Chapter 1

Introduction

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Abstract

This chapter introduces the fundamentals of Desertification, Land Degradation and Drought (DLDD) and the need to establish a coping capacity. Humans depend largely on the land system for their existence; thus, drawing dangerously from the land resources, thereby depleting its productivity and degrading it. The overexploitation of land leading to its degradation, desertification, and drought is being exacerbated by climate change. This has great consequences on the society and the environment.

Globally, 24% of the land is degrading and about 1.5 billion people directly depend on these degrading areas for sustenance. Nearly 20% of the degrading land is cropland, and 20-25%, rangeland. In Africa two-thirds of its land is either desert or drylands; in Asia (including Russia) more than one-third of its land is arid, while almost a third of U.S. is affected by desertification; and one quarter of Europe, Latin America and the Caribbean.

For those communities that rely heavily on land as their main asset, especially the rural poor, coping with or building resilience (ecological or social) to the challenges of DLDD is inevitable. Thus, this book seeks to add to the existing knowledge on DLDD and present case studies on dealing with DLDD challenges at different regions of the world; for enhancing coping abilities at all scales – local, national, regional and international and for policy formulation.

Keywords: Land, desertification, drought, zero land degradation, vulnerability, climate change, response, resilience and sustainable development.

1.1 DLDD Challenges and Resilience

DLDD is a climate-related hazard that is globally in nature; with both short and long-term impacts on various aspects of human well-being particularly, agricultural yields, water availability, energy production, human health, biodiversity and ecosystem/ecosystem services and invariably food security. DLDD poses a great threat to resilience of the socio-ecological systems and to achieving the Sustainable Development Goals (SDGs).

This book considers the multiple stresses, which are both natural and anthropogenic that reduces the productivity of the land system globally, as land is vital for the provision of resources – food system and materials – that support human well-being (IPCC, 2019)[1]. The importance of land to our beingness as stated by IPCC is in the fact that 'neither our individual or societal identities, nor the world's economy would exist without the multiple resources, services and livelihood systems provided by land ecosystems and biodiversity'[2]; thus, the need for resilience to aid planning and policy formulation. The

concept of resilience has different interpretation based on the context. Social-ecological resilience is defined as "the capacity of an integrated social-ecological system to adapt to disturbance"[2]. We consider resilience not just with respect to the adapting capacity of the challenges of DLDD, but that of various ways in which the societal agencies can build coping capacities, is illustrated in the case studies presented in this book.

Reduction of societal vulnerabilities to DLDD can be achieve through strengthening the resilience of the communities, individuals and governance institutions that are the custodians through capacity building, so as to reduce the impacts of land degradation. Governance is key for vulnerability and exposure reduction, through structured institutions. The role of governance can be played out through the implementation of the rule of law, awareness raising to build informed norms, which make for adaptive governance to enhance the move from risk to resilience.

Challenges associated with land degradation arise due to pressures on land to meet the demand of the ever-increasing global population and from climate change, Climate change has a significant impact on soil. Increases in global land surface temperature[3], influences wildfire regimes, affects precipitation patterns and invariably the soil moisture content, and soil productivity across the globe, particularly in the drylands with the likelihood of drought[4]. These perturbations will not only reduce yield but leads to the degradation of the land system.

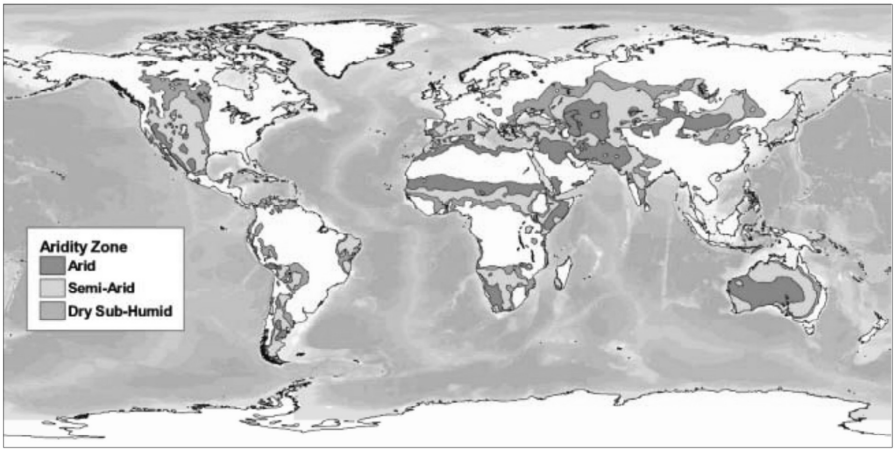
Other climate related impact on soil such as soil erosion leading to formation of gullies and landslides that give rise to land degradation are linked to extreme climate events like intense rain, storms, flooding etc. On the other hand, land contribute significantly to climate change challenges as a source of GHG emissions from agriculture, forestry and other land use activities, however, land also "mitigates climate change at the global scale, regulate water supply at the landscape scale, and support food production at the local scale[5].

