policy and governance.

Keywords Climate change • Human security • Governance • Securitization • Conflict

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1 Introduction

Climate change is a complex phenomenon, with multiple non-linear, direct and indirect physical and human effects that have the potential to trigger a number ofsecurity risks. Climate-related effects also entail threats to many aspects of human security such as water, food, health, and livelihood security and may furthermore exacerbateexisiting vulnerabilities. Climate change thus presents a greater threat to human kind than any previously experienced by the modern world. This reality brings new challenges to the agendas of governments, inter- and non-governmental organizations and the private sector.

While climate change effects will vary enormously across the globe, it is the states and people of the Global South that are the most vulnerable to the security implications of climate change despite the fact that they have not been heavy contributors to historicalcarbon emissions (Brock 2012: 4). In the coming decades, it is expected that climate change security implications will directly or indirectly increase the likelihood of conflicts in many fragile countries and regions (Mabey et al. 2011: 8). However, this changing reality need not been seen in a negative light, it can also act as a stimulus to international cooperation and convergence in tacklingcommon climate-change challenges.

While in the twentieth century, and especially since 1945, the 'security dilemma'of states prevailed in the analysis of international relations, since the end of the Cold War this state-centered security perspective has changed due to a *widening* (from military and political to economic, societal, and environmental security), *deepening* (from national and international to human, gender and global security) and *sectorialization* (energy, water, food, health, livelihood, and climate security) of the security concept (Brauch 2010: 35).

Climate change is being increasingly framed as a security issue by number of actors from the political, academic and public spheres (Brito 2011: 5). It has unequivocally entered the international security agenda despite the existence of an extensive debate on the advantages and risks of establishing a link between climate change and security. Peer-reviewed research assessed by the Intergovernmental Panel on Climate Change (IPCC) (2007), as a global scientific authority, leaves no doubt that during the twenty-first century humankind will face many new environmental security challenges that may pose fundamental new problems for the survival of individuals, states and global policy actors (Brauch 2010: 35).

The year 2007 was a turning point in the securitization of climate change (Brauch 2009). Major developments were: The publication of the fourth International Panel on Climate Change (IPCC) assessment report which promotedthe Panel as a new 'securitizing actor' since it highlighted the potential links between climate change and security concerns; the publication of the report on "*World in Transition: Climate Change as a Security Risk"*of the German Advisory Council on Global Change(WBGU 2008) that was released to the G-8 summit and European Union (EU) Presidency; the awarding of the Nobel Peace Prize to the IPCC and Al Gore. Also, and while no statement or resolution was adopted at the 2007 meeting, it was

a symbolic first-step towards the acknowledgement of climate change as a security issue, since the UN Security Council has primary responsibility, under the UN Charter, for maintaining international peace and security.

In 2008, a report by the European Commission and the EU's High Representative for Foreign and Security Policy[1] considered the impact of climate change on international security and, in particular, Europe's own security, thereby indicating potential EU responses. The report claims that climate change is a threat multiplier which exacerbates existing trends, tensions and instability in developing countries, and that these tensions may include conflict over resources – such as land, water, food, and energy. The expected increase in the frequency and severity of natural disasters, plus the slow-onset of environmental degradation, underminethe human security of local communities.

In 2009, the UN General Assembly for the first time adopted a non-binding resolution on climate change as an international security problem[2] requesting other Member States to address this linkage and requesting the Secretary-General of the UN to submit a report on this linkage (Brauch 2010: 29).

In 2011, a meeting on climate change saw the agreement on a statement where the Security Council expressed its "concern that possible adverse effects of climate change may, in the long run, aggravate certain existing threats to international peace and security" (United Nations Security Council 2011: 1) and requested further reporting to the Secretary-General.

Based on these developments, Mabey et al. (2011: 8) believe that there is a growing consensus in the security community that climate change presents significant risks to the delivery of national, regional and global security goals. However, whether or not the effects of climate change are really threats to 'security'depend on the nature and scale of those effects. According to IPCC Assessment Reports, climate change impacts are already endangering the ecosystems that form the foundation of human lives, health and activities (IPCC 2007). If appropriate measures are not taken promptly, these threats will grow and certainly cause regional instabilities and conflicts (Ministry of the Environment of Japan 2007: 2).

More recently, the IPCC's Fifth Assessment Report (AR5), which includes the first systematic assessment across the various dimensions of the concept of human security, claims that despite the uncertain interactions between multiple factors, there is robust evidence to suggest that human security will be progressively threatened by climate change since its impacts undermine livelihoods, compromise culture and individual identity, increase migration that people would rather have avoided, and may undermine the ability of states to provide the conditions necessary for human security (Adger et al. 2014).

In line with the above, this chapter aims to highlight the key economic, human, and geopolitical impacts of climate change and their security implications (2), investigate the extent to which these implications are currently well-managed (3),

[1] Paper S113/08 from the High Representative and the European Commission to the European Council on Climate Change and International Security, 14 March 2008.

[2] A/Res/63/281, 11 June 2009.

and assess the usefulness of 'climate security'as a framework for climate change policy and governance (4).

2 Climate Change Impacts and Security Implications

Since the Conference of Parties held in Copenhagen on 2009, the understanding of climate change implications has broadened, covering a complex web of development and security issues that are compounded by a shifting geopolitical landscape, population pressures, and environmental degradation (Pacific Institute of Public Policy 2012: 1). By placing strains on the infrastructure and resources necessary for the viability of the nation-state system and the well-being of its populations, and by physically changing the geostrategic environment, climate change presents a direct and indirect threat to both national and international security (Center for Climate and Security 2015: 1).

According to the Center for Climate and Security (2015: 1), Climate change *directly* impacts security through its effects on the critical infrastructure underpinning a nation's security. This includes *inter alia* the risks of sea level rise to military installations, which have the potential to reduce a nation's ability to conduct military operations, as well as extreme weather events that can devastate essential energy, financial and agricultural centers that support a nation's economic viability. In some cases, as with some low-lying small island states, sea level rise presents an existential threat to the entire nation. In addition, climate change *indirectly* impacts security by increasing stresses on the critical resources underpinning a nation's security, including water, biodiversity, food, and energy. These stresses can reduce a nation's capacity and legitimacy to govern: i.e. the inability to maintain a certain level of economic growth, to ensure sustainable livelihoods and to meet human security challenges may generate social unrest and protests that may result in decomposing the established political regimes; Arab Spring and its various consequences have been interpreted as the result of similar situations in many Arab countries (Werrell and Francesco 2013; Center for Climate Security 2012).

In addition, decline in these vital resources can deeply affect livelihoods, particularly among already vulnerable populations, and contributes to a broad range of problems and destabilizing trends such as population displacements, state fragility, conflicts, political unrest, and potentially state collapse (see Fig.1.1) (Mearns and Norton 2010). Climate change can also indirectly change or disrupt existing international security dynamics in environments of particular geostrategic importance, such as the Arctic and the South China Sea.

The following analysisdescribes the potential of selected climate change impacts to generate implications for security.

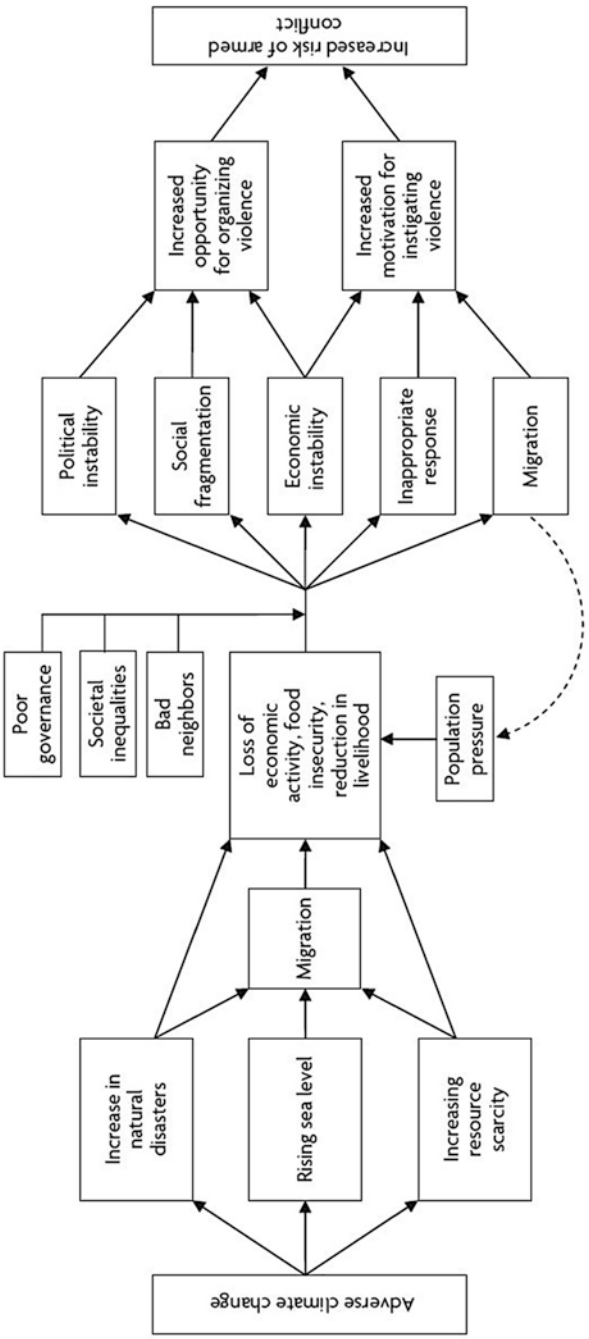


Fig. 1.1 Possible pathways from climate change to conflict (Source: Mearns and Norton 2010: 82)

2.1 Implications for Economic Growth

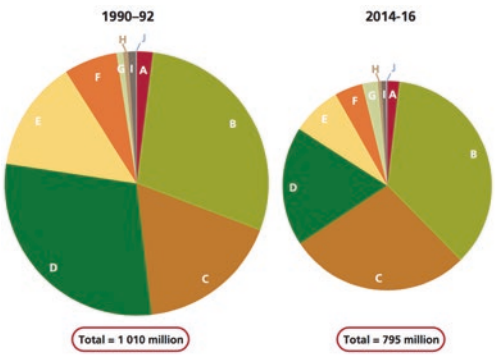
Even if only some of the predicted effects of a changing climate (such as rising sea levels and extreme weather events,floods, storms, and droughts) materialize, key infrastructure, such as transport systems, energy supply and communications will be damaged, destroyed or put under stressalong with human life and property damage. In Africa for instance, this process could threaten more than 25 % of the continent's population, who live within 100 km of the coast (Juma 2010). Catastrophic events from across the globe in recent years have already shown the level of damage nations – especially more vulnerable ones – are exposed to, along with their different human, economic, and ecological impacts. These disasters may generate additionaleconomic and social strain in some casessince the ability to cope with damaged infrastructure is generallydependent on economic capacity. Less stable and economically resilient states will unlikely be able to absorb these stresses without foreign assistance (Brock 2012).

The Stern Review (2007) found that the costs of not responding to climate change could be at least 5 %, and possibly 20 % or more, of global Gross Domestic Product (GDP), with the effects of climate change likely to have an economic impact as great as the Twentieth Century's two World Wars and the Great Depression.

In many countries, some climate change impacts, along with increasing incidences of natural disasters, are likely to reduce GDP in the coming decades.[3] Taking desertification alone, expected to be worse due to climate risks, many affected areas will be inhabited and unfit for human habitation and economic activities (Brock 2012: 5). Desertification is likely to affect the Arab world significantly (Shanin 2009), the United States along with southern Africa, southern Europe, central and east Asia (Rogers 2009). Desertification has been even considered as a driving factor in Darfur conflict (Gambari 2011). This ecological problem undermines agricultural development and related sectors, affects livelihood sustainability and worsens food and water security.

In addition, farming – often a source of primary income in less developed countries – will be severely disrupted by climate change in many areas. Land and soil quality will be affected by changes to temperature and water (for example through drought, flash floods, salt water intrusion, and particularly where agriculture is rainfed, by increased variability of rainfall) impacting crop selection, thus lowering the profitability of crops for sale. Other livelihoods may also be made less viable by climate change. Tourism for instance, which is the source of income in many developing and less developed countries, will be hit in some areas, as the particular climate of tourist destinations change over time, some destinations even become submerged by sea level rise, or rendered more vulnerable to climate shocks. According to Brock (2012: 7), the needs of non-basic infrastructure, such as tourism, may also produce tension amongst communities; tourism already diverts water

[3] In Latin American and Caribbean, the reduction of GDP is estimated at 1 % per year for the next 10 years. For more details see: ECLAC 2009.



	Number (millions)		Regional share (%)	
	1990–92	2014–16	1990–92	2014–16
A Developed regions	20	15	2.0	1.8
B Southern Asia	291	281	28.8	35.4
C Sub-Saharan Africa	176	220	17.4	27.7
D Eastern Asia	295	145	29.2	18.3
E South-Eastern Asia	138	61	13.6	7.6
F Latin America and the Caribbean	66	34	6.5	4.3
G Western Asia	8	19	0.8	2.4
H Northern Africa	6	4	0.6	0.5
I Caucasus and Central Asia	10	6	0.9	0.7
J Oceania	1	1	0.1	0.2
Total	1 011	795	100	100

Note: The areas of the pie charts are proportional to the total number of undernourished in each period. Data for 2014–16 refer to provisional estimates. All figures are rounded.

Fig. 1.2 The changing distribution of hunger in the world – numbers and shares of undernourished people by region, 1990–1992 and 2014–2016 (Source: FAO, IFAD and WFP 2015)

from agriculture, which can deepen water and food insecurity, and, whilst it does provide employment for local people, it may not always serve their individual needs, but rather the interests of companies operating within the tourist industry.

2.2 Implications for Human Security

There is growing evidence that climate change can have significant impacts on human security through its implications for areas such as food security, water security, biosecurity, livelihood security, health security. These impacts may also reduce the ability of communities to adopt long-term adaptation strategies orto avoid living in vulnerable and endangered areas.

2.2.1 Implications for Food Security

Food security is currently threatened by climate change, both directly by changing temperature and precipitation patterns, and indirectly through losses of agricultural land due to sea-level rise, greater levels of wind and water erosion, pests, and disease. In addition, human-induced land-use change linked to deforestation and desertification has already reduced the agricultural potential of many parts of the world (Beniston 2010: 563). The World Economic Forum 2015 report highlights the emerging risk of food insecurity as "access to appropriate quantities and quality of food and nutrition becomes inadequate, unaffordable or unreliable on a major scale"(World Economic Forum 2015). Despite the decline[4] in global levels of those living in hungeraccording to the last *State of Food Insecurity in the World* (FAO, IFAD and WFP 2015) (see the Fig. 1.2), the capacity of food production systems

[4] The so-called 'decline' has been criticized as being simply the result of a change in methodology in the measurement of hunger.

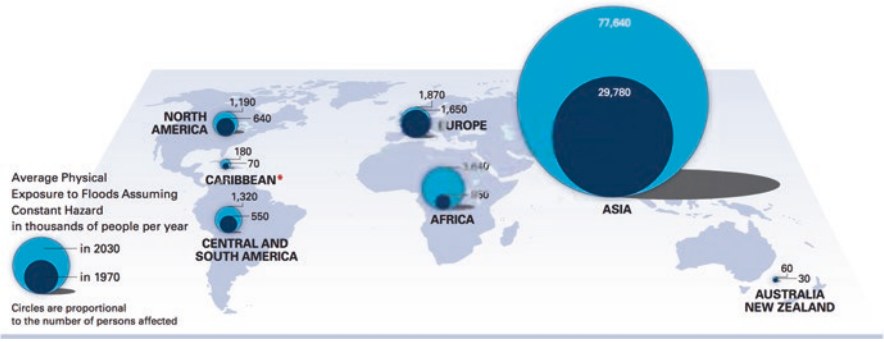


Fig. 1.3 The projected increase in the number of people (in thousands) exposed to floods in 2030 compared to those in 1970 (Source: IPCC 2012)

may decline during the coming decades because of different pressures exerted on the physical systems supporting agricultural and farming activities. According to Beniston (2010: 563), agriculture is probably the most vulnerable of all human activities to weather and climate variability; the chief controls on agricultural yields include temperature, precipitation, soil moisture, carbon dioxide levels, and disease and pests (themselves largely climate-dependent). Any changes in one or more of these controlling factors may have profound, non-linear effects on productivity (Beniston 2010: 563). Therefore, coupled with biofuel production, demographic growth, shifts in consumption patterns, especially in the Global South, and climate change impacts, food security is likely tobe severely undermined in the future (Behnassi and Yaya 2011).

2.2.2 Implications for Health Security

Human healths' vulnerability to climate changeis of paramount consideration. Extreme weather and climate eventsare causing and expected to cause substantial damages. Floods alone can cause widespread devastation, resulting in loss of life and damages to personal property and critical public health infrastructure that amount to billions of dollars in economic losses (see Fig. 1.3) (World Health Organisation (WHO) and the World Meteorological Organisation (WMO) 2012).

In addition to the health risks of extreme climate events, many noncommunicable diseases (see Table 1.1) and infectious diseases are expected to change their geographical or seasonal patterns and incidence due to climate change and variability (Patz et al. 2003).

Infectious diseases take a heavy toll on populations around the world and some of the most virulent infections are also highly sensitive to climate conditions (i.e. temperature, precipitation and humidity have a strong influence on the reproduction, survival and biting rates of the mosquitoes that transmit malaria and dengue fever, and temperature affects the life-cycles of the infectious agents themselves) (WHO

Table 1.1 Direct and indirect pathways from climate change to noncommunicable diseases (NCDs)

Climate change impacts	Pathway from climate change to NCDs	NCD outcome	Direction of health risk
Direct			
More frequent and increased intensity of heat extremes	Heat stress	Cardiovascular disease (CVD) respiratory disease	Increased risk
Increased temperatures and less rainfall	Higher ground-level ozone and other air pollutants	CVD respiratory disease (e.g., bronchitis, asthma)	Increased risk
	Increases in airborne pollens and spores	Respiratory disease (e.g., bronchitis, asthma)	Increased risk
Changes in stratospheric ozone and in precipitation and cloud coverage	Increased exposure to solar ultraviolet radiation (UVR)	Autoimmune diseases (multiple sclerosis)	Reduced risk
Higher winter temperatures in temperate latitudes		CVD respiratory disease	Reduced risk
Extreme weather event (fires, floods, storms)	Structural damage	Injuries	Reduced risk
Direct			
Drought, flooding			Increased risk
Extreme weather event (fires, flooding, storms)	Impaired agriculture, reduced food yields, and nutrition insecurity	Poor general health	Increased risk
Extreme weather event (fires, flooding, storms)	Trauma	Mental health (posttraumatic stress disorder)	Increased risk

Source: Friel et al. (2011)

and WMO 2012: 7). According to the WHO and the WMO (ibid.), the same meteorological factors also influence the transmission of water and food-borne diseases such as cholera and other forms of diarrhoeal disease. Diarrhoea kills over two million people annually, and malaria almost one million. Hot, dry conditions favour meningococcal meningitis– a major cause of disease across much of Africa – which kills thousands, directly impacting families and indirectly affectingeconomic development in the poorest regions. In addition, some 50 millions people around the world suffer from dengue fever each year WHO and the WMO (ibid.).

All of the above mentioned diseases are major health problems, and even if the public health community has made important progress against them in recent decades, the WHO and WMO (2012: 7) believe that they will continue to cause death and suffering for the foreseeable future (Table 1.2).

These diseases still have an insidious influence in many parts of the Global South and are likely to be a major human healthburden in the coming years due to climate change and other factors such as poverty and insufficient health infrastructure.

Table 1.2 Important examples of infectious diseases transmitted by insect vectors

Infectious disease	Causative micro-organism	Insect vector	Geographic distribution	% of world population currently at risk	Nature of illness
Malaria	Plasmodium species	Mosquito (Anopheles species)	Sub-Saharan Africa, Southeast Asia, Central and South America	45 %	Destruction of red blood cells, severe ill- ness or death in those with limited immunity (*e.g.*, young children)
Dengue fever	Dengue fever virus	Mosquito (Aedes species)	Tropical areas worldwide	40 %	Fever, rash, joint pain, can lead to severe bleeding and death
West Nile virus infection	West Nile virus	Mosquito (Culex species)	Essentially worldwide	N/A	Often asymptomatic but can cause encephalitis

Source: Shuman (2011:12)

However, and despite the alarming nature of a potential increase of infectious diseases, there is in fact still only limited specific scientific evidence in this area that can serve as a relevant reference for policy-making processes in many countries. According to Mills et al. (2010), because of the complex interactions of climate variables at the levels of the pathogen, vector, and host, the potential influence of climate change on vector-borne and zoonotic diseases is poorly understood and difficult to predict. Climate effects on non vector-borne zoonotic diseases are especially obscure and have received scant treatment. This makes planning more difficult, and indeed can exacerbate the public health problems, as not all scenarios can be effectively planned for.

2.2.3 Climate Change, Migration and Population Displacement

The impact of climate change on migration is drawing increasing attention from policy-makers, researchers, and civil society actors. Yet, knowledge in this field remains limited and fragmented. Available literature related to this topic highlights the complexity of the relationship between environmental factors and migration, and the fact that climate change is only one factor among several others in explaining migration dynamics. This can be clarified by the fact that any migratory movement is the product of several converging factors and that environmental stress is always mixed with other causes, which may include economic constraints or opportunities, social networks, political context, etc. (Piguet 2011).

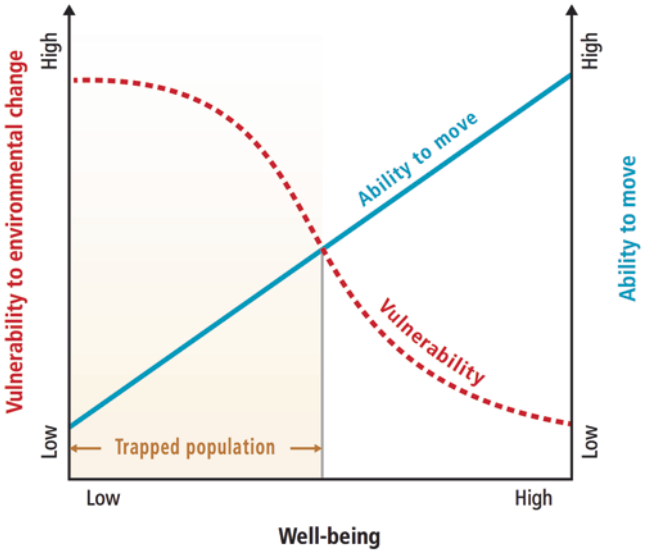


Fig. 1.4 Relationship between vulnerability to environmental change and mobility (Source: Adger et al. 2014)

Population displacement in response to significant environmental stress and resource scarcity often indicates the breakdown of social resilience (Beniston 2010: 567). Indeed, moving from one place to another is a fundamental way humans respond to challenging conditions (Adger et al. 2014: 770). Likewise, many climate change impacts are likely to encourage either displacement as a result of an emergency, or migration as a result of longer term changes in the climate (Brock 2012: 8) (see Fig. 1.4). According to Warner (2011), much expected climate change displacement will occur within countries not between them. People move, as an adaptive strategy, in order to improve the resilience of their households, to deal with future climate shocks and stresses, and to retreat from areas of intense climate stress.

However, migrants can be in competition for scarce resources in receiving regions, and this may result in conflict over such resources. In the context of food security, for example, displacement and coping strategies are an extreme manifestation of vulnerability. Coping strategies generally represent short-term adaptations to extreme events; they are usually involuntary, and rarely pave the way for reducing populations' vulnerability to future famine situations (Beniston 2010: 567). Equally, recent research has shown that environmental change can cause added problems associated with populations unable to move away from locations where they are vulnerable. According to the 2011 Foresight Report by the UK Government on Migration and global environmental change, populations most exposed and vulnerable to the impacts of climate change may have low capacity to move away from these threats.

2.3 Geopolitical Implications of Climate Change

According to the WBGU report (2008), climate-induced inter-state wars are unlikely, but climate change has the potential to trigger national and international distributional conflicts and intensify problems already hard to manage such as state failure, the erosion of social order, and rising violence. In the worst-affected regions, this could lead to the proliferation of destabilization processes with diffuse conflict structures. These dynamics threaten to overstretch the established global governance system, thus jeopardizing international stability and security. The northward movement of fish stocks due to a warming ocean in the South China Sea (Rogers 2012) – which has already witnessed geopolitical disputes between China, its neighbors, and the United States – is another example of how climate change can act as a risk multiplier and exacerbate conflict at an international level.

The WBGU report (2008) identified four conflict constellations as typical causal linkages at the interface of environment and society, whose dynamic can lead to social destabilization and, in the end, to violence: climate- induced degradation of freshwater resources; climate-induced decline in food production, climate-induced increase in storm and flood disasters; and environmentally-induced migration. Identified regional hotspots – regions that are particularly vulnerable to current or future climate impacts, and where human security may be at risk[5] – are North Africa, the Sahel zone, Southern Africa, Central Asia, India, Pakistan, Bangladesh, China, the Caribbean, the Gulf of Mexico, and the Andean region and Amazonia (Fig. 1.5).

In addition, the WBGU (2008) referred to six key threats to international security and stability which will arise if climate change mitigation fails: possible increase in the number of weak and fragile states as a result of climate change; risks for global economic development; risks of growing international distributional conflicts between the main drivers of climate change and those most affected; the risk to human rights and the industrialized countries' legitimacy as global governance actors; triggering and intensification of migration; and overstretching of classic security policy.

In some areas, climate change will mean greater competition over scarce natural resources, and this state has the potential to generate additional problems for concerned countries (Brock 2012: 6). In addition, and according to the EU High Representative for Common Foreign and Security Policy (CFSP) and the European Commission on Climate Change and International Security (2008), although all countries will struggle to adapt to the changes brought about through climate change, the challenge will be felt most strongly in situations that are already socially, economically and politically fragile, including where there are ethnic and religious tensions. Long-term tensions around sovereignty and indigenous rights are height-

[5] While some are academic exercises, many are produced with the goal of drawing policy maker attention to regions that are particularly susceptible to climate impacts, either to mitigate the risk of humanitarian crises or conflicts or to target adaptation assistance. For more details: see de Sherbinin (2013).

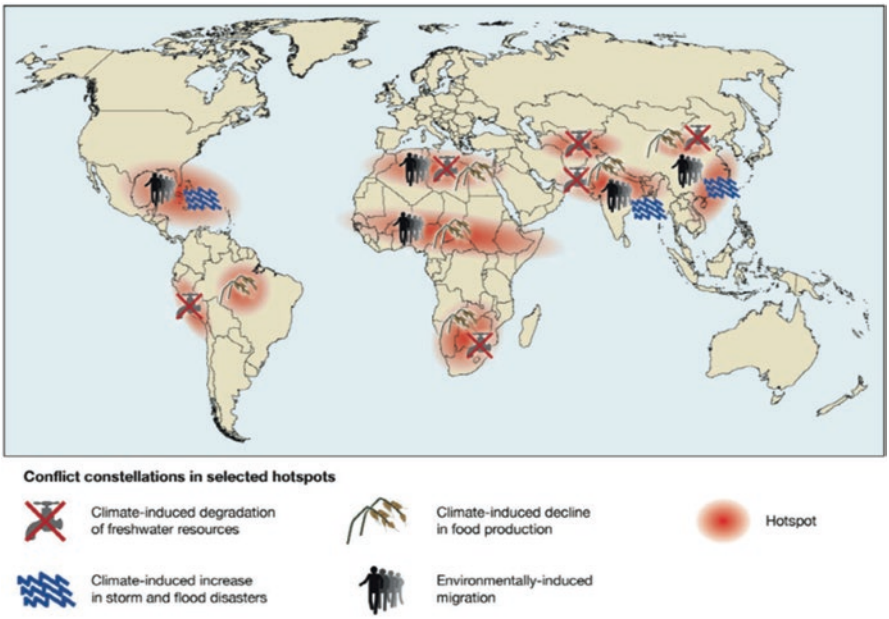


Fig. 1.5 Regional hotspots and security risks associated with climate change (Source: WBGU 2008)

ened, further entrenching the feeling of marginalization in many communities leading sometimes to violent reprisals from radical indigenous groups (Brock 2012: 8).

Due to sea level rise, climate change may cause the loss of territory and increase the risk of border disputes and political instability (EU High Representative for CFSP and the European Commission 2008). As noted above, many islands and cities that are located on low-lying coastlines, floodplains and river deltas will suffer dramatic impacts, and in some cases, may even disappear (Honig 2011).

3 How Far Are the Security Implications of Climate Change Currently Managed?

Whether the above identified conflict constellations and social and economic crises linked to climate change will occur depends, in addition to other factors, on the increase of global average temperature by the end of this century. The WBGU report (2008) arguesthat without resolute counteraction, climate change will overstretch many societies' adaptive capacities within the coming decades. This could result in destabilization and violence, jeopardizing national and international security to a new degree. Climate-related security challenges are also expected to put the international security architecture – that is already faced with the challenge of tackling a

range of complex global security issues such as terrorism and nuclear proliferation – under increasing pressure. This may also apply to domestic security governance (EU High Representative for CFSP and the European Commission 2008: 5). However, a positive development remains possible if the international community recognizes climate change as a threat to humankind and is able toset acourse to avoid dangerous anthropogenic climate change by adopting a dynamic and globally coordinated climate policy (WBGU 2008).

According to Mabey et al. (2011: 8),peaceful management of even moderate climatic changes will require investment in increased resilience in national and international security and governance systems. Security implications of climate change over the coming decades will not be fully avoidable under all plausible greenhouse gas emissions reduction scenarios, given the inertia in energy infrastructure and the global climate system. Thus, unless climate change is limited to levels where its impacts can be managed effectively, and unless successful adaptation programs are implemented, there will be a rapid increase in the risk of far more severe impacts, resulting in security challenges that are much more significant than current estimates indicate.

On this basis, it is appropriate to say that climate change is not presently well-managed since current responses are still failing to manage the full range of climate security risks effectively. In this regard, Mabey et al. (2011: 8–9) claim that there is a mismatch between the analysis of the severity of climate security threats and the political, diplomatic, policy and financial effort countries expend to avoid the attendant risks. Countries are failing to tackle climate risks effectively because they are not considering the full range of potential scenarios (ibid). For the authors, there are multiple levels of uncertainty involved in addressing and planning for climate change; this includes fundamental questions such as how much average global temperatures will rise, what the impact of more rapid regional climate change will be, and how effective countries will be in agreeing to and implementing adaptation and emissions reduction plans? However, debates on these issues are often over-simplified and uncertainty is recurrently taken as an excuse for inaction, often is response to lobbying dynamics. The authors claim that uncertainty *per se* cannot be a barrier to action because it does not mean we know nothing, just that we do not know precisely what the future may hold. Public policy decisions (ranging from military procurement, to interest rates, to financial system regulation) are taken under higher levels of uncertainty than exists over climate change science, impacts or policy choices. In fact, the range of uncertainty in climate change is generally smaller than that common in long-term security analysis, especially with the latest scientific evidence.

Therefore, and according to the WBGU Report (2008), climate policy and governance are essentially a preventive security framework, for if this framework succeeds in limiting the rise in globally averaged surface temperatures to no more than 2 °C relative to the pre-industrial value, the climate-induced threat to international security would likely be averted. This is in line also with the argument of Trombetta (2008: 585), according to which the securitization of the environment is transforming existing security practices and provisions. The WBGU Report (2008)

further argues that in case of failure to do so, climate-induced security risks will begin to manifest themselves in various regions of the world from around 2025 to 2040. The key challenge, as seen by the WBGU (ibid.) is thus to develop a robust climate policy and governance system within the next decade, in order to avert the socio-economic distortions and implications for international security that will otherwise intensify in subsequent decades.

According to Brauch (2010), "the new security challenges posed by climate change cannot be solved by traditional and power-based security strategies, policies, and measures. They require a shift from a unilateral national security concept to a cooperative and multilateral approach to security. The response to these new manifold challenges requires an extended security approach which, besides the foreign and defense departments, also involves ministries and agencies responsible for environment, development, science and technology as well as economic policies and measures to adapt to these new challenges and to mitigate against their impacts".

4 Climate Security as a Framework for Climate Change Policy and Governance

> The emerging scientific discourse, policy debate and securitizing process of climate change focus on the environmental dimension of security, and especially on complex interactions between human beings as causes, triggers, and victims of the societal consequences of this anthropogenic change. Thus, the securitization of climate change issues is also closely linked to different referent objects of international, national, and human security (Brauch 2009).

> With the *securitization* of climate change, the focus of analysis is on the process of scientific and political agenda-setting, and prioritization of nature-societal issues during the past 20 years. While in 1987, issues of climate change were still primarily emerging scientific problems for climate specialists, by 2007 – after intensive processes of *scientization*, *politicization* and *securitization* – global warming and climate change have moved to the top of the policy agenda as some of the most pressing security dangers and concerns that require both urgent, stringent, and long-lasting policy responses with a fundamental transformation of the global energy system (decarbonization), but also of human values and consumer patterns (Brauch 2009).

When we consider climate change in light of the fundamental concerns of 'security'– that is, *who* must act to protect *which values* from *which threats*, and in *what manner* – the challenge is above all how to protect citizens from the climate-related threats, since our global climate is the very foundation of human survival. To achieve this goal, each country's efforts, as well as unified international cooperation, are necessary to preserve the'global public good'that is our climate (Ministry of the Environment of Japan 2007: 3).

In this way, 'climate security'can be seen as a leading concept guiding future climate-related policies. Yet*what advantages are to be gained from such an approach*? Before answering this question, we will examine the securitization process of climate change, its rationale and different facets.

4.1 Securitization: Framing Climate Change as a Security Issue

The securitization framework is an essential tool forunderstanding how a particular issue is moved into the sphere of security. This theoretical framework, developed by the Copenhagen School (Buzan et al. 1998), provides a structured analysis of the process of the construction of security, evidencing the mechanisms through which issues reach the security agenda as well as the actors involved in the process. According to this framework, securitization occurs when an issue is successfully moved from the politicized level, where it is part of the public policy sphere, to the securitized level, where it is presented as an existential threat, thus calling for emergency measures and justifying actions outside the normal boundaries of political practice (ibid.). This process is enacted, according to the securitization framework, in a two-stage process, where in the first stage a securitizing actor performs a securitizing move by using rhetoric of existential threat and urgency to address an issue, and then the relevant audience accepts it, allowing for extraordinary measures to be adopted (Ibid: 25).

The securitization framework has been used to examine the transformation of climate change into a security issue. The securitization of climate change has entered the international agenda generating expectations of positive change, due to the fact that security constitutes a matter of high politics par excellence, and given the possible positive advantages of managing the issue through a security framework. However, proponents of the securitization framework themselves argue that issues should preferably be managed through normal procedures without extraordinary elevation of threats. They perceive security as negative for the reason that it represents a failure to deal with issues at the political level. Hence, they see 'desecuritization'as the optimal long-range option, since it takes issues out of a threat-defense sequence and places them at the political level (Ibid: 29).

Nevertheless, the securitization of climate change does not automatically imply the military management of the issueor inevitably imply linking it to military security (Brito 2011: 9). The environmental security discourse is more closely linked to notions of human security in which the protection of human welfare is central (Detraz and Betsill 2009: 306). Furthermore, there isinsufficient evidence that military responses to climate change will be formulated in a near future. This is not to say, however, that there is no role envisaged for the military in climate security. In fact,military forcesare seen as key players in climate-related crisis management and disaster response (High Representative for CFSP and the European Commission 2008: 10). Nevertheless, crisis response (with or without military involvement) remains just one component of national and international action on climate change which attempts to combine prevention, mitigation, adaptation, and response to crises (Council of the European Union 2009: 3).

4.2 The Advantages of the 'Climate Security' Concept

The concept of 'climate security'allows for climate change to be characterisedas a 'threat' facing all nations, organizations and individuals. According to the Japanese Government,climate change policy and governance can therefore be granted a higher priority at a national level, potentially paving the way for low-carboneconomic growth and related transformations of technologies and systems, as well as lifestyles. This mayalso improve efficiency in resource and energy utilization in economic production, thus directly contributing to resource and energy security. Moreover, as awareness of adaptation policies grows, it maybe possible to better contribute to securing the necessary foundations for human livelihoods, such as through reducing poverty, thereby contributing to human security (Ministry of the Environment of Japan 2007: 4).

International cooperative actions to reduce carbon emissions couldalso be justified in this way: e.g. in developing countries, feasible long-term policies can be promoted to address the weather-related disasters and other problems currently being experienced, while at the same time building appreciation of the need for them to actively participate in future international cooperative efforts. Also, as climate risks become more keenly felt, international pressures can be expected to grow for mandatory emissions reductions on the part of the major carbon-emitting countries that are causing such risks (Ibid: 3).

'Climate security', which views climate change impacts as threats to humanity, is a perspective that recognizes the effectiveness of urgent action in light of the comparative 'costs of action'and 'costs of inaction'on climate change, and as such can play a facilitative role with respect to negotiations concerning the future climate regime. Promoting an appreciation of climate security mayallow us to facilitate the multilateral negotiations, under which some partiesstill consider existing and proposed responses as a disadvantage to their national interest (Ibid: 4).

4.3 Delivering Climate Security: Some Recommendations

Climate change has the potential to reshape our economic and social systems. As such, it can also be seenas an opportunity to promote collaboration and co-existence between Northern and Southern states, forcing people to work together to find solutions (PACJA 2009). For Brock (2012: 14), this scenario would foster mutual dependence, solidarity and trust; developed states independently securing themselves against the adverse effects of climate change will only exacerbate the sense of 'the West versus the rest'.

Conversely, unilateral adaptation strategies (such as those covering shared international waters which may hinder access to water for other nations, particularly those

already living with water insecurity) may actually drive insecurity further and increase tensions (Ibid). It is important, therefore, that adaptation addresses power relations – expressed in gender inequalities, economic inequities and human rights violations – and promoting fair access to resources and services (PACJA 2009). Where adaptation measures are unilateral, rather than cooperative, conflict is more likely to occur (Brock 2012: 14). Thus, the enhancement of climate security maypositively impact international efforts to meet human security challenges, and help to reduce the probability of violent conflicts within or among nations. Climate change as a shared concern couldstimulate cooperation and understanding among nations, and consequently provide a fertile ground for managing existing divergence and competition. For instance, it is increasingly believed that the recognition of the impact of greenhouse gas emissions is occurring at a time when readily accessible fossil fuels, such as oil, are running out. Therefore, the need to diversify our energy resources is pressing and the alternatives we turn to must be renewable and sustainable. A move away from carbon-based economies is crucial if the security implications of climate change are to be avoided. This diversification will also ease tensions around competition over energy resources with the prospect to prevent many regional conflicts.

In addition, climate change demands a whole-of-government response, with environmental change and degradation taken account of in an integrated effort from ministries of environment, defense, energy, agriculture, finance, health, and foreign affairs. This needs to amount to more than a 'green wash', characterized instead by bold and visible steps towards a decarbonized economy (i.e. through a massive upscaling of funding for research and development into green economy, renewable energy sources, climate-smart agriculture, etc.), which recognizes the joined-up nature of security threats, examining key determinants (e.g. water, land, agriculture, health, energy, disaster risk management and early warning systems) in concert (Campbell 2010).

For de Ville and Kingham (2011: 8), even space programs should be designed and deployed to assist with both climate change mitigation and adaptation. In addition to the European Space Agency (ESA)'s Climate Change Initiative (CCI), which provides vital data sets on the Essential Climate Variables (ECV) to meet the needs of the UNFCCC and IPCC, and in addition to the Sentinel satellites associated with the Global Monitoring for Environment and Security (GMES) initiative aimed at providing essential data on the atmosphere, land use and oceans, the space community should also continue to give increased attention to the need for monitoring the impact of global warming on environmental and human security to assist decision makers in predicting, monitoring and responding to such impacts. This is critically important especially in areas where high vulnerability and low coping capacities heighten the possibility of climate change contributing to or exasperating local and regional conflicts. Indeed, a key message of the Report for the ESA *Recent Trends in EU External Action in the Fields of Climate, Environment, Development and Security* (Ibid: 12) is to argue that EU Space Policy should not merely promote "scientific and technical progress and industrial competitiveness", but should also promote, or even give priority to, the major security challenges of our time, which especially include the threat of climate change and its impacts around the world.

Certainly, the security implications of climate change need to be addressed at all scales, through intergovernmental and non-governmental organizations, regional fora, governments, local agencies, etc. In this regard, Brito (2011: 5) claims that security and cooperation are not mutually exclusive. It is widely acknowledged that the complexity of global threats faced today – such as global warming – renders it impossible for a single state to tackle them efficiently. Hence, delivering climate security in the twenty-first century entails a great level of international and transnational cooperation. Addressing climate change through a security framework can be a positive development, namely in terms of resource allocation and policy prioritization. This option also implies that actors develop security-sensitive adaptation and mitigation strategies.

As Brown et al. (2007: 1154 cited in Brito 2011: 12) so eloquently put it, "a 'securitized' climate debate might be able to marshal sufficiently compelling arguments to encourage the politicians to do something about reducing emissions and investing (carefully) in adaptation. These are things the international community should be doing anyhow and, done well, are consistent with enhancing security and reducing the potential for conflict at all scales. So if securitization speeds their implementation, it will serve a useful purpose".

5 Conclusion

Since the last decade, climate change has been intensively discussed as a security issue since its multiple effects have the potential to amplify many existing risks and vulnerabilities and to exacerbate existing trends, tensions and instability, especially in fragile regions. By focusing on the securitization of climate change, this chapter has addressed the linkages between climate change and its multiple security implications and the different advantages of mainstreaming climate security in key policy and governance responses to global warming.

Accoding to Berniston (2010: 567), dwindling resources in an uncertain political, economic, and social context are capable of generating conflict and instability, but the causal mechanisms often remain indirect. Resource scarcities usually constrain economic productivity and reduce the livlihood sutainability. Such situations are capable of generating social unrest and population movements. In extreme cases, these can contribute to local or regional conflicts, which may increase over time as environmental scarcities worsen (ibid.). The author claims that while such internal, resource-based conflicts may not be as conspicuous as wars at an international level, there is nevertheless a potential for significant repercussions upon the security interests of both the developing and the industrialized countries, for they can affect international trade relations, produce humanitarian disasters, and lead to growing numbers of refugee flows (ibid.).

Based on these assumptions, this chapter supports the belief that in the case that the international community and national governments continue to underestimate the climate-security concerns, serious threats will grow and certainly cause further

regional instabilities and conflicts. Therefore, a climate security framework may allow for the development of preventive policies and security-sensitive adaptation and mitigation strategies, thus creating new dynamics and momentum for advanced multilateral cooperation capable of building an ambitious international climate regime.

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Chapter 2
Global Environmental Change and the Crisis of Dominant Development Models: A Human Security-Centered Analysis

Reda El Fellah and Mohamed Behnassi

Abstract During the last decades, the global environmental imbalance has reached an intolerable peak, producing devastating impacts on vulnerable regions and populations, historically considered as less responsible for its underlying causes. The growing scientific consensus on anthropogenic environmental change has led to the creation of some paradigmatic approaches aimed to address this issue, such as the 'sustainable development' principle and, more recently, the green economy. Nevertheless, policy responses to environmental change have been largely grounded in the dominant development models, those that are arguably to blame for this situation. The present chapter suggests that the global economic system is still unable to propose workable alternatives to reconsider the structural drivers that give rise to the environmental crisis and increasing social inequalities. It discusses the interrelations between environmental change and dominant development pathways, and demonstrates how the environmental discourse is still disregarding human and social issues or, more precisely, the inter-linkages between the growing social injustice and the ever-increasing environmental crisis. By recognizing that social and structural inequalities are among the important drivers of ecological crisis, this research emphasizes this tight relationship, and shows, in the meantime, how the environmental crisis is further widening the rich-poor gaps and creates new grounds

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for additional vulnerabilities. This leads to the conclusion that fighting social vulnerabilities must be at the heart of policy responses to the global environmental change. Based on this mutual interaction, this chapter argues that the latter is predominantly a human-security issue and, therefore, related responses should be people-centered.

Keywords Environmental change • Human security • Dominant development pathways • Paradigmatic shift • Intra and inter generational equity

1 Introduction

1.1 Interlinkages Between the Environmental Crisis and Dominant Economic Models

Human history bears testimony that environmental change can contribute to the collapse of civilizations. The world today is on the crossroads as global environmental change (GEC) is increasingly recognized by scientists, activists, and policy makers, as a reality threatening the future of mankind and ecosystem balance. Over the last decades, a widespread scientific and even political debate has been engaged on the influence of anthropogenic activities on accelerating environmental change and the degree of this responsibility compared to natural factors. Scientific data, evidence and worldwide research studies, consistent with each other, lead to a strong consensus that human factors are the main cause of increasing global warming, biodiversity loss, degradation of major ecosystems, etc. Different methods have been used for instance to estimate the degree of scientific consensus about human drivers of climate change – including surveys of experts (Doran and Zimmerman 2009; Cook et al. 2013a, b), and reviews of the peer-reviewed literature (Oreskes 2004; Anderegg et al. 2010; Cook et al. 2013a, b). Both methods converge on the following conclusion: 97 % or more of climate scientists are convinced that human-caused climate change is happening (Maibach et al. 2014). This conclusion is almost equal to the last confirmation made by the IPCC 5th Report (2013) about the scientific certainty that human activity is the dominant cause of observed warming since the mid-twentieth century and that this certainty is reaching 95 %.

It's currently firmly recognized that over the last two centuries, industrial and technological development, unprecedented demographic growth, and excessive urbanization have provoked a rapid growth of ecological degradation (Magdoff 2002; Wilson 1992; Reid and Miller 1989). It is obvious that during this period the Earth System has been under an intense pressure from the *Homosapiens*, equipped with sophisticated technologies, and pursuing never ending growth and opulence. The changes caused by nature's selfish exploitation by humans caught the attention

of experts and environmentalists and make them agree on the supremacy of human activity impacts on environment and biosphere, as compared to all natural factors.[1]

This unprecedented impact is now perceived as permanent, even on a geological timescale, and many scientists claim that since the industrial revolution, humans enter a new geological epoch called the 'Anthropocene' (Crutzen and Steffen 2002; Zalasiewicz et al. 2010) where they are the most powerful geological force. This new reality is making the history of planet Earth accelerating. In addition, human effects on natural environment are inducing a cascade-like changes: global warming; ice melting; sea level rise; extreme weather events; species loss; ecosystems destruction; soil erosion; crop and water-vector diseases; deforestation; depletion of natural resource; and so on.

Based on these facts, it is becoming increasingly convincing that the interrelations between anthropogenic activities and global environmental crisis are closely associated with dominant development models and the social disparities they produce. What is referred to here is the liberal market-based economy characterized by the hegemony of capitalistic paradigms (multinational firms, trade liberalization, profit and productivism, natural resources and fossil fuel combustion-depending economies, growth obsession, mass consumption, etc.). Furthermore, these dominant paradigms often concentrate wealth in the hands of a small minority, leading to a growing inequality and widening the category of poor and excluded people. Viewing GEC through the lens of social externalities widens the research agenda to vulnerability issues, and helps build global change projections based on scenarios that incorporate social considerations and gaps between rich and poor. This chapter intends to analyze these questions from a human security perspective.

1.2 Growing Inequality and Long Term Economic Costs as a Consequence

Environmental change affects human societies and economies in many negative ways. The first to feel and suffer from environmental change are the least privileged individuals and communities, and usually the least responsible for ecological degradation. The interconnections between the environmental crisis and economic development pathways result in a growing poverty, unequal repartition of wealth, exclusion and marginalization of vulnerable groups that, in turn, undermine human security. The observed reality in the Global South shows some disastrous manifestations of these interconnections. "The effects of climate change are being felt all over the planet, but not equally" (Annan 2015). According to the most recent data (Global

[1] Man and nature; or, Physical geography as modified by human action written by Georges Perkins Marsh in 1864 was one of the first books to argue about the impact of human action onthe environment.

Climate Risk Index 2014[2] and climate change vulnerability index 2013[3]), poor countries are already facing climate change effects, and experiencing its indirect harmful impacts such as extreme weather events, droughts, crop yields reduction and malnourishment. The poorest people in developing countries, heavily dependent on their natural environment are the most vulnerable. Climate change induces cascade-like effects, for instance: soil erosion and natural resource depletion lead to loss of income, thus accentuating rural poverty and forced migration and deepening the social vulnerability to shocks; water shortage and crop decrease cause food insecurity; air and water pollutions increase health insecurity; and so on.

The prevalent approach to environmental change has been – since the Rio Summit in 1992 – centered on making economic growth and environmental protection compatible. However, and despite the fact that the 'sustainable development' principle is multidimensional in nature (covering environmental, social, economic, cultural, and recently governance considerations), the dominant economic paradigm, mainly preoccupied with material economic growth (Floro 2012), has not paid sufficient attention to environmental considerations, social justice requirements and the well-being of current and future generations. The economic dimension of sustainable development has often dominated environmental and social ones.

At the same time, the global economy is correlated with the rise of large private multinational corporations exerting significant influence on public policies, focusing on profit maximization, and contributing to significant worldwide environmental damage (Donohoe 2003:578; Roach 2007). Accordingly, responses to current global crises pertaining to environment, social inequity, and growing wealth disparities may not be effective without the engagement of business actors.

While pursuing an endless and highly carbonized model of economic growth, environmental costs are rising and human well-being is decreasing. Some experts describe the current economic growth model as uneconomic (Daly 2005; Watson 2014) since it becomes as a goal in itself, with less potential to enhance environmental sustainability or to create social and economic opportunities. In addition to its high cost for environment – both in its over-consumption of finite resources and production of externalities such as waste – the world economic growth paradigm generates wealth for business actors while environmental and social costs are merely transferred to the poorest, to future generations and to non-human species. As Daly made it clear "uneconomic growth occurs when increases in production come at an expense in resources and well-being that is worth more than the items made" (Daly 2005:103) […]. The global economy is now so large that society can no longer safely pretend it operates within a limitless ecosystem. Developing an economy that can be sustained within the finite biosphere requires new ways of thinking (Daly 2005:100).

[2] According to Global Climate Risk Index 2015: "Of the ten most affected countries by extreme weather events (1994–2013), nine were developing countries in the low income or lower-middle income country group, while only one was classified as an upper-middle income country".

[3] Climate Change Vulnerability Index 2013 shows that the most vulnerable regions to climate change are situated in Africa, South Asia and Latin America.

The debate over these issues has been caught up for a long time between opposite views and perceptions regarding the interrelations between dominant development paths and global environmental change, explored in Sect. 2. Section 3 will explore the new paradigms brought by economists and environmentalists in order to cope with economy-environment dilemma, and the ways and extent to which decision-making processes translate the new paradigms. The last section presents and defends the human security-centered approach to environmental change as a 'global to local' (glocal) policy driver at a practical level. The main ambition is to reexamine the concepts of 'sustainable development' and 'green economy' pushing towards a reform agenda with a holistic approach focusing on human security, instead of solely focusing on macroeconomic solutions. We believe that the primary reason for concern about environmental change is the security and welfare of human populations (Barnett et al. 2010:10), and any global response should therefore be people-centered.

2 Dominant Development Paths and Global Environmental Change

Since the 1980s, and following the Bruntland Report "Our Common Future" (WCED 1987), and particularly after the United Nations Conference on Environment and Development held in 1992, the global debate on the environmental crisis between scientists, policymakers, and economists has been caught up in rhetoric discourses, while major economic players have continued to do business as usual, and policy makers to implement trade and financial liberalization and parallel oriented-market policies following the economic growth model.

In essence, the scientific debate on global environmental change came to a consensus on three main facts: *Primarily*, that the environment is changing at a very quick pace due to different environmental problems and damages; *secondly*, the environmental change is human-induced and all causes happen through a subset of proximate causes, which directly alter aspects of the environment in ways that have global effects (Stern et al. 1992); *thirdly*, the change is global in magnitude because it has and will have global consequences.

Given the weakness of achievements in cutting greenhouse gas emissions, it is obvious that the policy-driven debate and actions on GEC have not been practice-oriented and coherent with the recognition of the undeniable scientific evidence related to this issue. In fact, much of the political discourse has brought alarming conclusions into the public sphere, with an exclusive focus on reconciling economy and environment, seeking for instance to provide evidence that climate action itself is a source of benefits and investment opportunities. This pattern is highlighted by recent literature (Zokaei et al. 2013) and institutional reports (Carbon Disclosure Project 2014).

2.1 The Triumph of Science-Based Approach: What Next?

For a long time, the scientific debate about the GEC prevailed over the political debate. The scientific investigations focused on observations, studies and model simulations produced by imminent scientists and research institutions around the world. The lack of global coordination and modeling analysis led countries under the head of the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO) to establish the Intergovernmental Panel on Climate Change (IPCC) in 1988 with three working groups in order to assess the state of existing knowledge about climate change – its science, the environmental, economic and social impacts – and possible response strategies, thus contributing substantially to global climate governance.

Since then, the scientific debate has become much more universal and coordinated, bringing together experts from both natural and social sciences. Conclusions are based on the assessment and the peer review of scientific literature on climate change carried out across the world, including global scale observations (direct measurements and remote sensing from satellites and other platforms) and model simulations.

New research carried out by independent and credible scientists provided an increasing body of evidence and scientific unanimity about the reality of the global warming and its impact on all natural systems (GEC) on one hand, and the interrelations between GEC and human activities – mainly industry, mining, transport,agriculture, and deforestation responsible for a significant increase in greenhouse gases (GHG) – on the other hand.

Anthropogenic activities are mainly responsible for the recent increase of atmospheric concentration of GHG, and by consequence for the warming trend and all sub-resulting degradations. The IPCC Fifth Assessment report (2013) made it clear that "It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century", which means 95 % of scientific certainty. Projections for the twenty-first century depend on GHG emissions scenarios, but the warming will continue even within the least pessimistic scenario (serious cut in fossil fuel burning and all GHG emissions).

A warming planet affects all natural systems in a vicious circle for long-term reinforcing feedback processes. If emissions continue according to the current pace through the current century, scientists say, the earth could warm by as much as 10 °F above the preindustrial level (Gillis 2014), which would have unexpected terrible cascading effects on human civilization.

Closely interrelated with those geophysical changes, the grievous impact on human security is much deeper than it looks or than it is estimated (i.e., it is expected that a huge number of deaths and considerable economic losses each year will be attributed to climate change risks, especially in the Global South). Environmental change affects communities and economies through contingent effects, and these effects are already being seen and felt today by vulnerable individuals and communities around the world, particularly in regions considered historically the least responsible for generating GHG emissions (UNDP 2014).

Given these conclusions, and taking into consideration the growing scientific consensus on climate change, and the observable occurrence of negative impacts on humans, it could be concluded that scientific debate regardinganthropogenic environmental change is almost complete (Cook et al. 2013a, b). Yet what about political and policy action? Is the scientific consensus paving the way for political implementation? To what extent is environmental change-policy action out of step – or even incompatible – with the existing scientific evidence? Is global environmental governance disregarding explicit links between the environmental crisis and dominant economic pathways?

2.2 Policy Action: Triggers and Limits

The formal discussion on policy response to climate change – as one main aspect of environmental change – focuses on two main approaches so far: mitigation and adaptation-oriented policies. Mitigation policies aim to reduce and stabilize GHG concentration in the atmosphere, while adaptation policies are directed to manage different risks and vulnerabilities caused by the negative impact of climate change on societies, economies, and natural systems. Environmental change is both local and global, thus the governance responses involve policy makers at different scales of space and targets. The policy action to manage the environmental crisis must therefore consider a paradox: the responsibility of policy makers to take into account the available scientific evidence, and therefore precipitate the implementation of rigorous mitigation and adaptation strategies and environmental laws, and at the same time support the market-oriented growth and a dominant culture of consumerism.

The dominant economic paradigm has led to a cultural belief that continuous growth of GDP and percapita income is positively associated with a greater attention to environmental problems (Floro 2012). This seems to be true in terms of defensive activities given the available resources to deal with environmental crisis (Duroy 2005). Indeed, it has been anticipated that the enhancement of environmental regulations come along with material growth, and people with high income tend to care more about environment, and therefore push forword to to set up protecting policies (Inglehart 1997). However, it is now clear that the increase of wealth, and in the amount of consumed goods and services, most often lead to more burning of fossil fuels, to natural resource overuse and to associated GHG emissions (Schandl and West 2010). Additionally, it is increasingly obvious that the GDP growth is not a viable measurement tool of economic well-being and social welfare. The dilemma the environmental policy is currently facing is mainly related to how our societies could improve the quality of life (life satisfaction) without constant pursuit of economic growth, based mostly on natural resource depletion and environmental degradation (Bergmann 2011).

In this respect, and due to the limits of GDP as an indicator of economic performance and social progress, many relevant initiatives (commissions, task forces…)[4] have been established with the aim of developing inclusive indicators, more sensitive to social and environmental dimensions. In addition to the GDP indicator, growth should be measured with reference to social and environmental welfare, facilitating the planning, acceptance and implementation of adequate environmental and social policies

Indeed, the political response to global environmental change is facing serious obstacles that affect its ability to cope with identified causes and consequences. At the first level, mitigation policies, even the toughest ones, will not stop global warming immediately, given the inertia of the climate system, and therefore the outcome of these policies will be merely beneficial for future generations (very likely not born yet). In a context of rapid and unpredictable variation (Doppelt 2006), the 'economic policy transition'to a 'low-carbon economy' imposes very immediate responses due to large-scale reinforcing effects of small changes. In addition, the world's biggest emitters, including some major developing countries[5] still resist robust mitigation strategies despite the fact that past carbon emissions are causing damages around the world with serious impacts especially for most vulnerable people, exposing them to floods, diseases, famine, etc. Also, conflicting interests and positions between the South and the North, and even within existing blocks of alliances, have made the recent multilateral climate negotiations very tough and tense.[6] This undermines international efforts to lower emissions.

Currently, the strong emphasis placed by policy makers on GDP as an indicator of social welfare explains why mitigation policies appear so unattractive to many governments, as the latter may result in a loss of GDP in the short term, and in turn may compromise the chances of re-election. Also, the translation of scientific consensus into policy action is still limited by some level of climate skepticism and the campaign led by lobbying groups and think tanks, mainly supported by manufacturing and petroleum firms with vested interests (McCright et al. 2013), arguing that GEC is not man-made but a natural process.

In addition, public support in wealthy countries for environmental change mitigation policies is still weak due to a 'consensus gap' and a public belief that the scientific certainty proving the anthropogenic nature of global warming is still embryonic (Cook 2013), or that climate science is politically tainted (Hamilton 2014). Indeed, despite the overwhelming scientific evidence, a significant part of public opinion in some countries is prompt to trust denial claims and continues to use a panoply of psychological escape mechanisms that allow citizens to stand against any attempt to change their conventional lifestyles, faithful to conservative political culture, voting for policy makers that are insensible to the environmental crisis discourse. This public misperception about the state of scientific consensus

[4] For instance the Commission on the Measurement of Economic Performance and Social Progress created by French government in 2009 chaired by the economist J.E. Stiglitz.

[5] Invoking their 'right to development'.

[6] The failure of Copenhagen Summit in 2009 was an obvious illustration of these divergences.

regarding the reality and causes of climate change matters a lot. Referring to the case of the United States (since the weak involvement of this key carbon emitter in global climate governance has made the process more or less slow), Maibach et al. (2014)[7] argue: "This misperception among Americans is not only pervasive but also highly consequential […]. Those who do not understand the scientific consensus about human-caused climate change are, in turn, less likely to believe that climate change is happening, human-caused, will have serious consequences, and is solvable (i.e., can be mitigated through concerted action). In addition, not understanding this scientific consensus undermines Americans' support for a broad societal response to the threat. As a result, knowledge of the scientific consensus on human-caused climate change can be considered a 'gateway' cognition; as members of the general public come to understand the consensus, they more likely come to the conclusion that human-caused climate change is happening and harmful".

Maibach et al. (2014) argue again: "The pervasiveness of this misperception is not an accident. Rather, it is the result of a disinformation campaign by individuals and organizations in the United States – and increasingly in other nations around the world[8] […] – who oppose government action to reduce carbon emissions […]. The claim that climate scientists are still arguing over the reality of human-caused climate change was designed to resonate with the sensibilities of political conservatives who are inherently suspicious of government intervention in markets and societies".

The change in perceived scientific consensus is considered by Van Der Linden et al. (2015) as a 'gateway belief' by influencing other key beliefs about climate change. In turn, this could reflect on behavioral and psychological aspects for public engagement and support for public action.

In most countries, public policies to cope with GEC – pertaining to both mitigation and adaptation – are generally conducted in accordance with the dominant economic development models, and within the growth paradigms. These policies intersect with human and socio-economic issues such as human security, equity,

[7] According to Maibach et al. (2014), "Human-caused climate change is happening and is accelerating; dangerous impacts are becoming evident around the world, and are projected to get worse in the decades to come, possibly much worse […]. Nearly all climate scientists are convinced of these basic facts, but more than half of Americans do not currently understand that this scientific consensus has been reached […]. Americans are not alone in this regard, although relatively less is known about the views of people in other nations. While 57 % of Britons aged 15 and older agreed with the statement 'most scientists agree that humans are causing climate change' […], a separate 16-nation World Public Opinion Poll (Public attitudes toward climate change: Findings from a multi-country poll, 2009, http://worldpublicopinion.org/pipa/articles/btenvironmentra/649.php?lb=brglmandpnt=649andnid=andid=) found that only a minority of citizens in seven nations said 'most scientists think the problem is urgent and enough is known to take action'; these were the United States (38 %), Russia (23 %), Indonesia (33 %), Japan (43 %), Brazil (44 %), India (48 %), and Mexico (48 %). Across all 16 nations, 51 % selected this response option, while 16 % said 'most (scientists) think the problem is not urgent, and not enough is known yet to take action', and 24 % said 'views are pretty evenly divided', another 10 % indicated 'don't know'".

[8] While originally launched in the United States, this disinformation campaign has been pursued in Canada, the UK, Australia, and New Zealand as well (Dunlap and McCright 2011).

sustainability, and economic growth. Therefore, political response will depend on our crucial choices with regard to growth, development, kind of society and type of environment we want to live in (Doppelt 2006). Hence, the ability of governments to make public policies successful depends on alternative models based on long-term benefits, neglecting short-term costs and utilitarian logics widely adopted by the environmental economic school.

3 Alternative Paradigms and Pathways

In the assessment models, upon which policy decisions are taken and implemented, monetization prevails through putting a price on what is intrinsically priceless (Ackerman et al. 2008) such as human life, natural ecosystems, and the global commons. The dominant economic models have responded to GEC with regulatory frameworks and solutions inspired by the globalized economy and market-based mechanisms – like carbon market, payments for ecosystem services, and cost-benefit analysis. Hence, large corporations are somehow granted a legal basis to pollute the atmosphere and make carbon cuts as cheap as possible (Bauwens 2011). According to neoliberal environmental economists, the environmental crisis – perceived as a market failure to give right prices to natural resources – is supposed to be solved by the market through price correction, which means economic efficiency. This approach ignores the fact that since resource prices reflect the relative scarcity of different resource types, and not their absolute scarcity (Baumgartner et al. 2006; Lawn 2010), it's not possible to get the right price for absolutely scarce, finite and non-substitutable resources (Sanders 2012). Therefore, this solution remains devoted to 'business as usual' approach that can lead to further natural resource depletion and overuse.

3.1 Sustainable Development

The emergence of the 'sustainable development'concept has reflected the broad awareness by the international community of the urgency to manage the ecological crisis in a way that is balanced with economic and social imperatives. In this regard, although the concept was strongly argued, it was rather perceived by environmentalists like moral injunctions rather than a concrete shift in economic paradigm. The attractiveness of this concept lies on a promise to make compatible ecological, social, and economic imperatives. Furthermore, growth was commonly considered during previous decades as necessary to fund environmental management actions and improve the quality of environment.

Almost three decades later, the objective of poverty eradication prone by the Brundtland Report, as the highest priority, is far from being achieved, not to mention the failure stories in the pursuit of the Millennium Development Goals (MDG's).

This is one of the reasons behind the current adoption of the Sustainable Development Goals (SDGs). In the meantime dematerialization of the economy didn't make it 'less energy-intensive in its impact'(WCED 1987:52). Indeed, dematerialization didn't reduce the material throughput of the economy, neither efficiency equates to less use of resources (Alcott 2008). Regrettably, within this logic, humanity is still unable to solve basic contradictions that undermine the viability of both environmental and human systems.

Some environmental economists blame the economic system, as it is currently designed and working, characterized by uninterrupted trespassing of biological and physical limits of the nature. The theory of limits (Meadows et al. 1992), known to be the basis of the 'sustainable development' construct, is the dominant paradigm for understanding the interactions between the economy and the environment (Daly 1979, 1996), and has effectively been used to raise concerns about the reciprocal correlation between both environment and economic collapses when those limits are reached or exceeded (Davidson 2000). Along the same line, a recent research testifies that humanity is exceeding some of the biophysical interlinked planetary boundaries (Rockström et al. 2009). Schellenhuber and other environmentalists warned against the irreversible consequences on the whole earth climate and ecosystems of crossing the tipping points, such as the melt of arctic ice sheet and the dieback of amazon rainforest (Schellnhuber et al. 2006).

Nevertheless, according to Tainter (1990), the limits paradigm neglected the fact that the human economy is designed to increase social and technological complexity in order to continue to expand, while pursuing ecological overshooting and deepening disparities between the rich and the poor. Such adaptation requires high flow of energy and resources, meaning eventually high levels of unsustainability. This situation sounds like running the planet Earth as if it were a business in liquidation (Sanders 2012). According to Gunderson and Holling (2001), the return to simplicity and sustainable use of natural capital may be a key design criterion to reduce per capita resource flows.

Sustainability has not been interpreted as a matter of human survival that is directly threatened by exponential global physical scale of the economic system, but regrettably been rooted in utilitarian considerations and driven by resource constraints and an assumption that rising prices, resource substitution, technological progress and human ingenuity will overcome the resource scarcity problem of future generations (Nordhaus 1992a). Maximizing present values, slogan of the market logic, is the opposite of sustainability and intergenerational equity. To be sure, the argument that technical change will allow economy to grow in spite of finite resources by pushing nature's limits (Nordhaus 1992b) is rather closer to economic sustainability than it is to sustainable development. In fact, the mainstream economic thought has privileged the 'weak sustainability model' (Ayres and Gowdy 1998; Sanders 2012) arguing that natural capital can be substituted for by financial, manufactured and human capital, instead of adopting the 'strong sustainability model' according to which natural capital stocks are the limiting factor, and must therefore be maintained (Daly 1991, 2005). Biophysical limits are merely recognized in order to prepare our ability to raise the threshold

of economic sustainability, and to prepare a transition to a dematerialized[9] and less high energy-based economy, henceforth wished to be feasible through the global green economy model.

3.2 Green Economy

'Green economy'is currently the buzzword among environmental economists, and represents a new paradigm to solve the contradiction between economic growth, environmental protection, and natural resource preservation. It relies on green technological innovations and green investments to make growth environmentally-friendly. But, what is the potential of this new paradigm to solve the sustainability dilemmain thecontext of a multidimensional global crisis?

The paradigm is proposed to policy makers by a widespread literature of environmental economists – including think tanks, experts, and NGOs – as a roadmap to practically translate the concept of sustainable development and the objectives of intra and intergenerational equity. Nevertheless, the paradigm suffers from the lack of an internationally agreed framework,[10] which is reflected in the design and implementation of interrelated policy measures and strategies. Recently, a modern wave of green economists, spurred by influential international organizations – such as UNEP, European Union (EU), Bretton Woods Institutions (IMF and the World Bank), Organization for Economic Cooperation and Development (OECD), etc. – and other research institutions, initiate guiding principles that frame and clarify the concept of 'green economy'. According to UNEP (2011), green economy refers to an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Therefore, the green economy roadmap is supposed to be global (relevant to both developed and developing countries), driven by public and private investments that reduce carbon emissions, and oriented to preserve and eventually rebuild natural capital assets, especially for vulnerable regions and populations whose income and security depend strongly on environmental services.

Be it a wishful thinking, a new means to expand corporate control on nature, or a real shift in the prevailing economic paradigm and related growth model, the concept is emerging in a context of global crisis (financial, social, security, and ecological) and unsuspected failure to achieve sustainable development goals – growing inequity and poverty, degradation of natural resources and ecosystems, loss of biodiversity and environmental services. The UNEP 2011 Report on green economy set up a roadmap to Rio+20 and beyond claiming the reallocation of public and

[9] According to the conventional environmental economic thought, economic growth can be sustainable so long as efficiency gains allow the economy to dematerialize by at least the same rate as it grows.

[10] For instance, the UNEP focuses on the 'green economy' while the OECD and the World Bank refer sometimes to 'sustainable growth' and 'green growth'.

private investments to enhance natural capital, resource efficiency, and renewable energy. Thus, the green economy is grounded in an optimistic scenario where the green investments are expected to enable GDPs to grow higher than currently, to create more and better jobs, and to alleviate poverty on a long-term perspective. Some new environmentalists even recognize it as the capitalism's best hope to create jobs, restore growth, and limit climate change (Jessop 2011).

Nevertheless, certain environmentalists contest the green economy agenda because it is perceived as vaguely connected to social and ecological systems, and fearing that claims for the required structural changes of the economic system will be captured by powerful economic agents. The global green economy roadmap is also criticized for being a diverted way enabling capitalistic interests to create new sources of profit and growth through putting price value to each component of natural capital (payment for ecosystem services). In terms of implementation, the green economy policies are facing serious limits given the political and financial weight of large corporations, and "the global operation of the political and economic relationships that today dominate the planet"(Lander 2011:4).

According to Lander (2011), authors of the UNEP 2011 Report opted to ignore the fact that the capacity of existing political systems to establish regulations and restrictions to the free operation of the markets – even when a large majority of the population calls for them – is seriously limited by the political and financial power of the corporations. This is particularly evident in some countries like the United States. No environmental regulatory policy and no international commitment can be assumed by the government of that country if it does not have the prior approval of the major corporations potentially affected by the measures. In fact, these corporations have the capacity to veto the policies with which they do not agree. They demonstrate this powerfully in the way the United States has been prevented from making any commitment to reduce GHG emissions in the United Nations climate change negotiations, and in the way they have prevented the passing of even the most timid environmental regulations that have been proposed in recent years. For governments, the political cost of affecting corporate interests is simply too high.[11]

The arguments advanced by green economy proponents look pertinent, especially the one related to the misallocation of the capital as being the source of the dilemma between economic progress and environmental sustainability. However, we believe that a 'market failure' (UNEP 2011) could not be solved by exclusively led market policies, established as a dogma to deal with all crises. Many analysts consider such policies and regulations as extensively committed to guarantee high profits for green investors, and make their businesses more competitive than it is in the 'brown economy'. Thereby, the panacea of green economy is vowed predominately to defend extension of the free market to natural capital (Lander 2011:4), with the same flawed paradigms that are responsible for global crisis, including environmental crisis.

Generally, the absorption of nature into economic calculation deeply brittle some basic principles already transgressed by the dominant model of development,

[11] For more details: http://www.tni.org/report/green-economy-wolf-sheeps-clothing.

mainly two old nowadays revived central concepts: natural commons (rights of mother earth) and human security (rights of all humans to live in dignity and freed from all risks). Both concepts are tightly linked to social justice and intergenerational equity, and may be adopted as a basis to set up new indicators to assess societal progress and wellbeing, particularly in current process of defining and implementing a post-2015 development agenda and sustainable development goals (SDGs) by the United Nations.[12]

4 Towards a Human Security-Centered Approach

The joint efforts of economists and environmentalists to propose alternative paradigms of sustainable development and green economy aim to replace current growth models with their negative environmental and social externalities. These paradigms tend to combine relevant criteria, such as efficiency and sustainability, but have been criticized for being anchored in the dominant economic paradigm (Sanders 2012), and associated with connotations and reform options "accepted by the realpolitik and the economy" (Unmüßig et al. 2012). The following analysis will focus on the human security-centered approach as a core paradigm that offers real alternatives to drive an overall transformation of the system, and capable to target within this transformation human security, and "by ricochet" the whole environment.

Less well explored in the field of actions, the concept of human security is both an epistemological tool for describing an empirical reality and a normative concept signaling the way the world should be and marking where change is needed. The very essence of the human security concept is its ability to stand at the core of the future we want for our civilization, because it is focused on human beings, and the fight against every single threat to their security.

According to Purgess (2009:49), the long debate on the meaning, nature and scope of the concept of human security has come full circle. Its epistemological pretences and methodological abilities have been discussed by analysts seeking to better grasp the world around them and to draw clearer and more meaningful conclusions about the security landscape as it is.

Human beings have always sought to secure themselves and their livelihoods from natural or man-made threats. This struggle for security is becoming more and more complicated insofar that most perils are increasingly provoked by human impacts on the environment. The following analysis explores the interrelations between human security and environmental security, highlights related implications, and investigates the relevance of using the human security approach as an entry point to manage GEC.

[12] For more details: https://sustainabledevelopment.un.org/post2015

4.1 Environmental Security as a Catalyst for Human Security

At the root of the emergence of environmental security field occurs a paradigmatic shift in the meaning of security from a traditional view – focused on national security and narrowed by nation-state boundaries – to a new people-centered approach. The focus on military defense to ensure the security of citizens has failed for two main reasons: First, because it is considered from the state rather than human-security perspective; secondly, because it ignores non military threats like those related to environmental risks (Brown 1977; Ullman 1993).

The rethinking of human security has been parallel to another interlinked paradigmatic shift in development economics as emphasis became less on per capita income and more on human well-being and fair distribution of wealth among individuals, communities, regions and countries (UNDP 1994). The development and security literature have been elaborated into intersected approach linking human security to human development (Ul haq 1996). The UNDP 1994 Human Development Report catalyzed this common interest in "human life and dignity", targeted to position human security as an organizing concept to deal with threats from multiple sources.

Although the concept has gained prominent importance among academic and policy circles, and considered by some countries as a key driver of foreign policy agenda,[13] it still lacks a commonly clear and measurable definition (King and Murray 2002). This prevents using the concept as a relevant reference for national and international policies aiming at improving human condition. For the purpose of this research, we recognize some international regulatory and policy frameworks where human security synthesizes all concerns for basic needs, human development, and human rights (Gasper 2005). We also refer to some recent literature that confers consistency and practical meaning to the human security concept, for instance by using some measurement methods (King and Murray 2002).

For our reasoning, we will use a clear, comprehensive and a working definition proposed by the Japanese Foreign Ministry (1999): “human security comprehensively covers all the menaces that threaten human survival, daily life and dignity – for example, environmental degradation, violations of human rights, transnational organized crime, illicit drugs, refugees, poverty, anti-personnel landmines and other infectious diseases such as AIDS – and strengthens efforts to confront these threats”. Also, with reference to the UNDP definition,[14] human security is regarded from a global perspective, through interdependent components, prevention-oriented, and people-centered. These four characteristics emphasize a double connection between human security and GEC (UNDP 1994).

[13] Canada, Japan and Norway are the leading countries for this modern view of human security.

[14] The 1994 UNDP Human Development Report has broadly defined human security as ‘freedom from fear’ and ‘freedom from want’.

