LUPINE PUBLISHERS

Current Investigations in Agriculture and Current Research

DOI: 10.32474/CIACR.2020.08.000288

ISSN: 2637-4676

Review Article

Climate Change Effects on Agricultural Production: A Short Review

Nazan An[1,2]*, M Tufan Turp[1,2], Murat Türkeş[2,3] and M Levent Kurnaz[2,3]

[1]*Department of Environmental Sciences, Institute of Environmental Sciences, Bogazici University, Istanbul, Turkey*

[2]*Center for Climate Change and Policy Studies, Bogazici University, Istanbul, Turkey*

[3]*Department of Physics, Faculty of Arts and Sciences, Bogazici University, Istanbul, Turkey*

***Corresponding author:** Nazan An, Department of Environmental Sciences, Institute of Environmental Sciences, Bogazici University, Turkey

Received: February 18, 2020 **Published:** March 02, 2020

Introduction

According to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), changing climate is observed to have a negative impact on product yield in many parts of the world [1]. Changes in climate and soil conditions affect agricultural productivity through changes in production quantity and quality. Climate variability is responsible for about a third of the change in global crop yield [2]. Some studies draw attention to the negative impact of temperature increase on crop yield [3-5] and indicate that temperature increase has a more critical effect on agricultural production than the decrease in precipitation [6]. In addition, duration of sunshine, relative humidity and wind speed are also effective variables on crop yield [7]. The severity of these negatidve effects exhibit temporal and spatial variability behavior. For example, excessive increase in average temperatures is expected to affect crop yield and this effect is predicted to be more destructive in tropical regions than in temperate regions [1].

Accordingly, climate change poses a risk to food safety by reducing the amount of food per capita with the increasing world population. If current trends continue, potential agricultural production is expected to decrease globally, and the rate of decrease is expected to be higher in developing countries [8]. Many developing countries, which are currently vulnerable to the effects of climate change and now face the issue of food security, have been intensely fighting with extreme climate events caused by climate change. The level of agricultural vulnerability may vary regionally depending on socio-economic competence and farmers' ability to use technological practices in agriculture [9]. Especially in countries that depend on food imports, weather forecasts and climate forecasts play an important role in accurately monitoring global food production [10]. In many countries of Europe, especially in the southern regions, the negative effects of rising temperatures on yield are mentioned [11], and it is noted that climatic changes have a positive effect on crop yield in northern Europe and new crops can emerge [1,12,13]. Along with the increase in temperature in Southern Europe, a decrease in productive agricultural lands is foreseen due to insufficient irrigation in agricultural areas and these adverse conditions are expected to affect the living conditions of Mediterranean farmers; and, serious agricultural losses are expected to occur particularly in Turkey [1]. Despite the high temperature in the Mediterranean region, production has increased in recent years, but the yield is still low [14,15]. However, agricultural areas in hot and dry regions are estimated to be severely affected by adverse conditions due to climate change [13]. The global and regional climate modeling projections associated with climate and climate variability envisage an overall dramatic increase in the number of heat waves and annual average temperature in Turkey at the end of 21st century. This projection indicates that the conditions defined today as the heat wave will turn into the conditions considered normal at the end of the century. In addition to the expectation of an increase in the number and the intensity of heat waves, climate projections predict a decrease in rain and snow precipitation, and an increase in the frequency and duration of drought events. In the Eastern Mediterranean, the combined effect of decreasing precipitation and rising temperatures, especially in semi-arid areas, and the intensity, severity and duration of extreme weather or climate events will adversely affect many sectors, particularly the agriculture towards the end of the 21st century [16]. Agricultural and livestock production are closely related to the presence and consumption of water. In addition, strong and excessive precipitation, floods, which are both observed in today's climatic conditions and likely to occur in future climatic conditions, can damage animal assets, agricultural production and ecosystems. These extreme climatic events can

increase soil erosion or negatively affect crop production due to various factors. Planting and harvesting dates and phenological periods of agricultural products are affected by climate conditions. Changes in the phenological structure affect the quantity and quality of production, which is especially important for products with high commercial value. In addition, agricultural products and livestock are also negatively affected, as regions that are likely to be affected by frequent, severe and prolonged drought events may face water scarcity during drought periods. On the other hand, the increase of evapotranspiration as a result of high air temperatures in climate conditions also increases the need for irrigation water.

