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Research Article

Impacts of Climate Change on Water Resources, Agricultural Production and Food Security: Evidence from Turkiye*

Mozharul ISLAM[1]

ABSTRACT

Since agricultural production depends mainly on nature and uses surface and groundwater reservoirs, changes in existing water resources significantly affect this sector. Again, changes in global climate bring changes in water levels, consequently affecting agriculture, food supply, and income sources of households in different areas. However, to date, no such research has investigated the farmers who are the producers and the most vulnerable group to the impacts of climate change. Therefore, this paper explores climate change impacts on the water resources of Sarayonu, which in turn affects the agricultural food production and food security of the producers' households and the country's market. This qualitative study conducted in-depth interviews with the farmers from the Sarayonu district of Konya province in Turkiye. The study results show that ground and surface water resources are negatively affected by climate change. Consequently, the study area observed a decrease in water level over the last 15 years. Thus, these changes in water resources have been significantly affecting the agriculture sector, which alters the food supply for the market in general and the producers in particular. When people have less water, they have low quality and quantity crop yields, resulting in food crises and economic difficulties.

Keywords: Climate change, Water Resources, Agriculture, Farmers' Household income, Food security

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[1]Asst. Prof., Istanbul Sabahattin Zaim University, Department of Sociology, Istanbul, Turkiye

ORCID: M.I. 0000-0002-7872-0046

Corresponding author:
Mozharul ISLAM,
Istanbul Sabahattin Zaim University, Department of Sociology, Istanbul, Turkiye
E-mail: mazhar.islam@izu.edu.tr

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1. Introduction

Climate characteristics are important for sufficient agricultural production, to maintain the food supply for households of the producers, and for the market. Already more than 700 million people are struggling with poverty, malnutrition, and meeting their basic needs (Hussain, Islam, Ahmed, Haq, & Islam, 2021; United Nations, 2019). Because the agriculture sector is climate-sensitive and depends mostly on nature and natural water resources, changes in existing water resources have great impacts on this sector. Climate change exacerbates the food crisis as it impacts food production around the world, since the frequency of various climate-induced disasters is very common worldwide (Haq, Ahmed, Islam, Hussain, & Islam, 2021). Many studies using both dynamical and statistical models argue that crop production in many parts of the world will decrease due to climate change's impact on agriculture (Islam, 2016; Roudier, Sultan, Quirion, & Berg, 2011; White, Hoogenboom, Kimball, & Wall, 2011; Zhu, et al., 2011; Laux, Jackel, Tingem, & Kunstmann, 2010; Liu, et al., 2010; Devereux & Edwards, 2004). It is argued that rainfall and cereal production will decrease due to global warming, which will create many problems such as the loss of arable land, increased water stress, and falling cereal yields, etc. Together, this will put pressure on the food supply, and countries will struggle to maintain food consumption through domestic production (Devereux & Edwards, 2004). Changes in global climate brings changes in water levels, which consequently affects the agriculture, food supply, and income source of households in different areas. Because water and food security are expected to face unprecedented outcomes in Turkiye in the changing climate conditions, they are a major concern for both academics and policymakers (Ağaçayak & Keyman, 2018).

The agriculture sector is the second largest sector in Turkiye and Konya is a leader of agriculture and agro-industry sectors because of its flat wide land (Bayramoğlu & Ağızan, 2022). Since the 1950s, the area has been known as the Grain House of Turkiye. However, changes in climate conditions, i.e., temperature increase, seasonal shifts, increasing water scarcity, and increasing frequency of extreme weather events, which have been observed over the last years (Soylu, 2021), have affected the agriculture sector of Konya as well as of Turkiye (Adaman, Avcı, Kocagöz & Yeniev, 2020). Because the agriculture sector depends mostly on nature and uses almost 60% of all the water resources available (MWI, 2010, 2009a, 2009, 2007, 1998), changes in existing water resources have a great effect on this sector. Climate change not only affects the water resources and water levels, but it also significantly affects the water quality (Aggarwal & Singh, 2010), which alters food security in the affected region. Moreover, surface and groundwater reservoirs are used in the agricultural sector of Konya. However, changes in global climate bring changes in water levels, which consequently affect the agriculture, food supply, health, industry, and tourism sectors of a particular area (T.R. Ministry of Environment and Urbanization, 2012). According to the Fourth Assessment Report of the IPCC, a temperature increase of 1^0C-2^0C in the Mediterranean region will increase aridity in the wider area, cause heat waves, and the number of hot days will increase, particularly in inland areas. The IPCC report also notes that Turkiye will be hotter, more arid, and unstable in terms of precipitation patterns. In Turkiye, the projected impacts of climate change are increasing summer temperatures, decreasing winter precipitation, loss of surface water, increased frequency of droughts, land degradation, coastal erosion, and floods. This will have negative impacts on water and soil, which are crucial for agricultural production and food security (IPCC, 2007).