4.2 Human Security Heavily Threatened by GEC

Critics who suggest that the human security concept is too broad and all-encompassing are to be questioned, since the current threats and risks are interlinked, complex, and not mutually exclusive. For our purpose, we believe that global environmental change, aside from being a source of non-military threats to national security (Barnett 2001), turns out to be a contributing factor to conflicts and instability (Barnett and Adger 2007), playing a catalyzing effect on all other threats.[15] In fact, the environmental factor appears to be the most important component as it impacts and somehow directly triggers or amplifies the other threats. Here are a few examples to figure out this interrelation: The scarcity of some natural resources (i.e. water) may lead to a violent conflict, in the same way that forced migration (caused by GEC) is synonym of deprivation and deep insecurity, and it may lead to conflict in host communities (Barnett and Adger 2007). Insufficiency of food resources caused by fisheries depletion, land degradation, water shortage, extreme weather events, etc. results in malnutrition, hunger and health problems. Furthermore, considering that the ecological degradation is causing a gradual failure of the whole system on which depend our lives and livelihoods, we can assume – as a result – that the GEC has the potential to deeply affect the future generations more than any other risks. Regarded from a global and measurable scale – global warming scenarios and related expected effects – human security has never been so challenged throughout the human history as it is today.[16]

With regard to the human security's four characteristics mentioned above, the GEC spreads out of the state traditional security logic, and make it unavailing. It undermines the most basic material and psychological needs of most vulnerable people, and weakens the freedom of future generations to live with sufficiently renewable natural resources. More precisely, the depletion of these resources – besides having physical and social adverse externalities (dissatisfaction of basic needs) – may interact with a range of economic, political, social, and cultural processes, intensify competition over these resources, and increase directly the likelihood of violent conflicts among communities and states (Dixon and Blitt 1998). In the academic sphere of environmental security, it was assumed that the environment might be a factor of international cooperation; however, this potential shift will remain dependent on the condition to place the GEC on the top of international human security agendas, and on the nature of geostrategic interstate tensions and dynamics.

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[15] According to a study published by the National Science Foundation in 2015, an extreme drought in Syria between 2006 and 2009 was most likely due to climate change, and that the drought was a factor behind the violent uprising that began there in 2011. For more details see the article appeared in New York Times on March 3, 2015. URL: http://www.nytimes.com/2015/03/03/science/earth/study-links-syria-conflict-to-drought-caused-by-climate-change.html?_r=0

[16] If we consider the most optimistic scenario of global warming (according to IPCC), the surface temperature will still increase by 2–4 °Cby the year 2100.

From another point of view, and according to Dalby (2002), "international relations operates on the basic assumption that states, given sovereign recognition in common, are at least legally equivalent units in the international system. Granted some are more powerful than others, but their rights in terms of international legal personality and their privileges granted in terms of sovereignty are assumed to make them the key actors in international politics. But shifting the focus to global changes suggests that this assumption is not necessarily a useful starting point for thinking about what is still inadequately understood in terms of environment. Clearly the transboundary 'flows' of environmental politics have challenged the assumptions of sovereignty in many ways that require international cooperation on many themes. In this sense, the 'greening' of sovereignty is occurring and the importance of international cooperation made evident, but environmental themes also do point to the limits of thinking in terms of sovereignty in the first place".

Hence, GEC is a multidimensional question of human security and is increasingly understood as a central and globally shared issue. Longtime framed as a discourse rooted in natural sciences and restricted to environmental externalities, GEC research begins to be increasingly approached from the point of view of its social externalities (O'Brien 2006) and newly from geostrategic externalities (Valantin 2013). Based on this approach, which views GEC as inherently a social problem (Barnett et al. 2010), which affects human security through many complex social processes (such as violence, discrimination, marginalization and exploitation), it is a social and human security based approach that must be considered the unavoidable path to tackle GEC since individuals and communities have the capacity and freedom to exercise enough options to end, avoid or to adapt to environmental change (GECHS 1999).

4.3 Human Security Approach to Tackle GEC

State-led approaches to securitize policies for tackling environmental change have shown little ability to prompt appropriately scaled policies in order to tackle environmental change, whereas the securitization constructed by people and communities (bottom-up led approaches) can put pressure on governmentsand consequently push policy makers to effectively respond to environmental change whilst prioritizing people's needs, values, rights, and equity within and between social groups and generations. At the first level, ahuman security approach promotes empowerment strategies by individuals and communities, with a focus on enabling them to maintain their livelihoodsin the face of social and environmental changes (Barnett 2008). Further, reframing environmental change as a human security issue will certainly expand the scope and heighten the relevance of the addressed issues to include an emphasis on equity, social justice, vulnerability, power relations, and the security of humans not born yet (O'Brien 2006). Refocused on human security, approaches to tackle GEC could very likely gather scientists and research institutions from all disciplines whilst connecting environmental change to their diverse core concerns.

The environmental crisis is intimately connected to the human and socio-economic context within which we live; this is the reason why the approach to address this crisis and solutions to cope with it must consider its interaction with contemporary economic structures, development paths, and powerful interests (O'Brien 2006). Human security is paradoxically most challenged and weakened in the "Anthropocene" era, where humanity is the most powerful geological force on Earth, because we are making the Earth a hostile, and in some cases, a non viable place for humans and other species.

More essentially, the human security approach is definitely used to raise new consistent solutions and policies that are not necessarily conceived within the imperatives of the capitalistic economic system, nor dominated by formal modeling (Dietz and Stern 2008). According to a new wave of scholars of environmental security,[17] environmental change can only be resolved by considering it as a human security issue. While there is a need for far-reaching policies to directly tackle environmental change, these policies also have the duty to target all sources of vulnerability and triggers that may intensify the effects of global change, and hinder people from appropriately adapting and responding to environmental crisis outcomes.

Approaching GEC from a human security perspective can contribute to the creation of regulations that are multidimensional and which comprise not only technical solutions(such as low emissions, green investments), but also address the socio-economic causes and consequences of global change, including poverty, inequality, failure of economic strategies, and failure of financial markets and international trade to reduce or even stabilize rich-poor gaps. The IPCC 2012 report made it clear: "A prerequisite for sustainability in the context of climate change is addressing the underlying causes of vulnerability, including the structural inequalities that create and sustain poverty and constrain access to resources" (IPCC 2012:20). Thus, the conception and implementation of effective solutions to the environmental crisis require powerful authorities willing to enforce strong policies and able to introduce real alternatives to the established economic system. From the same perspective, communities and individuals around the world should engage with the need for the concrete transformations that are crucial to sustaining human life on earth. Encouraging citizens to vote for governments that are strongly committed to take a robust climate and environmental action, even in opposition to corporate interests, may be an efficient way to make change.[18]

From the perspective of the global climate agreement adopted during the COP 21 in Paris by the end of 2015, one should remember that some trade-offs are inevi-

[17] A large literature emerged during the last decade aiming to address environmental change as a human security challenge. For more analysis on this issue, see (Barnett 2007; Dokos et al. 2008; Brauch 2012).

[18] As an illustration of this situation, it was reported by Gillis and Davenport (2014) that during the last two years, The US president and his aides have pushed for citizens to increase the pressure for governmental action, based on the premise that only popular protest can overcome the resistance in Congress.

table, especially when the rich lifestyle of a global minority threatens the human security of the majority. Certainly, we believe that the point is not to choose between economic growth and environmental protection, but to banish any further attempts to make benefits at the expense of the viability of social and ecological systems. Based on this, we support the idea that the current global environmental governance system, aiming at protecting the environment and coping with GEC, needs to be rethought through two fundamental concepts: global social justice and human security.

5 Conclusion

This chapter highlights our reservations on development perspectives based on GDP growth, and on the prevailing discourse founded on sustainable development and the green economy. Instead, we argue that a human security perspective is able to reflect the needs, aspirations of individuals and communities, hence facilitating their empowerment to influence and contribute to public policies.

The paradigmatic shift framing global environmental change as a human security threat, as supported by this analysis, must not be taken over by any political interest for its own ends, nor manipulated for short electoral purposes. It must be placed beyond divergent agendas as a worldwide multi-dimensional "social contract" which exhorts governments and international institutions to protect people from imminent threats, including non-military ones such GEC. To those who see it as being too idealistic, the answer is that the issues at stake are intrinsically incompatible with the zero-sum game logic. Global environmental change threatens poor as well as the rich countries and communities across the world. The fight against social vulnerabilities and environmental crisis must be united and global. Since the interrelations between social and ecological systems are growing at different scales, efficient coping strategies will have positive impacts globally, but any inertia will further deepen the inequalities worldwide, but more severely in the Global South with untold negative consequences.

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Chapter 3
Is Human Security a Relevant Concept in the Context of Climate Change Adaptation Policies?

Katriona McGlade, Christiane Gerstetter, Elizabeth Tedsen, and Rodrigo Vidaurre

Abstract This paper analyses the relevance of the concept of human security for the purpose of climate adaptation policies. The starting point of this inquiry is recent high-level debates and reports framing climate change as a security issue. One way in which climate change can be considered a 'security risk' is that its impacts are expected to undermine human security if adaptation measures are not taken. There is ample evidence that climate change poses threats to human security (e.g. water-related, economic, health, physical) from which it is necessary to protect individuals. However, the use and usefulness of the concept of human security for climate adaptation policy-making are much less apparent. This paper discusses the role of the human security concept in adaptation policies from an empirical and normative point of view. It examines its role in high-level discourse (e.g. in national foreign policy statements or at the UN general assembly) as well as in national adaptation policies. The paper is based, *inter alia*, on case studies that included over 70 in-depth, qualitative interviews with policy-makers and experts in four MMES (Mediterranean, Middle East and Sahel) countries (Ethiopia, Israel, Morocco and the occupied Palestinian territory (oPT)) as well as at EU and UN level.

Keywords Climate change • Human security • Adaptation policy • Climate conflicts • Water

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1 Introduction[1]

Climate change will have severe impacts on countries, communities and individuals around the globe if they fail to adapt. Adaptation can be understood as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects" wherein "various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned" (Metz et al. 2007). In recent years, different actors have used a range of concepts that seek to highlight the severity of likely climate change impacts as well as the need for urgent action. For example, climate change has been discussed in terms of its predicted impacts on human rights (e.g.UNEP 2015). In another framing, official political debates as well as policy documents and academic reports have presented climate change as an issue of international security (UN General Assembly 2009; Reuveny 2007; Buhaug et al. 2007; CNA Corporation 2007; Brown and Crawford 2009; German Advisory Council on Global Change (WGBU) 2007). Presenting climate change as a *human security* issue can be considered a strand of this framing and forms the focus of this chapter's analysis. The concept of human security can be used to identify a range of negative, climate change-induced impacts (for example food- or water-related, economic, health or physical impacts) from which it is necessary to protect individuals. While there is ample evidence that climate change may pose threats to human security, it does not necessarily follow that policies to adapt operationalise or indeed *should* make use of the human security concept. This chapter thus discusses the use and usefulness of the concept of human security for climate change adaptation policy-making and whether or not it has any normative value.

The focus of this chapter is on the Mediterranean, Middle East and Sahel (MMES) region and on the water–related impacts of climate change. The MMES can be considered a climatic "hotspot": a region that will experience large changes in climate mean and variability (Elasha 2010; Iglesias et al. 2007). Regional and global climate simulations project an increase in duration and intensity of droughts as well as the length, frequency, and/or intensity of warm spells or heat waves in the Mediterranean (Kovats et al. 2014; Christensen et al. 2013). A very likely decrease in mean annual precipitation over the Mediterranean region of northern Africa is also predicted for the mid- and late twenty-first century periods (Niang et al. 2014). However, this region is not only a "hotspot" for climatic reasons. Socio-political instability and conflict are features of many parts of the MMES, and concerns have been raised as to how these dynamics may be impacted by climate change (Lind et al. 2011; Elasha 2010; Brown and Crawford 2009).

[1] This paper was originally written and presented in 2012. Reasonable efforts have been made to ensure that facts are up to date and accurate at the time of publication.

This chapter is structured as follows: In Sect. 2, we discuss the relationship between human security and climate adaptation policy, showing links through a series of trajectories as well as highlighting the role of institutions and policies in mitigating climate-related risks to human security. In Sect. 3, we briefly elaborate on the role of concepts and ideas in policy-making in the context of (constructivist) political science research. In Sect. 4, we present our empirical findings, demonstrating how the concept of human security is being used in adaptation policy-making in various settings. Our focus is on the MMES region and on water-related impacts; European Union (EU) and United Nations (UN) policies, especially where these affect this region, have been taken into account. The empirical findings presented are based on, *inter alia*, policy reviews for 10 MMES countries and detailed case studies, including more than 70 in-depth, qualitative interviews with policy-makers and experts in Ethiopia, Israel, Morocco, the occupied Palestinian Territories (oPt) and at the EU and UN level.[2] On the basis of this research, we identify a remarkable split: human security is quite present as a concept in high-level political declarations, reports and policy agendas, particularly at the EU and UN level; in contrast, it is rare that policies at the national level reference human security as an explicit focus or objective or make use of human security frameworks to guide interventions. Finally, in Sect. 5, we discuss potential reasons for the observed split and, on this basis, reflect upon whether human security is a useful concept for the process of adapting to climate change in a national (domestic policy) context, or whether individual policies targeted either at a particular sub-aspect of human security such as food, water, health or physical or economic security are equally effective (or even the only available method) for ensuring human safety and well-being.

2 The Relationship Between Human Security and Climate Change Adaptation Policy

The concept of human security, though understood and used in a range of ways, has become a part of modern political parlance. Its seminal definition – and that which we take as the basis for this chapter – was established in 1994 by the landmark United Nations Development Programme (UNDP) Human Development Report (HDR). The report defined the term as having two core aspects: first, "safety from chronic threats such as hunger, disease and repression" and second, "protection from sudden and hurtful disruptions in the patterns of daily life – whether in homes, in jobs or in communities" (UNDP 1994). The HDR considered threats to human security in seven representative categories: economic security, food security, health

[2] (The research that this paper is based on was carried out as part of the conducted research project "Climate Change, Water Conflict and Human Security" (www.clico.org) funded under the EU's 7th Research Framework Programme (FP7). The empirical insights are presented at greater length in (Gerstetter et al. 2012).

security, environmental security, personal security, community security and political security. The report presented a notion of security that looked beyond conflict and which, while remaining distinct, intersected with people-centered development.[3] From this perspective, human security "no longer means carefully constructed safeguards against the threat of a nuclear holocaust…[but] responding to the threat of global poverty travelling across international borders in the form of drugs, HIV/AIDS, climate change, illegal migration and terrorism" (UNDP 1994). Within this context, climate change was put forth as one of many "challenges [that] threaten global security" (Ibid).

It is expected that climate change has the potential to pose a number of chronic and sudden threats to human security through natural disasters, disruption of ecosystem services and reduced access to natural resources (Barnett and Adger 2007). In its Fourth Assessment Report (AR4), the IPCC identified that changes to water availability, water quality, precipitation patterns and in particular the likelihood and magnitude of flooding events were likely to play a major role in driving adverse impacts to human settlements and infrastructure, i.e. areas crucial to human security, although no explicit mention of human security was made at the time of the AR4 (IPCC 2008). Indeed, as Barnett and Adger (2007) explain, environmental change does not undermine human security in isolation from social and economic factors. Rather, a whole range of phenomena influence human security, notably the operation of markets, the state, and civil society as well as poverty and discrimination (Adger et al. 2014).

The latest IPCC Fifth Assessment Report (AR5) carries out a systematic assessment across the various dimensions of human security. The AR5 report finds that despite the uncertain interactions between multiple factors, there is robust evidence to suggest that human security will be progressively threatened as the climate changes (Adger et al. 2014). The AR5 makes clear that there is a need for more comprehensive evidence, collected across multiple locations, and over long durations, to build and test theories about relationships between climate change and livelihoods, culture, migration, and conflict (Ibid.). In contribution to this need, and based on evidence gathered through case studies in Ethiopia, Israel, Morocco and the oPT, we have identified trajectories that highlight some of the relationships between climate-induced changes to water availability, human security/insecurity and conflict, and policies to mitigate negative impacts in these areas (Gerstetter et al. 2012). These links are elaborated on and presented in Box 3.1 below:

The overall capacity of societies to adapt to climate change and ensure the human security of citizens depends upon a number of factors. These include, *inter alia*,collective action, governance mechanisms, state level institutions that can manage the risks associated with climate change, and policies that enhance the

[3] Human security is not only about 'freedoms' and protection from threats, but is also closely linked to the development of human capabilities as conceptualised by Amartya Sen and the empowerment to respond to those threats in a positive manner. See (O'Brien et al. 2008; O'Brien and Leichenko 2007).

Box 3.1: Links Identified Between Climate Change, Human Security and Conflict

(i) *Existing human insecurity – climate change – lack of adaptive capacity/ policy response – increased human insecurity*

Persons experiencing poverty and other forms of insecurity (economic insecurity as well as related food, health and other insecurities) have considerably greater vulnerability to adverse climate impacts, such as water scarcity, and have less adaptive capacity or ability to mitigate threats. In addition to existing vulnerability, a general lack of financial capacity can constrain adaptation responses for both individuals and states; at the state level, insufficient financial capacity can leave developing countries unable to implement and manage adaptation measures, and make them dependent on external funding. At the individual or community level, costly adaptation methods may be inaccessible without financial means. Furthermore, when development or poverty reduction needs are pressing, more immediate social concerns are often higher on the agenda than climate change and may not be viewed in terms of their relationship to environmental risks. This, in addition to a lack of available funding, may lead to an absence of adaptation-related action by individuals or at the state level. Thus, the human security of previously "insecure" people is more likely to be negatively affected by climate change than that of people who already live in a more "secure" situation.

(ii) *Existing policies – human (in)security/conflict – climate change – human (in)security*

Existing policies can have a critical role in improving or harming the human security of groups, irrespective of climate change impacts.[4] For example, human development and agricultural policies in Morocco and Ethiopia are designed to contribute, *inter alia*,to improved food and economic security. At the same time, however, these policies may result in reduced land and water availability for certain groups that rely on these resources for livelihoods or short term food security such as small-holder farmers or pastoralist communities (see also Gebert et al. 2012 and Milman and Arsano 2012). In the case of Ethiopia, large-scale agricultural development programmes that often involve voluntary resettlement of communities have been found to not only pose a potential threat to human security, but were also identified as a recent source of conflict.[5] With the conditions of climate change, further stress on already

[4] A similar conclusion is presented in Urwin and Jordan (2008).

[5] See also d'Alisa (2012) for details of the strong state response to environmental impacts in Sarno, Italy where the politicisation and securitisation of the environmental situation, led to increased threats to human security.

(continued)

Box 3.1 (continued)
constrained resources, may cause this insecurity to persist or worsen, despite the root cause of insecurity being only indirectly related to climate change.

In other instances, existing policies play a more positive role. In the MMES region, water-related impacts of climate change are often the intensification of existing climatic conditions (e.g. water scarcity, drought, floods). In this way, many countries (including Israel, Morocco and Ethiopia) already have relevant institutions and policies in place that are unrelated to climate change, but can assist in and form a basis for adaptation action.[6]

(iii) *Existing conflict – climate change – lack of policy response – increased human insecurity/conflict*

Existing conflicts can also have negative impacts on policies addressing climate-induced risks to human security and conflict. (Indeed, conflict can be seen as a source of insecurity in itself). This in turn creates a self-reinforcing dynamic, increasing the likelihood of continued risks, climate-induced or otherwise, to human security. The case of Israel and the oPT illustrates this dynamic: Prior mistrust between these parties decreases the potential for cooperation over resources vital to human security, such as water, and for implementation of policies to ensure effective adaptation to climate change and human security.

[6]Furthermore, deliberative and participative processes can reduce the risks that adaptation may pose to human security and conflict adaptation Albizua and Zografos (2012), Pascual et al. (2012).

resilience of vulnerable groups within societies (Smit and Pilifosova 2003; Adger 2003; Barnett and Adger 2007). From a more normative perspective, it can be argued that it is governments who retain the primary responsibility to manage risk on behalf of its population, to ensure their survival, livelihood and dignity, especially for those who are among the poorest and most vulnerable (UNGA 2012; Lal et al. 2012; O'Brien et al. 2008; CCCD 2009). From this perspective, state-driven or -supported policies are an essential part of adaptation efforts and thus form the focus of our analysis. Despite this normative standpoint, it is important to recognise that environmental change may also undermine the capacity of states to provide the opportunities and services necessary to maintain the livelihoods of their citizens (Barnett and Adger 2007; Milman and Arsano 2012). Different policy approaches are possible for adapting to the impacts of climate change and ensuring human security is protected. These include mainstreaming climate adaptation into sectoral policies as well as policies specifically targeting climate change adaptation (Gerstetter et al. 2012).

3 The Use of the Human Security Concept

What role then, can be presumed for the concept of human security within climate adaptation policy-making? If climate adaptation policies play an important role in ensuring human security, does this consequently mean that human security is a relevant and useful concept for adaptation policy-making?

Traditionally, when analysing policy-uptake (or lack of) at the national or international level, political scientists have focused on factors such as underlying interests, power, institutions and problem-solving. However, in the past 20 years, the so-called "ideational turn" has proposed that political decisions are often influenced by ideas and by factors that are related to or influenced by ideas (for an overview see Bleich 2002). Some degree of disagreement persists on the definition of the term 'idea' and the precise role ideas play in policy-making (Beland and Cox 2010b) and a number of other terms can be described as relating to or building on ideas, such as beliefs, concepts, norms, frames or ideology (see for example Tannenwald 2005). "Human security" has been described in the literature as both a "concept", relating to ideas, and as a "discourse", broader than a concept (Gasper 2005).

Various ways in which concepts and ideas can influence policies have been identified. The most basic assumption is that ideas are what cause people to act, however, where the use of concepts and ideas becomes routine, they can translate into the building of new institutions and legitimate collective action, e.g. in the form of legal rules or policies (Beland and Cox 2010a; Metha 2010). Specific factors that have been identified as relevant for the degree to which an idea is adopted and to which it becomes influential include the feasibility of its implementation, and its acceptability to important and powerful actors. The attractiveness or intrinsic value of the concept on the other hand seem to be of limited importance with regards to its uptake (Metha 2010).

Indeed, although human security was identified by policy-makers as an attractive concept that also provides a practical framework for action (McGlade and Tedsen 2012a), it was above all in cases where powerful actors decided to support the concept, for a variety of motivations (Martin and Owen 2010), or when an epistemic community embraced it (Zwolski and Kaunert 2011) that the concept of human security gained political traction (see Sect. 4).[7] Human security is, undoubtedly, a broad and in some ways ill-defined concept (for a discussion of the various dimensions, see Gasper 2005). Yet, part of the appeal of the human security concept lies precisely in its broad scope which allows it to be connected to various disciplines, and across national borders and policy fields (Gasper 2005). In the UN system, for example, the concept has legitimated a broad range of policy responses (McGlade and Tedsen 2012a). Yet the wide, interdisciplinary nature of the concept has also meant that human security has also been used in an unclear, generic or overly broad manner, and has often tended to become irrelevant (cf. King and Murray 2002).

[7] For a discussion of the various dimensions of the human security concept, see Gasper (2005).

In many ways, human security has the potential to act as a relevant and useful concept for policy-making. However, there is no guarantee that human security, any more than any other concept, can be influential in a certain polity or given policy area at a certain time. Rather, the extent to which this is the case will depend on factors such as how easily the idea can be translated into political action or its attractiveness to powerful actors. In the following section we examine the ways in which this has happened in the MMES region and at the EU and UN levels.

4 The Use of Human Security in Policy-Making in the MMES Region

Effective adaptation to climate change requires action across a range of sectoral policy areas to prevent adverse impacts to human populations. In the previous sections, we have described links between human security and climate change adaptation policy and discussed the use of the human security concept in policy-making. The following section discusses whether and how the concept of human security has been taken up in policy-making and how the idea is tied to adaptation and climate change in these policy-making processes. We examine policies at both the international (UN and EU) level as well as at the national level for the MMES region.[8]

As described, our focus is on state-led or state-supported policies. We use the term "policy" in a broad sense, taken to include a range of overarching actions undertaken or supported by governments or public actors such as international organisations (e.g. laws, strategic programmes or guidance documents). Climate change adaptation policies are often in the form of wide-reaching programmes that simultaneously tackle a number of areas. Measures can either be specifically created, standalone measures or can make use of synergies with existing programmes (e.g. sectoral policies, agricultural or poverty reduction initiatives) aimed at improving adaptive capacity. Most commonly recommended is the latter approach (see, for example, OECD 2009; UNDP-UNEP Poverty-Environment Facility 2011) and is typically referred to as "mainstreaming" or "integration" of climate change adaptation (OECD 2009).

4.1 International Level – United Nations

The concept of human security owes much of its development to debate within the international community, and it is at the international level that it has found many of its greatest champions, most notably in the context of the UN and the EU. The

[8] These insights are based on an analysis of policy frameworks in Ethiopia, Morocco, Israel and the occupied Palestinian territory (oPt) as presented in Gerstetter et al. (2011).

concept of human security finds a natural home within the UN's mandate: to maintain international peace and security, develop relations among nations, achieve international cooperation in solving global problems, promote human rights and fundamental freedoms and harmonise national efforts to achieve common ends in these areas (Charter of the United Nations 1945). Over time, the conceptualisation of security in the UN system has evolved beyond the narrow frame of preventing state conflict to a broader protection of individuals (MacFarlane and Khong 2006). The UN has championed discussions on human security and although interest in the concept has not always been constant, climate change impacts as a source of human insecurity have slowly gained in visibility within this discourse.

The UN's Commission on Human Security was established in 2001, following the 2000 UN Millennium Summit and calls to promote "freedom from want" and "freedom from fear" (Commission on Human Security 2003). In the Commission's 2003 final report, climate change was briefly referenced in the broader context of environmental "special issues" (Ibid.). Two years later, in advance of the 2005 World Summit, then UN Secretary-General Kofi Annan presented a report that raised the profile of climate change as a human security concern, featuring it as one of several global challenges (UNSG 2005). The World Summit Outcome document committed "to discussing and defining the notion of human security in the General Assembly (GA)"and was subsequently subject to a number of debates at the General Assembly (UNGA 2005).

In UN Secretary-General Ban Ki-moon's 2010 report on developments since the World Summit, climate change was identified as "one of the most pressing issues of our time" (UNSG 2010). The report considered adaptation responses for governments and international partners and suggested that human security could be used to better assess and address climate-related insecurities (Ibid.). In a 2012 report,[9] the UN Secretary-General again gave emphasis to climate adaptation as a human security issue, prominently listing climate change and climate-related hazards first in the list of human security threats (UNSG 2012).[10] Member states were said to have "overwhelmingly highlighted the relevance of the human security approach to addressing the interaction of climate change with other insecurities" (Ibid.). Discussions included the use of human security as a tool for assessing vulnerabilities and capacities at the national and sub-national levels and for improved tailoring of adaptation strategies, such as early warning systems, in addition to repeating policy response suggestions from the 2010 report (Ibid). In September 2012, the General Assembly adopted resolution 66/290 "Follow-up to paragraph 143 on human security of the 2005 World Summit Outcome" in which Member States agreed on a common understanding on human security after 7 years of discussion.

[9] The report was written in response to a consensus resolution of the General Assembly noting ongoing efforts to define the concept of human security and requesting member state views (UN General Assembly 2010).

[10] Other listed activities included post-conflict peacebuilding, global financial and economic crisis and the Millennium Development Goals, and health and related challenges.

The consensus agreement paves the way to formally apply human security within the work of the UN.

In actual fact, the UN already has a number of policies addressing climate-related human security impacts. There are initiatives addressing links between human security and climate change adaptation, albeit without necessarily explicitly using a human security framework. For example, the UN Framework Convention on Climate Change's Adaptation Framework aims, in a general way, to reduce vulnerabilities in developing countries. Organisations such as the International Organisation for Migration, which works on disaster risk reduction, or UN Water, with its Water and Climate Change Thematic Priority Area, increasingly consider cross-sectoral climate-related water impacts and human insecurities in their respective work (McGlade and Tedsen 2012a). Numerous other bodies also target specific sub-aspects of human security such as the Food and Agricultural Organisation, which deals with food security, or the World Health Organisation, which addresses health and water security. The UN also makes links between human security and general environmental issues, such as through the Environment and Security Initiative (ENVSEC), a partnership with other international-level organisations, which seeks to reduce environmental threats to human security.

The UN's Trust Fund for Human Security (UNTFHS) and Human Security Unit (HSU), on the other hand, take human security as a central focus. The UNTFHS was established by the UN Secretariat and Japan,[11] with a particular focus on economic security in the wake of the 1997 Asian economic crisis (Howard-Hassmann 2012). The UNTFHS supports projects that translate the concept of human security into concrete activities to strengthen the capacity of individuals and communities to cope with and recover from climate-related threats while simultaneously addressing food, health and economic insecurities. These projects have demonstrated that a comprehensive and integrated approach can protect and empower people and help to reduce the social, political, economic and environmental consequences of climate change (United Nations Human Security Unit 2014). In 2004, management of the UNTFHS was placed in the hands of the UN's Office for the Coordination of Human Affairs (OCHA), alongside establishment of the HSU, an institution created with the aim of integrating human security into all UN activities. The HSU promotes the added value of a programmatic human security framework and has developed practical guidelines to operationalise this concept, most recently in its Strategic Plan 2014–2017 which outlines the way forward for mainstreaming human security in the activities of the UN and extending global awareness of the concept.

While UN and international-level discussions on human security have increasingly taken note of the threats presented by climate change, concurrently discussions on climate change have also been extended to include the subject of security. In the latter case, focus has been placed on the more traditional or "hard" aspects of

[11] Japan also later helped establish the Friends of Human Security network within the United Nations, a discussion forum for member states and organisations which has helped push the concept forward within the system (United Nations Human Security Unit 2009; Takasu 2012).

security.[12] The security implications of climate change were the subject of discussions at the Security Council in 2007 and 2011 and of a 2009 Secretary-General report to the General Assembly which described impacts on food security, water scarcity, land degradation, health and population displacement (UN General Assembly 2009). While centred on conflict and not making any explicit references to human security, these discussions nonetheless articulated connections to the concept: conflict could be sparked by a lack of resources, growing poverty or displacement, demonstrating the strong interlinkages between human and traditional security (Gerstetter et al. 2012).

4.2 International Level – European Union

In the following section we see that EU institutions have also made significant contributions to the human security discourse, producing high-level statements and initiatives that utilise the concept. Like the UN, EU institutions have shown an increased acknowledgement of the links between the physical impacts of climate change and human security. However, a gap remains between efforts to explore the concept and explicit incorporation into EU policy (Martin and Owen 2010).

In 2003, the European Security Strategy (ESS) was issued with a focus on traditional security. Here, impacts on individuals' freedoms and rights were included, albeit not as a central focus, in the EU's overall security strategy (Council of the European Union 2003). Also in 2003, a study group on Europe's security capabilities was convened at the request of EU High Representative for the Common Foreign and Security Policy Javier Solana (Martin and Owen 2010). The study group considered the implementation of the ESS and proposed *A Human Security Doctrine for Europe* (the Barcelona Report),arguing that a human security response force, comprised of both troops and volunteer civilians, a new legal framework and a human rights-based approach were needed (Albrecht et al. 2004). The report represented the EU's first coherent attempt to develop a policy for intervention based on individual rights to security (Matlary 2008). While lack of food and water were both mentioned as sources of insecurity, addressing the impacts of climate change was not a focus point. The 2008 ESS implementation report, however, reiterated climate-related security concerns and human security, and was the first time that human security was explicitly referred to by the European Council as being central to the EU's strategic goals (Martin and Owen 2010).

For the most part, direct and explicit use of the concept of human security has largely been restricted to EU foreign policy statements. However, aspects of human security are actively addressed through numerous internally and externally-focused policies and in the context of climate adaptation (McGlade and Tedsen 2012b). For

[12] I.e. relating to the protection of the nation state from threats, particularly where these stem from external sources.

instance, the 2009 EU White Paper on climate change adaptation, does not make use of the concept, but does examine climate-induced vulnerabilities and actions to promote resilience (European Commission 2009). The EU Adaptation Strategy Package which followed in 2013 makes more explicit references to sub-aspects of human security such as health and food security (European Commission 2013). In its development policy, the EU formally commits to integrating consideration of climate change impacts (European Commission 2003; EuropeAid 2009). In the 2011 *Agenda for Change*,for example, the term human security is not explicitly used, but connections between human rights, development and security are outlined. Furthermore, a strategic approach for EU development aid is proposed, looking at turning challenges of food security and climate change into opportunities for growth (European Commission 2011). Also in 2011, the EU External Action Service Strategy for Security and Development in the Sahel took a comprehensive approach to security issues, emphasising that "security and development in the Sahel cannot be separated" and making reference to climate change and human security challenges (European Union External Action Service 2011). By 2013, the EEAS had suggested that the nexus between climate, natural resources, prosperity and security be made a key strand of action for climate diplomacy, including the need to "sharp(en) an EU narrative on the intricate links between climate change, international and human security" (European Union External Action Service 2013). Initiatives such as the Global Climate Change Alliance promote cooperation with vulnerable developing countries and support for adaptation and reducing insecurities. The EU Water Initiative assists developing countries with water and sanitation, and considers climate impacts and has working groups for Africa and the Mediterranean. The EU also helped to drive the Strategy for Water in the Mediterranean, a framework for regional cooperation on water, human security and climate, which, however, has yet to be implemented.

Since the departure of Javier Solana as High Representative for the Common Foreign and Security Policy (CFSP) in 2009, debates on the subject of human security – either as a standalone issue or as linked to other topics such as climate change – have become less visible. One reason for this may be that the departure of Solana was also accompanied by the larger reforms of the 2009 Lisbon Treaty which have meant a period of considerable readjustment in the EU's foreign and security policy. Nonetheless, the concept retains interest amongst certain groups and institutions within the EU: in June 2012, a draft report from the European Parliament's Foreign Affairs Committee on the Common Security and Defence Policy (CSDP) in the case of climate-driven crises and natural disasters, recognises the EU's "obligation to preserve peace, prevent conflicts and strengthen international security" and that "the EU CFSP and CSDP are particularly designed to implement human security and the responsibility to protect" (Friends of the Earth Middle East; European Parliament Committee on Foreign Affairs 2012). Indeed, this more integrated version of human security (as opposed to the initial broad developmental concept as envisioned by the UN) is what Martin and Owen (2010) have argued is the emergence of an EU-led "second coming" of human security. Martin and Owen describe this renewed use of the human security concept as a combination of physical protection, material security, crisis management and conflict resolution. This approach moves away from the

broad, development-focused conceptualisation first envisioned by the UN, and fosters a much tighter, crisis or threshold-based conceptualisation (Ibid.). If the EU is indeed moving towards a conceptualisation of human security along these lines, it can be understood as an illustration of how the concept could act as a useful tool for addressing and bringing together many of the seemingly separate issues needed for successful climate adaptation policy.

Yet although EU policies often take sub-aspects of human security such as food security, health or physical security into account, there appears to be little interest or political will from the European Commission to take human security forward in the form of concrete policy proposals explicitly taking up the concept, either alone or in connection to climate adaptation. Commission staff interviewed perceived no additional value in using a human security approach in comparison to other frameworks or approaches to adaptation and, furthermore, often found the concept to be too intangible to be of any practical use for technical discussions on adaptation to the physical impacts of climate change (McGlade and Tedsen 2012b). In addition, with regards to the MMES region, case studies found that certain countries may be particularly sensitive to the use of the human security concept due to its connotations within domestic agendas (i.e. related to potential interference with national security and sovereignty) (Gerstetter et al. 2012).

4.3 National Level

The push to increase the uptake of human security at the UN and EU levels has been significantly influenced by a core group of countries. Japan and Canada in particular, as well as other members of the Human Security Network[13] have been visible proponents of the concept (Matlary 2008). Their proposed approaches for operationalising human security vary; they include, for instance, human rights and development approaches as well as more traditional areas of security (e.g. through work on landmines). It is more or less unheard of for these approaches to target climate change adaptation. These "human security policies" are almost always formulated within a foreign policy context rather than in relation to domestic agendas. This framing of human security by the primarily industrialised nations of the Human Security Network may also entrench negative (and conceptually incorrect) associations of human security with threats to national sovereignty, potentially exacerbating the aforementioned sensitivities in the MMES region.

[13] The Human Security Network consists of over a dozen countries – representing different regions of the world – with a common goal of identifying concrete areas for collective action in the area of human security. The members are committed to (1) promoting respect for human rights and international humanitarian law (2) strengthening the rule of law and good governance and (3) fostering a culture of peace through peaceful resolution of conflicts, controlling the instruments of violence and ending impunity in case of violations of human rights and international law.

Given its connections to foreign policy agendas and that the countries who promote human security do not include it in their own domestic policies, it is unsurprising that human security is not taken up in domestic adaptation policies of developing nations. In our review of national adaptation policy frameworks in nine MMES countries (Gerstetter et al. 2011), only one was found to have made the explicit connection between climate impacts and human security.[14] Nevertheless, a wide range of national level policies were found to contribute to adaptation and to ensuring aspects of human security in substance. As noted above, adaptation policies can take different forms, including mainstreaming adaptation into sectoral approaches, or as standalone strategies for targeted climate action. The findings of our case studies highlighted that many sectoral policies have the potential to contribute to positive outcomes for both climate adaptation and improved human security, even where these concepts are not explicitly used (Gerstetter et al. 2012).

In Morocco, for example, historical experience of temporal and spatial variability in rainfall has resulted in the development of policies and technical expertise (e.g. drought and water conservation plans) that in principle provide a platform for effective adaptation and avoidance of water-induced risks to human security. These policies can also contribute to protecting human health by ensuring that – even where it is scarce – water is of a sufficient quality standard for drinking (McGlade and Turcotte 2012). Measures such as water recycling and re-use and irrigation efficiency can both assist in adapting to reduced rainfall as well as in contributing to food security (Ibid). In Ethiopia, adaptation policies, relevant for food security, are not restricted to water-related measures, but also include wider national development approaches such as improving productivity of and commercialising agriculture, with the aim of improving income and thus household resilience in drought years (Vidaurre and Tedsen 2012). Israel has – with a view to long-standing low water availability in the country irrespective of climate change – put in place a number of measures aimed at increasing supply (e.g. through desalination) and enabling it to create an appropriate infrastructure for water management. In Israel today, at least for the Israeli population, there is consequently no water insecurity.[15]

Adaptation policies which lead to improvements in protective infrastructure, such as barriers and buffer zones against sea level rise, or increased drought monitoring and communication of extreme events through early warning systems[16] can also help to reduce vulnerability and ensure the physical security of populations. Where negative consequences of climate change cannot be avoided, social security and insurance schemes can reduce vulnerability to climate change by providing

[14] The Spanish Adaptation Strategy (*Plan Nacional de Adaptación al Cambio Climático*) states that impacts on human security and other human security-related aspects like food security, poverty or social inequality must be considered, although there is no further guidance on how human security impacts should be addressed or how to relate this action with adaptation actions.

[15] The situation of the population in the oPT is different (see Gerstetter and Bar-On 2012).

[16] For example, as pioneered in Spain through its Special Plans on Droughts (Planes especiales de sequía).

economic and food security to populations whose livelihoods are particularly at risk such as those dependent on the agricultural sector for food (subsistence farming) or income. In Morocco, schemes for agricultural insurance protect those active in the key employment sector of agriculture from the most severe drought impacts.

Although all these policies are effective for adapting to climate change and protecting human security in theory, they are all of course reliant upon effective planning and implementation to ensure that they (a) have the intended benefits, and that (b) positive impacts for the security or adaptive capacity of one group do not produce negative counter-effects for other groups (as highlighted above in Sect. 2 trajectory(ii)). All the same, it is clear that a number of policies in the countries examined in the MMES region are able to contribute to ensuring human security. The key question that stands is therefore whether or not human security is still a useful concept for the process of adapting to climate change in a national (domestic policy) context or whether individual policies targeted either at a particular sub-aspect of human security such as food, water, health or physical or economic security are equally effective (or even the only available method) for ensuring human safety and well-being.

4.4 Conclusions on the Use of the Human Security Concept in Policy-Making

As described above in Sect. 3, the concept of human security has a wide scope. This creates, on the one hand, the potential for it to become too intangible to be applied in any practical sense. On the other hand, its broad scope makes human security a useful umbrella concept under which a number of issues pertinent to human rights and development and to climate change adaptation might potentially be married.

We find that the concept of human security has a relatively strong presence at the international level; links between human security and climate adaptation policies are more frequently being considered. Internationally, human security has often been used in a normative way, to shape debates or, as Martin and Owen have argued, to provide a narrative thread to justify intervention and the "deployment of multiple tools of differing levels of intrusion" (Martin and Owen 2010). Indeed, attempts by members of the Human Security Network such as Canada and Japan to drive human security approaches forward, have been almost exclusively in a foreign policy context. Yet this interest in human security within an international context has not been matched with an interest in operationalising this concept in concrete policies and practical measures at the domestic level.[17]

[17] Since the initial research was conducted for this paper, a team at the University of Western Ontario has produced an extensive report which explores human security and its relationship to climate change vulnerabilities and adaptation in the Canadian domestic context (McBean et al. 2012). Nonetheless, this conceptualisation has yet to be taken up in national policy.

At all levels (international, regional and national) there are policies which assist with adaptation to the physical impacts of climate change and which contribute to ensuring various aspects of human security. However, these rarely apply or reference the concept of human security directly – at most they address the individual aspect of human security (e.g. food or water security) to which the adaptation measure relates. Furthermore, these policies are, with the exception of the UN's HSU and UNTFHS, never integrated within an explicit human security framework.

5 Discussion

The human security and adaptation agendas are driven by broadly similar concerns, both centering on the need to protect human well-being and safety. In addition, they share similarities from a policy-making perspective. In the MMES region, the widespread climatic impacts on water resources mean that policy action will be necessary across a variety of sectors and thematic areas to ensure human security as well as effective adaptation.

Yet despite these apparent synergies, human security has not been a common component of adaptation policy-making. Our analysis of policies relevant to adaptation efforts at the international and national level has shown that although human security is present as a concept in high-level political declarations and reports, particularly in a foreign policy context, it is rare that domestic adaptation policies at the national level reference human security as an explicit focus or objective. Neither do these policies make use of human security as a tool or framework to guide adaptation efforts. While this split between the international (and, in particular, UN) and national discourse may not be extraordinary *per se*, it is remarkable in the context of adaptation. Much of the impetus and guidance for adaptation activities in developing countries comes from the international level and yet the concept of human security has not found its way into national level policies.[18] In this final section, we discuss potential reasons for this observed split in the use of the human security concept and, on this basis, reflect upon its usefulness for adaptation policy-making.

There are several potential explanations for the lack of uptake of human security in national-level adaptation policy. To begin with, climate adaptation is still a relatively new policy area and most countries in the MMES region are still considering how to develop their policy frameworks in this regard.[19] Given these conditions, it

[18] Examples for this are the decision taken within the UNFCCC context that least-developed countries should adopt National Adaptation Programmes of Action (NAPAs) and the increasing amount of funding available for adaptation activities at the international level. On NAPAs, see National Adaptation Programmes of Action (NAPAs), http://unfccc.int/national_reports/napa/items/2719.php

[19] The UNFCCC Paris Agreement changes provides new momentum for this process through the inclusion of a global goal to significantly strengthen adaptation to climate change and the commitment to developing appropriate adaptation policies and programmes (Article 7) (UNFCCC Secretariat 2015).

may therefore seem unsurprising that the concept of human security has not been taken up in adaptation policy – often there is simply no elaborate adaptation policy yet. However, most countries have developed, or given thought to national adaptation strategies of some order in which the idea of human security could have been considered. Indeed, given the use of human security in high level UN and EU discourse, national strategies would be precisely where one would expect to find such concepts articulated (rather than at a localised level where adaptation action is being implemented). While the argument that this policy area is still in development may have some traction, the discussion in Sect. 3 on the role of concepts in policy-making also suggests some further explanations for the lack of uptake.

Human security clearly cuts an attractive shape as a holistic framework for action, as put forward by proponents such as the UNTFHS and HSU. However, as noted above, the attractiveness of an idea is not sufficient to induce its uptake into policy making (Metha 2010). Human security vies for attention alongside other ideas or long-term and more established country and institutional agendas such as human development and agricultural growth (e.g. Morocco) or development (e.g. Ethiopia) which may not be easily set aside. Indeed, for some countries, the concept of human security is anything but attractive. Human security has historically been rooted within foreign policy discourse, rarely being promoted for use within a domestic context. This connection to foreign policy and "harder" forms of the security discourse may be off-putting for countries concerned about the potential connection of human security to national security. For example, several developing countries have voiced concern over the UN Security Council taking up the issue of climate change.[20]

Furthermore, the uptake of ideas is often connected to feasibility of implementation. Human security is at its core a broad developmental concept which has the benefit of being able to bring a range of issues together under a holistic conceptual framework. This can be considered to be of great benefit for the type of cross-sectoral action that is needed for effective adaptation and also has links with the idea of an all-encompassing concept of sustainable development which indeed is closely related to adaptation in developing countries. From a more normative point of view, however, it can be said that human security is not necessarily any less 'valuable' or meaningful than other concepts such as sustainable development or human rights in terms of its capacity to protect human populations and may not bring much advantage in terms of policy improvement. Indeed, it may do the precise opposite if a human security approach results in the need for novel and resource-intensive 'human security' structures and approaches.

Despite its potential as a holistic framework, it would appear that a more pragmatic focus on its concrete sub-aspects, such as food security or water security, or indeed a narrower conceptualisation as proposed at the EU level (see Sect. 4.2 and Martin and Owen 2010) is necessary to make human security a more operational

[20] See United Nations Department of Public Information, Security Council SC/10332, http://www.un.org/News/Press/docs/2011/sc10332.doc.htm

concept. If the idea of human security is to progress down this avenue, it may make the idea more readily transferable into political action. However, as the concept moves away from its initial conceptualisation, it also loses part of the attractiveness and intrinsic value, thereby reducing its broad multi-sectoral appeal and benefits as a holistic conceptual framework for adaptation to climate change.

Is human security therefore a concept that provides any added value for adaptation? The concept of human security can certainly be of value for high-level discourse (e.g. for national foreign policy statements or at the UN general assembly) to bring attention to a range of interconnected issues that are intimately associated with the need to adapt to climate impacts. Yet in the context of concrete adaptation policy at a national and local level, it is difficult to see its additional value, and it is ultimately the local level where adaptation will have to take place. In other words, human security can help to frame initiatives and bring together different parties to act on a similar cause. As Andrea Cornwall (2010) has noted,"policies depend on a measure of ambiguity to secure the endorsement of diverse potential actors and audiences". The concept of human security may also be useful in helping to understand human vulnerabilities and resilience in the face of climate change. However, it appears unlikely that these activities will become "routine" enough to translate into some form of institutionalisation that will lead to a broader uptake of human security within adaptation policy. Furthermore, given human security's connections to notions of state and "harder" security, and associated discomfort with using the term among some actors, it is also unlikely that the idea of human security can serve as a widely accepted basis for the legitimacy of specific forms of collective action, such as legal rules or policies. Finally, as demonstrated above, although human security may provide, conceptually, a useful framework for adaptation policy, the presence of such a concept is not a prerequisite for developing effective adaptation policies.

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Part II
Impacts of Environmental Change and Implications for Human Security: Case Study Examples

Chapter 4
Climate Change Impacts on Water Availability and Human Security in the Intercontinental Biosphere Reserve of the Mediterranean (Morocco-Spain)

Diana Pascual, Eduard Pla, Jaume Fons, and Dania Abdul-Malak

Abstract The Mediterranean basin has been identified as one of the world most vulnerable regions to global change effects. Global and regional climate change scenarios foresee an increase in the average annual temperature over the planet's mean. These scenarios project an increasing frequency of drought episodes adding to the complexity of water scarcity management and questioning the future sustainability of water resource uses. This study assesses the potential water vulnerability in the Intercontinental Biosphere Reserve of the Mediterranean (IBRM), located in the western side of the Mediterranean Basin between Spain (Europe) and Morocco (Africa). The vulnerability assessment proposes an innovative and multidisciplinary approach based on the use of climate change scenarios, a hydro-ecological model and the participation of stakeholders and local experts in expert meetings. Future scenarios draw a more arid climate for the IBRM, with more frequent water scarcity phenomena. A reduction of around 28.1–30.3 % is expected in stream flows by 2070. Agricultural water demands are expected to increase between 7.5 and 16 % in the Moroccan side in order to maintain the current production standards, whereas Spanish pastures are expected to maintain current productions with no need of supplementary water supply. Within forests, tree covered areas showed a higher potential vulnerability to future climate change than shrublands proving higher adaptation to arid conditions. Finally, the tourism will be impacted by the increase in summer temperature and in water supply shortages. Moreover, a significant spatial segregation of impacts is observed. Higher altitudes will be less affected by

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climate change and changes may be relevant to biodiversity but not to human activities. On the contrary, lower altitudes and coastal areas will experience an increasing water demand to sustain different uses by the end of the century in a higher water scarcity context.

Keywords Climate change • Vulnerability • Mediterranean basin • IBRM • SWAT

1 Introduction

The Mediterranean basin is identified as one of the world's most vulnerable regions to climate related events (IPCC 2007). It is very probable that the expected increase in the average annual temperature in this region will be slightly higher than the world average annual expected increase (Hallegatte et al. 2007). The recurrence and increasing frequency of drought episodes in the Mediterranean region further add to the complexity of water scarcity management, with negative implications towards its current and future sustainability (Iglesias et al. 2007; Hisdal et al. 2001).

Additional climate change threats that are expected to cause significant socio-economic impacts in the Mediterranean region include reduced water availability and increased drought, severe biodiversity losses, increased forest fires, reduced summer tourism and reduced suitable cropping areas (Parry et al. 2007; Bates et al. 2008). Additionally, this region is undergoing an increasing pressure on water resources, especially in the coastal zones (Fornés et al. 2005). Blue Plan estimates show that regional water demand and consumption have doubled in the second half of the twentieth century, resulting from population dynamics and growth, agricultural intensification, economic and social development, touristic pressure, and over-consumption of water resources (Benoît and Comeau 2005; ENPI 2007). Previous experiences in the Mediterranean Basin prove that there is a growing evidence of limited capacity to cope with socio-economic and agricultural demands in extended periods of drought (Scheffran and Battaglini 2011). Examples include the effect of extensive droughts in the late 1990s in Spain, Morocco, and Tunisia where water resources were not able to cope with crop irrigation necessities and the production ceased. These conditions are already leading to significant problems due to an unbalanced distribution of water resources, conflicts among users and between countries (CRED 2010; Touchan et al. 2010).

In order to overcome the increasing pressures and threats, there is a strong need to find adequate adaptation and mitigation strategies that will support to decrease such vulnerability (Kallis 2008). In the context of Mediterranean communities, this requires measures that diversify livelihood options, reduce pressure on natural resources, and restore and protect ecosystems through sustainable management practices (UN-ISDR 2006; UNDP 2008).

The study focuses on the Intercontinental Biosphere Reserve of the Mediterranean (Morocco- Spain) (hereafter IBRM), located in the western Mediterranean basin between Spain (Europe) and Morocco (Africa). The Reserve is a particular case

where countries with different political and institutional contexts joint efforts to preserve the natural and cultural diversity of the region. The area is undergoing rapid socio-economic and technological transformations namely increasing pressures on land uses and increasing its demographic pressure. These changes are multiplying the pressure on its already structural water resource deficit and on the hydrological cycle. Furthermore, the registered inter-annual climatic variability in the last decades revealed water scarcity situations, including extreme drought events affecting directly the Reserve. These current conditions, together with the climate change regional projections, indicate an increased likelihood of droughts and hydrostress in the region, and conflicts among users, questioning the ability to maintain the current management philosophy of water resources on both sides of the reserve.

This study focuses on assessing the water resources vulnerability and future climate change effects on hydro-ecological systems and water availability in the IBRM. The developed methodology uses regional climate projections, calibrated Soil and Water Assessment Tool (SWAT) hydrological model and experts' participation, to address four main objectives namely to: (1) analyse current and potential future impacts of climate change on different water-sensitive sectors; (2) evaluate the present degree of adaptation and the adaptive capacity of these sectors to climate change; (3) draw conclusions on the vulnerability of the IRBM by considering potential impacts, adaptation degrees and adaptive capacity;and (4) assess to what extent the current IBRM institutional and management framework could face future challenges expected in this area. In this context, the figure of the IBRM promoted by the Man and the Biosphere Programme (MAB) of UNESCO can play a relevant role in the cooperative management of this challenge.

2 Study Area

The IBRM is located in the western side of the Mediterranean Basin shared by Spain (Europe) and Morocco (Africa). The reserve includes a marine area and covers an extension of one million hectares. It was created in 2006 under the UNESCO's MAB Programme (Fig. 4.1).

The IBRM is located in the semi-arid zone of the Mediterranean where the climatic conditions are known for their seasonal contrasts, characterised by high annual mean variability in precipitation (500–800 mm/year), high mean annual temperature (16–19 °C) and frequent drought episodes (Hijmans et al. 2005). Due to its geographic location, the IBRM is influenced by the contrasted winds of the western Mediterranean Sea and the Atlantic wet fronts. These wet fronts enter from the Atlantic and hit both sides of the Reserve, discharging high amounts of annual precipitation (around 2000 mm/year) in some points of the region.

Although both sides of the IBRM share very similar natural and biophysical conditions, the different approaches of land use management between the two regions shaped the landscape differently. Eighty percent of the Spanish side is covered by forest areas, including shrublands and pastures, whereas this land use

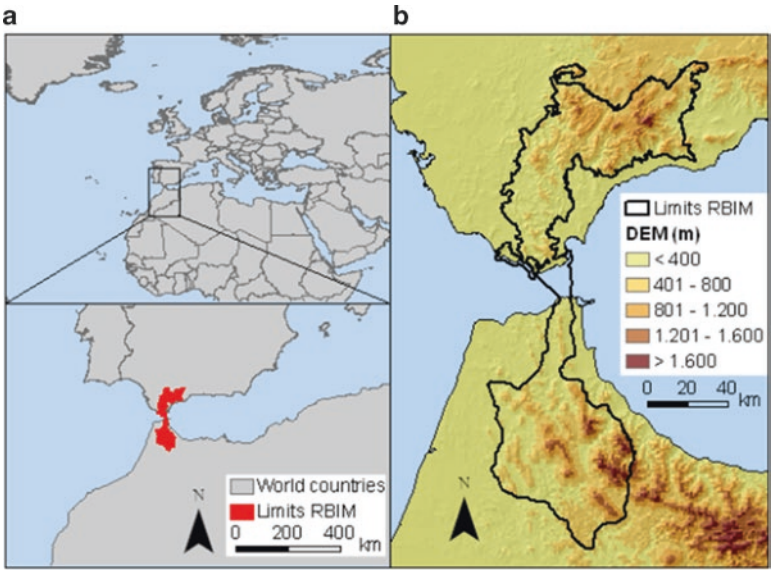

Fig. 4.1 (**a**) (*left*) Location of the IBRM case study. (**b**) (*right*) Detailed zoom of the digital elevation model

corresponds to around 38 % of the Moroccan side (Globcover 2005–2006). This is also mirrored in the extension of protected areas: 70 % in Andalusia versus 30 % in the Moroccan side (Molina and Villa 2008). On the other hand, the agriculture activity is much higher in the Moroccan side where cropland, mostly rainfed, covers more than 60 %, compared to less than 20 % of the Spanish side which is partly irrigated.

Both sides of the IBRM count around 556,359 inhabitants inside its limits (Molina and Villa 2008). However, when neighbouring towns surrounding the IBRM borders are considered, the population is almost three times higher (approximately 1,442,059 inhabitants). The Eastern side of the IBRM is the most exposed to external pressures in terms of population, mainly in coastal cities. Table 4.1 shows the marked socio-economic contrast between Spain and Morocco. Morocco shows a higher population density living in rural areas and relying on its local natural resources, whereas Spain shows a higher dependency on the urban areas where a high percentage of the population lives (around 78 % in Andalusia), and the dependency is rather on the services provided by the region, mainly tourism.

Drought is the major threat in the IBRM, known for its prolonged effects in time and its significant increasing frequency the last decades (Karaky 2002). In Morocco, the periodic drought episodes and significant rainfall variability greatly affect agriculture production (Karaky 2002) and livestock, affecting negatively the overall gross national product (GDP) (Touchan et al. 2010). After the 1970s, the decreasing trend in precipitation provoked water deficiency in many areas (Ouassou et al. 2005), and drastically affected the production of cereals (Skees et al. 2001). In

Table 4.1 Socio-economic indicators for Morocco and Spain

Indicators	Morocco	Spain
GDP/per capita in US Dollar (2009 est.)[a]	4600	33,700
Per capita–by occupation[a]:		
Agriculture:	18.8 %	3.4 %
Industry:	32.6 %	26.9 %
Services:	48.6 % (2009est.)	69.6 % (2009est.)
Labour force–by occupation[a]:		
Agriculture:	44.6 %	4 %
Industry:	19.8 %	26.4 %
Services:	35.5 % (2006est.)	69.5 % (2008est.)
Population living in rural areas (%)	47	22.4 (in Andalusia)
Population living in rural area in IBRM (%)	93	–
Land ownership (average farm side in ha.)	2–3	35
Use of total water resources (%)[b]	43	32
Water resources per capita (m^3/person/year)[c]	895	2557
Water use for agriculture (%)	86	70
Water use for tourism (%)	–	13
Irrigated agriculture (%)	10	90

[a] http://www.theodora.com/wfbcurrent
[b] Millenium Development Goal Indicators 2000
[c] http://earthtrends.wri.org

Spain, the major drought of mid 1990s affected over six million people and had severe effects on the agricultural economy (CRED 2010). Recurrent droughts involve serious losses and injuries in forestry, cropping and pastoral sectors (Mestre-Barceló 1995; Roberts 2002), together with shortages in water supply to numerous tourism villages (Méndez 2008).

3 Materials and Methods

The water vulnerability assessment used in this research is based on a multi-disciplinary approach. It includes the use of a set of regional scenarios of climate change, the application of a hydro-ecological model, and the assessment of the socio-economic effects through the participation of stakeholders and local experts, following the conceptual framework of Fig. 4.2.

3.1 Climate Change Scenarios

Climate projections are used to assess the impacts of climate change in the reserve, using as input data an ensemble median from several different Global Circulation Models (GCMs) under two IPCC scenarios (A2 and B1) provided by Bruggeman et al. (2010). The A2 scenario implies a high anthropogenic emissions level under a high economic and regional development, while the B1 scenario represents a low emissions level in a more environmental and global development (Parry et al. 2007). The projections included the climate change signal for average annual temperature and precipitation for the period 2040–2069 versus the period 1961–1990. The projected results indicate an average precipitation decrease between 17 and 18 % for the A2 scenario and 16 % for the B1 for the mentioned periods, and an increase in annual temperature of 2.3–2.4 °C (A2 scenario) and 1.7–1.8 °C (B1 scenario).

Future climate series were constructed considering this climate change signal using the weather generator developed under GOTILWA+ model system (Gracia et al. 1999). It generates daily climate series (1961–2070) with the same statistical pattern of observed climate data and allows the overlay of different climate change scenario signals. When using outcomes from these scenarios, uncertainties related to future climate projections linked to modelling purposes must be considered in the analysis and in the discussion of the results obtained due to cumulative uncertainties in GCMs projections, in downscaling procedures, in land-use assumptions or in models used (Ewen et al. 2006; Beven 2011).

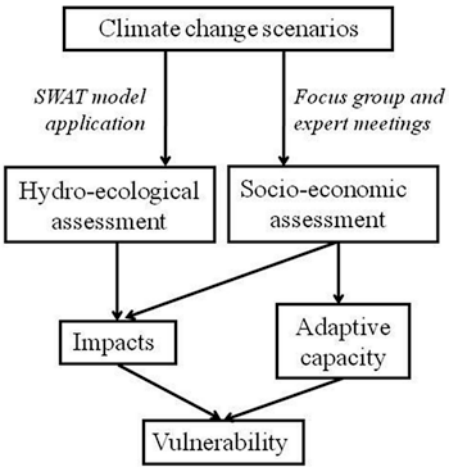

Fig. 4.2 Conceptual framework of vulnerability assessment applied in the IBRM

3.2 Hydro-ecological Assessment

The Soil and Water Assessment Tool (SWAT, Arnold et al. 1998) was used to simulate the hydro-ecological responses to climate change. This is a physically based, semi-distributed hydrological model that estimates surface and subsurface flow, erosion and sediment deposition and nutrient movement within the basin at a daily time step.

The input data needed for the SWAT model include climate, topography, soil and land use data for the simulation of the hydrological regime. The climate series were obtained from 23 meteorological stations located on the watersheds in and around the IBRM area, 8 in Andalusia and 15 in Morocco (AEMET, Spanish State Meteorological Agency and Loukkos Hydrological Basin Agency). Climatic series included precipitation and minimum and maximum temperature. These series were filled and corrected for the effects of orography on precipitation and temperature with SWAT equations (Sharpley and Williams 1990).

Elevation data was obtained from the SRTM digital elevation model (90 m spatial resolution, NASA) for Andalusia and the ASTER global digital elevation model (ASTER GDEM, 30 m, Earth Remote Sensing Data Analysis Centre) for Morocco. Soil data was specifically created for the project purposes, based on the Andalusian Soil Map (1:400.000, Andalusian Agricultural Regional Ministry and CSIC) and the Moroccan Geomorphological map (1:100,000, Mohamed V University in Rabat). Land use data was obtained from the Andalusia Use and Land Cover Map (2007, 1:25,000, Andalusian Environmental Regional Ministry) for Andalusia and Globcover V (2005–2006 version, 300 m, ESA GlobCover Team) for Morocco.

Model calibration through historical data is needed to adjust model parameters to the specificities and characteristics of the reserve. Then, validation is required to measure model prediction capacity through the comparison between simulated

Table 4.2 Equations used to estimate the NSE and RSR statistics, where Y_i^{obs} is the *i*th observation for the constituent being evaluated, Y_i^{sim} is the *i*th simulated value for the constituent being evaluated, Y^{mean} is the mean of observed data for the constituent being evaluated, and n is the total number of observations

Performance rating	$RSR = \left[\frac{\sqrt{\sum_{i=1}^{n}\left(Y_i^{obs} - Y_i^{sim}\right)^2}}{\sqrt{\sum_{i=1}^{n}\left(Y_i^{obs} - Y_i^{mean}\right)^2}}\right]$	$NSE = 1 - \left[\frac{\sum_{i=1}^{n}\left(Y_i^{obs} - Y_i^{sim}\right)^2}{\sum_{i=1}^{n}\left(Y_i^{obs} - Y_i^{mean}\right)^2}\right]$
Very good	$0.00 \leq RSR \leq 0.50$	$1.00 \leq NSE < 0.75$
Good	$0.50 < RSR \leq 0.60$	$0.75 \leq NSE < 0.65$
Satisfactory	$0.60 < RSR \leq 0.70$	$0.65 \leq NSE < 0.5$
Unsatisfactory	$RSR > 0.70$	$NSE \leq 0.5$

results and measured data in a different time period. SWAT model was calibrated and validated at a monthly time step with historical stream flow and reservoir management data for the periods 1983–2009 (Andalusia) and 1981–2007 (Morocco). Data availability included 16 and 3 gauging stations in Andalusia and Morocco respectively, and 6 reservoirs in Andalusia. Model calibration and validation was made for 3-year periods, due to the partial and low quality data series on stream flow and reservoir. Both processes were carried out to target three main objectives: (1) simulated curves similar to measured ones;(2) mean flow values and total contributions similar between simulated and measured data;and (3) good statistics of Nash-Sutcliffe efficiency coefficient (NSE) and RMSE-observations standard deviation ratio (RSR) following Moriasi et al. (2007). Table 4.2 shows the statistic calculation and the performance rating used in the calibration and validation.

Figure 4.3 and Table 4.3 show calibration and validation outputs for daily stream flow in two gauging stations of the IBRM. Similar results were obtained in other gauging stations modelled in this study. The graphical comparison between simulated and measured data shows a good adjustment, as well as mean daily values. Statistics NSE and RSR show a satisfactory adjustment in all gauging stations except in Khrofa (Morocco).

After SWAT calibration and validation processes, climate projections for the period 1961–2070 were introduced into the model to identify and quantify their impacts on the water resources in the region. At this phase, two assumptions were needed for the study: land use covers were considered constants along the twenty-first century, whereas reservoirs were simulated as uncontrolled.

3.3 Socio-economic Assessment

At the socio-economic level, the exposure of the IBRM communities to climate change effects and water scarcity was analysed through a series of local experts and stakeholders meetings and focus groups. Two stakeholders meetings (May 2011),

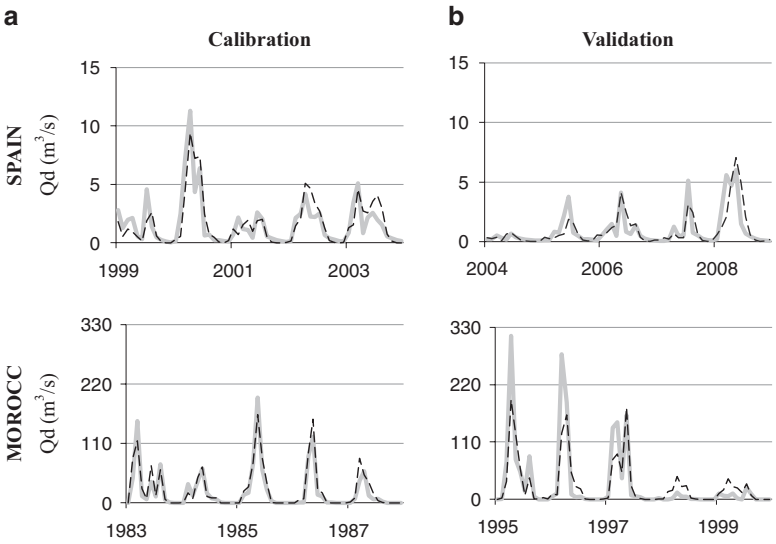

Fig. 4.3 (**a**) (*left*) Calibration results at monthly step: measured (*grey line*) and simulated (*black dashed line*) average daily stream flow (Qd, m^3/s) in Guadiaro river, Andalusia (6030 g.s.) and BOEM, Morocco (5764 g.s.). (**b**) (*right*) Idem for validation results

and two focus group meetings (February 2012), were developed in Andalusia (Spain) and Morocco. The stakeholders meetings identified the present most sensitive water-dependent areas and sectors in the IBRM. Based on these results obtained, future hydro-climatic and water use scenarios were drawn and were used in the focus group meetings. In these meetings, different local actors analysed the potential impacts of climate change on the livelihood in the region based on their expert knowledge and local experience through a structured dialogue among them. These identified impacts were scored according to the community/sector adaptive capacity and, consequently, their vulnerability. The results of this assessment were partially compiled in Abdul-Malak et al. (2012).

4 Results

According to the socio-economic assessment, four main categories of impacts were identified by stakeholders as the most relevant in IBRM: impacts on hydrology and climate, rural population, touristic sector, and natural systems. For each category, a summary of the results of the socio-economic assessment, joint with the contrasted outputs of the hydro-ecological assessment, are presented. Only results for the A2 scenario are shown, comparing the time span 2041–2070 with the baseline period (1961–1990).

Table 4.3 Calibration and validation results: mean monthly of daily stream flow values (Qm) from both simulated (Sim.) and measured (Meas.) data and statistics in an example of gauging stations

		Calibration					Validation				
					Statistics					Statistics	
		Period	Sim. Qm (m^3/s)	Meas. Qm (m^3/s)	NSE	RSR	Period	Sim. Qm (m^3/s)	Meas. Qm (m^3/s)	NSE	RSR
Spain	Guadiaro, 6030	1999–2004	1.7	1.6	0.7	0.5	2004–2009	0.9	0.9	0.6	0.6
	Palmones, 6083	1994–1999	0.3	0.4	0.8	0.4	2004–2009	0.4	0.3	0.6	0.7
	Guadalhorce, 6011	1999–2004	1.5	1.4	0.5	0.7	2004–2009	0.9	0.9	0.5	0.7
Morocco	M'douar, 612/04	1985–1990	14.8	12.9	0.5	0.7	1995–2000	13.0	16.0	0.4	0.7
	BOEM, 5764	1983–1988	24.7	21.7	0.9	0.3	1995–2000	18.6	18.1	0.8	0.5
	Khrofa, 1373/03	1981–1986	6.1	5.7	0.4	0.8	1995–2000	6.2	8.0	0.4	0.8

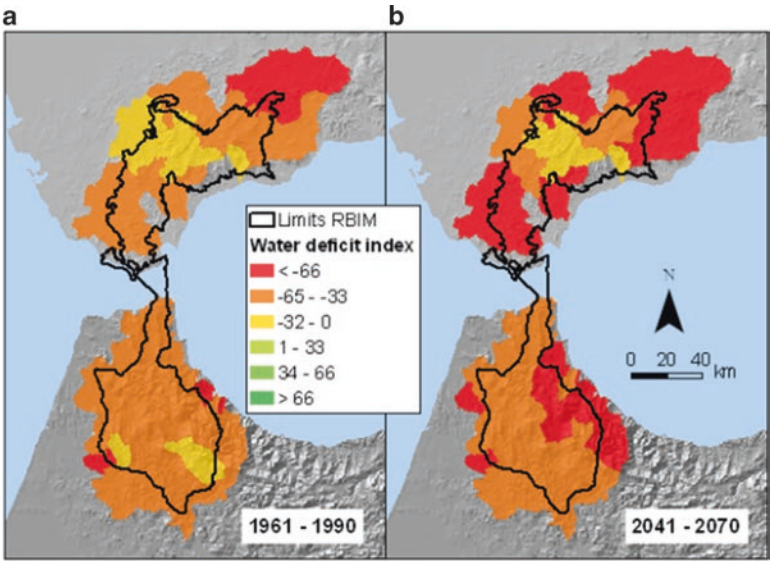

Fig. 4.4 (**a**) (*left*) Water deficit index (WDI, %) in the IBRM for the baseline (1961–1990). (**b**) (*right*) Idem for the 2041–2070 period. WDI = ((P−PET)/PET)*100; where *P* Precipitation, *PET* Potential evapotranspiration; negative indices mean limitations in water availability for covering vegetation requirements

4.1 Hydrological and Climate Impacts

Despite the uncertainty linked to the degree of change of future climate scenarios, the main concern in the region is the impact of more extreme conditions, especially, the effects on water availability and quality. The stakeholders consider that demand for freshwater services in the IBRM and the neighbouring area is high and is likely to continue increasing in the future due to an ongoing growth in economic and demographic developments. The results of the hydrological model provide a quantitative proxy of these trends and perceptions.

Climate projections show an increased aridity in the future within the IBRM, resulting in the combination of lower precipitation and higher annual temperature. Figure 4.4 shows the expected change of the water deficit index (WDI) that relates water availability with vegetation potential evaporative demand. The baseline period shows a deficit in water availability in the whole IBRM, following a decreasing gradient with altitudes (Fig. 4.4a). Coastal areas and other areas present at low altitudes show to be subjected to more pressure in the baseline scenario compared to mountainous and humid areas, such as the Spanish Grazalema (with 2.000 mm precipitation). Future trends show an expected higher aridity in coastal and low altitude areas, while no changes are forecasted in mountainous areas (Fig. 4.4b).

Table 4.4 Expected changes in mean annual precipitation (P) and temperature (T), potential and actual evapotranspiration (PET and AET) and daily stream flow (Qd) in the IBRM comparing the 2041–2070 period with the baseline

	P	T	PET	AET	Qd
Andalusia (Spain)	−17.6 %	+2.5 °C	+9.6 %	−7.4 %	−30.3 %
Morocco	−14.3 %	+2.4 °C	+8.6 %	−4.5 %	−28.1 %

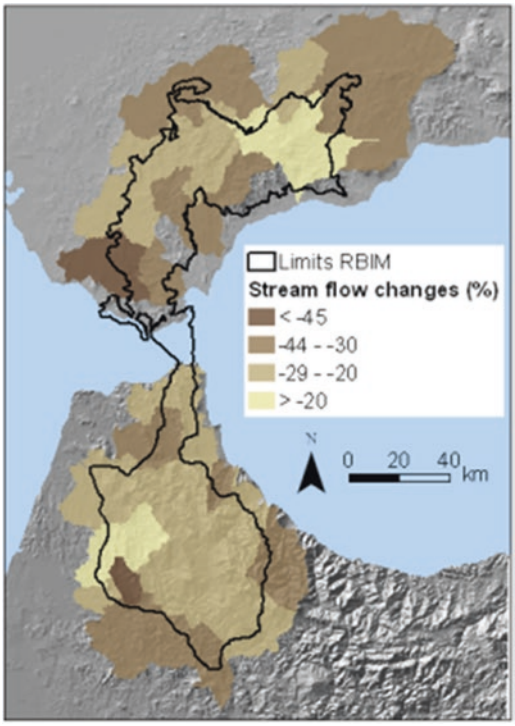

Fig. 4.5 Stream flow changes (%) in IBRM comparing the 2041–2070 period with the baseline(1961–1990)

The results show that the expected mean annual temperature increase of 2.4–2.5 °C will contribute to an increase in potential evapotranspiration (PET) of around 8.6–9.6 %,causing an increase in vegetation water demand (Table 4.4). Although PET will increase with temperature, actual evapotranspiration (AET), which depends on precipitation and temperature, is expected to decrease between 4.5 and 7.4 %. This AET decrease implies that vegetation water demands will not be covered, thus affecting negatively the vegetation development.

Hydrological simulations with climate projections predict a generalized reduction in stream flows along the twenty-first century. Figure 4.5 shows a projected reduction between 28.1 and 30.3 % in the stream flow by 2070, with the highest reductions expected in the Spanish Atlantic slope including the Barbate watershed.

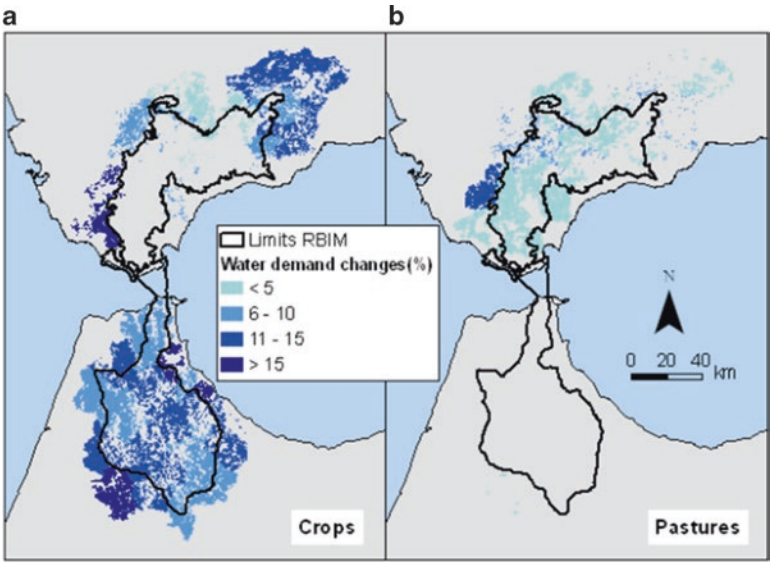

Fig. 4.6 (**a**) (*left*) Crop water demand changes (%) in IBRM crop areas comparing the 2041–2070 period with the baseline (1961–1990). (**b**) (*right*) Idem for pasture areas

4.2 Impacts on Rural Population

Agriculture and livestock are identified as the main exposed and economically sensitive sectors to be affected by climate change, especially in the Moroccan side. Traditional agriculture and extensive farming are still the main subsistence means for a great part of the population living on the Moroccan side of the Reserve. In Andalusia, recurrent droughts lead to serious losses and injuries in cropping and pastoral sectors, but the affected surface is generally small.

The results of the hydro-ecological assessment show a future general increase in crop and pasture water demand (Fig. 4.6). Water demand includes the supplementary water needed by crops and pastures to maintain actual production standards, based on the water stored in soil. In order to homogenise the analysis, the irrigated and rainfed crops are considered together as rainfed crops.

