REPUBLIC OF TURKEY
ERCIYES UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF AGRICULTURAL SCIENCE AND TECHNOLOGIES

INTERACTIONS BETWEEN CLIMATE CHANGE AND PADDY PRODUCTION AND ITS IMPACTS ON RURAL DEVELOPMENT IN IRAQ

Prepared By
Jawad Hassan HUMAIDY

Supervisor
Prof. Dr. Zeki GÖKALP

Ph. D. Thesis

July 2019
KAYSERİ

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SCIENTIFIC ETHICS SUITABILITY

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"Interactions between Climate Change and Paddy production and its impacts on Rural Development in Iraq" named Erciyes University Graduate Thesis has been prepared in accordance with Erciyes University Graduate Thesis Proposal and Thesis Writing Guidelines.

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02/ 07 / 2019

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09/07/2019

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ACKNOWLEDGMENTS

Doing a Ph.D. was one of my dreams since when I was a kid and getting to do so is such a rewarding experience. This incredible experience could not have been completed without the support of many people who I am in debt.

First, all praises belong to Allah, The Most Gracious and Most Merciful, for His blessings that enabled me to accomplish this dissertation.

Second, the accomplishment of this thesis would not have been possible without the assistance of many people, who have supported me throughout my academic years. And, this study is a product of many hands that directly and indirectly pushed me to gait the next steps. It is my pleasure to express my gratitude to individuals for their help and support.

- Above all, I would like to thank my supervisor, Assoc. Prof. Dr. Zeki GÖKALP for his human and professional quality, his patience, his time, his knowledge; the fact that his door was always open, and he was willing to discuss any issues that I encountered. I've learned a lot from him not only in the professional but in the personal levels, his guidance and thoughts have encouraged me to complete and consolidate the presented work.

He has turned my education into a unique and joyful experience.

Without his guidance, support and encouragement; this study could not have been established.

He was like a star in my sky, make them my leading point, I am very grateful to him.

- My wife (Um Ahmed); she smiles in my face while she is facing death back home, she mighty faces.

- Parliamentarian Zeinab Al-Tai; she has assisted me during my study period.

- Turkey: the country, who believes in me and gives me a big chance.

- Erciyes University: the place that supports me and gave me a big chance too, I love it a lot.

- The dean of the faculty of Agriculture science and technology, Professor Mehmet Arsalan, Dr. Mehmet Ulas and all the faculty staff: who can forget him never?

- The staff of Agriculture extension center in Al Muthanna, Thi Qar, and Al Qadisiyah; has assisted me during my research work.
- My friends in Iraq and in Turkey, who give me a motivation to go, feed me with love.

For all this and more give with love my efforts.

Jawad Hassan HUMAIDY

Kayseri, July 2019

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Ph.D. Thesis, July 2019
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ABSTRACT

Climate change is inevitable and will continue into the next century. Since the agricultural sector in Iraq is most vulnerable to climate change, a thorough understanding of adaptive measures is important for formulating effective policy decisions. This study provides an overview of the status of climate change and adaptation in the paddy sector and its impacts on rural development in four Districts (Al Najaf, Al Qadisiyah, Al Muthanna and Thi Qar) for the period 1966-2015 in South of Iraq. First, the study relies on descriptive statistics and maps to explore the long-term changes at both country and local level in climatic variables such as temperature, rainfall, and humidity. Second, it uses regression models to estimate the impact of climate change on Iraq paddy productivity. The primary data used in this study were collected through structured questionnaires administered to 223 randomly selected rice farmers and the secondary data were collected from the official organizations of Iraq. Statistical analyses revealed increasing average yearly minimum and maximum temperatures and decreasing total yearly rainfall in time. This scenario explicitly indicates how Iraqi agriculture (especially paddy production) and irrigation sectors are suffering from the scarcity of rainfall and rising in temperatures because of Iraqi agriculture and irrigation systems largely dependent on these two factors. The findings also revealed that increasing temperatures and decreasing precipitations had significant correlations with the outcomes of two primary water resources of Iraq (Tigris and Euphrates). Then, excessive water scarcity in two main rivers had adverse effects on rice yield of the study area. It was concluded that Iraqi government should take some initiatives to mitigate the negative effects of climate change on paddy yields. Iraqi government should give more interests on policy formulation and to find out the ways of adaptation and mitigation of adverse effects of climate change. Strong emphasis should be given on redesign of the water management plan, introducing suitable cropping pattern and varieties, developing awareness among the farmers and

strengthening the agricultural research and extension systems to lessen the detrimental effects of climate change as well as to ensure the sustainable agricultural development of Iraq.

Keywords: Climate change, Adaptation, Paddy production, rural development, Irrigation water scarcity, Rural economic.

İKLİM DEĞİŞİKLİĞİNİN ÇELTİK ÜRETİMİ İLE ETKİLEŞİMİ VE IRAK KIRSAL KALKINMASI ÜZERİNE ETKİLERİ

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Doktora Tezi, Temmuz 2019
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ÖZET

İklim değişikliği kaçınılmaz bir olgu olup önümüzdeki yüzyılda da devam etmesi beklenmektedir. Tarım sektörü iklim değişikliğine karşı en hassas sektör olduğundan etkin bir politika geliştirebilmek için iklim değişikliğine adaptasyona yönelik önlemler büyük önem arz etmektedir. Bu çalışmada 1966-2015 periyodunda Irak'ın dört farklı bölgesinde (Al Najaf, Al Qadisiyah, Al Muthanna ve Thi Qar) iklim değişikliğinin mevcut durumu analiz edilmiş ve çeltik sektörü ve buna bağlı olarak da kırsal kalkınma üzerine etkileri değerlendirilmiştir. Çalışma öncelikli olarak sıcaklık, yağış ve nem gibi ilklim parametrelerinde yerel ve ulusal düzeyde uzun vadede gözlenen değişimleri tanımlayıcı istatistikler ve haritalar ile analiz etmekte, ikinci aşamada ise belirlenen bölgelerde çeltik tarımı ve kırsal kalkınma üzerine etkilerini regresyon modelleri ortaya koymaktadır. Araştırmada kullanılan veriler tesadüfi örnekleme ile seçilmiş 223 çeltik üreticisi ile yüz-yüze görüşmelerle gerçekleştirilen anket çalışması ve Irak resmi makamları ile yapılan görüşmeler ile elde edilmiştir. İstatistiksel analizler söz konusu periyot boyunca yıllık minimum ve maksimum sıcaklıkların arttığını ve yıllık toplam yağışın azaldığını işaret etmiştir. Mevcut senaryo Irak tarımının (özellikle de çeltik üretiminin) ve sulama sektörünün yağış azlığı ve artan sıcaklardan ne denli etkilindigini olduğunu ortaya koymaktadır çünkü Irak tarımı ve sulama sistemleri tümüyle bu iki faktöre bağlıdır. Mevcut bulgular artan sıcaklık ve azalan yağışların bölgenin iki temel su kaynağının (Dicle ve Fırat) verimleri ile de önemli ilişkiler sergilediğini ortaya koymaktadır. Bu iki nehirde yaşanan su kısıtı çalışma alanı çeltik verimleri üzerine de olumsuz etkiler sergilemektedir. Tüm hususlar göz önünde bulundurulduğunda, Irak hükümetinin girişimde bulunup iklim değişikliğinin olumsuz etkilerini hafifletici tedbirler alması gerektiği aşikardır. Irak hükümeti bu konuda polika oluşturmaya özellikle özen gösterip iklim değişikliğine adaptasyon ve olumsuz etkilerini hafifletici tedbirler üzerine odaklanmalıdır. Özellikle su kaynakları yönetimi ve bitki deseni üzerinde durulup çiftçiler arasında bir bilinç uyandırmak için yayım servislerini güçlendirirek iklim değişikliğinin olumsuz etkilerini hafifletme ve sürdürülebilir bir tarımsal gelişme sağlanması gerektiği aşikardır.