Having a sufficient amount of food is termed *food securit*y, which can be managed through trade and domestic production. Thus, food security is not related to production sufficiency but to

the loss of food production of households because of the impact of climate change. A food crisis is the consequence of the loss of alternative income due to the farmers' decreased harvest, which is mostly dependent on agriculture. This situation brings food security concerns into the frontline. Therefore, climate change is one of the main factors that will undermine global food security in the next decades because it will alter precipitation patterns, affecting the supply of surface water and groundwater needed for agricultural production in the particular area (Wangchuk & Siebert, 2013; Ramirez-Villegas & Challinor, 2012; Vicuña, McPhee, & Garreaud, 2012; Devereux & Edwards, 2004). Turkiye's water resources are essential for proper agricultural production, which is gradually decreasing because of the impacts of climate change. As a result, water resources came in first place among the five most important fields supported by technical and scientific studies and participatory processes, followed by the agriculture sector and food security (T.R. Ministry of Environment and Urbanization, 2012).

Climate change has multiple impacts on society in the form of the diminishing amount of water for agriculture, decreasing water quality, changing sustainable agricultural production patterns, and changing biodiversity and ecosystems, which altogether eventually risk food security for the agricultural community (Aggarwal & Singh, 2010). Changes in climate may also lead to desertification in Turkiye (Tramblay, et al., 2020; Turkes, 2019, 2012). For example, the Konya Plain and Iğdir sub-region are located in a semi-arid region, which is prone to desertification (Çetin, Karaca, Haktanır, & Yildiz, 2007). All of these changes create a negative situation for agricultural food production, (Aggarwal & Singh, 2010) which ensures the food supply for many people around the world. Additionally, water is key to the agriculture in Konya Plain (Soylu, 2021). However, climate changes over the last 25 years (1991-2015) have affected the pattern and the type of agricultural products (Karapınar, Özertan, Tanaka, An, & Turp, 2020). If the current climate changes continue, their impacts on agriculture will be more striking. Nevertheless, very little research has been conducted in the Konya region from a sociological perspective incorporating the socio-economic aspects of the farmers (Adaman, et al., 2020). Most research on climate change impacts and future climate projections uses climatological and meteorological perspectives of natural science (Tramblay et al., 2020; Turkes, 2019; Ekercin, Sertel, Celik, & Durduran, 2013; Turkes, 2012). Nevertheless, Tramblay et al. (2020) emphasized the projected socio-economic impacts of droughts in the Mediterranean region.

However, there is scarce sociological research done in the study area incorporating the producers. This study will try to fill this gap by employing sociological research methods and techniques while exploring the goal of this study. Climate change has been affecting the agricultural sector directly and indirectly through decreasing surface and ground water resources. These changes will have great impacts on the small scale and subsistence farmers at the local level as they are highly vulnerable to climate change impacts and have less adaptive capacity to decrease their sufferings (Aggarwal & Singh, 2010). Therefore, this study examines the impact of climate variability on water resources of the Sarayonu district of Konya and consequent impacts on agricultural production and food security of farmers' households.

There are multiple reasons for choosing Konya as the location for this study. The Konya Closed Basin holds both the fourth and second largest basins based on its precipitation area and underground water potential (Bayramoğlu & Ağızan, 2022). However, disruption of the natural hydrological regimes and over-consumption of freshwater resources pose some serious threats to the wetlands, salt lakes, and freshwater sources. Irrigation schemes have diverted water from the streams that feed freshwater resources to convert some of the salty steppes to agricultural fields.

