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Nader Noureldeen Mohamed

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Nader Noureldeen Mohamed

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Nader Noureldeen Mohamed
Department of Soil and Water Sciences
Faculty of Agriculture
Cairo University
Giza, Egypt

ISSN 2213-784X ISSN 2213-7858 (electronic)
SpringerBriefs in Climate Studies
ISBN 978-3-030-38009-0 ISBN 978-3-030-38010-6 (eBook)
https://doi.org/10.1007/978-3-030-38010-6

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Climate change, water and energy are the major factors controlling the world food production as well as having direct impacts on food security, especially in the developing countries (water, energy food and climate change nexus; and indirectly will include population growth). The nexus of water, energy and food impacts the environment and communities around the world. Agriculture has the largest water footprint of any other activity and consumes a summation of 70% of global water. Agriculture sectors and the food industry consume more than 30% of the total global energy consumption. From the role of water in energy production to the 3000–5000 l of water needed to produce 1 kg of rice, the interconnected systems of water, energy and food present challenges and opportunities of global significance.

Water is the backbone of agriculture production before energy or soil; even water, energy and food become one nexus. It is well known that 15% of the global energy comes from water sources and 17% of energy is consumed by water delivery systems. Energy usage in water includes water collection, processing, distribution and end-use power requirements, such as pumping, transport, treatment and desalination. Water in energy includes thermoelectric cooling, hydropower, mineral extraction, mining, fuel production (fossil, non-fossil and biofuel) and gas emission control.

In the year 2050, the demands for water will increase by 30%, but under global heating the total water resources will decrease by 6%. Thus, food production will decrease by 12–20% and land degradation will increase according to the buildup of soil salinity due to the increase of soil solution evaporation. Increasing soil salinity means more water is needed to leach out salinity from the root zone of the surface soils. The decrease of accessible water will increase the need for treating all types of wastewater, in terms of reuse and desalination, for both sea water and marginal poor quality water that contains a lot of salts and minerals.

The frequencies of droughts and dryness will increase due to global heating, especially in upstream river basins; thus the need for extracting more groundwater even the deepest ones, as well as the need for water desalination, will increase sharply, which in turn will lead to more energy consumption.

The need for agro-food and other agriculture productions will increase by 60% in 2050, which means increase of the need for more chemical fertilizers and more pesticides and this increase of use is considered as a high intensive consumption of energy that leads to more energy consumption. Water scarcity under global heating will increase the need for intensive food production under greenhouse systems in addition to the need for air-conditioning, fast transportation and freights for food marketing which also increases the energy consumption. Increasing the agriculture activity and improving the lifestyle of rural areas means more gas emission and more energy are needed to meet these necessary requirements.

Cairo, Egypt
August 2019

Nader Noureldeen Mohamed

Introduction

Climate change has direct effects on all agriculture resources, such as water resources, wetlands, fresh water ecosystems, land degradation, food and other agriculture production, forestry, biodiversity and contamination. Climate change also affects agriculture indirectly through its impacts on energy, industry, commerce, financial service, human settlement, health, coastal zone, and marine and low deltas ecosystems (International Journal of Humanities and Social Science [December 2011], Edame et al. 2011). On the other hand, the 2010 World Development Report draws on the analysis of the Intergovernmental Panel on Climate Change (IPCC 2007a) to calculate that agriculture directly accounts for 14% of global GHG emissions in CO_2 and equals and indirectly accounts for an additional 17% of emissions when land use and conversion for crops and pasture are included in the calculations, with a total of 31%. Agriculture's share in global GDP is only 4%, which means that agriculture is a high greenhouse gas intensive producer (International Journal of Humanities and Social Science [December 2011]; IPCC 2007a; Edame et al. 2011; IPCC 2007b; NASA 2011).

Agricultural production directly relies mostly on weather conditions that include water from rain, surface and ground, which—together with soil conditions—controls the degree of plant growth and field productions. In some cases, weather conditions can be managed by using irrigation to replace the deficient rainfall or shifting the timing of the cropping season and replacing the weather humidity to avoid adverse weather conditions (e.g., irrigated rice and sugarcane in Egypt instead of rain-fed agriculture in some regions). Cultivation under greenhouse systems is another solution for tough weather conditions and water shortages, which provides completely controlled environments and precision in temperature, radiation and all other inputs. Moreover, and at the same time, it is considered as economically feasible in small-scale cases and for high-value crops. Some cases of extreme weather that lead to severe damage cannot be managed, such as strong winds, floods, hail or frost and drought (United Nations Development Programme (UNDP) 2007; FAO 2016; Food and Agriculture Organization of the United Nations (FAO) 2000).

FAO (2016) reported the effects of climate change on agriculture and food security, which stated that:

1. Climate change already negatively impacts agriculture and food security; thus, without urgent action, this impact will put millions of people at risk of hunger and poverty.
2. The impacts on agricultural yields and livelihoods will vary across countries and regions, but it will become increasingly adverse over time and potentially catastrophic in some areas.
3. The world should work hard to limit global temperature increases to 1.5 °C above pre-industrial levels, which would significantly reduce the risks and impacts of climate change.
4. Deep transformation in agriculture and food systems from pre-production to consumption is needed in order to maximize the co-benefits of climate change adaptation and mitigation efforts.
5. The agriculture sectors have the potential to limit their greenhouse gas emissions (31% of the total global emission), but at the same time, ensuring future food security requires a primary focus on adaptation.

Climate change has already become a problem that should be adapted to and mitigated. It is seriously affecting the agricultural productivity and food security even in developed or developing economies. According to (Barghouti 2009) the decline in expected food production due to climate change can be avoided through raising the irrigation efficiency, watershed management, good soil and water management, improving cultivation systems and livestock management in addition to the use of high productive seed and using plant breeding to adapt plants to frequent dryness, salinity and heating under higher temperature. Plant and animal biodiversity should increase resilience and adaptation to changing environmental conditions and stress, such as drought, salts, contaminators accumulation and flooding as an extreme event. Land use for livestock production, including grazing lands dedicated to the production of feed, represents approximately 70% of all agricultural land in the world (Barghouti 2009).

Thus, many developing countries consider adaptation the main priority because of the significant impacts of climate change which is expected to have on national development, sustainability and national security.

Climate Change, Water, Energy and Food Security

Climate change, water and energy are the major factors controlling the world food production and have direct impacts on the food security, especially in the developing countries (water, energy, food and climate change nexus; and should include population growth). The nexus of water, energy and food impacts the environment and communities around the world. Agriculture is the largest water consumer of any