Anahtar Kelimeler: İklim değişikliği, Adaptasyon, Çeltik üretimi, kırsal kalkınma, Sulama suyu kısıtı, Kırsal ekonomi

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ABBREVIATIONS

CH_4	: Methane.
CO_2	: Carbon dioxide.
COSIT	: Central Office for Statistics and Information Technology.
FAO	: Food and Agriculture Organization United Nations.
FAOSTAT	: Food and Agriculture Organization Corporate Statistical Database
GCMs	: General Climate Models.
GCRI	: The Global Climate Risk Index.
GDP	: Gross Domestic Product.
GHG	: Greenhouse Gases.
IAI	: Iraqi Atmospheric Institute.
IMOS	: Iraqi Meteorological Organization and Seismology.
IPCC	: Intergovernmental Panel on Climate Change.
IPCC SRES	: Special Report on Emissions Scenarios is a report prepared by the
IRRI	: International Rice Research Institute.
M^3	: Cubic Meter.
MENA	: Middle East and North Africa.
MMT	: Million Metric Tons.
MoA	: Ministry of Agriculture.
MoE	: The Ministry of Environment.
MoH	: The Ministry of Health.
MoP	: Ministry of Planning.
MoWR	: The Ministry of Water Resource.
N_2O	: Nitrous Oxide.
NAS	: National Academy of Sciences.
NCDC	: National Climate Data Center.
NGO’s	: Non-Government Organizations.

ppm	**:** Part per Million.
SFCCD	**:** Strategic Framework for Climate Change and Development.
Tg	**:** Tera-gram
UN	**:** United Nation.
UNDP	**:** United Nations Development Programme.
UNEP	**:** United Nations Environment Programme.
UNFCCC	**:** United Nations Framework Convention on Climate Change.
USGCR	**:** United States Global Change Research Program.
WB	**:** World Bank.

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INTRODUCTION

Climate change is one of the major environmental changes which affecting the humans live and ecosystem and a topical subject of global importance. Over the last several years, because of both human activities and natural phenomenon, the climate in the globe has changed. These changes have been shown to be more intense and frequent as well as disasters such as tsunami, storms, droughts, and floods induced irregular changes within and over the years. It is true that these changes have immense impacts on environmental, economic, and social systems and shaped the rural development and prospects for sustainable agriculture [1].

The evidence from several scientific researches made scientists speculate that greenhouses gases could promote changes. Although there is world-wide socio-economic suffering due to climate change, the majority of the empirical studies are focusing on the developed countries [2]. However, it is a common belief that the developing or underdeveloped countries are more prone to climate change due to their dependency on the agricultural system. The hypothesis of more difficulty of adapting to climate change by the low capital agriculture has never been tested although has been assumed. Even though the ability to project the differences in the regional level in impact is still showing lower effects, the climate change consequence in the future use of the use of agricultural land would be more drastic in the tropical or semi-tropical countries like [3].

Therefore, people living in underdeveloped or developing country citizens are highly prone to the impacts caused by climate change as they do not have preparation to withstanding a deleterious impact. It has been estimated that if there is an increase in global mean temperature at the lowest level, the global economy will be crumbling and there will be several negative impacts on developing countries. It is important to note that the climate change induced impact will fall unequally over the developing countries and thereby poorer people will exacerbate inequities health status and access to other resources, clean water, and adequate food [2].

Moreover, the absence of creating condition and poverty conditions of many of the lower adaptive capabilities of these developing countries have clearly contribute on the people live conditions. Therefore, most of these countries including Iraq, have no sufficient infrastructure to combat against such hazardous situation. The primary reason behind this situation is that these countries are mostly preoccupied with more pressing concerns such as recent urbanization, lack of infrastructure, a rapidly growing young population, primary education, drinking water supply, and malnutrition. Therefore, the environmental concerns of the most developing countries are dominated by the lack of investment and infrastructure [4].

As well as, agriculture and water resource are primarily dependent on the natural climate in many of the developing countries. Therefore, minimal changes in the climate such as the sunshine and rainfall would cause huge impacts on agricultural sector compared to other sectors such as manufacturing [5]. Different variables of the climate including temperature, humidity and rainfall level of the atmospheric carbon dioxide, etc. are found to be highly impacted the outcome of agriculture in developing countries. It has been projected using scientific models that the production of several cereal crops will be decreased due to a slight increase in the temperature caused by climate change [6].

It is important to note that the agricultural sector currently using 40% of the land area with accounts for about 24% of the world output [7]. This sector is highly dependent on the natural climate of the region and human are depending on the agricultural livelihood, the particularly poor community is more dependent on this sector. Therefore, to assess the impacts of climate change on the people in the rural area, agriculture has been a focus of those modeling [8].

It has been projected by [2] that the production of cereal in a global level could increase up to 4.8 billion tones by the end of 2080 if there is no climate change. It is true that specific climatic condition is the prerequisite to grow specific crops with higher performance. Any variations of the climatic condition may have harmful effects on crop production as well as the economic outcome.

Over the last three decades, Iraq has been facing low rainfall with higher temperatures. In addition, it has been estimated that the country could face a yearly mean temperature rise of 1.0 °C by 2030, 1.4 °C by 2050 and 2.4 °C by 2100. The cropping system and the plant yield is directly impacted by the weather and climate changes. Therefore, the variability in climatic condition and the function of weather could play a crucial role in the growth and yield of rice in Iraq [9]. The growth process could be hampered by the occurrence of unusual climatic events during the critical developmental stages or growing season resulting in the reduction in yield.

In this work, we will present the impacts of climatic variation on the production of rice in Iraq. In addition, this work will also highlight the impacts of rice production and climate changes on rural population and rural areas in Iraq. Based on the system-based studies and example cases in Iraq, the impacts of the climatic change will be described. In addition, measures of variability and key climate variables will be examined first and then the analysis of short-term weather episodes and long-term variability in the weather will be performed to distinguish the impacts.

However, the hypothesis of the study refers that Iraq is the second of Arab countries in oil production and the third largest populated and fast-growing economies among the Arab countries. However, it has several issues related to a social and economic condition which is unable to cope with the speed of economic growth. It is true that approximately 34% of the Iraqi population is living in rural areas. Therefore, there is a saying in Iraq that “Iraqi lives are in villages”. However, the fast-paced economic growth is completely absent in the rural area and does not truly benefit the people in the rural area [2]. Reduction of agricultural production is one of the major challenges faced by Iraqi people nowadays. This is mainly due to the rapid industrialization and urbanization along with the climatic change that resulted in the destruction of the agricultural land [10].

As in the introduction chapter, this study will be addressed the effect of global warming and climate change with its factors (Temperature, Rainfall and Humidity) on: paddy farms (production and yields) and rural development in area study of Iraq for four province Al Najaf, Al Muthanna, Al Qadisiyah and Thi Qar.