As a result, the overall freshwater content of the lakes, wetlands and streams decreases (Berktay & Nas, 2008). Additionally, because of environmental pollution and global climate change, the use of irrigation water from basin water has been reduced. Consequently, cultivators had to change their irrigation systems and use new technology in the irrigation process. In addition, some cultivators may shift to other places, mostly cities, for their survival. As a result, many people are leaving the agricultural sector for other industries. Because of decreased precipitation, Konya is an arid climate zone and agricultural drought makes the situation more dangerous for high water-consuming crops. According to a report, Konya experienced the most severe agricultural drought of recent years in 2021, which affected the yield to fall from 22.6 million tons in 2015, the year of ideal precipitation for wheat production, to 15-16 million tons (Soylu, 2021). This situation threatens the food security of not only the Konya region but also Turkiye. Additionally, increasing temperature leads to low yields of barley and wheat, which are highly dependent on rain (Al-Bakri, et al., 2013; Topak & Acar, 2010). As a result, the cultivators have to change the cereal production patterns as well as irrigation systems. Previous research on the agriculture sector of Konya show that the climate of the region has been changing, which has severe impacts on existing water resources and consequently on the agriculture sector and food security of the area. Therefore, the present study explores the effects of climate change on water resources and the consequent impacts on agricultural food production and the food security of Konya.

2. Literature Review

Climate change has two significant elements: changes in temperature and changes in rainfall. Although precipitation has increased globally, some parts of the world have shown a decreasing trend while the other parts have shown an increasing trend (Aggarwal & Singh, 2010). However, the water crisis is worsening all over the world. It is expected that an increase in global temperature due to climate change will contribute to increasing water scarcity, which is expected to affect almost five billion people around the world by 2025 (Devereux & Edwards, 2004) and to make more than 60% people in Southern Africa vulnerable (Nhemachena, Nhamo, & Matchaya 2020). Moreover, climate change has a disproportionately high effect on the food security of poor households. Further, households struggling with water and food insecurity, and households that have no alternative source of income face the largest impacts (Nhemachena, et al., 2020; Devereux & Edwards, 2004). The Menderes river basin of Turkiye has witnessed the effects of climate change on water resources over the last 45 years. In the last 45 years, a 1^0C temperature increase was measured, which decreased the annual precipitation trend of the region. In addition, climate change has impacts on the water resources of Seyhan River Basin, which is located in Southern Turkiye (Durdu, 2010).

Turkiye is one of the Mediterranean basin countries that will experience the largest precipitation changes. If we consider the precipitation of Turkiye, we see that the country has its highest precipitation rates in the winter season, and precipitation is much higher in coastal areas than in interior zones. However, because of hydrological changes, Turkiye has been experiencing temperature rising everywhere. The Turkish summer temperature increase has been particularly high. It is a projection that Turkiye's temperature will increase between 1.0 ^{0}C and 2.5 ^{0}C by the mid-21st century and between 2.5 ^{0}C and 5.0 ^{0}C by the end of the century. Meanwhile, at the same time, the average annual precipitation will decrease in southern Turkiye, and northern Turkiye will see an increase in temperature (Şen, 2013). It is claimed that increasing temperatures lead to low crop yields, particularly of barley and wheat, which are highly dependent on rain. Wheat

production will decrease by 3-10% with an increase in temperature of 1 °C (Al-Bakri, et al., 2013; Gohari, et al., 2013; Chiras, 2012; You, Rosegrant, Wood, & Sun, 2009; Anwar, O'Leary, McNeil, Hossain, & Nelson, 2007) while a total 25-50% yield loss is expected worldwide if the temperature rises 3°C (Karapınar, et al., 2020).

In addition, reductions in precipitation in arid and semi-arid countries may lead to a decrease in crop production. For instance, Turkiye will face a wheat production loss of 20% due to increased temperature and decreased precipitation, while wheat production will decrease from -2.5% to 20.7% in the Zayandeh-Rud River Basin in Iran, and there will be a 4.5% decline in China (Gohari, et al., 2013; Ozdogan, 2011; You, et al., 2009). Another semi-arid country, Jordan, also shows similar scenarios from the impact of climate change. Studies show that climate change impacts are devastating for arid countries like Jordan. Climate change puts extra pressure on already scarce water resources in countries with limited resources for agricultural production, which consequently puts pressure on the food security for those countries. All these changes create situations for farmers to develop adaptive mechanisms, particularly technological adaptive mechanisms to which producers react positively (Gohar & Cashman, 2016; Al-Bakri, et al., 2013). Further, climate change is expected to impact water availability in Southern Africa through increased temperature and decreased rainfall patterns, which will reduce agricultural production by 15%-60% (Nhemachena, et al., 2020). As a result, climate change is expected to increase the demand for water usage for agricultural production in Jordan, which is hampered by decreased rainfall and increased temperature. Therefore, the producers would depend mostly on irrigation, which is expected to increase by 14% by 2030 and 28% by 2050 respectively (Al-Bakri, et al., 2013).