This effect of evapotranspiration initially decreases with the biomass conversion provided by the plant using the water accumulated in the leaves as a result of carbon dioxide (CO_2) fertilization, which is enhanced by the high CO_2 concentration in the atmosphere. However, in the following years, increasing air temperatures and droughts will be able to eliminate this positive effect that may be observed at the beginning. In some regions, changes and prolongations in phenological growth periods may cause an increase in water requirement [17]. As an example of the Mediterranean Basin, when the changes in fundamental climate variables and/or parameters that will affect agriculture in Turkey are taken into consideration, scientific studies related to changes and trends show that the warming trends in the annual and seasonal average temperature, average maximum (maximum in daytimes) and average minimum (minimum at nights) air temperatures have been rising compared with the results of prior studies on the observed temperature trends in Turkey [16,17]. In Turkey, regarding to the increase that has been observed in average maximum and minimum air temperatures, the severity, frequency, and duration of extreme weather/climate events such as frosts, the number of summer and tropical days change as well. For example, between 1950 and 2010 in Turkey, the annual number of days of frost occurred primarily in Eastern Anatolia showed a decreasing trend, especially in the Marmara and the Mediterranean coast [15, 16]. In the second half of the 20th century in Turkey, a significant shift in the first and late dates of frost is observed. During the period of 1950-2013, while the first frost events of autumn shifted to a later date (0.71 days / decade), the last frost events of spring ended earlier (0.64 days / decade). As a natural result of these significant changes, in a large part of Turkey, a statistically significant increase took place in the length of the period in which the frost events were never observed [16]. In addition, the number of summer and tropical days shows a slightly decrease trend in the 1950-1975 period and a significant increase trend after 1975. In Turkey, the most remarkable year in terms of the numbers of summer and tropical days was 2010. In this year, the number of summer and tropical days exceeded 3 standard deviations from the mean of the period 1961-1990 in approximately half of the surveyed stations in Turkey, mainly in the Northeast Anatolia region [15, 16]. When the temporal changes of the annual numbers of the maximum and minimum air temperatures that was recorded in 1950-2014 period in Turkey are examined, it is remarkable that the frequency of record minimum air temperatures has decreased from the 1950s to the present day. On the other hand, an increase trend has been observed in the frequency of record maximum air temperature especially in 2000s, and half of the record maximum temperature events have been recorded in the period 2000-2014 since 1950 [15].

Seasonal and annual precipitation trends observed in Turkey are found to be not strong as the trends observed in air temperature. As in many regions of the world, changes in precipitation occur in the form of significant changes in frequencies and magnitudes of arid and moist (rainy) periods rather than long-term trends. In general, it is observed that there is a significant decreasing trend (drought) in winter and spring precipitation totals in the Marmara, Aegean, Mediterranean, and Southeastern Anatolia regions and the inner and southern parts of the Central and Eastern Anatolia regions in Turkey, where the Mediterranean precipitation regime is dominant. Some of the drought tendencies observed in Aegean, Mediterranean, and Southeastern Anatolia regions during the winter are statistically significant. In summer, both increase and decrease trends dominate, which are statistically significant. In autumn, it is observed that the increase trends observed previously and the number of stations with an increasing trend rise. The observed increasing trends are statistically significant in Central Anatolia, West Black Sea Region, South Marmara, and North Aegean regions [15, 16]. Due to the close relationship between climate change and food and water security, climate change is likely to affect all four aspects of food security, including the food availability, food access, consumption and sustainability. Considering that extreme events such as heat waves, floods, and droughts that stem from climate change and disruption of the stability of food supply because of climate disaster, the measures to be taken in this direction are of vital importance. As stable agricultural production means a stable and sustainable food security, scientific and socio-economic details are gaining importance as to what we are already experiencing and what future climate change and climate variability will have impacts on local scale or on other systems such as agriculture, water, and land resources.