It is worthwhile to note the different crop pattern between Spain and Morocco which have different consequences for their management. On the Spanish side, the low crop activity within the protected area contrast with a higher agricultural pressure on the neighbouring areas outside the IBRM. Results shown in Fig. 4.6a highlight that the increase in water demand will not be significant within the reserve along the twenty-first century. On the Moroccan side, no significant distribution on the crops inside and outside the IBRM is noted, but a higher demand on water resources is expected in the neighbouring areas of the reserve. In these areas, a 7.5–16 %-increase in water irrigation will be needed to maintain the actual crop production standards by 2070.

Pastures are only relevant in the Spanish side and are widely spread within the IBRM (Fig. 4.6b). Higher water demand is expected outside the reserve limits, meanwhile pastures inside the IBRM might be considered as rainfed where no important changes in water demands are expected.

4.3 Impacts on Touristic Sector

The touristic sector is identified as very sensitive to climate related impacts, especially in the summer period. Stakeholder's concerns include the effects of higher temperatures on the suitability of the region for tourism, together with the likely shortages in water supply.

The hydro-ecological assessment analyses the impacts of future higher temperature on some comfort indicators, namely: number of hot days (Tmax > 30 °C), very hot days (Tmax > 35 °C) and tropical nights (Tmin > 21 °C). The results for Malaga, an Andalusian coastal city, show an increase of 39 days per year of hot days, 46 days of tropical nights and a slight increase of very hot days (4 days) by 2070.

4.4 Impacts on Natural Systems

Stakeholders' concerns included the impact of the environmental aridity increase on forest and other natural ecosystems processes, with a likely loss in ecosystem integrity and biodiversity. Forest land and shrublands areas are the most extensive and representative natural systems present in the IBRM, and their protection was one of the reasons to create the reserve.

The selected indicator to assess climate change impacts on natural systems is the change in the amount of water stored in soil (Fig. 4.7), an integrative parameter related with forest health status, forest sensitivity to mortality and fire risk. Tree-covered forest areas show a higher reduction of water stored in soil than shrublands areas, pronouncing a potential higher vulnerability of forest to future climatic trends. Forests in the Moroccan side might be more sensitive to future conditions than the Spanish ones. Furthermore, shrublands arise as more adapted to arid conditions than forests, promoting the expansion of its distribution range along the region.

4.5 Adaptive Capacity and Vulnerabilities

The IBRM adaptive capacity to face the mentioned impacts, and therefore the vulnerabilities of each assessed system and sector, was tackled in the focus group sessions. In general, for the lowest climate change scenario (B1), there is a consensus

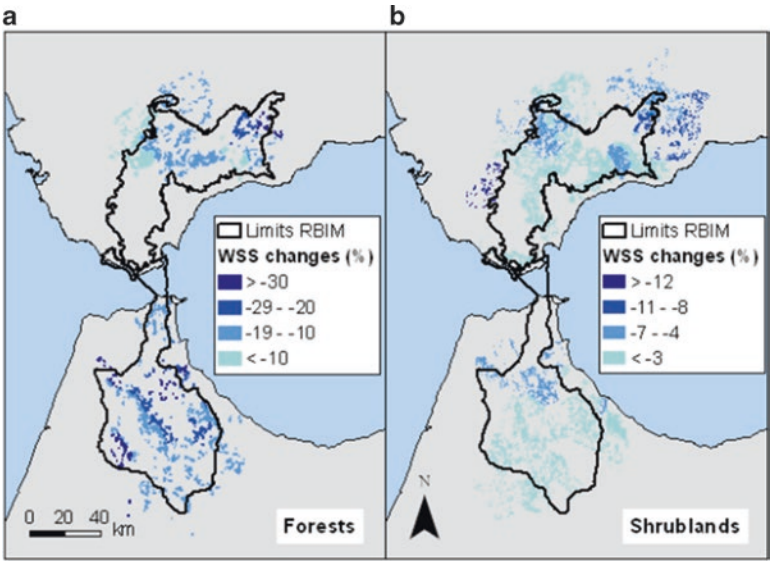

Fig. 4.7 (**a**) (*left*) Water stored in soils (WSS) changes (%) in IBRM forests comparing the 2041–2070 period with the baseline (1961–1990). Forest spots are pronounced to make them visible. (**b**) (*right*) Idem for shrublands

that the region, as a whole, has the capacity to face negative impacts without having major effects on the local community. Adaptive measures could be strengthened if the climatic conditions worsen (A2) but, despite that, some systems and scenarios couldn't be able to maintain their integrity in providing services sustainably.

During the focus group, stakeholders proposed adaptation measures to increase the adaptive capacity of the Reserve. Water management adaptation is the most developed sector. Water demand strategies, water pricing, water efficiency techniques and the use of water alternative sources are feasible measures together with the reduction of human pressure in water bodies. Forests in the region could have greater difficulty in adapting to climate change. Management options conducting to less water stressed systems and fire protection will be important in the Mediterranean, including the replacement of highly flammable species, regulation of age-class distributions and widespread management of accumulated fuel. Development of advanced systems of forest inventories and forest health monitoring, and public education are important prerequisites of adaptation and mitigation. Agriculture adaptation may include changes in crop species and varieties, modifying agronomical techniques and taking into account phenological changes. The likely reduction of tourism in the IBRM during the hottest summer months may be compensated by promoting new forms of leisure, such as eco-tourism, cultural or extending the attractiveness of the region for different months and for winter tourism.

5 Discussion

Future climatic scenarios draw a more arid climate and a strong alteration on water dynamics for the IBRM during the twenty-first century. Climate scenarios projected an annual mean temperature increase of two degrees, together with higher water stress and scarcity within the region. The same patterns and order of magnitude are found in other regional projection sources (Moreira and Ribalaygua 2007; AEMET 2009). Results show a different pattern depending on the altitude: a higher aridity is expected in coastal and low altitude areas, where a higher density of population is registered, meanwhile no changes are forecasted in mountainous areas. Consequently, there is a clear spatial segregation of ecological and social impacts of climate change: higher altitudes will be less affected and changes in species composition may be relevant for biodiversity, but not for human activities. On lower altitudes and coastal areas there will be higher pressure on water demand for different uses and, at the same time, higher water deficit.

Predicted changes on precipitation and temperature will have a direct impact on stream flow, where a 30 %-reduction is expected in the reserve. Similar stream flow reduction has been observed in other Mediterranean areas, as for example shown in Senatore et al. (2011) and Pascual et al. (2015). In consequence, there will be an increased seasonality on water streams, with important effects on water supply for environmental, agricultural and urban uses (Schröter et al. 2005). Riparian ecosystems and stream environment quality conservation would be deeply affected in some parts of the reserve due to the expected changes on water availability (Bates et al. 2008). In turn, the existence of some water bodies that are at risk of not meeting the environmental objectives of the European Water Framework Directive(2000/60/EC) is identified (Iglesias et al. 2007).

Temperature increase along the twenty-first century is expected to impact natural and agricultural ecosystems, affecting vegetation growth and development (Vicente-Serrano et al. 2013), vegetation phenology (Giannakopoulos et al. 2009) and species distribution (Serra-Diaz et al. 2012), leading to losses of climatically suitable areas for several species. Phenological changes together with lower water availability may lead to changes in crop species and varieties, modifying agronomical techniques and agronomic calendar (Moriondo and Bindi 2007; Giannakopoulos et al. 2009).

The increase of environmental aridity has a direct impact on forest and other natural ecosystems processes, with a likely loss in ecosystem integrity and biodiversity. Results show a higher reduction of water stored in soil in forest than shrublands areas, remarking a higher potential vulnerability of forest to future climatic trends. Shrublands, more adapted to arid conditions, might expand its distribution range along the region. Forest decline (Sarris et al. 2007) and forest fire (Moriondo et al. 2006) are two of the most relevant expected impacts. At the same time, decreases in soil water availability and changes in intra-annual variability could impact on woodland development and suitability of some forest species (Schröter et al. 2005).

Projected changes in climate conditions will have impacts on the touristic sector due to higher summer temperature and shortages in water supply. An increased mortality is the most drastic impact of hot days and tropical nights; however, exposure to hot weather can have various other impacts on human health and well-being, ranging from psychological factors (bad mood) to physical (discomfort and sickness). In the IBRM, the likely reduction of tourism during the hotter summer months may be compensated by promoting changes in the temporal pattern of seaside tourism, for example by encouraging visitors during the cooler months (Amelung and Viner 2006).

Present institutions and policies are considered adequate and sufficient to ensure climate change adaptation, but efforts shall be done in the fulfilment of the current laws and norms, the enforcement of their accomplishment and the reduction of duplicities among institutions. Public participation and population co-responsibility in water management needs to be strengthened and more effective. The awareness and responsibility of the civil society in water uses could reinforce and ensure the success of the adaptive measures. In this sense, participation platforms where all the stakeholders are involved should be reinforced and promoted.

Results highlight the strong impact of climate change on regional water resources and reflect the importance of incorporating these analyses into adaptive management in the Mediterranean region. The greatest challenge is the implementation of water resources in a way that ensures sustainability of natural systems and supports human activities in the Reserve (agriculture, farming and rural tourism) in strong competition with the neighbouring areas (coastal tourism and some major urban areas). In this context, the creation of the IBRM is considered an opportunity for promoting cooperation between Spain and Morocco and for ensuring the sustainable development within the region. But adaptation strategies and actions need to be introduced following an integrated implementation framework into the shared IBRM management plan and the national strategies in both countries in order to adapt to global change effects in the region.

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Chapter 5
Impact Assessment of Environmental Change in Nuba Mountains of Sudan

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Abstract Despite international efforts, environmental change still is one of humanity's greatest challenges. Moreover, it is one of the most serious threats, especially in Africa, related to many vulnerabilities associated with several factors such as increasing drought, variability of temperatures, higher percentage of unemployment, conflicts, desertification, lack of rainfall and destabilized security. Nuba Mountains is rich with various tree species which grow naturally, however it is very sensitive to global environmental and to the climate change. This research was designed to study the impact of environmental change on demographical dynamics and to determine the factors that exacerbate vulnerability in the study area as well as to map and assess the Land Use Land Cover (LU/LC) change during the past decades (1985–2011). Data was collected in two forms of semi-structured interviews of household heads with a sample size of 145 contributions, proportionally distributed between 11 villages in the state additionally multi-temporal optical satellite data (i.e. LANDSAT TM and TERRA ASTER) were used to study the LU/LC changes. The qualitative and quantitative techniques were used to analyze the socio-economic data. Post Classification Analysis (PCA), as well as Post Change Detection (PCD) techniques, were applied. The results show that there was a major degradation of surface vegetation in addition to high rates of displacement and migration to other states. In sum, the successful key to face the impacts of environmental and climate change need to create dynamic innovation research, strategies, management and policy that focus on local communities to avoid the hazard of marginalizing those who rely on natural resources for subsistence and income generation.

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Keywords Environmental change • Land Use Land Cover (LU/LC) change • Socioeconomic factors • Displacement and migration • Nuba mountains

1 Introduction

The problem of understanding environmental change is one of the major challenges confronting the current and future generations. Despite growing concern, transnational advocacy, and scholarly research, we haven't sufficiently investigated negative environmental and social outcomes as explicated by the deadlock of environmental change.

In recent years, there is no doubt that global environmental change has observable development impacts, which seriously threaten the capacities of individuals and communities at all levels. Many world regions face this threat but it is already a reality in Africa and raised plenty of reasons for concern during the last years. This change has taken several forms such as fragile ecosystems, disability in the development, force large-scale migration, land degradation and intensified droughts in eastern part. In addition to higher poverty rates, unprecedented floods and increased risks to public health in western, beside increasing ocean acidification around Africa's southern coast (Lisk 2009).

Like any other developing country in Africa, Sudan is highly vulnerable to an environmental change. The interaction of multiple stresses, ecosystem degradation, endemic poverty, complex disasters and conflicts, limited ability to capital, infrastructure and technology contributed in further weakening the adaptation of environmental change. During the past century, these changes have increased rapidly in the country and had a direct impact on the livelihoods, health and welfare of both poor rural and urban communities that depend on ecosystem services (Zakieldeen 2009; Deafalla 2012).

Recently, many concerns have been raised about the relationship between environmental change and human activities. Within the concept of these relationship, we can find they two simultaneously were reinforced each other and formed the vicious circle. Several studies, such as Foley et al. (2004) and Mahmood et al. (2010), confirmed that there is a strong and complex link between environmental variability and LU/LC. This relationship has taken more important dimension when we start thinking of building resilience against insecurity or problems related to sustainable management of ecosystem services.

In developing countries as general, and Sudan in particular, environmental planning and resources management sector facing hampered of data collection that require comprehensive information on LU/LC dynamics. Earth observation data has an important role in regional planning at different spatial and temporal scales. Furthermore, remote sensing technology provides a cost-effective and accurate alternative for the understanding of landscape dynamics and human-environment interaction (Dale et al. 1993). This along with geographical information system

(GIS) assist in maintaining update LU dynamics information for a sound decision and a cost-effective planning. Furthermore, change detection can help to enhance the capacity of local governments to implement sound environmental management (see Prenzel and Treitz 2004). Moreover, it can help analyzing the rate of changes as well as the causal factors or drivers of changes (Ramachandra and Kumar 2004). In addition to that, the use of these advanced technology is a significant way toward answering questions concerning the spatial and temporal dimensions of variation in environmental resources (Ehlers 1996).

More important now than any time before is to think about the environmental change within the broader context of sustainable and scientific management of resources away from isolated strategies. This study is an attempt to measure the rates and spatial distribution of the change by overlaying maps of LU/LC classes acquired at different points in time, as well as to assess the vulnerability associated with the environmental change. It also outlines some of the actions being taken to help a country adapting to the changing climate, and makes recommendations for how such actions could become more effective.

2 Study Site

The study area is located in the north-western part of the central clay plain of the South Kordofan State in the dry land savannah zone in the Sudan. It lies between latitudes 10° and 13° N and longitudes 29° and 33° E (Fig. 5.1). The region has a varying climate, ranging from semi-desert in the north to rich savanna in the south. Annual rainfall ranges from less than 50 mm on the northern border to more than 800 mm on the southern border. The rainy season varies from about 5 months or less, with rains occurring between May and October. The average daily temperature ranges from 10 to 35 °C with an annual variation of 15 °C. April to June is the hottest period and December to February is the coldest. Wind direction differs according to seasons: northeast in winter and southwest in summer (El Tahir et al. 2010). Total population of Nuba Mountains in 2008 was 1.3 million distributed into 120,986 households (CBS 2009). The livelihood activities found in the area are agro-pastoralism, nomadic pastoralism and rain-fed agriculture, both traditional farming for subsistence and mechanized farming for commercial operations. In addition to that, a third source of livelihood is derived from the natural forests in form of woody and non-woody production derived from various tree species (UNDP 2006).

3 Research Methods

Two approaches were applied to analyze the long-term environmental changes and trends during the period 1985–2011 in the Nuba Mountains:

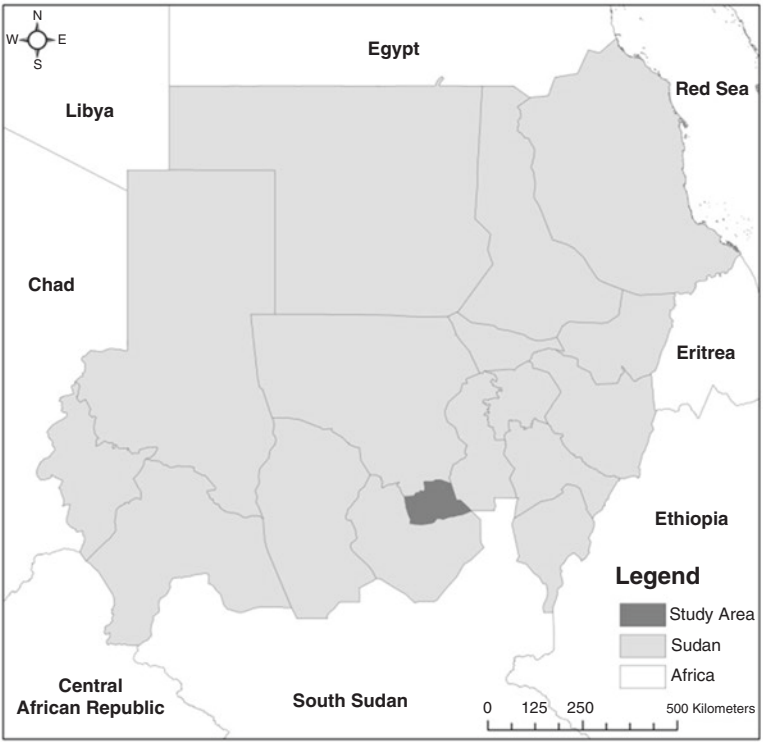

Fig. 5.1 Location of the study area (DIVA-GIS, developed by author)

3.1 Remotely Sensed Data

Two subset scenes acquired from Landsat Thematic Mapper (TM) and Spaceborne Thermal Emission and Reflection Radiometer (TERRA-ASTER) satellite Advanced were applied. The image processing, analysis and classification have been carried out using Earth Resources Data Analysis System (ERDAS) Imagine and ArcGIS softwares. These include radiometric, spatial and spectral enhancements, maximum likelihood classification, and post change detection. Environmental Visualization (ENVI) software was used for the image pre-processing and enhancement. The main approach includes supervised classification that attempts to identify spectrally homogeneous groups within the image that are later assigned to information categories of LU/LC classes (Richards 1993; Chuvieco 1996; Lillesand et al. 2008).

3.1.1 Image Registration

Image registration technique was applied based on ground control points using the Polynomial geometric model, so that the geometry of the images (1985 and 2011) has been normalized accordingly.

3.1.2 Supervised Classification

The study applies supervised classifier as a per pixel approach based on spectral properties. Maximum Likelihood (ML) classifier was selected as one of the common used method, which it quantitatively evaluates both the variance and covariance of the category spectral response patterns when classifying an unknown pixel (Lillesand et al. 2008).

3.1.3 Change Detection

After classifying the imagery of the selected dates, multi-temporal classified maps (1985 and 2011) were introduced to the PCD to determine changes in LU/LC during the study period using mean-shift and outlier-distance metrics. In order to perform an appropriate multi-temporal analysis, the Post Change Detection (PCD) might reduce the possible effects of atmosphere, sun angle, seasonal variation of acquired date and multi-sensor variability (Singh 1989). However, rather than using multi-spectral imagery, the classified images were used. In addition, the post classification comparison provides class changes from-to and a change matrix.

3.2 Socioeconomic Data

Socio-economic survey carried out in 2008 distributed in three units of Nuba Mountains: Rashad, Elabasia, and Abu Karshola. Within each unit, a sample of households was randomly selected. The total sample size was 145 contributions distributed among the 22 villages according to the principle of population proportional to size. Statistical Package of Social Sciences (SPSS) was used for data analyses. Descriptive statistical methods were applied to the data concerning household social characteristics and respondents' perspectives about different aspects of the change.

4 Results and Discussion

Unfortunately, the environmental variability pervasive in Nuba Mountains already poses direct threat for both human security and vegetation cover. The present results clearly indicate the changes in the environment of study area which include several forms such as: resource scarcity, prolonged spells of drought, biodiversity loss, ecosystem degradation, in addition to the continuing obstruction effects on human wellbeing of market failure, poverty, violence and war, along with water, energy, health and food security concerns, high rate of displacement and migration.

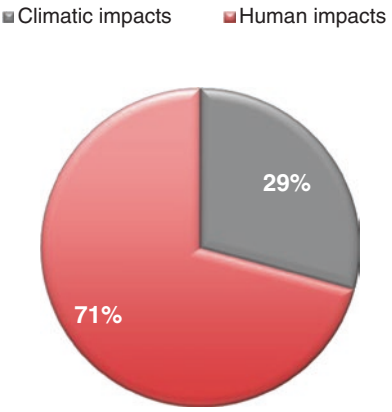

Fig. 5.2 Investigated factors of environmental change in the study area

4.1 Investigating the Factors

From the statistical analysis of social data, the forms of degradation were most closely related to admixture dynamic interactions between social and ecological systems. Meanwhile, the higher weight with almost about two third of the total percentage was investigated to be attributed to the anthropogenic activities as described in Fig. 5.2.

4.1.1 Climatic Impacts

LU/LC Dynamics

Nuba Mountains is rich with various tree species which grow naturally. However, during the last decades it has been exposed to a series of recurring dry years. Beside the widespread reliance of households on natural resources to meet their subsistence needs, in addition to slash and burn, agriculture practices have both contributed to degradation and depletion of biodiversity in the study area. Environmental degradation, which is pervasive in the study area, already poses direct threat for both human security and vegetation cover. The main forms of environmental degradation include: resource scarcity, ecosystem degradation, high rate of displacement and migration, in addition to destruction of natural forests. The result of the case studies reveals that, the area has been severely hit by recurrent droughts in addition to an intensive and dynamic rate of deforestation. Where the natural vegetation has been removed, degraded and substituted mainly by crop fields, grasses, and bare land. The classifications were performed for the imagery from 1985 to 2011, which allowed for an overall assessment of change over the past decades. In this work, a LU/LC classification scheme is generated representing five land features i.e., cropland, desertified lands, forest-land, grassland, and scattered forest as shown in Fig. 5.3.

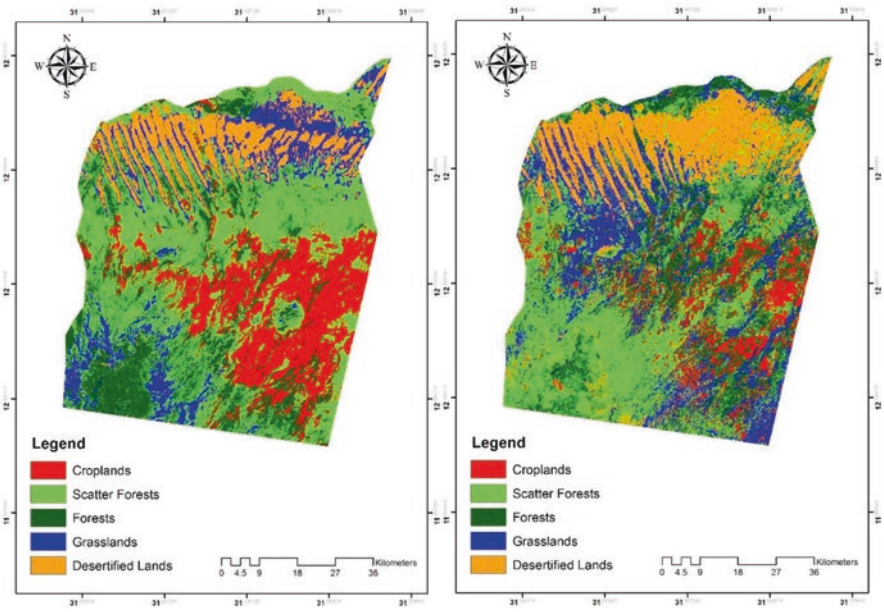

Fig. 5.3 LU/LC classification for the study area for the years 1985 and 2011 from the *left* to *right* respectively

Table 5.1 Change matrix for the LU/LC classes from 1985 to 2011

	Cropland	Scat. forest	Forest-land	Grassland	Desertified lands	Total/%
Cropland	**30432.2**	11832.5	7254.5	29.5	46.1	**9.6**
Scat. forest	21913.3	**92261.8**	41373.8	20728.5	1029.7	**34.3**
Forest-land	34520.8	39044.9	**23486.7**	2794.5	685.8	**19.4**
Grassland	14970.7	52885.9	16697.3	**2589.3**	1140.5	**17.1**
Desertified lands	107.1	8339.2	28687.9	8007.5	**56559.2**	**19.6**
Total/%	**19.7**	**39.5**	**22.7**	**6.6**	**11.5**	**100**

The initial clustering analysis of the data proves massive changes in LU/LC classes. As shown in Table 5.1, desertified land areas increased approximately to 19.6 % while forest-land decreased to be 100,532.7 ha (19.4 %). Cropland and scattered forest areas were decreased also to 49,594.8 ha (9.6 %) and 177,307.1 ha (34.3 %) respectively. Relatively, grassland area increased to 19.6 % from 1985 to 2011.

The analysis indicated that a wide area of agricultural land was abandoned as a result of the armed-conflict in the region. Nevertheless, an extreme agricultural expansion during the past decades contributed in the propagation of desertified land as well as the shrinkage of forest areas as shown in Table 5.1.

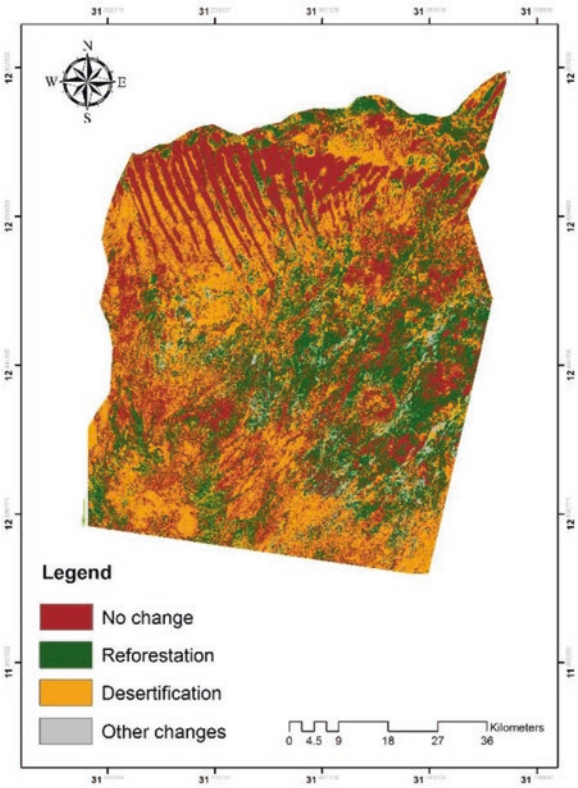

Fig. 5.4 Thematic map of the LU/LC change dynamics

Furthermore, to evaluate results of conversions, PCD was applied to identify the magnitude and the distribution of changes.

Disappointingly, the degradation of ecosystems as a result of environmental change right now is considered as a marginal issue on the Africa's agenda despite its large negative impacts on economy. In the study area, the sand encroachment represents a great concern for both scientists and governments. The main reason to aggravating of soil erosion in the study area was strong winds. The direct effect of sand encroachment is clearly evident in many areas of Nuba Mountains as shown in Fig. 5.4. As a result, major socioeconomic damage at local and national levels is observed. The water resources of the study area were affected, where groundwater recharge was decreased by soil erosion, precipitation and/or increased temperatures, and evaporation. Interestingly, the time consumed in a trip of water collection for household uses ranged between 2 to 3 h in 2003 and increased to 3 to 5 h in 2008. Water-related problems are likely to worsen as a result of environmental change during the upcoming years. From the other hand, crop production is predicted to decline substantially in upcoming years specifically: Cotton (*Gossypiumspp*), Maize (Zea mays), Sesame (*Sesamumindicum*), Peanuts (*Arachishypogeae*), and Millet (*Panicunmilieaceun*).

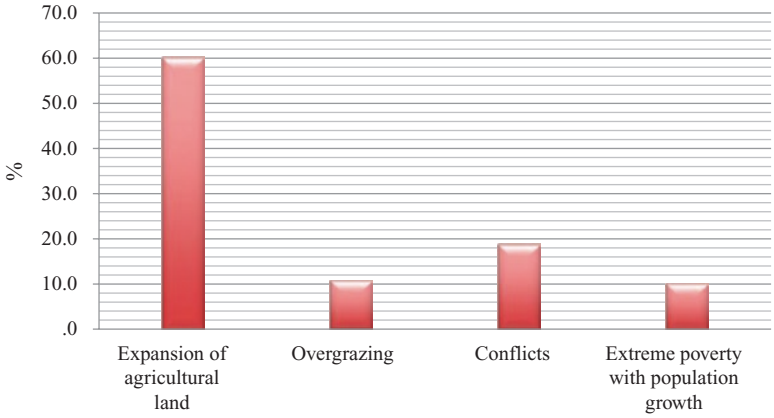

Fig. 5.5 Human impact and the environmental change

This was expected also for horticultural products namely: Mango (*Mangiferaindica*), Limon (*Citrus aurantifolia*), Guava (*Psidiumguajava*) and Bananas (*Musa acuminata*), in addition to forest loss due to soil infertility resulted to a shortage of manure, tillage practices, intensification, monocropping, indiscriminate cutting of trees, limited crop rotation, burning of crop residues and bush fires.

4.1.2 Human Impacts

Human activities that move beyond its limits in many forms, and generally these differences are linked with each other (Fig. 5.5).

Misuse of the Land by Expansion of Agricultural Land and Overgrazing

The land tenure system has been considered as a major underlying factor behind the use of natural resources. Rainfed sector has mainly depended on the natural base of available land and natural water sources from rainfall. Generally, agriculture in the study area is labor-intensive (where 82.3 % of the respondents are farmers) and provides the main livelihood source (Fig. 5.6). Severe and prolonged droughts and loss of arable land due to desertification and soil erosion are reducing agricultural yields and causing crop failure and loss of livestock, which endangers both pastoralists and rural peoples.

10 % out of the total respondents declared that they rely on livestock to improve their diet and food security. IFAD (2010) suggested that, where pastoral mobility with bigger herds size of presumed and local decision-making institutions are constrained, land degradation often occurs. Recently, demand for land has increased and the spread of cash-crop farming has been to the detriment of subsistence farming

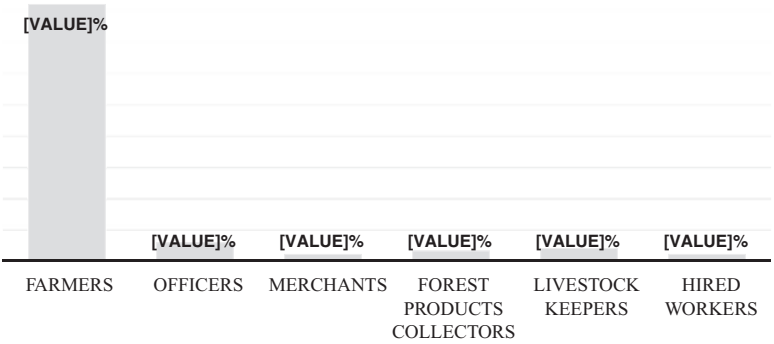

Fig. 5.6 Main occupation in the study area

and rangelands used by nomadic people. On the other hand, pastoralists who have taken the decision on the movement of their herds from drought-stricken areas have found themselves facing livestock disease, conflict over access to land, and other such conditions that could plunge them back into poverty and conflicts.

Conflicts

The relationship between environmental change and conflict is very complex. Given the history of ethnic and political conflicts in Kordofan Region, environmental change could aggravate territorial and border disputes and complicate conflict resolution and mediation processes in the near future. Now Nuba Mountains is a critical flashpoint zone in Sudan, and have communities living in fragile and unstable conditions, which making them more vulnerable to the risk of violent conflict and environmental change's effects (Fig. 5.4). The tribal conflicts along with natural resources degradation causing major destruction of assets, harvest damage, diminished agricultural labor opportunities, and reduce the accessibility for land cultivation and civilian displacement. The rates of displacement and migration has increased during the last 4 years, which estimated to be more than 30 %. The magnitude and complexity of migration makes it an important force in development, social, economic and stability. Unfortunately, this migration had negative consequences for political stability in the area near the border of south Sudan. The current study supports Thomas and Blitt (1998) who noted thatthe absence of social and economic adaptation toenvironmental scarcity contributestoethnic conflicts, migrations and insurgencies, besides indirect effects to the international community.

Extreme Poverty

The study area is rich in natural resources, however it is still burdened with widespread and persistent poverty as shown in Table 5.2. Faki et al. (2011) mentioned that Kordofan and Kassala states are believed to be among leading states in poverty

Table 5.2 Annual income (by US$) from the main occupation

Highest	Lowest	Mean	Std. deviation
1309.1	8.2	1173.6	**1312**

levels, comparing with other states, due to weakness in infrastructure and poor natural resources management in addition to high dependency on rain-fed agriculture for their livelihoods. Skoufias et al. (2011) suggested that the change in the environment might affect the path of poverty. The majority of responders are subsistence poor and highly dependent on natural resources for daily life and income generation. Additionally, there are insufficient financial and technical capacities to manage environmental risk, insufficient ability to adapt, as well as to access credit and safety nets. On the other hand, the current research agrees on the significant overall negative impact of global environment change on livelihood, which also has the potential to exacerbate other real or potential forms such as discrimination, terrorism, and poverty (Thomas and Blitt 1998). Environmental change impedes poverty reduction; hence it is a key factor for poverty-reduction strategies such as the UN's Millennium Development Goals (Lisk 2009).

5 Conclusions

The use of high-resolution satellite imagery, integrated with model-based terrestrial information, provides a precise knowledge about the magnitude and distribution of LU/LC patterns. This technique can make an important contribution toward abetter understanding of environmental change dynamics over time (Jensen 1996; Deafalla et al. 2014). Kordofan region is struggling with climatic effects and human impacts, land misuse, overgrazing, and ethnic conflicts. Knowledge about the interaction of these variations is still poor, compared to the urgent need of strategies and measures to adapt with these changes. Mitigation strategies can facilitate the adaptation to environmental change by enhancing the resilience through the reduction of anthropogenic pressures and recovering the biodiversity. Furthermore, new studies are required based on advanced techniques that might contribute to the understanding of LU/LC context, which are necessary to cope with high levels of environmental change.

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Chapter 6
Global Environmental Change as a Human Security Threat: Situation in Nigeria

Suleiman Iguda Ladan

Abstract Global environmental change is the set of biophysical transformation of states and flows of land, oceans and atmosphere driven by an interwoven of human and natural processes which are intimately connected with the processes of socio-economic and cultural globalization. This change has implications for human security which is the protection of the vital core of human lives in ways that enhance human freedom, safety and fulfillment. One region of the world where the impacts of global environmental change are felt adversely is Africa due to the lack of economic development and institutional capacity to mitigate and adapt to changes. This chapter examines the situation of global environmental change as a human security threat in Nigeria, a country with tropical climate, coastal location and being the most populous in Africa. Data for the study were generated through observation, documentation and secondary sources. The type of secondary sources used include textbooks, journal articles, Internet retrieved materials, television programmes and daily newspapers. The findings have shown the threat posed by global environmental change to human security as a result of increase in precipitation and temperatures, significant shift in rainfall pattern, water stress, occurrence of extreme weather events such massive floods, hailstorm etc. and coastal erosion and flooding affecting coastal settlements in Lagos area and the oil rich Niger Delta. From the year 2010 to date, many people lost their lives or were injured, and roads, bridges, houses, farmlands and even cemeteries damaged or destroyed due to the effects of the change. The situation in Nigeria is seriously threatening the security of humans in the country. The government should therefore take a critical look at the issue and constitute a professional panel of indigenous scientists to study the situation and partner with their foreign counterparts in order to adequately respond to the threats posed by global environmental change.

Keywords Global • Environmental change • Human security • Threat • Nigeria

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1 Introduction

During many years of the planet earth's history there had been changes in the global environment. These changes were mostly natural as the events that set them occurred naturally. However changes today appear to be largely the result of human activities (Bilham-Boult 1999). Global Environmental Change is the states and flows of land, oceans and atmosphere driven by an interwoven of human and natural processes which are intimately interconnected with the processes of socio-economic and cultural globalization. Global environmental change include changes in the physical and biochemical environment, either caused naturally or influenced by human activities such as deforestation, fossil fuel consumption, urbanization, land reclamation, agricultural intensification, freshwater extraction, fisheries over exploitation and waste production (GECAMPS 2012).

The different elements of environmental change are interlinked through a complex set of physical chemical and biological processes. When natural or human activities lead to changes in one component this have ramifications for other components as well. For example, climate change affects biodiversity and alters ecosystems such as forests and coral reefs, and influence the stratospheric zone layer. Likewise, conversion of forests to other uses can increase greenhouse gas emissions and reduce biodiversity and water resources.

Global environmental change has implications for human security. Human security is the protection of the vital core of human lives in ways that enhance human freedom, safety and fulfillment (UNTFHS 2012). The United Nations Trust Fund for Human Security (2012) further explained that human security means protecting fundamental freedoms, protecting people from critical and pervasive threats and situations, using processes that build on people's strengths and aspirations, creating political, social, environmental, economic, military and cultural systems that when combined give people the building blocks for survival, livelihoods and dignity.

Human security is achieved when and where individuals and communities have options to end, mitigate, or adapt to risks to their human, environmental and social rights, have the capacity and freedom to exercise these options and actively participate in attaining these options (ESSP 2012).

Global environmental change has human dimensions as it affects the quality of human life and sustainable development on a worldwide scale (ESSP 2012). One region of the world where the impacts of global climate change are felt particularly adversely is the continent of Africa due to the lack of economic development and institutional capacity to mitigate and adapt to changes.

This chapter examines the situation of global environmental change as a human security threat in Nigeria. Nigeria is a country with tropical climate located on the west coast of Africa between the Bight of Benin to the fringes of the Sahara Desert (between Benin Republic and Cameroon). The country occupies an area of 923,768 km with land of 910,768 km^2 and 13,000 km^2 of water and coastline of 853 km (See Fig. 6.1). The population of the country based on 2006 National Population Census is 140,431,790 which make Nigeria the most populated country in Africa and the 10th most populous country in the world. Presently the population is estimated at over 150 million.

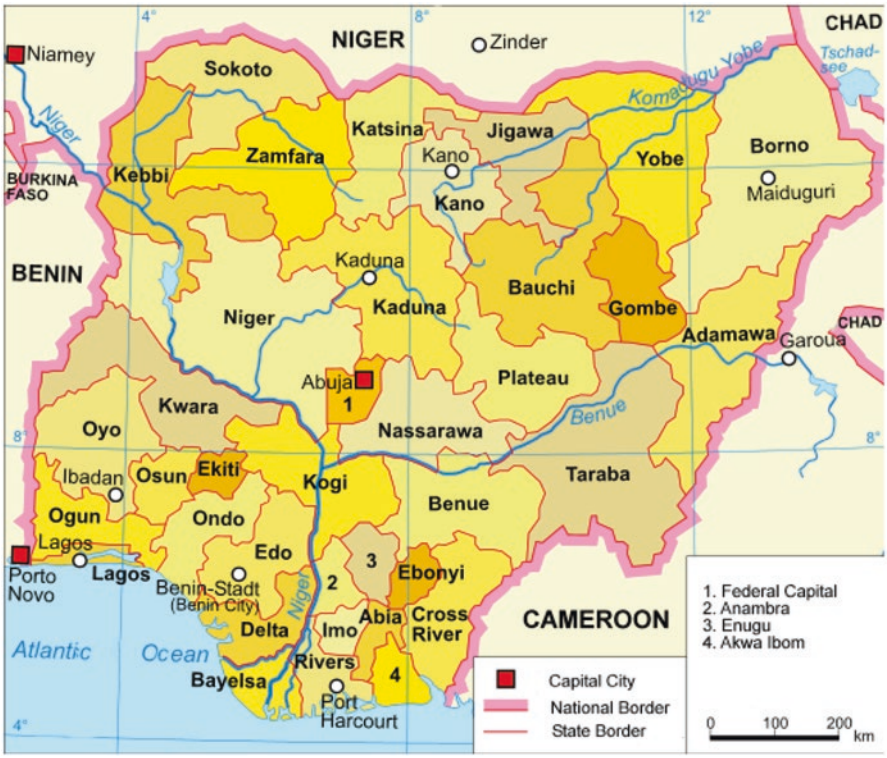

Fig. 6.1 Map of study area Nigeria

2 The Situation in Nigeria

The physical environment of Nigeria consist of swamps and high forest vegetation covering 20 % of the land area found in the south and tropical grassland vegetation in the north covering 80 % of the land area. The climate is sub-equatorial in the south and tropical continental in the north with double and single maxima rainfall. The relief consists of few highland areas and many low land areas found along the river basins and the coastal areas. The drainage consists of a close network of rivers and streams with the two major rivers Niger and Benue flowing through the center of the country. There are also dams such as Kainji dam, Shiroro dam and lake Chad that serves multipurpose uses (See Fig. 6.1). Global environmental change in Nigeria manifests in the following ways:

2.1 Drought and Desertification

The environmental change manifested in terms of drought and desertification in the north-eastern region particularly in the Lake Chad area of which is characterized by the drastic reduction in the volume of the water in the basin with serious

consequences to the local and global environment (Dami et al. 2011). The Lake Chad has been reduced in size and that is associated with climate change and human demand for water. The climatic factors are the declining frequency and volume of rainfall received within and outside the basin. The human factors are mainly related to land use and are driven by an increasing demand for water even as its supply is decreasing (Dami et al. 2011). Drought and desertification becomes imminent in this area when vegetation in particular gets degraded or completely removed due to human activities particularly fuel wood extraction and grazing by animals.

During the 1983 and 1989 droughts, the Lake Chad's water level had fallen by 239 m. There were losses in crop production and livestock population as during the 1983 drought about 1,447,512 tonnes of crops and 9.8 million livestock were lost in the present day Borno and Yobe states (Ayuba 2005). Furthermore it is estimated that Nigeria is losing about 351,000 km^2 to desert representing 38 % of its total landmass along the desert frontline states of northern Nigeria and millions of people live under the hardship of desertification (Ayuba 2005).

2.2 Deforestation

Deforestation of large areas of land is a manifestation of environmental change in Nigeria in both the north and south. Deforestation is a major environmental problem in northern Nigeria even though afforestation continues to be a priority of successive governments. It is estimated that about 90–95 % of the rural households and 85–90 % of the urban households in the region use fuel wood (Ayuba 2005). Most of the gazetted forest reserves have become *defacto* open access areas or have been converted to other land uses. A study by Ayuba (2005) for Borno state revealed that out of the nine major forest reserves, six have witnessed 60–90 % degradation due to encroachment by farmers. Another study by Ladan (2011) in Katsina metropolis, Katsina state have shown that all the four forest reserves that surrounds, the metropolis are at various stages of degradation by not only the local people but even by the state government as witnessed in 2006 and 2009.

In the southern part of Nigeria, deforestation has led to change in the vegetation type from high forest to derived savanna as large hectares of forests are cleared for fuel wood, lumbering, agriculture and urban uses. In the Niger Delta region, oil exploration and exploitation activities have brought about deforestation of the mangrove forest vegetation. In the year 2010 Nigeria had 9 million hectares of forests, 336,000 ha of which of which were primary forest. Nigeria has one of the highest rates of deforestation in the world, having lost around 410,100 ha per year over the period 2005–2010. Studies in the southern region have cited rapid population growth, agricultural expansion, use of fuel wood and logging as major drivers of deforestation in the country (NCI 2013).

2.3 Increasing Temperature and Rainfall

In Nigeria, both temporal and spatial variations were observed in the air temperature distribution. The temporal air temperature trend has remained generally on the increase since 1901 (Odjugo 2012). Within 105 years, temperatures increased by 1.2 °C in the coastal cities of the Niger Delta and 2 °C in the northern extreme of Nigeria. A mean air temperature increase of 1.7 °C was observed in Nigeria for the last 105 years. The lowest mean annual temperature was recorded on the Mambilla, Obudu and Jos Plateau because they experience semi-temperate climatic conditions. The current available evidences show that Nigeria, like most parts of the world is experiencing the basic features of climate change (Odjugo 2012).

Rainfall in Nigeria is unevenly distributed as areas on the coast receive more rain than those further inland. It is characterized by latitudinal and longitudinal variations in amount and distribution. Significant rain is recorded from April to October in the southern part and from June to September over the northern part during the period 2010–2014. Recently heavy and unusual rains have been falling in both the northern and southern parts of the country. For example in August 2010 heavy rain fall caused havoc in the northern states of Kebbi and Sokoto. In Ibadan, South West Nigeria, on August 28th 2011 heavy down pour the highest in more than five decades wreaked havoc across the city. The rain that falls on that day hit an all time high of 187.50 mm accompanied by wind gusts reaching 65 km/h. The previous highest recorded rainfall was 178.30 mm in September 1987 (IITA 2012).

2.4 Occurrence of Extreme Weather Events

Extreme weather events have been occurring for some time in Nigeria, but they have become severe and widespread in the last 2 years. In the year 2010, a hailstorm occurred on the 15th July in Katsina metropolis. The hailstorm which consist of falling hailstones of different sizes and shapes, caused extensive damage to over 200 car windscreens, many house roofing sheets and household items were destroyed or damaged and 12 people suffered injuries on the heads and hands (Ladan 2011). In the month of August heavy rains led to the flooding of large areas of land in Sokoto and Kebbi states destroying farmlands and houses. River Sokoto over flooded its banks submerging adjacent farmlands.

In the year 2011, massive floods of rainwater swept different parts of the country in cities such as Ibadan, Lagos, Kano and Sokoto. The Ibadan floods of 26th August was described as disastrous, as the more than 6 h rain of 187.50 mm killed over 100 people, destroyed houses, cars, cemeteries and damaged key infrastructures such as bridges, roads and electric poles. Furthermore gardens, poultry farms and fish ponds were lost to the floods (Sunday Tribune 2011).

In the year 2012, there were more severe and disastrous extreme weather events occurring in different parts of the country. Hailstones that accompanied heavy rains

caused widespread destruction of houses, farmlands and agricultural products in some local government areas of Jigawa and Katsina states. According to the residents of the areas the events were never seen in their entire lifetime (Ibrahim 2012).

Nigeria witnessed its worst flooding in five decades in the months of July to September 2012 as flood waters affects thousands of people in 21 out of the 36 states. The President while visiting some worst affected areas called the floods a national disaster. Vast stretches of land in Africa's most populous nation were submerged by floods as major rivers like the Niger and Benue burst their banks. At least 140 people were killed, hundreds and thousands displaced and tens of thousands of hectares of farmland were submerged, raising concerns about food security (Daily Herald 2012). Thousands of people have lived in refugee camps/displacement camps with little provision for sanitation and hygiene and personal security of the displaced.

3 Implications of the Situation for Human Security

There are several implications of the current situation on global environmental change on human security in the country. These are listed below:

- There is no security of human lives especially during the rainy season when heavy rains and floods caused destructions that claimed human lives. The total number of people that died as a result of heavy rains and floods in the year 2012 was the highest in the history of the country. According to the Red Cross 148 people died as a result of the 2012 floods in 21 States across Nigeria.
- There is a threat to personal safety of people as many were injured by falling hailstones in Katsina and Jigawa states for example. Besides many people including the vulnerable population such as children, women and the aged struggled to move to higher ground to escape the flood waters.
- The sources of food for the people were destroyed as farmlands, poultry farms, fish ponds and gardens were destroyed. This means that hunger and malnutrition could easily set in, thereby threatening the health and personal wellbeing of people.
- The national food security is now under serious threat as farmlands and farm crops were destroyed by the extreme weather events. The likelihood is that the affected people will have to depend on food aid while the food crops in the markets will attract higher prices as the supply is reduced.
- People have no shelter as their houses were destroyed. Presently thousands of people are living in makeshift displacement camps such as primary schools, political party offices, local government buildings etc. Life in these camps is difficult as there is no adequate supply of food and sanitary conditions in these camps are unsatisfactory according to reports (NTA 2012).
- People have lost their properties such as houses, motor vehicles and personal belongings such as clothes, furniture, and electronics which make them to feel insecure because of these losses.

- The damage to infrastructure posed a serious threat to the security of the people. For example as a result of the massive floods the Abuja-Lokoja road was washed away and submerged under water. Travelers along the road were stranded for about 3 days. Motorists were asked to seek alternative routes as the Federal Road Safety Corps blocked the road for safety reasons.

4 What the Country Should Do to Salvage the Situation?

Global environmental change based on the situation in Nigeria is a serious threat to human security. Therefore, in order to salvage the situation, the following measures/steps are recommended:

- People should be encouraged to adopt favourable attitude to the environment through appropriate landuse and putting a stop to the destruction of vegetation for fuel wood. In line with this an alternative source of domestic energy should be made available to people.
- Afforestation programmes should be encouraged by all tiers of government. Planting of trees will ensure that the environment is protected against the harmful effects of deforestation and climate change.
- The increasing rainfall in the country should be harnessed through the construction of dams to store the water for use as irrigation water and to supply water to the increasing population especially in urban centers.
- The public should be educated on what to do before, during and after an extreme weather event such as hailstorm, floods in order to help reduce the causalities and damage to properties.
- Federal, state and local governments throughout the federation should invest in flood protection since flooding has now become part of the rainy season. Besides, this climate change should be incorporated as part of development plans by all the tiers of governments.
- The federal government should collaborate at regional level with the neighbouring countries on the need to improve the water level of the Lake Chad, regular information of water level in Logdo Dam in Cameroon and the situation of water level on the River Niger in the countries where it flows.
- The federal government should take a critical look at the issues of global environmental change and constitute a professional panel of local scientists to study in partnership with their foreign counterparts in order to adequately respond to the threats posed by global environmental change.

5 Conclusion

Global environmental change is seriously threatening the security of humans in Africa's most populous nation in a number of ways. The situation is aggravated by the lack of economic development and institutional capacity to mitigate and adapt

to the changes. The recent flood disaster in different parts of the country has clearly shown that the federal and state governments are not ready and prepared to respond adequately to the manifestation of global environmental change. Based on this experience the government should now put all structures in place and enlighten the people on the changes and on how to adapt to them.

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Chapter 7
Eco-Adaptation Strategies of Health to Climate Change: Case of Zoonotic Cutaneous Leishmaniasis(ZCL) as Vulnerability Indicatorin Pre-Saharan Region of Morocco

Kholoud Kahime, Lahouari Bounoua, Mohammed Messouli, Samia Boussaa, and Ali Boumezzough

Abstract Human societies are rapidly increasing in size, driving with them the level of appropriation of Earth's resources, including land use. Today, human influence has reached global proportions and has altered ecosystems with consequences for local and regional climates. These changes in climates often alter the biosphere's ecosystem services and social livelihood; and in some cases they strongly affect human security, including publichealth. For example, in Pre-Saharan North Africashifts in surface climate associated with climate change may have altered the dynamic of zoonotic cutaneous leishmaniasis (ZCL), a vectorial disease causing threat to health security in most North African countries. Leishmaniasis is a vector-borne disease widespread in most countries of the Mediterranean basin, including Morocco where it causes a public health problem that is worsening with changes in climate and unsustainable population activities. ZCL is a form of leishmaniasis endemic in south-east Morocco, especially in the province of Errachidia. Caused by

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Leishmania major, this form is transmitted by *Phlebotomus* (*Phlebotomus*) *papatasi* (Diptera: Psychodidae), with *Meriones shawi* grandisthe main reservoir host. This investigation is carried out in the province of Errachidia with the aim to assess the vulnerability of local populations to ZCL, as influenced by climate change, and identify potential adaptation strategies susceptible to reduce the risk of infection. Our research is based on extensive interviews with local populations, particularly about their behavior and their interactions with local environment changes. It also refers to reports from the Moroccan Ministry of Health on the prevalence of disease and socio-economic data from the region. As results, we report on micro-environmental and socio-economic aspects that may act as risk factors conditioning the resurgence of this parasitic disease. It is a contribution that raises the flag about ZCL in order to develop an eco-health approach and determine adaptation procedures able to reduce the sensitivity and exposure of vulnerable populations. Based on population perceptions, the relationship between the transmission cycle of disease, environment and local population was discussed.

Keywords Leishmaniasis • Vulnerability • Climate change • Adaptation • Morocco

1 Introduction

Several climate models with varying complexity indicate a projected warming globally and moistening of the surface climate in most regions except the Mediterranean, the southwestern part of the United States, South Africa and Southwest Asia (IPCC 2007). In addition, the climate changehealth impacts are currently among the most investigatedissues in public health and environmental sciences (Patz et al. 2014; Johnson et al. 2015; SCESEHD 2015; IPCC 2014). The impacts of a changing climate on human health and wellbeing have therefore been a central part of the climate change debate and a consensus has been reached in the recent years (IPCC 2014). While the burden of climate change could be alleviated for causes such as heat and cold related morbidity and mortality, or injury and death following extreme weather events, infectious diseases, especially vector borne diseases, are likely to be a major human healthburden in a changing climate (IPCC 2014).

Climate change is expected to affect the distribution and prevalence and lifecycle of several vector borne diseases such as leishmaniases which are a group of diseases caused by parasites of the genus *Leishmania* and transmitted by sandflies (Bounoua et al. 2013). They are closely associated with environmental factors (Rioux and de La Rocque 2003). We can distinguish three forms of leishmaniases: cutaneous, mucocutaneous, and visceral. The *Leishmania* pathogen complex (parasite, vector, and reservoir) operates in specific geographic areas defined by a set of bioclimatic conditions. Environmental changes affect leishmaniasis foci and their territorial

expansion (Boussaa 2008), either by acting on the vector (Rodhain 2000) or the parasite and reservoirs (Bounoua et al. 2013). Climate may constrain or exacerbate favorable conditions for the disease, including acceleration in parasite development or synergistic interactions between reservoir and vector causing a population explosion. For example, an increase in precipitations may increase the vegetation density, and thus the number and quality of breeding sites for both the rodents and the sandflies (Yates et al. 2002).

On the other hand, droughts and high temperature may be limiting factors for *sand flies* lifecycles and vegetation phenology. There have been a number of recent reviews covering aspects of global change and health, specifically targeting vector-borne diseases (Gubler 1998; Haines 1998; Patz et al. 2000; Reiter 2001; Sutherst 1993, 1998, 2001; Taubes 1997). In the Mediterranean regions, several studies have revealed correlations linking the incidence of ZCL to bio-climatological factors (Rispail et al. 2002; Toumi et al. 2012). Cutaneous leishmaniasis due to *L. major* (ZCL) seems most clearly related to climate and vegetation (Bounoua et al. 2013). Its epidemiological cycle is based on the presence of the *Meriones shawi*, a gerbil dominating remote Douars, small isolated villages often surrounded by palm trees, and acting as a reservoir to the *leishmania* parasite.

In this study, we explore empirical relationships between environmental indicators, climate, socio-economic factors and the incidence of ZCL in order to identify appropriate adaptation actions. We elect to target ZCL, a disease which creates an alarming situation in the high risk Moroccan oases.

2 Materiel and Methods

Data collection was achieved through: (1) individual interviews (in the field, Errachdida province); (2) electronic questionnaires (specifically addressed to health personnel); and (3) literature search (Ministry of Health's reports).

We were able to reach and obtain detailed information on 100 people. Before handing over the questionnaire, we made it clear that the interviews were about the ZCL. The survey questionnaires focused on three main themes:

- Identification of the respondent in terms of age, gender, education, and profession;
- Issues related to Leishmaniasis: notion and risk factors (climate change, vulnerability, risk factors, intra-domestic investigation); and
- Adaptation strategies as solutions.

The investigation is carried out for a target population living in areas with the same risk level. It uses the Schröter's approach (2005) to assess vulnerability. This approach is useful for assessing risks to human societies from leishmaniasis diseases which are influenced by climate.

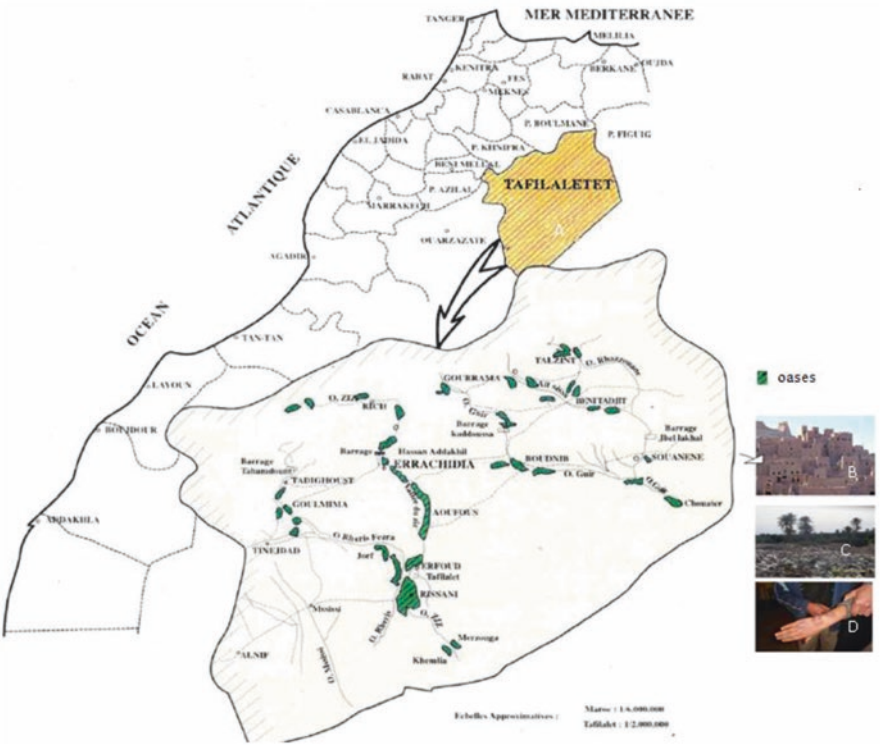

Fig. 7.1 (**a**) The study area (province of Errachidia, Morocco Kabiri 2004), (**b**) ksours, (**c**) discharge, and (**d**) Cutaneous ulceration due to ZCL

2.1 Study Area

The study area concerns the region of Tafilalet in the province of Errachidia. It covers about 8.44 % of the surface of Morocco (Fig. 7.1). The region includes the biosphere reserve oases of southeastern Morocco (El Rhaffari et al. 2002), and forms an agglomeration of *ksours* (Berber architecture in the form of small castles). It is surrounded by an area devoid of vegetation; dunes give way to *regs* (vast expanse of stones) where *khetaras* (structures related to the ancient local irrigation system) are still visible.

The total population of the province of Errachidia is estimated at 600,000 (Amarir et al. 2011). The area is under a semi-arid climate regime characterized by relatively cold and humid winters and hot and dry summers with a large diurnal temperature range (Tahraoui et al. 2006; Bounoua et al. 2013). We focus on areas of high risk of Leishmania, characterized by a significant rate of infection such as the Rissani Tinjdad and Goulmina areas (HPDE 2012).

Fig. 7.2 Illustration of the cycle of ZCL due to *L. major* (HPDE 2012)

2.2 Epidemiology of Leishmaniasis

In some countries, Leishmaniasis has become an emergency health problem. It is endemic in 88 countries and four continents: Africa, North and South America, Asia and Europe. The World Health Organization (WHO) estimates that worldwide about 14 Millions people are infected with leishmaniasis with about two Millions new cases per year, and only a third of the cases officially declared (WHO 2007). Currently 350 Million persons in 88 countries are at risk (WHO 2010). In Morocco, Leishmaniases are endemic diseases constituting a major public health threat (Mahjour et al. 1992). According to Kahime et al. 2014, cutaneous leishmaniasis (CL) is caused by three clinically important *Leishmania* species (*L. major*, *L. tropica*, and sporadic CL cases due to *L. infantum*, flagellate protozoa of the family *Trypanosomitidae)*; Visceral Leishmaniasis is also caused by *L. infantum. Leishmania* infection is transmitted to human host as a result of a bite by an infected female sandfly of the genus *Phlebotomus* on exposed parts of the human body. Sand flies live in a wide range of habitats and individual species often have specific habitat requirements.

In this work, we are particularly interested in ZCL. Described for the first time in 1860 by Hamel, ZCL due to *L. major* is endemic in the arid zones of the palm groves of the southern foothills of the High Atlas Mountain (Rioux et al. 1986). These areas are highly infected and thus likely to shed new epidemic waves. Incidence can reach more than 4000 cases per year (DELM 2012). The epidemiological cycle of this form of disease revolves around the presence of a rodent, *Meriones shawi* (Belazzoug 1992), found in Douars and palm grove, which act as a reservoir to the parasite (Fig. 7.2). Lesions from this disease are sometimes discrete,

usually located on the face, but indelible. The transmission of the parasite from the reservoir to humans is done by *Phlebotomus papatasi*, a vectorabundant in contaminated Douars and well adapted to local climate (Rioux et al. 1986; Boussaa 2008). This vector has been widely studied in southern Morocco (Boussaa et al. 2005; Guernaoui et al. 2006) and modeling studies have attempted to predict its range expansion associated with global warming (Cross et al. 1996).

2.3 Concept and Use of Vulnerability in Leishmaniasis Context

Vulnerability is conceptualized in different ways by different disciplines. Turner et al. (2003) recognize that vulnerability is not only determined by exposure to hazards, but also depends on the sensitivity and resilience of the system experiencing the risk to such a hazard. The vulnerability of a region to climate change is described by three elements: exposure, sensitivity, and adaptive capacity (IPCC 2001);where *exposure* can be interpreted as a direct threat (stress factor) such as temperature, precipitation, or extreme weather events; *sensitivity* describes the conditions of human environment that can increase the risk, improve the danger, or trigger an impact; and the *adaptive capacity*which means the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

The concept of vulnerability is also useful for assessing risks to human societies from vector-borne diseases and the extent to which these diseases are influenced by climate. Indeed, the examination of the seasonal and inter-annual dynamics of the incidence of ZCL, as function of surface climate indicators in Errachidia, suggests that changes in climate may have resulted in an increase in ZCL incidence (Bounoua et al. 2013). On the other hand, it is generally accepted that leishmaniasis infections are associated with local socio-economic conditions (Ready 2008). Accordingly, we have chosen leishmaniasis as an indicator of vulnerability of local population in the region of Tafilalet.

2.4 Data Processing

Data collected from the interviews combined to the online survey were entered and analyzed by using the Statistical Package for the Social Sciences (SPSS, Version 10.0). The differences between the studied variables were determined through comparison of means established by the one-factor analysis of variance (ANOVA), and the general linear model for multivariate analysis. Thus, multiple *a posteriori* comparison tests were performed to determine homogeneous groups using the Tukey's test. Some non-parametric data were analyzed using the Chi-square test because

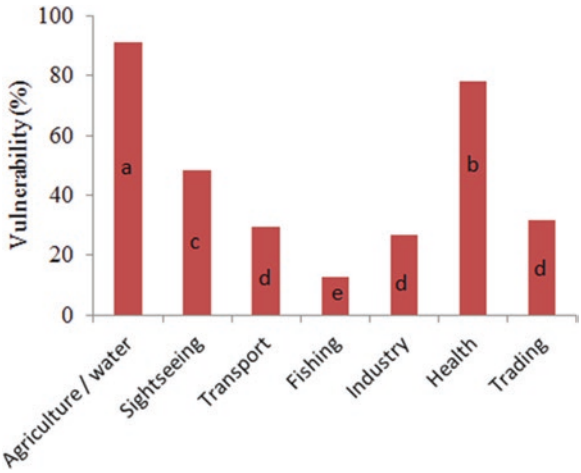

Fig. 7.3 Ranking of proposed sectors according to their vulnerability to climate change as determined from the interviews. Highest values correspond to highest vulnerability. Except for those sectors labeled with the same letters, differences among all other sectors are statistically significant at 5 % confidence level

sometimes the number of samples (or classes) was small, and there was no certainty that the data was normally distributed. We used the 5 % significance level for all the tests.

3 Results and Discussion

Morocco is a signatory of the United Nation Framework Convention on Climate Change (UNFCCC 1992) and has taken various measures to assess and adapt to climate change impacts. Remarkable progress has been made in developing projects (MDP projects, INDCs) and process (INDH) that makes environmental protection a major concern in political, economic and social. However there was little progress shown concerning health issues and their relationship to environment and climate change. There is general consensus among climate models projections that Morocco's climate, as part of the Mediterranean region, will experience a warmer and dryer trend to the end of the century (IPCC 2007). This will likely redefine the distribution and endemism of some epidemic diseases in the region or increase their incidences (Bounoua et al. 2013). Therefore, it is necessary for Morocco to adopt a new vision and strategy for health issues in order to improve the well-being of populations. Such strategy must include the assessment of the fragility and vulnerability of the health sector to climate change.

The classification of economic sectors according to their vulnerability to climate change, as established by the interviews, is illustrated in the Fig. 7.3. Except for transport, industry and trading, the analysis of variance (ANOVA) between each proposed sector shows a statistically significant difference at 5 % ($p \leq 0.05$). Agriculture and water constitute the most vulnerable sector ("a") followed by health ("b").

Based on our interviews, local population refers to the disease in the Tafilalt dialect as '*Ihboben', which* means 'spots or pimples', given the nature and digging inflammatory ulceration caused at the infection site. In agreement with reports provided by the ErrachidiaProvincial Health Delegation (EPHD 2012), about 80 % of people surveyed confirm suffering from the infection and that the disease has epidemic periods. According to Dedet (2001), the geographical distribution of leishmaniasis has been linked to environmental conditions that affect the distribution and density of both the sandfly and the rodent. In this context, the recent research (Bounoua et al. 2013) shows a robust relationship between climate variables such as minimum (T_{min}) and maximum (T_{max}) temperatures, relative humidity (H) and vegetation density represented by the Normalized Difference Vegetation Index (NDVI), and the dynamics of the incidence of ZCL from 1990 to 2010 in the same study area. This work suggests that, in this area, recent changes in surface climate may have initiated a trophic cascade that resulted in increased ZCL incidence.

The research finds the correlation between the rainy season precipitation and the same year NDVI to be strong, while the number of ZCL incidence lags the precipitation and NDVI by 2 years. The ZCL seasonal dynamic appears to be controlled by the minimum temperature and presents a 2-month lag between the reported infection date and the presumed sandfly biting date. The decadal increase in ZCL occurrence in the region suggests that changes in climate, and especially minimum temperature, haveincreased sufficiently to create new conditions suitable for ZCL endemicity. They also find that high temperatures above certain values suppress the ZCL incidence by limiting vegetation growth and the vector's ability to reproduce. Desjeux (2001) attributes the main cause of ZCL to urbanization with the spread of suburbs near gerbil colonies and irrigation systems expanding the rodents' ranges. Many other climatic factors can be listed that influence the onset of ZCL epidemic (Bounoua et al. 2013).

It was thus judged prudent to assess the vulnerability to climate change impacts in a local socio-economic and cultural framework.

Our results show that 82 % of population are aware of changes in climate and their adverse impact on health, but remarkably, all respondents had a non-alarmist attitude suggested by a fatalistic approach grounded in prevalent religious beliefs. Respondents indicated that Morocco is a country vulnerable to changes in climate and that their own region suffers in greater proportion. This reality is also documented by IPCC(2007), especially for pre-Saharan areas located in south-eastern Morocco. Indeed, 85 % of participants confirm that the natural oases and human capital are vulnerable to climate change because of their limited adaptation capacity which is due to limited resources and the lack of social support.

It is clear that everybody can be infected at any age, however the economically and socially marginalized groups in rural areas are more exposed and suffering is intense. From our analysis, the active population (between 15 and 45 years) is most affected (Fig. 7.4) and represents about 52 % of affected people. This result is alarming and consistent with the analysis of epidemiological data of the region (EPHD 2012). Statistical analysis using the Chi-square showed no statistical significance between the number of incidence when age is used as an indicator.

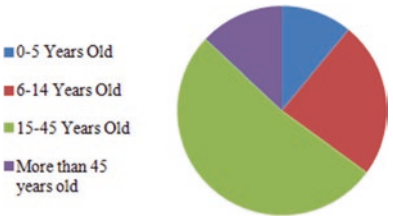

Fig. 7.4 Percentage of ZCL cases according to age

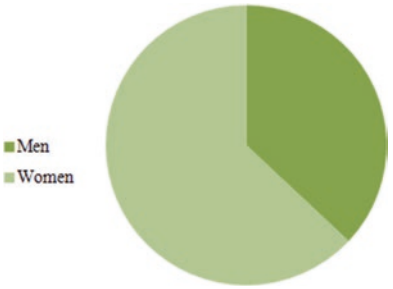

Fig. 7.5 Percentage of ZCL cases infected by gender

Results also show that females accounted for 56 % of ZCL patients (Fig. 7.5). The difference in the occurrence of the disease between gender was not statistically significant at 5 % ($p = 0.04$), although the poor women found to be more disadvantaged. They encounter higher financial and cultural barriers to healthcare and more intense stigma than their male counterparts.

Furthermore, results indicate that the perception of the severity of lesions and scars of ZCL variesby gender. About 83 % of the respondents believe that ZCL is a disease which creates an impediment or barrier, since its lesions prevent the adequate fulfillment of daily activities (wage-earning occupations for men and domestic tasks for women). In addition, it creates a self-exclusion, a 'social shame', notably in the case of young girls. 85 % of surveyed patients find the scars left by ZCL distressing.

More important, we noted that the majority of local population doesn't know the real causes of ZCL. Only 40 % of the interviewees claim to know the cause of CL and 33 % are not sure aboutthe declared cause. The different causes mentioned by our interviewees include a fly or insect bite, lack of resources and hygiene.

Drainage and water supplies are critical factors that determine the extent to which diseases are either contained or propagated in urban communities. In the study area, we observed prominent heaps of garbage and manure, and lack of drainage system of solid and liquid waste throughout rural communities. In many instances, waste containers were found to provide breeding sites for vectors of the disease.

Our field study confirms that the province of Errachidia is vulnerable to changes in climate for many reasons. Interviews attest that it is a poor region which is still dependent on subsistence agriculture and tourism. The decrease in rainfall has led

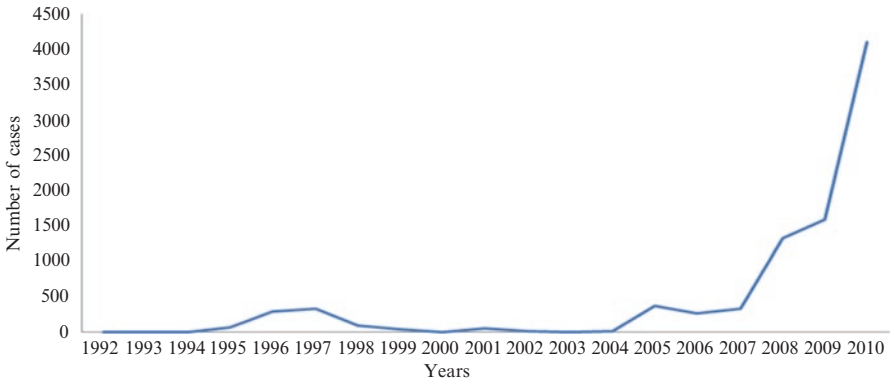

Fig. 7.6 Number of ZCL cases due to *L. major* in Errachidia between 1992 and 2010 (DELM 2012)

to reduced agricultural production while the global economic crisis seriously affected tourism. These factors have fragilizedthe region by increasing poverty and reducing its infrastructure, and may have contributed to augment cases of ZCL.

Beside, the existence of unmanageable lands (desert), and the population's behavior (movement of non-immune people into areas with existing transmission cycles, pollution,life style…) may exacerbate the incidence of ZCL in douars and villages with the risk of spread into urban areas. Risk of ZCL is unavoidably associated with poor housing conditions with cracked mud walls that provide daytime resting places for sandflies, damp earthen floors that prolong sandfly survival and open areas in the walls that enable sand fly entry. The study confirmed that rural areas are most vulnerable, followed by peri-urban and then urban areas. Thus, the great risk of ZCL epidemic in the region's urban centers lies somewhere in peri-urban pockets of Errachidia such as Amejouj, Ouled Tguir, Targa Jdida, Azmer, where ZCL foci exist and basic hygiene conditions are not met. In these poor areas, the local way of life and the type of housing present serious risk factors. People live in Ksours with little light penetrating the rooms and where latrines replace the sewerage system (an ideal environment for sandflies). In this context, our intra-household investigation for already infected households shows with high statistical significance that in homes with sanitation services, the percentage of infection with ZCL was 40 % lower ($p \leq 10–4$) then that in homes where this infrastructure is absent. Moreover, the presence of livestock, an ideal environment for parasitic spawning, and special rooms to conserve grain and other products, an enabling environment for rodent's reservoirs of parasites. This explains the high prevalence of cases in the province of Errachidia, given that all favorable conditions for the development of an epidemic are present.

A change in the geographical distribution of a vector-borne disease has a quantal effect on the exposure of naive hosts to that disease. Such a change can come about from the displacement of either the vector or the pathogen to a new environment (Sutherst 2004), or human migrations. The field observation reveals low heterogeneity

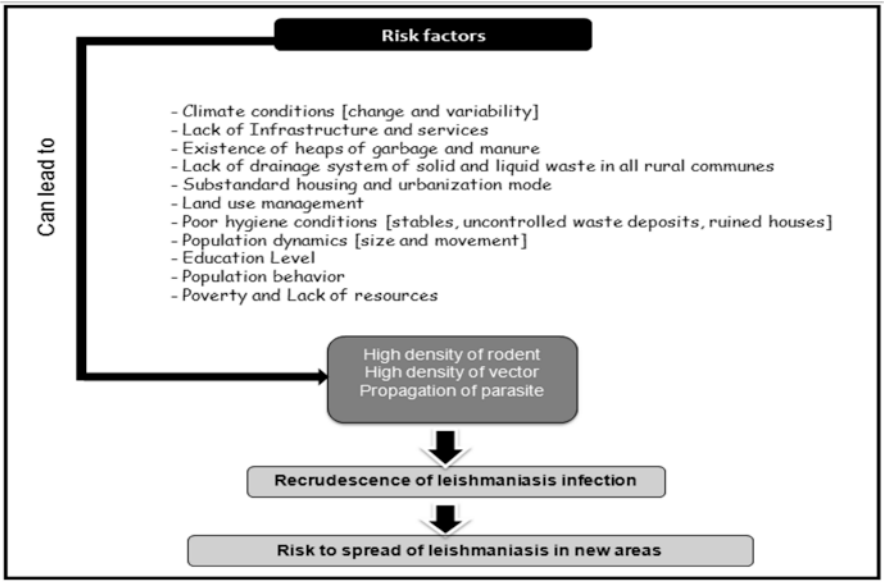

Fig. 7.7 Layout showing important factors involved in the pathogenesis of the disease in the studied region

in ecological and socio-economic conditions in the study area which leads to the spatial spread (EPHD 2012) due to an increase of ZCL incidence (Fig. 7.6).

In addition to noted global change, socio-economic factors such as ignorance, lack of infrastructure, lifestyle and factors influencing the environment, climate and poverty appear to be among the majors underlying determinants of leishmaniasis in the region; a result in agreement with previous studies (Bounoua et al. 2013; Alvar et al. 2006). Figure 7.7 below summarizes the risk factors that we have determined through thisresearch.

Based on this research,the following recommendations may alleviate the vulnerability of local populations to the ZCL and its social implication:

- It is necessary to adopt measures that help citizens, especially in marginalized rural and peri-urban areas, to reduce their exposure. This may include enhancement of awareness, exchange and integration of ZCL prevention measures in the region's school system via adult education first. For example, habitations improving, cleanliness, the use of insecticide nets. This will result in better management of the health risk associated with this disease and the ensuing problems across social scale;
- Urban infrastructures should be improved. Rehabilitation and restructuring of *ksours* with suitable drainage and waste disposal systems, as well as an environmental management, elimination of the habitats of the elements of the disease complex (vector and reservoirs), will definitely reduce the disease incidence;

- The need to enhancea sustained and effective struggle to control the transmission of ZCL in all active foci by establishing a monitoring program. This program should be developed through a participatory approach involving local population and all stakeholders such as NGOs and scientists;
- The need to develop the guidance and planning of transverse measures, such as the National Initiative for Human Development (INDH), not only to adopt aspects of environmental protection and the fight against poverty through income generating activities, but also to develop strategies valuing environment as an important and direct determinant of human health.

4 Conclusion

ZCL is currently at the centre of interest in Morocco, especially in the southeastern regions where rural and suburban areas are more vulnerable to the disease due to rapid environmental degradation. The cumulative effects of poor housing conditions, hygiene, type of urbanization, lack of water supply and sanitation, and climate change cause a siginificantimpact on the health of vulnerable groups and could potentially lead to the spread of the disease.