Taking examples from Turkiye, Şen (2013) mentions that there are some important sectors of Turkiye, which are significantly affected by climate change. These sectors include Human Resources, Water Resources, Agriculture, Forest, Tourism and Energy. In addition, agriculture, Turkiye's dominant sector, where nearly 15 million people are employed, needs 73.2% or 85% of the total water supply of the country (Bayramoğlu & Ağızan, 2022; Dogdu & Sagnak, 2008). Another study tried to determine the effects of climate change on the water resources of Konya through climate data and multi-temporal Landsat images. Employing an engineering perspective and using technical data collected through a remote sensing method to identify the climate change impacts on water resources, the study shows that Konya has been in a drought for the last two decades due to two main aspects: uncontrolled use of groundwater in agriculture and a lack of sufficient precipitation. The primary data source of the research is remote sensing satellites, which generally did not consider the social consequences of climate change (Ekercin, et al., 2013).

A study report (Dursun, 2010) on the effects of global climate change on the water balance of Beyşehir Lake in Konya shows that the water level has been fluctuating due to two important factors: global warming and activities of local people. As a result, during the wet season, the water level rises, which is harmful to agriculture and human beings. During the dry season, there is lack of water flow, which leads to drought in the mentioned area. It is also shown here how evaporation, precipitation, and runoff affect the water level of the Beyşehir Lake. At the same time, the Carsamba River is an important source of water for the lake. Therefore, changes in this river flow ultimately affect the balance of water level of Beyşehir Lake. The construction of a dam and unconstrained use of water in agriculture have also destabilized the water level of this lake. At the end, this report urges to maintain water level in Beyşehir Lake in order to ensure economic benefits of water and suggests educating the farmers about the proper use of water in irrigation systems (Dursun, 2010). There are many other studies conducted in the Konya region on climate

change and its impacts on water and agriculture, namely Bayramoğlu and Ağızan (2022), Aydın et al. (2015), Dogan, Berktay and Singh (2012), Topak and Acar (2010) etc.

For example, socio-economic drought, one of four types of drought observed in Konya (Dogan, et al. 2012), is also defined as the result of meteorological, hydrological, and agricultural droughts happened due to low precipitation in Konya (Bayramoğlu & Ağızan, 2022). This situation entails more demand for a financial product than the supply in the affected area. The main reason for less precipitation is climate change, which also leads to less agriculture production in the affected area and alters food security, leading to famine and health problems (Bayramoğlu & Ağızan, 2022). Therefore, farmers of Sarayonu district of Konya were interviewed because they are the actors who face climate-induced vulnerability most and whose household income and food security is most affected.

3. Objectives of the study

The broad objective of this study was to explore the impacts of climate change on the water resources of Sarayonu, Konya, and the consequent impacts on the food security of the households of the farmers. This broad objective has been split into several specific objectives and questions, which include:

a. To find out the existing water reservoirs (ground and surface) required for agricultural production.

b. What types of changes are there in water resources of the society in the last 15 years?

c. What are the social impacts of water scarcity resulting from climate change? Does water scarcity have an effect on the poverty of the farmers?

d. How and to what extent does water scarcity affect the decision-making process of farmers for further cultivation?

e. How do the changes in water reservoirs affect the quality of agricultural production of the community and the income sources of the households of the farmers?

f. How do the changes in water resources alter the food security of the households of the producers?

4. Methodology

In the present study, a qualitative research methodology was employed and the study design is descriptive-exploratory. Field interviews were conducted in 2018 on the farmers and a semi-structured in-depth interview form was designed. The interview guides were designed in both English and Turkish and were pretested and updated accordingly. Furthermore, the current study concentrates on the changes in number of wetlands, lakes, and irrigation pumps of the study area in the last 15 years in order to support the descriptive design of the study. The researcher received ethical approval from Ankara Yildirim Beyazit University Ethics Committee (Decision No: 2018-226/28.06.2018/44) to conduct this study. Changes in water resources affect the agricultural sector and consequently the social status of the people engaged in this sector, as the income level is affected by these changes. Moreover, some people are expected to leave their production jobs and migrate to other places for their survival, while others still live there and struggle with the environmental changes resulting from climate change. These bring qualitative changes to the community and to the people's lives. The fieldwork approach demands that social life can only be understood through interpretation (Goffman, 2002; Bechhofer & Paterson, 2000). Qualitative researchers collect data through examining documents, observing behavior, interviewing people, or describing a

group of people that interact with each other. I have followed all these activities in this research. Therefore, the success of qualitative inquiry depends on the skills, assumptions and practices of researchers engaged in research (Creswell, 2014; Neuman, 2011; Denzin & Lincoln, 1998).