In order to obtain an idea about the climate change-induced changes in the socio-economic condition affect the use of agricultural land in Iraq, it is important to measure the use of agricultural land effects of climate change. The most important hypothesis is summarized below:

1- Severity of climate change effects (states or regions that are most vulnerable) on the regions in Iraq caused drastic irrigation water scarcity and agricultural productivity reduction.

2- Lack of adaptation of the modern agriculture technologies in the rural part of Iraq resulted in a critical impact on rice production as well as on the agricultural production patterns in Iraq.

3- One of the major socio-economic problems in Iraq is the rural poverty which is not only greatly influenced by the climatic and socio-economic factors but also related to the performance of the agriculture of the region or state.

4- There is a direct relationship between the socio-economic status of the area and the vulnerability against climate change e.g. rice production reduction, destruction of agricultural land, migratory situation, infrastructure index, less economic growth, etc.

5- Measuring the interactions index between the rural population and paddy production with climate changes in this area, is this index negative or positive for rural development.

The primary goal of the study is to understand whether the climate and weather have a direct effect on the development and growth and occurrence of climatic disasters and any fluctuation in the temperature could impact in the crucial stage of growth and finally reduce the productivity significantly. Because of that, variability in the climate and weather will play a significant role and will have a direct influence in rural socio-economic condition. Therefore, the major objectives of the current study are to find out the following: -

1. Explore the impacts of climate change on the agricultural sector and this including: -
    - Paddy production.
    - Paddy Adaptation.
2. Analyze the impacts of climate change on water resources and this including: -
    - Water resource quantity.
    - Irrigation water quality.
    - Irrigation systems.
3. Explore the effects of irrigation water quantity on paddy production.
4. Explore the impacts of paddy production, water resources, and climate change on rural development in the study area this including: -
    - Economic.
    - Relationship.
    - Landscape.
    - Rural immigration.

Several studies have aimed to examine the weather influence and/or variations on the production of crops including rice and different strategies adopted by the framers in the Asian region and beyond. However, in each location, the outcome is different and primarily depends on the location-specific management, the response of the crops and the magnitude of these changes. Therefore, to understand the location-specific climate change effects on the production of paddy and to recommend proper corrective procedures, it is very important to study the impacts of climate change in the farm level and rural people using farm-level survey data. The rationale of the current study is interactions between climate change and paddy productions and its impacts on rural development in Iraq.

CHAPTER ONE

LITERATURE REVIEW

1.1. Effects of Climate Changes

It is important to mention that the climate in a region could affect different aspects of economic prosperity including water resources and hydrology, manufacturing, tourism, forestry, agriculture, and food security, and finally the health of the community (Fig. 1.1). Minute deviation in the variables of climate is, therefore, highly affecting these sectors. This study focused on the impacts of climatic changes on agriculture, water resource, paddy production, and rural development. Because of the sensitivity and the size of the agricultural sector, the changes in the climate could affect more in this sector compared to other sectors. The scale of harm due to the climate change to the entire agricultural sector would completely depend on the future climatic condition and the level and type of inputs in the production system of agriculture. In addition, it is worth to mention that the dryland farms are more sensitive than the irrigated farms elasticities for precipitation [11].

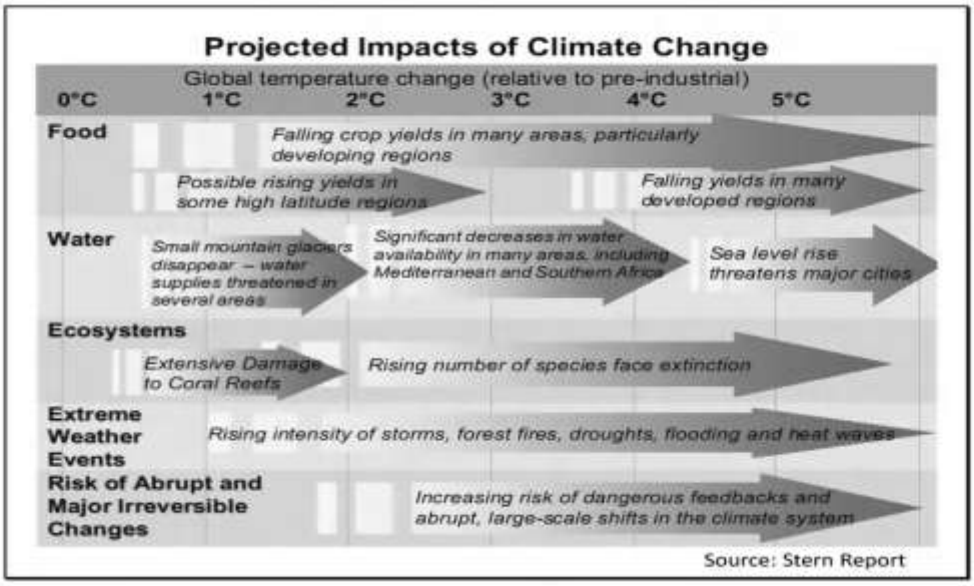


Figure 1.1. Projected Impacts of Climate Change [12].

On the other hand, it is worth to point out that climate change is not just affecting the agriculture- the production system of agriculture could also need to be exacerbated or mitigate the trend of climate change. It is also important to mention that the Intergovernmental Panel on Climate Change [13] has shown that the agricultural sector influencing the climate change by contributing around 13.5% of the total GHG (greenhouse gas) emission. The agricultural production system is producing some major GHGs including nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2) [14].

Although the agricultural production system in the United States is one of the major sources of N_2O and CH_4 emission, it is relatively a small producer of CO_2 from on-farm energy use. In the US, the agricultural activities producing a total of 413.1 Tg CO_2eq, which is estimated 5.8% of the total GHG emission in the US. The agriculture activity categories comprise the contribution of the following [14]:

- A broad array of activities including irrigation, production of N fixing crops and forages, soil cultivation, manure deposition by grazing animals, fertilization with synthetic fertilizer and other activities are covered by Agricultural Soil Management. The category covers GHGs emission from both grassland and cropland. Total GHG emissions of more than 200 Tg.
- The digestive system of the agricultural animals, particularly both the small and large ruminants, are producing methane (CH_4) gas. Total GHG emissions more than 140 Tg.
- During the storage and handling, nitrous oxide and methane gas are emitted which belongs to Manure Management emissions. Total GHG emissions around 60 Tg.
- Cultivation of rice under anaerobic conditions in the flooded fields in the US resulted in methane emission. Total GHG emissions around 10 Tg.
- The CO_2 emissions due to the burning of agricultural residues in the field results in huge CO_2 emissions, however, it is not counted due to the reason that the plants may reabsorb CO_2 in the next growing season. It is important to note that field burning not only producing CO_2 but also nitrous oxide, methane, and other minor GHGs.

In above we addressed the effect of agriculture on climate change, this part of this chapter will be addressed the impacts of climate change on the socio-economic security in the MENA (Middle East and North Africa) region felt greatly in the water sector, yet few adaptive measures and proactive policies are required to solve this crisis. It is true that the policy measures are sometimes in response to a definite problem where the resulted impacts are generally clearly seen and create sufficient media exposure, such aquifer and drought depletion, which straightly limits the supply of water. In many of the cases, it is just agricultural output decrease and lack of water in the cities that the reforms of water policy to address the security concerns in human society. Besides the climatic factors, the scarcity of water in the MENA region is derived from the continuously increasing demands along with demographic growth that occurs rapidly. It has been concluded by reviewing many studies that was investigated the flow of Nile and climatic models since 1981 that the climate change-related impact on the flow of Nile will be relatively lower in comparison with other changes induced by human including development strategies, choice of land use, and population growth [1].