The various stressors on land system are pushing the biophysical limits available for human to its tipping point or have already been exceeded[6], hence the need to build resilience.

1.2 Global Drylands

The drylands known as areas with low or variable rainfall (comprising of arid, semi-arid and dry sub-humid regions) account for about 41% of the Earth's land surface, and cover some of the world's poorest countries[7]. Map 1.1 shows the location of the global drylands. One of the features of the dryland is water scarcity (aridity or drought) which adversely affect people living in the region. One-third of the world population, over 2 billion people live in the drylands; of which 90% live in the developing countries. Africa is the most affect continent, with two-third of its land as dryland or desert, followed by Asia one-third arid, and USA one-third desert. While one quarter of Europe, Latin America and the Caribbean is affected by desertification.

Land degradation in drylands is referred to as desertification; which is linked to climatic issues of low soil moisture content, rainfall patterns and high evapo-transpiration; as well as anthropogenic factors. Desertification negatively affects the livelihoods of over 1 billion people in many regions of the world, and unfortunately the dryland area is still expanding. However, dryland ecosystem mitigates climate change by storing about 53% of global soil carbon and 14% of global biotic carbon in its plants[8]. Again, dryland supports 44% of world's cultivated systems and 50% of the world's livestock. Our concern is to showcase the complexities in the drylands and present case studies that is aimed at curtailing degradation and in-order to support live system in the region.



Map 1.1: Global Drylands (Source: World Resource Institute)

(Map 1.1 Description: The extent of drylands within each region ranges from approximately 1.3 to 18 million km^2. Asia and Africa have the largest total amounts (18 and close to 13 million km^2, respectively); Central America and Europe have the least. Source: WRI: Drylands, People, and Ecosystem Goods and Services 2019).

1.3 Land Degradation and Desertification

Globally, 24% of the land is degrading and about 1.5 billion people directly depend on these degrading areas. Nearly 20% of the degrading land is cropland, and 20-25%, rangeland. Every year 12 million hectares of land are degraded – this is invariably 23 hectares per minute! For those communities that rely heavily on land as their main asset, especially the rural poor, coping with or building resilience (ecological or social) to the challenges of DLDD is inevitable. Land degradation and desertification are often used interchangeably, but UNCCD 1994[9], defined "desertification as land degradation in the arid, semi-arid, and dry sub-humid areas resulting from many factors, including climatic variations and human activities"; which conveys the idea of land being converted into

deserts, which is not so for all land degradation processes. Land degradation also occurs with soil erosion in situations where the topsoil is eroded away faster than it can be replaced by water or wind agent, leading to gully formation and the degradation of the land. Land degradation is also defined "as a negative trend in land condition, caused by direct or indirect human-induced processes including anthropogenic climate change, expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity, or value to humans"[2]. When land degradation happens in drylands it is known as desertification; so the distinguishing factor between desertification and land degradation is location-based. This book presents case studies of land degradation and the coping strategies employed to enhanced productivity.

The problem of desertification and land degradation even drought leads to hunger and poverty, forcing people to migrate from their locality to a more secured location, which in itself may lead to scare resource and possibly conflict. The related issues of Desertification, Land Degradation and Drought (DLDD) has long been a burning issue on global discourse. With over 40 years of conferences and legal regimes related to DLDD, yet the challenge is escalating. "Life on Land", "Zero Hunger", "No Poverty', "Clean Water and Sanitation" and Climate Action" are some of the Sustainable Development Goals relating to the land system. The SDG agenda is a universal call for action to achieve a land degradation-neutral world, protect the planet, end poverty and ensure that all people enjoy peace and prosperity by 2030. Yet, it is estimated that in 2030, the demands for energy will rise 50%, food 45%, and water 30%; all translating to further pressure on the land system and its productivity. So, we must incorporate resilience in all our institutional planning and policy implementation.