To increase the reliability and in-depth understanding of the problem, an observation method was also employed and field notes were taken during observation alongside the interview. Sarayonu district was selected as the field of study because it is located in Konya Plain (*Konya Ovası*) region, which is the least rainy area of Turkiye with an annual average precipitation of 310.3 mm (Bozyiğit & Tapur, 2009). The respondent farmers were purposively selected from different villages (*Mahalle*) of the Sarayonu sub-district (*İlçe*) to investigate the changes to water resources and water quality of the area, which are essential for agricultural production. Using convenience sampling, I tried to reach a sufficient number of farmers who pass their time in the tea stall of the study area (Baker, 1994). The farmers generally gather in the local tea stall to spend their off-season time. Therefore, it was convenient to reach the target group of my study. Because it is a qualitative research, the number of the participants is less important here. Nevertheless, using the snowball sampling, a sufficient number of farmers, 31 farmers, were interviewed to reach the research objectives. After interviewing 31 farmers, the interview ended. Extra interviewees did not add any new thematic information, and data saturation was achieved (Crowe, Cresswell, Robertson, Huby, & Avery, 2011). The interviewees were given free choice to express their vulnerabilities. Income loss and food crisis of their households happened due to lack of water resources. Because participants' explanations are the foremost source of qualitative data, I took some notes while performing face-to-face interviews so as not to miss any nuance in the responses. A thematic method was applied to transcribe the interview data, and interpretative data analysis technique of qualitative research methodology was used to analyze them. The researcher has coded the transcripts manually to develop themes and sub-themes, which were later categorized. In order to increase reliability of the study results, the verbatim method (Silverman, 2006) was used in this study, i.e. the direct remarks and opinions of the respondents taken from the study notes are included in the analysis section of the research.

5. Results and Discussion

For information about water resources in the study area, the study considered the last 15 years. This study considers how the water resources were 15 years before and what types of changes happened to the water resources and water quality in this time. The agriculture sector is dependent on water, which covers over 70% of the earth's surface, but only 2.5% of water is fresh water, which is used for drinking, hygiene, agriculture, and industry. Studying water and its consequent impacts on agriculture is central, as two-thirds of all countries will face water scarcity by 2025 (SESRIC, 2019). In addition, climate change has great impacts on water resources in the form of low rainfall, less precipitation, etc. As a result, rain-fed agriculture, which is a source of food security, will be highly affected by the scarcity of water, i.e. the crop yield will decrease etc. (SESRIC, 2016). Therefore, both water resources and agriculture, which are vulnerable to the impacts of climate change, are the primary focus of my study.

Previous studies have shown that the Konya closed basin, which claims the least rainfall among the provinces in central Anatolia, has observed a rapid depletion in surface and groundwater resources due to increased water use in irrigation for agricultural production (Çelebi, 2016; Bozyiğit & Güngör, 2011; Kara, Topak, Şahin, Süheri, & Yavuz, 2008; Topak, Süheri, & Acar, 2008). Because the agriculture sector depends mostly on water resources (which consume be-

tween 70% and 90% of fresh water) and because climate factors affect the groundwater level negatively in the Konya Plain region (Bah & Acar, 2017; Cihan & Acar, 2016; Çelebi, 2016; Bozyiğit & Tapur, 2009), agricultural producers in Sarayonu face the highest vulnerability. The socio-demographic results of my study show that most of the farmers are over 40 years old and do not have higher education. This reveals that the young and educated portion of the population do not engage in the agriculture sector for various reasons. This sector is not profitable enough to maintain their livelihoods. This result contrasts with a previous study that argues that university graduates are entering the agriculture sector because of its being profitable (Bah & Acar, 2017). Due to climate change, the price of agricultural inputs and equipment are high, and an increasing number of youths receive higher education in cities and find their sources of income there. Thus, they do not return to Sarayonu, nor become involved in the agriculture sector. All of the respondents also mentioned that they try to ensure schooling of their children so that they can get a secure job in urban areas, because agriculture brings too little income to maintain the expenditures and food security of the households. This finding is also supported by a previous study, which claims that countries that have arable land and limited water resources are directly affected by the impacts of climate change in terms of food crisis and water scarcity (Al-Bakri, et al., 2013).