The population size of the MENA region is expected to increase from 300 million in 2000 to about 540 million in 2025. It has also been estimated that the availability of water will vary by different orders of magnitudes for the various countries towards the region of MENA and the water availability per capita will be ranged from low water-stressed countries like Iraq (4,340 m^3/year/capita) to high water-stressed countries like Jordan (200 m^3/year/capita). It is important to note that the ground water-based countries have a significantly higher level of water stress, while the countries based on surface water flows (Iraq, Syria, Lebanon, and Egypt) are with surplus water. It has been predicted by the researchers that the water stress will be increased in the MENA region dramatically due to the increase in the population in 2025 and the availability of water is expected to be reduced 30% - 70% per capita. The estimated enhancement in the stress of water could affect countries in the MENA region, although countries based on groundwater sources expected to exacerbate the already existing problem related with water crisis [1].

1.1.1. Effects of Climate change on Water Resource

It has been recognized widely that the regional and global hydrological cycle potentially greatly impacted by the slight increase in the temperatures. Global warming or the increase of temperature will have dramatic impacts on the geographic areas where the water cycle is dominated by snowmelt hydrology because the temperature could affect the snow melting seasonal cover and snow runoff (Fig 1.2). For example, the Himalayan area is considered to be the greatly impacted area and highly vulnerable to the increase in temperature due to the impacts on glaciers and snow cover. Therefore, the study of the potential impacts of climate change on the water resources and hydrological cycle in these areas has been attracted by several researchers. These places are considered to be the best place for studying climate change because these places are remote and far away from human development [10, 15].

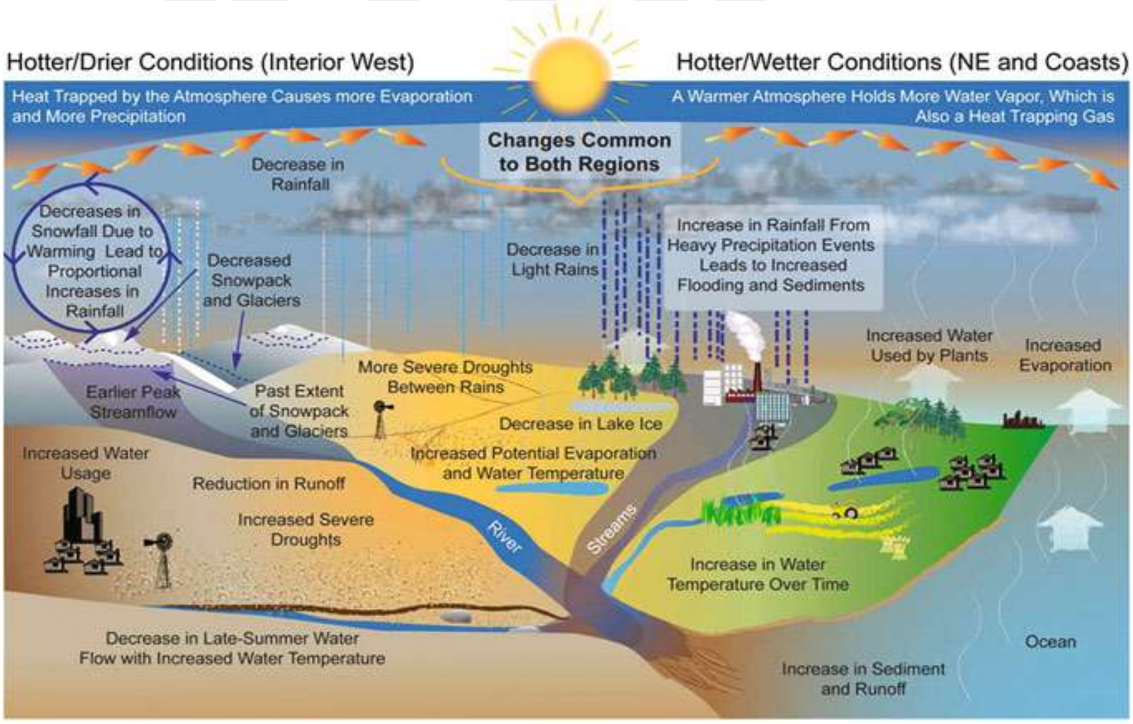


Figure 1.2. Interdependence of Meteorological Variables and Hydrological Cycle, [16].

However, due to the remoteness of these areas several factors including the difficulty of maintaining the hydro meteorological stations and the inadequate observational networks potentially could affect the quantity and quality of the obtained data which might be used to study the climate change in that particular region. In addition, regional conflicts and disputes could severely complicate the inset data collection in some of these regions.

It is important to note that global warming is a recent phenomenon and has been accelerated in the past few decades. For instance, while, there was about 0.18°C increase in the temperature in each decade in the last 25 years, there was about 0.75°C increase in the temperature in the last 100. The increase in the temperature has been observed in both oceans and lands. Increase in the temperature due to global warming resulted in glaciers melt, rise in the sea level, and changes in precipitation patterns. It is true that in general, extreme weather events in recent days are increasing in terms of their intensity and frequency [17].

Climate change has an impact on both oceans and freshwater resources in terms of coral reef bleaching and acidification. The ocean's capacity to absorb CO_2 from the atmosphere is likely to be reduced by a slight increase in the ocean acidity. Therefore, the effects of climate change are huge in marine life and could affect the total ocean food chain. According to the above, the result is that climate changes affect the irrigation sources that user in agriculture. In addition, different river basins and regions, groundwater and surface resources are overexploited which resulted in permanent damage in the ecosystem by reducing the water flow in wetlands, lakes, and rivers. However, in some area, the situation is slightly different. For example, a huge amount of untapped water in Sub-Saharan Africa could be major source of water and expected to be generating economic prosperity because of its use in the agricultural activities. Therefore, it is true that the major challenge in the development of agriculture in the future is the management of water resources sustainably [18].

1.1.2. Effects of Climate change on Agriculture

Increase in climate change risks and projected changes in the climate over the 21st century pose serious challenges to developing countries in terms of development in the agricultural system [19]. Due to the poor infrastructure and low adaptive capacity, Iraq is one of the most vulnerable countries against climate change. By examining the extreme weather events and climate change in a period of 1995 to 2014, the Global Climate Risk Index (GCRI) ranked Iraq in number 8 in the list of most affected countries. Because of climate variability and extreme events, the livelihoods in the rural area and the major crop productivity including date palm, rice, barley, and wheat have been affected in a great scale over the last few decades [20].

The dependency of the agriculture on the climatic condition is the primary obstacle for the socio-economic prosperity in Iraq because more than two third of the country's population lives in rural regions and completely dependent on the agricultural system for their livelihood [21]. In addition, it is important to note that climate change has huge implications on local food security in underdeveloped countries through the adverse effects on the food price and cereal productivity. Therefore, the big gap between the potential and actual crop production is the primary factor that contributes to the inadequate supply of cereal grains in the countries [20]. This part of this study will be addressed the influence of climate change on the production of major crops.

