Chapter 18
Climate Change Effects on Agriculture and Water Resources Availability in Syria

Bachar Ibrahim

18.1 Introduction

The topic of climate change is nowadays announced as one of the most important subjects and challenges at the global level. Climate change is expected to have many strong effects on the global environment. Many studies show that climate change has caused a decrease in the agricultural production and in water storage in the Middle East region. For example, in the years 2007–2008, drought took place in Syria that led to a decrease in wheat production by 78.9 % in most of its areas and it reached about zero in rain-fed areas, while in the irrigated areas the average yield dropped by 31 % due to the lack of water needed for irrigation (UNDP 2008). There has been a decrease in groundwater because of a shorter period of the recharge season and the drop in water retention as of snow (Döll and Flörke 2005). Such a decrease of agricultural products and water shortage would definitely impede economic growth and create difficulties against achieving sustainable development in the countries of the region in general (Droubi 2009).

The recurrent drought led to a reduction of the available water supplies and to negative impacts on the quality of water, and consequently to aggravating problems related to water resources management in the country. At present, most Syrian cities are suffering from a water supply shortage.

A preliminary assessment has revealed nationwide changes in rainfall patterns and fluctuations in temperature during the past five decades. Over the past years, average annual rainfall has fallen dramatically in the main agricultural areas. As a result, the country has suffered from a lack of rain and the effects of drought in the long term (National Communication 2009).

Climate change will have negative impacts on the land use patterns, accelerate the pace of land degradation, and increase the risks of drought. In the Eastern region

B. Ibrahim (✉)
Department of Rural Engineering, Damascus University, Damascus, Syria
e-mail: bibrahim@scs-net.org

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of Syria, heat waves and dust storms have become a nightmare to the residents, as they are increasing. The rise of sea level is expected to overflow the lowlands on the Syrian coast (Meslmani and Faour 2009). Moreover, climate change will have impacts on health services and on other economic sectors and natural ecosystems. Due to the above mentioned facts and based on prophylactic principles, Syria has been concerned about issues related to climate change and how to deal with its causes and consequences within the framework of international activities. Syria had participated in relevant negotiations under the United Nations Framework Convention on Climate Change and the Kyoto Protocol (Droubi 2009).

18.2 Overview

The Syrian Arab Republic lies in Western Asia, on the Eastern shores of the Mediterranean Sea. Syria is bordered in the North by Turkey, in the East by Iraq, in the South by Jordan, and in the West by Lebanon and the Mediterranean Sea. Geographically, it is located in the middle of arid and semi-arid areas. Its climate differs among the coastal region, the desert in the middle and the forestry areas in the North and Northwestern regions of the country. The surface area of the country is about 185.518 km^2, out of which 32.2 % is arable land (six million ha), and 45 % steppe and pasture lands. The country is divided into 14 governorates. Figure 18.1 shows the distribution of those governorates in the county.

18.2.1 Soil

Soil types and soil structure have a direct impact on agriculture. For example, the newly-formed basaltic rocks in Hawran plain south of the country, where the area is overlain by this type of nude superficial geology, reduce the area of agricultural land. The Gypsum rocks overlie soil in the Jazira region and in the region of the Al-Bishri Mountains. The sand overlies its surface that is subject to wind erosion and the formation of drifting sands (Droubi 2009). Figure 18.2 shows the different types of soil in Syria (Tavernier et al. 1980).

18.2.2 Climate

The climate in Syria is Mediterranean. There are four different seasons i.e. winter which is cold and wet, summer which is warm and dry, and spring as well as autumn. The precipitation range is between 100 and 1,400 mm/year. Syria is divided into five different climatic zones: the very arid, arid, humid, semi-arid and semi-humid as shown in Fig. 18.3.