This analysis shows that there is a serious problem of transmission of ZCL in the studyarea. Women and children appear more vulnerable than their male and adult counterparts, and the risk factors identified appear linked to the socioeconomic level and the environment. The population would strongly benefit from a community intervention to improve the environmental hygiene and housing conditions.

With changes in climate, in the short term, Morocco is likely to face new challenges in the fight against infectious diseases. Implementing the suggested recommendations may promote dialogue on eco-adaptation strategies and alleviate these conditions. It may also lead to the adoption of the following adjustments:

- Improvement of the awareness and preparedness of the population to health problems such as leishmaniasis, from policy makers to local communities;
- Initiation of a process to reverse the trends in population's inappropriatebehavior that increase the risks of infection;
- Reappraisal of current plans to improve the robustness of design standards in those infrastructures which are usually rudimentary;
- Enabling people to increase control over, and to improve, their health;
- Creating a strong partnership between the health sector and other sectors, an essential step in effective epidemic combat and control, and orienting and charting the transverse measures;
- Improving the monitoring and surveillance and preventive eco-adaptation measures towards leishmaniasis related risk factors.

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Chapter 8
Anticipating Emerging Risks and Vulnerabilities from Sea Level Rise Induced Preventive Resettlement in Greater Alexandria, Egypt

Niklas Baumert and Julia Kloos

Abstract Taking the city of Alexandria in Egypt as an example, this chapter discusses a hypothetical vulnerability scenario for sea level rise (SLR) induced preventive resettlement in Low Lying Coastal Zones (LLCZ). As preventive resettlement may become a realistic –and under some conditions –unavoidable adaptation option to sea level rise and storm surge impacts in the future, the assessment and anticipation of future vulnerabilities and (human) security risks arising from preventive resettlement become important, particularly in developing countries. In this research, a conceptual framework for the anticipation of preventive resettlement induced vulnerabilities has been developed and applied to: (1) assess the conditions that deem Greater Alexandria as uninhabitable; (2) identify exposure of Greater Alexandria to sea level risk and characteristics of communities that require resettlement assistance; and (3) anticipate future vulnerabilities emerging from preventive resettlement. The results for Alexandria show that if current trends in socio-economic conditions prevail, communities will be vulnerable to unemployment and homelessness after being resettled. The assessment can be used to inform policy makers about the needs and possibilities to prepare well in advance for a preventive and people-centered resettlement in order to avoid large-scale displacement. This could lead to associated security challenges of trapped populations as soon as sea level rise progressively impacts exposed communities. Policies that tackle these future vulnerabilities could provide a win-win solution by meeting communities' needs today and in the future, especially when it comes to reorganizing livelihoods in the course of preventive resettlement.

Keywords Sea level rise • Vulnerability scenario • Preventive resettlement • Alexandria

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1 Introduction

Deltas are Low Lying Coastal Zones (LLCZ) which are subject to vast economic development through human activity and settlements, and have been identified as being particularly affected by a range of climate risks including sea level rise (SLR), coastal erosion, floods and tropical storms (Nicholls et al. 2007). SLR can induce an irreversible change in these coastal landscapes, impacting coastal livelihoods in the near future (Nicholls et al. 2007; Wong et al. 2014, cop. 2014) by causing them to become uninhabitable or too perilous to live in. This research is based on a global trend, in which population growth and urbanization in LLCZs, as well as unsustainable development and the increasing dependency of societies on coastal resources, will likely increase the intensification of exposure and susceptibility to SLR (Biermann and Boas 2010). Moreover, we take notice of the fact that in many LLCZ 'preventive resettlement'[1] might become an important adaptation option to address SLR. Nonetheless, the resettlement process is a complex and costly transformation, associated with many challenges and uncertainties that present difficulties for planning and management (Sherbinin et al. 2011). Badly implemented resettlement programs can result in a 'second disaster' for affected communities (IPCC 2012; Cernea 1997; 2004), causing local and global disruptions and security challenges. The generally negative experiences with Development-Forced Displacement and Resettlement (DFDR), and the trauma induced through such processes, have led preventive resettlement to be regarded as a 'last resort' kind of solution (Barnett and Webber 2009). The great risk for the 'mal-implementation'[2] of resettlement programs might explain why the issue of preventive resettlement appears to be one of the last considered and least developed options (Warner 2011). This may also have contributed to the stalling of its development as a possible adaptation strategy and its consequent 'taboo' status. Nevertheless, a turn in thinking has emerged. The IPCC (2012) recognizes that due to climate change "migration and displacement could become permanent and introduce new pressures in areas of resettlement". Moreover, the decision to include human mobility in the Cancun Adaptation Framework legitimizes preventive resettlement as a possible adaptation option (Warner 2011; Ferris et al. 2011).

[1] Preventive resettlement is identified as: "a corrective mitigation measure through intervention in an existing risk condition corresponding to the sphere of public policy, that is based on recognition of the rights and responsibilities of public, private, and civil society stakeholders; is guided by principles of effectiveness, equity, and precedence of public wellbeing; and takes place in a specific economic, institutional, legal, and political context. Disaster risk management requires a decision taken jointly by the government and communities to reach consensus regarding acceptable and feasible safety conditions in the context of somewhat uncertain events and regarding the assumption of responsibility for the consequences of decisions taken." (Correa 2011).

[2] The term „mal-implementation" in the context of resettlement refers to difficulties; e.g. of government institutions; to adequately comply with the requirements and the needs of the resettled populations during the transformation process creating for them livelihood risks.

Against this background there is a need for more discussion about the issue of preventive resettlement in order to avoid mal-adaptive[3] outcomes that increase vulnerability and overall livelihood risks. Additional research is required to anticipate and take stock of the future risks and vulnerabilities that might emerge from mal-implemented preventive resettlement. This research aims to advance this area by proposing a new framework and a scenario-based approach guiding how to conduct causal vulnerability and risk research arising from future SLR induced preventive resettlement challenges. Until now, scenarios have mainly been constructed to estimate directions and magnitudes of climate change. However, in order to project climate change impacts, the anticipation of future exposure and vulnerability emerging from likely occurring adaptation pathways (e.g. resettlement) are equally important (Garschagen and Kraas 2010; Birkmann et al. 2013).

Greater Alexandria, in Egypt, acts as a test bed for the framework and for the construction of a vulnerability scenario. Its urban agglomeration is located at the western coastline of the Nile Delta and is one of the most heavily populated and intensely cultivated areas on earth. It is part of an area of 700 km^2 (35 % of Egypt) lying below sea level. Hence, Greater Alexandria is considered to be a key societal hotspot of coastal vulnerability (Nicholls et al. 2007) facing most likely serious impacts from SLR (El Raey 1997). Consequently, Alexandria is a suitable example for assessing future vulnerabilities and risks arising from preventive resettlement as one of the potential adaptation options.

This chapter is structured as follows: firstly, a conceptual framework for assessing risk and vulnerability in the context of SLR induced resettlement is presented. Then, the framework is tested for the conditions in Greater Alexandria: Based on IPCC predictions, we located the SLR-exposed areas and described the key socio-economic parameters of the exposed population of Greater Alexandria. Using the identified preferences and needs for resettlement programs of the different social groups identified in Kloos and Baumert (2015), we analyze the capacity of Greater Alexandria to meet the preferences based on future political, spatial, housing and employment trends and conditions. In a final step, we discuss the implications of vulnerability to unemployment and homelessness as future risks in the course of preventive resettlement, and derive policy recommendations.

2 Conceptual Framework

This section elaborates the conceptual framework for assessing future risks and vulnerabilities in the context of preventive resettlement tied to the development of scenarios (see Sect. 3 on methods). The scenario constructed is based on a vulnerability causality frame that views exposure and susceptibility to climate change impacts as a result of lack of climate risk and vulnerability reduction. Hence, the

[3] "Mal adaptation refers to actions, or inaction that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future" (Noble et al. 2014, cop. 2014).

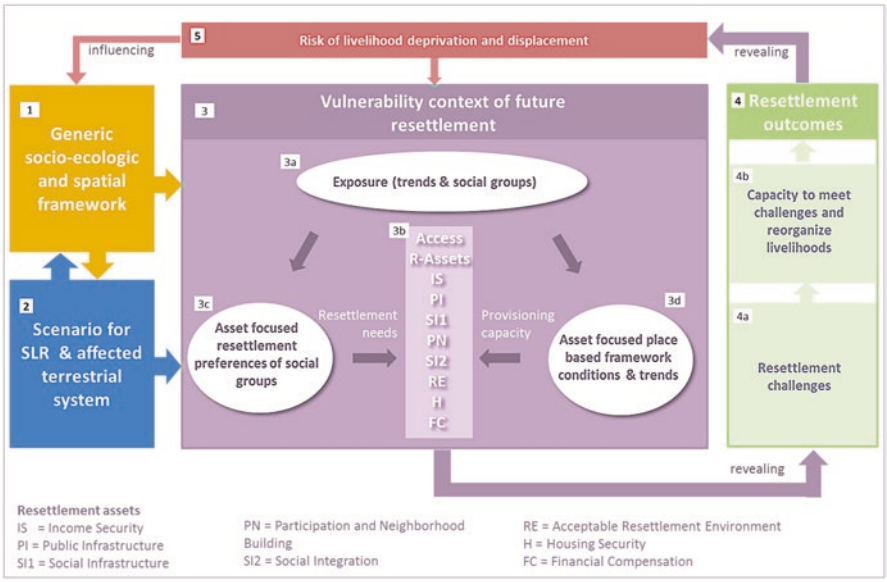

Fig. 8.1 Risk and vulnerability research framework in the context of SLR induced preventive resettlement (Source: Authors)

focus is on the link between risk, vulnerability and (mal)-adaptation, in which the issue of mal-adaptation producing new risks and vulnerabilities is addressed (Milman and Arsano 2014; Kloos et al. 2013) and translated into the context of SLR induced resettlement.

The risk and vulnerability research framework in the context of SLR induced preventive resettlement presented in Fig. 8.1 integrates the provisions of the Sustainable Livelihoods Framework (Ashley and Carney 1997) and the vast literature on impoverishment risks in the context of development-induced resettlement (Correa 2011; Scudder 2005; Wet 2006). Existing empirical research suggests that during processes of resettlement people are confronted with a complex, cascading sequence of events. Such events often involve homelessness, unemployment, the dismantling of families and communities, stress to adapt to a new environment, loss of privacy, political marginalization, and in some cases even severe deterioration of mental and physical health (Cernea 1997; Colson 1971; Scudder and Habarad 1991). Based on future SLR projections and the socio-ecological framework conditions, the conceptual framework identifies risks of livelihood deprivation and displacement. Exposure to SLR and the capacity of states, societies, regions, and geographies, etc. to support affected social groups determine whether these risks can be mitigated through ensuring their access to a number of defined resettlement assets during the process of resettlement and in its aftermath[4] (based on UNISDR 2009). In the follow-

[4] The four stage model developed by Scudder reveals that changes in vulnerability and risk vary in different phases of resettlement and that various and multidimensional stresses relocated people

ing sections, each of the different framework components will be presented in detail. As the effects of SLR will primarily manifest themselves in the future, the framework stresses the importance of anticipating future socio-ecological development paths in which SLR induced resettlement is likely to occur, based on current socio-ecological actions at a global scale. This means the framework connects with the prevailing discussion by risk and vulnerability scholars on how to construct vulnerability scenarios (van Ruijven et al. 2014; Kriegler et al. 2012).

2.1 Generic Socio-ecologic and Spatial Framework (1)[5]

This component of the framework addresses the generic conditions under which resettlement processes emerge and may lead to livelihood deprivation and displacement. It is built upon the notion of an integrated concept of 'humans-in-nature' that asks how human societies deal with changes in social-ecological systems, how capacity can be built to adapt to these changes (Berkes et al. 2008), but also how social-ecological relations produce risks and vulnerabilities (Adger et al. 2005). For example, how do socio-ecological processes within a spatial entity of concern (e.g. a city, a rural community) influence SLR induced impacts on the terrestrial system through i.e. erosion, land subsidence, infrastructure, and natural resource use (rows from box 1 to 2). And in the context of SLR-induced resettlement, how do socio-political (Mc Dowell 2002), socio-economic, political-economic, geographic, spatial, environmental, and cultural factors, conditions and processes affect the capacity to a society to accomplish sustainable resettlement (rows from box 1 to 3).

2.2 SLR Scenario Affecting a Terrestrial System (2)

The climate change scenario component of the conceptual framework forms the starting point for thinking about resettlement as a measure of adaptation. As a result of thermal expansion of sea water and the melting of land-based ice, global sea levels rose by 17 cm in the twentieth century (Church and White 2011). The estimates for future SLR by 2100 diverge, depending on the assumed future developments that in turn drive climate change, yet all scenarios project an increase (Stocker 2013). SLR impacts terrestrial systems causing land loss for settlement and economic activity as a result of coastal erosion, salinization of surface and ground water, and degradation of coastal habitats such as wetlands (Field et al. 2014, cop.

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and households have experienced can be classified and differentiated in four phases [23,24]: (1) 'planning and recruitment' (2) 'physical removal of communities' (3) 'community formation and economic development', (4) 'handling over and incorporation'.

[5] For better reading and comprehension, where necessary, reference numbers have been allocated made to the specific framework component.

2014). In some locations, these impacts may be exacerbated by (1) climate changed induced extreme whether events and human induced alterations of terrestrial systems, such as land subsidence due to ground fluid withdrawals, especially in deltas (Nicholls 2011).

2.3 Vulnerability Context of Future Resettlement (3)

2.3.1 Exposure to SLR – Trends and Exposed Social Groups (3a)

Determining 'SLR Exposure' refers to the identification of a suitable SLR scenario, the subsequent extent of SLR affecting terrestrial systems, and identifying and assessing objects that are exposed and of specific interest. Moreover, the analysis of exposure also includes, identifying trends of exposure manifestation in the areas of concern, as well as understanding the socio-economic fabric of SLR-exposed social groups requiring resettlement assistance by governments. In particular, exposed resource poor and marginalized groups may become trapped in unfavorable livelihood conditions, hampering self-motivated and successful migration (Foresight 2011). This challenges governments to manage the large-scale physical removal of communities and to ensure sustainable livelihood reintegration of resettled communities (Ibid).

2.3.2 Resettlement Assets (3b)

Based on the significant research on impoverishment risks resulting from development-induced resettlement, we have defined eight 'resettlement assets'(Fig. 8.1, 3b). These assets act as a reference frame for anticipating future vulnerabilities; where populations are exposed to SLR, and these assets cannot be accessed, they reveal livelihood deprivation and displacement in the course of resettlement (resettlement outcomes, 4). The use of the term 'assets' was informed by the definition of livelihood assets from the sustainable livelihoods framework (Ashley and Carney 1997). These assets include housing and income security, access to acceptable resettlement environment, social integration, access to public and social infrastructures and participation in resettlement planning and decision-making. The conditions under which these assets can be accessed are outlined in the following two sections.

2.3.3 Asset Focused Resettlement Preferences and Needs of Social Groups (3c)

Resettlement programs by governments need to take into account the preferences and needs of the population when designing people-centred resettlement programs that ensure a sustainable process of livelihood reorganisation. People may have different preferences and needs for these key assets and some may have a relatively

higher level of importance than others, presumably, formed and based on communities' or households' prevailing livelihood structures and conditions. For example, to be resettled SLR exposed households desire to continue with their former type of employment, because they are lacking skills for other types of employment offered to them. This also accounts for 'housing security' (Kloos and Baumert 2015).

2.3.4 Asset Focused Place Based Framework Conditions and Trends (3d)

The generic socio-ecological and spatial context framework influences the conditions under which resettlement takes place. In addition to this, asset focused and place based framework conditions have an influence on whether affected social groups can access their preferred and needed resettlement assets. For example, to ensure income security in the course of resettlement, the trends in the labor market and their underlying factors play a role and require investigation. Often they are multi-causal, and assessing them also means constructing causal analysis chains that may connect to the generic socio-ecological and spatial framework.

2.4 Resettlement Outcomes (4) – Displacement, Livelihood Deprivation, or Sustainable Resettlement (5)?

What are the challenges to be addressed for reducing the emergence of vulnerability in the course of resettlement? Can they be treated in an anticipatory and preventive manner? This would mean facilitating the long-term mainstreaming of identified resettlement challenges (as a result of the anticipation of future vulnerabilities) into development planning, and hence creating those framework conditions in which preventive resettlement programs are capable to provide affected communities with their preferred and required resettlement assets to rebuild their livelihoods. If not, mal-implemented resettlement may result in cascading effects of mass-displacement, precarious livelihood conditions and marginalization. Often, community's preferences are not taken into account; leading to planning failures, resistance, impoverishment. The implications for human security would be enormous, especially taking the dimension of SLR into consideration. But, if identified vulnerabilities are marginal, and preventive resettlement planning is conducted according to the preference and requirements of affected communities, resettlement can represent a viable adaptation strategy to SLR.

3 Methods

This chapter outlines the methods applied to operationalize the resettlement framework. They focus on how future exposure of Greater Alexandria to SLR is assessed and how resettlement challenges, potential resettlement outcomes and

resulting vulnerabilities can be anticipated (Sušnik et al. 2015). Here, a scenario-based assessment guides the case study work.

Gordon (2009) distinguishes between different options to create scenarios, such as qualitative and quantitative-, simplistic and complex methods. Birkmann et al. (2013) add more criteria, such as global top-down, local bottom-up, multiple spatial scales, and different time frames.

However, common shortcomings of such vulnerability scenarios include: lack of robustness; inadequate data availability; as well as a lack of temporal dynamics, and subjectivity. They are especially valid, when scenarios are created based on expert judgements to determine future trends. In this research, we consider these shortcomings by avoiding the attempt to extrapolate too many variables into the future. Hence, the scenario construction is guided by the following question: What are the risks and vulnerabilities arising from preventive resettlement if SLR was to affect Greater Alexandria today? Based on existing projections of future SLR, vulnerabilities arising from preventive resettlement (under today's configuration and conditions influencing resettlement outcomes) are assessed. The scenario construction focuses on Greater Alexandria and applies a mixed methods approach comprised of a standardised household survey, literature review, secondary data collection, and expert interviews. The analysis is based on the data used and processed data and include the following three steps:

1. Scenario coordinates and set-up: The scenario coordinates define the baseline for the operationalisation of the resettlement scenario conducted (based on the resettlement framework). They include a 'SLR' projection and the description of the 'socio-political' context in Egypt.

    - Firstly, a fictive projected SLR in the Mediterranean (1 m bathtub) is used, upon which the mapping of the potential spatial distributed inundation in Greater Alexandria is accomplished;
    - Secondly, the current socio-political context of Greater Alexandria is detailed on the basis of literature research, including the geographical conditions relevant for SLR.

2. Assessment of the future vulnerability of exposed communities to SLR due to resettlement. According to the conceptual framework, this includes:

    - Elaborating the future framework conditions under which resettlement likely occur. This includes the identification of drivers and possible outcomes of future trends in which exposure will manifest itself (literature research, expert interviews), as well as the socio-economic characterization of exposed communities within the potentially inundated area (household survey with a sample size of 500);
    - Estimation of resettlement preferences and needs of affected communities based on future livelihood conditions. Here we use the findings of (Kloos and Baumert 2015);

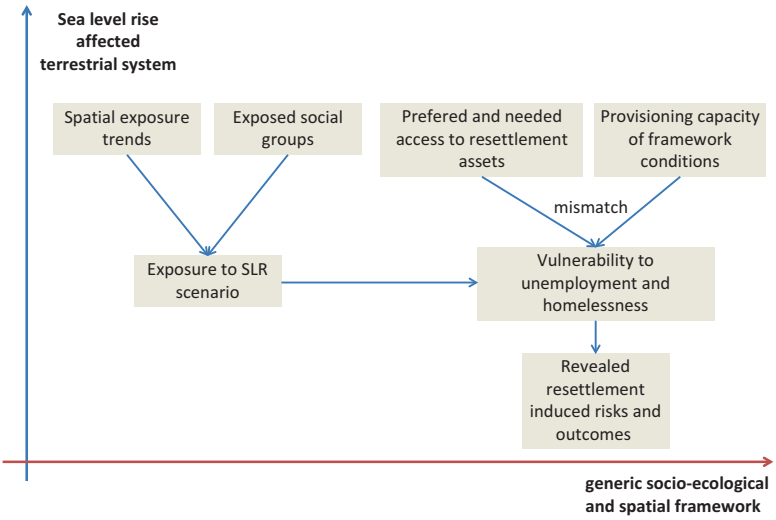

Fig. 8.2 Overview of assessment procedure

- Contrasting resettlement preferences and needs of resettlement assets with current framework conditions and trends in Greater Alexandria and Egypt. Based on empirical work by Kloos and Baumert (2015), preferences and needs for resettlement assets are mirrored against the current framework conditions. Here, we focus on the assets of income security (IS) as well as housing security (H) and examine how many exposed people are vulnerable to unemployment (=lack of IS) and homelessness (=lack of H). For our analysis, vulnerability to unemployment is determined by (1) households' employment preferences and profiles, which can reveal how easily or not they can access different employment markets, and (2) the current and future trends in employment supply for different sectors, such as in industry, agriculture, and services. The anticipation of vulnerability to homelessness is determined by (1) the type of households' housing preferences (2) and the current and anticipated situation of the Egyptian housing market.

3. Anticipating future resettlement outcomes via preparing for future resettlement challenges.

This is done in order to reduce the identified vulnerabilities and evaluate whether these challenges can be met under conditions of the prevailing socio-political context of Greater Alexandria (compare scenario coordinates).

To illustrate the multiple methodological components, Fig. 8.2 provides an overview of the assessment procedure and Table 8.1 summarizes the different assessment steps and the data used for each of them.

Table 8.1 Steps of scenario construction and data sources

Scenario coordinates	
Current socio-political and spatial framework (1)	Literature research,
Sea level rise and affected terrestrial system (2)	Fictive 1 m bathtub inundation of the delta close to the Greater Alexandria, literature, tide gauges data
Vulnerability context of future resettlement (**3**)	
Exposure scenario (3b)	Trends in Greater Alexandria: Reports on urbanization and land-use, city plans, expert interviews and workshops held in December of 2011 in Alexandria
	Exposed social groups: Randomly stratified household survey in highly exposed areas around Greater Alexandria, compare Kloos and Baumert (2015)[a]
Anticipating vulnerability to unemployment and homelessness of affected social groups (3a, b, c, d)	Mirroring employment and housing sector trends (3d) with resettlement preferences and needs (3c) to identifying misfits and gaps (Analysis, Discourse, Discussion)
	Resettlement preferences (3c) (choice experiment, compare Kloos and Baumert 2015)[a]
	Resettlement needs (3c): Households labor and housing profiles based on the stratified household survey
	Provisioning capacity (3d): Key socio-economic data and trends relevant for the employment and housing sector from the literature and reports
Revealed resettlement outcomes (**4**)	
Challenges for preventivere settlement (4a)	Using the anticipated vulnerabilities to unemployment and homelessness, future challenges to be addressed are delineated (Interpretation, discussion)
Synthesizing the capacity to meet challenges (4b)	Conclude if challenges can be met under the current and prevailing generic socio-political and spatial framework in Egypt (Scenario workshop on the current and future socio-economic conditions for climate change adaptation organized by the authors and conducted in Alexandria in 2011)

[a]The stratified random sample selection of households focused on the degree of exposure within the area below sea level, type of settlement (rural/urban) and resource poor households. The standardized questionnaire included questions covering socio-economic parameters, perceptions of climate change related impacts, experiences of damage related to flooding, as well as factors reflecting households' attitudes towards resettlement

4 Results

4.1 Generic Socio-ecological and Spatial Context of Egypt (1)

Anticipating the future socio-ecological framework conditions is ultimately linked to Egypt's political and societal future, which is in the course of the Arab Spring context highly uncertain. The Arab Spring context was the result of a non-redistributive and highly corrupt authoritarian state regime. The state failed in its

role as a 'service provider' to its citizens through equity-based resource distribution, participatory decision-making, and law enforcement. 'Services' were only delivered and resources shared amongst the most influential groups – the private sector and extended family members within the regime. Consequently, long-term economic depression, as well as social friction between the disadvantaged majority and the private-political elites culminated in social unrest (Anderson 2011). This had led to the collapse of the Mubarak regime and to the reinstallation of an autocratic, military influenced government led by Al-Sisi. Hence, the societal-political development path that Egypt will follow in the future is highly uncertain, but suggesting to remain in authoritarian governance structures. If so, a path-continuing socio-ecological scenario is likely, in which past and current land use processes and trends tend to prevail.

Egypt ranks among the lowest in the world for the usability of its land. Only 3–5 % of its territory is habitable, and yet it is estimated that in the future more than 90 million people's livelihoods will depend upon this land (Ibrahim 1996). Expanding territories by reclaiming desert land is extremely difficult (Adriansen 2009). Thus, land in Egypt is a very limited resource and under pressure from different sectors for housing, economic welfare and sustainable livelihoods. Any further increases in population and subsequent intensification of demand for land use, together with the loss of arable territory to SLR will exacerbate land scarcity. As the same amount of people would have to live on a shrinking area of usable Egyptian territory, the need to compensate for the loss of formerly habitable productive territories puts an additional pressure on Greater Alexandria.

4.2 Sea Level Rise and Affected Terrestrial System (2)

SLR and storm surge are not new threats for the Nile delta and the Greater Alexandria area. From 8000 to 5000 BC the marine transgression had reached its maximum landward extent, as far as 10–20 km inland of former Lake Maryut and former Abu Quir lagoon (Sestini 1989; Vincent and Stanley 1987). They belong to the original setting of the Nile's estuary. The following historical maps from the nineteenth century show the spatial extent of these lagoons (Fig. 8.3).

Global scenarios forecasting SLR in the Mediterranean show high uncertainties with a variance of 50–140 cm until 2100 (Umgiesser et al. 2011; El-Raey et al. 1999). El-Raey et al. (1999) assume a SLR of 50 cm until year 2050, including 2.5 mm/year land subsidence. Frihy et al. (2010) analyzed the relative SLR from tidal gauges and found trends of annual 1.8 mm for Alexandria (1944–2006), and 3.4 mm for Abu Qir (1992–2005, equals 1.5 m in 2050) at the northern end of the Alexandria metropolitan area. These numbers include vertical land movements, which occur along the northern coast of Egypt.

These facts also contribute to the circumstance that 35 % of the Nile delta is below the mean sea level. Additionally, large parts of the Governorate of Alexandria (North-Western delta region) lie below sea level. They have been drained and

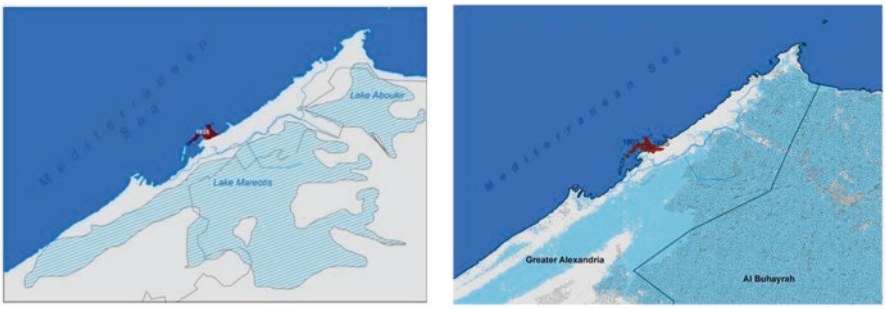

Fig. 8.3 Map 1: The size of Alexandria in 1905 and the location of old lagoons in nineteenth century (*left*) and 1 m bathtub = 1 m SLR (*right*)

reclaimed for agricultural use. Even today, hydraulic devices (such as the Abu Quir wall) keep the area free from water. However, in case of their failure, and without additional adaptation, extreme events and their effects, triggered by SLR, could lead to the inundation of the area below the sea level (The World Bank 2011). This scenario is even more likely if coastal erosion, submersion, and sand dune quarries erode natural and man-made coastal protection works. This can be seen through the sinking of the sea wall at the Rosetta promontory (El-Raey et al. 1999).

Recent studies suggest that SLR could reach up to 1 m during this century (Stocker 2013). Moreover, a warmer ocean is likely to intensify cyclone activity and heighten storm surges (Michaels et al. 2005; Knutson et al. 2001). Since there are large uncertainties associated with current SLR scenarios (Parry et al. 2007), our scenario construction does not reference a specific SLR case in Greater Alexandria, and uses a hypothetical scenario of 1 m SLR.

4.3 Vulnerability to Unemployment and Homelessness in the Context of Future Resettlement (3)

4.3.1 Exposure Trends to Sea-Level Rise and Exposed Social Groups

Most likely, the topographical depressions of Alexandria's hinterland (former lagoons of the Nile's estuary) will become future hotspots of social, economic and infrastructure exposure. Projections of prolonged unregulated urban growth of the coastal city into the agriculturally dominated low lying coastal hinterland is likely to further intensify exposure of populations. Land-cover changes reveal that since the 1960s rapid urbanization at the expense of agricultural land has occurred at an annual rate of 1,4 % (Azaz 2008; Salem et al. 1995). If the same rate continues in the future, by 2060 Alexandria's hinterland would become fully urbanized, a significant increase in exposure to SLR. Alexandria's population is extensively growing with an expected increase of 65 % to 6.8 million inhabitants by the year 2030

Fig. 8.4 Exposure of urban settlements to SLR: The Alexandria hinterland (east) with Lake Maryout in the front

(The World Bank 2011). Current trends show that the city expands from the slightly elevated city centre not only westwards but also into the SLR exposed rural hinterland from Lake Maryut to Abu Quir (Fig. 8.3).

Areas like the Abu Quir (formally Abu Quir lagoon), and areas near Lake Maryut are currently experiencing rapid urbanization (Azaz 2008). Consequently, Lake Maryut, which serves as a drainage instrument to compensate for Nile water level fluctuations is shrinking. In addition, water levels are silting, which leads to an increased risk of flooding. There is little evidence that further intensification of exposure will cease in these areas. Although efforts are made to redirect city growth to the west, weak law enforcement (e.g. land registration) and corruption causes uncontrolled and informal construction in Alexandria's highly SLR exposed hinterland (The World Bank, Arab Republic of Egypt 2007). Housing shortages for low and middle income groups in the not SLR exposed city centre area will further encourage low skilled wage workers to settle in the exposed east and south (as they need to live close to centres of employment) (Ibrahim 1996). Moreover, Bayat and Denis (2000) assert a growth of agro-towns and development of industrial towns as a result of urban centres growth saturation. Even on the basis of a 50 cm SLR scenario for the case of Alexandria in 2050, about 30 % of Alexandria's city area will be lost and over 1.5 million people will have to be relocated (Agrawala et al. 2004). Taking a 1 m SLR scenario, Egypt is considered as one of the top five countries in the world expected to be mostly impacted by SLR and storm surge in the world (Dasgupta et al. 2009).

The current livelihood condition of the highly exposed coastal population in Greater Alexandria is shown by assessing some key socio-economic characteristics. Two major social groups who are living in such trapped conditions can be identified. They are characterized based on income sectors and livelihood criteria outlined below:

- The most likely affected groups are coastal-rural and rural households living directly at the north-eastern coast of Alexandria along Abu Quir Bay. They are primarily either marine or lake fishermen, and live at the main entry points of SLR and storm surge inundation. Others are farmers living in Alexandria's hinterlands and close to the lake Edko (Figs. 8.4 and 8.5).
- The second exposed group lives in the direct urban environment of Alexandria (at the fringes of the city to the east), where the city's main area topography drops to sea level or even below.

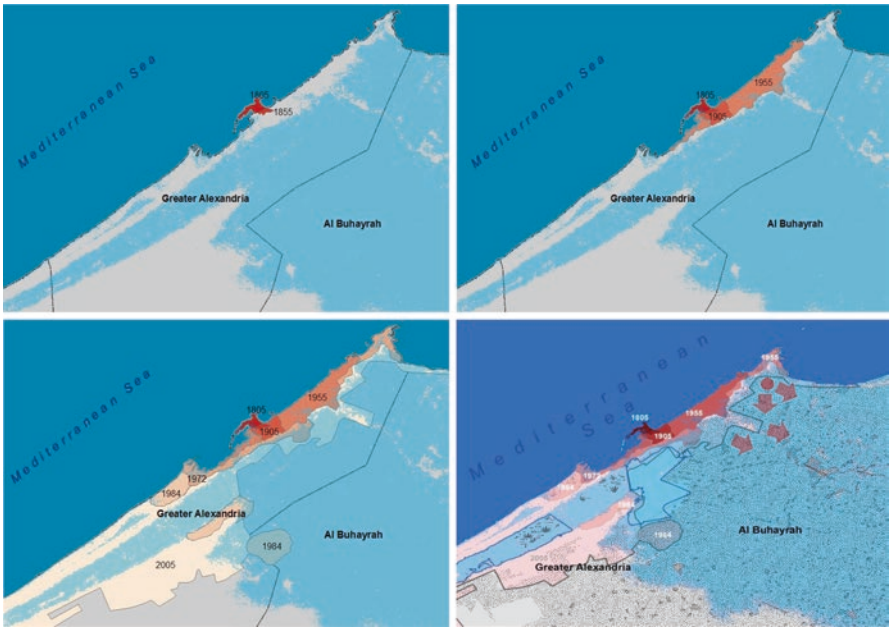

Fig. 8.5 The evolution of exposure to 1 m SLR in Alexandria from 1905 – and future trends (Source: own map based on data from National Authority for Remote Sensing and Space Sciences (NARSS) in Egypt and Department of Environmental Science at the Faculty of Science from the University of Alexandria)

Based on the standardized survey results, Table 8.2 shows the socio-economic living conditions of these two groups. They play a role in evaluating affected people's capacity to utilize their resources and to manage a safe resettlement.

The coastal-rural population is considerably more exposed to SLR; it has a good access to informal sources of financial capital, but lacks access to formal sources. Although these people have a relatively high degree of climate change awareness, they are less well educated. A large share of them depends on place-based ecosystem services related to farming. The implications of the social structure of the household sample for their vulnerability to unemployment and homelessness in the course of resettlement will be explored in the following sections. The figures show that many groups exposed to SLR in Greater Alexandria are trapped and have limited means to migrate themselves. Hence, planned resettlement programs initiated by the government are essential in order to facilitate resettlement and support these households.

4.3.2 Vulnerability to Unemployment

According to the results of the choice experiment conducted in 2012, affected groups prefer to keep their current employment rather than to work in other professional contexts (Kloos and Baumert 2015). This finding might correlate with the

Table 8.2 Exposed groups' socio-economic characteristics based on a household survey

Socio-economic characteristics		Values (%)	
Education	High school	20 (26,9 Egypt, 1996)	
	Diploma and Bachelor's degree	8 (5,7 Egypt, 1996)	
Monthly income (groups according to wealth ranks in Egypt, local currency has been converted in to US$)	<115 US$	59.99	
	115–330 US$	33	
	330–830 US$	5	
	830–2470 US$	2	
	>2470 US$	0.01	
Household size		5.45 (4,4 Egypt, 1996)	
Employment structure		**Rural/coastal**	**Urban**
	Agriculture, fishery	73	8
	Public services, trade, industry	27	92
Access to property	Lease	4	22
	Rent	2	15
	Own (certified)	95	65
Don't feel safe due to storm surge	Disagree very much	29	36
	Disagree	15	15
	Agree	14	20
	Agree very much	42	29
Belief in increase of storm surge	Disagree very much	20	40
	Disagree	8	10
	Agree	24	22
	Agree very much	48	29

Source: Own survey

fact that, based on the household survey conducted, more than 80 % of exposed households are exhibiting homogeneous employment structures with no family member working in a different sector (Fig. 8.6, left graph). Very few households have a more diversified employment structure, working in at least two sectors like agriculture and fishing, and one of the other economic sectors.

Moreover, the majority of households working only in one employment sector are engaged in farming or fishing, followed by a smaller share employed in the industry and the service sector (Fig. 8.6, right graph). Hence, most households have relatively limited capacities to flexibly enter various employment markets and instead prefer to reestablish their livelihoods with their income sector of origin.

Especially, agriculture-based and mono-structured income household livelihoods are the most vulnerable to unemployment when trying to re-enter the employment market after resettlement, as the sector specific labor force trends show that agriculture is suffering from a long-term decline (Fig. 8.7). Although agriculture employs the largest share of Egypt's labor force, the total GDP dropped continuously from roughly 39 % at the beginning of the 1970s to 13.99 % in 2010 (Herrera

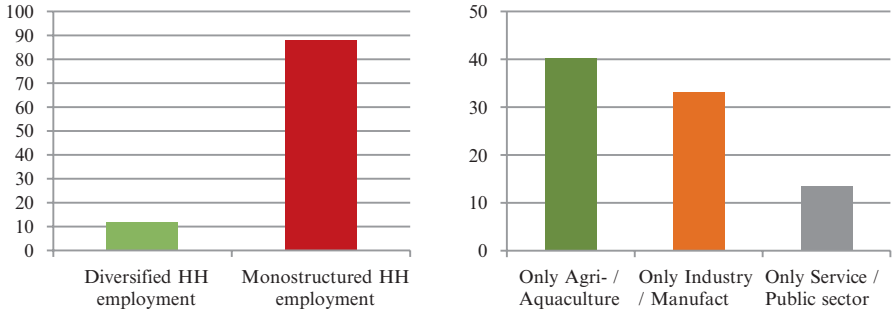

Fig. 8.6 Employment structure of exposed households to SLR in Egypt (*HH* = Household) (Source: Own survey)

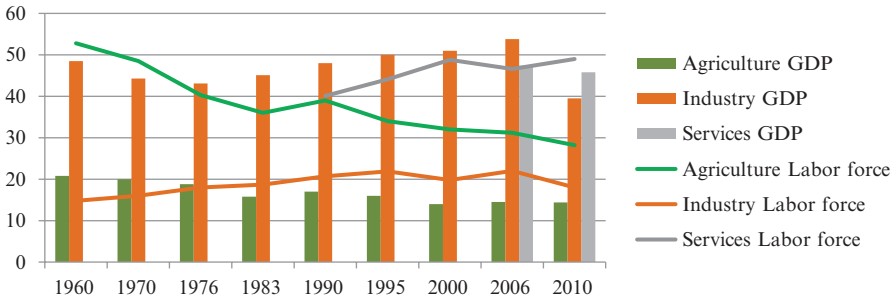

Fig. 8.7 Labor market and economic growth trends for different sectors (Own figure, Source: Central Agency for Public Mobilization and Statistic-CAPMAS)

et al. 2010). Strzepek and Yates (2000) forecast a further decrease of agricultural GDP to 6 %. Apart from the productivity problems Egypt lost nearly 1 Million ha of productive land suitable for agriculture, 395,000 ha alone between 1970 and 1990 (Elwan 2003). Reasons for this include rapid urbanization, infrastructure intensification and land degradation (salination, moistening, sanding). Urbanization is characterized by a constant growth of rural villages developing into towns (Elwan 2003) and settlement encroachment from large cities such as Alexandria into agricultural plains at the fringes of cities (Ibrahim 1996; Azaz 2008). This downward trend in the agricultural sector is likely to be even more aggravated under the conditions of SLR. Given a relatively low SLR of 0.5 m, it has been estimated that 195443 jobs are at stake, and that 4500 km^2 of agricultural land will potentially have to be abandoned. The loss of farmland means that in Greater Alexandria more than 10,000 farmers would lose their property and have to seek employment elsewhere, hampered by an environment of agro-economic decline and general land scarcity (El-Raey et al. 1999). Hence, a significant proportion of rural households with income that solely depends on agricultural production would be very much vulnerable to unemployment. These households are likely to drift into informal employment while trying to sustain their livelihoods during the course of resettlement.

In contrast to the agricultural sector, households employed in the industrial or service sector have a better chance of reintegrating back into their original area of employment. Although second ranked with regard to its contribution to Egypt's total GDP, the service sector is currently the most important labor absorbing sector, followed by the industrial sector (Fig. 8.7). Although, associated with high uncertainties (e.g., world economic development, current crisis associated with the Arab Spring), those sectors will likely to play in the future a major role in general GDP growth and labor demand, also a consequence of Egypt's economic policy (Rachid 2005). Hence, with a focus on industrial production and services, the area of Greater Alexandria will provide good labor market opportunities for the future. That is not to say that SLR will not influence job opportunities, particularly in the industrial sector, where, according to El Raey (1999), 151,000 jobs could be lost. This impacts specifically the area of Greater Alexandria, since much of the industrial production of Egypt is located in this region (up to 70 %), which is also exposed to SLR (El-Raey et al. 1999; Agrawala et al. 2004).

Nonetheless, a comparably better economic outlook for this sector, as well as the possibility of resettling industrial estates (which is not possible with agricultural land), might provide income security for households that already work in the industrial and service sector. But the city is already today at the limits of its carrying capacity for labor seeking people. Demographic trends partly explain the increase in labor supply as compared to demand. Egypt's increasing population and its age structure leads to a rising number of people in the productive ages (from 19,7 mill. in 1976 to nearly 45 mill. in 2006, CAPMAS[6]). The unemployment rate has been around 9 % during the last decade until 2011, and the crisis saw this figure rise to 12.4 % in January of 2012 (tradingeconomics, 2012[7]).

4.3.3 Vulnerability to Homelessness

According to Kloos and Baumert (2015), preferred resettlement programs are those which enable households to access privately owned housing of equal standard within established communities. This significantly increases the utility of a resettlement program as well as people's participation in it. In fact, the majority of surveyed households currently own their own property (Fig. 8.8), and would therefore be unlikely to accept being relocated without receiving at least equal property conditions within an environment they are familiar with (Kloos and Baumert 2015).

But today, and possibly in the future, considerable housing shortages will remain for low and middle income segments. 12–15 million people in Egypt have inade-

[6] CAPMAS (Central Agency for Public Mobilization and Statistic of the Arab Republic of Egypt). Population & Food in Egypt from 2001 to 2006. Available at: http://www.msrintranet.capmas.gov.eg/pls/educ/npopulation_e?lang=1&lname=FREE (last retrieval: 23.04.2015).

[7] Tradingeconomics.com: Industry; value added (% of GDP) in Egypt, and other data. Available at: http://www.tradingeconomics.com/egypt/industry-value-added-percent-of-gdp-wb-data.html (last retrieval: 23.04.2015).

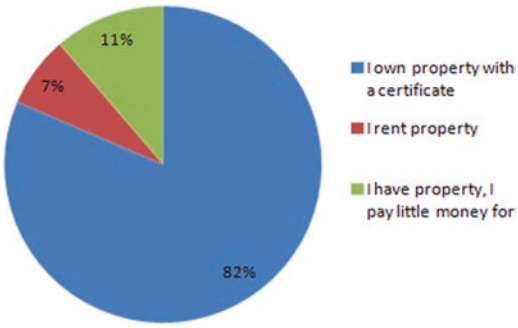

Fig. 8.8 Housing security of exposed households to SLR in Egypt (Source: Own survey)

quate access to housing (Jacobs and Madkour 2008). In Alexandria, 40 % of the city's population lives in squatted settlements (The World Bank and GOPP 2008), even though there remains a large proportion of vacant housing – 31 % alone in Greater Alexandria (The World Bank 2011). Several legal and institutional framework conditions strongly regulate the housing market and form the root cause of the mismatch between affordable housing supply and demand (Jacobs and Madkour 2008; The World Bank and GOPP 2008; The World Bank and Arab Republic of Egypt 2007). Inherited from the 'Arab Socialism' in the 1950s (Nasr's rule), the housing rental market is very small and non-flexible. Due to a law granting lifetime tenant protection, owners have little means to acquire personal use of their own houses. Moreover, legally fixed rental prices (which remain as low as in the 1950s) and high construction costs hamper investment in renovation as well as incentives for the development of a housing market targeting low and middle income groups. As a result, the only solution young families are left with is to buy a house. However, the real estate market is as small as the rental market. Additionally, due to a drastic increase in land and construction prices, which increased the marked value of properties, owners of newly-constructed real estate began using their properties as a monetary investment or for speculative purposes. Consequently, a huge level of vacant housing has emerged in Egypt. In addition, government-supported low-cost housing is very rare and unsustainable, while privately constructed low-cost housing has also been subject to speculative business practices by upper and middle class businessmen.

Hence, in absence of a rental and real estate market for affordable housing, along with a sea level rise, which would induce a drastic increase in the demand for housing, as well as the likely refusal of vulnerable groups to live in remote and newly-constructed settlements (Kloos and Baumert 2015), reveals the likelihood of increased vulnerability of SLR exposed social groups to long-term homelessness. The importance of meeting increasing demands for low-cost housing is currently already high, and will be even more pressing under conditions of SLR. Consequently, a significant growth of informal settlements that adds to the current trend of their increase could lead to various social problems: more poverty and social deprivation, exacerbation of human insecurity, crime and social unrest.

4.4 Resettlement Outcomes (4)

Using the identified potential vulnerability to unemployment and homelessness, this section will explore the socio-economic, socio-spatial and socio-political challenges associated with reducing these vulnerabilities through anticipatory resettlement planning. For the last step of the conceptual framework, an outlook on potential future resettlement outcomes for greater Alexandria will be provided.

4.4.1 Anticipated Resettlement Challenges to Ensure Employment and Housing Security (4a)

In the face of limited employment opportunities in agriculture, and at the same time a high demand for employment in this sector, options to reduce resettlement induced vulnerability to unemployment would include: increasing the overall productivity of the agricultural sector, expanding irrigation systems into the desert, transforming urbanization from space extensive to intensive development paths, limiting general population growth, or simply providing support for farmers' occupational retraining and improving levels of income diversification.

Policies to enhance the development of an affordable housing market to accommodate the huge existing demand and SLR induced increase in demand would include: liberalization of the tenancy law, including the cancellation of dismissal protection and fixed rent prices, as well as the development of a housing credit market system. Moreover, subsidies and incentives would be needed to allow for the implementation of affordable housing projects through public and private investment (Jacobs and Madkour 2008). The creation of a sufficient and affordable housing market today minimizes future resettlement costs for governments, and reduces homelessness vulnerability in the course of resettlement.

4.4.2 Anticipated Capacity to Meet Challenges and Resettlement Outcomes (4, 4b, 5)

The discussions on the scenario workshop in Alexandria (see methods) revealed a consensus amongst participants that the prevailing top-down political-economic governance structure needs to be transformed into a cooperative and equity based participatory governance system in order to facilitate a people-centered resettlement process. This would include a vast transformation of the current land use system in the course of resettlement of large groups evolving in a discursive and equity based cooperative process, and reducing the identified vulnerabilities by mainstreaming people-centered preventive resettlement policies into current development trends and agendas.

The outlined socio-political context in which resettlement might evolve draws a rather pessimistic picture. With the recent political developments in Egypt in the

aftermath of the Arab Spring, such a resettlement challenge could overburden the capacity of the prevailing governance system and potentially create social tension. Kloos and Baumert (2015) found that more than 20 % of surveyed and SLR exposed households were unwilling to resettle, irrespective of how the resettlement program was designed. The perception of the government as being an autocratic top-down decision making institution might have provoked such anticipated resistance. Furthermore, conflicts might emerge over contested land as a result of uncontrolled displacement and invasion of masses into safe areas, which might later become battlefields for scarce resources, such as water and land, and food security. These types of conflict are likely to increase vulnerability to loss of livelihoods and their long-term interruption.

5 Discussion and Conclusions

Although it is often considered as an option of 'last resort', preventive resettlement could become a realistic –and under some conditions – unavoidable adaptation option to SLR for many coastal zones. The objective of this chapter has been to develop a scenario approach that can be used to anticipate the conditions of regions under which such adaptation to specific risks and vulnerabilities are likely to emerge in the future. As the case study on Greater Alexandria has shown, SLR induced preventive resettlement can lead to a severe disruption of social groups' livelihoods, as they are vulnerable to displacement, unemployment, and homelessness; given – and depending on –the magnitude of exposure, and the capacity of the generic socio-ecological and spatial fabric within an area of concern to meet social groups' resettlement preferences and needs.

The case of Greater Alexandria, representing similar conditions in coastal zones around the world and particularly in developing countries, has shown that the issue of preventive resettlement requires already much more attention at national and international policy levels in the present moment, and that governments should not delay until resettlement becomes a matter of urgency. Thereby, much more effort is needed for current policies to meet future SLR induced resettlement challenges. For example in Alexandria, to enhance adequate access to housing of resettled groups in the course of large-scale resettlement potentially occurring in the future, current policies should address the lack of adequate housing for low and middle-income groups. This also applies to other sectors such as employment, land-use, public and social infrastructure. Hence, mainstreaming SLR induced resettlement challenges into current sector-specific development policies helps to resolve development problems, both now as well as those associated with SLR induced resettlement in the future.

The results and the approach and methods used for constructing an adaptation option, specific (here resettlement) risk and vulnerability scenarios are useful for policy making because they address a specific policy or adaptation challenge guided by the question: what would be the possible future adaptation induced vulnerabili-

ties and risks if climate change adaptation had to be accomplished today. Such types of scenarios integrate hypothetical climate change projections with the knowledge and analysis of today's socio-ecological and development conditions. Except for projecting future climate change conditions, such a scenario approach is built on real – and not hypothetically constructed – data based on a selected framework, such as the resettlement framework used in the case study. In this way, it raises awareness about current problems related to a likely future adaptation challenge could help to promote the design of corrective policies conducive for meeting adaptation challenges in the future. The scenario construction could be a useful tool to regularly monitor resettlement requirements, and to provide guidance for resettlement policies within changing socio-ecological framework conditions by combining projections and real-world data.

The framework and scenario technique have proven to be very useful for detecting future risks. However, depicting the complexity of livelihood risks in a resettlement process is still challenging, especially when attempting to cover all resettlement assets and their influencing variables as captured in the framework. The reliability of the outcomes of the scenario-based assessment depends strongly on the collection of and access to good-quality data from different disciplines, and an in-depth understanding of people's preferences and needs. Lack of data and inherent methodological challenges in analyzing people's preferences are potential shortcomings of this approach. Furthermore, since it is important to conduct such local level assessments in different regions, future research should target a larger scale, applying indicator based assessments to better compare preventive resettlement challenges between different parts of the world.

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Chapter 9
Consumption, Climate Change and Human Security: Targeting Consumer Groups for the Mitigation of Climate Change in India

Madhumati Dutta

Abstract The production of man-made goods for satisfying basic as well as extra-basic needs is endangering human security by causing climate change. When determining policy for the mitigation of climate change, there is a tendency to target production and producers. An alternative approach may be to look at consumption, and gear policy towards changing what consumers wish to purchase and consume. As India 'develops' in terms of a rapidly increasing GDP, it has also become the third highest emitter of Carbon Dioxide. Indians are consuming more, not only in aggregate but also on a per capita basis. Therefore, while it is well recognized that the rise in population contributes towards raising total consumption and greenhouse gas emissions, it must also be conceded that individual consumption behavior, because it impacts per capita emissions, requires the attention of policy makers. The objective of this research is to see how the quantity and composition of the average Indian's consumption of goods and services has changed in the past two decades, and whether there are differences in consumption behavior based on rural or urban residence and on expenditure class. The changes and the differences have implications for emissions of greenhouse gases. Identifying them, therefore, helps the policy maker to locate the products as well as the consumer groups that need to be targeted.

Keywords Consumption • Expenditure • Climate change • India • Policy

1 Introduction and Objectives

If the objective of economic growth is to enhance the well-being of the human race, this can be achieved, from a narrow perspective, by increasing the quantity or diversity of man-made products available for consumption. It may even be recognized

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that at least some of these products do contribute towards enhancing human security. In recent decades, however, it is becoming increasingly evident that this limited conception of human needs may actually endanger human security, where the term 'security' encompasses the most basic requirements of human existence, including, in the context of the present volume, a compatible environment. In other words, to be secure, the need to have a natural environment that one can live in is at least as important as all other products, if not more so.

Of the various qualities of the environment, the earth's climate is arguably the most critical factor that currently endangers human security. In this chapter we confine ourselves to the objective of mitigating climate change, and hence the greenhouse gases that cause it, while recognizing that the production of goods and services has a detrimental effect on many other components of the environment. The technological approach towards ending the conflict between material goods and climate change would be to move away from fossil fuels and increase fuel efficiency. These would, in effect, eliminate the conflict. At the present moment, however, there are limits to either. We, therefore, cannot ignore the option of taking a good look at whether we can change what is being produced, in order to change its effect on climate.

One may approach the problem of increased emissions of CO_2 and other greenhouse gases from the perspective of production and producers; however, if production is for the ultimate satisfaction of consumers of final goods and services, one can alternatively look at household consumption. The rise in household consumption may either be due to a rise in population, or due to a rise in per-person consumption. If it is the rise in population that has solely caused the rise in total consumption, policy remains confined to reducing the net birth rate. But a look at real per capita consumption figures indicates that in many countries, per-person consumption has been steadily going up (Euromonitor International 2013). This, in turn, has caused per person emissions to also rise. Whilst a 'minimum' quantity and range of material goods may be necessary from the point of view of human security, such as a healthy diet and comfortable shelter, it is quite possible that for many, this 'minimum' has been exceeded. Further, many products may have substitutes that require less emissions for their production or use. It is thus possible that changing the quantity as well as composition of the consumption basket may lead to a net rise in human security if lower emissions of greenhouse gases are accompanied by a rise in the well-being that is derived from consumer products.

In this chapter, the focus is made on the quantities and composition of consumer goods used by the individual Indian consumer, and its implications for policies to mitigate climate change. India is a rapidly growing country, despite the global recession in recent years, and now holds third position in terms of total GDP.[1] Unfortunately, it also ranks third in terms of total carbon dioxide (CO_2) emissions. Although India's position in terms of per capita emissions of CO_2 is quite low (ranked 145), indicating that in India population is an important determinant of total

[1] Using the Purchasing Power Parity (PPP) method.

emissions, it is also true that in recent years per capita emissions have been growing rapidly.[2]

A major contribution to the field of consumption behavior and its carbon footprint comes from scientists who are exploring the relative carbon footprints of specific consumer goods including various food categories (Carlsson-Kanyama 1998; Carlsson-Kanyama and Gonzalez 2009; Kim and Neff 2009; Hertwich and Peters 2009; The Washington State Department of Ecology 2007). Social scientists, too, are looking at the role of the consumer in climate change. Some of them explore the political economy of consumerist growth led by the middle classes in developing countries, who are influenced by the state as well as entrepreneurs to consume more (see articles by Reusswig and Isensee, Fernandes, Katz-Gerro and Chua in Lange and Meier 2009). For India, similar studies have been done by Padukone (2010) and Sanwal (2012). Others have begun to take a closer look at the reasons behind changes in consumption over time in the context of global warming (Dietz et al. 2007; Parikh and Parikh 2002; Hertwich and Peters 2009). Although they identify population and household consumption as the two main drivers of environmental impact, they also tend to think that these cannot be contained, so that climate change mitigation policy has to centre on technological solutions.

Data-based research on household consumption in India and its implications for climate change is somewhat limited. Rather, there is some literature on consumption and its determinants which can be useful, though it does not touch upon carbon impacts (ICMR 2007; Gangopadhyay and Wadhwa 2004; Rao 2010; Pachauri 2007). The most concrete analysis of the connection between consumption and climate change in India remains the paper by Murthy et al. (1997), where they connect consumption behavior amongst certain classes of Indian consumers and the resultant carbon emissions. They thereby estimate average emissions per capita in 1990 and project what it will become in 2020. By exploring scenarios of technology improvement, they, too, indicate that technological efficiency is the only way forward. My research, therefore, carries this enquiry forward, looking in some details at consumer expenditure in the 20-year period of 1987–1988 to 2007–2008. However, the presumption in this research is that policies to reduce carbon emissions can target household consumption behaviour, and in fact the focus of this research is the individual consumer.

More specifically, the objective of this research is to see how the quantity and composition of the average Indian's consumption of goods and services – mostly represented by real monthly per capita household expenditure (MPCE) – has changed in the past two decades, and whether there are differences in consumption behavior based on rural or urban residence and on expenditure class.[3] The changes

[2] The increase has been from 0.8 metric tons in 1990 to 1.1 metric tons in 2000 (38 %), and to 1.4 metric tons in 2009 (an increase of 75 % since 1990). Further, it is expected to reach a range of 2.77 to 5 metric tons by 2031 (mongabay.com 2006; UN Statistics Division 2012; CDIAC 2012; Report of the Swedish Ministry of Environment 2009).

[3] There may be other kinds of grouping of consumers on the basis of age, education and profession. Other studies, however, indicate that in developing countries age is not important in consumption

and the differences have implications for greenhouse gases emissions, and therefore, if the Indian state wishes to limit average emissions, without confining itself to technological solutions, it has to direct policy towards maneuvering this consumption behavior in an environment-friendly direction. Identifying the changes and differences, therefore, helps the policy maker to locate the products as well as the consumer groups that need to be targeted.

2 Changes Over Time

That India has become more responsible for carbon emissions, not only because its population has increased, but also because each Indian, on average, is consuming more, is evident if we look at the growth of real MPCE (Table 9.1). We see that between 1987–1988 and 2007–2008, it has increased by 24 % in rural India and 46 % in urban India. Not only are Indians spending more, but the composition of their expenditure has changed. Table 9.2 shows the steady decline in the share of real expenditure on food between 1972–1973 and 2007–2008. Hence, if the emission of greenhouse gases is greater for the production and use of non-food items like fuel for cooking and lighting, transport, buildings and durables (see Table 11.1 in IPCC 2007, 627 which implies this), this shift in the composition of expenditure over time implies an increase in carbon emissions in excess of that implied by the increase in MPCE per se.

Looking at individual food items, the consumption of cereals has declined, whilst the consumption of milk, meat, eggs and fish (with the exception of goat meat) as well as of almost all vegetables and fruits has increased (NSS Report No. 530, Tables 7U and 7R, pp. A22–A23). Hence, amongst foods, the greater importance of non-cereals, and especially of animal and dairy products, may indicate a better standard of food consumption, but it also indicates a greater use of natural resources, and hence a higher carbon footprint (Carlsson-Kanyama and Gonzalez 2009; Kim

Table 9.1 Growth in monthly per capita expenditure (MPCE) in India at constant prices, 1987–2008 (rupees)

Year						
MPCE	1987–1988	1993–1994	2004–2005	2005–2006	2006–2007	2007–2008
Rural	158.10	162.56	181.56	186.99	192.03	196.16
Urban	249.92	268.38	326.80	329.75	345.39	364.11

Source: NSS Report No. 530, p.16
Base Year: 1987–1988

decisions, and there are conflicting evidences on education and profession (Wodon 1999; Dietz et al. 2007). Moreover, the National Sample Survey provides data on the first two categories (class and rural/urban location) only.

Table 9.2 Shares (Percent) of real MPCE between food and non-food, rural and urban, 1972–1973, 1987–1988 and 2007–2008

Product category	Rural			Urban		
	1972–1973	1987–1988	2007–2008	1972–1973	1987–1988	2007–2008
Food	73	64	52	64	56	40
Non-food	27	36	48	36	44	60
Total	100	100	100	100	100	100

Source: NSS Report No. 530, Tables 8R and 8U, pp. A24-A25, and NSS Report No. 508, (ii)

and Neff 2009). Trends amongst the non-food items also indicate a higher carbon footprint of the average Indian. Expenditure on most non-foods has increased, but their relative shares have changed. The real MPCE on fuel and lighting as well as on miscellaneous goods and services (which includes education, medical care, rents and taxes) has, between 1987–1988 and 2007–2008, increased substantially, whilst that on clothing and footwear has increased only marginally. For durables, the increase is moderate. Further, we see an increase in the expenditure on bicycles in rural areas and in motorcycles, scooters, cars and jeeps in urban areas over 1987–2000 (NSS Report No. 530, Tables 7R and 7U, pp. A22-A23, NSS Report No. 461, Statements 1R and 1U, pp. 25, 29). Hence, even within the non-foods, the trend towards greater use of energy and motorized transport compared to other consumer goods also indicates a higher emission of greenhouse gases.

I now look in greater detail at four expenditure groups – energy for cooking, energy for lighting, durables and housing. The choice of these four groups has to do with their importance in terms of the resultant emissions of greenhouse gases, as well as with the availability of data.

2.1 Energy for Cooking or Lighting

Data on energy use for cooking or lighting is largely given (by the NSS) in terms of the percentage of households that use specific types of energy. When this data is used to track consumption over time, there may be an implicit presumption that the per-person use of energy for cooking or lighting remains the same over time. But in fact real MPCE on fuel and lighting in rural India increased from Rs. (Rupees) 11.77 in 1987–1988 to 19.29 in 2007–2008, and in urban India from 16.72 in 1987–1988 to 31.27 in 2007–2008. Prima facie, there does not seem to be any reason for a significant increase in cooking per person, but it may well be the case that energy used for lighting by the average Indian has increased over time, as the use of lighting, especially in the rural areas, was, in the early phase of the time period under consideration, very limited, especially in the rural areas. Hence, even if the composition of fuel sources had remained the same over time, emissions would have

increased. This needs to be kept in mind in the following discussion on changes in the composition of fuel types used by households (particularly for lighting) before arriving at any conclusions.

Firewood has been the dominant cooking fuel in India, and it remains so, especially in rural areas, although the importance of liquid petroleum gas (LPG) has grown steadily. Between 1987–1988 and 1993–1994, households using LPG went up by 2 % and kerosene by 1 %, whilst households using 'firewood and chips' (which we shall henceforth call firewood) declined by 3 % (derived from highlights given in NSS Report No. 410/2, 1997b, 1). Another report shows that between 1999–2000 and 2004–2005 the use of LPG has gone up by 13 % whilst the use of both kerosene and firewood has declined by 12 % and 1 % respectively (NSS Report No. 511 2007, i). Hence, there has been a reversal over time in the trend for kerosene with a significant drop in its use, whilst the (increasing) trend for LPG has accentuated. The use of firewood has not really changed significantly, mainly because of its continued dominance in rural areas.

Table 9.3 provides data on carbon emissions for certain types of fuel. It indicates that coal and wood cause similar quantities of emissions per kilowatt hour of use, kerosene emits significantly less, and gas (including LPG) emits the least. Hence, in terms of energy use for cooking, India has become more environment friendly in terms of the composition of fuel used for cooking. If we assume that the average quantity of energy used to cook for one person has remained the same, we can also conclude that the per-person emissions due to cooking have also reduced.

By 2007–2008, electricity and kerosene together served 99 % of the households as the primary source for lighting in both rural and urban areas (NSS Report No. 511 2007, ii). Between 1987–1988 and 1993–1994, there has been an increase in the proportion of households using electricity for lighting by 13 % (24–37 %) in rural areas and 9 % (72–83 %) in urban areas. In 1993–1994, kerosene remained the main source of energy for lighting in rural India. But there has occurred a decline in the percentage of households using kerosene (74–62 % in rural and 27–16 % in urban areas) since 1987–1988 (Report No. 410/2, highlights and Chapter 4).

By 2004–2005, kerosene no longer remained the main source of lighting in rural areas, and became insignificant in urban areas. There has been an increase in the proportion of households using electricity as the major source of lighting by 7 percentage points (from 48 to 55 %) in rural areas and by 3 percentage points (from 89 to 92 %) in urban areas between 1999–2000 and 2004–2005. In the same time period, there was a drop in the percentage of households using kerosene as the primary source of energy for lighting from 51 % to 44 % in rural India, and from 10 % to 7 % in urban India, since 1999–2000 (NSS Report No. 511, ii).

This clear dominance of electricity as a source of lighting has certainly implied a decline in local emissions of harmful gases, but the resultant (per person) global emissions of CO_2, if we accept the emissions data on different fuels (Table 9.3), are more. Moreover, if we add to this the fact that for lighting, energy use per person has gone up, the emissions per person are even greater than what is implied by the change in composition of fuel source.

Table 9.3 CO_2 emissions by fuel type (grams/kwh)

Fuel name	Emissions
LPG	240
Kerosene	260+
Coal/Electricity	370/370+
Wood	390

Source:www.engineeringtoolbox.com

Table 9.4 Percentage of households possessing various durable goods, rural and urban, 1993–1994 and 2000

	1993–1994	1993–1994	2000	2000
Item	Rural	Urban	Rural	Urban
Bedstead	68.7	74.3	79.1	81.8
Radio	26.8	41.8	30.4	35.1
TV/VCR/VCP	7.0	40.5		
TV			18.7	59.5
VCR/VCP			0.5	3.7
Tape recorder/CD player	5.2	21.6	9.1	27.8
Electric fan	15.9	56.6	26.3	68.5
Air cooler/AC	0.5	6.4	1.7	10.9
Clock/Watch	31.1	58.6	38.9	60.4
Bicycle	32.7	37.1	40.5	39.0
Motor cycle/Scooter	2.1	11.6	4.5	18.4
Refrigerator	0.9	12.3	2.7	22.9
Washing machine	0.2	4.1	0.6	8.9
Stove (Pressure/Wick)	16.2	54.3	27.3	61.8
Pressure cooker	7.4	39.6	13.1	49.6
Sewing machine	5.6	18.4	7.4	20.3

Source: Derived from NSS Report No. 426, pp. 14, 15 and NSS Report No. 461, Tables 5R and 5U, pp. A-468 and A-501

2.2 Durables and Dwelling Units

There has, in general, been a rise in MPCE (for purchase as well as for maintenance) on durables such as bicycles, televisions, furniture, motorcycles, cars, tape recorders or CD players, utensils, stoves, electric fans and clocks and watches (NSS Report No. 426, pp. 29–30, NSS Report No. 461, Statements 1R and 1U, pp. 23–29). In certain cases, as for motorized vehicles, the rise is very steep. Although detailed data on durables is not available post-2000, it may be reasonable to expect that this trend has continued. Similarly, the percentage of households possessing specific durables has in general increased, sometimes significantly, between 1993–1994 and 2000 (Table 9.4), except in the single case of radios in urban areas, which may have occurred because the television has replaced it.

Table 9.5 Dwelling units by type, percentages, rural and urban

Type of dwelling unit	1993–1994 rural %	1993–1994 urban %	Change since 1987–1988 (Rural)	Change since 1987–1988 (Urban)	Change until 2007–2008 (Rural)	Change until 2007–2008 (Urban)
Katcha[a]	33	10	−16	−8	−14	−7
Semi-Pucca	38	20	+6	–	−7	−11
Pucca	29	70	+10	+12	+21	+18

Source: Report No. 410/1 (highlights), and Report No. 530, 32/33
Katcha dwellings are made with natural materials and pucca houses are made with industrially produced inputs

In the period 1987 to 2008, the number of katcha houses (made with natural materials) has fallen steadily, whilst the number of pucca houses (made with brick, cement, steel etc.) has increased, the increase being much more pronounced in recent years. On the other hand, the number of semi-pucca houses increased until 1993/4 and decreased after that (see Table 9.5). It appears that by the end of the first decade of the twenty-first century, pucca houses dominate the scenario.

If we consider the materials that go into the production of katcha and pucca houses (Industrial and Economic Planning Division of TCPO, 118) it may be deduced that the latter, for the same floor area, causes much more carbon emissions, as their production is very energy intensive, whilst the former are by-products of agricultural production or non-timber forest produce.[4] We can then deduce that this pronounced shift in the direction of pucca houses has vastly increased carbon emissions from dwelling units.

3 Rural Urban Differentials

I wish to see whether rural-urban location is, in actuality, an important determinant of consumption behavior in India, and to identify the differences. As we have already observed, the increase in real MPCE has been far greater in urban compared to rural India (Table 9.1). Whilst the MPCE in rural areas was a fraction of that in urban areas (63 % in 1987–1988), this fraction has only declined over time (54 % in

[4] This should be true even if the katcha houses require greater maintenance, with regular replacement of some of the materials, because most of these materials are normally collected from forests and other areas surrounding the houses, and are renewable.

2007–2008).[5,6] This clearly implies that the consumption habits of a rural resident, on average, causes less global warming compared to his urban counterpart, and the difference has only increased over time.

Moving on to categories of expenditure, Fig. 9.1 gives the break-up (by item groups) of MPCE in rural and urban areas in 2007–2008. We see that (a) urban MPCE is greater for both the food and non-food components, compared to rural, and all individual components (whether in the food or non-food categories) are greater in urban India, (b) on the other hand, MPCE on food as a percentage of total MPCE (52 %) is greater in rural India and MPCE on non-food items as a percentage of total MPCE (61 %) is greater in urban India, and (c) within the category 'food', all components (in terms of percentage of total MPCE) are greater in rural India, except for fruit and the category 'beverages, refreshments and processed foods', whilst within non-foods, some components[7] (in terms of percentage of total MPCE) are greater in rural India, others[8] in urban India.

Therefore,[9] while we can clearly pinpoint the greater carbon footprint of urban Indians on the basis of MPCE, as well as the food/non-food components of MPCE, looking at the components within the food and non-food categories does not, per se, give us any clear indications.

3.1 Energy for Cooking and Lighting: Rural Urban Differentials

As already discussed, data on energy use is largely given (by the NSS) in terms of the percentage of households that use specific types of energy. Therefore if we wish to obtain information on the (per capita) responsibility in terms of product use, we need, in addition, data on average use per person. MPCE on fuel and lighting in 2007–2008 is Rs. 75 in rural areas and Rs. 126 in urban areas (NSS Report No. 530,

[5] It may be questioned whether we can compare rural and urban consumption levels with the help of MPCE, as there may be differences in rural and urban prices. NSS data on prices in rural and urban areas (Deaton 2008, 47) indicates that prices in urban India are on average higher by only about 7 % (2004–2005), with the difference being much lower for food items (2.4 %). One can therefore take MPCE differentials to reflect consumption differentials, except in cases where the differentials are very minor. It should, however, be conceded that if one corrects the MPCE for prices to get real consumption, the rural consumption would be marginally greater, especially for non-foods.

[6] Several factors, such as the marked difference in per-person GDP, in addition to the absence of demonstration effects, the lack of access to products (or types of products) and the lesser need for certain products in rural areas, may be the reason behind the lower MPCE in rural India.

[7] Pan (betel leaf, an intoxicant), tobacco and other intoxicants, fuel and light, clothing and footwear and medical expenses.

[8] Education, conveyance, consumer services excluding conveyance, miscellaneous goods and entertainment, rent, taxes/cesses and durable goods.

[9] Assuming that food production causes less emissions compared to non-foods (IPCC 2007, 627).

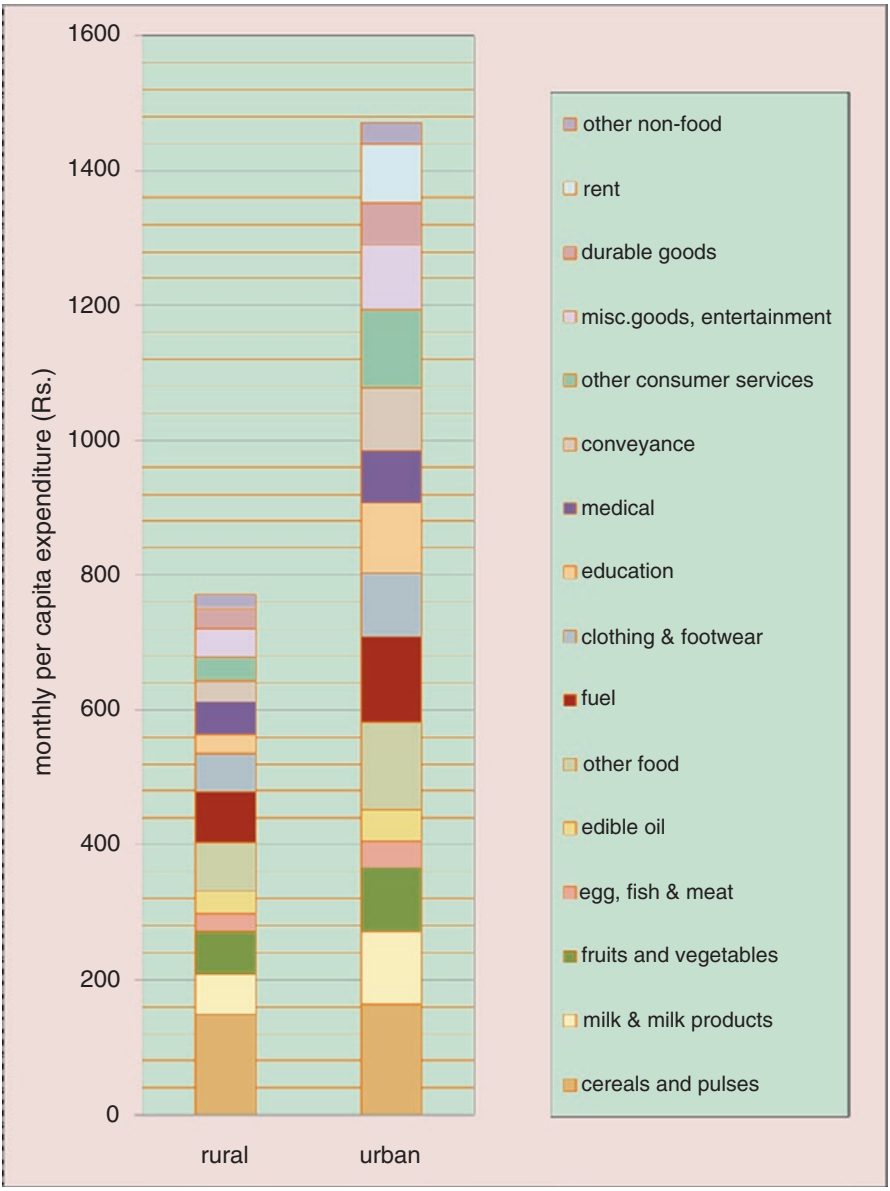

Fig. 9.1 Break-up of average rural and urban MPCE, 2007–2008 (Source: NSS Report No. 530, p. 20)

Table P5, p.19): Thus there is a vast difference in the energy used for cooking and lighting combined in rural and urban areas, with urban energy use being greater by a multiple of 1.68. However, it is possible that the difference is caused by the lesser use of lighting in rural areas; we can at least say that it is not clear whether this difference holds for cooking fuel as well as for lighting individually.