1.1.2.1. Climate Change Effect on Crop Yields

Because of the fact that CO_2 could increase photosynthesis in both C_4 and C_3 crops, there is a potential benefit if the atmospheric CO_2 increases. It is important to mention that both the pasture and crop production and yield potentially enhanced due to the efficient use of water caused by reduced stomatal conductance at the time of higher CO_2 concentration. However, change in precipitation and increased temperature are the limiting factors in plant response to enhanced CO_2 concentrations. Decreased phosphorus and nitrogen level in the soil that is the case of several parts of Asia could potentially limit the plant response to increased CO_2 concentrations. It has been demonstrated by Cheng; *et al*. [22], that the enhanced level of CO_2 concentration is stimulating the release of cations from the soil and influence the growth of plants in a positive manner. However, in the long run, CO_2-induced cation release could accelerate the loss of cation from the soil and causes soil erosion [11].

Rainfall, the concentration of CO_2, and changes in the level of temperature could have a huge impact on the reproduction, distribution, development, survival, life cycle duration population dynamics of many pathogens and pests. Altered patterns of crop yield system because of the climatic condition may also influence the kind of pathogens and pests that affect the crop production. Therefore, it is clear that the status of the pest on these organisms completely depends on the climatic condition and greatly influenced by climate change as well as disease and pest management strategies. Similar to the economically important crop plants, the development and growth of the weed species are indirectly and directly influenced by the increase in the temperatures, increase in the CO_2 concentration, and patterns of the rainfall. Therefore, the crop-weed relationship/interaction will be determined by the differences in response to these changes of environment [11]. It has been shown by several studies that crop production in the Asian area is likely to be decreased in the changed climatic condition in the future.

1.1.2.2. Impacts on Rice Production

Rice is the staple food for more than half of the world's population and considered to be one of the important food crops. It has been estimated that the production of rice should be increased by around 60% by the year 2025 in order to mitigate the requirement of the increasing world's population [23]. However, several factors including scarcity of irrigation water, shrinking of arable land, global warming, and increased environmental stress pose a grave threat in rice production globally. Because of the fact that the rice is extremely sensitive to any kind of change in the climate particularly related to the extended drought period, fluctuation of the CO_2 concentration, an increase in the temperature, adjusting with the demand of rice globally would be a difficult task [24].

It has been estimated by a different study that the simulated production reduction of 5-7% major crops including rice due the rise of 1 °C mean daily temperature. It is important to note that the reduction in the production was mostly related to the increase in maintenance respiration, shortening of growth duration, and decrease sink formation [25].

It has been shown that the enrichment in the atmospheric level of CO_2 concentration has a significant increase in the yields (15-39%) and biomass (25-40%) in rice production when the temperature was ambient. However, these advantages in productivity seem to be decreased when the temperature is increasing along with the CO_2 level. The decrease in the yield due to the continuous temperature and CO_2 increase are basically caused by high-temperature-induced spikelet sterility. It is important to note that if the night temperature is more than 21°C, a higher level of CO_2 could result in direct inhibition of the maintenance respiration. The response of rising to an enhanced level of CO_2 atmosphere could also depend on the supply of nitrogen. However, it is important to note that the growth response and photosynthesis could be highly affected by the additional CO_2 is given when N is limited. Although new genes, mechanisms, and traits associated with the temperature and CO_2 concentration increase have not been completely identified, there is plenty of evidence that there is the occurrence of genotypic variations because of climate change [26].

The flowering stage in rising usually lasts two to three weeks which requires extreme maximum temperature [Figure. 1 3]. It is important to note that only a few hours of exposure to an enhanced temperature could greatly reduce the yield due to the decrease in the pollen viability. It is an accepted notion that there is an increase in the spikelet sterility if the temperature is more than 35 °C. In addition, the elevated level of CO_2 could make the problem more complex, perhaps, because of the lack of respiration mediated cooling. Field observation in several high producing rice regions with a higher temperature and drier climate (such as Southern Iran) suggesting that there was no significant increase in the spikelet sterility even the temperature is more than 40 °C. It is important to mention that in rice, the poor thecae dehiscence is resulting due to the mechanism of high temperature-induced floret sterility [26, 27].

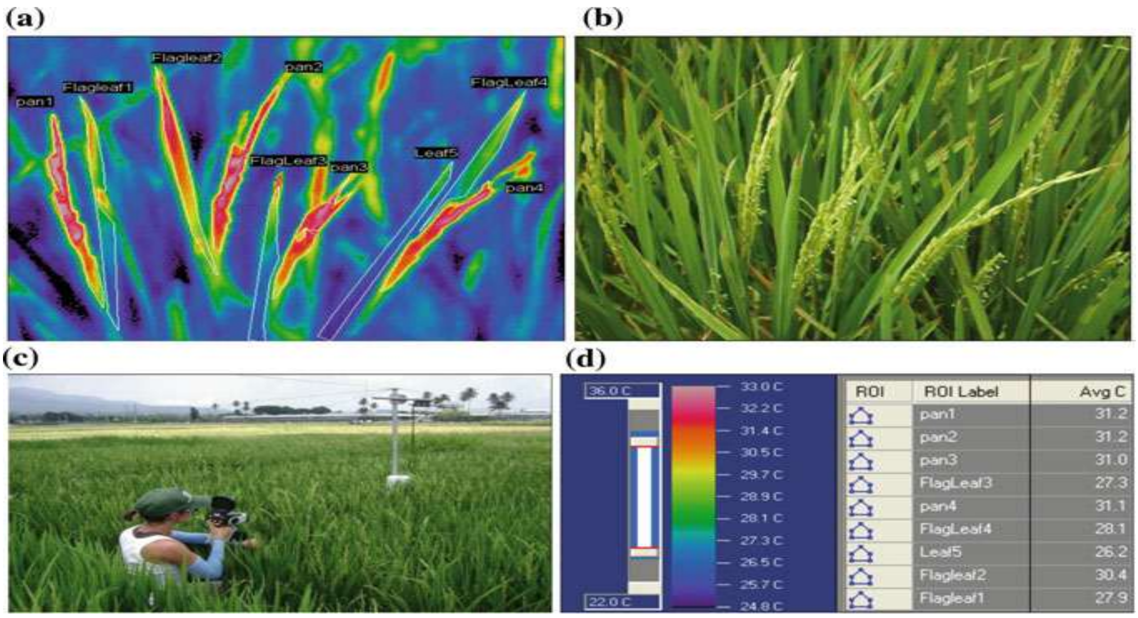


Figure 1.3. Different Images of the Effect of Temperature on Rice Yield in different Stages of Growth [28].

Changing of time-of-day when flowering commences to the cooler periods is another strategy. It is important to mention that there are almost 3 hours differences in the time of flowering in the wild rice accessions which have been evaluated at IRRI (International Rice Research Institute). To avoid the adverse effects of climate change, rice fertility could be protected by shifting the flowering time to the early morning hours [29].

Interestingly, the effects of increasing minimum temperature on the production and growth of rice are not well understood compared to the effects of extremely high day temperatures on spikelet sterility. There is plenty of evidence that the spikelet sterility is due to the increase in the mean night temperature since the middle of the 20^{th} century. Differences in the radiation of solar increased the differential effects of day vs. night or respiration losses of maintenance in crop phonology, grain filling, stem elongation, leaf-area expansion, till ring have been proposed as a possible reason [2].

It is true that climatic alteration is likely to have a crucial influence on the efficiency of the use of water and water maintenance. Increase in the temperature generally resulted in higher evapotranspiration losses. However, it is also important to note that the new evidence suggesting the increase of CO_2 concentration may lead to the increased efficiency of the water use because of the combination of increased biomass production and reduced transpiration resulting from increased shading from large leaves and decreased stromal conductance [30].