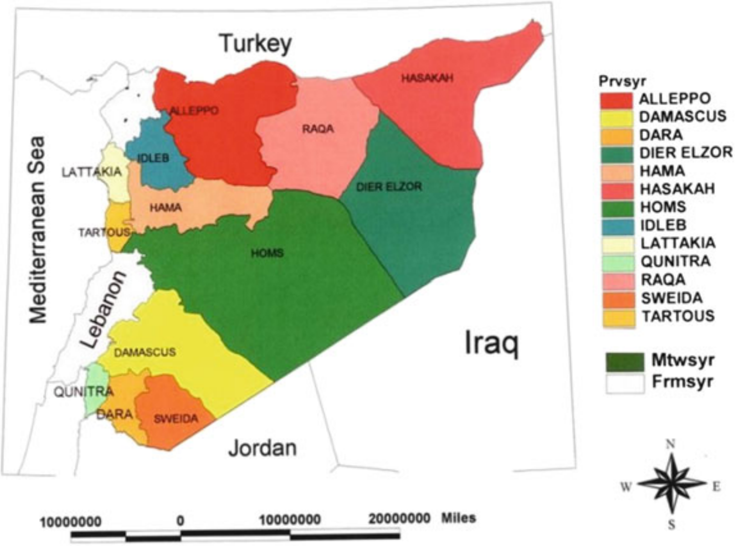

Fig. 18.1 The governorates of Syria. Source FAO (2004)

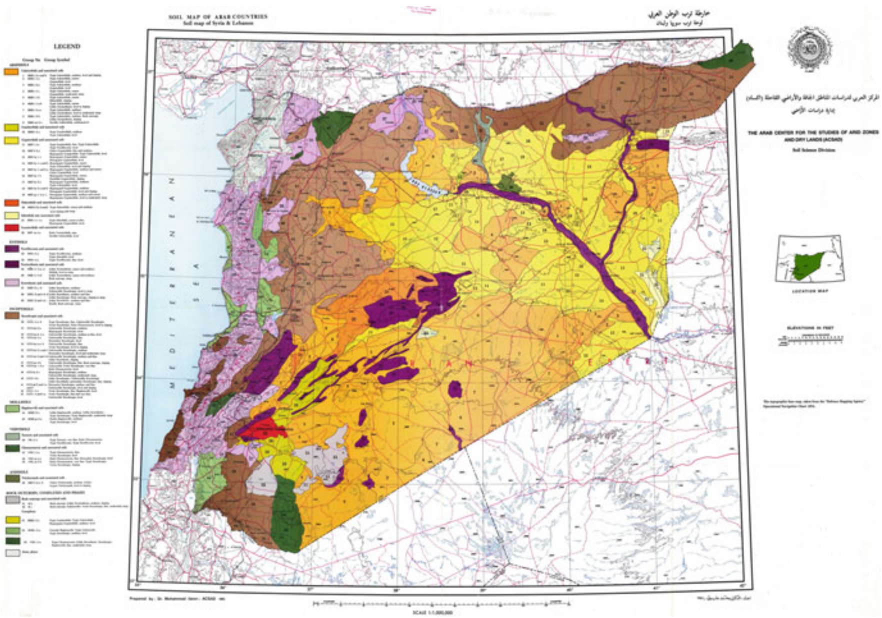

Fig. 18.2 Soil taxonomy and the soil map of Syria and Lebanon. Source the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)

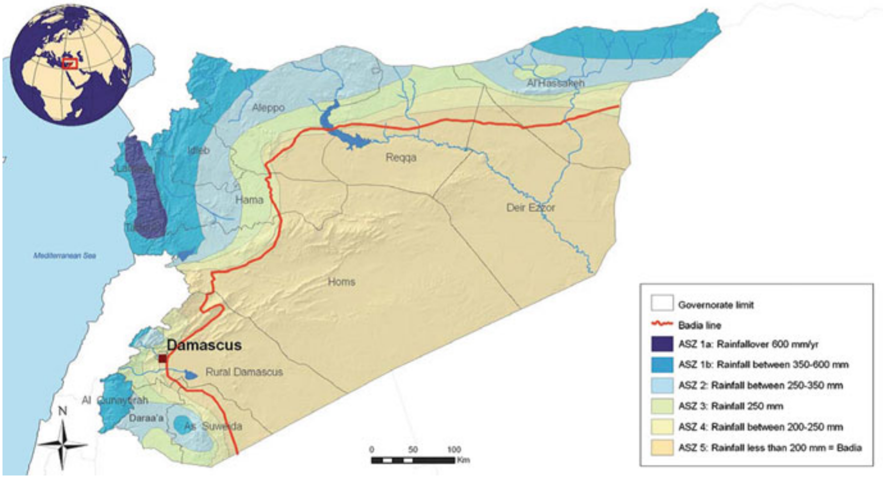

Fig. 18.3 The different climatic zones in Syria. http://www.ifad.org/pub/pn/syria.pdf. Source IFAD (2010)