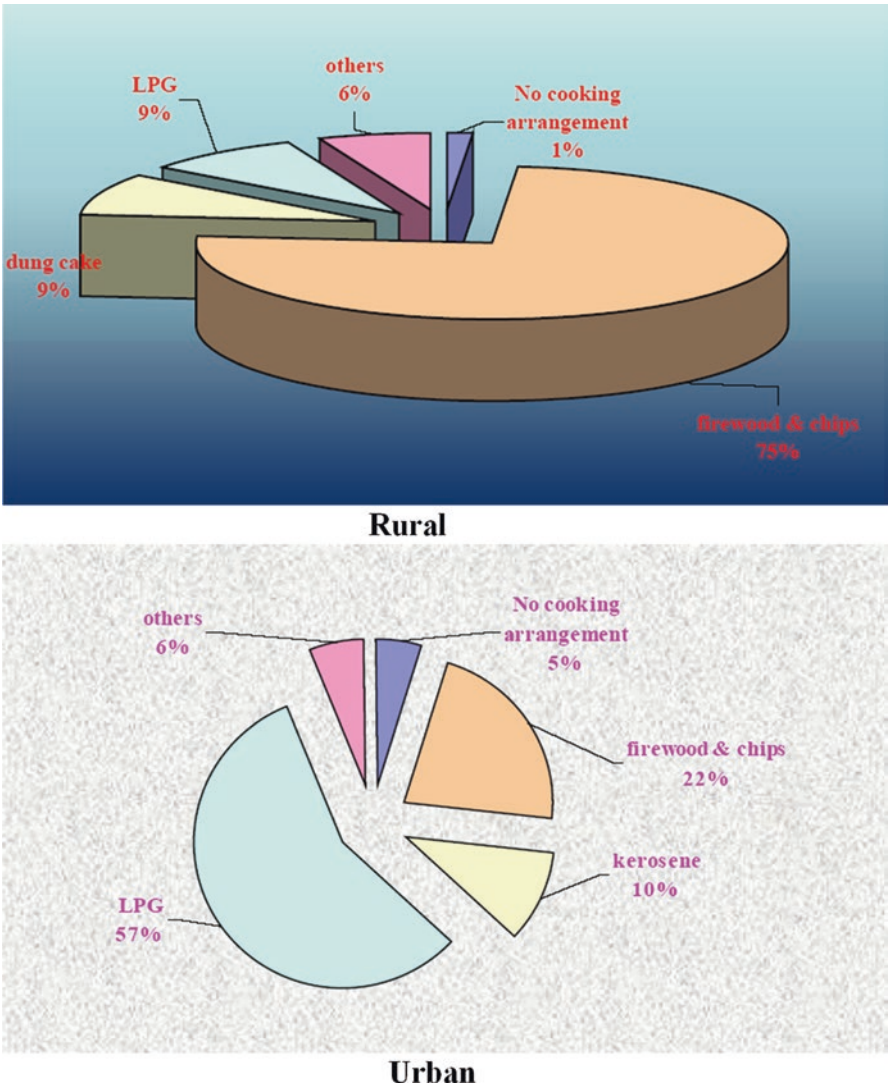

Fig. 9.2 Distribution of households by primary source of energy used for cooking, rural and urban India, 2004–2005 (Source: NSS Report No. 511, pp. 8–9)

Figure 9.2 presents the percentage distribution of households by primary source of energy for cooking in rural and urban areas in 2004–2005. It shows that in rural areas, there is a huge dependence on firewood, whilst dung cake[10] and LPG have a small and equal presence. In urban areas, LPG dominates, but there is also a signifi-

[10] Dried cow dung.

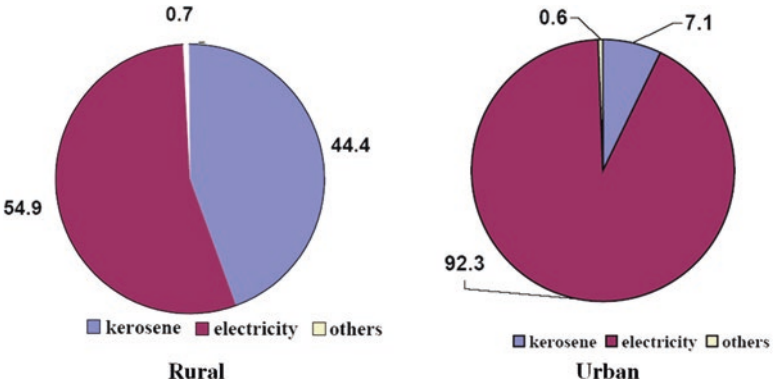

Fig. 9.3 Distribution of households by primary source of energy used for lighting, rural and urban India, 2004–2005 (Source: NSS Report No. 511, p. 13)

cant dependence on firewood. Kerosene at 10 % is a low third even in urban areas, whereas its presence in rural areas has become insignificant.

Hence, using Table 9.3, which gives carbon emissions for various sources of energy, we can deduce that the nature of energy use makes rural households more responsible in terms of carbon emissions. As it is not absolutely certain whether the per-person use of energy for cooking is less in rural versus urban areas, we can at most say that there is a possibility that this rural (per capita) responsibility may be somewhat less than is concluded from the percentage distributions.

Figure 9.3 provides a clear picture of the difference between rural and urban India in terms of energy used for lighting in 2004–2005. Whilst kerosene has a presence in rural India, it has already gone below the halfway mark. Its use is very unimportant in urban India where 92.3%of households use electricity for lighting. If, in terms of carbon emissions, kerosene is better than coal (Table 9.3) which, in India, is by far the most major source of electricity, this indicates that for lighting rural India is in a better position compared to urban. The rural (per person) responsibility would be even less if we factor in the strong possibility, supported by the discussion at the start of this section, that per person use of energy for lighting is less in rural versus urban India.

3.2 Durables and Dwelling Units: Rural Urban Differentials

There is a significant difference in MPCE on durables between rural and urban India – in fact, in urban areas it has been around double (usually more) that in rural areas. Further, the difference is far greater for electronic or fuel-using goods like the television or motor car. In terms of MPCE, the motorcycle or scooter and TV/VCR/VCP were the most important durables for urban India, whilst bicycles occupied that place in rural India (NSS Report No. 426, pp. 29–30 for 1987–1988 and 1994–1995, and NSS Report No. 530, Table P5, p.19 for 2007–2008).

Table 9.6 Dwelling units by type, percentages, rural and urban, 2007–2008

Type	Rural (%)	Urban (%)
Katcha	19	3
Semi Pucca	31	9
Pucca	50	88

Source: Report No. 530, 32/33

It is clear that the rural-urban difference lies far more in the percentage of possessor households (Table 9.4), rather than the average number possessed by the possessor households. The percentages are nearly all substantially higher in urban areas. The difference is particularly wide for electronic/motorized goods like the television, the refrigerator, the motorcycle/scooter, and even electric fans. The percentages are closer for products like bedsteads and bicycles, and in 2000 the difference has come down significantly for radios. On the other hand, India's relative under-development implies very low holdings of durables. For a vast number of durables, the average number possessed by a possessor household (in 1993–1994) varies from 1 to 3 and is usually around 1 in both rural and urban areas. The possession of electronic goods (for those who do possess them) is close to 1 for all such goods except electric fans, and even for fans it is less than 2 in both rural and urban areas (NSS Report No. 426, 24, 26).

Thus, if we concede that amongst durables the production and use of electronic and motorized goods causes much more global warming compared to the production and use of other durables, urban India becomes a far greater culprit. At the same time, it is heartening to observe that the tendency to possess more than one of a particular item is low in both urban and rural areas. Also, given that the use of bicycles (which cause zero emissions during use) implies the non-use of motorized vehicles, their significant presence and increased use in both rural and urban areas is a good thing.

The domination of pucca and semi-pucca houses (97 % in 2007–2008) in urban India makes it, once again, more responsible than rural India in terms of the nature of dwelling units and its implied carbon emissions (see Table 9.6). However, the percentage of pucca dwellings in rural areas (50 % in 2007–2008) is not at all small. Moreover, the average covered area is greater in rural compared to urban areas (52 versus 47.2 square metres per household) – this may be due to the significantly lower cost of land in the rural areas. Hence the responsibility of the rural areas in terms of carbon emissions due to housing is not insignificant.

4 Class Differences

I now investigate whether there are also clear differences in per capita consumption behavior, as a whole and in terms of individual components, between classes. The NSS divides up the population into decile classes on the basis of MPCE (see NSS Report No. 530, Table P2, p. 14 for details). The way that the shares of various

Table 9.7 Directions of change in shares of MPCE for consumption categories with a rise in expenditure class, 2007–2008

Consumption category	Direction of change	Comments
Cereals	↓	Steep decline
Pulses		Steep decline
Vegetables		Steep decline
Edible oils		Steep decline
Fuel/light		Mild decline
Clothing/footwear		Mild decline
Processed foods	↑	Mild increase
Education		Increase steep after 7th decile
Medical care		Increase steep after 9th decile
Conveyance		Steep increase all through
Other consumer services		More steep after 8th decile
Durable goods		Mild increase until 9th decile and then steep
Milk and milk products	↑↓	Maximum reached for 6th (urban) and 9th (rural) deciles

Source: NSS Report No. 530, pp. 26–28

groups of consumer goods in MPCE change with MPCE class in 2007–2008 is given in NSS Report No. 530 (pp. 26–28). Whilst the graphs vary for rural and urban India, the general trends are largely similar. These trends are summarized in Table 9.7.

In terms of shares in expenditure, therefore, the fact that food and in particular the staples become less important with higher MPCE and conveyance and durable goods become more important, point towards consumption habits that cause greater damage in terms of carbon emissions amongst the more affluent. The remaining product groups do not, per se, give any clear indications. Compared to cereals and pulses, both milk/milk products and processed foods (which largely rise with expenditure class) may be expected to have greater carbon impacts. The facts that fuel, lighting and clothing/footwear become less important amongst the affluent as proportions of expenditure perhaps has to do with the fact that they are relatively more 'basic', with a minimum essential quantity required for most classes. Their mildly reduced importance, coupled with the greater expenditure on education, medical care and other consumer services for the upper classes perhaps reduces their responsibility in terms of carbon emissions.

There are, therefore, two reasons why the carbon footprint increases as we move up the class ladder. One is the fact that, for a higher class, the average individual spends more on just about everything, and the other is the fact that the composition of expenditure shifts towards products that cause more global warming.

4.1 Energy for Cooking and Lighting: Class Differences

The observations regarding using data on household percentages made prior to discussing rural-urban differences (Sect. 3.1) holds for my discussions on class differences. Comparing these differences over classes would require considerations regarding the average quantity of use by a household in each class. Once again, this should vary, especially in the case of lighting.

In the rural areas, the use of firewood (in 2004–2005) is high over all classes, but drops for the higher classes which have shifted to LPG. The only other form of energy whose use, though much less than firewood or even LPG, is not insignificant, is dung cake,[11] whose use goes down very slightly for the highest classes. As for the urban areas, we have seen that the three main types of fuel are firewood and LPG, distantly followed by kerosene. The use of firewood and chips is very high for the lower classes, and drops significantly for classes having higher MPCE, whilst the use of LPG is low for the lower classes, and goes up significantly with class. The use of kerosene is low for the highest class, but apart from this there is no clear order (NSS Report No. 511, Statement 2, p. 10).

From the above observations we can conclude, using Table 9.3 which gives us the CO_2 emissions for different types of energy sources, that the higher classes pollute less in their use of fuel for cooking because they tend to use LPG. The lower classes are more polluting, particularly as they tend to use firewood and chips. Whilst it is a relief that the use of electricity for cooking is nearly non-existent,[12] at the same time the fact that gobar gas (gas produced from cow dung) has not made a dent in the rural areas is a disappointment, given the efforts made by the State to popularize it as a cheap and renewable source of energy.

In the rural sector, the use of kerosene for lighting drops significantly and that of electricity rises significantly with higher MPCE in 2004–2005 (NSS Report No. 511, p. 15). All other forms of fuel are insignificant across all classes. In the urban sector, the directions of change are the same, although the absolute values of kerosene use are much less and of electricity use are much more, compared to the rural sector.

If the production of electricity causes more emissions relative to the production and use of kerosene, the higher classes become more responsible for emissions. This is accentuated by the strong possibility that the higher classes use more lighting per person.

[11] Which is cow dung shaped into discs and sun-dried.

[12] Given that in India electricity is largely produced from coal so that its production causes a great deal of pollution – moreover, a great deal of electricity is lost in transmission, implying even greater emissions per unit use.

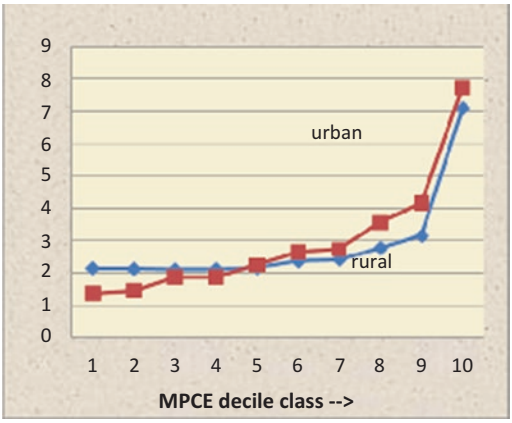

Fig. 9.4 Percent share of durable goods in consumer expenditure over MPCE decile classes, 2007–2008 (Source: NSS Report No. 530, 27–28)

4.2 Durables and Dwelling Units: Class Differences

The percent spent by MPCE classes on durables (Fig. 9.4) indicates that the share increases with a rise in MPCE and this increase is very sharp for the uppermost decile. The percentages of possessor households over expenditure classes are available for 1993–1994 and 2000 (NSS Report No. 426, pp. 16–20, NSS Report No. 461, pp. 33–35). The patterns have remained very similar over this period. As may be expected, the possession of durables and especially electronic goods normally goes up with decile class and the magnitudes of increase are greater in urban India. Also, for rural India, the rise tends to be steepest for the uppermost decile. Hence, the responsibility of carbon emissions due to the possession of durables and especially electronics increases steadily with class and this increase is more pronounced in urban India as well as the richest class in rural India.

For bicycles and stoves, only, there has been a reduction in the percentage of possessor households for the urban upper classes, but this, per se, does not reduce the urban upper class responsibility in terms of implied emissions. The reduction in the use of bicycles would go hand in hand with the greater use of motorized vehicles by these classes, and the drop in the percentage of urban households possessing 'stoves' in the upper deciles has to do with the fact that only kerosene stoves (and not gas burners) are accounted forhigher income groups in urban areas tended to use gas rather than kerosene.

Hence, emissions caused by the possession of durables would also be higher, higher is MPCE class, but the footprint is stronger for the urban upper classes, and for the uppermost class in both urban and rural India.

There is a clear connection between the type of dwelling and average MPCE (Table 9.8), with, obviously, the poorer households living in katcha houses, as these are significantly cheaper. Also, the average covered area of a household goes up with MPCE class in both rural and urban sectors (NSS Report No. 530, Table P20, p. 37), though the values are correspondingly greater for rural India. We see that the carbon impact (due to a higher covered area) for the upper classes is greater by

Table 9.8 Percentage of households and average MPCE by type of dwelling (Unit, 2007–2008)

Structure of dwelling unit	Rural Percent of households	Rural Average MPCE (Rupees)	Urban Percent of households	Urban Average MPCE (Rupees)
Katcha	18.8	594	2.9	732
Semi-pucca	31.4	649	9.1	824
Pucca	49.7	917	88.0	1564
All	100.0	772	100.0	1472

Source: Report No. 530, Table P12, p. 32

approximately 50 % between the lowest and highest fractile classes. If we take into consideration the lower average family size of the upper classes,[13] their per capita responsibility is even greater.

5 Summary and Concluding Comments

Not only aggregate consumption, but also per capita consumption has been increasing in India in the last few decades. Further, the consumption basket is changing in the direction of products whose production and use causes greater global warming. Urban India is far more responsible for global warming compared to rural, firstly because it consumes more per person than rural India, and secondly because of the distribution of its consumption basket. Moreover, as one goes up the expenditure class ladder, the consumer becomes more responsible for emissions of greenhouse gases, not only because of an increasing per capita consumption, but also because she/he uses a higher proportion of products that cause these emissions. The consumer groups that are most culpable are the urban upper classes, and the uppermost classes in both urban and rural areas.

The only product which mitigates the greater damage caused by the urban and upper classes is liquid petroleum gas (LPG), whose use as a cooking fuel has increased rapidly over time. However, the use of firewood is still predominant, and this is bound to have severe implications in terms of local as well as global emissions. Thus, the movement in the direction of LPG has to be strongly encouraged. The two other 'positives' are the extensive use of bicycles in both rural and urban India, and the low number of any specific durable product owned by a household. However, both these features are probably related to the incapacity to pay for motor vehicles or the other durables, rather than the absence of need. Policy makers will, therefore, have to devise ways in which these positives can be retained even as India develops.

There are several reasons, apart from the rising GDP, why all the negative tendencies will be accentuated in the coming years. One is the fact that rural India is

[13] The range is from 5.77 to 3.53 (rural) and from 5.9 to 2.87 (urban).

increasingly emulating its urban counterpart. As shown above, its food basket is leaning towards non-cereals and animal products. It is using more electricity for lighting, and shifting to pucca houses. Secondly, the Indian population is urbanizing at an annual rate of around 2.7 % (Bhagat 2011:10). Hence there will be more people who shall shift to the urban pattern of consumption.

The consumer groups that need to be targeted most for the mitigation of climate change, therefore, are the urban upper classes, followed by the uppermost class in the rural sector. One cannot, however, lose sight of the consumption choices of the rest of the population, who are increasingly attempting to emulate urban lifestyles.

The products whose demand needs to be controlled (with the help of market instruments like carbon taxation or other methods of demand management like ensuring the availability of environment-friendly substitutes) are food items like meat, dairy products and processed foods, and durables that cause significant carbon emissions during production, use and disposal, such as motor vehicles. Some of the trends, however, cannot (and perhaps should not) be changed, because the concerned products have no substitutes, or are vastly superior in comparison with their substitutes. This includes the use of electricity for lighting, the steady shift towards pucca houses, and the purchase of certain durable goods, including electronic products like the television. They can still be taxed differentially, but the State needs to focus more, for these products, on resource efficiency, alternative forms of energy in production and use, and proper disposal. The identification of target products as well as groups increases the efficiency of policymaking in reigning in climate change whilst ensuring acceptable living standards – two crucial elements in the quest for human security.

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Chapter 10
A New Era for Energy: The Nightmare Gulf Scenario and Its Implications for Human and Environmental Security

Nabil Sultan

Abstract The world is increasingly becoming an uncertain and unpredictable place for both individuals and governments. High oil prices have enriched many nations and impoverished others while the environment suffers in the process. Then, out of nowhere, came the global financial crisis to add more pressure and uncertainty to a world bruised by wars, divisions, violence, poverty and inequality. But the uncertainty of the world we live in continues. The recent emergence of shale gas (natural gas extracted from shale rock formations) as, potentially, a major competitor to conventional natural gas and even oil has created a great deal of excitement and concern in the energy world and among environmentalists. It has also created more uncertainty. This development in the energy landscape could have serious implications for many of the world's producers of oil and gas (especially those in the Arab Gulf region) and their millions of expatriates (many of them from poor third world countries). This chapter will provide a historical and current account of the "shale phenomenon" and its implications for a region whose prosperity and stability was secured by generous wealth distribution programmes made possible by massive financial resources generated from the sale of conventional oil and gas.

Keywords Oil • Gas • Nuclear • Shale • GCC • Arab Gulf

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1 The Impact of Oil and Gas on the GCC Region

The Gulf Cooperation Council (GCC)[1] region holds 45 and 15 % of the world's proven conventional oil and gas reserves respectively, according to some conservative estimates (Emerging Markets Monitor 2008). High prices of oil since 2003, which secured a combined GCC nominal GDP of over US$ one trillion and an average GDP per capita of US$ 61,000 (CIA's World Fact Book 2011) have given those countries the firepower to implement multi US$ billion programmes in real estate, infrastructural and alternative energy programmes. The region (historically known for its tribal and ruling clan infighting) has experienced, thanks to oil and gas revenues, relative stability and prosperity during the last five decades. Generous wealth distribution programmes, job creation and modern city infrastructural projects for the national citizens transformed the lives of many people and the landscape in this desert region and bought peace and security in a historically impoverished and politically unstable region.

The effects of these development programmes had a dramatic human security impact. Life expectancy increased by almost 10 years to 74 years during 1980–2000, literacy rates increased by 20 percentage points to about 80 % over the same period. The total population of the GCC countries in 1950 was just over four million inhabitants (Tabutin and Schoumaker 2005). In 2004 the population of the GCC countries (excluding expatriates) reached 21,184,000 (Kapiszewski 2006).

During the last decade, many of the GCC countries have embarked on ambitious diversification and alternative energy programmes designed to meet the challenges of the post-oil era. High oil and gas prices since the early 2000s provided these countries with the needed financial resources to pursue such objectives. While the economic rationale underpins these mega plans for the future, the political rationale is just as important in a region where money was used to buy peace and loyalties.

2 The Quest for Renewable Sources of Energy

Concerned about the potential decline of their fossil-based natural resources (due to environmental concerns or technological breakthroughs) as a major money earner most of the GCC countries have initiated massive programmes aimed at diversifying their economies for a post-oil future and developing alternative sources of energy themselves. The drive for renewable energy in this region is also motivated by economic and strategic factors. The demographic and rapid economic developments of the GCC countries during the last few decades have also made them major consumers of energy. Extremely hot weather conditions and lack of natural water resources have necessitated the need to use increasing amounts of oil and gas for

[1] The GCC is an economic and political union comprising Saudi Arabia, Oman, United Arab Emirates, Qatar, Kuwait and Bahrain.

power generation required to air-condition homes and offices and desalinate massive amounts of sea water.

Estimates suggest that electricity demand in the region has been increasing at an annual rate of around 8–9% – faster than the growth recorded in any other region of the world and that over the next decade the GCC countries will need to add 100 gigawatt (GW) of additional power to support their economies that are running at twice the growth rate of major advanced world economies. In the UAE, for example, electricity demand is expected to more than double within the next decade, rising from 16,000 MW to 40,000 MW by the end of 2020 while in Saudi Arabia electricity demand is expected to continue to climb rapidly to reach 60,000 MW over the next 15 years (Alnaser and Alnaser 2011).

Given the high world prices of oil and gas during most of the 2000s and the early 2010s (until the last part of the first half of 2014), the GCC governments felt that selling as much as possible of those highly valued commodities on the international market (rather than burn an increasing percentage of them on highly subsidised power-hungry local installations) made economic sense while the world is still prepared to pay high oil and gas prices.

Almost all of the six GCC countries have ambitions and/or major plans for using renewable energy (Reiche 2010). Until recently, the UAE and Saudi Arabia had by far the most ambitious renewable energy plans in the region. They have now been joined by the gas-rich Qatar. The next few pages will limit discussion on the achievements of these three important GCC countries in this pursuit.

2.1 UAE

In terms of renewable energy plans, the UAE is by far the star of the Gulf region. In 2006 the UAE launched Masdar (meaning ‘source’ in Arabic), a multi-faceted, multi- US$ billion investment initiative in renewable and alternative energy and technology. The company (also called Masdar) that oversees this initiative is made up of five businesses that include a power company, Masdar City, a research institute, an investment company and a business to develop carbon capture and sequestration projects. Masdar city is a futuristic carbon-neutral and waste-free model city. Construction of the city (which occupies an area about 6 km^2 near Abu Dhabi’s international airport) began in 2008 at an estimated cost of US$ 18.7 billion and is expected to be completed by 2020–2025. The city will house hundreds of companies, a research institute and 40,000 residents, as well as accommodating 50,000 commuters (Rodes 2012).

The company has spent hundreds of millions of dollars investing in renewable energy projects and companies worldwide (e.g., UK, USA, Spain, Seychelles). On the home front, the company initiated many renewable energy projects to meet the country’s rising energy demands. Abu Dhabi wants 7 % of its electricity supply to come from renewable sources by 2020, and most of that is expected to come from solar. The aim is to install 1,500 MW of centralized and distributed solar energy

generation by the target year. One of the large solar projects to contribute to that objective is 'Shams 1' ('shams' means sun in Arabic). This project is valued at US$ 600 million and is designed to construct a 100-MW solar thermal power plant in Abu Dhabi. The project began in the third quarter of 2010 and was commissioned in 2013. The plant will use technology from Abengoa Solar (a subsidiary of the Spanish multi-national corporation 'Abengoa') which uses parabolic mirrors to concentrate the sunlight onto fluid-filled tubes to produce steam, which then drives turbines to produce electricity. Shams 1 is registered as a project under the UN's Clean Development Mechanism (CDM) and is, therefore, eligible for carbon credits. It is the first concentrated solar power (CSP) plant registered under the CDM. The plant will displace about 175,000 t of carbon dioxide a year, equivalent to planting 1.5 million trees or removing 15,000 cars from Abu Dhabi's roads (Alnaser and Alnaser 2011).

The emirate is developing a 30-MW wind energy project at Sir Bani Yas Island, 250 km south west of Abu Dhabi (Dodd 2011). However, wind is not expected to play a key role in the UAE's energy generation. This is possibly due to the large amounts of land required by wind farms. The country is very small (83,600 km^2) and therefore cannot afford to dedicate large swathes of land for this purpose. Generating energy through geothermal processes is also being explored. This source could be enough to power heat exchangers to air-condition homes and offices in a district-wide network (Wang 2011).

2.2 Saudi Arabia

Saudi Arabia, which has 20 % of the world's oil reserves, is targeting renewable energy and nuclear power in a $100 billion spending drive aimed at meeting its spiralling electricity demand and positioning the country for the post-oil era. The country sees solar power and other non-hydrocarbon as essential for boosting its electricity-generating capacity by 50 % in this decade, according to Abdullah al-Shehri, governor of the country's Electricity and Co-Generation Regulatory Authority, and expects 10 % of its electricity to be supplied by solar power by 2020 (DiPaola 2011).

Saudi Arabia has about 18 % of the world's desalination plants (estimated at more than 12,000). A great deal of the country's daily consumption of 1,500,000 barrels of oil is devoted to powering those plants (Alnaser and Alnaser 2011). To address this problem, the country embarked on an incremental process of constructing solar-powered desalination plants. Indeed, the potential of solar energy in the GCC region and Saudi Arabia in particular (due to its size) is huge. In 2011 a German solar project developer won a contract to build Saudi Arabia's largest photovoltaic plant on a parking area at a new Saudi Aramco complex in Dhahran. The 10-megawatt project makes it the world's biggest solar facility on a parking area. Another German group, based in Oman, also won a contract in 2011 to develop a 3.5-megawatt project near Riyadh for the same oil company (Roca 2011). The

largest solar park in the country, prior to those projects, was a 2-megawatt rooftop plant at the King Abdullah University of Science and Technology near Jeddah, built by Conergy AG, another German company. Saudi Arabia's 2 trillion m^2 land is able to produce 14 trillion kilowatt hours of solar energy every sunny day that is enough to power the world (Kraemer 2012). Hence, the prospect of Saudi Arabia becoming a major exporter of solar energy in the future cannot be discounted.

In April 2010 Saudi Arabia issued a royal decree to begin the construction of King Abdullah City for Atomic and Renewable Energy (KACARE), based in Riyadh, in order drive the country's growing energy needs and reduce its dependence on fossil fuels. The city, which is supervised by a 13-member council of representatives from relevant ministries, is expected to play an important role at a local and international levels. Internationally, KACARE will represent Saudi Arabia at organisations such as the International Atomic Energy Agency (IAEA). At the local level, it will contribute to sustainable development by promoting renewable energy and the peaceful uses of atomic energy in areas such as agriculture, desalination, medicine and mining and will support scientific research and development, training programmes and conferences, and coordination of the country's renewable energy centres. It will also be responsible for drafting a national policy on nuclear energy development, and supervising all commercial uses of nuclear power and handling of radioactive waste (Alnaser and Alnaser 2011).

2.3 Qatar

Qatar is an oil and gas-rich nation, with gas reserves counted as the world's third largest and the second wealthiest nation in terms of per capita GDP (estimated at US$ 104,300) after Liechtenstein) and has the world's lowest unemployment rate. The country's proved oil reserves are in excess of 25 billion barrels (enough to last for 57 years at current levels of production). However, its proven reserves of natural gas exceed 25 TCM (trillion cubic meters), more than 13 % of the world's total of conventional gas and the third largest in the world (CIA's World Fact Book 2011).

Like some of the other six GCC countries, Qatar embarked on a number of ambitious infrastructural projects during the last decade. In 2004 it unveiled a US$ 15 billion tourism master plan designed to make Qatar a 'world-leading high-quality tourist destination'. It is also building a new US$ 5 billion international airport (expected to have an annual capacity of 50 million passengers by 2015) in order to boost its emerging tourist industry. Some of its other major infrastructural achievements include the Education City (home to branch campuses of six US universities) and Qatar Science and Technology Park which houses branches for some of the biggest international names such as Microsoft, General Electric, Exxon-Mobil and Shell who have pledged to invest in research and development (Sultan et al. 2011).

Such developments (coupled with increasing inflows of foreign labour) translated into high demand for electricity. The country's demand for power is likely to expand further over the next few years as it pursues economic diversification in

energy-intensive areas such as petrochemicals and heavy industry and prepares to host the 2022 Fifa World Cup. According to Qatar's Electricity and Water Company (QEWC) the number of hotels in the country will double in the coming decade. The country is also expected to build residential and commercial developments and rail and metro networks in preparation for this major sporting event. Qatar's successful bid for the 2022 World Cup is expected to spur rapid deployment of more renewable technologies as the country aims to make good on its pledge to host a low carbon event. Green solutions are pertinent especially with the expected boom in construction in the lead up to 2022 (Norton Rose 2011).

Given the size of this tiny emirate (83,600 km^2) solar (as opposed to wind) energy seems a more logical approach to the country's drive to creating an infrastructure for renewable energy. This choice seems to have been made clear following the country's bid to hold the 2022 World Cup event which is expected to be the first carbon neutral World Cup and will be utilizing solar energy for its air conditioned solar stadiums and fan zones. There are already some projects using solar energy in Qatar. For example, the Qatar National Food Securities Programme is exploring the use of solar energy to power its desalination plants. Moreover, the country also established Qatar Solar Technologies (QST), a company jointly owned by the Qatar Foundation, Solarworld AG and Qatar Development Bank. The company plans to develop solar-grade silicon in its new plant and hopes to export to other parts of the world, but also to local companies engaged in the manufacture of solar panels (Miller 2012). Qatar Foundation, the parent company of QST, has several projects such as the Qatar National Convention Centre, the new student housing complex and the Msheireb Properties development that will derive a percentage of their electricity needs using solar energy (Renewable Energy Focus 2012).

2.4 The Nuclear Option

In addition to wind and solar, nuclear power is by far the most attractive alternative source of energy. For the small countries of the GCC (apart from Saudi Arabia and Oman) nuclear power is more attractive economically and geographically. Nuclear fuel materials (e.g., uranium) are abundant and cheap and nuclear power generation installations take considerably less space than other alternative energy generating solutions such as solar and wind. For example, generating a gigawatt of electricity with wind takes hundreds of square kilometres when a nuclear reactor with the same capacity will fit into a large industrial building (Morton 2012).

The UAE, by far, has one of the most highly developed programmes for producing electricity from nuclear power among the GCC countries (World Nuclear Association 2011a). One of the main declared reasons for the UAE government to consider the nuclear power option was to address the country's huge demand for electricity which relies for its generation on large quantities of its finite (and valuable) fossil-based natural resources. The government appointed the US-based consultancy company "CH2M Hill" as nuclear agents in the year 2008 to assist in the

development of the peaceful nuclear power programme for the next ten years. The Emirates Nuclear Energy Corporation (ENEC) was set up in 2009 with a royal decree on recommendation by the IAEA. ENEC, which is based in Abu Dhabi, was initially funded with US$ 100 million to evaluate the potential of nuclear power in the UAE. According to ENEC, the demand for power is increasing at 9% per year which is more than three times that of any country globally. To take care of regulations in the nuclear programme the Federal Authority for Nuclear Regulation (FANR) was setup in 2009. The FANR is responsible for establishing and implementing regulations to oversee the long-term safety, security and sustainability in the peaceful uses of nuclear energy of the UAE (FANR 2011).

The UAE's nuclear power programme is at an advanced stage which includes a designated nuclear power plant site at Barka in the emirate of Abu Dhabi and the appointment of a prime contractor (a consortium of South Korean companies). The programme, which costs US$ 20 billion, will result in the building of four 1400 MW nuclear reactors at Braka by 2020 with the first operational reactor to be completed by 2017.

The UAE began to pursue its nuclear objective by collaborating with the USA for setting up the Gulf Nuclear Energy Infrastructure Institute (GNEII) in association with Khalifa University for Science Technology and Research (World Nuclear News 2010). Moreover, ENEC has introduced a scholarship scheme aimed at supporting nationals to take up training in the hope of joining the country's emerging nuclear industry (ENEC 2011).

Saudi Arabia is the largest country, in terms of geography (2 million km^2) and population (26.5 million) in the GCC group of countries and the gulf peninsula and is ranked as the world's largest exporter of oil (CIA's World Fact Book). The Saudi government appointed 'Poyry' (a Finnish-Swiss based consultancy) to carry out supervisory roles in evaluating the use of nuclear energy for desalination purposes. The country has also signed nuclear cooperation contracts with countries such as China and France. Saudi Arabia's nuclear programme is currently in the exploratory/planning stages. However, there are intentions to build 16 nuclear reactors by 2030, each costing about US$ 7 billion (Humaidan 2011).

The remaining four GCC countries have also peaceful nuclear intentions (Sharma et al. 2012). Almost all of them are at the very early stages of this process. The UAE and Saudi Arabia, without any doubt, will take the lead in this Arab Gulf nuclear project. The UAE, undoubtedly, has the most advanced civil nuclear programme and is well developed in terms of legal and regulatory infrastructure (World Nuclear Association 2011b). Saudi Arabia is a latecomer but, given its huge spending power, is expected to make rapid progress in this regard.

According to the World Nuclear Association (2011b), there are about 45 countries in the world that have embarked on new peaceful nuclear programmes. The countries within the Gulf region, while counted among those, appear to be the most dynamic in their pursuit of that objective. One analyst commented that nuclear power is a creature of politics rather than economics (Morton 2012). In the case of the Gulf, however, nuclear power is probably a creature of both politics and economics.

The nuclear reactor disaster of Fukushima[2] that was triggered by a 9.0 richter-scale magnitude earthquake and a tsunami causing sea waves of 15 m high demolished cooling systems at the six-reactor plant (Daiichi) and caused the meltdown of 3 of its 6 reactors. It later transpired that the head of Japan's Atomic Energy Commission drew up, two weeks after the incident, a worst-case scenario, that was presented to Naoto Kan (then Prime Minister) that could have resulted in the evacuation of Tokyo (Kubota 2012). This incident has created a great deal of concern in many countries in the world. Germany, which in 2011 produced 5% of the world's nuclear electricity, has abandoned its nuclear energy plans altogether (Morton 2012). It has committed US$ 23 billion for decommissioning its 23 nuclear reactors and has embarked on one of the most ambitious renewable energy drive in the world (Post 2011).

Following this disaster, increasing attention and questioning began to be raised on the economics, environmental and human security of this source of energy. Aside from the human cost, especially when disaster strikes, the building and eventual decommissioning of nuclear plants is a very costly process. Should Japan decide to abandon nuclear energy, as did Germany, one academic from Tokyo University suggests that the decommissioning cost of this heritage could be as high as ¥50 trillion, or US$ 623 billion (Morton 2012). Notwithstanding the Fukushima incident, there are still many (almost 50) countries (including the Gulf) that are operating, building or simply considering nuclear generation as a viable solution for electricity generation (World Energy Council 2012a).

Despite the gloom cast by this unfortunate Japanese nuclear energy disaster, the GCC countries remained composed in the wake of such adversity. The GCC countries have the advantage of learning from past disasters and the resources to implement world class security measures and technology to address issues relating to security.

3 Shale Energy and a New Environmental Debate

The recent emergence of shale gas (natural gas extracted from shale rock formations) as, potentially, a major competitor to conventional natural gas and even oil has created a great deal of excitement and trepidation in the energy world. Extraction of shale gas dates back to as early as 1821 (Word Energy Council 2010). However, despite the interest shown in this natural resource (especially from the USA) during the 1970s and the 1980s, it was not deemed commercially viable. This is not surprising given the low price of oil and natural gas during that period. It was during the 1990s that interest in shale gas began to develop progressively in the USA when the publicly funded Gas Research Institute granted Mitchell Energy (a Texan gas company) a subsidy in 1991 to experiment with horizontal drilling, a process that was developed in the 1980s with support from the US Energy Department

[2] A region in eastern Japan, about 250 km north of Tokyo.

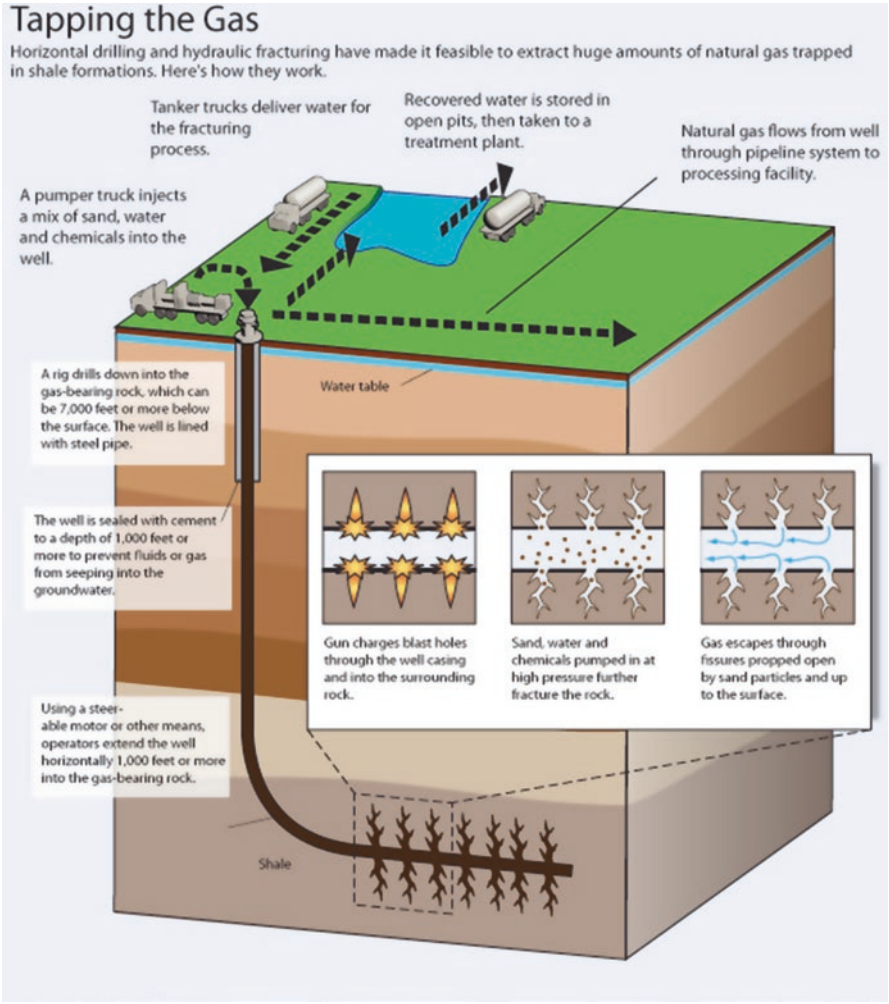

Fig. 10.1 Steps of shale gas extraction (Source: Chesapeake Energy; Al Granberg; WSJ Research)

(Shellenberger and Nordhaus 2011). In 1998 Mitchell Energy used, for the first time, a process known as 'slick-water fracturing'(also known as 'hydraulic fracturing'or 'fracking') to produce the first economical shale gas extraction (Trembath 2012). The process involves pumping huge amounts of water (up to 6 million gallons of water per well) mixed with chemicals and sand to fracture rock formations (up to 2 miles underground) so that trapped oil and gas can be extracted. Since then, the two processes (horizontal drilling and hydraulic fracturing) have become the main drivers for extracting shale resources (Fig. 10.1).

The world is full of shale rocks, not least in the USA which prompted President Obama to declare his country 'the Saudi Arabia of natural gas' (Parsons 2012). In

Table 10.1 Likely (recoverable) shale gas and proven natural gas reserves

Region	Technically recoverable shale gas resources Trillion Cubic Feet (TCF) – 2013
USA	1161
China	1115
Argentina	802
Algeria	707
Canada	573
Mexico	545
Australia	437
South Africa	390
Russia	285
Brazil	245
Others	1535
World Total	7795

Sources: Energy Information Administration (2013). Technically Re coverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States

fact, shale gas has already begun to flow in the US markets where the volume of natural gas in storage in 2010–2011 reached historic heights, thus resulting in downward pressures on gas prices in the country. For example, in April 2012 gas prices dipped below US$ 2 Mbtu[3] for the first time in a decade. This is quarter of the European gas sold at US$ 9 Mbtu (Fortson 2012). Shale gas development, according to this source, can have a significant impact on the dynamics and prices on the natural gas market, and on gas-fired power generations.

This is not surprising, given the fact that the world's reserves of gas (as depicted in Table 10.1) – thanks to shale gas – have more than doubled at a stroke, thus providing the world with access to a potentially cheap and relatively clean source of energy for many years to come.[4] Only half a decade ago it seemed as if the world only had 50 or 60 years-worth of gas. With shale gas, this period is now estimated to have increased to 200 or more years (The Economist 2012). It is now estimated that The increasing participation of the big oil producers in North American shale gas exploitation, according to World Energy Council, is likely to have positive implications for the use of best practices and technologies in drilling and processing, which could make the extraction of shale gas cleaner (poor casing practices by small exploration companies has been the cause of much of the challenging environmental issues). Furthermore, those companies will most likely lead shale exploration activities worldwide (Word Energy Council 2012b).

This picture is made even gloomier for the future prospects of the GCC countries when shale liquids are considered. Shale liquids is a term often used to refer to

[3] Gas prices have since recovered to reach $5.20 Mbtu in early 2014 (SRSrocco Report 2014).

[4] World reserves of natural gas for end of 2012 are estimated at 6614 TCF (BP Statistical Review of World Energy 2013).

liquids such as "pure" oil (also called "tight" oil) and other substances such as shale oil (processed from kerogen, a solid organic substance that exists in shale rocks) or natural gas liquids such as ethane, propane, butane and pentane that can be extracted from processing "wet" shale gas.[5] Given the depressed natural gas prices in countries such as the USA (thanks to shale gas production) many oil companies are also devoting a great deal of their expenditure to shale liquids (Chazan 2012; Radler 2012).

Historically, petroleum-based crude oil has been cheaper to produce than shale oil because of the additional costs of mining and extracting the energy from shale oil. However, this situation could change. It is expected that wet gas projects will rise steadily due to their high returns in comparison to conventional gas projects. For example, typical Marcellus[6] wet gas prices are about 70% over dry gas. This situation could prompt a switch from oil to gas (in compressed form). The switch could include methane propulsion of vehicles and gas-to-liquids derived diesel and gasoline (World Energy Council 2012b). Compressed Natural Gas (CNG) is widely used in fleet and public vehicles in some parts the world. For example, most buses, taxis and rickshaws in New Delhi and Kuala Lumpur are powered with CNG. As a consequence, the beneficial effect on the air quality has been remarkable due to the fact that CNG replaces diesel, which has high particulate emissions. One of the pillars of the Pickens Plan[7] in the USA is to use the country's abundant natural gas resources in order to reduce its reliance on foreign oil and to improve security of supply for transportation fuels. In addressing the transportation fuels issue, the plan calls for the widespread switch from gasoline to gas (World Energy Council 2010).

4 Implications for the Future

The aforementioned developments of shale gas and oil and their petrochemical by-products, if realised, do not bode well for the future prospects of the GCC countries and the millions of foreign workers (mostly from third world countries) that make up the bulk of their national work forces. The population of the six GCC countries, almost 39 million in 2008, included 23 million natives and 16 million foreigners (41%). Two thirds of the labour force in those countries (estimated at 16.5 million in 2008) were made up of foreigners (Migration News 2012).

[5] Gas containing less than 95% methane and more than 5% of heavier hydrocarbon molecules (e.g., ethane, propane, and butane) is sometimes referred to as wet gas.

[6] The Marcellus is a deep layer of sedimentary rock formation (known for its rich gas deposits) located in the eastern United States and extends from southern New York across Pennsylvania, and into western Maryland, West Virginia, and eastern Ohio.

[7] The Pickens Plan is an energy policy proposal announced July 8, 2008 by American businessman T. Boone Pickens. Despite wide support for the plan from politicians the plan was defeated in March 2012 when 47 senators voted against it in the US Senate even though 52 senators voted for it. The US Senate, which no longer abides by majority rule, required 60 votes to pass the plan.

Indeed, there are already signs that this scenario is beginning to unfold. Prices of crude oil (until mid 2014) were above US$ 100 per barrel but since then went down steadily. At the time of writing the update to this paper, crude oil was trading below US$ 50 per barrel. Gas prices were already showing downward pressures in shale-rich countries such as the USA and with the recent decline of oil prices they continued to fall further. US gas price at the time of writing this update were trading below US$ 3 Mbtu for the first time since 2012 (Butler 2015). With oil and gas trading at such low levels many of the GCC countries' ambitious post-oil plans (including those relating to renewable energy) could be jeopardised. Due to the high transport costs associated with gas, it does not behave like a commodity. Gas prices are not globally indexed (and traded) as is the case with oil. Only one third of all gas is traded across borders, compared with two-thirds of oil. In places like the USA, Britain and Australia, it is traded freely and prices are set through competition. In other places such as continental Europe, for example, even though traded gas markets are gaining a foothold, gas is mostly delivered through pipelines and sold on long-term contracts linked to the price of oil (which can mean high gas prices). The transport problem was characteristic of oil during the 1960s until the advent of the supertankers which made transporting oil relatively cheap. If a similar solution materialises for gas the current situation can change, and gas, like oil, can have its prices traded globally. Given its abundance (in the light of shale gas discoveries), this will almost certainly translate into low gas prices for many decades (see The Economist 2012). But could this decline impact shale gas production which is more expensive to extract than conventional gas? Time will tell. However, the economics will not be the only determining factor. Other factors relating to human and environmental security are also important. Major countries such as China have already indicated that they will continue with their shale gas investments (Aizhu 2014). Moreover, the US Administration is also keen to have a secured supply of oil and gas.

Some of the GCC countries, such as the UAE, which have invested heavily in renewable energy projects in order to preserve their highly-valued fossil-based resources for export, may not be able to realise any future return on investment (ROI). Renewable and nuclear energy projects and infrastructures are capital intensive and will need a great deal of government subsidies and support to maintain them for many years to come. Should world oil and gas prices experience dramatic declines (as they did since the second half of 2014 and as predicted by this author) those countries could find themselves unable to sustain such investments. Many of the GCC countries, thanks to increasing world demand for oil and gas, have accumulated massive monetary resources which enabled them to create large government bureaucracies to provide employment and many free services for their national citizens. Plans to diversify GCC economies (many of them are underway already) could also suffer as some of those plans are worth hundreds of US$ billions which oil and gas sales were expected to finance for the next few decades. Saudi Arabia, for example, is building six 'economic cities' at a cost US$ 500 billion, financed by both private and public capital, which the government hopes will contribute US$ 150 billion to its GDP by 2020 and provide job opportunities for 1.3 million people

(Sultan et al. 2011). Furthermore, the Arab Spring uprisings of 2011 have forced a number of GCC countries to pledge billions of US dollars for their nationals and even for the nationals of their less endowed neighbours such as Oman and Bahrain (Abu-Nasr 2012). If the current decline in oil and gas prices continues and prices remained low for the foreseeable the GCC countries' huge economic and human investments could ultimately present the GCC regimes with serious future political challenges and security risks. Moreover, such scenario will have serious human security implications for the millions of foreign workers in those countries who, almost certainly, will risk deportation. Many of these workers come from poor third world countries whose economies also benefit from the remittances that are sent by their expatriates. Total expatriate workers' remittances from the GCC countries reached US$ 63.75 billion in 2010 and estimates suggest that this figure could have reached US$ 74.9 billion in 2011 (John 2011).

Having cast a potentially promising scenario for shale oil and gas (and a dark one for the GCC countries) it must be indicated here that the future of this new energy resource is far from certain due to a number of factors. In North America and Europe, the environmental implications of shale gas (e.g., earth tremors, groundwater contamination) are still a major concern. The Europeans consider energy security to be a great problem, but they have yet to accept shale gas as a possible solution to reducing their dependency on imported fossil-based energy products. For example, New York State, France and Bulgaria have outlawed fracking. Furthermore, despite the availability of proven production technologies, the environmental impacts are still being queried; in particular the impact on ground water resources and the possible methane[8] releases associated with current production techniques. These environmental security issues are the subject of intense scrutiny at the moment. Finally, the issue of property and mineral rights differ across the world. In some parts of the USA, for example, individuals can own the mineral rights for land they own but in many parts of Asia, Europe and South America this is not the case. Such unresolved legal issues, therefore, remain obstacles for shale gas exploitation in many countries across the globe (World Energy Council 2012a).

It should also be noted that shale gas and oil extraction is relatively expensive. It is also expensive (as indicated above) to transport. Shale gas and shale oil have been known to exist for many years. What prevented their extraction was cheap conventional gas and oil (whose prices began to decline dramatically since mid 2014). The GCC countries (as leading members of the OPEC cartel) indicated, following OPEC's November 2014 meeting that was held in Vienna, that they will not cut crude oil production to halt this decline. By doing this, they are hoping to kill the extraction and exploration of gas and oil through fracking. However, it is difficult to see how some of the GCC countries will be able to sustain the current low prices of

[8] Methane gas is a powerful greenhouse gas with a global warming potential that is far greater than that of carbon dioxide . Up to 7.9% of methane produced from shale-gas production escapes to the atmosphere in venting and leaks over the lifetime of a well. See: Robert W. Howarth, R. W, Santoro, R and Ingraffea, A. "Methane and the greenhouse-gas footprint of natural gas from shale formations", 2011.

these commodities whose economies rely on massively. Indeed, many of these countries have already crossed their break-even oil prices.[9] For example, in 2013 Oman's break-even oil price was US$104 per barrel (up from $91.60 in the previous year) while Saudi Arabia's break-even price was $71 per barrel in the same year, up from $69 last year (Arnold 2013). The UAE is even in a worse position than its neighbours. Its break-even price for oil rose in 2012 to US$107 per barrel, the highest among the GCC countries (Valdini 2012). Moreover, affordable energy prices can help alleviate the world's current economic woes and will ultimately result in global economic growth and human security. Oil price increases have, historically, been responsible for many of the world's recessions and slow growth (Hamilton 2012). Low and stable oil and gas prices could help render shale exploration less attractive to some potential produces. But energy is increasingly being perceived as a strategic commodity whose supply must be secured and not left to the good will of unstable regimes such as those that exist in the Middle and other parts of the world. This can only mean one thing: shale gas has the potential to become an important source of energy for the next few decades and possibly even for the rest of this century.

5 Conclusion

The GCC region is one of the most economically vibrant regions in the world. Its massive oil and gas resources, helped particularly in the last decade by increasing energy prices, have provided its countries with enormous wealth. Some of that wealth was distributed to the national citizens of this region through well-paid jobs in the public sector and free health, education, housing and social security provisions. During the last decade a great deal of that wealth was (and is) being spent on very ambitious economic diversification and renewable energy plans. Some aspects of those plans, as indicated in this chapter, are underpinned by economic and political rationale. The GCC region is also one of the most politically sensitive regions in the world whose stability and security, during the last few decades, was maintained by generous government subsidies and wealth distribution plans that made it one of the world's richest in terms of GDP per capita.

However, prosperity for some countries could also mean hardship for others. The spiralling oil and gas prices across the globe have had the opposite effects on world's consumers of those two important commodities. This is particularly evident in the current world economic situation that was spawned by the financial crisis of 2008. Moreover, security of energy supplies is becoming an important issue for many countries (such as the USA) that see in domestic shale gas exploitation an opportunity to free themselves from the political uncertainties (or pressures) that often characterise many of the major global producers of conventional oil and gas.

[9] This is the budget break-even cost (i.e., the price at which the major oil producing countries need to sell oil in order to be able to fund their national spending).

Shale gas and shale oil extraction, once considered economically unviable, is now experiencing a comeback, thanks to developments in drilling technology. Notwithstanding this development, there are still issues associated with the extraction of shale resources. The most important of them is their environmental impact, particularly the threat of earth tremors and groundwater contamination. Should those threats prove to be environmentally acceptable or should drilling technology and/or best practice improve to mitigate them, shale gas and shale oil exploration could become widely popular. If this happens, the potential impact on conventional gas and oil can be severe. In the case of the GCC countries, this scenario could have both economic, political and human security implications for their future and for the future and wellbeing of millions of their foreign migrant workers who are often in low-paid jobs and come from predominantly poor countries.

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Part III
Regional Focus on Water Security

Chapter 11
Water Resources, Food Security and the Role of Virtual Water Trade in the MENA Region

Marta Antonelli, Francesco Laio, and Stefania Tamea

Abstract Food security, and in particular food availability, depends on environmental resources, climatic conditions and agricultural practices, having water resources as a common denominator. There is major concern about food security in countries having limited water resources, due to the large volumes of water that are required to produce food commodities. Water-deficit countries tend to rely on international trade to close the gap between water (and thus food) demand and supply. Against this backdrop, the purpose of this study is twofold. First, to analyse water resources in the Middle East and North African region also considering the political economy trends and dynamics, which drive the region's demand for water. Secondly, the study aims to increase understanding on the role that trade of agricultural commodities has played in meeting the requirements of the MENA populations, in terms of food and associated water 'embedded' as a factor of production. The study argues that *virtual water trade*, that is, the virtual transfer of the water used for agricultural production from producing to consuming countries, has provided the region's economies with water and food security over the past 25 years. The study shows that virtual water imports have more than doubled and the increase has been more than proportional to population growth in the area. Food products account by far for the largest share of virtual water flows, while crops and high value foods are the main categories of agricultural products associated with virtual water imports. The largest share of the MENA imports originate from outside the region, thus determining a marked dependency on water resources available elsewhere, but not always from water-secure countries.

Keywords Water scarcity • Food security • Virtual water trade • Import dependency

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1 Introduction

Water and food security are very much interrelated due to the large amounts of water resources that are necessary to produce food commodities. The water 'embedded' in food (and other products) can be defined as *virtual water* (Allan 1993). The virtual water content of a product depends on the food commodity, the country of origin, its climatic conditions, as well as on the processing techniques and production system. Animal-based products, for example, have been shown to be the most water-intensive food products due to high feed consumptions and (often) low edible product fraction (Hoekstra 2013). The water virtually 'embodied' in food commodities accounts for the largest share of the water needed by individuals and society – about 90% (Allan 2013). The import of food can, therefore, be considered as an import of the water 'embedded' – as a factor of production – in the traded commodities (Allan 2001).

The focus of this study is on the arid and semi-arid Middle East and North Africa region (hereby referred to as MENA), characterized by limited water resources and fast-growing water demands. The region suffers not only from physical water scarcity, but also from large-scale water management problems, such as over-exploitation of aquifers, deteriorating water quality, and rationed water supply and sub-optimal irrigation services (World Bank 2007). Water-related issues affect social and economic potential in the region (Tropp and Jagerskog 2006), and future tensions are likely to arise depending on how the political economies of the region will manage the water-deficit and secure the food needs of their populations (Allan 2001).

The purpose of this study is to analyse the political economy trends and dynamics in the MENA region which drive the region's demand for water. Major drivers have been recognized to be: the increasing demand for food associated with population growth, the advancement of the region's economies coupled with rapid urbanisation, and the associated changes in living standards (Allan 2001). Given the limited availability of freshwater and the problematic depletion of groundwater resources, often coupled with land scarcity, the MENA countries are strongly reliant on food imports, especially grains (World Bank 2009; Minot et al. 2010). The present study also aims to quantify and analyse the water 'embodied' in agricultural trade of MENA countries over the past 25 years, and to show the extent to which the region have relied on this source of water to meet their population's needs for food commodities.

This chapter is structured as follows: The first section will provide an overview of the MENA water- and food-related problems; the trends and driving forces impacting water demands are analysed in the following section; the third section presents the concepts of virtual water and virtual water trade deployed in the analysis of the MENA water and food security; the fourth and fifth section present, respectively, the methodology and the results of the MENA virtual water trade assessment; and the final section draws some conclusions.

2 Water Resource Problems in the Middle East and North African Region

The Middle East and North Africa[1] is widely acknowledged as being the most water deficient region in the world (Gleick 2000; Roudi-Fahimi et al. 2002; World Bank 2009). The region endures diverse climatic conditions, and its economies are subject to the difficult combination of very low and highly variable annual precipitation. The region has five per cent of the world's population and only one per cent of its freshwater resources (UNDP 2009). Absolute and per inhabitant freshwater resources are the lowest in the world (FAO 2003), and increasing population is severely decreasing the average per capita resource availability. For example, internal renewable water resources in the area have decreased from an average per capita value of 3200 m^3/year in 1962 to below 1000 m^3/year in 2012 (Fig. 11.1). This compares with a per capita world average of 6066 m^3/year in 2012 (AQUASTAT 2014), where internal renewable water resources are used in that they are the only figures that can be added up for regional assessments (FAO 2003). Renewable water resource withdrawal in some countries within the region already exceeds the critical threshold of 40 % of renewable water resources, and water tables are declining as

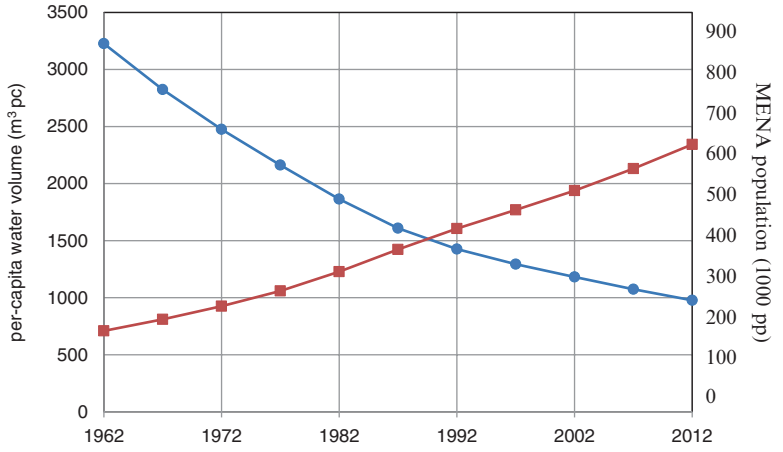

Fig. 11.1 Average per capita internal renewable water resources per year in the MENA region (*blue dots*) and average population in the area (*red squares*) (data from AQUASTAT 2014)

[1] For the purposes of this study, the Middle East and North African region extends from Morocco (west) to Iran (east), and from Turkey (north) to Yemen (south). In alphabetic order, it consists of Algeria, Bahrain, the Arab Republic of Egypt (hereafter referred to as Egypt), the Islamic Republic of Iran (hereafter referred to as Iran), Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco (including Western Sahara), West Bank and Gaza (also referred to as Occupied Palestinian Territories), Oman, Qatar, Saudi Arabia, the Syrian Arab Republic (hereafter referred to as Syria), Tunisia, Turkey, the United Arab Emirates, and the Republic of Yemen (hereafter referred to as Yemen).

farmers and cities abstract water above rates of replenishment from recharge and aquifer leakage (FAO 2011). Water availability is also affected by recurrent droughts, which also result in significant social and economic impacts (FAO 2008a).

The region is also one of the first major regions in the world to run out of water. Since the 1970s, the water demands of its political economies have exceeded the capacity of the local resource base for food self-sufficiency (Allan 2001). In the MENA region there is "virtually no more freshwater to develop" (FAO 2000: 50). The development of integrated hydrological and economic information on water resources for policy and decision-makers has been recognised as a crucial step if more sustainable water management is to be installed in the region (Sakmar et al. 2011). The burgeoning water deficit has been recognised as a serious threat to human security in the region (UNDP 2009). The region is locked in a 'sanctioned discourse' concerning water as a social resource rather than an economic resource, which determines the extent to which sound water policy reforms can be proposed and achieved (Allan 2001). Considering water as an economic resource means that its allocation maximizes its value, whereas considering water as a social resource implies that its availability should favour social wellbeing (Veiga da Cunha 2007). Economically and environmentally sound water reforms, which would require changes and water re-allocation policies, have never taken place in the region, with the exception of Israel. Although sluggish water reforms in water-scarce countries are not limited to the MENA area, given the size of the challenge in the region, the cost of inaction is likely to be higher there than elsewhere (World Bank 2007).

Agriculture is the most water-intensive activity in society and by far the biggest water user in the MENA region. Water consumption by households and the industry sector is relatively small in most of the region's economies compared with allocations to irrigated agriculture. Agricultural water use is over 80 % of total water withdrawal (i.e. including domestic, industrial and agricultural uses) in 9 out of the 20 region's economies (AQUASTAT 2014). Freshwater is mainly allocated to cereal irrigation, which generate returns that are a tenth of what would be achieved by growing higher-value crops (World Bank 2008). Although the share of population employed in agriculture is declining, this sector does represent an essential source of livelihood in many countries in the region (such as, Morocco, Egypt, Turkey and Yemen). Employment in agriculture accounted between 25 and 40 % of total employment in 2010–2012 (World Bank 2014).

In part of the region, agriculture is highly dependent on groundwater resources (FAO 2011). The UAE, Saudi Arabia and Oman are almost totally reliant on aquifers, as well as Jordan, Lebanon and Libya. In some countries, such as Libya and Saudi Arabia, the main groundwater resources are found in non-renewable aquifers. Bad management has lead to overexploitation of resources and severe environmental problems (e.g., Al-Rashed and Sherif 2000). Declining aquifer levels and extraction of non-renewable groundwater thus present a serious concern for food production systems in the region. Groundwater development in agriculture started in the 1960s and grew very rapidly, enabling an important socio-economic rural transition, but also leading to the dangerous impairment of water systems in some

economies, such as Yemen and Saudi Arabia (Allan 2005). Non-conventional water sources, such as desalination of brackish or sea water, and re-use of wastewater are increasingly deployed for domestic and industrial use in the high-income economies in the region. A direct relationship has been found between income per capita and desalination capacity in the region (Fichtner and DLR 2011).

The MENA is also probably the poorest region in the world in terms of soil water (also referred to as *green water*), as the region endures arid and semi-arid circumstances. Soil water ranges from relatively abundant in the northern part of the MENA region (Turkey, Syria and Iraq) to negligible in Egypt and in the Arabian Peninsula (Allan 2001). The volumes of soil or green water used for crop and livestock production globally and across the region have had no metrics until 2011 (Gerten et al. 2011). This source of water has never been taken into account in the national water budgets of the MENA economies, although it provides water for long established but non-optimum dryland winter farming and grazing.

Transboundary waters represent a major share of the MENA surface renewable water resources. Sustainably sharing, allocating and managing these resources have been identified as the major water-management challenges of the region (World Bank 2007). The main transboundary rivers in the MENA are the Euphrates-Tigris, the Kura-Araks, the Asi-Orontes, the Jordan, and the Nile. Some aquifers in the region are transboundary waters. The main transboundary groundwater systems are: the Disi aquifers, shared between Jordan and Saudi Arabia; the Mountain Aquifer, shared between Israel and the occupied Palestinian Territories; and the North Western Sahara Aquifer System, shared between Algeria, Libya and Tunisia (SIWI 2009). There are also shared aquifers in the Arabian Peninsula.

The availability of arable land, as well as its suitability for agriculture, is a further constraint to food production in the region. Some of the MENA economies – such as, Qatar, UAE, Bahrain and Kuwait – have the lowest arable land per capita in the world (FAOSTAT 2013). Land and water scarcity are major drivers of the new surge of foreign investment in agricultural land in the MENA and elsewhere (Antonelli et al. 2015). Due to water and land scarcity (and suitability), in economic terms, the MENA barely has a comparative cost advantage in the production of agricultural commodities. This is reflected in the region's dependency on food imports. All the region's economies are, in fact, large net importers of agricultural products, such as cereals, sugar, cooking oil and other food commodities (World Bank 2003, 2007). The dependency on international trade may intensify as a result of the increased demand for food. The World Bank, FAO and IFAD (2009) have recognized that one of the top priorities for the economies in the region is the diversification of production out of staple low-value crops into high-value crops.

Allan (2001) argued that the import of food commodities has not only effectively mitigated the water (and food) deficit of the MENA region, but also allowed the procrastination of politically hazardous decisions in the water sector (such as the adoption of water market or re-allocation policies).[2] The virtual water solution, enabled by downward trend in food prices, proved to be "politically silent and eco-

[2] Israel is an exception in this regard (Gilmont 2014).

nomically efficient" (Allan 2001). A major aim of the present study is to investigate the extent to which import of water resources have provided the region's economies with water and food security over the past three decades.

3 Drivers of Water Demand in the MENA Region

Four factors can be identified as main *driving forces* of freshwater demand in the region. The first one is the dramatic increase in population, and the consequent increase in food demand. Population in the MENA region has quadrupled during the second half of the 20th century and is the second fastest growing population in the world (Roudi-Fahimi and Mederios Kent 2007). Urbanisation is also a driving force that will impact future water choices in the MENA region, as most of population growth has occurred in urban areas (Tropp and Jagerskog 2006).

Secondly, dietary shifts towards a higher calorific intake. Since the mid 1960s, the MENA per capita supply of calories has increased from 2200 pc kcal/day to over 3000 in the late 1990s, and is expected to reach almost 3200 pc kcal/day in 2030 (WHO/FAO 2003). As a result of an 'industrialisation of the diet', the region has progressively lost its traditional diet in favour of an increased consumption of animal-based products,[3] pre-processed foods, sugars and fats (Fahed et al. 2012), which are generally water-intensive. Thirdly, additional water demands have been associated with rising standards of living, industrial activity and energy demands (O'Sullivan et al. 2011).

Fourthly, expected impacts of climate change on the region's water resources and agricultural land, which will not only affect agricultural productivity but also the functioning and operation of existing infrastructures, such as drainage and irrigation systems (IPCC 2008). Climate change will affect the MENA region by causing higher temperatures and lower precipitation, resulting in lower annual crop yields, sea level rise, which increases water salinity in delta areas, and increase in frequency and intensity of extreme weather events (FAO 2008b). Based on climate change projections, two thirds of the region's economies will have less than 200 m^3 per capita of water by 2040–2050. Unmet water demand for the whole MENA region will also increase from current 16–37 % in 2020–2030 and 51 % in 2040–2050 (Immerzeel et al. 2011). The region as a whole could experience a decrease in agricultural output by 80 % in 2080 according to Cline (2007).

While these forces have driven an increased water demand and may exacerbate the MENA physical water resource scarcity, the reasons for water problems lie, however, in the capacity of agricultural sectors, local governments and interna-

[3] It is noteworthy to say that the extent to which livestock industry and meat consumption impact water resources is determined by meat production systems, which are very heterogeneous both in farm practice and in geography. Industrial systems are far more water-intensive than grazing systems, as the water footprint of concentrates is five times larger than the water footprint of roughages (Hoekstra 2013).

tional institutions to respond and adapt to the region's resource scarcity (Allan 2001). The water scarcity predicament of the MENA region has been compounded by large-scale water management problems, such as over-exploitation of aquifers, deteriorating water quality, and rationed water supply and sub-optimal irrigation services (World Bank 2007). These problems also have negative impacts on human health, the productivity of agriculture and water ecosystem services (Immerzeel et al. 2011).

4 Virtual Water Trade

Virtual water can be defined as the volume of water used in the production of internationally traded commodities and was identified by Allan in 1993. Accordingly, the term *virtual watertrade* refers to the water 'embedded' in the products that are 'exchanged' among trade partners. When a commodity is exported, its virtual water content is in fact implicitly 'exchanged' as well. Vice versa, when a good is imported, the water used in its country of production is 'imported' in virtual terms. The terms 'trade', 'flows', 'imports' and 'exports' when associated with virtual water will be used throughout the text without quotation marks, although, as pointed out by Merrett (2003), it is in fact goods that are being traded, not water.

A trade matrix of value or quantity flows of traded commodities can be translated in terms of equivalent virtual water flows. The sum of all translated matrices provides a picture of the virtual water flows associated with international trade in agricultural products. This conversion enables one to appraise the invisible implications of commodity trade in terms of water security in both importing and exporting countries.

Virtual water trade has enabled water-deficit countries to cope with increasing needs of water for food production, and to exceed the limits of local hydrological endowments. It has been argued that, by mitigating local water deficits, virtual water trade has often prevented social unrest and conflicts (Allan 2001; Barnaby 2009). Virtual water trade, however, is not consistent with water resource scarcity. It seems rather to be more related to factors such as GDP and population (Tamea et al. 2014). The factors associated with agricultural trade, which distort prices and obscure the potential comparative advantage or disadvantage arising from water availability, are many. The comparative advantage associated with relative water endowments is often 'latent' so that water is *not* a major determinant of trade. Water resources in fact generally account for a tiny share of production costs in agriculture, and tend to be either under-priced from a societal point of view or not priced at all (Reimer 2012). This is the reason why a number of water-scarce countries in the world are net virtual water exporters, whereas some water-abundant countries are net virtual water importers.

The concept of virtual water has globalised the discussion on water security, environmental sustainability, food security and consumption by linking the challenge of water scarcity to global, regional and local trade flows (Roth and Warner

2007). The globalisation of freshwater, however, also brings risks, as the indirect effects of water withdrawal are increasingly *externalised* to the virtual water exporting economies. About 19 % of global water (accounting for 1762 km^3/year) is used in fact for producing and processing products for export (Mekonnen and Hoekstra 2011). Water in agriculture is often priced far below its real cost and the price of the imported commodity does not reflect the cost associated with water use in the exporting economies (Mekonnen and Hoekstra 2011). The world's major food exporting economies generally have high water productivity in comparison to many food-importing economies (Yang et al. 2006). The world's major virtual water exporting economies generally have high inputs, including fertilizers and pesticides. The excessive use of these inputs has become a major environmental hazard (Zehnder et al. 2003). Whether the global water 'savings', which are (arguably) brought about by international virtual water trade result from more efficient water resource use or to the higher levels of inputs used in agriculture in the world's exporting economies is still under debate (Yang et al. 2006).

These issues raise many questions on the risks brought about by an increased trade in virtual water, in particular as 80 % of global virtual water flows originates from only 4 % of the total number of connections established through trade (Konar et al. 2011; Suweis et al. 2011). The fact that the largest exporters in the world of *blue w*ater (surface and groundwater), namely the USA, Pakistan, Australia, Uzbekistan, China and Turkey, are, in part or as a whole, under conditions of water stress (Mekonnen and Hoekstra 2011) raises concerns about the environmental sustainability of production for exports in such countries, especially as externalities and scarcity rent are not included in the price for water. An expansion in irrigated areas in the world's food exporting economies could thus exacerbate the local resource depletion and increasing the opportunity cost of that water.

Studies on the temporal evolution of the virtual water trade network have shown that the global virtual water exchange has progressively intensified over the past decades and that a small number of actors control the network (Carr et al. 2012, 2013). The role that virtual water trade plays in the water-deficit MENA countries has been addressed for some of the region's countries (Yang and Zehnder 2002; Nassar 2007; Yang et al. 2007; El-Fadel and Maroun 2008; El-Sadek 2010; Faramarzi et al. 2010; Antonelli et al. 2012; Mohammadi-Kanigolzar et al. 2014). This study is, to our best knowledge, the first comprehensive analysis of the virtual water trade phenomenon in the MENA. Moreover, despite the database used in this work has been build and used to investigate the global and local virtual water trade of other countries, it has never been used to analyse countries of the MENA region nor the area as a whole.

4.1 Virtual Water Trade: Methodology and Data Sources

The datasets deployed for the assessment of virtual water trade at the global level and for the MENA countries are based on data provided by the Food and Agricultural Organization of the United Nations Statistics Division (Faostat). Data collected,

processed and disseminated by FAO comply with the standard International Merchandise Trade Statistics Methodology, and are mainly provided by national authorities and other international organizations.[4]

Data collected from FAOSTAT (2013) consist of detailed international trade of 309 agricultural commodities exchanged globally during the period 1986–2010. Traded volumes for each product in any given year and country are those reported by the world's exporting economies and have been rectified to political changes over the 25-years period to allow comparison among different years. Political rectification is detailed in Carr et al. (2012; 2013). The 309 commodities analysed are listed in Tamea et al. (2013: Supplementary Material) and include crops and animal products having an available estimate of the country-specific *virtual water content* from the recent assessment by Mekonnen and Hoekstra (2010a, b).

The virtual water contents provided by Mekonnen and Hoekstra (2010a, b) refer to the average of the years 1996–2005. These estimates, therefore, do not take into account possible variations in virtual water contents of crops due to changes in efficiency, technology improvements or climate variability, which affect the water requirement of crops. This assessment provides, to our best knowledge, the only available dataset on the topic and has been used to convert the volumes of traded commodities into virtual water equivalents.

Virtual water flows associated with international trade were assessed by following two main steps. First, trade matrix for each product and year were generated. Secondly, virtual water trade matrices were obtained by multiplying each product quantity by the corresponding virtual water content for the country of origin. The virtual water flows reviewed in the following analysis include green water (precipitation stored as soil moisture) and blue water (surface and groundwater used for irrigation), which are evapotranspired during the growth of agricultural product and consumed for its processing. Water polluted in the production process – often referred to as *grey water* – was not considered here because of the uncertainties inherent in its determination.

Virtual water trade data were also subdivided into four primary groupings: edible vegetal-based products (such as cereals, fruits and vegetables), hereby referred to as *crops*; edible animal-based products (such as meat and dairy), hereby referred to as *animal products*; high-value food commodities (such as sugars, coffee and chocolate), hereby referred to as *lux-foods*; and non-edible commodities (such as plant fibres, oil cakes or animal hides), hereby referred to as *non edible.*

Data describing the production of agricultural commodities in each country and each year in the 25-years span are considered as reconstructed by Tamea et al. (2013). They result from multiplying the production volumes given by FAOSTAT times the corresponding country-specific virtual water contents. The sum of virtual water contents over all items produced by a country in a given year, excluding double counting of secondary products, gives the water footprint of production (Mekonnen and Hoekstra 2011).

[4] For further details on the International Merchandise Trade Statistics Methodology, the reader is referred to UNDESA (1998).

Assuming negligible stock variations, it is possible to "close" the virtual water balance by equating all the virtual water inputs and outputs in a given area or country. This balance reads

$$P + I = C + E$$

where P is the water footprint of production (i.e. the water used to produce agricultural commodities in the area), I is the virtual water import, C is the water footprint of consumption (i.e. the virtual water associated to the consumption of agricultural commodities in the area) and E is the virtual water export. This relationship allows us to compute the virtual water embedded in the national consumption of all countries in all years as $C = P + IE$. Per capita values of virtual water trade and production are based on population data from FAOSTAT (2013), which refer to the "World Population Prospects: The 2012 Revision" by the UN Population Division.

5 Water Security and Virtual Water Trade in the MENA Region

In each country, the virtual water traded and the water volume embedded in the country agricultural production contribute to a virtual water balance. Similarly, at the region's scale, the virtual water balance may be established by cumulating the terms in each country balance, determining a cumulated import and export of the MENA region, as well as a cumulated volume of water embedded in the agricultural production and consumption in the area. The temporal evolution of the cumulated terms is shown in Fig. 11.2 and summarized in Table 11.1.

In 2010, the MENA countries imported a total of 273 km^3 of virtual water with an increment of 162 % with respect to 1986 (104 km^3). This import was facilitated by a downward trend in food commodity prices, which fell, between 1980 and

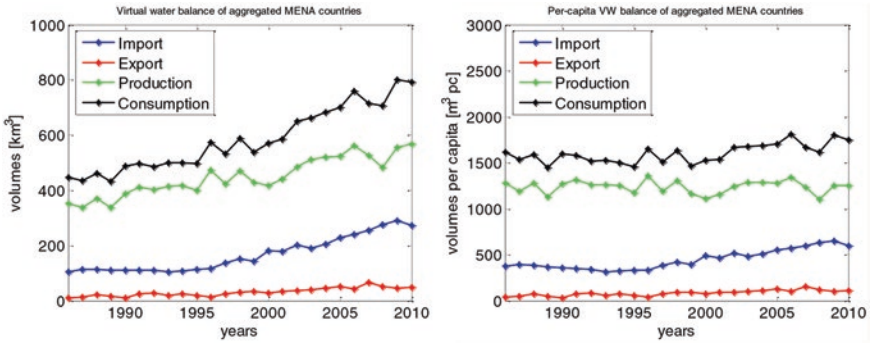

Fig. 11.2 Temporal evolution of the virtual water balance of MENA countries as total water volumes (*left*) and per capita water volumes (*right*) per year

Table 11.1 Summary of Fig. 11.2, WF stands for water footprint

	Volume 1986 (km^3/year)	Volume 2010 (km^3/year)	Var. % 1986–2010	PC volume 1986 (m^3 pc/year)	PC volume 2010 (m^3 pc/year)	Var. % 1986–2010
Import	104	273	+162 %	378	601	+59 %
Export	11	48	+327 %	41	106	+160 %
WF of production	354	567	+60 %	1281	1248	−2.6 %
WF of consumption	446	791	+77 %	1618	1743	+7.7 %

2001 by 35 % (UNDG 2011). The 2007–2008 spikes seem not to affect virtual water imports over these years, although the price for food was 100 % higher than in 2000. Virtual water export has increased up to 48 km^3 starting from very low values in 1986, whereas virtual water embedded in agricultural production has ranged from 354 km^3 in 1986 to 567 km^3 in 2010. The occurrence of severe and periodic drought in the region has been showed to be a cause of agricultural production volatility (De Pauw 2000; Shetty 2006), which is reflected in the virtual water of agricultural production. The virtual water consumption, obtained from the closure of the virtual water balance, increased by the 77 % over the period, reaching a total of 791 km^3/year.