Regarding the existing water resources, the interviewees claimed that the existing water reservoirs are not sufficient for agricultural production. Water services for agricultural farming use a very small number of deep wells. The deepness of all the wells is on average 200-250 meters. Although there is a lack of information among the farmers regarding the water reservoirs, the reality for the Sarayonu district is that existing water resources are not enough for proper agricultural crop production. This is also supported by a previous study, which argues that there is not sufficient knowledge about climate change's impact on regional economies (Gohar & Cashman, 2016).

Moreover, there were fewer and shallower water wells 15 years ago, as the stream water flow was very good and the level of ground water was very close to the surface. All of the respondents mentioned that there were very few water wells in Sarayonu and the average depth of the water wells was below 100 meters and the average precipitation was regular and high before 15 years ago. Therefore, all farmers could produce agricultural products through irrigated farming. This result echoes a common feature of the region where agricultural production mostly depends on irrigation (Çelebi, 2016). However, my present study results show that the situation changed in the region where the water reservoirs lost 70% of their total amount of water in the last 15 years. In-depth interviews reveal that the number of water sources has been reducing day by day and irrigation systems went only to the hands of prominent and wealthy farmers, as digging deep wells is expensive. This result reflects a previous study that argues that water resources are controlled by cooperatives, which have a connection with the state (Adaman, et al., 2020). Therefore, small and poor farmers cannot afford them because they lack social capital. This result may show a striking scenario that deserves further evaluation in broad aspects. All the farmers claimed that both surface and ground water levels had diminished because both surface water and ground water had been used extensively for agricultural production for many years due to increased temperature and decreased precipitation in the region. This ultimately creates pressure on the existing surface water resources, which are limited, and on groundwater depletion, as rainfall maintains the surface and ground water storage (Almazroui, Şen, Mohorji, & Islam, 2019). As a result, food security is a serious concern under climate change. This correlates with a previous study that argues that shortages in surface water and groundwater depletion create a threatening situation for sustainable agricultural development (Gohari, et al., 2013).

Additionally, the study area's only pond, which was the main source of irrigation, became dry. Thus, farmers could not irrigate for many years. Consequently, the households of the farmers could not ensure proper a harvest and lost their income source and fell into food crisis. Moreover, the groundwater level dropped down. Farmers used to get water from about 90 meters deep 15 years previously but now get water from 150-180 meters deep and in some places from more than 180 meters deep. In my current study, the respondents viewed climate change in the form of decreased precipitation, increased temperature, and a fall of groundwater levels, which correlates with some previous studies conducted on water resources in Jordan (Schacht, et al., 2011; Abdulla, Eshtawi, & Assaf, 2009; Abdulla & Al-Omari, 2008).

There are a number of causes for changes in water resources. For example, some respondents mentioned the excessive and unconscious use of water by farmers in their agricultural lands, while most of the respondents noted less and irregular precipitation and drought due to the impact of climate change as the primary cause of these changes to water reservoirs. Because of climate change, the expenses for wells increased, which the poor farmers cannot afford. As a result, these farmers fall into a vicious circle. They lose income because they do not have a proper harvest, and they cannot have a proper harvest because production costs are high. Climate change has impacts on water used in irrigation for agricultural production. The more water is used, the more the groundwater level will decrease. As a result, the production costs for the farmers increases (Shahid, 2011). In addition, the production cost gets higher as the agricultural varieties and commodities are expensive and scarce (Wheeler & von Braun, 2013; Batisani, 2012; Ahmed, et al., 2011; Schneider, et al., 2011). Because the farmers lose their income, they have less access to food and cannot maintain the higher expenses of food production (Mushtaq, Marasenia, & Reardon-Smith, 2013).

The study results also show other reasons for the changes in water resources, such as global warming, climate change, lack of services, increased use of irrigation, a lack of new deep wells, the flow of stream affected by the ponds dug in the mountain villages, the irregular and wild irrigations, etc. All these factors cause changes in water reservoirs, which have consequent impacts on agricultural crop production. The study shows that farmers' energy expenses are high because farming requires frequent irrigation due to drought and other climate change impacts. They also cannot get a return on their expense at the end of the harvest, because when the amount of production decreases, the quality of the crops reduces. Therefore, in the next yielding year, the farmers are unmotivated and have insufficient capital for further cultivation. Consequently, their income sources and levels gradually decrease.