Table 18.1 The different cultivated areas and plants in the several stabilization zones in Syria (Drubi 2009)

Stabilization zones	Annual rainfall	Area (ha)	Cultivated plant
1	Over 600	2,701,000	Field crops
1.1	Over 350		
1.2	350–600		Wheat, legumes and summer crops
2	250–350	2,475,000	Barely, wheat, legumes and summer crops
3	250	1,303,000	Barely legumes
4	200–250	1,830,000	Barely
5	Less than 200	10,209,000	Prohibited cropping

Syria is divided in terms of its agriculture into different stabilization zones related to different crops cultivation areas, as illustrated in Table 18.1.

18.3 Climate Change Global Impacts in the Mediterranean Region

The Middle East region suffers from a big problem with water-stresses and water scarcity which may be affected by climate change. The effects of climate change on the Eastern Mediterranean region was analyzed by Alpert et al. (2008) and found the following:

1. The average temperature over the whole Mediterranean area has increased by 1.5–4 °C in the last 100 years,

2. The precipitation has had a negative trend in the last 50 years,
   Weiß et al. (2007) expected that the drought events in the Middle East may increase ten times in the next 100 years.

The climate change impact on precipitation and temperature was evaluated within the framework of the national communication 2009 which indicated an increase in summer temperature in all climate stations in the country and an increase in the yearly precipitation amount in coastal and Western regions. There have been changes in both winter and autumn season, and precipitation in winter in the northern and north eastern zones of Syria showed some decrease in the last five decades.

18.3.1 Climate Change Impacts on Water Resources in Syria

The total available water resources of the country are estimated at around 17,454 mm^3/year including the treated waste water and the drainage water from agriculture, 10,959 mm^3 of which is surface water and 6,044 mm^3 of which is groundwater. The total demand is about 17,828 mm^3/year water. Table 18.2 illustrates the evaluation of the average annual water balance of the seven different Syrian water basins as calculated by the Ministry of Irrigation for the year 2003.

Table 18.2 shows that most of the water basins in Syria are suffering from water shortage. According to Döll and Flörke (2005), the change of groundwater recharge between 1961 and 1990 and the 2050s (2041–2070) could be more than minus 30 %. The overall water deficit in the country is growing. In the years 2001–2002, the average value deficit was 16 % more than in the years 1992–2000 (Rabboh 2007).

The climate change projection for the upper Euphrates and Tigris watershed area shows that major reduction changes in snow water equivalent may occur in the stream flow for these two rivers. The reduction may reach up to 100 mm in snow water equivalent (Onol and Semazzi 2006). The model-derived climate sensitivity of the Euphrates River discharge shows that a 25 % increase or decrease in precipitation rises or lowers the discharge profile of the river while keeping its hydrograph shape unchanged (Smith et al. 2000). This prediction means that the annual discharge rises to 40,655 mm^3 or drops to 15,751 mm^3 compared to the reference value of 27,048 mm^3. This is a 50 % rise and a 42 % drop respectively, nearly twice the imposed percentage change in precipitation. Other studies predict around a 10–25 % reduction in river runoff in the upper Euphrates and Tigris basin in 2070 compared to the average flow of the year 2000 (Lehner et al. 2001).