All temporal trends are markedly positive, as highlighted in the left panel of Fig. 11.2, but given the large increase of population in the area a better insight is provided in the right panel, showing the per-capita values of the water balance. Population in the area rose from 276 in 1986 to 454 millions in 2010. Per capita production and consumption remained quite stable over the period, indicating that the increase in water volumes can be explained mostly by population growth. On the contrary, per capita virtual water imports (and exports, to a lesser extent) show a marked positive trend proving that import has grown more than population and should be explained by other drivers, such as the increase in living standards and a shift towards a more water-intensive diet.

It is noteworthy to point out that the MENA shows per capita virtual water imports and exports which are, respectively, far above and below the average per capita volumes of virtual water exchanged worldwide (Fig. 11.3). This indicates that MENA countries are net water importers and are thus dependent on water resources available elsewhere. The water footprint of agricultural production in the MENA shows values that are comparable with the global average, although with ample fluctuations. The volatility of agricultural production in the region, which determines in turn the volatility of water footprint, can be related to the often adverse climatic conditions in the region and to the occurrence of droughts.

While the virtual water export of MENA countries is equally shared between countries inside and outside the region, the origin of virtual water import is mainly extra-regional. Countries providing major volumes of virtual water to the MENA region, in 2010, are shown in Fig. 11.4, where the virtual water import from each country is plotted together with the cumulative share of sorted countries, as a

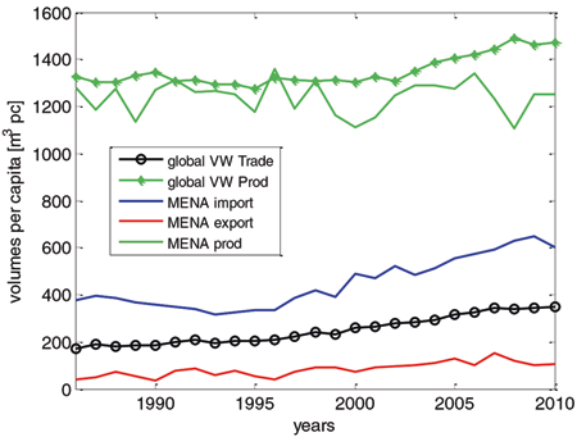

Fig. 11.3 Comparison between global (world) and MENA per capita virtual water flows and water footprints of production of agricultural products (1986–2010)

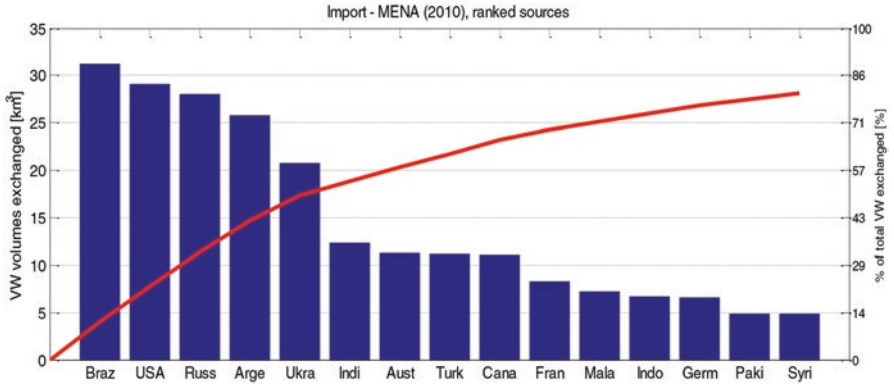

Fig. 11.4 Temporal evolution of the virtual water balance of MENA countries as total

percentage of all imports. The figure highlights the large contributions given by Brazil, USA, Russian Federation, Argentina and Ukraine which contribute to more that 50 % of import of the MENA area, whereas the histogram is ceased at about the 80 % of all imports and neglects virtual water flows smaller than 5 km^3 per year. Some of these countries (such as parts of the USA, Australia, Pakistan, India, Turkey) endure, to different extents, water stress conditions (Smakhtin et al. 2004) thus represent uncertain, and potentially critical, sources of virtual water for the MENA region.

Figure 11.5 investigates the categories of agricultural products composing the virtual water import of the MENA countries, differentiating *crops* (c), *animal products* (a), *lux-foods* (l) and *non-edible* agricultural commodities (ne). The total volumes of virtual water imported across the 25-years period are given by the colour area in the left panel. Total import increases substantially in time with greater contributions from Turkey and the United Arab Emirates, which adds up to contributions from Iraq, Saudi Arabia and Syria in the last decade. Crops take the largest

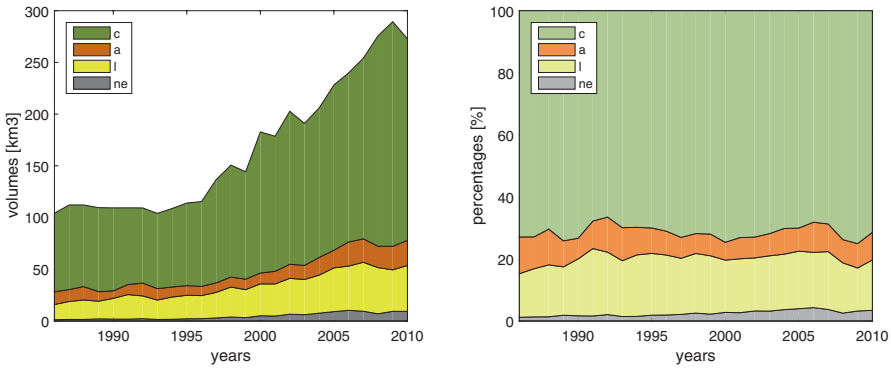

Fig. 11.5 Temporal evolution of the virtual water import of MENA by category (*crops*:c, *animal products*:a, *lux-foods*:l, and *non edible*:ne); volumes of virtual water (*left panel*) and share of each category (*right*)

share, followed by lux-foods, animal-based and non-edible products. Relative share of each category (Fig. 11.5, right panel) do not vary significantly, apart from a steady increase of non edibles, lasted until recent years. Food products have always covered a total share of not less than 95 % of all virtual water import.

The dependency of MENA countries from external water resources can be evaluated by deploying a *virtual water import dependency* indicator (D). This is defined as the ratio between virtual water imports minus re-exports over the total water footprint of consumption (Hoekstra et al. 2011), that is

$$D = \left(I - reE\right) / C$$

where reE is the fraction of imported goods that is re-exported. Since the available dataset do not enable commodities tracking, it is not possible to quantify the fraction of exports that actually results from re-export of imported goods. However, the range of variability of D can be identified by considering the two extremes cases in which: (i) all imported goods are consumed within the country and the maximum value of D is obtained when there is no re-export ($reE = 0$); (ii) local consumption is met by internal production only, and the whole export is a re-export of imported goods ($reE = E$), identifying the minimum value of D. This range of minimum-maximum values is here computed for the virtual water import dependency of each MENA country. Results are given in Fig. 11.6. Considering the importance of food products, the present analysis only considers the dependency associated with virtual water trade in crops, animal products and lux-foods.

Figure 11.6 shows the values of D obtained with average import/export/production values over the period 1986–2010, where averaging allows to increase robustness to limit the effect of occasionally missing data (e.g., Iraq, or Algeria in 2010). Virtual water import dependency has limited variability due to the small values of virtual water export reported by each country. Countries with higher human

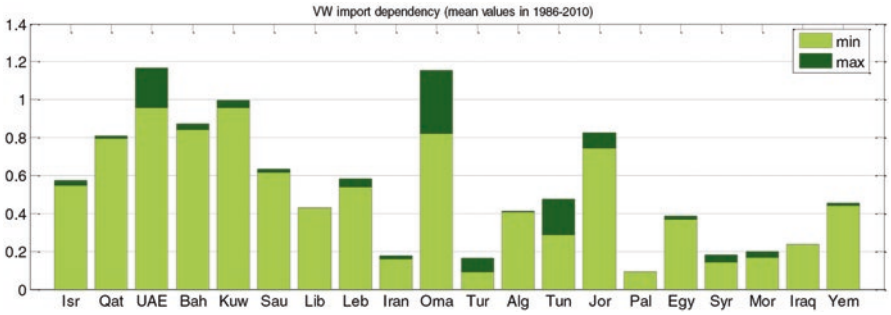

Fig. 11.6 Minimum and maximum values of the virtual water import dependency (*D*) of each MENA country, sorted by decreasing human development index (HDI)

development index (HDI) have – on average – a high dependency on external water resources; examples are the UAE, Kuwait, Bahrain and Qatar whose dependency *D* are greater than 0.8. Oman shows a high dependency (*D* around 1) with large variability, due to its significant exports in wheat flour, vegetable oils and dry milk. Countries with large agricultural production and relatively higher water endowments compared with other MENA economies (e.g., Iran and Turkey) have very low values of *D*, indicating a low dependency on foreign water resources.

The 2007–2008 spikes in food prices witnessed the vulnerability of large food importers, such as the MENA economies, to the oscillations and distortions of global markets. Over these years, the region experienced the difficult combination of sudden restrictions by the world's exporting countries, in the form of bans and quotas; soaring food bills, which results in an increased pressure on public finance and consumers' expenditure on food (Woertz 2013). These factors spurred civil unrests and turmoil in some of the region's countries (Lagi et al. 2011). A recent study forecasts an increase in the region's food import bill from 61.4 to almost 93 US$ billion by the year 2020 (Al Masah Capital Limited 2012). These changing conditions for importing food (and virtual water) are likely to affect more the less diversified economies in the region, preventing their capacity to achieve food security in the way they have managed to do so over the past decades.

6 Conclusions

This chapter has investigated the MENA water resources problem considering the social, economic and political challenges the region is now facing. Water resources in the region are not only scarcely available but also already under major pressure. The main challenge for the region is to be able to feed future populations in the light of population growth, changing diets and lifestyles. This chapter has argued that trade in agricultural commodities – that is also an implicit exchange of water in virtual form – has provided the MENA economies with water and food security over

the past few decades. Relying on trade has enabled the MENA countries to secure their food and water-related needs without undergoing major changes in water allocation and management. Over the last few decades, this process has been facilitated by a downward trend in food prices (apart from temporary peaks), which has benefitted virtual water importing countries, on the one hand, but also increased their dependency and vulnerability to international price fluctuations on the other.

The chapter has provided a comprehensive assessment of the MENA countries' virtual water trade in agricultural commodities by exploring its structure and evolution in the period 1986–2010. Over this time span, virtual water imports have more than doubled and their increase has been more than proportional to population growth in the area. Food products account by far for the largest share of virtual water flows, while crops and lux-foods are the main categories of agricultural products associated with virtual water imports. The largest share of the MENA virtual water imports originate from outside the region, thus determining a marked dependency on water resources available elsewhere, but not always from water-secure countries. Finally, the region's more diversified and adaptive economies tend to show higher dependency on virtual water imports compared with less diversified countries.

In order to address water scarcity problems at a more fundamental level, different policy measures are needed. These include: Improving agricultural water use efficiency; promoting the production of less-water intensive cash crops with high economic returns per unit of water; and unlocking the potential of rainfed dryland agriculture with supplemental irrigation. The reliance on virtual water imports can be considered as a strategy aimed to address the water deficit problems, by relieving the pressure on local water resources that can be reallocated to other uses, including environmental purposes.

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Chapter 12
Managing Water Crisis in the North African Region: With Particular Reference To Jijel Region

Abdelhafid Aimar

Abstract Global water supplies have been seriously affected over the last two decades. Freshwater is becoming scarce in many parts of the world and now a significant number of regions are under serious water stress and about 50 % the world's population is projected to suffer acute water shortages by 2030. This has mainly been attributed to fast population growth, soaring demand for food and energy and climate changes. Water shortages have created intense competition among users and among different types of use. This is making it increasingly difficult for planners and policy makers to meet increasing water and food needs and to sustain social and economic development. The North African region is generally arid and is facing severe water scarcity, particularly in the southern parts (desert). In the northern parts of the region, where the majority of the population lives, rainfall is decreasing and hence water resources are shrinking. Now, water scarcity is considerably obstructing the region's development, affecting the quality of life, creating social tensions and threatening human security. In spite of a significant annual rainfall, averaging 814 mm, and an important water infrastructure, two completed water dams and an important water supply network, Jijel region is still suffering water shortages. Inefficient water management, municipal budget deficits and the lack of people's awareness are worsening water scarcity and exacerbating environmental and water degradation.

Keywords Climate change • Water management • Water scarcity • Water security • Sustainability

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1 Introduction

Water is a crucial natural resource: While it covers 72 % of the Earth‘s surface, only 0.08 % of it is available for human use (Kirby 2000). Furthermore, an estimated 1.8 bn people lack access to clean water, and half of the world‘s population is expected to suffer acute water shortages by 2030 (WBCSD 2006). The perils of a global water crisis and the threats of water insecurity are looming with the number of people facing water scarcity expected to further rise to 4 bn in the decades to come (Medalye 2008).

Global water demand is projected to continue to grow significantly in the future due to increases in the world's population, urbanization, irrigation and energy production. This is expected to further intensify competition among users and among different types of use (UN-Water 2009). Thus planners and policy makers are faced with the challenge of meeting the increasing water needs of a fast growing population. Increasing water scarcity will affect water quality and will likely generate serious environmental problems. This urges the need for an efficient management of water resources to sustain water supplies, avert depletion of water resources and mitigate environmental and water degradation.

In developing countries, freshwater resources are decreasing because of soaring demand and extreme climate events. Now millions of women and children die annually because of drought, hunger and water-borne diseases. Families living on one dollar per day are likely to lose access to safe drinking water (Johnson 2005). In Africa, families looking for drinking water lose nearly 40 bn work hours each year, which is nearly the annual work hours of the entire workforce in France (WP 2014). This means less time for children to go to school, and less time for women to earn a living and look after the family, and thus an increased threat to economic security, human development and general well-being.

This chapter focuses on water crisis in the North African region in general, and on the Jijel region in particular. It sheds light on available water resources in the region, highlights the causes and features of water problems and discusses possible solutions to avert water crisis and assure water security. It stresses the need for a management system adapted to climate change to protect water resources and raise water-use efficiency. It also stresses the necessity of cooperation to save the region from potential environmental disaster. The ultimate aim is to find approaches that are conducive to bridging the widening gap between rising demands and diminishing water resources, and hence sustain water availability and assure water security in the North African region.

2 Overview of Water Resources

The Earth's water stock is fixed at about 1386 bn cubic kilometres, 97.5 % of which is saltwater, the rest of which is fresh water (Gleik 1993; Kirby 2000). Two-thirds of the remaining 2.5 % are in the form of icecaps and glaciers (Kirby 2000).

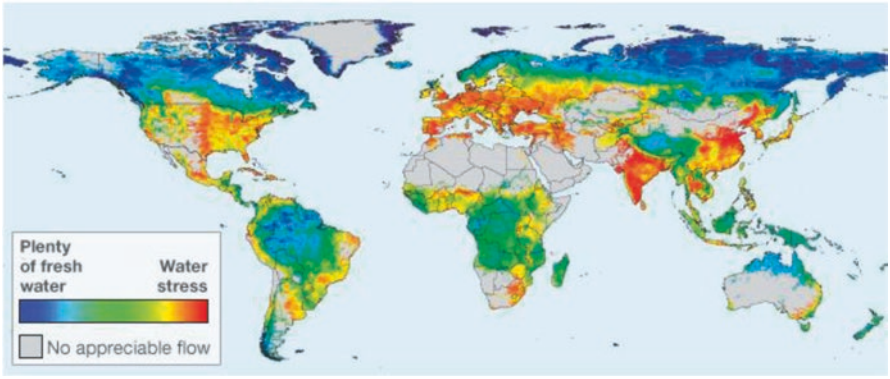

Fig. 12.1 Global water map (Source: Black R. (2010), Water map shows billions at risk of 'water insecurity', http://www.bbc.co.uk/news/science-environment-11435522)

However, while the world's total freshwater remains unchanged, estimated at 0.08 % of the Earth's water (Kirby 2000), the world's population is forecast to grow to 9.6 bn by 2050 compared to 7 bn in 2011 (UN 2014). As a result of population growth, water use is expected to increase by 40 % by 2025 (Dubigeon 2009). More importantly, freshwater is unevenly distributed worldwide. Nine countries (Brazil, Russia, China, Canada, Indonesia, U.S.A., India, Columbia, and The Democratic Republic of Congo) have 60 % of the world's freshwater where only 40 % of the world's population lives (WBCSD 2006). Figure 12.1 clearly illustrates the uneven distribution of global freshwater resources. It indicates that areas in Africa, the Middle East and South-East Asia are the driest. Thus, there are mounting pressures on limited global freshwater resources and increasing threats to global water and food security.

The world average water use per capita is estimated at 1.500 cubic metres per year for rich countries (Jagannathan et al. 2009). In the Mediterranean, 60 % of a total population of 450 million has yearly water availability per person of less than 1.000 cubic metres (CEPF 2010). In MENA countries, water consumption per capita per annum is estimated at 500 cubic metres, and in some regions, such as in Yemen, this figure is below 200 (WBCSD 2006). So, it is crucial for these countries to improve water resource management and raise efficiency to assure water security.

It is agriculture and animal rearing which consume most of the world's freshwater withdrawals. Water use in agriculture represents a global average of 70 % of total use, but in developing countries this percentage is between 80 and 90 % (UN-Water 2012). Moreover, water needs in the agricultural sector are expected to rise by 20 % over the next 20 years, and those of industry and energy by 22 % (Dubigeon 2009). Thus, to meet increasing water and food needs, the world is expected to make available the needed water for agriculture in the future. In this way, there is a need for cooperation at all levels in order to conserve dwindling water resources.

Table 12.1 Estimated groundwater storage for North Africa (in cubic km)

Country	Best estimate	Range[a]
Algeria	91,900	56,000–243,000
Libya	99,500	64,600–234,000
Egypt	55,200	36,000–130,000
Morocco	7410	3970–20,700
Tunisia	7580	4910–18,100

[a]The range is calculated by recalculating storage using the full ranges of effective porosity and thickness for each aquifer, rather than the best estimate
Source: MacDonald (2012)

With a total population of about 168 million, the North African region is one of the most arid zones in the world, but it is characterized by two different geographical areas. The northern part is cool and temperate with a Mediterranean climate, while the central and southern parts are desert with an extremely hot and dry climate. Annual rainfall in the region ranges from less than 50 mm in the southern parts to 1.000 mm in some northern areas with a total annual precipitation of 1.611 cubic kilometers (Pietersen and Beekman 2006).

With the exception of the Nile Delta in Egypt, the North African region depends on seasonal rainfall and has very few rivers in the northern areas with limited water flows. Indeed, nearly the entire region relies very much on fragile aquifers and most of which are non-renewable (UN-Water 2012). Table 12.1 shows the distribution of estimated groundwater storage in the North African region. It is clear from this Table that Libya and Algeria hold the best estimated storage with 99.500 and 91.900 cubic kilometers respectively.

In Algeria, water resources are estimated at 19.4 bn cubic metres per year, 14.2 bn in the North and 5.2 bn in the South (Messahel and Benhafid 2007). Surface water is estimated at 12 bn cubic metres and groundwater at 7.4 bn, of which 5.4 bn cubic metres are in the South (surface and groundwater) (NWC 2011). But despite the construction of a considerable number of dams in the North, groundwater still accounts for about 65 % of annual water supplies in some northern regions (Croitoru and Sarraf 2010). Moreover, the arid south remains wholly dependent on groundwater due to the lack of water storage and water transfer projects from the north of Algeria.

In Tunisia, total available water resources are around 4.6 bn cubic metres, 54 % of which are surface water and the rest of which is groundwater (Croitoru and Sarraf 2010). In Libya, water is being pumped from the desert to the north at a higher cost of $ 20 bn, but it is reported that aquifers there are non-renewable (Vidal 2011), because rainfall is very scarce. Depletion of aquifers will drive Libya to rely more on desalinated water in the decades to come.

In Egypt, about 97 % of water supplies come from outside the country's boundaries (Rogers 1997). The Nile is a river from Ethiopia and Sudan, and therefore Egypt is likely to be subject to future water tensions, as the Nile water flows fall and Egyptian water demand rises. Probable tensions can be attributed to the construction of water dams and expansion of irrigated lands in Sudan and on the Blue Nile

in Ethiopia which supplies the Nile with 60 % of its water (ABU JU'UB). These water works are likely to affect the Nile's annual flow and, therefore, water availability in Egypt by more than 15 % (Kiser 2000).

Drought in Algeria, Morocco and Tunisia has become more frequent over the last 20 years. For instance, until 1990 the cycle of drought in Morocco was once every 5 years, but ever since, this has turned into 1 year every 2 years (Eaamar 2012). More significantly, severe climate variations in the region are affecting water flows in rivers and streams. North African rivers are forecast to either decrease in water flows or indeed dry up entirely. For example, Nile water flows are forecast to drop by half by 2050 (Hoffmann 2009). Thus, water resources are under increasing stress in the region and, therefore, human water security is being placed at imminent risk. According to a World Bank report issued in 2007, freshwater resources per capita in the Middle East and North Africa have become the lowest in the world. Resources are now at one-third of 1960s levels and are expected to further decrease by half in the next three decades (WB 2007). The report warns that growing water shortages in the region could lead to stagnation in economic growth and a drop in investments destined to improve water supply (WB 2007). In this respect, the World Bank notes that the lack of access to safe water causes economic losses in some countries that could reach 7 % of GDP every year (WB 2014). Thus, acute water shortages will likely affect living standards and may raise social tensions in the region, particularly in highly water-scarce areas (Juusola 2012; SFG 2014). One example of this was in the Nile Delta (Egypt) in 2007 and 2008 and in Setif region (Algeria) in 2013 where violent demonstrations broke out against drinking and irrigation water shortages (PI 2013).

3 Water Use in the Region

Global water resources are being consumed at a rate that exceeds the period needed for renewal by 30 % (UN-Water 2012). If this trend continues, the environmental footprint will grow by more than twice the biological capacity of the entire globe. According to UN reports, 80 % of wastewater in the world is neither collected nor treated (UN-Water 2012). If governments fail to build sufficient wastewater treatment facilities in coming decades, and humans fail to change their water consumption habits, the world will likely face a serious environmental disaster before the turn of the century.

As mentioned above, agriculture is by far the largest user of water in the world. In this regard, Table 12.2 presents some staggering figures about the quantities of water required for food production. For example, the production of 1 kg of meat requires about 15,500 l of freshwater. The water used in food production is expected to further rise by at least 50 % by 2050 due to population growth and increases in global food demand (WB 2014). The latter is expected to grow by 70 % over the same period (UN-Water 2012). This will result in substantial increases in basic food prices. According to some estimates, prices of corn, rice and wheat will rise by 48 %,

Table 12.2 Water consumption in food production (litres/01 kg)

Product	Quantity of water
Beef	15,500
Chicken	3900
Rice	3300
Sorghum	2800
Soya	1800
Wheat	1300
Corn	900
Potatoes	900

Constructed from: Banque Mondiale (2010: 149)

40 % and 27 % respectively by the end of the current decade (Eaamar 2012). This is likely to expose 1.3 bn poor people earning less than a dollar per day to hunger and death (Johnson 2005).

In the North African region, there is an excessive use of water mainly because of low water tariffs and lack of controls. In Algeria, this is also due to high government subsidies and cheap energy. Agriculture in the North African countries consumes about 85 % of freshwater withdrawals compared to a global average of 70 % (WB 2010 & 2012). Indeed, irrigation is expected to continue growing far beyond the water availability in the region because of the urgent need to increase food production for a fast growing population. Antiquated irrigation techniques are still widely used, causing significant water wastage, and hence reducing water-use efficiency. It is estimated that non-modernised irrigation systems contribute to water wastage by about 75 % (Gardner 1998). It is worth noting here that Morocco has recently started applying drip-irrigation, but irrigation efficiency is still about 30 % in the entire region against a world percentage of 45 % (Abou-Hadid 2010). In this respect, it is reported that agricultural production can be raised four fold with the same available quantities of water if countries in the region adopt modern water-saving irrigation techniques (Ibid.).

Demand for water for non-agricultural uses is equally rising in the North African region. This is mainly due to industrial development and urban expansion. As a result, groundwater in some regions is being excessively extracted to meet increasing demand, something which threatens the depletion of aquifers, and thus increases the pollution of water resources. Today, more than 50 % of the available supplies of freshwater are typically used for toilet flushing and other sanitary activities while sewage and wastewater treatment facilities are limited in the region (Rogers 1997). Thus, moving away from water-based sanitation could save the region considerable quantities of water per annum. Currently, rivers and aquifers are becoming polluted and wetlands are drying up. The North African region is now facing serious water quality problems which pose serious threats to the region's human security. Shrinking water resources may ultimately force governments in the region to choose in the future between using water in agriculture and industry and satisfying the needs of a growing urban population.

4 Features of the Water Crisis

The most salient features of the water crisis in North African countries are scarcity, salinity, pollution, and dam sedimentation.

4.1 Scarcity

Recent estimates show that water resources availability per capita will decrease by 50 % worldwide over the period 2000–2025, while global water demand will increase at an annual rate of 8.4 % (UN-Water 2012). In this respect, the UN estimates that two-thirds of the world's population will face freshwater scarcity by 2025 (UN-Water 2012). Climate change is expected to increase global water scarcity by around 20 % (UN-Water 2007).

The North African region is in'water deficit'; that is to say it uses more than it receives in rain or snowfall. In the next few decades, it is forecast to face increasing water shortages because of water mismanagement, climate variations and population growth. According to AFED reports, temperature in the region will rise by 1–2 °C, causing an increase in the rate of water evaporation by 25 % and a reduction in rainfall by roughly the same percentage by the turn of this century (Abou-Hadid 2014). Yearly water availability per capita in the region is expected to further decrease to below 500 cubic metres by 2015 compared to a yearly global average of 1500 cubic metres (Jagannathan et al. 2009).

Global water scarcity affects land temperature, precipitation patterns, soil humidity, river flows and groundwater, causing floods, drought, desertification and forest fires. These environmental impacts are expected to affect food production and thus food and overall human security as millions of people will likely be exposed to water scarcity, food shortages, diseases and hunger (UN-Water 2012). In the North African region, harvests relying on rainfall are estimated to drop by 20 % (Abou-Hadid 2014), thus aggravating the region's food production deficit and, therefore, food insecurity.

4.2 Salinity

Higher salt concentrations in soil and water are expected to affect food crops and exacerbate water scarcity, particularly in coastal areas. Misuse and overexploitation of groundwater are reported to threaten depletion of aquifers and aggravate salinity. For instance, in Tunisia 53 % of mobilized water resources already contain a salinity level higher than 1.5 g per litre (Croitoru and Sarraf 2010). In addition, increasing global temperatures are expected to result in sea level rise, filling coastal groundwater

stocks with sea water. According to AFED reports, an increase of 1 m in the level of the Mediterranean Sea will affect 42.000 km square of Arab lands and 3.2 % of Arab population (Abou-Hadid 2010).

4.3 Pollution

Rivers, groundwater and marine coastal water are being affected in many countries by wastewater containing considerable chemical and bacteriological wastes. In MENA countries, 43 % of used water is left without any treatment, and only an estimated 20 % of it is recycled (AWR 2010). In Tunisia alone, the World Bank recorded more than 750 sources of water pollution and 155 million cubic metres of waste every year (Croitoru and Sarraf 2010). These wastes pose serious threats by contaminating and reducing the quality of increasingly scarce water resources. Therefore, unless tackled seriously, pollution could jeopardize human water security and health in the whole region.

4.4 Dam Sedimentation

Dams built in the North African region to supply water to inland areas are facing dangerous problems of siltation. Sediment accumulation can block dam outlets, causing devastating floods. Furthermore, silting lowers water levels and thus threatens to render dams in the region completely useless over time. According to some estimates, silting in certain dams has already reached 17 % of their initial capacity in 2002 (Croitoru and Sarraf 2010), and sediment levels are predicted to further increase by 2020. This will likely put further stress on water resource availability, posing threats to food, water and overall human security in the region within the next few decades.

5 Effects of the Water Crisis

Specialized international institutions (The UN, The World Bank, FAO, WHO…) and regional organizations (AFED, ECCAS…), along with environmentalists and water specialists (such as Gleik 1993; Hoffmann 2009; Croitoru& Sarraf 2010) are warning of the dangers of the global water crisis. This crisis is projected to generate serious economic, social, political and environmental problems in many parts of the world, particularly in arid and semi-arid regions in South Asia, the Middle East and Sub-Saharan Africa. The growing global water crisis will severely affect water availability both quantitatively and qualitatively. In 1995, it was estimated that 8 % of the world's population lacked drinking water, and this percentage is forecast to increase to 50 % by 2032 (Dubigeon 2009).

Moreover, water shortages, pollution and drought impact biodiversity and human health (WHO 2012). When water is scarce, survival becomes extremely difficult. Water scarcity causes thirst and death by dehydration. It is currently estimated that 1.8 million children die annually because of waterborne diseases, such as cholera, typhoid and diarrhea (WBCSD 2006).

The UN reports that "farm land is becoming unusable as irrigation schemes and intensive farming lead to waterlogging and raise salt concentration in soils" (Vidal 2011). This combined with water scarcity will jeopardize development and increase emigration from dry regions. As a result, political tensions are likely to rise in areas where rivers and lakes are shared by more than a country like the Nile and Niger rivers (Juusola 2012; SFG 2014). Growing water shortages will further prompt additional social unrest in water scarce regions (Gehrig and Rogers 2009), as food prices hit record levels and demand for water and energy soars.

Decreasing water resources render economies more fragile and more sensitive to the way water is extracted, conveyed and consumed. Insufficient water resource availability will raise competition among different sectors and can aggravate uneven local-level water distribution. More significantly, water scarcity will worsen the food deficit in a large number of countries, and increase water imports in the form of foodstuffs and other goods (see for example Antonelli et al. Chap. 11 of this volume, for a discussion on 'virtual water'). For example, in 2011 Arab countries imported about $ 55.6 bn worth of food, 25 bn of which were cereal imports (Sadik 2014). This figure is projected to increase further in the years to come. Thus, water availability and food security in the region may be seriously compromised; and indeed may have knock-on effects for water security in (virtual) water exporting regions.

To cope with growing water demand, countries in the region, such as Algeria and Tunisia, have embarked on building desalination plants in coastal urban areas. However, although desalination costs are forecast to fall substantially over the next two decades (WA 2012), it is energy intensive, emits greenhouse gases, raises salt levels in the long-run and is likely to jeopardize marine life in the Mediterranean and affect fishing catches. In this way, desalination is harmful to the environment on a number of levels and cannot be viewed as a sustainable solution to the water crisis.

6 Water Management in Jijel Region

Situated in the east of Algeria, 360 km from Algiers, Jijel is a coastal region with an area of about 2400 square km, and composed of 28 municipalities. It is mainly mountainous, with plains constituting only 288 square km, that is 12 % of the total area. The region's climate is temperate and varies from cool to warm, but rainfall is substantial compared to other regions in Algeria. The average annual temperature in the region is 18.2 °C and precipitation averages 814 mm (C-D 2014). This makes the hydrographic network very rich as it amounts to a total capacity of 1.2 bn cubic metres per year, 7 % of which goes underground. Moreover, the region has five

Table 12.3 Valley water resources in Jijel region (in cubic hectometers/year)

Valley water	Volume
Nil valley	20
El-kibir valley	40
Djen Djen valley	12
Mencha valley	1.1
Kissir valley	1.7
Total	74.8

Source: DHWJ 2011

water valleys with important but decreasing water flows estimated at 74.8 cubic hectormetres per year, as indicated in Table 12.3. Nevertheless, groundwater remains the main source of water supply to the region‘s population estimated at 653.272 (ANIREF 2011) (Fig. 12.2).

6.1 Surface Water

Surface water in the Jijel region is estimated at 124 mn cubic metres per year, 121 mn of which are in water dams situated in the areas of Irraguen (completed in 1963) and Agram (completed in 2001),in addition to 3 mn cubic metres in small water filled barriers numbering 26. According to some estimates, the lack of sufficient water dams causes water losses of about 1 bn cubic metres per year, amounting to 85 % of the region’s water flow (DHWJ 2011). These substantial water losses are discharged into the Mediterranean Sea and represent serious economic losses for the region.

6.2 Groundwater

The Jijel region still depends extensively on groundwater in spite of the construction of some water dams. Groundwater in the Jijel is substantial and most of the aquifers are renewable. Today, there are about 72 water wells in the region, 64 of which are being exploited (DHWJ 2011). Although it is *difficult* to accurately *calculate* the *volume* of water moving into and out of aquifers, the existing wells combined with an important number of springs give the region an estimated annual groundwater of 42 mn cubic metres (DHWJ 2011). According to Jijel’s Water Directorate, groundwater supplies are distributed as follows:

– 24 mn cubic metres for agriculture, representing 57.1 % of the estimated groundwater;
– 14 mn cubic metres for urban and human use, that is 33.3 %; and
– 4 mn cubic metres for industry, that is 9.5 %.

Fig. 12.2 Location of Jijel Region (Source: ANIREF (2011))

It should be noted, however, that the water supply network in the region is estimated to be 1393 km long, and the number of water reservoirs at 234, with a total storage capacity of 104,970 thousand cubic metres. Groundwater pumping stations are about 89. This water infrastructure has enabled the region to increase drinking water network connection to 67.5 % and now around 71 % of the region's population is supplied by piped drinking water (DHWJ 2011).

Nevertheless, the quantities of water supplied to different users in Jijel region remain insufficient and, therefore, are unable to meet the growing needs of the population. Indeed, some areas in the region lack regular water supplies, while others suffer acute water shortages, particularly during the summer months as groundwater-levels drop and a significant number of water wells and springs dry up. This does not only obstruct development in the region, but also generates frequent social tensions. Indeed, local authorities throughout the region face increasing pressures from the population because of water shortages and frequent supply cuts. Increasing demand for water in the region has prompted the construction of more dams. But this operation is slow and lacking integrated water planning. This is likely to make it difficult for the local authorities to optimize the use of scarce water resources and to raise the region's adaptation to severe climate variations.

Table 12.4 Water dams in the region (in mn cubic metres)

Dam	Reserv. capacity	Targeted municipalities
Kissir*	48	Jijel town, Lawana, Emir Abdelkader, Tahir, Chekfa, Sidi-Abdelaziz
Boussiaba*	134	Settara, El-Milia, Sidi-Marouf, Ouled Yahia, Ouled Rabah, Ghbala
Tablout**	151	Texana, Djimla, Benyajis
Irjana**	68	El-Ancer, Mharka, Belhadef, Oued Ajoul, Djemaa Bni-Habibi
Bouajoul	10	N/A

Source: DHWJ (2011)
*Completed **Under construction

6.3 Water Dams in the Region

The geographic features of Jijel region have enabled the public water resource authorities to locate suitable sites for the construction of five new water dams. Two of them have been recently achieved (Kissir and Boussiaba), but the latter has not started operating because the pumping station has not been achieved yet. The other three dams (Tablout, Irjana and Bouajoul) are currently under construction. The reservoir capacity of each of the five dams is illustrated in Table 12.4. When completed, these five dams are expected to raise the volume of surface water in the region to 535 mn cubic metres per year.

The construction of water dams in the region is expected to enable the local authorities to extend the drinking water supply networks to reach other urban and rural areas. It should be noted, however, that it is planned to pump about 80 mn cubic metres annually from Boussiaba dam to the nearby Ben Haroun dam at Mila region. The aim is to raise the reservoir capacity of this dam so that water can be piped to other inland water-scarce regions, such as Constantine. Water is also expected to be piped from Tablout dam to other country‘s inner regions like Setif and El-Hodna. This operation is expected to alleviate the problem of water shortages in inland areas, mitigate the effects of climate change and promote the development of irrigated farming to raise agricultural production and reduce food imports. Thus, the ultimate object of dams’ construction is to help achieve the country’s water and food security

6.4 Managing Water Supply in the Region

There are two institutions responsible for water supply management in the region: Municipal councils (*Assemblées Populaires Communales*) and a public water authority (*L’Algérienne des Eaux-ADE*).

Fig. 12.3 Communes (Municipalities) of Jijel Region (Source: ANIREF 2011)

6.4.1 Municipal Water Management

This form of water management is in operation in 21 municipalities (communes) out of a total number of 28. Here, it is the municipal council which ensures the supply of drinking water to the local communities. Water is often delivered at no cost to households and to other users because they are not equipped with water meters. This makes it difficult for the local councils to regulate the supply of drinking water and, therefore, water consumption can neither be controlled nor rationalized (Fig. 12.3).

Furthermore, most municipal councils in the region suffer from significant budget deficits and a lack of qualified personnel. Financial hardships have made it difficult for the local councils to purchase sufficient numbers of water meters and to extend water distribution networks, particularly to remote areas. This coupled with inadequate management capacities have made local councils unable to develop an efficient local water supply system capable of conserving water and rationalizing its use. As a result, many rural and semi-urban areas remain unconnected to water supply networks, while other areas, mainly urban, receive regular water supplies. The former generally depend on springs, water wells and privately-owned water tanks for their daily water use. This inefficient distribution of water resources will likely be a source of social tensions in the years to come.

Financial constraints have also led to a deficient water maintenance system in the region. Most of the water pipes are aging and are frequently leaking while the local councils lack the financial means to carry out the necessary reparations. As a result, significant amounts of water are lost daily throughout the region. More significantly, most of the local-level water reservoirs in the region are not cleaned regularly. This combined with frequent supply cuts undoubtedly affect the people's health and their security.

6.4.2 Public Water Management

The public water authority (ADE) is in charge of the management of water delivery in the remaining 7 municipalities of the Jijel region. It runs the region's water distribution network with the assistance of 19 water agencies to provide the following services (ADE 2011): supplying water to residential and commercial buildings; equipping and cleaning reservoirs; ensuring daily water treatment; repairing water leakages; and extending water supply networks.

It should be noted, however, that this public water authority depends mainly on groundwater for the supply of drinking water. With the exception of Kissir dam which now guarantees regular water supplies to Jijel city and its suburbs, dams in the region are either under construction or still unused for supplying drinking water because pumping stations are lacking. As with the municipal councils, most of the ADE's agencies are under-equipped and suffer from a shortage of qualified personnel and, therefore, lack the resources and capacity to fully tackle the water supply problems that occur daily. As a result, water leakages are frequent and people from different parts of the region come quite often to the water agencies and to municipal councils to complain about water shortage or cuts in their locality. Today, most households in urban areas depend almost entirely on roof storage tanks for tap water which are often filled from water truck tanks. However, water from truck tanks is not always treated. This undoubtedly renders water unsafe to drink and thus can cause various health problems. This has prompted a large number of households to shift to bottled water, but at exorbitant costs. Today, the price of a five-litre bottle of water is 75 Algerian dinars, which is the equivalent of about one US dollar. Thus, if safe drinking water is not supplied to the region's population, water costs are likely to become a heavy financial burden to many households, particularly to those with low incomes.

More importantly, the exploitation of groundwater in the Jijel region is nearing its limit and its quality is at risk because of a poor sewage system and an excessive underground concentration of iron and ammonium. This critical situation, combined with a decreasing annual precipitation and a fast growing population, have forced the local authorities to plan to build more water treatment stations and raise surface water storage capacity in the region. Unless water resource management is improved and the pressing water needs are met water shortages will likely worsen in the near future, impacting livelihoods and exacerbating social tensions in the region.

6.5 Water Pollution in the Region

Despite significant efforts made in public sewage connection and disposal, the Jijel region is still lagging behind as compared to other regions in Algeria. The public sewage network in the region is about 693 km in length and connection to public sewage is around 70 % (ANIREF 2011). Thus wastewater remains a serious threat

to safe drinking water as the region still depends largely on groundwater for daily water use.

More importantly, there is only one water treatment station, located in the Jijel municipality. As a result, regional waters in coastal areas, rivers and plains still receive large quantities of wastewater. It should be noted here that ammonium pollutes around 11 million cubic metres annually, a fact which reduces levels of groundwater in the region to about 73 mn cubic metres per year (DHZJ 2011). Therefore, pollution is exacerbating water scarcity in the region and hence is threatening human security. However, the local authorities have recently adopted new development programmes aimed at building more public sewage works and water treatment stations. If achieved, these facilities will help reduce water pollution in the region, sustain water availability and help protect the environment.

7 What Can Be Done to Avert the Water Crisis?

It has become extremely clear that water scarcity, salinity, water pollution and related problems constitute serious challenges for the North African region. Now what matters most is how the water crisis can be averted in the region. To do so, governments, experts and all stakeholders must cooperate to make prudent choices and genuine commitments to increase water-use efficiency, and to balance increasing water needs with water availability. The aim must be to sustain water resources and thus sustain life in the region. From this perspective, a large number of options have been suggested and a series of measures have been undertaken. Nonetheless, the North African region should focus on the following actions of particular importance:

– **Thorough Analysis of Available Water Resources in the Region**

– There is a need for expert collection of accurate information on groundwater availability, wetlands and river basins. Efforts should also focus on underground water storage as surface water storage is too costly in terms of construction and maintenance and is exposed to evaporation.

– **Water Management Strategy**

– In this respect, Jagannathan and others argue that such a strategy should"go beyond finding engineering solutions to include a rights regime, regulatory framework and public-private partnership". They continue by pointing out that"accountability needs to be deliberately promoted among different partners and information about water fully shared to improve water management in the region" (Jagannathan et al. 2009).

– **Water Management Policies Based on Demand and Efficiency**

– Governments in the region need to adopt sustainable management policies adapted to climate change and oriented to satisfy demand and improve efficiency.

Water management should not be exclusively related to water resources development, but to management improvement and rational consumption as well. It should also take into account five levels: Supply, distribution, governance, responsibilities, and engineering. An integrated water resources management should not be excluded as well, as it is vital for water conservation and water use efficiency.

– **Modern Irrigation Techniques Adapted to Climate Change**

– Because agriculture is the dominant user of water supplies, the region should move away from antiquated irrigation systems to more effective water-saving techniques, such as drip and surge methods. New water-saving irrigation techniques, such as remote sensing and evapotranspiration, can also be operationalised. Land productivity should be calculated on the basis of the quantities of water being used rather than the number of hectares being exploited. Furthermore, regional cooperation and scientific research should be promoted to develop salt-resistant and water-saving crops. The use of safe recycled water should also be encouraged in agriculture and industry.

– **Curbing Water Profligacy and Pollution to Avert Ecological Disaster**s

– Water must be considered an economic good. This could be achieved through raising people‘s awareness, water price adjustment to cover costs and the development of water-saving systems. Shifting from water-flushing to dry-flushing toilets and installing water-saving devices in all buildings, including schools and mosques can reduce water wastage and save millions of cubic metres per year. Water losses during storage and distribution processes must also be eliminated.

– **Water Transfer Projects**

– Although it is costly, transferring water through pipes from coastal areas to dry inland regions is inevitable in the region. Such works will raise water availability in water-scarce areas and help balance growing demand for freshwater and scarce water resources. This will also contribute to maintaining stability in those regions.

– **A New Role for Governments**

– Governments in the region should shift their role from supplying water at cheap prices to planning and organizing water resources. The private sector should be encouraged to participate in developing the water sector. It should be noted here that Algeria is moving to grant the private sector a share in water project development, such as desalination plants. Despite that desalination remains a negative option, proponents of this technology claim that it will increase the country‘s water availability, lower water costs and improve efficiency.

Mobilizing all parties concerned to participate in water management will help encourage people to change the way they consume water. This will undoubtedly reduce water wastage and pollution and will likely sustain water resources in the region.

8 Conclusion

This analysis has revealed the magnitude and nature of the global water crisis. This is not just the outcome of an environmental crisis; human practices like water pollution and irrational use and population growth must be considered part of the problem as well. In other words, it is not just a shortage of water which is behind the crisis, it is also the way in which water resources are used and managed.

International and regional cooperation is needed to deal with the crisis, as environmental and water degradation is the responsibility of every country. Shared rivers and lake basins must be managed collectively to avert potential political tensions and social disturbances. Water management must be efficient and geared to achieve water and food security worldwide.

In the North African region, the water crisis manifests itself in terms of quantity and quality. The region is facing decreasing rainfall driven by climate change, overexploitation of groundwater and water pollution. To avert the impacts of the water crisis, a substantial effort is needed across the region. Important public and private investments are required to improve nationwide water availability and to deal with water salinity, particularly in irrigated areas. It is equally crucial for the region to improve water quality and promote sanitation and healthy hygiene practices to solve the problems of pollution and waterborne diseases.

Water availability is vital to sustain life and promote development in the North African region. This region must now be wholly concerned with curbing water wastage and preventing water degradation. This could be achieved through the adoption of new water-saving practices and an efficient water management system throughout the entire region. To this end, the public must be made aware that it is everyone's task to protect water resources from depletion and pollution and to ensure the safeguarding of the environment.

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Chapter 13
Turkey's Water Policy in the Euphrates-Tigris Basin

Özden Zeynep Oktav

Abstract When looking generally, fresh water resource issue has been defined from geopolitical point of view which mostly disregards human factors. However, since the 1990s, water scarcity issue has been evaluated in terms of human security which reconceptualizes security so as to integrate non-military threats like factors of human development. The increasing number of publications about water-security nexus urges us to understand whether the countries resort to conflictual methods to meet their water needs or prefer cooperative relations. Turkey's water policy and its impact on bilateral relations with Syria and Iraq in Euphrates Tigris basin illustrate and even epitomize that water can be used both as a weapon of war during hostilities and as a source of cooperation. In an attempt to contribute to the current debate over water- interstate security nexus, this chapter will first evaluate the historical background of the relations between three countries concerning water scarcity problem, and later discuss the reasons for the rapprochement between Turkey-Syria and Iraq which led to an unprecedented cooperative relations in dealing with water scarcity with the beginning of the twenty first century. Lastly, Syria's civil war will be analyzed as a case study to understand whether water scarcity can be a source of intrastate conflict, and at the same time of cooperative relations between Turkey and Syria even in the midst of the crisis. In addition, the worsening water scarcity issue in parallel with the sectarian based war in Iraq – which has been exacerbated by the Syrian crisis and the advance of the Sunni Jihadist group, the Islamic State of Iraq and al-Sham (ISIS) – Iraq's Sunni insurgency will be the other concerns of the study.

Keywords Human security • Water scarcity • Syrian civil war • Turkey • Iraq

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1 Introduction

The conflict over water resources is generally defined in terms of the economic, political and military capacities of riparian countries. This geopolitical point of view, for the most part, disregards human factors such as the social, ethnic and religious aspects of addressing problems of water scarcity. This, at the same time, reflects a traditional understanding of security as opposed to human security, suggesting that access to fresh water is a matter of national security. The water-security nexus has been a dominanttheme in scholarship dealing with national strategic issues, in particular following the end of the Cold War. A diversity of scholarly publications on the water-security nexus debated the 'new security concept',(Gleick 1990, 1993; Ullman 1983; Kliot 2000; Tickner 1995; Wolf 1995; Chaturvedi 1998). However, as Burgess et al. (2013) note, water is defined as a simple commodity and its important role outside the sphere of geopolitics is mostly ignored.

Within the past 20 years, and especially since the United Nations Development Programme (UNDP) adopted the concept of 'human security' in 1994, the reconceptualizing of security so as to integrate non-military threats and aspects of human development came to the fore. The control over natural resources, not only those resources with a high market value such as petrol and diamonds but also water, increasingly became a strategic goal in national security policies as it became evident with the policies of international organizations like NATO and the UN which integrate environmental factors into their threat analyses (UNEP 2009). In this context, the probable threats to water scarcity e.g. demographic, urban, sanitary, agricultural, climatic (Houdret 2004) are worth closer analysis.

Since the 1990s, scholars have become increasingly concerned about the relationship between water scarcity and interstate conflict. For example, Gleick (1993) defends the idea that water scarcity can lead to interstate conflicts, and water has started to be a salient element of interstate politics including violent conflict. However, Yoffe et al. (2003) in a major research project have demonstrated that shared water resources predominantly act as a source of cooperation rather than conflict. Nonetheless, as Beck (2014) notes, a brief survey of literature shows that the relationship between water and interstate-armed conflict still merits revisiting. States can pursue conflictual, as well as cooperative methods, or a combination of both, in striving to meet their water needs. For example, Israel, which did not allow further utilization of the water of the Mountain aquifer in the West Bank, changed its attitude and supplied additional fresh water for domestic and urban use to the West Bank communities and communities in the Gaza Strip in accordance with the terms of the Oslo Agreement (Shuval 2007).

Turkey's water policy and its impact on bilateral relations with Syria and Iraq in Euphrates Tigris basin illustrates and even epitomizes the idea that water can be used both as a weapon of war during hostilities and as a source of cooperation. In an attempt to contribute to the current debate over water-interstate security nexus, this chapter will first evaluate the historical background of the relations between three countries involved in managing a shared problem of water scarcity, and later discuss

the reasons for the rapprochement between Turkey-Syria and Iraq which led to unprecedented cooperative relations in dealing with water scarcity at the beginning of the twenty first century. Lastly, Syria's civil war will be analyzed as a case study to understand whether water scarcity can be a source of intrastate conflict, and at the same time of cooperative relations between Turkey and Syria even in the midst of the crisis. In addition, the worsening water scarcity issue in parallel with the sectarian war in Iraq – which has been exacerbated by the Syrian crisis and the advance of the Sunni Jihadist group, the Islamic State of Iraq and al-Sham (ISIS) – Iraq's Sunni insurgency will be the other concerns of the study.

2 Historical Background

Turkey's perception of its water resources as a source of national pride was reflected in the establishment of the General Directorate of State Hydraulic Works (or DSI, by the Turkish acronym) in 1953 and the massive construction of dams from the 1950s onwards (Milliyet 2013). As Turkey planned to build a network of dams for power generation and irrigation purposes on the Tigris and the Euphrates rivers (Fig. 13.1), the question of the shared use of the waters from the Euphrates-Tigris

Fig. 13.1 The Tigris and Euphrates watershed

between Turkey, Iraq and Syria took on an increasing importance in bilateral relations (Ministry of Foreign Policy 2012).

The lack of binding international law concerning the utilization of the trans boundary Euphrates and Tigris waters has always been one of the main sources of disagreement between Turkey on the one hand and Syria and Iraq on the other. For example, when the Turkish government commenced construction plans of the Keban dam Project in 1963, it had difficulties in finding financial support from international donors, such as the United States Agency for International Development (USAID) and the World Bank, who felt that the lower riparians ought to be consulted and their concerns accommodated (Turan 2011). Thus, Turkey's perception that its rivers are the national ones was challenged at an international level.

Turkey's grand initiative for hydro development known as the Great Anatolian Project (GAP) (Oktav 2003), which consists of 22 dams and 19 hydroelectric power plants (HEPP), intensified the existing conflictual situation. This giant project consists not only of water resource development but also of investments in all related sectors, such as agriculture, energy, transportation, health care, education, urban and rural infrastructure, in an integrated manner (Ministry of Development 2012). Put differently, the GAP marked a significant transition from a purely hydroelectric use of water, to water usage for irrigation purposes. Therefore, Syria complained not only about the polluting effects that the GAP would have on the waters of the Ephrates, but also about the fact that the eventual flow of Euphrates water would be reduced to 300 cubic meters per second once the GAP was fully operational (State Hydraulic Works Digital Leaflet 2011).

The GAP was, at the same time, perceived by Turkey's neighbors as a manifestation of Turkey's reluctance to share the waters of the Euphrates and its enthusiasm to utilize it arbitrarily. Turkey's preference for making unilateral statements regarding the expectations of the downstream riparian countries led to Syrian and Iraqi initiatives for a financial campaign against the upstream Turkish projects. Turkey objected to the Syrian and Iraqi complaints concerning the arbitrary determination of the quantity of water needed for irrigation on the ground that it had single-handedly undertaken costly water projects which benefitted both downstream states and protected the entire ecosystem. For example, the Turkish government proposed the 'Three Stage Plan' for the equitable and optimum allocation of the Euphrates and Tigris Rivers based on systemic assessment of water needs for irrigation of all parties during the fifth meeting of the Joint Technical Committee in 1984. The above-mentioned plan, which considered the water transfer opportunity from the Tigris to the Euphrates, was opposed by Iraq, which based its arguments on its 'ancestral rights' over the Tigris. Syria also opposed the 'Three Stage Plan' and refused to negotiate the Orontes basin together with the Euphrates-Tigris basin. In other words, the proposal in the plan to consider the Euphrates-Tigris basin as a single unit, to determine the common use of the waters by all three countries, and the suggestion that modern technologies be utilized to minimize the requirements for agriculture, were seen by Iraq and Syria as an infringement of their sovereignty (Kibaroglu 2010a, b).

Another source of friction which hindered the reaching of a consensus is that the three sides were unable to agree on the definition of the river system. Turkey claimed the Euphrates and Tigris to be 'transboundary' rivers, whereas Syria and Iraq considered them to be 'international'. Adopting the legal doctrine of *absoluteterritorial sovereignty*, Turkish sources argued that the Euphrates and Tigris both originate on Turkish soil and are Turkish rivers while they flow over Turkish territory, concluding that Turkey is *not obliged* to share its waters with its neighbours. The ninth Turkish President, Süleyman Demirel's words 'Turkey's resources are Turkey's. The oil resources are theirs (Arabs'). We do not say we share their oil resources; and they cannot say they share our water resources' (Kazem and Osman 1998). Kazem and Osman (1998) raised the question of the legal status of water and the legitimacy of drawing a parallel between the legal status of oil and water. Syria adhered to the doctrine of the *limited territorialsovereignty* (Dolatyar and Gray 2000), and suggested that the Euphrates must be shared according to a formula calculated according to the riparian's declarations of water demands and the river's capacity (Güner 1997). Iraq held to the doctrine of *absolute territorial integrity*, insisting on its ancient or prior rights to the use of water from the Euphrates and Tigris rivers (Kiliot 2000).

That Syria was reluctant to share the transboundary river, the Orontes, became another contentious issue between Turkey and Syria. From the Syrian perspective, Turkey's reference to the Orontes raised the thorny issue of its historical territorial dispute with Syria over Hatay province. Syrian officials were quite reluctant to come to an agreement over the Orontes River on the grounds that it would mean the recognition of the Hatay province as Turkish. On the other hand, Turkey complained that the water of the Orontes was completely consumed by Syria and Lebanon, while Turkey released 500 cm/s of water even when the velocity of the Euphrates fell to 100 cm/s.' (Oktav 2003).

As Gleick (1993) explains, water is used for the most part as a weapon of war and as a military target during hostilities. Indeed, water mostly became a tool in relations between Turkey, Syria and Iraq primarily because water was seen as a source of national pride and as a commodity rather than a natural resource which should be preserved as a contribution to water and human security. Turkish leaders portrayed the GAP as a matter of national pride and the governing parties regardless of their ideology have consistently supported this giant project. Indeed, it was constructed in the Kurdish part of Anatolia as a tool for peace and unification of the Kurdsand Turks against a common enemy (Oktav 2003). As Kut and Turan (1997)suggest, "water disputes may be handy to politicians in personifying real or perceived outside threats in the domestic context, and in this way serve to unite the society against 'foreign enemies' and mobilise support for the government".

In a similar vein, Syria, being aware that it had a potentially strong security card to play, waged an undeclared war against Turkey, and assisted the Kurdish separatists to create leverage to induce Turkey to solve the water problem. Whenever Syria felt vulnerable to future cut-offs and reductions of water, it did not avoid playing the Kurdish separatism card against Turkey. Throughout the 1990s, a war-like atmosphere dominated bilateral relations between Turkey and Syria. Despite the 1987

temporary protocol of economic co-operation which stipulated that 500 cubic meters of water per second would flow to Syria regularly even when the velocity of the Euphrates fell to 100 cubic meters a second, Syria did not give up its support for the Kurdish separatist organization, the PKK (Oktav 2003).

During the 1990s, Turkey enhanced its efforts to build new dams. In parallel with increasing number of dams in Turkey, Syria turned a blind eye to the influx of PKK militants to Turkey via Syria. For example, the construction of Birecik dam was followed by the PKK's attacks on Hatay from 1995 onwards. This war-like atmosphere lasted until the signing of the October agreement in 1998 and the capture of Ocalan, head of the PKK. The relations between Turkey and Syria improved to a large extent with the death of Hafez Assad, and peaked with occupation of Iraq by the United States in March 2003 (Oktav 2003).

3 Water and the Rapprochement Between Syria-Turkey-Iraq

It is very apparent that the basic reason for the amelioration of relations concerning the acute water problem was security-based. In the face of the probability of Iraqi fragmentation, and thus clearing the way for an independent Kurdish state on Turkey's southern border, Turkey preferred to adopt closer relations with Syria which had already been improved to a large extent after the signing of the Adana Agreement in 1998 (Oktav 2001). Soon after Hafez Assad's death, and because of the political reasons mentioned above, Syria felt the need to solve its acute water problem with Turkey and a Joint Communiqué was signed between the General Organization for Land Development (GOLD) of the Syrian Irrigation Ministry, and the Turkish GAP Regional Development Administration (GAP-RDA) in August 23, 2001 (Oktav 2009). The agreement envisioned the cooperation of the two sides in areas such as training, mission studies, technology exchange, and the implementation of joint projects. The aim of both countries was that this agreement and its subsequent implementation protocol (2002) would lead to a sustainable use of the region's land and water resources, and would address water management within a larger picture of overall socio-economic development and integration of underdeveloped regions in Turkey and Syria.

In December 2004, Turkish Prime Minister Recep Tayyip Erdoğan visited Damascus, where he and his Syrian counterpart, Muhammed Naji Otri, signed a free trade agreement, which was under negotiation for several years (Akıncı 2004). During the visit, Otri said: 'Other problems are forgotten' (Akıncı 2004), apparently referring to other key obstacles to full normalization of relations, such as the sharing of the Euphrates River. It is also noteworthy that the Syrian President Bashar al-Assad, during his visit to Turkey put emphasis on the fact that the two countries moved together from an atmosphere of mistrust to one of trust, which was entirely due to their joint opposition to the US-led invasion and occupation of Iraq (Al Jazeerah 2004).

Turkey, having the advantage of being upper riparian, wanted to centralize planning of all dam projects on the Euphrates-Tigris Rivers and also claimed that the upstream dams helped to regulate the rivers through cushioning floods and droughts in the downstream regions. It was also Turkey's attempt to include the waters of the Asi (Orontes) river on the negotiation agenda, a claim long rejected by Syria for the reason that Iraq is not a riparian state (Dalar 2010). Despite these longstanding differences of opinion, in March 2008, the three co-riparians had declared their will to cooperate by establishing a joint water institute with experts from each country (Todays Zaman 2008).

Throughout the 2000s, water turned out to be a mechanism for cooperative relations, while only a few years before it had been a main cause for a covert war, particularly between Turkey and Syria (Cumhuriyet 2011). However, the water scarcity issue continued as a dormant issue between the two countries. This became most visible in relations with Iraq when Iraq voiced its complaints about water rights during the water summit in Ankara in 2009. For example, Iraqi Water Minister Latif Rashid complained that Turkey had broken its promise to increase water flows down the Euphrates River. Energy and Natural Resources Minister Yıldız mentioned that while Turkey provided Syria and Iraq 500 cubic meters of water a second, central and eastern Turkey received only 350 cubic meters/second of water in 2009 (CNN Turk 2009). In addition, the Turkish government, noting that Turkey released water from Atatürk Dam on the Euphrates to its neighbors at the cost of risking its own share of energy to meet the demands of Iraq and Syria, emphasized that water is an opportunity for international cooperation rather than conflict (CNN Turk 2009).

However, since it is strongly believed that Turkey's GAP project and the Ilısu dam would reduce the waters of the Tigris River by 47 % and deprive the northern Iraqi city of Mosul of 50 % of its summer water requirements, official circles in Iraq and Syria were quite pessimistic about international cooperation (Ntvmsnbc 2009). Here the issue is that, as many analysts argue, water was perceived as a matter of hegemony. For example, from Syria's and Iraq's perspective, the Ilısu dam would let the Turkish government control the Tigris River, and this was a mechanism to control the water in the region which would undermine Syria and Iraq's access to water (ORSAM Water Research Programme 2011).

Despite everything, the atmosphere throughout the water summit in 2009 was quite peaceful and the three parties were entirely willing to cooperate over water scarcity issues due to the political conditions. First of all, American troops would leave Iraq in November 2011 and Iraq was still not stabilized. Secondly, Syria had no choice but to end its isolation in international arena and, therefore, turning a blind eye to the chronic disagreements over water in order to cooperate with Turkey was more beneficial for the Syrian government. Syria's existing anxieties regarding a pincer movement scenario coming from the two strongest armies in the region (from Turkey in the north and Israel in the south) were further exacerbated by the military presence of the United States in Iraq. Here, the reasoning is that only with a strong Turkey in the region was there a chance for Syria to counterbalance Israel and the American military presence in the region.

Both Syria and Turkey felt vulnerable to the threats of global and systemic changes such as the demise of the Cold War and the lack of a global power balancing the superiority of the United States in the new century. Therefore, they upgraded bilateral relations especially at the economic level (Ayhan 2009). Both countries also favored cooperative relations at a military level and decided to deepen collaboration between their defense industries. For example, they conducted a joint military exercise in April 2009 (Saab 2009). From Damascus's perspective, it could be seen as a political message to send to Washington and to make Israel nervous, while Turkey saw it as contributing to the security of its borders and relations with its Arab-Muslim neighbours. The improvements to political relations were followed in the economic sphere, enabling Turkey to build a regional economic belt extending towards the Arab and Gulf area. Turkey increased its trade volume with Iraq as well, by adopting the same motto it adopted in its relations with Syria, 'common destiny, history and future' in order to build the future together (Oktav 2011).

The cooperative relations between Turkey and Syria gained momentum with the signing of the September 16, 2009 Treaty (Today's Zaman 2009) which removed visa requirements. The establishment of the High Level Strategic Cooperation Council for the first time at ministerial level on 13 October 2009 in Gaziantep and Aleppo was also a turning point in bilateral relations. Over 10 ministers from the two countries participated in the meeting. It was followed by High Level Strategic Cooperation Council meeting at prime ministerial level on 23 December in Damascus (Republic of Turkey, Ministry of Foreign Affairs 2014). In this context, Turkey and Syria signed 51 protocols by March 2010, among these protocols, the ones related to water were noteworthy (for further details see Maden 2012). The two sides signed the memorandum of understanding to construct a friendship dam over the Orontes River in 2010 (Poyraz 2009). The dam, which would be used not only for energy and flood prevention but also for irrigation, was already planned with the signing of 50 protocols in 23–24 September 2009 between Turkey and Syria. It would also irrigate 13,334 ha of farmland and generate almost 16 GWh/year of electricity (Maden 2012). The construction of the Orontes River Friendship Dam started in February 2011, however, activity came to a halt after only one month in March 2011, with the outbreak of the Syrian civil war in the city of Daraa, Latakia, Hama, Humus, Idlib, Deyr ez Zor (Maden 2012).

4 Water and Syria's Civil War

As many analysts argue, no single factor can account for the Syrian uprising that started in March 2011. Rather, factors varying from religious and sociopolitical to economic and environmental ones triggered the outburst of the armed struggle in Syria. In Wieland's interpretation, the al-Assad and his Ba'athist regime failed to respond to the demands for change (Wieland 2013). According to Beck (2014), the crisis includes "long-standing assimilation and containment of the middle class as

an independent political force; repression by the security apparatus; indefinite delay of structural political reforms; high levels of administrative corruption; high youth unemployment rates; and increasing income disparities after the introduction of economic liberalization reforms". Gleick (2014)sees a direct relationship between the internal displacement/water availability problem and the civil war in Syria. He suggests that the dislocation of Syria's rural population, because of the drastic decrease in water availability, water mismanagement, agricultural failures, and related economic deterioration, led to the crisis. Put differently, the unemployment of those dislocated rural communities in urban areas is one of the important factors which triggered the mass protests aimed at regime change in Syria. Femia and Werrell (2012)also view rapid population growth and mismanagement of natural resources as important reasons for internal mass displacement which precipitated the crisis in Syria.

The Ba'athist regime mismanagement can be highlighted as follows: "Syria sold much of its emergency wheat reserve to make a quick gain from high prices in 2005, however, the drought in 2008, the worst one for 40 years, urged the Syrian government to import wheat for the first time in 20 years. Furthermore, the regime of Al Assad, both Hafez and Bashar, disastrously mismanaged the water issue. They subsidized thirsty cotton and wheat, then allowed over-extraction of groundwater, causing aquifer levels to sink. Fields were turning into deserts" (Mills 2012). The 2008 drought had then led to migration of 50,000 Syrian families from rural areas just in 2010, "on top of the hundreds of thousands of people who fled in earlier years" (Femia and Werrell 2013).

As Gleick (2013) notes, the American embassy in Damascus warned in 2008 that the drought in Syria would lead to destabilization of the country. The number of Syrians who were left extremely food insecure by the drought lay at about one million (Worth 2010). According to the UN report, the number of people driven into extreme poverty was even worse, with an estimated two to three million people affected (Femia and Werrell 2012).

In a nutshell, Syria's efforts to achieve 'a relative food security' failed as its economy which depended mostly on agriculture worsened with each passing day (Worth 2010). The Euphrates Valley Project is a conspicuous example with respect to understanding the Syrian policy of energy and irrigation, which resulted in a failure on a grand scale. By 1963, the Syrian government decided to go ahead with the project with plans to build a large dam on the Euphrates River called the Euphrates-Tabqa, renamed al-Thawra. The dam was completed in 1975, but its lofty targets were largely misplaced, partly due to overestimation of irrigation potential of the gypsiferous, crust and erosion prone soils in the area, salinization caused by over-pumping and by the collapse of canals due to seepage (Quarrie 2004). Another reason for failure, according to some analysts, was that Syria's drive to develop the Euphrates Valley had nothing to do with energy or agricultural production, but it was a clear method of the Ba'athist regime to extend their authority and recast the social class (Richards and Waterbury 1990). The current food shortage which triggered the civil war in Syria should be viewed against this background. At the present day, the food shortage is increasing so much with each day that "a group of

Syrian clerics have issued a ruling – or fatwa – allowing people living in besieged suburbs of Damascus to eat ordinarily forbidden dog meat" (Usher 2013).

The Syrian civil war has also proved that water is of crucial importance for the human security and survival of internally displaced people as well as the refugees fleeing the war in Syria. As Beck (2014) notes, "inside Syrian borders, basic humanitarian aid is often not reaching rebel-controlled areas. In neighboring countries, the provision of safe and sufficient drinking water and sanitation has become a challenge due to the steadily growing influx of refugees from Syria".

Syria's civil war and the influx of Syrian refugees to the Turkish border has had a direct and negative impact on cooperative relations between the two countries, and became a litmus test for Turkey's good neighborhood policies. In the face of the increasing tension in Syria, which had a spillover effect (Oktav 2015),[1] and al-Assad's remaining indifferent to Turkey's warnings about the implementation of political reforms, Turkey believed that Syria would be stabilized only with a regime change. When a Turkish jet was shot down by Syrian forces in June 2012, and explosions in places near to border and violent confrontations along the border led to the deaths of many Turkish civilians, the Turkish government responded in support of government opposition groups (Oktav 2015).

In the meantime, Turkey has contributed to the protection of hundreds of thousands of Syrian civilians fleeing the war by providing them with accomodation in refugee camps including access to clean drinking water and sanitation. Turkey currently shelters Syrian civilians whose number has exceeded 1.000.000 and applies an open door policy which enables Syrian refugees to have temporary protection regardless of their documentation (Dinçer 2013).

Interestingly, although Turkish-Syrian relations came to a halt at a diplomatic, economic and political level, the increasing water shortage due to the state of war pushed Syria to maintain communication with Turkey in order to deal with the water scarcity issue even in the midst of the crisis. For example, the ongoing construction of the Orontes Friendship dam is noteworthy with respect to understanding how water can be a leverage point for Damascus to maintain communication with Turkey even though it is modest and low level (Todays Zaman 2012).

One explanation for cooperation over water shortage during the crisis is that over the course of the conflict in Syria, both the opposition groups and the Syrian government targeted the capture of dams on the Euphrates River such as the Tabqa and Tishrin dams. As the attacks on these dams increased the water shortage, the growing demand for water increased (Saad and Gladstone 2013). This automatically provided a venue for Turkish-Syrian cooperation. As Kibaroglu and Scheumann (2013) note, "partial institutionalization of water cooperation and growing networks of water dialogue at both the governmental and nongovernmental levels have continued to serve as open channels for easing the tensions".

As a war-torn country, Iraq also has been suffering from food insecurity like Syria. After the American presence in Iraqa large percentage of Iraqi people could

[1] "The spill over effect of the Syrian civil war became evident with the attacks on Turkish towns like Akçakale, Cilvegözü ve Reyhanlı in 2013 which costed the lives of Turkish civilians".

not secure enough food, due to reduced domestic agricultural production that led to inflation, unemployment and a crumbling system of subsidized food distribution.. According to Iraqi official figures, about 23% of Iraqis live below the poverty line (Iraq Business News 2009). For example, at the water summit in Ankara, Iraqi Water Resources Minister Abdel Latif Jamal Rasheed highlighted the terrible state of irrigation in Iraq (Landis 2009). Even cutting the electricity production at the dams over the Tigris and Euphrates rivers and releasing their waters had not prevented catastrophic impacts, which have forced many Iraqis, especially those in the south, to leave their homeland (CNN Turk 2009). In addition to the fact that the two thirds of the total land area of Iraq is desert, decreasing amounts of rainfall in the last years have made Iraq highly dependent on the Euphrates and Tigris for irrigation water (Albawaba News 2014).

When it comes to Turkey's relations with Iraq, tensions between the two countries are ratcheting up as Iraq becomes more and more vulnerable to water shortages and drought, which had already increased, and in particular after the American occupation, during which a large part of Iraqi forests were damaged by the American occupying forces. Due to its heavy reliance on the River Euphrates and Tigris for agriculture and electricity generation, Iraq renewed its efforts to reach deals with Syria and Turkey to increase water levels on the River Euphrates which flows from these two countries into Iraq. Baghdad's efforts, however, remained fruitless and the severe water-supply shortage in early 2009 led to the deterioration of bilateral relations between Turkey and Iraq. This added to the diverging interests and postures of both sides towards Syria's civil war and increased Iraqi officials' accusations towards Turkey (Oktav 2015).

According to the Iraqi parliament, "as a result of Turkey's infrastructural works in the Euphrates and Tigris river basin, spring water reserves in Iraq dropped to a total of 11 billion cubic meters, compared to 40 billion cubic meters only 3 years ago" (Jongerden 2010). From Iraqi officials' perspective, 'the outdated Sumerian flood irrigation methods used by Syria and Turkey will deteriorate the quality of water reaching Iraq with drainage water from irrigated fields upstream being fed back into the Tigris and Euphrates rivers. The drainage water is not only highly saline, but is also loaded with pesticides and nutrients from fertilizers. This result of the reduced water quality is the slow death of agriculture in the land where it was developed in southern Iraq' (Clughton 2011).

As many analysts agree, solutions to the existing water problem require vision and cooperation between the countries that share the basin of these two great rivers. According to Azzam Alwash, the director of one of Iraq's largest non-governmental environmental organisations, Nature Iraq, one solution is to coordinate the policies concerning the release of water from dams, and the other is to improve and modernize irrigation methods to eliminate water wastage and over use (Clughton 2011). The issue is that the implementation of such a plan requires trust and a cooperative approach. However, this is not possible at a time when Turkey's relations with both countries have been deteriorating, in particular since the Syrian civil war (Oktav 2015).

Despite the economic sanctions imposed by Turkey on Syria and diverging interests with Iraq throughout the Syrian crisis, Turkish top officials clearly stated that Turkey would not use water as a trump card, on the contrary, it would favor equal and optimum allocation of Euphrates-Tigris waters to Syria and Iraq (Today's Zaman 2011). The idea behind this Turkish policy is that water originating from Turkey and flowing into Syria and Iraq is of crucial importance for human life and, therefore, cannot be used as a tool against Syria and Iraq where the food shortage crisis peaked due to war conditions[2] (Maden 2012). As the Forestry and Waterworks Minister Veysel Eroğlu openly stated, Turkey would not cut off water and electricity to Syria, because from Ankara's perspective, the problem was not with the Syrian people but with the Syrian regime (Today's Zaman 2012). However, Turkey has been increasingly criticized on the ground that it has stopped the flow of water from the Euphrates to the Northern Syrian province of Raqqa under ISIS control for political reasons (Milliyet 2014). While Turkey condemned the repression of the Syrian people at the hands of the al-Assad regime, Syria perceived this as an encroachment on Syria's internal affairs (Oktav 2015).

In a similar vein, Turkey's pro Sunni approach to Syrian crisis, and its rapprochement with the Iraqi Kurdistan, were seen by the al-Maliki government as an encroachment on Iraq's internal affairs. Iraq increasingly lost its trust in Turkey on the ground that Turkey favored only the rights of Sunnis, which, from Iraqi officials' perspective, became evident with Ankara's policies favoring Sunni opposition groups in Syria throughout the Syrian civil war. Ankara's sheltering of Sunni vice-president Tarık Hashimi who was sentenced to the death penalty by the Iraqi government also exacerbated the existing tensions between the two countries (Oktav 2015).

The transfer of northern Iraqi crude oil via Turkey bypassing the central government in Baghdad, Davutoğlu's visit to Kirkuk were harshly criticized by the al-Maliki government on the ground that Turkish policies were endangering the territorial integrity of Iraq. At a time when "Iraq is battling on three other fronts – handling its water crisis, rejuvenating its economy and oil exports after 6 years of instability, and resolving its long-running dispute with the autonomous Kurdish region in northern Iraq" (Vemuri 2011), it is badly in need of Turkey's help and support. The advance of the radical Sunni Jihadist group, ISIS so as to initiate a new sectarian based war in the country will, no doubt, change the dynamics of Turkey-Iraq and Turkey-Syria relations in the short run. Currently, the borders of both Syria and Iraq have been redrawn and ISIS has been attempting to control Iraqi dams such as the Haditha Dam, the second largest in Iraq, raising the possibility of catastrophic damage and flooding (Rubin and Nordland 2014). ISIS has already opened the Felluce dam, flooding crops all the way south to the city of Najaf (Hamza 2014). This is one example of how water and food security in Iraq has been endangered by the sectarian based war, and this suggests that there is a close relationship between water resources and intra-state armed conflict (Hamza 2014).

[2] "Turkish prime minister Davutoglu also declared that any restriction related to water would not be made on transboundary Euphrates and Tigris waters".

Needless to say, in such an atmosphere, high politics issues dominate bilateral relations and, therefore, the expectations concerning the search for a firm and optimum solution to water scarcity problem among the three countries seem quite weak. Put differently, Turkey's efforts, and Syrian and Iraqi willingness to find a firm and optimal solution on regional rivers currently seems to be paused on the altar of high politics.