In addition, the study results show that farmers are disturbed by the price of seeds, fertilizer, and diesel, which have negative impacts on crop production and the economic condition of the farmers. One interviewee claims in this way:

"Before we used to buy 1 liter of diesel by selling 1 kilo of wheat, but now 3 kilos of wheat is needed to buy 1 liter of diesel. The price of wheat has been the same for the last 4 years but expenses increased 3 to 4 times."

Moreover, climate change makes the situation worse. Due to climate change and its impacts on water resources, farmers' efficiency drops, crop varieties change, and farmers do not have a good harvest. Farmers stop planting particular types of crops, i.e. sugar beet, and consequently those crops cannot be found in the market after some time. Some farmers leave the farming industry completely and shift to other income generating activities, while others leave some parts of their land empty. This type of attitude of the farmers creates pressure on the food security of their households.

In addition, interviewees stated that wind erosion happened in the study area for two consecutive years, which damaged the surface level of the agricultural land for 2 meters. Drought, which is also a very common problem of the study area, was a problem almost every year in the last few years due to a lack of precipitation (Bayramoğlu & Ağızan, 2022; Turkes, 2019; Dogan, et al., 2012). The farmers were affected highly in the sense that they could not even repay agricultural loans taken from the government or afford their production costs. As a result, they fell in economic crisis and great debt. The interviewees claimed that when a disaster occurs, they lose their plants, become weak economically and mentally, and face a food crisis. They cannot buy fertilizer and pesticides for their farms, and they lose their motivation for further cultivation in the next years. Climate change also exaggerates the situation negatively. The study results also show that drought, which occurs due to lack of water, requires frequent irrigation. However, the farmers lack water, so they cannot plant and harvest crops properly. Thus, the farmers are in a vicious cycle of climate-induced devastation, which weakens the farmers mentally alongside the economic crisis. The results show that the water resources of the study area are highly affected by climate change. The number of water reservoirs deteriorated, water level of the reservoirs dropped, and groundwater levels dropped to more than 180 meters deep. All these changes have created water scarcity in the area, which has effects on the agriculture sector as because it is climate sensitive. When people have less water, they get low quality and low quantity crop yields, which cause the households to fall into poverty (Bayramoğlu & Ağızan, 2022). At the same time, food insecurity increases when farmers do not have proper harvest in back-to-back years, which also leads to the increase of commodity prices, as was expected by Güngör (2018). The present study results show that climate change affects water, which in turn has had negative impacts on food production in the study area in the last 15 years consecutively. Back-to-back damage in agricultural output due to climate change contributes to the food crisis of the farmers' households. The farmers get less harvest, cannot get returns on their production expenses, and engage in other income-generating activities, primarily in city areas. This result supports the results of previous studies, which argue that climate change impacts the water and food supply of the climate-affected areas (Gohar & Cashman, 2016; IPCC, 2007).

Water scarcity occurring due to climate change only alters the economic condition of the producers, not their health condition. The respondents mentioned that because they do not find natural drinking water anymore, they depend on bottled water for drinking. Therefore, they do not suffer from water-related health problems. Nevertheless, water scarcity increases the possibility of crop-related diseases such as pied disease. Some farmers have given up production and are searching for new income sources, while some others are changing the crop varieties in order to stick with this sector. As one farmer stated:

"When the water is over, civilization is over. It is apparent from the color of the face of the farmers that if there is no water, they become unhappy. Their income drops, and they fall in a food crisis. These altogether also affect their both their physical and mental health."

Households of the farmers face net income loss due to a decreasing trend in consumer surplus, caused by a decrease in food supply and a price hike (Gohar & Cashman, 2016). As a result, farmers try to adapt to new irrigation technology, such as drip irrigation, in order to maintain their yield and increase their household incomes. Therefore, employing such adaptation technologies could be helpful to ensure food security for both the consumers and the producers, as efficient irrigation systems can contribute to saving water. This in turn can be used in other economic sectors can extend cultivable land for food production (Gohar & Cashman, 2016; Jägermeyr, et al., 2016; Jägermeyr, et al., 2015; De Fraiture & Wichelns, 2010).