1.4 Drought

Desertification and drought are closely related, but drought is defined as a departure from the average or normal rainfall/water conditions, sufficiently prolonged as to affect the hydrological balance and adversely affect ecosystem functioning and the resident populations. The Synthesis Report (SYR) of the IPCC Fifth Assessment Report (AR5), defined drought as "a period of abnormally dry weather long enough to cause a serious hydrological imbalance"[10]. Drought causes significant economic and ecological losses. Over 2 billion people or about 30% of the world population live in countries experiencing high water stress, and about 4 billion people experience severe water scarcity during at least one month of the year[11]. Under the climate change scenario, nearly 50% of the world's population by 2030 will be living in areas of high-water stress and between 24 million and 700 million people will displace in arid and semi-arid areas[12]. The stresses of drought are presented in this book and the responses as it relates to the social and ecological system to support economic and human well-being.

1.5 Land Degradation: Vulnerability and Responses

Cases of land degradation is reported in all regions of the globe. The causative agents are majorly poor land management system and planning, coupled with extreme weather events or natural disasters. An estimated 700 million people will be vulnerable to land degradation challenges. Therefore, there is the need to take action to enhance the coping capacities of the locals to reduce vulnerabilities to these challenges in the affected regions of the world and enhance resilience. Local action by communities that build upon science and traditional knowledge can change the drivers of land degradation. This book diagnoses the constrain and vulnerability of the socio-ecological systems to climate change and land degradation and presents the responses at local levels to retaining ecosystem integrity and maintain sustainable rural livelihoods in the face of climate change and DLDD challenges. The responses may be autonomous, reactive, planned or anticipatory, which can be by coping, adjustment or transformation (field-scale or policy-based)[13]. Evaluation of interventions designed to enhance adaptive capacities is also presented.

1.6 Synopsis of the Chapters

The contributing authors from their expertise portrays various ways of building coping capacity thereby reducing vulnerability and enhancing adaptive strategies in the face of climate change and DLDD risks at different regions of the globe. DLDD challenges affect people's lives in different ways in different regions of the world. In the U.S.A one-third of the country was experiencing at least a moderate level of drought as at the end of the climatological summer of 2020[14] and the drought condition continued in spring and early summer of 2021 affecting almost half of the US[15], with its attendant dryness and heatwave. LeBlanc in her write-up described the role of anthropogenic (i.e., human caused) climate change in the United States (U.S.) leading up to the devastating western wildfires in the summer of 2020 and 2021. (From January 1 to July 27, 2021 about 2.8 million acres were burned, compared with 1.9 million in 2020 over the same period. About 10.1 million acres were burned in 2020, compared with 4.7 million acres in 2019). In particular, the status of the state of California's crops, and their economic impact throughout the country, increased food prices impacting food security in the light of the COVID-19 pandemic.

The devasting impacts of weather/climatic events has propelled government and scientists to make frantic efforts in weather control. Controlling the weather is an ancient quest with a checked history says Fleming J.R in chapter 5. If we can control the weather, then we can control virtually everything related to its services, such as agricultural productivity and income, biodiversity and forest loss, heatwaves, windstorm, wildfires, human well-being, military dominance, etc. Over the years, rainmaking has attracted both commercial charlatans and sincere scientists who thought they had finally solved the elusive problem. Fleming argued that the science of rainmaking in the past was

incomplete, the science is still not settled and has been militarized, and the tantalizing goal of tapping sky water is still beyond our grasp.

The semi-arid north-eastern Brazil (the Caatinga) characterized by species-rich, seasonal tropical dry forest ecosystems with high endemism rate and relevant ecosystem carbon stocks shows a high risk of degradation and desertification in addition to severe grazing and browsing along with a high vulnerability to climate change according to Silva de Almeida et al.