5 Conclusion

A survey of relations between Turkey-Iraq and Syria in terms of water scarcity issue makes it evident that shared water resources can act as a source of cooperation as well as of conflict depending on the changing circumstances on political, economic and national security level. When looking closely, although Turkish foreign policy mostly perceives and approaches water as an element of cooperation, Ankara has been reluctant to sign up to international conventions such as the UN Convention on the Law of Non-navigational Uses of International Watercourses, the UN Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes, and the Environmental Impact Assessment in a Transboundary Context. Instead, Ankara has tried to find out a solution by furthering cooperative bilateral relations with Syria and Iraq.

During the 1980s, the Turkish government embarked on a major stabilization and economic liberalization programme, and as a reflection of liberal economic policies, Ankara both tried to extend cooperative relations with Iraq, Syria and started to see water as a commodity to be sold with the aim of coping with its high inflation and economic problems (Kibaroğlu et al. 2011). Turkey's 'peace pipeline' and Manavgat water supply projects illustrate this trend. Turkey, who pursued huge development projects, failed to take the interests of water-scarce downstream riparians into account throughout the 1990s. Thus, it both emphasized its superiority as an upper riparian and pushed the downstream states to politicize water more aggressively (Oktav 2003). However, with the beginning of the new century, dramatic changes at the systemic and regional level strengthened regional cooperative relations in dealing with water scarcity between the three countries until the outbreak of the Syrian crisis.

The Arab Spring in Tunisia, Egypt, Libya and Syria emerged for different reasons. Generally speaking, there has been a wave of reaction of the masses to the dictatorial and out-of-touch regimes in these countries. Looking more specifically, it can be said that those mass movements were the result of the erosion of the social contract between citizen and the government, especially in Syria. The al-Assad regime remained indifferent to the newly emerging social, economic, environmental and climatic changes which led to the strengthening of opposition groups. For example, Damascus could not cope with social unrest which, to a large extent, was due to the worst long-term drought and most severe set of crop failures between 2006 and 2011.

Iraq's situation is particularly perilous, as it faces a drought for the fourth straight year and tries to fulfill the basic water needs of its people at a time when it is going through a very unstable political process both at the domestic and international level. Iraq is currently very open to external threats mainly due to its extremely fragmented societal structure on the basis of sectarian identity as has become evident with the advance of the Sunni jihadist group ISIS to cities such as Mosul and Telafer in June 2014. Most important of all, the lack of unity among its ruling elite and the lack of a unified approach towards its international relations mean that Iraq has a reduced capacity to address its urgent water scarcity problem.

The conflicts in the war-torn Middle East are not primarily about water. However the ongoing civil wars are devastating the political, social, and economic fabric of both Syria and Iraq and water will be critical to reconstruction in the aftermath of the conflicts. This will automatically urge Turkey to release more water to downstream countries for humanitarian reasons in the post-conflict period. Therefore, Turkey's future water policy and political stance towards both Iraq and Syria will make clear whether water really can be a trust-building and cooperative factor or a cause for the relations among the three neighboring countries to become more problematic and contentious.

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Part IV
Critical Perspectives and Approaches for Addressing the Impacts of Environmental Change on Human Security

Chapter 14
Human Relationship to the Land from a Legal Perspective as a Human and Environmental Security Challenge

Olivier Barrière

Abstract In a context of global change, the human relationship to the land – comprising as well a connection to its natural resources – increasingly defines a key challenge to human and environmental security, which pertains to the socio-ecological unit (socio-ecosystem) of man to his environment. Indeed, from this relationship materializes an ecological dimension on which the humanity depends for its existence, well-being, health, and development. In other terms, human societies rely on a life-support, that is the land which forms the "territory" and the natural resources which sustain human lives. Current pressures on land, including the land grabbing phenomenon, that are growing worldwide and particularly in Africa, place the land issue at the heart of the human and environmental security (through many problems such as food insecurity and climate change induced displacements or 'climate refugees'). This issue is even considered as one of the main drivers of many current and potential violent conflicts. The human relationship to the land and its resources, and the resulting consequences, depend on how they are supported by relevant laws. The reason is that land-related laws are not subject to a unique thought since they are plural and diversified worldwide. Based on this, and by perceiving legal systems in 'paradigmatic' terms, this chapter places side by side two exclusive legal perspectives on the human relationship to the land and its resources due to the cultural diversity which is still present and expressed worldwide despite the claims of the dominant discourse: In a first stage, the 'property' paradigm is thoroughly analyzed, allowing its foundations to come to the fore; this leads us to the second stage which deals with a 'territorial' paradigm constructed within a logic of social reproduction relating to the law of utilities (cultural, socio-cognitive, economic and political).

Keywords Common heritage right • Property right • Legal paradigm • Land tenure • Land grabbing • Legal socio-ecology

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1 Introduction

The viability of human systems and their capacity to reproduce are questioned today because of the unprecedented negative impact that humans have on the planet. This viability depends on an ecological interconnection (Dalby 2002) which is increasingly threatened by the growing environmental damage and conflicts engendered by different pressures for the sole goal of reaching resources. Human security (Kaldor and Marcoux 2006), which is growingly affected by the already-mentioned factors, represents the safety-ecology binary which puts into practice a plan for the future of human societies. The interdependence between societies and their natural environment promotes the socio-ecological unity that the notion of security integrates in the plurality of its dimensions. Therefore, the concept of 'human security' transcends the challenges related to human rights and includes both the security of states and the security of individuals. These challenges emerge simultaneously from different areas such as the social, economic, political, and environmental ones. Thus, the environment, peace, and progress influence each other, and this situation contribute to the fusion of many issues within the socio-ecological system. This fusion includes the regulation, be it international, national or local, which plays an essential role in defining the logic of particular paradigms, or in being the result of these paradigms. This is particularly the case in the human relationship to the land.

This relationship is indeed becoming a confirmed challenge within a globalized context marked by a strong population growth (around nine billion people in 2054[1]) and a changing climate with substantial impacts (see the 5th IPCC report 2014), particularly a migration process generating a growing number of 'climate refugees' expected to reach 250 million in 2050.[2] In this background, which also includes the issue of food security, an emerging phenomenon called 'land grabbing', or even 'spoliation', takes place in the world, and particularly in Africa. To counter the increased competition over natural resources, the Tirana Declaration (2011)[3] called

[1] http://www.statistiques-mondiales.com/croissance_population.htm; the world agriculture is facing major challenges: increasing food production by 70 % to feed an additional 2.3 billion people by 2050 (FAO 2009), Forum d'experts de haut niveau, Comment nourrir le monde en 2050, Rome:http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/Issues_papers_FR/L'agriculture_mondiale_à_l'horizon_2050.pdf).

[2] http://www.refugiesclimatiques.com

[3] The Declaration defines the land grabbing as "acquisitions or concessions that are one or more of the following: (i) in violation of human rights, particularly the equal rights of women; (ii) not based on free, prior and informed consent of the affected land-users; (iii) not based on a thorough assessment, or are in disregard of social, economic and environmental impacts, including the way they are gendered; (iv) not based on transparent contracts that specify clear and binding commitments about activities, employment and benefits sharing, and; (v) not based on effective democratic planning, independent oversight and meaningful participation". The Declaration was orchestrated by the International Land Coalition which is a global alliance of civil society and intergovernmental organizations working together to promote secure and equitable access to and control over land for poor womenand men through advocacy, dialogue, knowledge sharing and capacity-building (www.landcoalition.org).

for the securing of "the poor's access to land" through a land regulation that recognizes the rights of local communities and denouncing all forms of land grabbing, be it international or national: "We note that land and other natural resources are increasingly scarce and under threat due to a number of factors, including population growth, migration, changes in consumption patterns, climate change, land degradation, corruption, and other forms of poor governance. Moreover, this is taking place in a context in which the control of land is increasingly concentrated in the hands of a few, while at the same time, a growing number of rural and urban poor are left with small and fragmented lands. This fosters conflict and food insecurity, and exacerbates poverty".

Land grabbing, or the massive purchase of arable land by foreign public and private investors, is a form of ownership on a long term or permanent basis (by purchase or lease) for the objective of outsourcing food production via agro-industrial projects. According to HLPE-FAO (2011:10),[4] this phenomenon is happening in practice with a real abolition of the people's rights to agricultural land, thus generating a growing factor of food insecurity. The established agreements are never favorable to the people: "Investors usually have the obligation to consult with local communities but the consultations are often done in haste and without correctly informing communities, the benefits of the transaction being exaggerated and the negative effects minimized. The power relations between the different actors involved in the negotiations (investor, government, local population), and the information available for each of them, are extremely unbalanced. Consequently, local people are almost always losers, and the governments often allow missing long-term revenues and opportunities for their people" (HLPE-FAO 2011:10).

The first investor countries are: The USA, Malaysia, Singapore, the United Arab Emirates, the United Kingdom, Canada, India, Saudi Arabia, Russia, China and South Korea. Multinational corporations, agribusiness, financial institutions and national elites define these international investments. The massive land acquisitions are primarily made in: (a) African countries (16.5 million hectares), covering particularly Burkina Faso, Guinea, Sierra Leone, Liberia, Mali, Benin, Togo, Senegal, Niger, Côte d'Ivoire, the Democratic Republic of Congo, Sudan, Ethiopia, Zambia, Rwanda; (b) Asian countries (nearly six million hectares) such as those of South East, Indonesia, the Philippines, Cambodia, Papua New Guinea; (c) the countries of Eastern Europe (2.6 million hectares) including Romania, Kazakhstan, Lithuania, Mongolia…; (d) Latin America (2.5 million hectares), including Brazil, Nicaragua, Chile and Argentina; and (e) Oceania (2.2 million hectares). The quantification of

[4] See the alarming report on the grabbing of agricultural land in the South: FAO-IIED-IFAD (2009). According to HLPE and FAO (2011:8–9), there are good reasons to worry about the impact of these land acquisitions on the food security of the populations of many concerned countries. Do these large-scale investments have beneficial effects, or will they inevitably affect the livelihoods of local people and generate social and environmental costs? (…) It seems rather that these large-scale investments are harmful for the food security, incomes, livelihoods and environment of local people.

land acquisitions is the subject of the investigations led by the Land Matrix Project[5] (a transaction recording program), which showed a very strong growth in land deals in developing countries since the 2000s, especially between 2005 and 2008 to reach in 2015 a total of almost 30 million hectares rented (concessions) or sold[6] (in cross-checks), or from 50 to 80 million hectares, according to another interpretation (Africa would be subject to 134 million hectares of which 34 million have been the subject of cross-checks).

In 2012, the G8 launched the New Alliance for Food Security and Nutrition as an initiative to promote food security in Africa by encouraging foreign investment in sub-Saharan countries. According to this initiative, the "goal is to increase, in partnership with the people and African leaders, responsible foreign and domestic private investments in African agriculture, to ramp up innovations that improve agricultural productivity and reduce risks affecting vulnerable economies and communities". Many NGOs (such as Oxfam, CCFD-Terre Solidaire, Action Against Hunger, ActionAid) stressed their concerns from an economic perspective: "Africa is seen as a possible new frontier to make profits, with an eye on land, food and biofuels in particular. The recent investment wave must be understood in the context of consolidation of a global food regime dominated by large corporations in input supply (seed and agrochemicals) especially, but also increasingly in processing, storage, trading and distribution".[7] Therefore, behind this official initiative, economic interests – opening new markets for the G8 member states' businesses – are detected rather than solidarity concerns; thus accelerating additional land grabbing rather than promoting the food and nutrition security that will enable to get 50 million people out of poverty through public-private partnerships.

According to Curtis (2015), if the profit perspective is considered, the inclusion of the needs of poorest people is not. The impact of the New Alliance on the land reform agenda in concerned African countries is reduced to the promotion of investments. The objective of securing land is reflected either directly by the generalization of registration, or more indirectly through the recognition of customary rights formalized in legal document, such as a certificate or a land title. This recognition, by transforming the oral form of a right into a written one, tends to its more or less visible and progressive transformation into the law of property or ownership. In Burkina Faso, for example, the national framework of the New Alliance aims in its

[5] The Land Matrix is a global and independent land monitoring initiative. Its goal is to facilitate an open development community of citizens, researchers, policy-makers and technology specialists to promote transparency and accountability in decisions over land and investment ». The project has been initiated through an international partnership between 5 organizations: International Land Coalition, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Centre pour le Développement et l'Environnement de l'Université de Bern, German Institute for Global and Area Studies et le Deutsche Gesellschaft für Internationale Zusammenarbeit. For more information: http://www.landmatrix.org/en/about/

[6] Data available online at: http://www.landmatrix.org/en/get-the-idea/agricultural-drivers

[7] Declaration of the civil society in Africa, "Modernising African agriculture: who benefits?" signed by many organizations and networks in Africa including Via Campesina, African Biodiversity Network,…For more information: http://www.inadesfo.net/A-qui-profite-la-modernisation-de.html

objective no.4 on the sustainable development of natural resources to "facilitate access to land and its safe productive use". The advocated means, based on the Law of land tenure in rural areas (Act No. 034-2009/AN), consist in the creation of 'landholdings' certificates', a national committee and regional committees for rural land tenure security, rural land services and village land commissions. The process of 'setting property' or land capitalization is launched. The case of Nigeria is also expressive. This country has just joined the New Alliance in 2013, in partnership with the United Kingdom, and has decided to implement a program for systematic land titling and registration in order to provide cheap land rights (…) which act as a stimulus for land market (cited by Curtis 2015).

Yet, the World Bank emphasizes the importance of the recognition of customary land rights (World Bank 2007), and the FAO Voluntary Guidelines on the Responsible Governance of Tenure of Land[8]recommend states to protect the people's rights to land using customary systems of land management in order to eliminate hunger and poverty (FAO-CSA 2012). These Voluntary Guidelines are used as soft standards in form of 'recommendations', but their legal value deserve to be considered despite the absence of coercion. Without prejudice to the sovereignty of States, these guidelines emanated from the international community that advocates the necessary recognition of indigenous legal systems or 'legitimate rights', that is the customary law, by declaring that States should recognize and adequately protect the legitimate tenure rights of indigenous peoples and other communities which apply customary tenure systems (FAO-CSA 2012).

Therefore, the real question is how these lands (of the Global South) can be transferred to non-local actors, with what control power and on the basis of which legal status of land. It should be noted that if the regime of property rights is not widespread or very little current, there is no unoccupied, 'masterless' or 'vacant' land that is not subject to an entity's right, be it a person or a community.[9] The question of recognizing the local people's rights to land is essential when it comes to the issue of land grabbing because grabbing requires an owner or at least someone who pretends to be so. Here, another question should posed: How far can the opposition of a right falling outside the legal regime of property resist to the legal pressure of multinational corporations? (Chouquer 2012a, b). If we deepen our thinking, we will be dealing with the 'land paradigm' in its full dimension, which can be expressed in terms of a 'clash of civilization'. This clash, pertained to socio-cognitive representations, highlights a real 'cultural' conflict: What is outside the legal system of property, i.e. the commodification, does not exist; the land is thus a 'vacant' object and 'without a master' by definition. From this positivist ideology, carried by the capitalist economy, arises the very negation of a relationship to land which considers the 'land' something that is not a good or a commodity: no land can not be

[8] Adopted by the Committee on World Food Security (CFS) in its 38th session on May 11, 2012.

[9] "Much land in middle and low income countries is productively occupied and used, but does not have formal paper title, rendering such customary rights vulnerable to dispossession. Rights of women, social groups relying on the commons (grazing, woodland, wetlands), ethnic minorities and indigenous peoples are particularly insecure" (HLPE-FAO 2011:10).

appropriated and not considered as constitutive of a common heritage. Unable to free itself from the Western thought, it is the paradigm of the regime of property rights that hides any different or concurrent system. This paradigm perceives the system based on the logic of endogenous non-westernized groups, called 'customary' by the colonizer, as an argument to consider the land resource as free of all rights, vacant and ownerless, since it is not in the regime of property rights.

It is in these terms that the issue is being raised in Senegal (who joined the New Alliance in 2013 in partnership with Canada) within its land reform agenda. The committee in charge has explored no other option but to generalize the land registration, that is the regime of property rights: The inalienable land, national heritage or domain (1964 Act of Leopold Sedar Senghor), will certainly become an appropriable good, and therefore falls within the logic of commodification, thus speculation. This will facilitate achieving more transactions with agribusiness, by the State and local government owners, on behalf of development (as part of the Sustainable and Inclusive Agribusiness Development Project, which predicts investments in 55,000 ha, mainly in horticulture). The land reform project is moving indeed towards the development of leases and subleases that rural communities will offer to investors.

Accordingly, as in Malawi, the objective of land reform is to ensure adequate access to land and an established land tenure status to private operators. The Malawi National Export Strategy 2013–2018 intends, among its priorities, to ensure appropriate titling of agro-industrial land and land acquisition (…) for new commercial agricultural projects. In 2013, Malawi adopted four land-related laws (Land Bill, Customary Land Bill, Lands Acquisition Bill, and Registered Lands Bill) which aim to encourage the land registration, including customary lands. Moreover, the legislator granted full powers to the State and local authorities to carry out leases on public land without the requirement to obtain the consent of concerned people.

Yet the 2012 IIED, CIRAD and the International Land Coalition report supports our approach by stating that "we are at a critical juncture – a crossroads – beyond which appears to lie a path of rapid and irreversible change in the ownership and control of land resources, in agricultural systems, in rural societies, in ecosystems, and in how we try, globally and locally, to feed ourselves". Although not expressly mentioned, it is however this idea of paradigm that prevails when authors conclude that eventually "land and other natural resources should not be treated as mere commodities, but rather as elements of a complex and diverse social, cultural, and ecological systems" (Anseeuw et al. 2012:67).

The human relationship to the land is currently a significant human security challenge brought to the fore by the land grabbing practice and the growing number of climate/environmental and political refugees. The increased pressure on natural resources, including land, and the diffusion and export of land property model are worrying, for their autism, with respect to other property paradigms which are still relevant to a part of the world population. This chapter places side by side these two exclusive perspectives on the human relationship to the land due the cultural diversity which is still present and expressed on the planet.

We also suggest that the viability of the socio-ecosystem interdependence, on which the global security depends, is founded on a regulatory basis that consists of

legal orders and systems. This framework reflects the man/nature rational paradigms which are: ownership and transmission. Both approaches to life express the bipolarity present in the planet, consisting of "homo economicus" and "homo territorialis" (David 1999; Bonnemaison 1981). As a result, two fundamental legal regimes emerge within a perspective spotlighting legal pluralism.

The socio-ecosystem regulation, which associates a society to the environment in which it develops and procreates, has a dual nature in representations and in legal regimes. This regulation is defined either through the notion of 'goods', that is a 'merchandised' item, or through the notion of 'utility', which refers to a territorial relation. The legal space does not limit itself to a single model because of the diversity of legal paradigms and the ontology of human-nature relationships underlying socio-ecosystems.

Within the Romano-Germanic civil rights,[10] goods are items that could be object of ownership: "goods are things whose usefulness justifies ownership" (Zénati-Castain and Revet 2008, 18); or "the items that fulfill individuals' needs" (Terré and Simler 1992, 11). Therefore, the possibility of ownership is necessary to transform an item into goods (Carbonnier 1995, 93). Thus, the ownership account defines goods[11] in the sense that goods are inevitably items which serve as a substance of property; and the right to property itself, "absorbing every utility of the item," "confounds with it" (ibid.). Consequently, property becomes goods (Carbonnier 1995, 102)[12] : but this seems improbable, "how is it possible to get hold of a relation of ownership ?" in addition to that, the utility associated to exclusivity engenders property, which allows the item to become goods (Zénati-Castain and Revet 2008, 21).[13]

However, in this context we are dealing with a legal system which reflects a Western relationship to the world (culturally and economically speaking). If it seems true that this system seems to dominate increasingly the planet by means of globalization and by a sort of imperial business, a significant proportion of the world-population still does not adhere to this paradigm: socio-cultural contexts restrict or prohibit apprehension as goods of various items.[14] These contexts offer another representation which makes any kind of item inadequate to be ownership in and of itself. The relation of these contexts to the world is based on other values for which the item (land, forest, pasture,…), object of utilities (cultivating, cutting, plucking, grazing, fishing,…), cannot be goods but rather a generational and intergenerational connectivity. This connectivity is a space for social cohesion as much

[10] In opposition to common law.

[11] "Goods are physical items for which exists demands, on which rights of property may be established, and whose property may be transferred from an institutional unity to another through market transactions" (INSEE, online : http://www.insee.fr/fr/methodes/default.asp?page=definitions/biens.htm).

[12] This assertion is not a unanimity in the contemporary doctrine, cf. Frédéric Zenati, 1981; Sarah Vanuxem 2012.

[13] "constituting goods whose entity is identifiable and isolable, equipped with utilities and the object of a relation based on exclusivity" (Zénati-Castain and Revet 2008, 21).

[14] The same analysis was formulated by Frédéric Zénati-Castaing and Thierry Revet, 2008, page 21.

as of socio-cultural perpetuation of the group in which utilities of the item is founded. The separation between the utility and the item characterizes this paradigm: the item "funds" cannot be the object of ownership, so it takes the characteristics of "common heritage" because of the transmittable objective which it implies. Whereas the utilities that the object of incorporeal rights, prerogatives, are susceptible to incorporate legal trade.

As already mentioned, the study of legal regulation cannot be limited to the investigation of a single paradigm, so it requires the integration of a plurality of situations and modes of representations found within ethnocentrism or West-centrism. Indeed, a law, environmentally defined, is situated within the relationship that societies possess with their natural environment; and it is translated, from a holistic perspective, through the association of the socio-cultural dimension to its scientific dimension.

2 Man-Nature Relations

Through the relationship of societies to their environment, the concern of regulation is defined within the viability and the adaptation of socio-ecosystem, and with a degree of resilience. The socio-ecosystem translates a notion of 'connection' (Berkes and Folke 1998) or "dual" (Liu et al. 2007) attached to the notion embodied by an imbricated system as long as the integration of systems impose themselves in the analysis of the viability (Bourgine 1996; Aubin 2010) leading to the notion of anthroposystem or the socio-ecosystem.[15]

If the conviction of the intertwining of man is notably affirmed in the global Charter of Nature in 1982, the concept of biosphere itself situates individuals as members representing parts which belong to a whole. This relation is available as a concept of "social ecosystem" defined as "an interactive system including two different groups which consist of one (or more) sociosystem(s) and one (or several) natural(s) and/or artificial(s) ecosystem(s), belonging to a geographical area and developing over time. This process allows interactions between that which belong to human societies and that which belongs to the natural context".[16] The definition of socio-ecosystem converges on the paradigm of reconnection with the biosphere (Folke et al. 2011).

The law is situated within the process of adaptation which societies are capable of undertaking. By definition, the law represents a social fact which contributes to social viability, and its function consists of proceeding to regulations and normalizations in order to ensure the sustainability or the character of the group. In

[15] Many authors have tried to understand the manner by which the complex socio-ecological systems function, including: Holling 1973; Funtowicz and Ravetz 1993; Holling 2001; Walker et al 2002.; Pahl-Wostl 2005; Folke et al. 2005; Folke 2006a, b; Folke et al. 2010.; Janssen et al. 2011.

[16] Lévêque et al. 2003; Lévêque and Van der Leeuw, 2002.

this case, the legal system contributes first to social resilience, but jurists are still not capable of grasping the full extent of this concept.[17]

The resilience of adaptive systems cannot be defined merely by both its ability to resist change and to conserve an existing state. Generally speaking, resilience denotes a system's capacity to absorb disruptions through restructuring this system's functions and identity. However, this concept does not reduce itself to the notion of resistance to a perturbation or a shock. According to Carl Folke (2006a, b:259), resilience functions within the reconfiguration of structures and processes provoked by the disruption, which generates new trajectories relating to the system. In accordance, resilience provides a capacity to adapt since its benefit is situated within the dynamics of systems which follows the disruption. Undeniably, resilience is extremely dependent on the genuine capacities directed towards its internal organization. The resilience of socio–ecosystem, therefore, integrates the idea of adaptability,[18] apprenticeship, and endogenous organizations, which all contribute to create a capacity to endure disruptions. In its broadest sense, the law is situated in this level; the space which offers the proper aptitude for a group to react through transforming or innovating its internal regulation. Furthermore, in terms of services provided by ecosystem, resilience is defined as "the implicit capacity of an ecosystem to preserve desired ecosystem services in relation to a fluctuating environment and human usage".[19]

2.1 Socio-ecological Viability

The contribution of socio-ecological systems to societies (or ecosystematic services: that which nature provides individuals with) suggests, in this context, that the viability of societies depends on the viability of ecosystems. The viability of each social and ecological system moves with their interdependence, and the dependence of ecosystems on socio-systems proves to be more and more significant. The intervention of individuals makes use of "an environmental service" (or anthroposystematic service) in order to maintain biodiversity or to ameliorate the workability of the ecosystem.

Consequently, legal regulation intervenes at the same time on: (1) the inveiglement of ecosystematic elements (profits) and the management of these benefits for socio-systems; (2) the impact on ecosystems (flux of that which infringe ecosystems through socio-systems).

[17] Concerning natural risks, see: Sanseverino-Godfrin 2009.

[18] « Adaptability is a part of resilience. Adaptability is the capacity of a SES to adjust its responses to changing external drivers and internal processes and thereby allow for development within the current stable domain, along the current trajectory » (Folke et al. 2010).

[19] Folke 2006b, cited by Deffuant and Gilbert 2011, 10.

2.2 *The Anthropo-Legal Dimension of an Approach to Law*

There are two ways to trivially address law: the first approach suggests that law is limited to texts from which it arises (positive law) by associating jurisprudence to it, and the second approach rephrases the first but surpasses it to guarantee the continuity of the quest, through going beyond codes to include societies and their cultural traits. The sociology of law and, above all, legal anthropology situate the place and function of a law between fiction, "that which must be", and reality, "that which is". Taking into consideration legal pluralism by the presence of several spaces of legal regulation (transnational, national, and infra-national[20]) changes law from 'monological' to 'dialectical' law[21] (Chevallier 2001:835). Therefore, law cannot limit itself to a pyramidal logic,[22] to an exogenous state order for groups and individuals, without questioning the viability of the norm and of everything that "makes the law". The scope of regulation recovers processes related to socio-cultural, identity, and social cohesion reproduction in a vital perspective of existence, of the becoming of the group, and of the process of adaptability to a changing world. Therefore, the question focuses on elements that condition certain practices, actions and decisions related to "a juridical status", resulting at the same time in external/internal systemic relationship and in endogenous process of the formation of law. In other words, this inquisition concentrates on the legal process of a socio-ecosystem.

Consequently, the law that concerns itself with the environment should consist, in recurrent confrontations, of duties surpassing a scientific relation to nature in order to integrate the relationship between individuals and biosphere (cf. Naim-Gesbert 1999; Folke et al. 2011). Thus emerges the necessity to surpass the concept of law by opting for a 'legal regulation' in order to exit a positivist paradigm. This shift facilitates the integration of a sum of sources conditioned by the law, by that which 'makes the law' according to the societies with the goal of integrating diversity of the ontological equation: society/nature. We suggest that the legal regulation of socio-ecosystem is formalized within a contexts of 'service' or of 'utility', according to the level of objectification given to nature; it can be either 'environmentalist' in a naturalist or anthropocentric account, or identified in terms of "biosphere" which individuals are part of.[23] This description gives rise to the notion of socio-ecosystem.

The position of the relation between ecosystems and individuals, or between individuals and their environment, develops between the ownership system (property rights) and the common heritage, which we will develop. It will be thus necessary to transcend the Western logic of article 714 of the french Civil Code. This

[20] « That which is founded on « partial» or « local » solidarity (Chevallier 2001, 835).

[21] A concept put forward by Edgar Morin in order to express a fusion in a complex unity (that is to say, at the same time complementary, competitive, and antagonist) of two or several different logics, see oppositions (Morin 1990; 99).

[22] cf. Ost and Kerchove 2002.

[23] A position which permits to confers to nature a status of subject of rights (cf. Hermitte 2011).

article does not confer to the status of a common item only as that which is a "dead angle of property" (Chardeaux 2004) in a world where the rules of ownership remains privileged.[24]

This paper investigates two paradigms corresponding to a dual of legal systems: property (property law) and the law we call "utility." This latter is located outside the context of land ownership, but it is anchored in a social scheme of patrimonial transmission. The inappropriateness, along with ownership, is always organized by law. According to the paradigm, rarity generates either an ownership of an item which became "goods," or it restricts access to the "space-resource" (a concept which does not belong to the domain of property but belongs to another legal paradigm).

Utility may become privatized, not fall under the category of common items, without being acquired because of its non-profit status. Therefore, we find ourselves trapped within a complexity by gathering data concerning contradictory paradigms: the merchandised, the non-merchandised. The latter is non-ownership; it may be either common or susceptible to be private, and the village irrigated parcel of finage (in Africa) may be a perfect example for such situation.

The french Civil Code defines the notion "common" as that which is "common to all" (article 714). Nevertheless, the legal system of utility considers the "common" as that which is related to a specific attribution; in this case, it is the survival of a group (its procreation and its development) related to a specific territory (land, area, and yards of a territory as much as the territory of the entire clan or the ethno-lineage community). Thus, within this paradigm, attribution itself justifies and defines a system, which refers to the public interests of group that works for its sustainability, structured in terms of the notion of utility (whether tangible or intangible).

Legal paradigms which concern the coexisting society/nature duality are devised into two major main groups: on the one hand, we have groups defined in terms of the prevalence of market logic, and on the other, we have groups focused on the prevalence of a territorial logic. The representations of societies and the values these societies attach to biospheric elements are, of course, merely the reflection of legal regulation in effect. The categorization of items remains eventually bounded within these two main groups.

Article 714 of the French Civil Code suggests that usage is common to all, implying a vocation to serve everyone. This insurgent character of acquisition, which is the basis of the absence of a vocation of property, does not represent an obstacle to owning lands, for instance. We remain here in the context of the property paradigm. Similarly, items or things "without an owner" imply a vocation of being goods, but they still do not fully become so because of the lack of an owner (*res nullius*). This situation remains temporary because of the presence of a vocation to find an owner to become or re-become goods, often because of the influence of this item. Public items or properties, which involve the public domain or the "national domain," a legal category specific to African legislators existing in Senegal for instance, remain

[24] With a nuance to the "forms of more united ownership" (Rochfeld 2009:73).

inalienable because of their destination. Lastly, private items define private properties (involving the private domain of "public individuals" public entity).

However, outside the scope of item-goods, item-funds are 'territorialized' since they constitute a territory; one which is attached to these funds, rendering them a full construct. Item-funds participate in the definition and the constitution of the so-called territories and their inhabitants. Indeed, it is the items common to a group, with its cultural identity, values, and procreation, which leave the market logic to express a *sui generis* regime of common patrimony.

A larger conception of law authorizes us to transcend positivist principles; principles fortified with a reading of Romano-Germanic accounts concerning the creation of relations with the world through the legal system of goods. Through opposing a position of universality, we can affirm that property systems cannot be considered anymore as a 'civilizer' characterized with an incontestable ability to emerge from natural laws.[25] It is necessary to stress the prism of property regime which emerges from a Western paradigm that is not shared by two thirds of humanity (Le Roy 2011:348).

Consequently, we shall keep in mind the existence of two main legal paradigms that correspond to two perspectives of the world coexisting in the same planet: marketed goods or items (3) and territorial utilities (4).

3 Property Law: The Absolute Freedom of Individuals on Items, a Market Logic

The socialization of relations to nature in the West was formalized through a categorization of items, especially through a relation of acquisition. The item placed to become "property" constitutes goods. Moreover, property is usually considered the basis by which an individual definitely (*ergaomnes*) discards an item, be it tangible or intangible. However, even though the definition may seem too simplistic,[26] it still founds a paradigm entirely Western, which lies under a division of individuals and items (the *summa divisio*) in which goods reside; goods which are capable of designating items "that are susceptible to procure individuals with an exclusive utility and to become the object of property" (Xifaras 2004:36 citing Demolombe 1854). The object of property is, thus, an item-object or "goods" which focuses a body of (real) rights, attributes which constitute the dismemberment of property, such as usufruct, servitude, usage, and habitation.[27] As a deduction, the relativity of the

[25] which some authors affirm, especially: "… in all societies, there are rights that we must recognize as property rights. (…) Rights … related to necessary resources for the life and the survival of a family. Such rights may be qualified as property. (…) " (Berge 2007, 385).

[26] « There is no property definition capable of correctly describing entirely the actual law » points out Xifaras (2004, 8).

[27] But Sarah Vanuxem prefers the development of a renovating theory of property through the idea of "things-environments", 2010 and 2012.

"absolute" power which a person exerts on an item leads us to another notion; "one that concerns a bundle of rights characterized by being devisable and stackable, without necessarily having tangible items as objects, but it designates the irreducible heterogeneity of acquired objects and legal regimes to which they are subjected" (ibid.:9).[28]

Goods are particularly characterized by their capacity to be alienated and their ability to join legal and economical business, and all goods are susceptible to have those characteristics, such as space portion. In this case, the relationship of the trader to the "item-funds" is the result of distancing the individual from the item. This dichotomy, which concerns *the summa divisio*, defines the Western paradigm of the real estate. Property, pasture, forest, and other funds become an object because of their marketable value, related to transfers or guarantees. Bounded, they become a commodity, be it closed or not.

The emergence of this paradigm in the West is situated in the limits of possession, which allows the creation of land ownership whose objective is establishing acquired funds included in all utilities (Sect. 3.1). Constructing a system of property outside the West, which history did not construct, makes use of a method of purging the endogenous rights (customary) attached to funds (Sect. 3.2).

3.1 The Acquisition of Funds: Inserting Property Through Possession

Within land tenure law, indivisibility and inalienability are the general characteristics of possession (Proudhon 1866:88), and hereditary possession excludes any abusive tendency.

Property emerges through the legal recognition of the control that a holder exerts on an item. The possession, defended by force, is commuted to ownership by the social guarantee of a right related to the alienation (transfer or destruction) of an item: "… laws do not only protect property, they also produce and determine it. Laws give a property the rank and extent which it occupies in the rights of the citizen" (Laboulaye 1839:59). Property, thus, emerges from the law which recognizes the right to abuse.[29] Without law, there is no property, "which is contemporary with "first" society, that is momentary occupation, or with common possession: acquisition comes only later through the development of freedom and the slow construction of laws" (Proudhon 1866:71).

[28] « property is a bundle of all possible tangible rights on an item" (Xifaras 2004, 98) citing Demolombe, 1854.

[29] Ownership, or property right, exists only in relation to the right to abuse: « when the right to abuse does not exist, when society does not recognize it, there is no (…) property right; there is merely the possession right" (Proudhon 1866, 16). *Abusus* is limited. Joseph Comby stresses the impossible character of absolutism of property.

Originally (sic), there was no property, but only "occupation" (Laboulaye 1839:60). The emergence of property is characterized by confusing "having" and "being" usually related to a process from having to being and from possessing to owning. There are goods that fall under the "having" category, be it personal (*propres*) or mercantile (*capitalia*), but there are also familial properties "destined to be passed down from generation to generation, which makes them exposed to various forms of unavailability" (Xifaras 2004:483).[30] This situation incites authors to think that "by moving inheritances to the sphere which concentrates on propres, the modern theory of patrimony creates the unification of the personal "having" and "being"…" (ibid.). Whereas, "legacies" are usually portions of space, that is par excellence familial property.[31]

3.1.1 Roman Property: Quiritarium (Entirely) and Publicus (Concession)

According to Edouard Lefebvre de Laboulaye (1811–1883),[32] who is a legal expert,[33] property originates from a Roman context. It supposedly comes from the land share made by Romulus (the first king of Rome, 754–715) into thirty portions equal to thirty curia (with a definition of the people realized by a subdivision of the three first tribes – ethnic groups), a portion to the Cult and a portion to the State. Patricians, Roman noblemen, who followed Romulus, are landowners subordinated to the king. Their adherence to the kingdom transforms their possession (*possessio*) into property, giving the dominium. Patrician rights[34] refer to owners law (*jus quiritarium*). In the Roman context, property, or ownership, constitutes the object through which the domain is applicable: "*dominium is utendi juice and abutendi re sua, quatenus juris patitur ratio*" (*the domain* – or property – *is the right to utilize and abuse items, as much as law suffers it* insofar as law permitted it). The term "domain" derives from *dominus* (master) and *dominium* means "mastery" (control on the land). The translation of "mastery or control over domains" into property (*proprietas*, etymologically "quality of that which is clean" or "that which is the nature of

[30] Reference to « inner » rights, constitutive of personality, « right mixed with the existence of the individual, and which have for their object his individuality » (Xifaras 2004, 37, from Demolombe, 1854). These goods should not be goods, but they should be common patrimony with intergenerational characteristics.

[31] cf. French civil code which still employs this « heritage » term for property, for instance article 637: "'A servitude is a charge imposed on a heritage for the use and usefulness of an inheritance belonging to another owner', or for example article 666: "any cloture separating inheritance is deemed common, unless there is only one inheritance in a state of closure, or if there is ambiguous mark". Etc.

[32] Re-used by Proudhon (1866, 106).

[33] Author of "History of ownership in Europe from Constantine to the present day" (1839), a work noticed by the Academy of Inscriptions and Belles-Lettres. He was professor of comparative legislation at the College de France.

[34] Allowed to share conquered lands, and later to 376 plebians by law tribunes Licinius and L. Sextius stolon.

an item"), is avoided by Roman law (see Proudhon 1866:73), but it is still appropriate to the Civil Code in 1804, operating the confusion between subject and object, being and having.

Roman property (II B.C – II AD), which refers to owners or investors, gathers every power that we can exert on an item; an ultimate power exerted on an item defining *dominium*, as total mastery. Property is different from other real rights in the sense that it brings together the three attributes which defines it: *usus, fructus, and abusus*. It is important not to forget that the period when the concept of property affirmed itself corresponds to a commercial time, making of *abusus* the criterion of value of goods: including its market value, and its selling price.

Later on, King Servius was the first king to grant few lands to peasants, but all these attributions were made as possession since the common man merely possessed a usufruct sort of right. However, this right *possessio* was protected: the detention of a possession entered into the market in order to be transferable. Land arisen from the *ager publicus* retained their attachment to the State (which was favorable to patricians, plebs made use marely of common pasture). Only the land originating from the first division could be owned or invested. Possession was the rule while property was the exception. Possessors were defined in terms of the state, and the latter was necessary for their use, while the owner did not necessary need the state, since he has his own domain or land.[35]

However, historians stress the importance of the notion of family since it was so powerful in Rome that the owned domain remained indivisible and inalienable (compatible to a fiefdom) because the Roman state was merely a federation of families, small independent societies. In this context, the Roman land property neither alienates itself nor divides itself; it implies a duty of conservation: "The biggest concern (of the patrician) and his main task will always be the transmission of the entire land to his own family" (Proudhon 1866:109).

3.1.2 Feudal Property: Allod, Beneficiary, and Fiefdom (Between Freedom and Souverainty)

The end of the Roman Empire was marked by the invasion of "barbarians" (migratory crowds), which resulted in the transformation of data related to land property: "Barbarians, rulers of the empire, limited themselves to a part of the territory, leaving the rest to the former possessors (…): Burgundians and Visigoths took the two-thirds of the land which suited them; the Heruli seized a third of Italy; Ostrogoths seized the territories of Heruli; the Lombards, after taking state lands and anything else which was convenient to them, demanded also third of gains produced in properties spared for Romans. As for the Franks, they were not traders under the leadership of a king the way Burgundians and the Goths were; rather, they were only a few Germanic groups, united by a conquest labeled within the boundaries of war. Thus,

[35] which Proudhon stresses, 1866, 111.

they are unlikely part of land domination which stripped the former possessors of their lands" (Laboulaye 1839, 251).

While cities were given to Roman, the rural area was divided into hundreds of cantons. Without a central administration, public safety was supervised throughout the canton by an earl, whose responsibilities included being both a warlord and a judge of peace.

The events of the Germanic period favored land dealings over personal dealings because acquiring lands could command the status of individuals. Three types of land statutes prevailed: the noble, the "barbarian," and the Roman: "personal status was the condition to property (…) the land of noble was noble, the Barbarian's tax free, the Roman's (in cities) was subjected to tax. Lands being the source and the stamp of power, (…) rendered the state of individuals commissioned by the state of the lands" (ibid., 257). A landscape submitted to an account of vassalage, freedom and taxation; three simultaneous tenure systems, mainly related to fee and allod. Social conditions were increasingly integrated into land dealings through their dependence on types of property, which conditioned the rights and freedom: "(…) as we draw away from the conquest, with social conditions being increasingly incorporated into lands, successive variations of ownership resolved almost by themselves the mode and the vicissitudes of all conditions, all rights, all freedoms" (ibid., 258).

Feudal property is characterized by the fee, noble tenure, defined in terms of dependency and concession between suzerain and vassal (feudal lord) within the limits of a double state ownership, eminent domain and useful domain. Fee is a sovereign property, and it has kingly characteristics (civil and criminal justice, tax, tolls, right to issue coins and to lift the ban). This property stands alongside the "allodial" property, an individual and independent property, where all rights are reserved to the sovereign (hunting, fishing, river dam being part of the allod),[36] which reminds us of the property of Roman law. Allods or tax-free property, are lands free of any charges, free of all feudal duties (not belonging to any lord), including transfer taxes (lods): a land owned as a whole, as opposed to fiefs or *censives.* Tax-free property, with the characteristics of nobility, was justice oriented and perceived the *cens*; whereas, tax-free property of the common man had no such powers, and was directly connected to the Roman property. Free lands (excluding those which fall under vassalage category) were exposed to pressure within power dealings: any owner unable to be a leader was bound to be a vassal. This means that lands like men were chained to a leader, a lord, a mutual bond of protection and loyalty. This subjection destroyed low-ranking allodial property for a property considered beneficiary (or hierarchical property), that is a property favoring more powerful persons: "power alone could secure (independent) property" (Laboulaye 1839:280). Thus, the property was located in huge domains: "the yeoman was frequently attacked, looted, robbed; so he had to reduce himself to a

[36] It was still for sale *cum omnibus pertinentiis, pratis, pascuis silvis, venationibus, piscationibus, molendinis* ((with all its outbuildings, meadows, woods, pastures, hunting, fishing, mills) (Laboulaye 1839, 389).

simple use placed under the protection of the powerful men, who at least do not usually oust him entirely"(ibid., 280). Low-ranking allods were converted into "profits" by an allegiance based on mutual commitments, which consists of serving the Lord in order to benefit from his protection. In return, low-ranking allods received a "benefit"; that is to say, they received a portion of land that constituted their only wealth. This kind of "recommendation" allowed the preservation of his property by entrusting the Lord with eminence in order to have only a useful property[37] or usufruct.

The feudal reality of an eminent and useful domain offered the capacity of sublicense: each fee holder had the useful domain across the complete sphere of conceded fee along with the direct domain of under-indenture lands. At the end of the old system, all funds depended on each other, but the domain of the crown was ultimately influential to them.

Medieval property (V–XV), which was multiple and divided, was constructed in terms of a familial and village-like solidarity. User rights (common grazing, "*affouage"* (right to take wood in a forest), gleaning, heating,…), distinct from property of villages, are recognized by the rule put forward by Louis XIV in 1669 concerning waters and forests. They reflect a sort of a "survival" right which allows a sustainability of the basic needs of residents with communal and *sectionalized* constituting collective property of communities. Strict regulation of user rights aims to preserve the heritage of the communities against Lords, who exert fiscal pressures due to numerous wars). At the end of the old regime, the objective of owners was to liberate forests from "devouring" servitude, generating several trials between lordships and communities. Several user rights were converted into useful property right, and the hostility towards user rights increased (Gau-Cabée 2006).

The system is very hierarchical. It is built within the boundaries of dependency and mutual obligations, in which the property burst into "property rights" has become an obstacle to agricultural development necessary for population growth.

3.1.3 Property Unity Through Exclusivity and Individualism

Near the end of the eighteenth century, a redefinition of property characterized by unity and privacy emerged. With the collapse of the feudal power in favor of central government, the affirmation of individualism (Renaissance) under Louis XV witnessed the emergence of physiocratic doctrine promoting the liberalization of funds. The revival of economy ignited by agricultural progress justified individualism: "it was necessary to multiply individual property by removing common properties, to

[37] "The owner was stripped from the property, and he transferred the seisin to the Lord by symbol presented as a stick or a tuft of grass; then he immediately received the property as income – to make profits from it *absque Aliqua diminutione, usufructuatio* ordine (without any reduction of the usufruct order). However, becoming beneficiary, the recommended find himself in the position of a usufructuary, and he ensured in advance to his descendants the estate of profit" which was done automatically by presentation to the successor (Laboulaye 1839, 292).

liberate culture from collective servitudes and feudal rights, to promote large properties capable of creating noticeable progress and erudite cultures, to check the high cost or fair price produced by free trade, to multiply wealth more than the population". To ensure agricultural progress, physiocrats were eager to promote individual ownership, and they were equally eager to prove the irrationality of the communal system which was considered based on tyranny of the crop rotation, and of uncultivated lands on which collective practices depended (Gau-Cabée 2006:16). From 1769 to 1781, communal sharing was authorized, but the emergence of edicts allowed fencing lands which contributed to the establishment of private property for which user rights are "modern agriculture unworthy" (ibid.). The transition to exclusive property, confusing the right to the item or thing, is effectuated by the confrontation of two conceptions of ownership. The insurrection of low-ranked farmers and village communities lead to the transformation of property rights to individual rights. Simultaneously, properties placed on the same fund disappeared through the formalization of the Declaration of Human Rights (1789 and 1791),[38] confirmed in 1804 by the Civil Code to the holders of the user rights. The space consisting of simultaneous or seasonal tariffs became private, due to political choices of an ultimate liberty.[39] Property changed into "the right to benefit from and dispose of one's belongings in the most absolute manner, as long as one respects the law" (article 544 cci). This new form of property produced double absolutism: the one making the possessor becoming owner, and the one making the state the determiner of ownership. This situation leads back to the Roman property, *juice and utendi abutendi*, with a *dominium* restricted by the general interest and its social function.

In 1948, the Universal Declaration of Human Rights fully recognized property right, be it individual or collective. In its article 17, the Declaration mentions that "any person, individual as well as collective, has the right to property. No one shall be arbitrarily deprived of his property".

The social function of the property shapes the latter's legitimacy, which seeks to create equilibrium between private interest and public interest. The main definition of article 544 French civil code) emphasizes the opposition of the individual interest, of the owner with absolute capacity, and the general interest, laws and regulations. The social aspect of the property resides in the respect of all towards the state, but it could be dominant.

To conclude, the historical development of property reflects the genesis relations involving nature and the history of social legitimation of men taking over lands. From Possession to property, a point of no return inserted itself because of an institutionalization of an alienated property. The portion of space, holder of multiple resources (crops, forest products, game, fish,…), was the main riches available

[38] Its article 17 rejects that « property right is the one which allowed any citizen to use or dispose of his goods the way he wants, along with his income and profit which his industry provides him with » ; with a transition to the plural of "property rights", rectified in 1791, to the singular (Suel 1974).

[39] Article 544 du cci makes use of a political process: "(…) it is because it establishes, from the side of the individual, the absolute freedom, and it should be recognized that he has the right to have on items or things the ultimate domination" (Xifaras 2004:26).

which entered into "goods" category, object of ownership: of occupation, of monopolizing, of exchange, of reward, of gift, … and of sales. However, the emergence of property took place in a context relating power to men, through the establishment of a relation based on dependence, or subjugation, by means of the control of property. Subjecting utility to and orchestrated and eminent power lead, within a cascade of property rights, to economic individualism, which is elevated to a dogma of property. However, history is trapped within a perpetual motion, and the absolutism of exclusivity gradually collapses to be allocated within a bundle of rights in the contemporary process of the transformation of legal regulation.[40]

Concerning English laws, absolute and combined property does not exist. Following the feudal system established by William the Conqueror in 1066, all lands depend on the Crown, and the holders of lands are only owners of interests of lands defined in terms of "tenure" (real property). The "property" translated as "that which may be acquired." The population possesses rights to particular resources on the utilities fund (grazing, firewood and timber, fishing…). However, the growing process towards full ownership (*dominium plenum*) is fully engaged (see Berge 2007).

In short, within the context of property, civilian property is characterized by the rejection of elements influencing funds (multiple rights) in order to liberate it to ensure full sovereignty to the sole owner. However, in a context where the system of property has not emerged from a historical process, as it happened in the West, states attempt to impose it by limiting or annihilating the endogenous factors of the legal connections between man and his environment (the "customary" law) through the creation *ex nihilo* of land property. Consequently, on the one hand, a purging process within legislation appeared, and on the other, we find the implementation of a 'nationalization' or 'domanialization' of space, often present in conjunction with a form of recognition of the endogenous right.

3.2 Substitution and Integration: Purge and Recognition of Endogenous Rights or How to Create Property Where It Does Not Exist

We can always persuade ourselves, with an extreme ethnocentric attitude[41] (juricentrist) that the only legal system of property belongs to property. However, this idea is not completely supported, as we already mentioned in the introduction, and

[40] Xifaras speaks about a significant event involving the disintegration of owner dogma (2004:13) by becoming a "bundle of rights" (ibid., 18): "it is (…) not the political contestation of the owner order that overcame the classic property, but the evolution of capitalism itself, carrying in its transformations the dogma that gave it birth, and the pro-or contra- ideologies integrated this dogma" (ibid., 12). On the transformation of legal regulation, see in particular Clam and Martin 1998.

[41] Term designating "a collective attitude consisting of the repudiation of cultural forms: moral, religious, social, aesthetic, which are most distant from those specific to a given society" (Bonte and Izard 2010).

as certified by the processes introduced by colonial powers in conquered territories. With a reference to the Western model of modernity," and through the adoption of the dominant economical system, the system of property seems to impose itself as an evidence to most legislators. Evolutionist view functions through an inevitable realization of ownership accounts by individual property.

The confrontations which legal paradigms are exposed to represents a reality affecting native and local populations located outside the Western world or in places undergoing Westernization. The oxymoron between purging and recognizing genuine rights of local societies summarizes the problem arising because of the refusal of legal pluralism which collides with the principle of national unity.

Nonetheless, the case of New Caledonia suggests that the principle of adaptation (see articles 73 and 74 of the french Constitution) offers new possibilities, which still seems to be limited to "integration" of the Kanak customary law in positive law. The function given to customs is particularly important to point of equating it to the Civil Code.[42] To temperate this claim, it appears that "the influence of custom is very marginal in the local legal system" in New Caledonia (David 2012:200). Moreover, according to the same author, "it is never a question of integrating customary practices in the development of rules of the law" (ibid., 203). The integration of an environmental law facing customs arises fully against legal pluralism. Nadège Meyer and Carine David (eds.) tackle this issue in their collective work, through "the integration of custom in the development of environmental norms" (2012). The relation to power seems apparently to work, with the inclusion consumed under the form of integration; is custom captured by the positive law? But is it absolutely necessary that one absorbs the other?[43] The magistrate Régis Lafargue considers customary reality[44] as an identity; the custom in New Caledonia represents "the right to be oneself" (2012), with supporting customary assessors (New Caledonia uses the system status of a specific customary law).

Leaving aside the particular context of New Caledonia, we enter in a vaster context of Westernized French Africa and Equatorial French Africa where property system is introduced. Here we find ourselves faced with the imposition of a so-called 'civilizing' paradigm (by public law and civil law) in a cultural context, far from Europe, with a background of economic interests and political issues. It was

[42] Article 75 of the French Constitution, Kanaks could retain their personal customary status. In addition, the "option right," which is judicially origin, generates real customary common law in that no one may renounce the application of the customary rule. Organic Law of thee 19 March 1999 confirms this position by derogating from the application of the common law: custom is not subject to the rules of the Civil Code. The two statutes are equal (article 7 of Law No. 99–209 of 19 March 1999 on the organic New Caledonia), Lafargue 2010, 297; 2012.

[43] This is indeed the case in legal orthodoxy: a recent call for proposals of GIS law Research and relative justice on "The integration of custom in contemporary normative corpus in New Caledonia" (http://www.gip-recherche-justice.fr/IMG/pdf/AO_2013_Coutume-Nouvelle_Caledonie.pdf) (September 2013)

Do not forget to refer to Lafargue 2003, 2010; 2012 on the issue of custom in New Caledonia.

[44] Compare with: the attribution of customary lands – judgment of the Court of Appeal of Noumea on 11 October 2012; and personal status of the CA September 29, 2011.

all about creating *ex nihilo* property on a 'customary'[45] system. Indeed, within the context of the French colonies, the relationship with the land is not perceived to be part of natural law: "natives who currently own lands under local custom in the annexed territories have no regular title of property, so it is necessary to incite natives to regularize their possession in order to develop private property in the colonies."[46]

Justificatory colonial theories aiming at acquiring lands consisted of twofold orders. The thesis of the beginning of colonization concentrated on eminent domains, resulting in the emergence of the administrative concession. Colonial powers took over the function of local leaders, holders of prominent law. This subrogation theory has known sever condemnation by the Court of Appeal of french Western-Africa (AOF) in a judgment of principle of 10 march 1933: "conquest is not a mode of transmission of regular law (…). Abuse does not create the law, and the State cannot succeed native sovereign without violating the rights of people."[47] Until the beginning of the 20th century, annexation and acquisition were the only ways permitting to claim the management of colonized lands. Land claim was then justified according to the criteria of the vacancy of the Civil Code (articles 539 and 713), by the theory of "vacant land and ownerless." Therefore, the endogenous system of property was totally ignored by the logic of white settlers. Yet, the Decree of AOF which took place in 15 November 1935 substituted an economical criterion to the Civil Code: lands undeveloped within the last 10 years belonged to the state. The Decree of AOF established in the 20th of May 1955 removes the presumption of state ownership by the obligation of the State to prove the vacancy … through the lack of development, third justificatory theory of land monopoly by the State.

Thus, introducing property in Africa was made in two stages: the first is authoritative through the justification of an eminent sovereignty, and the second is "liberal" through a procedure for recognition of endogenous tenure ("traditional") before transforming it into property. The slow motion of change leads to the belief that

[45] The "customary law" notion is very simplistic, so it does not reveal the full dimension of endogenous law. It is a term preferred in legal anthropology, meaning "that which starts inside" of the socio- cultural group. In Africa, in the pre-colonial ownership rights were described as "traditional" then called "customary" in the colonial period. The distinction between "customary rights" and " traditional rights " shows, according Ouedraogo (2011, 80), that " African rights as compiled by the colonial administration probably had not much more to do with the original rights such as the ones interiorized and experienced by people. " The concept of endogenous law settles itself on "local ownership practices" of societies that do not reproduce the same old practices, and do not adopt State law; rather they put into use a capacity concentrating on "adaptability and legal creativity" (ibid.)

[46] Decree of 11 March 1865, called "Faidherbe" decree which greatly manifest the will of the settler to impose on Africa the system of ownership of article 544 of the Civil Code. This decree never published.

[47] French State c/Almeida, *Penant*, 1933 T1, p.252: for the Court, the only admissible theory is the one dealing with vacant land without an owner. It is a decision which was recovered in a judgment taking place in the 2th of November 1934, quoting the decree of 23 October 1905 and 24 July 1906, regulating the domain of the State in Africa, "(…) the State would not claim any other private property than the vacant lands without master. "/Cf. Verdier 1986 and Durand 2004 322.

"nothing will be done without the necessary involvement of natives" (Durand 2004:325) in the economic projections of the colonial power. The Decree of 24 July 1906, including the organization of the ownership in the AOF; and the Decree of 26 July 1932 desiring the imposition of the property, recognizes the user rights of natives before accessing full property. This "native detention" recognition requires a procedure known as the "recognition of customary land rights" which permits to "purge" these rights in order to obtain the property (Decree-Law of 20 May 1955). We are witnessing here an artificial creation of the property. A procedure was invented particularly to generate the property where it does not exist: registration.[48] Once purged of endogenous rights, the land undergoes a procedure in order to assume a property function.

However, this form of acquiring property was introduced to the French civil law for the Constitution of the last French department, Mayotte[49] (Mar. 31, 2011) with the creation of a cadastral[50] adopted by countries in order to generate property in a non-Western context. Yet, property rights are exposed to an endogenous system ("user collective rights"[51]) do not submit to a system of registration. The transition to property necessitates an individualization of the right on the land, which is a necessary condition to proceed to registration (articles 2511–4 of the french civil code). This procedure was changed by inserting a "vivification of land" (development as a key concept in the colonial law and in several African legislations).

[48] In order to fill the gaps related to ownership of the Civil Code of 1804, the lawyer Decourdemanche proposed system of registration, real civil status of ownership, consisting of land registration after their public demarcation and a verification of the reality of real rights relating to it. This procedure was initiated by the Director of Australian of lands, Torrens, in the " Real Property Act " of July 2, 1858. Later, France applied registration in its colonies, even before the completion of the extraparliamentary commission of the Land Registery which was completed in 1906.

[49] Registration is introduced through the article 1 of the Ordinance No. 2006–346 of 23 March 2006 relating to security, and it is also found in the Civil Code: Book V, Title IV ("Dispositions related to the registration of buildings and rights to property"), Article 2510 : " The registration of a property guarantees the right to property as much as all the other rights recognized in the title of property established after a procedure which permits to reveal all the rights already established on this property …". See the Enforcement Decree No. 2008–1086 of 23 October 2008 related to registration and to the recoding of rights concerning property in Mayotte.

[50] Article 2513 of the french civil code and Section 2 of the Decree of 23 October 2008 op.cit.

The property register is introduced in France, in Alsace and Moselle on January 1, 1900 by the 18 August 1896 law. Law of the 1st of June 1924 maintains in force the property register by adapting it to the French law. The Decree of 18 November 1924, supplemented by that of 14 January 1927 are the fundamental texts concerned with keeping the property register until the Law of 4 March 2002 which introduces computer storage of the property register (article 36–2, paragraph 2). Finally, article 102 of the Law of 25 March 2009 (modifying the Act of March 4, 2002 and the Act of June 1, 1924), currently functional, suggests computerizing a property register.

[51] These collective user rights "include those of passage, grazing and harvesting, consecrated by custom. They can always be converted after the vivification of these lands in individual ownership in favor of the person who worked in them. This then requires the registration of the land "(Article 3 of the Decree of 23 October 2008 op.cit.). The transformation of user rights to property rights on funds is ambiguous: it is unclear how those receiving collectively a particular right of passage, grazing or harvesting through funds can privatively acquire fund. Here we "phagocytize" a legal order by another.

The goal of legislators of Independent States is to establish property by the means of a title, a book, a property register, or a land register, relegating to the "customary law" statue the local paradigm relative to the land. "Domanialization" (national domain, public domain, forest domain belong to the state, domains belonging to collective territories, or private domain of the State) in the African law is similar to the concept of eminent domain. Anything useful nestles (barely) in the registered property, in concessions, and endogenous rights. The securitization of property remains the objective of the legislators who define it in terms of property registered in land ownership,[52] a property-related or registration book.

This Cartesian logic, which considered everything in terms of "goods"; this representation of property accounts characterized by being individual and material, results from a well rooted positivism within globalization, one which does not allow alternatives. The scope of property is a symptom of the idea of a single paradigm. This worldview is troublesome in that it does not allow the conception of an intergenerational property, which may sometime be defined in terms of connections. A less radical and simplistic approach of otherness is first situated in "what is framed inside" a social construct.

4 Recognition of a "Legal Endogeneity"

The position adopted in our work, conducted in non-Western contexts, was concerned with reading and analyzing legal regulation produced by the group itself. Taking into account the endo-regulation was a preferred approach over the exclusion of law emanating from the power of the state. The legal space would have been addressed only in one dimension; the one concerned with the norm set by the state without going into living-law, built and shaped by local actors. Indeed, if we limit ourselves to legislative law, what would become of this living-law[53] which arises from the very existence of the social construct? While the norms and life-forms developed within it[54] construct legal "endogeneity," independent by definition of national legality: the socio-cultural legitimacy faces a normative legality produced from authority. A theory of legal endogeneity is developed by Lauren Edelman suggesting that the law constructs meaning from social arenas that it seeks to regulate (Edelman 2002:2005). Legal endogeneity theory articulates the process by which

[52] Rural property includes a detailed plan, similar to a cadastral one, along with a property register. It allows you to acknowledge in writing individual rights. It gives rise to a rural property certificate; a certificate of recognition and confirmation of property rights acquired or established by custom or practice or local standards. It provides a presumption of acquired rights. See for example art. 111 of Act No. 2007–03 of 16 October 2007 on rural property regime in the Republic of Benin.

[53] Cf. Michaïlidis-Nouaros 1982.

[54] "(…) African communities have generated, through their history, their own property systems, and which we cannot understand because it lacks coherence and consistency when looking at them for what they are and not for what they lack "(Ouedraogo 2011, 79).

the daily practices of organizations, routines and structures, subtly influences legal thinking, legal categories and legal logic.[55]

Lastly, Gerard Timsit suggests that legal endogeneity represents one of the most influencing phenomena of the recent transformation in the whole world concerning the normative presence.[56] The process is indeed well initiated. The phenomenon is revealed in the recognition of native law in terms of international law (14.4.1), and in the recognition of local populations' law in terms of national legislators (14.4.2).

4.1 Recognition of the Rights of Natives in the International Law

Article 8 J of the International Convention concerning Biological Diversity (CBD)[57] recognizes non-Western modes of life (native communities and local communities). Guidelines of the Convention for the key concept concerning a sustainable usage of biodiversity (Secretariat of the Convention on Biological Diversity 2004) encourages taking into consideration the "local customs and traditions" and the strengthening of local rights (Principle-Practice n°1 and 2). The seventh meeting of the Working Group dealing with the Article 8 J of the CBD on the customary use (Montreal, October 31 – November 4, 2011) leads to the promotion of a new action plan concerning a sustainable customary use, whose objective is to protect, respect and preserve traditional knowledge. The promotion also includes innovations and practices of natives as much as of local communities in terms of a sustainable usage and the conservation of biodiversity (see Report of the 11th conference of the Parties of the CBD, Hyderabad, 2012, p.173 and c.). Other conventions have preconfigured the recognition of local populations such as the Convention on the polar bear in 1973,[58] the Convention of the International Labour Organization No. 169 (1989),

[55] Edelman et al., 2010.

[56] The author gives a related definition to our approach: "an auto or endo-normativeness, one which is not organized around the concept of public power, but taking an opposite direction: that of the civil society and the associations representing it or reflecting its intentions, worries and concerns – a normativeness characterized by progress and respect, by the actors themselves towards the rules they have made (such as, codes of good conduct or good practices), and they themselves apply it. We find here decentralization, the non- prioritization that regulators claim and which permits the establishment the legitimacy of the rules of operation through various techniques, in particular to ensure transparency, predictability, fairness of their actions – this allows them to obtain a recognition by their peers (other regulators) and by actors of the system themselves" (Timsit 2005, 85).

[57] "Subject to its national legislation, respect, preservation and knowledge, innovations and practices of native and local communities which incarnate a traditional lifestyles necessary for the conservation and sustainable use of biological diversity and promotes its application on a larger scale. With the approval and involvement of the holders of such knowledge, innovations and practices emerge along with the encouragement of equitable sharing of benefits arising from the utilization of such knowledge, innovations and practices "(article 8j, CBD, 5 june 1992).

[58] Agreement on the conservation of polar bears, Oslo, 15.11.1973 (between: Canada, Denmark/Greenland, Norway, the Soviet Union/Russia, and the United States): art.3: « Subject to the provisions of Articles II and IV any Contracting Party may allow the taking of polar bears when such

the Convention for the Safeguarding of the Intangible Cultural Patrimony (UNESCO, Paris, 17 October 2003),[59] the Convention on the Protection and promotion of the Diversity of Cultural Expressions (UNESCO, Paris, 20 October 2005),[60] and lastly, the United Nations Declaration on the rights of Natives adopted on 12 September 2007[61] which fully recognizes the rights of the people in their territory. However, the challenge lies in their implementation (see Bellier 2013).

4.2 Recognizing Natives' Rights Within National Law

Recognizing pre-colonial and native property rights is an issue which national legislators have to deal with when the concerned context is either qualified as being native or local. Despite globalization effects, which consider property systems to be essential and unavoidable, if we are not within the context of environmental acquisition, which transforms anything into property,[62] in which world are we living in?

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taking is carried out: (…) d) by local people using traditional methods in the exercise of their traditional rights and in accordance with the laws of that Party; (…) ».

[59] Recognizing that communities, in particular native communities, groups and, where applicable, individuals, play an important role in the production, safeguarding, maintenance and recreation of the intangible cultural heritage, thus helping to enrich cultural diversity and human creativity, (…) "," "intangible cultural heritage" means the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artifacts' and cultural spaces associated with them – that communities, groups and, where applicable, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, which provides them a sense of identity and continuity, thus contributing to the promotion of the respect for cultural diversity and human creativity."(Article 1)

[60] In order to reach a convention, "it is understood that : " cultural diversity "refers to the manifold ways in which the cultures of groups and societies express themselves. These expressions are passed on within groups and societies. Cultural diversity is made manifest not only through the varied ways in which the cultural heritage of humanity is expressed, transmitted through the variety of cultural expressions; rather, it is also expressed through diverse modes of artistic creation, production, dissemination, distribution and enjoyment of cultural expressions, whatever the means and technologies used" (Art. 4). The objectives of the Convention include " (a) the protection and promotion of the diversity of cultural expressions; (…) (b) stimulation of inter-culture in order to develop cultural interaction for building bridges among peoples ; (c) promotion of respect for the diversity of cultural expressions and being aware of its value at the local, national and international levels; (…) "(Article 1).

[61] An essential text which agrees with Native Claims … on paper: "respecting native knowledge, cultures and traditional practices contributes to the development of the environment and to its good management "(considering)," natives in general to have the right not to be subjected to forced assimilation or to have their culture destroyed"(Article 8)," natives have the right to maintain and strengthen their distinctive spiritual relationship with the land, territories, waters and coastal sea areas along with other resources which they traditionally use and occupy, assuming their responsibilities in regards of future generations "(Art. 25)," recognize the rights of natives with regard to their lands, territories and resources "(art. 26 and 27).

[62] While in the West, « goods are items whose utility justifies ownership » (Zenatti 2008, 18).

The recognition of pre-colonial traditional or customary rights (cf. Decree 1925 AOF) was a part of a strategy concerning the installation and the generalization of ownership, with the intention of recognition for transformation. The contemporary situation does no longer necessarily correspond to this situation. Legal pluralism is clearly not (yet) an envisaged solution in the constitutions (subject to a thorough verification); the argument of national unity being emphasized. The legal innovation or simple confirmation of the existence of an endogenous law becomes necessary to bypass the denial of local realities. For example, the Burkinabe legislator explicitly recognizes local property conventions as being "inspired by the customs, local property activities locally developed and (…) taking into account the diversity of ecological, economic, social and cultural contexts in the rural world."[63] In Benin, the law emerging from recognized local practices and customs could serve as a guarantee to credit-granting.[64] The Malian ownership code of 22 March 2000 recognizes, through "confirmation," the "customary rights exercised collectively or individually on unregistered land" (Article 43). France recognizes that the custom in New Caledonia is not subjected to the Civil Code, allowing the emergence of a real "customary law" status (already seen above).

In Australia, the Mabo judgment (Mabo v Queensland No.2 1992 (Cth) reverses the "terra nullius" (no-one's land) doctrine: the judgment recognizes the traditional property rights of their islands situated in the eastern Torres Strait. The judgment also suggests that the Aboriginal title existed for all natives in Australia before Cook instructions and before the creation of the British colony of New South Wales in 1788. This decision has changed the basis of property tenure in Australia.[65] After the Mabo judgement, the Parliament of the Commonwealth of Australia adapted in 1993 the Native Title Act which recognizes and protects native property rights, with the creation of a "right to negotiate" among others (art. 43).

From a legal point of view, the recognition of a legal system that is not set by the State, through native rights and property rights of the first occupants, gives us legal endogeneity.

We have already pointed out that the legal relationship to the space portion does not limit itself to a commercial relationship, and we have just seen that the system of ownership emerges out of a history, which chiefly concerns the West. However, even though property acquisition spreads around the world, the model has not yet reached universality because there is another concept which participates in the legal regulation within socio-ecosystems; a concept based on a territorial logic. Beyond the context of the "propertist" system, a different analysis is usually depicted by reference to this system. Scientific rigor, which suggests that law can be seen as a science,[66] was forced out of the civil-law category of "customs" or "local practices"

[63] Article 6 which presents local property charts of the law n° 034-2009/AN 16 June 2009 including rural property tenure (Burkina Faso).

[64] art.9 Law No. 2007–03 of 16 October 2007 including rural property tenure.

[65] cf. Merle 1998 ; Lafargue 1994, 1996, 1999.

[66] Cf. Ost and Kerchove 1987.

to reposition legal endogeneity, either as a system or as a legal order.[67] We move, thus, from a legal paradigm to another, from "goods" funds "utilities" funds.

Before investigating this issue, we should note that the concept of utility defines the notion of goods. In general, elements included in the civil rights (tangible and intangible) are investigated in terms of their usefulness. When goods transcend their corpus, utility no longer becomes their physical quality. The broad legal definition of utility, given by Aubry and Rau, includes "everything that can contribute to the moral and material well-being of man, therefore including advantages not necessarily attained by money,"[68] which extends the field of property placed within the sphere of acquired things to the one encompassing all useful goods, "including innate property and real rights of personal space." For Aubry and Rau, that which is useful is goods, and all things are goods.[69]

This assumption is related to the paradigm of acquisition which suggests that any acquired item becomes goods. The notion of "territory" refutes this position and invites us to adopt another position.

5 Utility Rights: A Territorial Logic

The analysis presented here is the outcome of terrain work produced in the French department of Sahelian Africa, Morocco and French Guyana. Because of the different socio-cultural realities of these regions, it was necessary to deepen the legal regulation applied by these contexts. This regulation is the consequence of an insufficient legality or one which is not registered with the local actors.

Territorial logic replaces a logic inserted in two kinds of relations within a group; these relations are characterized by being either internal/internal or internal/external. The "territorialized" land, seen from different perspectives, is not defined as "goods;" instead, it belongs to a context of inter-generational transmission; one based on an exclusive control. The transfer modes of that exclusive control are: inheritance, loan, gift, exchange (sometimes), and more rarely purchase. There is no "land market". Alienation cases are not significant of a "commodification of land." Portions of land or pasture travel are only subjected to a "possession" and their prices do not dependent on a supply/demand rule.

The constitutive elements of a non-Western property rights are based on the principle of the association of the territory to the socio-cultural identity. Territorial identity of the non-Western groups is based on their own legal system. This system relies on generic structures devoid of monographic specificities. The wide variety of situations and contexts are not opposed to an (imperfect) modeling of the system of Rights.

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[67] Cf. Chevallier 1983 ; Santi 1975 (1946).

[68] Cited by Laboulaye 1839, 332.

[69] Xifaras 2004, 229–232.

This system is qualified as "utilities rights", and we will see later why it revolves around three fundamental principles: (a) the status of common heritage (land funds are not goods, but an item or a thing to pass on to next generations, creating a continuity materialized by connections); (b) property relations depend on the level of the utility of resources; (c) prerogatives on resources outline various property control through operational rights of administration and superintendence.

Land funds control is founded on utilities established as a common "heritage" of a group, starting from the small family unit to the clan or community of residence.

Since land funds are considered as a territorialized space, which is socialized by a specific group, they are defined by their functionalities. Therefore, land funds are closely attached to resources, which give rise to the concept of "resource-space". This concept justifies the "fund utilities" terminology. Territories are organized according to resource-space, permitting the legalization of the funds-resource relation which "constitutes the law". The legal account emerges from the distribution and delimitation (allocation and assignment) of resources which establish the land fund support. Prerogatives concerned with resources and space funds are defined in terms of property control that revolves around rights, crystallizing a double social connection with the space and with the resources. The Man-land funds/resource relation is translated into a bundle of interests expressed by a series of rights denoting "environmental property control," which distinguish a right from its object.

The law which concerns utilities of the item is based, by nature, on a relation which denotes a "connection" and not "goods;" i.e., portion of space, of land fund, constitutes the materialization of the connection between generations. Therefore, the set of utilities is that which constitutes the territory, which is not necessarily a polygon designed in space. In this conceptual context, acquisition concerns itself with utilities and not with the item itself, due to the fact that the territorialized item participates in the group's existence, the individual being only part of the common. In a certain way, the system of utilities presented here, participates in a real law of future generations.[70]

In order to define this system, we will develop the legal connection of utility to resources (14.5.1); however, we first need to define the paradigm of utility (14.5.2).

5.1 The Paradigm of Utility

The notion of utility leads us to the relation between an item, which could be qualified as goods, and the satisfaction it provides in response to needs. The utility of any item measures the overall satisfaction that the individual withdraws from it. The overall level of utility could depend on the quality of the item. Anything useful is often confused with the interest, the profit, and the concept of service. Indeed, the quality of that which is useful is confused when it comes to its capacity to ensure a certain function. This function is the source of a desire or a need. Instead of being

[70] cf. Gaillard 2011.

the physical property of the item, utility reflects the importance that an individual attaches to this item, on which his/her subjective well-being depends. In economics, utility implies an assessment[71]; the concept is therefore subjective by nature. We are thus able to define utility within the terms of the satisfaction produced from an item, which denotes an advantage. This advantage shapes the outline of a "service," whose function is to help bringing to the fore something material or immaterial. We will stop at this key term in order to define utility or utilities. In the transect of ontological representations of the already studies society-nature relation, the level of utility constitutes the fundamental basis which conditions the connection to natural and property resources, and consequently, it conditions the system of regulation which is its expression. At this stage, it is necessary to refer to utilitarianism, as long as the term "utility" carries specific meanings, as a criterion for assessment of the well-being of individuals.

Attached to utility, the concept of utilitarianism is a concept both fundamental and ancient in the context of the economic and philosophical approach. In this sphere, we are not concerned with the development of the proliferation of work on the issue of utilitarianism founded by Jeremy Bentham and John Stuart Mill.[72] However, the connection between value and utility is necessary in a legal approach, even if the economy takes hold of it. Indeed, "the utility founds economic relations, as it is recognized that an object without utility would not have any kind of value which would mean that it cannot enter in the exchange relations. Thus, value and utility are closely related and therefore cannot be defined in separate fields, individual for utility, social for value"; the value is the measured utility thereby defining the economic space (Bailly Jean-Luc 2012).[73]

Utilitarianism emerged from the philosophy of the eighteenth century. This concept is presented as a science of morals which serves happiness. The utility theory is originally developed by Hutcheson (1725) and Jeremy Bentham (1789). This theory comprises two levels; the first evaluates the well-being of individuals according to the utility, and the second level, which is a collective one, aggregates the individual evaluations of different situations from which a deduction is formed concerning the best possible situation for society (Igersheim 2004, 112). Utilitarianism comprises an ethical theory which is based on political principles, those concerned with *welfarism* for maximizing happiness. They were introduced in 1979 by Amartya Sen who called for an evaluation of the social state which is based solely on utility generated by this state. The author suggests that "utilitarianism can be conceived as a combination of welfarism, classification by summation (individual

[71] Dictionary of Economic Sciences, published under the direction of Romeuf in1958, Puf.

[72] The utilitarianism suggested by Bentham and Mill defends the idea that a behavior (or a politic) which is morally right is the one which produces the greatest happiness of the members of a society. John Stuart Mill, 1838 1861 repr. Puf, 2009; Catherine Audard, 1999; François Dermange, 1997. For Jeremy Bentham, "an action is said to conform to the principle of utility (…) when its tendency to increase the happiness of the community is greater than its tendency to decrease it" (*An Introduction to the Principles of Morals and Legislation*, 1789/1823).