The change of climatic condition could also impact on the production of rice by increasing the sea level. The analysis of the observation of the tide gauges revealed that there is an increase of mean global sea level rise from about 10 to 25 cm over the last 100 years. This increase in the sea level could be the result of climate change and increase of temperature. Increased temperature resulted in the melting of polar deposition of ice. To identify the future rise of the sea level, various models were employed, and the results indicated that the rise of sea level will be between 13 to 94 cm by the end of 2100 with an average rise of 49 cm. Cultivation of rising is the dominant use of land in the different deltaic and coastal region of the tropics. It is important to note that other crops except rice may be unable to grow under the salinity and in the majority of the location unstable water levels. The consequence is the increase in the production of rice in the delta of Asian areas contributing to the quick growth in the global production of rice and facilitates the export of balk rice from countries including Vietnam. It is worth to mention that there was a transformation of floating and deep-water rice ecosystem to the irrigated rice ecosystem in these delta regions in Asia. However, an increase in the sea level could decrease the production of rice in the highly productive rice delta in these areas. For instance, in the Mekong Delta, it can be noticed from the Cambodian border that the sea level has risen. The sea level rise may become a crucial obstacle to the global as well as the national supply of rice because these areas are the major exporter of the rice in the world [26].

1.1.3. Effects of Climate Change on Rural Population

Climatic change is one of the biggest threats to human health in the 21st Century. Many climate change hotspots lie in rural and remote communities. Climate change and associated impacts will affect everything and everyone the young and the old, the healthy and the infirmed, the rich and the poor, some by a little and some by a lot. While some of the changes, like more intense heat waves, will affect us directly, many of the impacts are likely to be experienced through impacts on the natural world on which we depend. Although preparation and adaptation can moderate some of the impacts, new ones are likely to arise as the global energy system is changed to limit emissions of the gases and aerosols that cause climate change (Figure. 1. 4). A few of the changes may lead to local opportunities and gains, but many are likely to result in negative consequences, many arising because the extremes that already impose costs will occur more frequently and be even further from the norms to which society and the environment have become reasonably adapted [31,32].

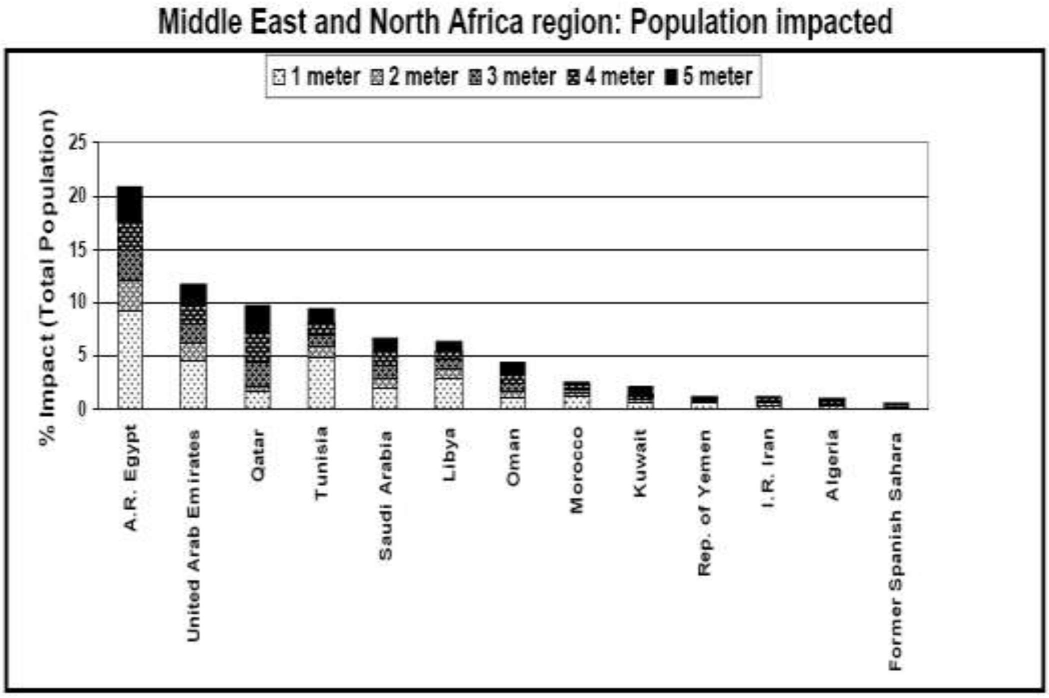


Figure 1.4. MENA Population, [33].

It has been predicted that agricultural productivity was reduced by climate change and creates a treat to the security of food when there are widespread mortality and poverty across the world. People rely on the natural environment who are living in the polar region, mountains, and coastal areas are at most risk due to climate change. Because of the direct impacts like vector-borne disease and malnutrition, the children in the rural area are particularly vulnerable and could affect their cognitive development and long-term growth rates are affected.

Women and children in the rural area are perhaps the most vulnerable to the environmental changes because of their higher dependency on the healthcare choice, occupational, limited educational and the environment. It has been shown that adolescents in rural Poland have increased rates of chemical poisoning, serious accidents and poor educational and physical development –, in particular, females. Due to the low-level long-term exposure of pesticide, the children in the rural U.S. have a higher risk of cancer [34, 35].

1.2. Impacts of Water Resources, Agriculture and Paddy Production on Rural Development

The major objective of this part of the chapter is to examine the economic indicators focusing on the regions of a rural area and to find out which indicators can be used to examine rural development. There are several environmental, cultural, social, and economic indicators and factors which may be used to measure the development in the rural area. It is true that there is no consensus about how to identify the major factors that affect the development in a rural area, although the rural development phenomena are discussed by many institutes, authorities, and authors for decades.

Agricultural growth with water resources remains two key pillars of the development of economies in the agriculture dominating economies, but, difficulties still persists to investigate environmental constraints, institutional innovations, technological advancement, food value chains, and integrating the rural development that has changed in the context of agriculture's role. The attention on narrowing urban-rural disparities, reducing vulnerability and poverty and accelerating economic growth for developing and underdeveloped countries through the development of agriculture. To benefit economic growth and to address the different dimensions of socioeconomic development in the rural area, it is important to keep a focus on new agriculture for development framework.

1.2.1. Effects of Water Resources on Rural Development

Water and food security are intimately connected. In the rural social system and economy, water is considered as the lifeline especially in the semi-arid and arid areas of the countries in the globe, where the means of irrigation is extremely limited, and the agriculture is heavily depending on the natural rainfall. Therefore, the development strategies in these areas are focusing on ensuring the water availability for drinking and irrigation [36].

In the current world, many of the people are living in water-scarce regions and still go hungry. It was understood that limited water access is one of the major constraints to increase the production of food when FAO started a special program for Food Security in 1994. Therefore, now the primary question is whether storage of water will act as a thoughtful brake on the production of food in the future. Several people, many people confess in order to obtain the answer: the major point of their argument is that the renewable sources of water in the world is fixed and it cannot be changed. Therefore, as a result of population increase, the per capita allocation of water is decreased [37].