From Mexico, Pérez et al show case the impact of soil degradation and climatic changes on coffee and cane sugar production, and how to apply landscape engineering and sustainable land management to enhance resilience. Mexico, they said for more than 30 years ranked third as a coffee producer worldwide (1980-2015), but now ranks between seventh to nineth due to land degradation and/or desertification. Coffee is highly important in the global community as the second most internationally traded commodity and remains a primary export for most Central American countries. As the fifth largest coffee producer in the world, Mexico is reliant on the crop as a source of income for many of its citizens. The authors established a means of fighting soil degradation and desertification to enhance yield.

Africa is the continent most affected by desertification and drought. Two-thirds of the African continent is desert or drylands and droughts have been particularly severe in recent years in the Horn of Africa and the Sahel, thus as the productivity of the land supporting this population declines, it lives the timing population improvised. About “one-fifth of the irrigated cropland, three-fifths of the rain-fed cropland, and three-fourths of the rangeland have been at least moderately harmed by desertification”[16]. For many African countries, fighting land degradation and desertification and mitigating the effects of drought are prerequisites for economic growth and social progress[17].

One major action to combat desertification in Africa is the Great Green Wall Initiative, which is intended to grow an 8,000km trees across the Africa's Sahel and Sahara region (entire width of Africa), spanning 11 countries. The Sahel region more than anywhere else on earth, is on the frontline of desertification, drought, famine and climate change and millions of locals are already facing its devastating impact. Chinweze C., in chapter 2 indicated the significance of this project to the sustainability of lives and ecosystem in the region affected.

In Nigeria, the most populous African nation as a case study, according to Eze and Abiola-Oloke, twelve of the nineteen northern states are embedded in the Sudano-Sahelian Region, with eleven designated as frontline states. They highlighted the farmers’ coping abilities within this belt. Benjamin et al also indicated that the prevailing condition implies that the production capacity of rural agrarian communities will be unable to meet the food demand of the growing urban population and therefore proposes a small-scale aquaponics system with a pilot run in Lagos, Nigeria, based on Net-Discounted Benefit-Cost Rate (DBCR) from existing research to boast urban food demand.

Vallerini in his chapter analyzed soil as a basic resource, showing that soil fertility, its conservation and recovery, is an essential part for the landscape management. Based on his Oasis Ecosystem Project, he demonstrated that putting together the three basic elements for the life: the soil reconstruction, the supply of water and the planting of trees, shrubs and herbaceous plants, it is possible to not only expand the ecosystem of the Loiyangalani Oasis (North Kenya) but to defend it from the desertification.

In Madagascar, land is a major resource that the local population depends on for agriculture, livestock and farming or reforestation. Degradation of land means poverty, lack, conflict and migration. Harifidy et al in their contribution indicates methods employed to sustain the land productivity and for the people to continue to stay in their region.

From Asia, Lihui indicated the measures that can be employed in humid dry region of China to help the local people and government to restore and reconstruct the ecological environment, alleviate the current contradictions between human and land, make the regional economy and eco-environment develop in a sustainable way.

Misak in his contribution gave an insight into the trends and targets of Land Degradation Neutrality in Kuwaiti.

With over 2 billion hectares of degraded land globally and counting; and half of the world's land being used for farming, it is imperative that a sustainable means of food production be established. Clément B. E in his chapter showed that agroforestry is a multi-faceted solution to climate, water, food, social, and economic security, if done with is the integration of native or bio-regionally appropriate species. There are several success stories to attest to the efficacy of agroforestry.

In conclusion, Chinweze highlights the need to urgently move from desertification, land degradation and drought (DLDD) risk to resilience; so as to reduce vulnerability and enhance adaptive capacities; and move towards achieving the targets of sustainable development goals and a land degradation neutral world.

1.7 Discussion and Conclusion

To reduce the vulnerability of the society to the impacts of DLDD requires the implementation of robust proactive risk management approaches, that involve all stakeholders so as to reduce and/or reverse the threats of desertification/land degradation and drought to the people. Exposure to the risks of DLDD can be reduced by reducing the drivers.

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Chapter 2

Drought, Water Stress and Food Security Issues: A Review from a Global Perspective

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Abstract

This chapter provides the statistics of drought and water stress from a global perspective. Droughts and water stress are intimately linked to food insecurity and have clear negative impacts on lives, livelihoods, health, ecosystem, economies, societies; often leading ultimately to conflicts, migration, and national security hazards. Drought is defined as a period of abnormally dry weather long enough to cause a serious hydrological imbalance. Water scarcity impacts 40% of the world's population and 700million people are at-risk of being displaced because of drought by 2030. Under the climate change scenario, nearly half of the world's population in 2030 will be living in areas of high-water stress[1]. Currently, about two-third of the global population experience some level of water scarcity and 815 million of the world population are food insecure.