Table 18.2 Water balance of an average year of water basins in Syria

Water balance components	Unit	Khabour and Tigris	Euphrates and Aleppo	Orontes	Coastal basin	Barada and Aawaj	Yarmouk	Badia basin	Total
Basin area in Syria	km^2	21,129	51,238	21,624	5,049	8,630	6,724	70,786	185,180
Basin area/area of Syria	%	11.7	28.3	10.1	2.8	4.8	3.2	39.1	100
Surface water	Million m^3	788	7,105	1110	1,557	12	180	163	10,915
Ground water	Million m^3	1,600	771	1,607	778	838	267	183	6,044
Surface and ground water	Million m^3	2,388	7,876	2,717	2,335	850	447	346	16,959
Degree of organization	Million m^3	95	95	85	65	90	85	60	575
Available water resources	Million m^3	2,269	7,482	2,310	1,518	765	380	208	14,932
Recycling of treated drainage water	Million m^3	95	306	325	0	260	72	35	1,120
Refunded agricultural drainage	Million m^3	430	575	210	57	89	32	0	1,402
Total water resources	Million m^3	2,794	8,363	2,872	1,575	1,123	484	243	17,454
Demand on irrigation water	Million m^3	4,300	5,755	2,093	566	983	400	68	14,165
Demand on drinking water	Million m^3	38	322	240	124	270	89	44	1,127
Demand on water for industry	Million m^3	89	86	229	85	76	7	2	574
Evaporation	Million m^3	132	1,614	148	16	6	31	15	1,962
Total demand	Million m^3	4,559	7,777	2,710	791	1,335	527	129	17,828
water balance	Million m^3	1,765	586	162	784	−212	−43	114	−374

http://environ.chemeng.ntua.gr/ineco/Default.aspx?t=318

18.3.2 Climate Change Impacts on the Agricultural Sector

Agriculture is one of the most important economic sectors in Syria and provides nearly 25 % of gross domestic product (GDP). Agricultural activity in Syria is considered as the most important production activity (Masayuki et al. 2012). Agricultural exports have a big share in foreign trading and contribute to bringing in foreign currencies. Furthermore, the agricultural sector affords a lot of raw materials for other economical and industrial sectors. It also contributes to employing manpower and serves as a source of livelihood for a significant portion of the population. The agricultural sector occupies the second rank after oil in export revenue in the balance of Syrian export (Statistical Abstract 2004).

The two most important crops in the country are wheat and cotton. Wheat is considered the most important and strategic crop in Syrian agriculture (NAPC 2002). It occupies 70 % of the irrigated land devoted to strategic crops (National 2009). The climate change impact on the agriculture, as before mentioned, causes reduction of the agricultural productivity. More detailed facts on this can be found in the results of the study conducted within the framework of the national communication of Syria submitted to the UNFCCC in 2009. This was done using the CROPWAT model which is an irrigation management model developed by the FAO Land and Water Management Division (Smith 1992). It was used in evaluating crop water requirements and irrigation needs. It was also utilized to assess the effect of climate change on wheat (irrigated and rainfed) yield and on cotton yield in Hassakeh governorate.

The results showed that wheat requirements from water are 563 mm annually. However, actual crop water use is estimated by 402 mm. Consequently, the difference between actual and potential evapo-transpiration is 161 mm. This indicates that wheat grows under water stress under the current crop management system and the diminution in yields due to this stress is about 30 %. Cotton water requirements are 1,287 mm annually and the actual crop water use is estimated by 1,169 mm annually and the crop production under this condition of water shortage will be reduced by 7.5 %.

18.4 Adaptation Measurers to Climate Change in Agricultural and Water Sector

The conducted adaptation measurement to climate change effects in the agricultural sector were: (1) increase the irrigation water use efficiently through conducting a national program for promoting modern irrigation approaches and convince farmers to change from inefficient traditional irrigation systems to advanced efficient modern systems. For this goal, a fund programmed with 52 billion pounds[1] was

[1] 52.000.000 SYP = 338.000 € (2009: 1 SYP = 0,0065 €).

established for financing farmers. (2) Developing the capacity of the department of extension services by conducting advanced training program in the field of agriculture and water resources management. (3) New water policies have been adopted by the ministry of irrigation based mainly on water demand management rather than on water supply management, reducing water loss and reallocating water to crops with higher economic value.

18.5 Conclusion and Suggestions

In order to address the consequences of climate change on the agricultural sector, it is not adequate to handle the problem of climate change only by trying to solve the problem of water shortage and how to save water efficiently. Actually the following measures should be taken: (1) Surface water resources should be used in an optimal way, (2) improvement of ground water management, (3) imposing control on the use of ground water resources, (4) protection of environment from pollution, (5) treatment of sewage water, (6) determining and growing plant species that can bear drought and, (7) increase rain effectiveness through conservation farming and water harvesting.

Biography Professor at University of Damascus, Faculty of Agriculture Department of Rural Engineering. Department Head-Rural Engineering, responsible for teaching and research. Licensed Syrian EIA expert and listed EIA trainer. Email: bibrahim@scs-net.org, Damascus-Syria.

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