It seems that the researches who are optimistic about the water resources in the future are as rare as thunderstorms in the desert. However, there are few articles that discussed water resources management in the future. One of the article's key message is that in the coming 30 years, we are able to increase the total area under irrigation in the developing countries by 34%, and importantly, we need only 14% more water to do this job. Is it really possible? There could be two possible explanations. One way is to change of food habits of the inhabitants of the developing countries could help to increase the efficiency of water which could be used further in the crop production. For instance, rice is a very water intensive crop and require two times more water than wheat per hectare. Therefore, when people eat more wheat and less rice, less water for irrigation will be needed. Although the effect of the trend is very minute, however, it will be noticeable by the end of 2030 [38, 39].

It is important that we believe the efficiency of the use of water for irrigation may be increased over the next 30 years, from an average of 42% to 38%. An analysis of a total of 93 developing countries done by FAO revealed that their abstraction of water in the agricultural area in 1998 was around 2 128 km^3 /year. If it is possible to increase the irrigation efficiency by 42%, with a constructed effort, using the advanced technology, we assume that only 2 420 km^3 of water may be needed to abstract in 2030 for irrigating a net harvested area more than one-third larger than it is today. We must not forget that in several countries, water supply is already limited and in many other countries, they are suffering a severe shortage of water locally. It is important to note that these regions and countries may need extra attention will need special attention in the coming years. Furthermore, it is necessary to increase the efficiency of irrigation by more than just 4%. Getting more crop per drop- increase the efficiency of irrigation — should, therefore, become the top priorities on our list [40, 41].

It is important to note that water availability worldwide will be the major key issue in the 21st century. Per capita, the availability of water is going to be projected to decrease from 6600 to 4800 m^3 between the year 2000 and 2025 due to the lack of even distribution of water resources. However, the majority of the population of the world will have been lower than 1700 m^3 per capita. Water availability is a major concern in the rural communities of the world. Past and current high rates of population growth in rural communities have contributed significantly to the increase in water consumption. Efficient management of water resources is therefore important if the health and well-being of the people, particularly in rural areas, is to be maintained [1].

1.2.2. Effects of Agriculture on Rural Development

Providing food for more than seven billion people is the major challenge in the world today. It is important to note that this challenge will not end here. It has been estimated that by the middle of this century the world's population may increase more than nine billion. This looming scenario needs dramatic improvement in the efficiency in the production of agricultural research.

The energy, water, and arable land are the most important resources for the production of food that are interlinked in a multitude of dependency. There is a consistent competition for the use of resources in different sectors. It is true that the largest user of natural resources is the agriculture and also provide huge opportunities to use the resources in a sustainable way [30].

Agricultural production for food, fiber, fuels, and industrial inputs and an increasingly wide range of products are becoming the inseparable part of the living standard of more than 2.6 billion inhabitants. More importantly, many of the people are living in developing countries and their average income is lower than $2 per day [35]. Since the 2008-2009 global financial meltdown and the crisis of food price in 2006-2008, it has been estimated by the FAO that more than 1.02 billion people are not getting the nutrition properly and the majority of them are living in the rural areas [32]. The crisis of food in the year 2007-2008 has shown that for food security producing more food is not a solution but is a strategic option for the development of economic condition [31].

The report by World Bank regarding agriculture for development (2007) indicating that to move more than hundred million poor people out of poverty through the introduction of smallholder animal husbandry and framing, jobs in the rural area, entrepreneurship, employment in high-value products, agriculture is the vital option. It has been indicated in this report that these objectives can be achieved through increasing the competitiveness and productivity of the agricultural system in general and generating the opportunity of non-farm employment in the rural area in the first place. Secondly, by increasing the support system and capabilities of small-scale farms.

New technologies related to the agricultural production must fulfill the potentially conflicting dual goals such as providing food for increasing demand and preserving the natural resources. Now the prime question is how prepared we are?

1.2.3. The Paddy production and Rural Development

It is important to note that rice is the central ingredient of the food security of more than half of the world's community and is the staple food in many of the Asian countries. More than 90% of the consumption and production of rice is accounted for by Asian countries. It is important to note that production of rice is one of the major sources of livelihood of more than 140 million rice-farming households. Due to the fact that the overall political stability and economic growth of a region, it is considered as a strategic commodity and affordable and continuous supply of this commodity is crucial in this regard. There are still several important challenges remain to ensure the stable and adequate supply of this important food ingredient to the consumer with an affordable price, although several important technologies have been employed in the production of rice in the wake of Green Revolution [37]. Therefore, the primary challenges in this regard are the production of more rice to mitigate the increasing demand due to the exponential population growth. In addition, changes in the demographic composition of labor in rural areas; changes in dietary composition with income growth and urbanization; increasing competition for water, labor, and land from industrial and urban sectors; global climate change; a decline in rice biodiversity and loss of rice heritage; environmental degradation associated with intensive rice production; and the deceleration in the growth of rice yield are the major points to be considered to increase the production of rice under climate change. In the same way, to achieve the stability of the price of rice is one of the major challenges if we consider the transmission context of hocks because of the higher interrelationship of rice with various sectors and the major affected areas will be the export areas of a country [37,42].

Although there are many challenges, there are several opportunities are present in order to enhance the production of rice to increase the security of food and reducing poverty, malnutrition, and hunger. New technological inventions and different scientific approaches in the modern era make it possible to enhance the productivity of rice in a stable manner, make the rice production system climate-smart, reduce the environmental footprint of rice production, reduce losses from drought and flood, and add nutritive value to rice. In the same way, there will be the availability of new opportunities to increase the safety of rice and rice products, ensuring higher quality, adding value through secondary processing, reducing post-harvest losses, and enhancing rice value chains. The network in a region may be used to share the market information and technology related to rice production through improving the arrangement of trade [43].

Overall, how to transform the rice production sector is now the primary strategic issues for the region. There is an urgent need to transform the rice production sector itself because Asian economies are currently undergoing a transformation [42].

1.3. Background of the Study

The Republic of Iraq is one of the important countries in southwest Asia between longitudes 38° 45' and 48° 45' E and latitudes 29° 5' and 37° 22' N. It is important to note that Iraq is the eastern frontier of the Arabic countries. The Kingdom of Saudi Arabia, Kuwait, the Arabian Gulf to the south, Jordan, Syria and the Kingdom of Saudi to the west, Iran to the east, and Turkey to the north (Figure 1.5). The country is characterized by its unique social, biological, and environmental features, which cannot be found elsewhere in the Arabic Peninsula. The total land size of the country is around 438 317 km^2.

Figure 1.5 Map of Iraq [28].

The population of Iraq is estimated in July 2016 approximately 36 million people. Among which 30.6% of the total population (approximately 11 million) are living in rural areas. The growth rate of the population is 2.7%. Baghdad is the capital of Iraq and consists of approximately 6 million people. Population distribution/density is presented in Figure 1.6.