Agricultural production is closely linked with water availability, globally 70% of freshwater is used for agriculture (crop growth and animal husbandry), invariably food production will be hampered in water scarce regions. Food demand by 2050, will go up by and estimated 50% with an increased water demand.

A proactive rather than a reactive approach to drought risk management will make for a resilient socio-ecological system. The proactive approach entails implementing necessary measures to prevent or minimize drought impacts in advance. These measures include drought monitoring, forecasting, early warning and vulnerability reduction, coupled with adaptation to a changing climate and actions to increase societal and environmental resilience.

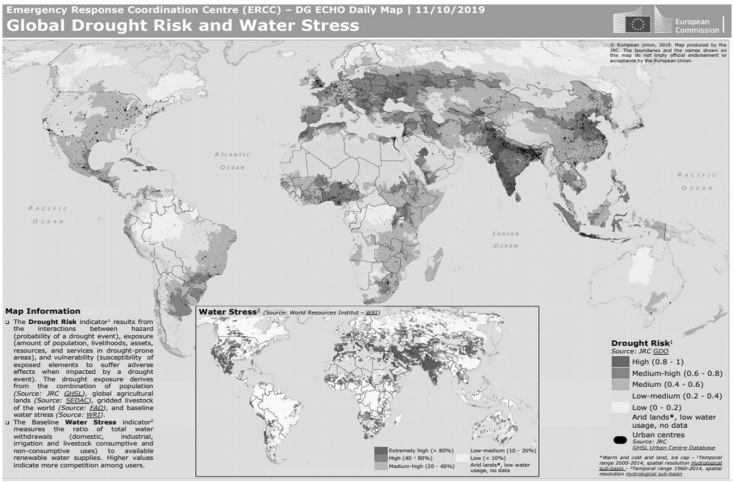
Keywords: Drought risk, water stress, drylands, food security, impacts, climate change and Sustainable Development Goals (SDG)

2.1 Introduction

Drought is defined as a sustained and spatially extensive period of below-average natural water availability[2], with possible long-term socio-ecological consequences. Drought originates from a deficiency of precipitation that results in a water shortage for some activity e.g., crop production or users of water resources[3]. Drought conditions also arise from changes in atmospheric conditions; the El Niño Southern Oscillation, the Pacific Decadal Oscillation and the Interdecadal Pacific Oscillation are key indicators of low-frequency changes in persistent atmospheric circulation patterns associated with drought conditions over large areas of the world[4].

There are four different classes of droughts which define the hierarchal set of water deficit characterization, these include “Meteorological drought” (reduction in rainfall leading to excessive heat and heightened evapotranspiration[5]), “Agricultural drought” (low soil moisture content with its impacts on crop yield), “Hydrological drought” (conditions of reduction in stream flows and groundwater storage) and “socio-economic droughts” (impact of deficit in water supply on the economies of the affected population). The newest class of drought is the “ecological drought”, which emphasizes the vulnerability of ecosystems to intense water shortages[6].

Clearly water shortages impact directly on food system and food security. Many regions in the world have been affected by drought-related challenges as deficiency of precipitation, lack of irrigation water, and severe water stress. Water stress occurs when demand for water (total water withdrawals) in a given area exceeds the supply (surface waters – rivers, lakes, and reservoirs – and groundwater). Roughly 70 percent of the world’s freshwater is used for agriculture, and the rest for industrial (19 percent) and domestic uses (11 percent).



Map 2.1: Global Drought Risk and Water Stress (Source: European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations 2019)

Droughts and water stress undeniably have negative impacts on the society, economy, the environment (e.g., forests, wildfires, wetlands, biodiversity). It leads to low agricultural yields. This means reduced food availability which brings about higher food prices. This will make many people within low-income cadre to go hungry and eat only what they can afford and not necessarily what is nutritious. Undernourishment and hunger which is prevalent in low-income countries is related to drought, water imbalance and low food production.