References

1. Porter JR, Xie L, Challinor AJ, Cochrane K, Howden M, et al. (2014) Food security and food production systems. In CB Field, VR Barros, DJ Dokken, K J Mach, MD Mastrandrea, TE Bilir, ... & LL White (Eds.), Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of working group II to the fifth assessment report of the Intergovernmental Panel on Climate Change Cambridge, Cambridge University Press, United Kingdom, pp. 485-533.
2. Ray DK, Gerber JS, MacDonald GK, West PC (2015) Climate variation explains a third of global crop yield variability. Nature Communications 6: 5989.
3. Asseng, S, Foster IAN, Turner NC (2011) The impact of temperature variability on wheat yields. Global Change Biology 17(2): 997-1012.
4. Adams RM, Chen CC, McCarl BA, Schimmelpfennig DE (2001) Climate variability and climate change: implications for agriculture. In D. C. Hall & R. B. Horwarth (Eds.), The long-term economics of climate change: beyond a doubling of greenhouse gas concentrations Bingley United Kingdom: Emerald Group Publishing Limited, UK pp. 95-113.

5. Mall RK, Singh R, Gupta A, Srinivasan G, Rathore LS, et al. (2006) Impact of climate change on Indian agriculture: a review. Climatic Change 78(2-4): 445-478.
6. Lobell DB, Schlenker W, Costa-Roberts J (2011). Climate trends and global crop production since 1980. Science 333(6042): 616-620.
7. Zhang P, Zhang J, Chen M (2017) Economic impacts of climate change on agriculture: The importance of additional climatic variables other than temperature and precipitation. Journal of Environmental Economics and Management 83: 8-31.
8. Turkes M (2014) Iklim degisikliginin tarımsal gıda guvenligine etkileri, geleneksel bilgi ve agroekoloji [Impacts of the climate change on agricultural food security, traditional knowledge and agroecology]. Turkish Journal of Agriculture - Food Science and Technology 2(2): 71-85
9. Brown ME, Funk CC (2008) Food security under climate change. Science 319(5863): 580-581.
10. Iizumi T, Sakuma H, Yokozawa M, Luo JJ, Challinor, et al. (2013) Prediction of seasonal climate-induced variations in global food production. Nature Climate Change 3(10): 904-908.
11. Peltonen-Sainio P, Jauhiainen L, Trnka M, Olesen JE, Calanca P, et al. (2010). Coincidence of variation in yield and climate in Europe. Agriculture, Ecosystems & Environment 139(4): 483-489.
12. Ewert F, Rounsevell MDA, Reginster I, Metzger MJ, Leemans R, et al. (2005) Future scenarios of European agricultural land use: I. Estimating changes in crop productivity. Agriculture, Ecosystems & Environment, 107(2-3: 101-116.
13. Olesen JE, Bindi M (2002) Consequences of climate change for European agricultural productivity, land use and policy. European Journal of Agronomy 16(4): 239-262.
14. Ciais P, Reichstein M, Viovy N, Granier A, Ogee J, et al. (2005) Europe-wide reduction in primary productivity caused by the heat and drought in 2003. Nature 437(7058): 529-533.
15. EEA (2004) Impacts of Europe's changing climate-an indicator-based assessment (Report No. 2). Copenhagen, Denmark: European Energy Agency.
16. Turkes M (2018) Kuresel ısınma duzeyini sınırlandırmak için hala çok geç degil [It's still not too late to limit the level of global warming]. Dunya Gıda Dergisi, Kasım p50-53.
17. Turkes M (2019) İklim degisikligi ve kuraklıgın tarıma etkileri Climate change and the effects of drought on agriculture. Tarım Gundem. Temmuz-Agustos p. 21-25.

DOI: 10.32474/CIACR.2020.08.000288