[73] On the anthology of utilitarianism, cf. Audard, 1999 and on the relative and absolute utility, cf. Kim Cuong Pham Thi, 2008.

utilities are aggregated simply by their summation) and consequentialism (judging the rightness of an action, a policy or any other choices solely on the basis of the resulting state of affairs). The functions of the social well-being are not necessarily welfarist although it is difficult to dissociate them from consequentialism" (Sen 1991:16).

We will not develop further this area of study in order to remain in the limits of our subject.

At this stage, we are concerned with investigating how the law can be based on utility.

It is the question of justice which comes against utilitarianism since it is founded on the collective happiness as the sum of individual utilities without being preoccupied by the distribution of resources as much as the well-being. Yet, resource distribution is precisely the basis of the individual and collective well-being around the objective of the coherence emanating from the group which is necessary for its sustainability. For us, law is related the value of utile items within the context of the social reproduction, which is investigated in terms of the survival of the group. In this context, we take as a reference the ontology of the society/nature relationship without obscuring the promotion of happiness or the well-being, which is of course essential to the future of a society in general and its members in particular.[74] In societies where the individual depends totally on the group for his/her existence, the utility is situated in the sphere of general interest. We situate our approach in this context.

5.2 From Utility to Resource

Resources are connected to utility in the sense that acquisition reflects utility. The notion of utility is highly pragmatic. As we have already seen, utility depends on its ability to respond to needs; needs which fall within the context of the reproduction of a group. Social values on resources and their consumption mode are reflected in the regulation which gives access to the resources and the behaviors to adopt. The value/utility relation is justified by the existing social solidarity within a group. This social connection allows cohesion which is necessary for the maintenance of a group, and the law expresses this in its regulatory purpose. Therefore, social utility is the result of social solidarity, or rather the result of a "sense of sociality". According to Leon Duguit, law translates into legal concepts the essential values for the social reproduction (Duguit, 2008, 57, 86, 90). These values could be declined in terms of rights on lands and resources.

Utility law may only be translated within the terms of the interference of the law in the resource dependency on its supporting material (territorial funds), giving

[74] Amartya Sen rethinks the well-being by the approach of 'capabilities', a term which does not have a satisfactory translation, but which means "the level of satisfaction of human needs, allowing to behave as a human being" (cf. Muriel Gilardone welfare 2007, Valérie Reboud, 2008).

access to the "resource-operator-law" which is necessary to decode and conceptualize the legal system.

We have investigated five terrain of research, and each one of them has given rise to a matrix of resource rights (Barrière and Barrière 1997; Barriere 2003, 2008). The five terrains are: the inland delta of the Niger River in Mali (1995), the gum tree zone of Chad (1998), the Bassari region in eastern Senegal situated on the outskirts of the Niokolo Koba national Park (1999), the territory of the tribe Aït Zekri of the Moroccan High Atlas, Morocco (2007), and the territory Wayana in Guyana, the Maripasoula commune (2009). A summary of these five site situations has been completed, giving rise to a matrix which expresses a system of "right of utilities". We will investigate this in stages.

Societies' legal relations to their environments result in levels of action and intervention which depend on both the status of the concerned actor (Sect. 5.2.1) and the resource contextualized in a given space (here we speak of "resource- space") (Sect. 5.2.2). Law (Sect. 5.2.3) will intervene between the actor and the "resource- space", representing the object of his interest.

5.2.1 Actors and Governance

The actors have, more or less, specific features depending on the terrains concerned. Exploring the five terrains, allows us to develop a clear objective. This objective aims to preserve the diversity of the encountered situations as a reflection of the complexity of systems. Twenty actors were selected from the community's lineage, from residence, or from exogenous institutions. It would have been possible to reduce this number, but we would have lost the criterion of diversity. The chosen actors intervene in four categories of management mode, including the private, public, and collective contexts along with the communal one. The relations instilled between actors build local governance in an internal/external and endogenous/exogenous relationship. We illustrate it as follows (Table 14.1).

There is a correspondence between the 20 actors and the four management modes (intra and inter-communal, collective, private, and public) through the governance mode which emerges from this relation: be it internal, external or both, between lineage communities and resident communities. The Management, be it public or private, always integrates a rational logic of intern/extern governance. While the village chief is situated in an internal space of residence, pasture inspector functions in a lineage space, and the regional council associates the internal and external contexts. The territories investigated transcend the limits of the resident and lineage community. The simultaneous concern regarding both territorial collectivities and the state is situated in the terrains where these institutions constitute a referential, regardless of the actual amount of operability. The choice of 20 actors selected is the result of an empirical comparative analysis of various monographs of dynamic territories. Overall, the intra-communal, lineage, or residence governance generally prevails, but being open to the external world is a phenomenon which still exist in these contexts.

Table 14.1 Levels of local governance

Management modes ACTORS	Private	Collective	Intra-communal/ Inter-communal	Public
Transhumants association			Internal lineage	
Head of the family/ lineage/clan			Internal lineage	
Household head	Internal resident			
Farm manager unit	Internal resident			
Village chief			Internal resident	
Agdal committee			Internal lineage	
Tribal/lineage community			Internal lineage	
Resident community			Internal resident	
Regional council		Internal-external lineage/resident		
Rural council		Internal lineage/resident		
Water supervisor			Internal lineage	
State				External lineage/ resident
Foreigner	External lineage/resident			
Married woman	Internal resident			
Group of farmers			Internal-external lineage/resident	
Land master			Internal lineage	
Water master			Internal lineage	
Pasture master			Internal lineage	
Follower	External lineage		Internal lineage	
All				Internal-external lineage/resident

5.2.2 Resource-Space

Resources are not taken into account outside their spatial context as property support. The notion of ‘resource-space’ (Barrière and Barrière 1997) was developed due to the fact that the actors bring a resource closer to the geographical

environment of their situation; they territorialize it which allows it to gain property identity. The resource-spaces retained on the five terrains reflect the territory, as it is perceived in the socio-cultural representations of the actors. Territorial dynamics depend on the territory's resources. Thus, the resource situates itself in the territorialized space. The pressures practiced on each resource is orchestrated by a "legal governance" of access and management which takes place via a connection to funds.[75] This "space" (that is to say a specific location) and resource (biotic or abiotic natural element) dichotomy expresses a relation to the 'media', as ecological systems which structure the territory.

Each resource-space gives rise to specific resources, which we will specify in the following table. It contains a total of 45 resource-spaces, as they are named and used by the concerned actors. Here again, we have attempted to keep diversity intact in order to take into consideration the singularity of situations.

The resources in question constitute 14 types and emerge from all five terrains, but not all of them are found in every terrain (for example, Arabic gum is situated only in the Chadian area). Each resource represents a sufficient object of interest, which renders its access a legal one. The mining resource is absent in the list because it does not part of the communities of the concerned territories. Even if the term 'biodiversity' itself is untranslatable in the vernacular, it still constitutes a recognized reality for the local authorities. In addition, it seeks the local involvement of the State by the establishment of protected areas, namely a national park. The interference of this new resource in local governance is more or less a reality depending on to the terrain, if ever expressed thus. In itself, it remains a field of research (Table 14.2).

In the five selected terrains, the recurrence of resources highlights a set of four distinctive resources: wood, earth, plant, and grass. However, the value of this result is linked to local specificities of selected terrains. We must keep in mind that the local or micro-local scale is inevitable, and that local governance also requires attention in any environmental regulation, necessitating an articulation between the general and the specific.

5.2.3 Endogenous and Legal Law

The understanding of regulation modes of local communities arises without having to resort to the Western legal system; in fact, it is necessary to dispose of the ethnocentric reference in order to better decipher the realities of practical law.

The reading of endogenous systems (cf. customary) leads us to reason in terms of property rights, along with administrative and superintendence ones (which corresponds to the right to preservation present within the context of transmitting wealth to future generations). These collective or individual rights exist in local

[75] If we are here within the context of acquisition in the sense of assigning a usage, we do not use the notion of "appropriation system" since it is affected by its "taking back" sense, which assimilates the system of acquisition to the system of property rights.

Table 14.2 Resources present in the 'resource-space'

Resources Resource-spaces	wood	Land	Plants	Grass	Game	Crop residues	Fruits	Fish	Water	Arabic gum	Biodiversity	Salt	Flowers	Swarm
Old "abattis" (field, in amazonian forest)	x		x		X		X							
"Abattis" being cultivated		X			X									
Future "abattis"	X		X		X		X							
Tree/shrub rangelands	X		X											
Wood (fire and work) : plant/perimeter	X													
Bush	X		X	X			X							
Shallows field		X				X								
House field		X				X								
Collective field		X				X								
Flooding field		X												
Gum tree field										X				
Irrigated field		X												
Lineage field		X				X								
Enclosed lineage field		X				X								
Mopti rice office field		X												
Enclosed personal field		X				X								
Pluvial field		X				X								
Transhumant corridor				X										
Water flow and channels					X			X	X					
Forestry picking			X				X							
"Environmental space"											X			
Protected space (park)											X			

Salt rift												X		
Village land	X	X		X					X					
Local river/territory					X			X						
Lineage forest	X		X		X		X							
Primary forest	X	X	X		X		X							
Village forest	X		X		X		X						X	X
Natural gum forest	X		X	X			X			X				
Lineage fallow	X		X	X										
Personal fallow	X		X	X										
Village's fallow	X		X	X										
Familial forest path					X									
Village forest path					X									
Sacred place	X		X	X	X									
Lineage pond		X		X	X			X						
Fish farming pond								X						
Village pond		X		X				X	X					
Mountain pasture of "agdal" (common management)	X		X	X										
Flooded pasture ("burgu")				X										
Pasture territory	X		X	X										
Village's pasture	X		X	X										
Transhumant path				X										
Temporary river ("oued")								X	X					
Salty lands												X		

Table 14.3 Reading of the internal legal report of communities concerning properties and renewable natural resources[a]

Regulation	Types	Levels
Individual prerogatives (subjective law)		
Way (passage) (access to, pass through and parking = the right to enter and sometime park)	**Operational** (temporary action of presence in a place)	**Individual**
Withdrawal (get natural resources elements = extraction = free product (not a human production) = catch fish, collect forest resources, …)	**Operational** (subsistance action)	**Individual**
Exploitation (production: work on natural resources = farm, lumbering, …)	**Operational** (production action)	**Individual**
Governance norms (objective law)		
Exclusion (determine who have a prerogative and how this prerogative may be transferred = contrôle on resources)	**Administration** (distribution of powers, allocation of land and resources)	**Collective**
Disposal (sell or lease either or both of the above rights)	**Administration** (transfer of land and resources, transfer of rights in utilities)	**Collective**
Intentional (guide the behavior of actors: negotiations, incentives, forms of contracts or arrangements, gift, … regulation)	**Stewardship** (regulatory practices: responsibility for the defense of the general interest)	**Constitutional** (as normative source)

Rights of access natural resources:
How to read the internal legal relationship of communities to land and renewable natural resources
[a]Barrière (2009). Cf. The model of Elinor Ostrom and Shlager Edella (1992) available in economy is a model of "property rights," and we do not believe that it could be used, firstly, in the tropical area because there is a risk of ethnocentric transposition and, secondly, this model creates a (huge) confusion between possession and ownership

regulations. The latter are founded on the value of utility, and not on the value of land funds which supports them. Consequently, actors are holders of the functions of rights, "rights to": hunting, farming, grazing, fishing, collecting, cutting, and passing (etc.), and this rights form a bundle of prerogatives. The purpose of acquisition concentrates on these prerogatives, contrarily to the Western logic. The latter consists on acquiring space, regardless of its conferred allocation, in order to exert exclusivity and power on it. Apart from an ethnocentric standpoint, territoriality bases itself on the modes of exploitation related to methods of spatio-temporal actions, which we can identify as immaterial goods subject to acquisition: I have the right to use a given space, as a hunter or cultivator. I can yield, exchange or alienate this space… however, the land funds itself remains non-acquirable.

This mode of reading is reflected in a table which emerges from the classification of rights in which a right is taken into consideration in its broadest sense, legal proceeding (Table 14.3).

This Table was elaborated in relation to the realities of certain terrains. Therefore, it is the result of an empirical reading of the itemization of right, which does not reflect the theory of property rights presented from the Romano-Germanic perspective. We should not forget that the initial promise was to reject the civil code as an unfit reference for the analysis of endogenous legal systems applied on the (non-Western) studied groups.

A matrix is formulated on the basis of different local matrices, each corresponding to a fieldwork collected by ourselves (1993–2009). We have followed the same protocol in each terrain. The synthesis performed on the already mentioned five chosen terrains results in the matrix shown below. This matrix highlights the control of territory (governance in red), and the access to the resource (prerogatives in blue) as related to the analyzed resource-space (Table 14.4).

The prominent element of the matrix is the regulation giving access to the resource; this information is obtained through responding to a specific question: who intervenes on what and how? Of course, the pretence of finding a model is a challenge that the complexity of situations provoke. However, the matrix permits to learn a number of lessons; lessons that are not revolutionary in themselves, but they are still demonstrative. Finally, we have to bear in mind that the right to disposal located in the matrix is not concerned, or is rarely concerned, with the land; instead, it concentrates on the transfer of the function, of the utilities of items.

The precision devoted to the investigative work through a direct knowledge of the territorialized communities as much as the analysis of straightforward data justifies the necessity of creating a distance in order to underline elements of an endogenous law. Decryption of endogenous systems constitutes the main object of the anthropology of law. The matrix leads us directly to that context.

The structural elements which emerge from the matrix of endogenous systems are the four following elements:

1. The determination of concerned actors, belonging to a large panel, imply a distinction between the participators who are physically related with the resource, and those involved in their management; the latter are situated in another spatial or territorial level. We deduce that rights related to space or the resource integrate three categories of actors:
   - Lineage and residential actors: family/lineage/clan, tribal/lineage community, residential community, water inspector, pasture master, land master, water master, transhumant associations, agdal committee, and village chief.
   - Operators: households, business unit, married woman, business group, follower, foreigners, State.
   - Elected actors: rural council, regional council.
2. Access to resource is more legalized (Elinor Ostrom may say ‘institutionalized’) than the strong pressure exerted on resources. The distribution of rights defines thus the mode of the actual governance, which will depend on the state of the resource (its presence/absence level). This is what we previously deduced in terms of internal/external relation and in terms of the alliances that depend on it,

Table 14.4 Matrix of Man/resource relations present in an endogenous legal context of local communities of five locations (Mali, Senegal, Chad, Morocco, Guyana) (1993–2009), or Endogenous Matrix Systems

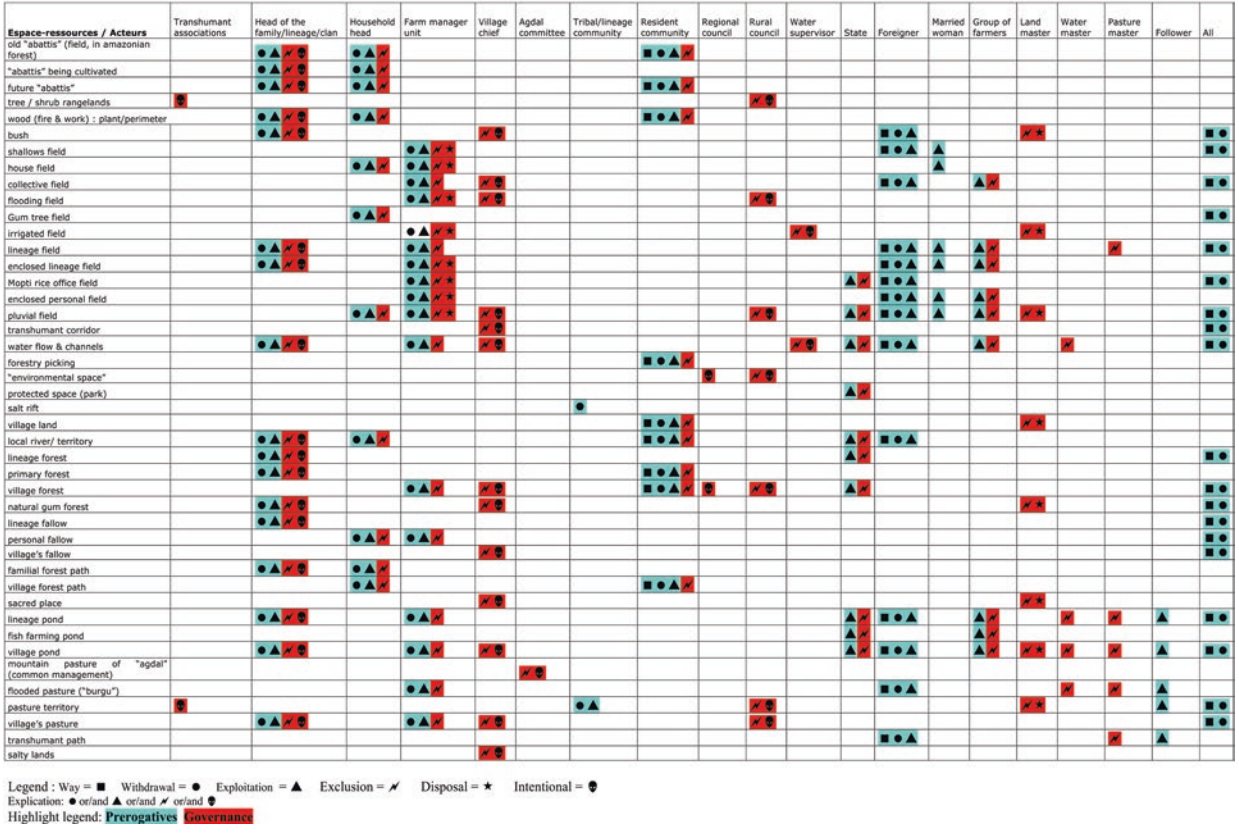

Table 14.5 Actor/rights relation present in five terrains

Actors/Rights	Way (passage)	Withdrawal	Exploitation	Exdusion	Disposal	Intentional
Transhumants association						×
Head of the family/ lineage/clan		×	×	×		×
Household head		×	×	×		
Farm manager unit		×	×	×	×	
Village chief				×		×
Agdal committee				×		×
Tribal/lineage community		×	×			
Resident community	×	×	×	×		
Regional council						×
Rural council				×		×
Water supervisor				×		×
State			×	×		
Foreigner	×	×	×			
Married woman			×			
Group of farmers			×	×		
Land master				×	×	
Water master				×		
Pasture master				×		
Follower			×			
All	×	×				

for instance, the case of the follower (in the Niger Delta) or the foreigner (in terms of lineage or residence). In the High Atlas, the "agdal"[76] implementation of a pasture depends on the pressure exerted on that which is, in itself, the repercussion of the level of presence of the resource and the number of those who possess certain rights.

3. The exclusion right constitutes a central apparatus in the access schema because of its interstitial situation present between operational prerogative and governance. As the following table suggests, the number of actors who possess the exclusion right hold also an intentional management right, along with the disposal right (although it is rare) (Table 14.5).

Is the overlap between operations (action on the resource) and management in relation to administration and superintendence effective or efficient? Overall, those who exploit are able to exclude since the operational law of direct debit or of exploitation depend on the intervention on the resource, and not on the support for these

[76] Agdal is a territory which depends on a communal management, including establishing defenses in order to preserve resources (cf. Auclair and Alifriqui, 2012 and Barrière 2012a b.

actors. He who has the ability to exclude, without being in the operational context, is located in a level of territorial governance of the resource; that is to say, in a ratio of property management of the resource: the right of the resource connects to both a functional relationship (that the right translates into prerogative) and a management report (that the law translates into governance). According to the type of resource-space concerned, the actors will be more or less astride or in superposition between function and management, combining a direct relationship to the resource with a property connected to the territory.

4. The issue of acquiring resources: space control and the access to resources through resource-space control.

The objective is indeed to acquire resources. The very development of the resource-space concept shows the central place which space occupies, investigated in terms of funds/property. In the one hand, we have the physical apprehension context of the resource; and on the other, we have the possession, the extraction, or the acquisition of the resource through the act of "direct debit" or "exploitation," which necessitates a legal understanding legitimizing for the group and foreigners the access to resources. In this configuration, the property space reflects a set of "resource" functionalities. Thus, the issue of authority is more territorial and property-related for the fund, as the latter cannot be appropriated. It does not integrate the civil right category, but is an inalienable[77] or elusive item as much as an incommutable and untransferable[78] item; this is why we rehabilitated the concept of "land-environment" since our first fieldwork (Barrière and Barrière 1997).

In the analysis of the relationship between man and natural resources, the utilization of the "control" concept permits to bypass the ethnocentric nature of the utilization of the 'property acquisition' term, which expresses a relation to property in the context of law (as already seen). Moreover, it should be noted that we are not in the presence of the law system of goods; instead, we are dealing here with the system of a law concerned with utilities or functionalities. The account of power as related to law (signified by the control) remains neutral and free from any Romanist connotation. Being attached to the affected rights, the control is divided into six elements: minimal, punctual, specialized, exclusive, absolute, and intentional. Each one of them is attached to a precise function, a "right to": move in a perimeter (to walk, to cross over…); take off a resource (for personal consumption: cultivating, pasturing, fishing, cutting,…), exclude from territory (not allowing access to natural resources or land), dispose of the fund (which is often only the price of an invest-

[77] For instance, customary lands of kanak are recognized by the legislator as inalienable (art.18 law of the organic law n 99–209 du 19 march 1999) although the term "property" is used.

[78] Still in New Caledonia, the detention of the Governor of January 22, 1868 "relative to the constitution of native territorial property," states that the land delineated for each tribe constitute an incommutability (art. 2–1), i.e, an impossible dispossession. The tribal lands are also "elusive" (Art. 2, 3). In 1959, deliberation No. 87 of 10 March 1959 regarding the system of native reserves in New Caledonia (enforced by Order No. 181 of 16 March 1959, CANE from 6/13 April 1959) states in an article that single "native reserves are incommutable, elusive and inalienable properties of the tribes to which they belong."

Table 14.6 Land control defined by the functionalities or utilities of resource-spaces

Mastership (land and environment) / Functionality (right of)	Minimum	Ponctual	Specialized	Exclusive	Total	Intentional
Way (passage)	**C**	A	A	C	C	A + C
Withdrawal		**A**	A	C	C	A + C
Exploitation			**A**	C	C	A + C
Exclusion				**C**	C	A + C
Disposal (alienation)					**C**	A + C
Intentional management						**A + C**

Legend: C = land/territory control; A = resource access

ment or annuity), guide the behavior of actors taking part in the natural or land resource of the territory (intentional management). The following table summarizes this view (Table 14.6).

Each control has one to six features or utilities, and each corresponds to a "right to" way (passage), withdrawal, exploitation, exclusion, disposal (alienation) or intentional management. The cursor varies depending on the level of territorial control or the access to the resource, defining the space governance concerned with the associated actors. By reconsidering the matrix of endogenous systems (presented above), we highlight two control categories corresponding to two fields of governance, shown in color: one of them is related to the control of the territory, while the other concerns the access to resource.

The matrix representation of the five concerned terrains highlights the importance of certain actors in territorial governance and resources. Their lineage or residential character clearly emerges, without making the benefiting foreigner, often through alliances, feel totally excluded.

The matrix representation of the systems of law applied in the selected terrains permits us to investigate explicitly intervention modes of each group of actors. The complexity of each situation is respected, which does not facilitate the reading of the matrix. This being said, its major purpose is to generate a mode of analysis of legal systems divorced from the civil law concerned with goods. The land is not transformed into an alienable thing, whose price fluctuates on a legal and economic market. The encountered situations did not correspond to property markets.

Thus, we had to extract a reference of reading which permits to produce a schema of understanding. This tool will be indispensable for connecting what is legitimized locally, which works with public national politics, with the territorial and environmental legislation which have to be developed.

Being able to decrypt the endogenous law is an initiative step while instilling a connection with the legal system is the second step. Here we are confronted with the challenge related to the acceptation of legal pluralism or blocking the positivist dogma. If we take the example of the Guyana Amazonian Park (Barrière and Faure 2012), which is confronted to the relation of positivist law and endogenous

law, the result of the chart project demonstrated that the road taken to flatten ethnocentrism is still very long because of the strong presence of ethnocentrism.[79] The right to be constructed here is situated in the crossroads of an intercultural perspective, not related to "integration," but through "adequacy" which is the outcome of a negotiated compromise. This process helps overcoming the limits of a representative democracy for a participative democracy.

6 Conclusion

The process of massive land acquisition in the Global South, or land grabbing, reflects the shock of paradigms between the regime of land property and the regime of endogenous transmission. The dominant ideology of a liberal economy based on the capitalization of goods, services and natural resources generates increased insecurity for a humanity that constantly grows, because it only benefits a minority. The issue of land access also covers the challenge of access to natural resources especially land, water, grazing, timber or fisheries. In addition, the legal status of the land is increasingly becoming a central issue for human and environmental security. The land concern pertains to a political and economicstrategy, to a societal choice and cultural references against the challenges of climate change and food security which are threatening a growing part of the humanity.

> Land is becoming a global asset to be traded just like any other commodity. Yet land is different, since it provides a livelihood to more than two billion smallholders, many of whom are poor and food insecure. Land is also different due to the valuable environmental services it provides, and its strong social, and cultural attributes (HLPE-FAO 2011:8).

We deepened the question of the human relationship to the land within the perspective of its importance in terms of human security. Could we analyze this issue without touching its foundations? The analysis has led us to develop two legal paradigms that do not have the same foundations and language: The paradigm of property law, which seems common for to the dominant economic ideology, and that of the utilities 'or customary' law, whose internal legitimacy for local populations precedes the first one. Indeed, the genesis of the property regime is confronted to the reality of an endogenous property rights indivisible from the access to renewable natural resources. Concerning the 'utilities', it is a notion that participates to the definition of the right being objectified. It also contributes to the edification of a common heritage through the permitted functions. Here, utilities are in the core of the territorial construction, where they are edified to become object of property.

From the object right to the function right, the legal regulation present within the socio-ecosystems will always be dependent on the ontology of the relationship of

[79] Read the chart project: http://www.parc-amazonien-guyane.fr/le-parc-amazonien-de-guyane/la-charte-des-territoires/

societies to their environment.[80] In this perspective, the human security must integrate these two legal paradigms pertained to the human relationship to the environment: The first one reasoning in terms of 'price' (acquisition), where preservation fits into the right to goods which is related to the naturalistic ontology for whom nature is an object; and the second one reasoning in terms of 'obligation' (transmission), conditioning the access right, where nature is a social and identity challenge.

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Chapter 15
Environmental Change and Gender: Rethinking Traditional Approaches to Food Security in Rural Beitbridge, Zimbabwe

Mark Matsa, Winniefridah Matsa, and Manuku Mukoni

Abstract This study sought to identify traditional and cultural approaches to food security and features of environmental change in Beitbridge district. The gendered impact of environmental change on food security was also established before assessing the resilience of traditional and cultural approaches to food security in the face of environmental change. Since Beitbridge is a multi-cultural district comprising Suthu, Venda and Shangani ethnic groups who are intermingled yet each has strong cultural traits, network referencing was used to select 40 respondents per ethnic group to answer the self-administered questionnaire interview schedule. Respondents of 40 years and above, and who have stayed in the district for more than 30 years, were considered credible and to have a change experience. Six interviewees (3 men and 3 women) aged 60 and above per ethnic group, were also selected and interviewed. The kraal head (or chief) for each ethnic group, the district agricultural research and extension (AGRITEX) officer, district environmental management (EMA) officer, World Vision and CARE non-governmental social welfare organisation officers were all interviewed for their expert ground experience on environmental change, gender and food security in the district. Direct observation was used to 'ground truth' evidence of environmental change. Results indicated that traditional food sources in Beitbridge were diversified and divided into wild and domestic sources. Evidence of environmental change included silted rivers, extinct plant, animal and bird species, failure of some traditional crops, shortages of pastures, firewood and water. Results also indicated that communities believed that traditional methods to food security, which were gendered, were more reliable than modern ones. It is recommended that, given the resilience and faith that local communities have in traditional food and traditional food approaches, it is important for scientists

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and nutritionists to understand and study them further, and promote them from the communities' indigenous knowledge point of view.

Keywords Environmental change • Food insecurity • Traditional approaches • Gender • Indigenous knowledge

1 Background

Africa is commonly identified as a region highly vulnerable to climate change and food insecurity (Thomson et al. 2010). In particular, the Sahel region, East Africa, West Africa and parts of Southern Africa; have been identified as hotspots of climate change and food insecurity (Warren et al. 1999; Ericksen et al. 2011; CGIAR 2009). In 2007, the IPCC – cited in Feresu (2010) – projected that yields from rain-fed agriculture could be reduced by 50 % in some African countries by 2020. The UNDP (2004) Human Development Report states that 17 % of the world's population is malnourished with the majority of the victims being in Sub-Saharan Africa.

In Zimbabwe, there are signs of gradual warming in both summer and winter and that the Southern region of Zimbabwe will experience a minimum rise of 2.7 °C in temperature by the end of this century (Zhakata 2007). Further, the region as a whole is predicted to experience decline in rainfall with potential evaporation of 30–90 % above the long-term mean (Zhakata 2007; Masendeke 2007; Feresu 2010). Maize, the staple crop in Zimbabwe, is sensitive to temperature and precipitation changes. A decrease of temperatures in winter by 4 °C creates an environment that is too cool to grow maize in Zimbabwe (Zhakata 2007). The overdependence on rain-fed agriculture to grow such staple crops, coupled with a high incidence of poverty, results in an increased vulnerability to climate and environmental change in Zimbabwe (Feresu 2010). Indeed, already, two thirds of most food insecure and vulnerable farmers live in degraded and marginal lands where maize and rice are susceptible to rising temperatures, extreme seasons and unpredictable weather patterns (FAO 2006; DREA 2010). In this way, climate change can act as a 'risk multiplier' in developing countries leading to a range of human insecurities due to the high level of dependence on natural ecosystems and subsistence agriculture for livelihoods (CGIAR 2009; Ericksen et al. 2009).

Uncertainties about climate change can also lead to uncertainties about food production and security (IFPZ in CGIAR 2009). Climate and environmental changes can lead to shifting and unpredictable agricultural seasons which can no longer be foreseen using traditional tell-tale methods such as the flowering of certain tree species, fruits, or a halo around the sun or moon to predict rainy weather (Dimes 2007; Care 2011; Mogotsi et al. 2011). As a consequence, smallholder farmers in many regions of Zimbabwe may experience chronic food insecurity[1] and low crop yields

[1] Chronic food insecurity, according to Ericksen et al. (2011), means people cannot meet their basic requirements for a significant period of time with long-term outcomes.

(Dimes 2007; Parawira and Muchuweti 2008). Furthermore, poor groups in Zimbabwe, in their search for the means to sustain themselves, often engage in activities such as slash and burn that cause further damage to the environment in ways that are costly to repair (Gomez 1988).

The challenges facing food systems in Africa will accelerate in the coming decades, not only as a result of climate change but also as a result of the need to feed a rapidly rising global population. It is expected that demand for food will double in the next 25–50 years in developing countries (Ericksen et al. 2009). Current intensive agricultural practices, employed to meet this demand include the clearing of land, inefficient use of fertilizer and organic residues. These practices have a negative impact on natural systems and contribute environmental change by depleting resources, disturbing biodiversity and causing land degradation (Chenje et al. 1998; Ericksen et al. 2009; CGIAR 2009, 2011; Feresu 2010).

2 Traditional Food Security Strategies and Indigenous Ways of Adapting to Environmental Change

According to the FAO (1996) *food security* is when all people at all times have physical and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active healthy life. For a population to be characterized as food secure, they have to have access to nutritious yet affordable food, and be sufficiently protected from future disruptions to adequate food (Ericksen et al. 2011). However, food security and access to food is not only determined by physical availability or agro-climatic change, but also on its economic, accessibility, utilization and stability FAO (2008).

In Zimbabwe traditional approaches to food security have been found to be resilient (Shava 2002). Traditions are ways of doing things that are handed down from generation to generation (Hornby 1980); *Traditional approaches* refers to indigenous strategies that are native or belonging naturally to the people regarded as original inhabitants of an area (Matsa and Mukoni 2012). In traditional societies, food security strategies rely on a wide variety of foods and diversification of activities related to food procurement (Jelliffe et al. in Chenje et al. 1998). Such foods consist of wild food resources, of plants, fruits, animals, insects, and wild vegetables (Mapara 2009). Other methods include polyculture where more than one crop is planted on one piece of land. Drought and flood resistant seeds/crops are planted in the same field. The traditional crops that are emphasized are adaptable to climate, environmental change and local conditions as compared to commercial crops. They are not capital intensive, for example, they can thrive well with or without manure or fertilizer. Tsiko (2009) notes that wild plant foods are effective as a survival strategy at household level. Wild fruits, game meat, honey are risk coping strategies (Mathofi et al. in James 2008). Food preservation is one of the traditional strategies of achieving food security in Zimbabwe. Common preservation methods include sun drying, smoking, dried salted of cooked and uncooked wild vegetables and leaf crops, meats, fruits, insects. These wild leafy crops and vegetables include cucurbit

(pumpkin leaves), pepo (*muboora)* vigna (*nyemba*) and cleome (nyevhe) (Garwe et al. 2009). Traditional communities also developed their own alternative recipes of food, for example *umhiqo* (porridge before fermentation), traditional beer, *mahewu* (traditional drink made of mealie meal), and *umkumbi* (traditional drink from fruits of the *umganu* tree) which increased food security. Mixed economies have also proved to be a powerful food security strategy where both pastoralism and cultivation are practiced (Feresu 2010; Van Rooyen and Homann 2007). Zimbabwe is endowed with diverse breeds of indigenous species of cattle and goats which are adapted to local environmental conditions (Hargrieves et al. 2004). Nyathi in Van Rooyen and Homann (2007) revealed that in Zimbabwe most goats and goat products originate from Matabeleland, for example, Gwanda, Matobo, Mangwe, Bubi, Bulilima and Beitbridge.

3 Gender and Food Security

Sengendo (2002) defines *gender* as the social relations between men and women determined by their different social roles and the attributes allocated by societies and communities. In traditional societies, food production is carried out by both males and females, however, there is a gendered division of labour that leads to differential contributions (Ericksen et al. 2009). For example, production of grain crops is carried out by both genders while the production of different types of nuts (groundnuts, peanuts and beans) is the role of women. Transportation of grain crops from the fields is mostly done by males while the processing, packaging and storage is the role of females. Sun drying, salting and smoking are all done by women (Matsa and Mukoni 2012). Pastoralism is carried out by males, although females do participate where there is a shortage of male labour (Garwe et al. 2009). Responsibility for food security falls heavily on women because of their crucial role in food production, processing, storage and preparation for consumption. In this way, food insecurity affects males and females differently. Furthermore, climate and environmental change are also gendered in their impacts, thus impacting food security in a gendered way (Kraub 2011; Care 2011).

This chapter aims to identify features of environmental change in Zimbabwe's Beitbridge district. It will examine the traditional cultural approaches used by ethnic groups there in order to ensure food security as well as the gendered impact of environmental change on food security. Finally, the resilience of traditional and cultural approaches to food security in the face of environmental change will be assessed.

4 Theoretical Framework

This research is founded on post-colonial and eco-feminist theories, which are briefly outlined below. Eco-feminism focuses on women's interaction with the environment and their exclusion from environmental issues, while post-colonial theory deals with exclusion of traditional knowledge from development models.

4.1 Post-colonial Theory

Post-colonial theory refers to the colonized announcing their presence, identity and claiming their lost or distorted past (Mapara 2009). Post-colonial theory is non-western and critical of development theories which often overlook indigenous knowledge in formulation of development strategies. The theory originated in British colonies of the Caribbean, Africa and India. Post-colonial theorists argue that post-colonial theory is necessary to deliver effective development, societies do not need universal theories of development. It opposes Eurocentric theories of development and offers resistance to cultural domination or displacement of cultures of the colonised (Sharp and Briggs 2006). Key post-colonial scholars include Bhabha Komi, Gayadtyi Spivak and Edward Said who argue that the knowledge of the colonised is also important and prefer traditional understandings of societies. They critisise what they refer to as 'hybridity'which is the mingling or integrating traditional and bourgeois cultures leading to cross-fertilisation of cultures. Post-colonial theory presents the west as unappreciative of past achievements and traditional ways of doing things by the formerly colonized. Traditional societies in Africa had their own ways of iron smelting, food processing and preservation, as well as an intimate understanding and knowledge of farming and natural conservation, crop and food storage (Chandler and Wane 2002; Mapara 2009). The theory links well to the rethinking of traditional approaches to food security in the face of environmental change. Traditional societies, especially women in these societies, had skills to identify good varieties of seeds and grain from the previous harvests so that these could be preserved through sun drying and smoking to protect them from borers, rats and other pests. Mapara (2009) notes that: "Today's seeds cannot be kept for more than one season. The short life span of today's seed is an indicator that Western science does not always benefit those who are interested in long-term planning…".

4.2 Eco-Feminist Theory

Key proponents of eco-feminism include Susan Griffins, Carolyn Merchant, Caren Warren, Val Plumwood and Vandana Shiva, among others. The theory is a unified exploration of the commonalities between gender oppression and environmental degradation caused by male dominance (Manion 2002). From this perspective, men view both the environment and women as untamed and subjugate both for their benefit. Momsen (2004) argues that ecological damaging issues have detrimental effects on women than men because women tend to be involved in household management of sustainable food provisions. Climate and environmental issues such as deforestation, desertification, access to safe water and fertile land, flooding, pollution, toxic waste disposal affect women more than men, both directly and indirectly. Women are seen to be closely intertwined with environmental issues, and have a closer connection with the earth, while men are seen to be closer to culture (Manion 2002).

Eco-feminism unifies gender and environmental issues. It focuses on the role of women in solving ecological issues (Momsen 2004; Chandler and Wane 2002). Like post-colonial theory, eco-feminism calls for a return and preservation of traditional practices. Capra and Berry in Chandler and Wane (2002) argue that solutions to major environmental issues require a profound shift to remnants of traditional values, beliefs and indigenous knowledge systems that are still found all over the world. Eco-feminists argue that women's indigenous knowledge of the environment is excluded in development and looked down upon (Chandler and Wane 2002). Chandler and Wane (2002) note that reconceptualising and resituating indigenous women as resource managers is central to the creation of alternative policies for development.

5 Tools of Analysis

Against the background of the theoretical framework described above, this chapter uses the 'food systems' concept and Gender, Environment and Development (GED) as tools of analysis. Food systems analysis reveals activities that people carry out in order to ensure food security such as producing, processing, preserving, storing, preparing, distributing and consuming food (Ericksen et al. 2009; CGIAR 2009). This analysis is used to explain how vulnerability of food systems to climate change arises as a function of social and environmental processes (Ericksen 2008). GED is a development approach that takes gender and development into consideration. Women are often excluded from environmental issues and policies when they have the potential to make a large contribution to the solution of environmental crisis. Women also bear the highest cost of environmental crises because of their role in providing water and energy within the family and community levels. The practical relationship between women and the physical environment must therefore be made visible. However, the GED approach is not only concerned with women, but with the social construction of gender and assignment of specific roles, responsibilities and expectations of men and women in relation to the environment (Dankelman 2002). The GED tool also explains the impact of the environment on men and women, and how men and women affect that environment through their gendered activities. It also advocates for the participation of both males and females in environmental issues affecting their livelihoods and food security.

6 Location and Physical Setting

Zimbabwe has five eco-regions. Beitbridge lies to the south of the Save-Limpopo eco-region which covers 78,15 km^2 in the south-eastern part of Zimbabwe (Fig. 15.1). At 20 % of the entire country, it is the second largest eco-region after the Central region (Chenje et al. 1998). Save-Limpopo eco-region is drained by the Save and Limpopo basins. Its average altitude is 500 m and has the lowest altitude in the country (162 m) at the confluence of Save and Runde rivers.

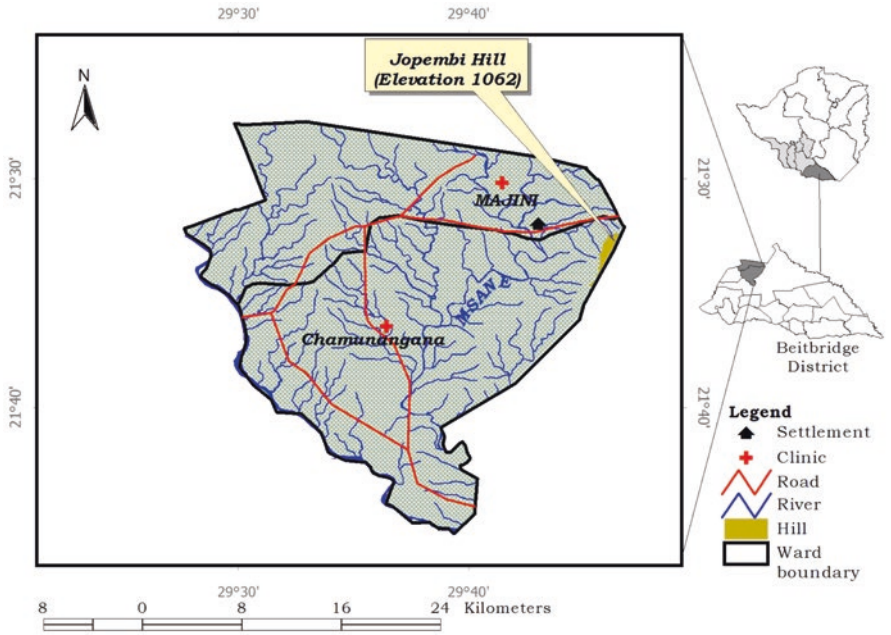

Fig. 15.1 Localization and description of the studied sites (Source: GIS-generated by authors)

The Limpopo Valley area, in which Beitbridge lies, is a paragneiss zone that stretches from the east of Chiredzi to the Border with Botswana. Mean annual rainfall in this region is between 300 and 600 mm with 40–45 % co-efficient of variation (Feresu 2010). Rain falls during the summer months: October to March. Mean annual temperature is between 25 and 27, 5 °C.

Soils in the eco-region are varied, depending on the parent materials and age. On sedimentary formations, soils that occur in younger deposits are deep and often stratified. On levee deposits, soils are relatively light-textured with a high proportion of coarse sand of granitic origin. Basin areas have given rise to heavy textured soils derived from fine materials deposited during floods.

Vegetation varies from the savanna on deep fertile soils to shrub savanna on shallower ones. It is of lower stature of 2–6 m high with a sparse grass cover of mainly *sporobolus spp* (love grass) and *cynodon dactylon*. Common trees in this region include mopani, which is prevalent on salt-rich soils, baobab, *marula* and various species of combretum and acacia (Feresu 2010).

7 Human Activities and Environmental Change

The eco-region was a tsetse belt infested with tsetse flies, but like the Zambezi eco-region in the north of the country, it suffered severe environmental damage over the past years due to the early methods used for tsetse fly control. The great rinderpest

outbreak of 1896, which killed large numbers of wild animals and livestock and caused the tsetse fly to recede in many areas, had clearly demonstrated the link between the tsetse fly and vertebrate blood, its sole food and drink. This led to 800,000 wild animals being shot in the early battle against the fly in the eco-region between 1920 and 1945 (IUCN 1988).

Later, the axe succeeded the gun, with large-scale tree felling and bush clearing and burning to displace wild animals. These techniques deprived the fly of its essential food and also deprived it of shade and resting places. They also opened up thousands of square kilometers of former fly belt to settlement and the plough. On the other hand these techniques caused widespread environmental damage (Chenje et al. 1998).

This damage was worsened by insecticidal spraying. First came Dieldrin in 1961, which was lethally toxic to small mammals, birds and reptiles, it was followed by another dangerous chemical, DDT in 1968. The environmental effects of these persistent chemicals were not investigated until some years later when it was discovered that they were environmentally lethal. Studies in Zimbabwe revealed that the accumulation of DDT in human milk was twice the maximum levels recommended by the World Health Organization (WHO) (IUCN 1988).

Apart from the urban setting of Beitbridge as a border town with South Africa, the west of Beitbridge district is semi-arid, remote and marginal. Farmers are generally sedimentary pastoralists who practice dryland farming which concentrates on drought-tolerant small grains like sorghum, millet and rapoko. There is also salt extraction from salt pans. The population density of Beitbridge district is between 4.42 and 10.61 (Chenje et al. 1998).

8 Methods and Research Techniques

This study was carried out between March and October 2012. This allowed the researchers time to have a comprehensive triangulation of research methods. Surveys, interviewees, direct observations and focus group discussion were used in this study.

Beitbridge is a multi-cultural district comprising Suthu, Venda and Shangani ethnic groups. To capture views of all cultural groups concerning environmental change and gender against traditional approaches to food security in the district, network referencing was used to select 40 respondents per ethnic group. Research participants from a particular ethnic group were requested to facilitate the selection of other participants from the same ethnic group. In all, 120 questionnaire respondents answered the questionnaire, and since these questionnaires were self-administered by the researchers, the response rate was 100 %. To qualify, respondents were supposed to be 40 years and above, and should have stayed in the district for more than 30 years. Such respondents were considered credible to have knowledge of climate and environmental change in their communities. They were also believed to be well versed with traditional strategies of food security in the area.

In addition, interviews were held with three elderly men and three elderly women, randomly selected per ethnic group (60 years and above). These were considered to have profound cultural knowledge about food security in light of environmental change. Thus, six elders per cultural group were interviewed giving a total of 18. For each cultural group, a traditional leader (kraal head or chief) was also interviewed to cement or elaborate on each ethnic group's perceptions on environmental change, gender and food security. Key informants, like the District Agritex office and the District Environmental officer, were also interviewed. The Agritex officer's views were critical in sharing his experiences on the ethnic groups' ways of farming, their preferences, adaptation mechanisms to environmental change and their willingness to adapt to modern ways of farming. The Environmental Officer's views were critical in sharing the community's response to environmental change and their willingness to participate in prescribed environmental rehabilitation and management mechanisms. Local coordinators for World vision and CARE non-governmental social welfare organisations operating in the two wards were also interviewed for their expert ground experience on environmental change, gender and food security.

Direct observations were used to 'ground truth' evidence of environmental change in both wards 10 and 11 where the study focused. For this technique an observation check-list was prepared to guide the researchers identify phenomena like silted rivers, state of pastures, dry wetlands, state of forests as well as traditional ways and gender roles of collecting, preparing, preserving and storing traditional food items for both present and future use.

Focus group discussions were initiated by the researchers at meetings at schools, clinics, food-for-work programmes, boreholes and even political gatherings to hear the locals' views on environmental change, gender, their cultural preferences and food security in Beitbridge district.

9 Results and Discussion

9.1 Evidence of Environmental Change in Beitbridge District

Environmental change in Beitbridge district manifests itself in diverse ways as shown by the survey results in Table 15.1. Increased incidences of drought and silted rivers are the major forms of evidence as identified by all respondents. Other salient manifestations of environmental change include drying up of wetlands, ponds and pans; early ceasation of the rain season; reduced length and delayed start of the rainy season; reduced rainfall quantity; reduced pastures; and the fact that some crops are no longer in the district

In an interview, Gogo Sibiya, 82 years old lamented incidences of recurrent drought in Beitbridge district, and observed that in the past droughts were not as frequent as they are nowadays. She explained that droughts and unpredictable rain

Table 15.1 Evidence of environmental change

Observed criteria of climate change	Ethnic groups				
	N = 40 Suthu	N = 40 Venda	N = 40 Shangani	Total N = 120	%
Silted rivers	40	40	40	120	100
Extinct bird species	23	19	22	64	53
Extinct plant species	27	26	24	77	64
Extinct animal species	21	21	20	62	51
Reduced pastures	34	33	31	98	82
Disappearance of thick forests	29	30	33	92	77
Water table now very deep	27	29	31	87	72
Some crops no longer viable	33	34	31	98	81
Delayed start of rain season	37	38	40	115	95
Early ceasation of rain season	38	39	40	117	97
Wet season now shorter	39	38	39	116	96
Cold season now warmer	09	07	08	24	20
Reduced rainfall quantity	35	37	36	108	90
Increased incidence of drought	40	40	40	120	100
Drying of wetlands, ponds, pans	39	40	40	119	99

patterns only became serious issues after the country's independence in 1980, and that this could be because the ancestors are not happy that a lot of blood spilt during the struggle for the country from colonialism is not yet accounted for. She believes that there is a need for a national cleansing ceremony to appease the spirits. CARE and World Vision officers who operate in the district, however, attributed these weather phenomena to global warming. They cited these as reasons for their intervention in the district. Both the Agritex and the EMA (ward 10) officials linked the degraded state of Beitbridge's environment to the operation to get rid of tsetse flies in the area. Tsetse flies cause Nagana to cattle and sleeping sickness to people. These officials also explained that thick forests were lost during the 'operation tsetse control' whose effects disentangled food chains and food webs with disastrous environmental consequences whose reality is regretted to this day.

Tlou (95) of ward 10 strongly believes that the chemicals which were used in tsetse eradication are responsible for poor pastures. He explained that prior to their use the three communities under study (Suthu, Venda and Shangani) had large heads of cattle. The Agritex officer for ward 11 seemed to share Tlou's view by explaining that chemicals used to control tsetse flies, Dieldrin and DDT are dangerous substances whose effects are long lasting and could partially be responsible for poor pastures in parts of the district.

The kraal head Ndou (75) of ward 11 attributed extinct bird, plant and animals species to the drying of wetlands, ponds and pans, explaining that these acquatic ecosystems have some endemic plant and animal life which is only sustainable as long as the conditions are within their optimum range of tolerance. EMA officials for both wards 10 and 11, however, added that changes in the terrestrial habitats also

cause the extinction of species in an area. They elaborated that the disappearance of forests may have resulted in the so-called 'extinct' species migrating to areas which are still pristine, possibly across the border into Kruger National Park in South Africa.

Although 80 % of the questionnaire respondents alluded to the fact that the cold season was getting colder, no interviewees from any ethnic communities could explain why this was happening.

9.2 Traditional and Cultural Approaches to Food Security

The three dominant ethnic groups in Beitbridge district are heavily dependent on the environment. They produce their own food which they rely on throughout the year and sometimes even beyond. During the wet summer season, they mainly rely on green, fresh or perishable crops like green melons, watermelons, green mealies, and groundnuts from their fields (Table 15.2).

Pumpkin leaves, okra and milk are the main types of accompaniment served with the staple sadza (thick porridge) from maize, millet or sorghum. Maize is the main national staple crop in Zimbabwe, but its yield is very unpredictable in the semi-arid environment of the country. For this reason, maize yields hardly feed households for a complete year. It is the small drought tolerant grains, millet, sorghum and rapoko which, though not very palatable, become more reliable throughout the year. From the natural environment, Beitbridge communities get different forms of relish which include vegetal *ulude* and wild okra. They also capture insects like locusts and cicadas and the mopane worms, a delicacy among the Venda, the Suthu and the Shangani. During this same period, wild fruits, which will be in season for example *amaganu, umviyo, umqokolo, umthunduluka*, become an important part of the diet. Focused group discussions in the study area revealed that these traditional sources of food are dependable, available and affordable and hence should be preserved and passed on from one generation to the next. Direct environmental observations by the researchers however pointed to the need for enhanced environmental management to protect the remaining plant and animal species in the district.

Winter season in Beitbridge is cool and dry. The luxury of multiple food items from both crop fields and the wild passes with the summer season. Communities in the district thus prepare for winter during the summer period. Most of the summer crops and wild food items are sun-dried and preserved for future use. Melons, which normally need to mature first before being consumed by humans, and pumpkins, which have a long shelf life after harvesting, are the few crops available in winter. Melons are used to prepare traditional foods like *umxangxa* (a cooked mixture of sliced pumpkins, few maize grain, water and sugar) and *nhopi* (sliced pumpkins, water, salt and peanut butter).

From the wild, it is mainly quelia birds and wild game which provide food to communities through hunting by boys and elderly men. Gogo Hlatshwayo (65) from ward 11 bemoaned her two grandsons who illegally crossed into South Africa

Table 15.2 Beitbridge Ethnic groups common food by season and type

	Common food by season		Type	
Ethnic group	Wet season	Dry season	Domestic	Wild
Suthu/Venda/ Shangani	Water melons		√	
	Green melons		√	
	Pumpkins	Pumpkins	√	
	Sweet reeds	Dried sweet reeds	√	
	Groundnuts	Dried groundnuts	√	
	Roundnuts	Dried roundnuts	√	
	Beans	Dried beans	√	
	Green mealies		√	
	Milk	–	√	
	Ibhobola (pumpkin leaves)	Dried *bhobola*	√	
	Ulude	Dried *ulude*		√
	Okra	Dried okra	√	√
	Locusts	–		√
	Cicada	–		√
	Mopane worms	Dried mopane worms		√
	Wild fruits (e.g.*amaganu, umviyo, umqokolo, umthunduluka etc*	*Inkelo, umkhuna, umkhomo*		√
	–	Melons	√	
	–	Quelia birds		√
	Game meat	Game meat		√

Source: Primary data from survey and focused group discussions

in 2008 saying since their departure, she has had serious problems getting some meat for the family. Cows are normally not milked during the dry winter season since they will be very thin because of poor pastures. Whatever milk the cows produce is reserved for the calves.

Approaches to food security among the Suthu, Venda and Shangani revolve around their traditional ways of food production, processing, preservation, storage and preparation. Their indigenous ways are locally adaptable thereby achieving food security in the face of climate change.

9.3 Farming Methods and Local Knowledge

Polyculture is a common traditional approach to planting in Beitbridge. This is whereby more than one crop is planted on one piece of land. Respondents revealed that they planted drought and wet resistant seeds on the same piece of land. For example, sorghum, millet and melons which are drought resistant are planted

together with maize, groundnuts and round nuts which require normal or above normal rainfall. This is meant to ensure that at least a reasonable harvest is realized if the season has low or high rainfall. Respondents also indicated that long-term (crops which take long to mature), and short-term varieties of crops (crops which mature early) are planted at the same time on the same field. Their long-term varieties include sorghum, millet, round peas and groundnuts while the short-term are maize, water melons, green and yellow melons. However, respondents noted that some of the crops have their long-term and short-term varieties. For example the big red groundnuts are a long-term variety compared to the small round groundnuts. Long-term varieties of maize include R52 and *shumba* (medium term) and the common *tsoko* (short term varieties). The red sorghum (*tsweta*), which looks like sweet reeds, is a long-term variety, while the short white (afumbathayo) is a short-term variety.

Other strategies include early sowing and dry planting to allow the opportunity for resowing if patterns of rainfall change *(ukuqabanga and ukuphendulela phansi inhlanyelo)*. There are also multiple sowing dates across the fields to spread the risk in case of floods, drought, locusts and birds. During observations, fields with different sizes of crops and different varieties were evident. There was also an attempt by households to produce crops that cover the whole year or years, for example, sorghum, millet, and groundnuts, maize and round nuts. Other crops like green and yellow melons were for immediate use only while others could be preserved for future use (for example, water melons).

Traditional indigenous methods of farming also include use of traditional insecticides and manure to prevent seeds from attacks by different types of birds *(izikhwehle)* and small animal ruminants (inhloni and inungu). The seeds are treated by a poisonous onion-like plant (*isigenama)*. Aloe Vera (*malungusane* in Suthu and *chigavakava* in Venda) is also sprinkled on seeds some days before planting maize, round nuts and groundnuts. Beitbridge is a dry region, hence respondents reported that there is little investment on modern fertilizer. Ash from burnt tree branches *(amabibi*) is very useful as manure though it interrupts the ecosystem by destroying other living organisms. Grass and stalks of crops are ploughed back into the fields as manure. In severe cases of the need for manure, people go to the extent of carrying fertile soils from anthills and the foot of the mountain to the fields.

Mixed economy or diversification of economic activities was reported by all respondents as an important strategy for achieving food security among the three ethnic groups. This involves practicing cultivation, fishing, pastoralism; gathering, hunting, barter trading, formal and normal employment. Respondents noted that these results in diverse products for food obtained from different economic activities. Diverse breeds of livestock are kept, some of which are drought resistant. Examples are the Matebele mie goats which prefer dry mountainous areas associated with their favourite tree food *(umtshatshatsha)*. The goats together with short fat-tailed sheep were reported to be highly fertile with multiple births within a year. The common drought-resistant cattle include *mabula, manjanja, Nguni* and *Tuli* breeds which are locally adaptable. Hunting supplements food through game meat from small ruminant animals like hare, buck and rock-rabbits to big game like

impala, kudus and antelopes. Respondents reported that game meat can be sold for cash to buy grain or mealie-meal.

Gathering of fruits such as amaganu, umviyo, umkhomo, umqokolo, umwawa, umtshwankela, umhlali and umkhemeswane was reported to be an important supplement to food. Wild vegetables like *ulude, idelele* and *imbuya* are gathered to supplement relish during the wet season. These together with domestic vegetables like pumpkin leaves and bean leaves are also gathered, dried and preserved for use during the dry season. The roots gathered for food in the Venda diet include *mutobhi, mukwikwi and mudzamoyo*. These are onion-like and are found in wet areas (amaxhaphozi).

The common creeping organism that was reported to be an important part of relish was the Mopani worm (amacimbi). These are processed, fried and roasted though they may also be eaten fresh. Mopani worms are also an important source of income that can be used to buy other basic commodities like grain and mealie-meal. Locusts, *inhlwa* and *inyeza* (cicada) supplement relish.

9.4 The Gendered Impact of Environmental Change on Food Security in Beitbridge

Although environmental change and food insecurity affect men and women, it must be noted that the effects and response to the two ills is different. The respondents reported that there are differences related to gender roles, relations and the general division of labour. Gender activities relating to food production, processing, preservation, storage and preparation are gender specific.

9.4.1 Male Roles and Expectations

Interview responses from the three ethnic groups indicated that the men as a breadwinner has the responsibility for securing food, women participate as helpmates. The major roles for women in food security issues were reported to be relating to food processing, preservation, storage and preparation. For the above reasons, men were to acquire or identify land for cultivation and for livestock grazing. In Beitbridge communal lands, women do not own land in their own right, but access it through their male counterparts. Only a few women accessed land in resettlement schemes, for example, in Model A1. Hence land acquisition for agriculture and its clearance is a man-specific role. Taking livestock to seasonal grazing lands (imilaga) is also a role for men.

It was also reported that, it is a man responsibility to seek additional stock-feed whether traditional or modern. If there is shortage of man labour, it is the responsibility of men to employ cattle herders and men workers in issues relating to land clearance, cultivation, fencing and livestock management. Men and women respon-

dents indicated that culturally in all the three ethnic groups, land and livestock belong to men. Cultural, gender and power relations determine differential access and control of land and livestock resulting in gender differentiated roles in field and livestock management. If men fail to produce sufficient food through cultivation and pastoralism, it is mandatory that they find alternative means of food acquisition as breadwinners. They were reported to find formal and informal employment locally or migrated to towns. Men cross-border migration to Botswana and South Africa was reported to be a common feature in Beitbridge. Interviewed women indicated that men who failed to find alternative ways of winning bread are labeled as useless husbands *(omayihlalela*), a derogative term.

The migrated men are expected to send home remittances in form of food groceries, clothing, farming implements and cash for seeds, fees, payment for herders and other men workers. Women indicated that those who failed to meet the above expectations were again labeled as failures (*migewu or omadliwa*), men who are good for nothing.

9.4.2 Female Roles and Expectations

Food processing, preservation, storage and preparation fall heavily on women because of their reproductive roles as child carers and family service providers. Women indicated that their important role was food preparation but that food needs to be processed, preserved and stored for future use. Poverty and hunger were reported to be indicators of husband's failure to meet his traditional expectations and that is embarrassing to any woman. The other point mentioned was that traditionally children and family members approach women for food when they are hungry. Respondents reported that it is embarrassing and depressing for women to fail to give children food.

The above situation forces some women to migrate for formal employment in towns or cross the boarders to Botswana and South African. Other women reported that they worked informally for well-off families locally to obtain food. Some women resorted to gathering flying insects and creeping ants, roots, wild vegetables and fruits to supplement their diets. In order to make use of these food varieties, women process, preserve and store these for future use. Key sources of such food and related activities are described below:

Insects

Insects like locusts, *inyeza, amahlabusi* and *izinhlwa* are collected and fried for immediate use as relish, while *amacimbi* are processed by boiling them, treating with ash and charcoal before sun drying for future use. The Mopani worms were reported to be preserved and stored in granaries for a period of up to a year. However, in many households, mopane worms were sold to urban dwellers because they attracted cash that can be used for other food necessities. The processing, treating

and preservation was reported to be a laborious process that took a lot of women's time. Available men and boys assisted in the collection of the worms since most are found on top of trees and far away from homes. Men may also provide firewood using scotch carts or wheelbarrows because the treatment process demands a lot of ash and charcoal. When the researchers visited Beitbridge, women were busy in *iziza* (where harvested crops are kept before processing) situated on *dwalas* using sticks to roast mopane worms using ash and charcoal. This process required a whole day's business.

Roots

Interviewed women indicated that most of the gathered roots were eaten raw. For example *amagonsi* (sweet potato like root), *ubhande* and *savaha* (an aloe vera-like root) can be boiled or eaten raw. These types of roots serve as dessert or starters. In times of food insecurity, they supplement the diet. Children and herders depend heavily on them.

Wild Fruits

Fruits like *umthunduluka, umqokolo, umviyo, amaganu* and *umhlali* are collected by women and children for immediate use during the wet season. However, women indicated that they processed *umhlali* into a milk or beer-like liquid for children as relish. One Venda woman narrated that they crushed the fruit and emptied the contents into a container of 500 ml of water and left the contents for about 20–30 min. The seeds are removed leaving a beer or milk-like liquid for drinking. Collection of *amaganu* is done mostly by women, young boys and girls. Men were reported to help when *amaganu* were collected in the forests far away in large quantities.

One Shangani woman MaDhliwayo (73 years old) narrated how the fruit is prepared for immediate and future use. She pointed out that the fruits are opened using a sharpened animal rib or stick. Then both the liquid and seeds are poured into a bucket. Water is added and everything is mixed thoroughly using hands. To remove the sweet stuff surrounding the seeds, seeds are pounded in mortars using pistles. The pounded stuff is returned into the container and there is thorough mixing of the contents. The sweet liquid is stored in clay pots and calabashes to ferment for 1–3 days depending on temperature. This was reported to be an important type of food that people depend on when doing hard work like weeding, bush-fencing or during work parties (*amalima)*. The whole family can drink the sweet liquid. The removed seeds are piled to dry. Women further crush the dried seeds to remove the inner nut that is pounded *(ukuchola)* to produce a form of peanut butter for mixing with dried vegetables and meat for relish, during the dry season. Children, both boys and girls are fond of eating the raw nuts (inkelo) which they crush using stones. The nut was reported to be tasty, fatty and filling.

Umwawa, uxakuxaku, umtshwankela, umphafa, umkhomo and *umviyo* were eaten during the dry season. All these fruits can be eaten raw. However, some need processing, preserving and storage for future use. *Umphafa* and *umtshwankela* are for immediate use only. *Uxakuxaku* is dried, boiled for future use and stored in treated granaries. *Umviyo* is first pounded and dried for future use. *Umkhomo* is collected, dried and stored for future use. Dried contents can be mixed with milk to produce a thick sour mixture that can feed the family. One Venda woman Mrs. Tlou (66 years old) revealed that *umwawa*, referred to as *mukwakwa* in Venda, takes a lot of women's time in processing, preservation and storage. The ripe fruit is opened and put on *ihaha* made out of *ubhuzu* or *umklampunzi* box fibre of approximately 50x40cm until every part of the surface is filled within the fruit stuff. The layer is first sun dried until the top surface is shiny. The process is repeated until 3–4 dry layers have been formed and become compact enough not to fall off the mat (ihaha). The *ihaha* is then placed near the fire for heat baking and drying *(ukuchochombisa).* The process takes 2–3 days. Total dryness is reached when the inner seed is loose enough to produce a sound when shaken. The dried layers are removed for storage in khaki papers that absorb moisture. *Umwawa* can then be stored in harvesting baskets, drums, clay pots and granaries for future use. It should be safe from moisture otherwise moulds can easily develop leading to *umwawa* going bad.

Vegetables (Wild and Domestic)

Women were reported to collect domestic and wild vegetables for immediate and future use. The vegetables collected include domestic bean leaves (*nhawa* in Venda), and pumpkin leaves (*bhobola* in Suthu) and wild okra (*phulule* in Suthu), (*munyovhi or munimbvi* in Venda) and soft green leaved *imbuya* found near cattle or goat kraals and climbers like *mufhafhe* and *chibavhe*. All these, can be prepared for immediate use and be dried for future use. In the case of *ulude/munyovhi* and *indumba/nhawa* leaves, women cut the softer ends of the vegetable, boil them and dry them for future use. They are packed in plastic papers and stored in sacks and treated granaries for protection from moisture.

Preservation and Storage of Harvest Crops

Interviewed women from the three ethnic groups revealed that varieties of melons were not treated but simply stored in granaries, in huts and grain barns (ingalane) to protect them from weather conditions. Even the seeds are not treated but sun-dried for use in the next planting season. The inside of a melon is cut into thin slices and sun-dried for use in the preparation of a thick porridge, *nhopi* in Venda. Slicing and drying is done by both men and women. The planting of groundnuts, round peas and beans is done by women, so is harvesting, processing, preservation and storage. Outer covers are removed and the nuts are treated with the mixture of ashes. However, women noted that those dried with their covers and stored in granaries or sacks stay longer, up to 12 months.

Sorghum, Millet, Rapoko and Maize

The first stage in the processing of millet, sorghum and rapoko after harvest is the shelling or pounding (*ukutshokola) of* heaped and dried grain yields. This is done by both males and females. Winnowing and packing of grain is women's role. Men assist in transportation of grain from *izihonqo* (grain barns) to the granaries for storage. This work demands physical strength. The preparation of ash mixtures using tree branches and leaves for grain preservation is done by women.

One Suthu woman, MaMkwebu (62) indicated that harvesting, shelling, winnowing and treating for storage stretches from May to September every year. The types of trees that are burnt to mix with goat manure include aloe vera, *umtshiwili, mwonze and umhlonhlo* depending on the ethic group and availability in the area. The same mixture is used to treat granaries to protect grain from borers. The seeds (inhlanyelo) from millet, sorghum and sweet reeds are dried and smoke-coated by women in kitchens to ensure availability of seeds for the next season thereby ensuring food security. Smoke produces a bitter taste that keeps fungi off the seeds for a year. Traditional granaries among the Venda, Shangane and Suthu of Beitbridge are built on big stones. Observations revealed that those granaries are four-cornered mud huts divided into separate compartments. The granary stands out on big stones of half a metre above the ground to protect the structure from ground water while the thatched roof protects it from the rains. On stones are laid on table-like strong logs that make up the foundation on which the granary wall is built. The granary symbolises success in farming, ensures food security and secure storage. Women use dagga to build compartments and thatch to roof the granary. The inside of compartments is treated with cow dung, ash and manure mixtures as preservatives.

Women also ensure food security through preparation of various mixtures of food varieties. For example groundnuts, round peas, beans and maize seeds can be mixed and cooked together to form a nutritious traditional type of food called *inkobe*.

One Suthu women MaMkwena (39) mixed maize grain with sliced melons to prepare *umxhanxa/ravarhiya*. She also added slices of pumpkins to give a thick porridge-like dish. Women have developed their indigenous recipes that ensure food availability, sufficiency and sustainability. Different types of fresh and dried vegetables and meats are mixed with peanut butter for relish (*idovi/idobi)*.

Table 15.3 reveals that traditional inputs are more readily available to Beitbridge's three main ethnic groups than convectional inputs like modern seeds, insecticides and fertilizers. Communities prefer their traditional seeds (78 %), traditional insecticides (77 %) and traditional fertilisers (86 %). Most respondents also qualify the same local traditional inputs as both affordable and reliable.

Table 15.3 also shows that most of the food items on which communities depend in Beitbridge are locally produced on farm plots (fields) or are provided by the local ecosystem. These food items are therefore readily available. They are affordable since for most very little or no money is needed to acquire them. They are also reliable since nature provides these food items (mainly wild fruits and wild vegetables and roots) variably throughout the year. Beitbridge communities have advanced

Table 15.3 Availability, affordability and reliability of inputs and food items (N = 120)

Inputs	Availability	%	Affordability	%	Reliability	%
Modern seed	60	50	55	46	52	43
Traditional seed	94	78	88	73	87	72
Modern insecticides	40	33	42	35	57	48
Traditional insecticides	92	77	9	79	107	89
Fertilisers	30	25	41	34	40	33
Manure	105	86	111	92	100	83
Food items						
Sorghum	115	96	112	93	100	83
Millet	100	83	109	91	102	85
Maize	93	77	75	63	61	51
Wild fruits	98	82	100	83	103	86
Insects	100	83	99	83	99	83
Roots	105	86	98	82	96	80
Game meat	65	54	79	66	63	53
Domestic meat	60	50	68	57	61	51
Wild vegetables	104	87	107	89	78	65
Domestic vegetables	92	77	105	86	101	84

indigenous knowledge systems of crop, fruit, meat and vegetable preservation which reinforce the reliability of these food items, as they remain available all year round. This indigenous knowledge is a preserve of women who expertly identify, harvest, collect, process, store and finally prepare these food items for family consumption. In this food matrix, men are mainly involved in hunting and bringing game home before women take over the rest of meat processing including slicing, salting and drying. Hunting is however becoming a less reliable way of security because of the disappearing forest habitats which have led to reduced occurrences of the different types of game. It is important to note from Table 15.3 that maize (main staple crop in Zimbabwe) at 53 % reliability is not as trusted as both millet and sorghum. This is mainly because although they grow maize every year, harvests are always very unpredictable because of rainfall variability and droughts.

9.5 Rethinking Traditional Approaches to Food Security in the Face of Environmental Change

The study has revealed that there are widespread indications of environmental change in Beitbridge. It is also evident that environmental change has an effect on food security. The impacts of environmental change and related food security issues affect men and women differently. The communities in Beitbridge (Suthu, Shangane and Venda) depend heavily on their traditional approaches to secure sufficient food. Their indigenous knowledge systems (IKS) of food production, processing,

preservation, storage and preparation are locally adaptable. For the above reasons, there needs to be a refocus on cultural and traditional ways of achieving food security in such communities. There should also be a refocus on women, as the study revealed that men can produce food but that important processes like processing, preservation, storage and preparation depend on women. Both men and women in these communities should participate in programmes, projects and conferences on climate and environmental change as these affect them directly and indirectly.

10 Conclusion

Widespread indications of environmental change in Beitbridge relate to unpredictable patterns, quality and quantity of rainfall. This has resulted in land degradation, loss of forests and disturbance of biodiversity, poor pastures and insufficient food for the people. The three ethnic groups in Beitbridge largely depend on the natural environment for their livelihood. They produce traditional food varieties that stretch from the wet to the dry season. Diversification of economic activities is an important traditional mitigation strategy against environmental change. It is an insurance against food insecurity during poor harvests resulting from droughts and floods. The economic activities include formal and informal employment (in towns and locally), cross-border migration, pastoralism, hunting, gathering and fishing. Approaches to ensure food security in Beitbridge include indigenous ways of food production, processing, preservation, storage and preparation most of which is done by women. Processing, preservation, storage and preparation of seed, grain and food varieties ensure sustainable availability, affordability and reliability during the dry season and dry years. The research carried out suggests a refocus on gender and traditional ways of achieving food security in the face of environmental change. It also suggests that women be included in policies, projects and programmes relating to environmental change, natural resource management and food security, especially in relation to indigenous species and due to their strong dependence on biodiversity for food security. However, both genders depend on the natural environment for their food security and thus the adoption of a GED approach is a way to include all relevant perspectives.

Foreign experts and Agritex officerts, with areliance on modern scientific models, should also recognise the vast traditional subsistence strategies for food security that have been developed by local communities over many generations. Cultural approaches to food security should not be overlooked or sidelined and mitigation strategies should be embedded in the IKS of local communities. This knowledge needs to be documented and shared among ethnic groups and regions through ‘intra and intergenerational transfer of IKS’, (Madebwe et al. 2005). Ignoring IKS in relation to farming practices, processing, preservation, storage and preparation of food may contribute to negative attitudes towards the intervention of external experts and their methods. Traditional food processing, preservation, storage and preparation

should thus be harmonised by incorporating relevant aspects of modern technologies to improve food nutrition availability, reliability and affordability.

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Postface

For many populations that are already socially marginalized, resource dependent, and with limited capital assets, human security will be progressively undermined by environmental change. Throughout this volume, it has been demonstrated that global environmental change in general, and climate change in particular, are putting both human security and human rights (such as right to life, health, shelter, and food) at risk. The volume's authors have investigated how global environmental/climate change may worsen threats to human security by focusing on specific dimensions – such as food, water, health, and economicsecurity– from the primarily regional focus of the Middle East and Africa and explore critical perspectives and approaches to address the identified impacts. Through its theoretical essays and a range of country-level case studies and experiences, the volume aims to provide readers with access to valuable research material and insights about the interactions between environmental change and human security from a range of perspectives.

The contributions demonstrate above all that the risks posed by environmental/climate change to human security arise through multiple and interconnected processes operating across diverse spatial and temporal scales. This complexity means that there is no single conceptual model or theory that can fully capture all interactions between all environmental/climate changes and dimensions of human security. For this reason, and as highlighted by the IPCC's AR5 report, many environmental risks to human security warrant further investigation (i.e. links between environmental change and migration, between climate change, conflicts and instability, between climate change and health security, etc.) (Adger 2014). This publication aims to contribute to the growing academic literature while enhancing political discussions and policy agendas on how to address current and future challenges. Indeed, and as suggested by Gasper (2010), we hope that the framing of environmental/climate change as a human security issue can facilitate and provide the space for exchanges across academic disciplines and the boundaries of diverse policy communities to take place.

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The Institute of Research for Environment, Human Securityand Governance (INRES), formerNorth-South Center for Social Sciences (NRCS), intendsto investigate in future research projectsthe current and expected state of human and environmental security in the era of global risks and how to efficiently manage it. The recent international conference organized by the NRCS in November 2015[1]– covering the same topics – was an opportunity to understand the relevance of these areas for both research and policy making agendas. Future projects will be conceived in such a way as to build on some of the many issues highlighted by this volume and the recent conference outcomes. We hope that this process will open further points for discussion and offer readers some thought-provoking insights.

AgadirMorocco — Mohamed Behnassi

Berlin,Germany — Katriona McGlade

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[1] The International Conference on "Human and Environmental Security in the Era of Global Risks" (HES2015) was organized on November 25–27, 2015 in Agadir (Morocco) by the North–south Center for Social Sciences (NRCS) and the UMR ESPACE-DEV, Research Institute for Development (IRD), France in collaboration with many national and international partners (such as the GIZ, the CIRAD, the Universidade Federal do Pará (UFPA) and the Universidade Federal da Bahia (UFBA), Brazil…).

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Jaume Fons-Esteve (PhD) is a biologist, expert on research in plant and soil relationships as a support to land management in the Mediterranean. Since 2001 he is supporting the European Environment Agency on land use dynamics and sustainable soil management. He has been involved in several FP7 projects related to urban environment (e.g. Urban Nexus) and climate change (CLICO, CLIP-C). He represents the Mediterranean node on the Sino-European Panel on Land and Soil supported by the EC. Since 2012 he is managing the ETC/SIA.

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He is member of the editorial boards of highly ranked journals in the field of Geosciences and Water Resources (WRR, HESS, AWR), and he acts as a reviewer for various scientific journals as well as for the US, Swiss and Dutch Science Foundations. He has served as project coordinator and/or scientific responsible of several funded projects at the national and international level, and his most recent project, funded by the Italian Ministry for University and Research under the Future in Research programme, is about "The global virtual-water network: social, economic, and environmental implications".

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