If it is possible to increase the number of water reservoirs in the Sarayonu district, it will be possible to create new ways to gain income sources for the people who are new in the agriculture sector. In this regard, I can add success stories from the Konya-Karapınar district in Turkiye, which has been greatly affected by soil degradation and desertification (Turkes, 2019). Therefore, governmental and non-governmental bodies came forward to improve the soil quality in Karapınar and handed over 4,300 hectares of cultivable land to the farmers (Turkes, 2019). My study results show that because expenses are high, young farmers are trying to leave this sector and engage in other income generating activities. Farmers buy diesel, fertilizer, pesticides, and seeds at a higher cost. Gradually, the price of the agricultural equipment is increasing, and farmers' expectation from the government is only to lessen the price of agricultural production goods and to start issuing licenses to dig new wells so that they can continue crop production. Local actors also demand long-term annual unconditional monetary support from the government, as the banks provide them with credit for short-term payments.

There are some forms of support from the government to the farmers. They provide support for the irrigation system. The government also provides the farmers with insurance against natural disasters and catastrophes. Furthermore, farmers demand that the government introduce advanced technologies in the agriculture sector, as they are very expensive, and farmers cannot afford these upgrades due to their existing income crisis and the loss of agricultural production resulting from climate change. The farmers demand that the government should reduce the price of agricultural production goods. In addition, local farmers should be asked about the problems they encounter due to the impacts of climate change and their opinions should be evaluated in decision-making processes.

6. Conclusion

This study shows that climate change is a major concern for Turkiye, and the country is already experiencing its negative implications on agriculture (Soylu, 2021; Adaman, et al., 2020), which is highly dependent on the natural climate for a maximum harvest. Turkiye has been observing temperature increases, which create two problems for the agricultural sector of the country. First, changes in precipitation have been observed in Turkiye. Consequently, water levels and the water quality necessary for the agricultural production have decreased. Second, because the study area has been observing an increase in the temperature all over the region, farmers have to irrigate the agricultural lands frequently, which is not possible for farmers due to their socio-economic status. Therefore, they have not been able to produce quality agricultural goods in the last few years. These factors destabilize the farmers' income source and decrease the food security of their households. From the study it is clear that water is very important for agricultural production. The respondents assume that water is essential for civilization and say that if water finishes, it means that civilization is finished. From this claim, it is clear that the future of Turkiye is still largely dependent on its agriculture sector in order to maintain a high GDP.

In addition to climate change's implication on the agriculture sector, the people engaged in this sector also struggle with the high prices of agricultural goods such as seeds, diesel, manure, pesticides, etc. At the same time, they get less income from their products in the market. This creates a double burden for the farmers and consequently they lose motivation to continue in the future. Therefore, climate change and its impacts on water resources and the subsequent impact on agriculture have implications on the income levels and food security of the people engaged in the agriculture sector. Thus, some climate-affected farmers have adopted strategies to cope with

the situation, i.e. introducing new irrigation systems and leaving some part of the land empty. For others, migration is the only adaptive mechanism. There is little or no sociological research on climate change's impact on water and food security conducted in Konya and insufficient knowledge on the impacts of climate change on regional economies (Bah & Acar, 2017; Gohar & Cashman, 2016; Bozyiğit & Güngör, 2011). Again, Islam (2016) suggested doing more research using different methods to help researchers, academics, and policymakers understand the impacts of climate change on societies and the adaptive mechanisms to cope with the changing situations. This research thus aims to fill this knowledge gap by addressing climate change's impact on water resources and agricultural production and the consequential impact on the income levels and food security of households of Konya province in Turkiye.

In conclusion, this paper finds that the government should listen to this group of people, provide them with monetary support, and decrease the price of agricultural goods, as they provide the largest supply of food in Turkiye. The study results will be helpful for the national and local governments to review the existing risks on water resources and agricultural food production. Because it is claimed that climate change will bring a serious threat for Turkiye in the future, this research is needed to plan for adaptation. Pressures on water resources will hamper the agriculture sector, which is one of the sectors most dependent on the climate.

Geolocation Information of the Study Area

Sarayonu is a town and district of Konya Province in the Central Anatolia region of Turkiye. The geographic latitude and longitude of the district is 38° 15' 58 N and 32° 24' 23 E, respectively. Its total area is 1,088.07 km^2 and the total population of the district where the study was conducted is approximately 26,875 (2018 data).

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