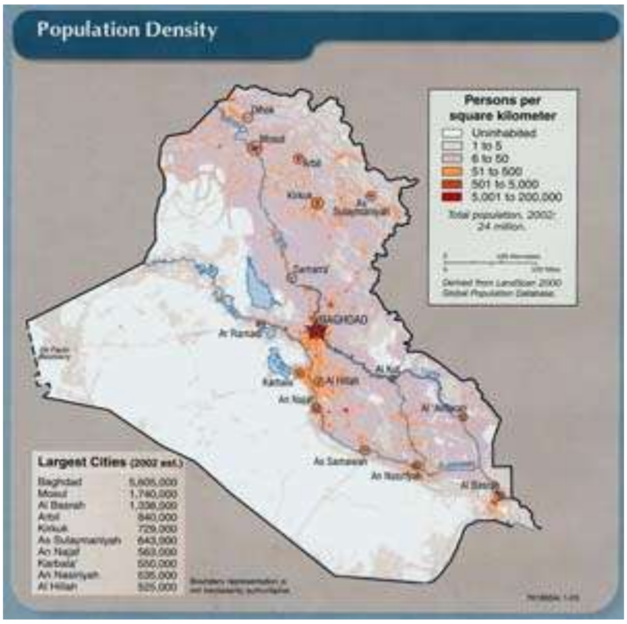


Figure 1.6. Population Density of Iraq for 2016 Records

Approximately, 97% of the total land in the country is arid with erratic and low rainfall. The agricultural sector in most part of Iraq is suffering from the higher rate of evapotranspiration and the rate is more than rainfall. Particularly in the desert area, the temperature ranges widely from 10 to 46°C during the growing season of rice.

The agricultural system in Iraq still highly rely on the rainfall for both sheep and crop production, although irrigation is available in a considerable portion of its agricultural lands foothills, mountainous, and desert areas are heavily depending on the rainfed agricultural practice.

Although crop production and climate change are an international concern, they are also very important for the development of sustainable agriculture in Iraq as well. Due to the physiographic status and geographic position, Iraq is a country of diverse climate throughout the year. The climate conditions and the unfavorable weather condition are always affecting the agricultural sector. It is true that the climate and weather are key determinants for the sustainability and productivity of agriculture, although a significant technological advancement has been achieved. Therefore, the agricultural sector in Iraq is under huge pressure, both from the obstacles related to the degradation of agricultural land and water endowments as well as huge and increasing demands for food. Any external and internal risk (environmental, natural, political, and social) to agriculture could directly affect the food security of the country as well as the production of rice. Often the relationship between the production loss and these key factors are indirect, many of the cases the circumstance is obvious. Iraq’s capability for restoring its development is experienced with significant challenges and confounded by climate change, although the recent strides regarding gaining sustainable development.

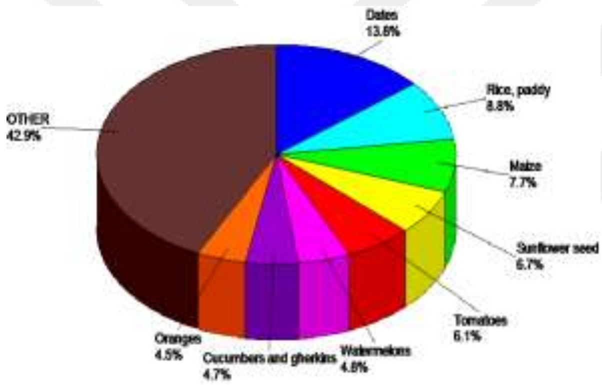
However, Iraq is a different case or situation because the Iraqi government does not care about this problem even though Iraq is also having serious conflicts which are more important than climate change for Iraqis to be considered. At the same time, there are many individual studies about the main factors to prove the change in the climate, the increase in temperature, the number of the dust storms and the decrease of rain levels. It is important to note that at the end of the 21st century, the irrigation water and agricultural production will be sustainably impacted by climate change in many parts of the world including Iraq. It is worth to mention that the many of the farmlands in the south and middle of Iraq is depending on the Tigris and Euphrates River for the irrigation. The Iraqi government has taken water development programs which have connected most of the water resources in Iraq that contribute significantly in the local economy. In Iraq, more than 10 million people who live in a rural area, completely depends on the irrigation system for their agriculture. Approximately, 20% of the national employment is contributed by the agricultural sector.

Iraq is facing mixed prospects for the next year's grain crop of the winter season. Will-below-average winter precipitation and late plantings across the areas that are depending on the rainfall, particularly in the areas of northern Iraq are reducing the prospect of production of grains in the winter in Iraq. Due to the fact that the vegetative growth decreased in many irrigated areas in Iraq, the increase in the planted area under irrigation is still under question. In the present study, we include several climatic tables and maps which are highlighting the principal zones of agriculture in Iraq, and it also accumulated several historical data to understand the evolution of the production of the agricultural system in the 21st century Iraq [44].

1.3.1. Agriculture Sector in Iraq

A small but vital proportion of the Iraqi economy is represented by the agricultural sector. However, limited land coupled with the exponential growth of the population and general inactivity in the productivity of the agriculture has consistently increased the dependency on the import of food crops to mitigate the increasing demand since the mid-1960s. Agriculture was Iraq's primary economic activity before the development of the petroleum industry. As late as 1976, employed more than half the total labor force and it still contributed about 10% of Iraq's GDP. Different natural factors like shortage arable lands, scarcity water resources, and climate change, and several political factors like involvement in military conflicts, particularly during the 2003 war, 1991 Gulf War, and 1980-88 Iraq-Iran war, have been heavily influencing the role of agriculture in the national economy [42].

The production system of the agriculture in Iraq is primarily divided into irrigated agriculture, mainly in the plain of the Mesopotamia including the Euphrates and Tigris rivers and rain-fed agriculture, mainly in the North of the country. Barley and wheat are the most important rain-fed in the North, both of them are growing in the months of winter and accounts for the one-third of the cereal production nationally (Figure 1.8). In the Mesopotamian plain, the same winter crops are cultivated and produced. It is important to note that fruits, vegetables, cotton, dates, corn, and rice are the major irrigated summer crops in Iraq (Figure 1.7). In addition to barley, several forage crops including alfalfa and legumes are grown for the livestock. Several political and socioeconomic events were affecting the production system of agriculture in Iraq. Not only that, simultaneously, other agricultural technologies, advances in agronomic practices, as well as the introduction of new crop varieties, reclamation of saline lands, installation of drainage systems, water availability, and variations in climate heavily influence the production capability [45].



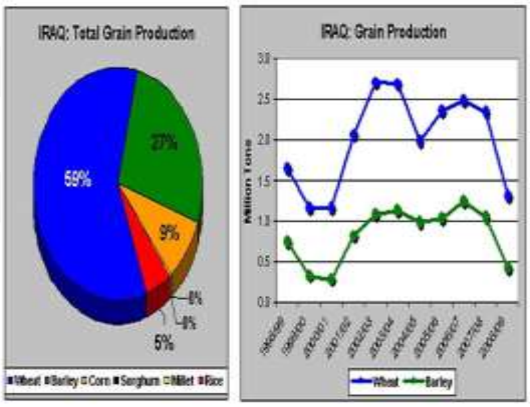


Figure 1.7. Summer crops, [46]. Figure 1.8. Winter crops [46].

For main winter crops in Iraq (wheat and barley), between Oct-Nov and December, is the growing season for the production of barley and wheat (Figure 1.9). These crops cultivated in (Ninawa, Salah Addin, Dahuk, and Erbil) are mainly rainfed wheat. Moreover, the southern Iraq started to cultivated wheat and barley in 1991 and depends on irrigation. It has been projected that the production of wheat is currently 2.18 million metric tons across Iraq. Decreased production of these crops in the rain-fed agricultural system will be heavily subsidized by the production increase in the irrigated areas. The total area is more than 17 million hectares in the whole of the country, as lower harvested areas will be seen in northern Iraq. Even though the increases production in the irrigated areas, primarily in Wasit provinces and Kirkuk will not be able to compensate for the lost area in the north.

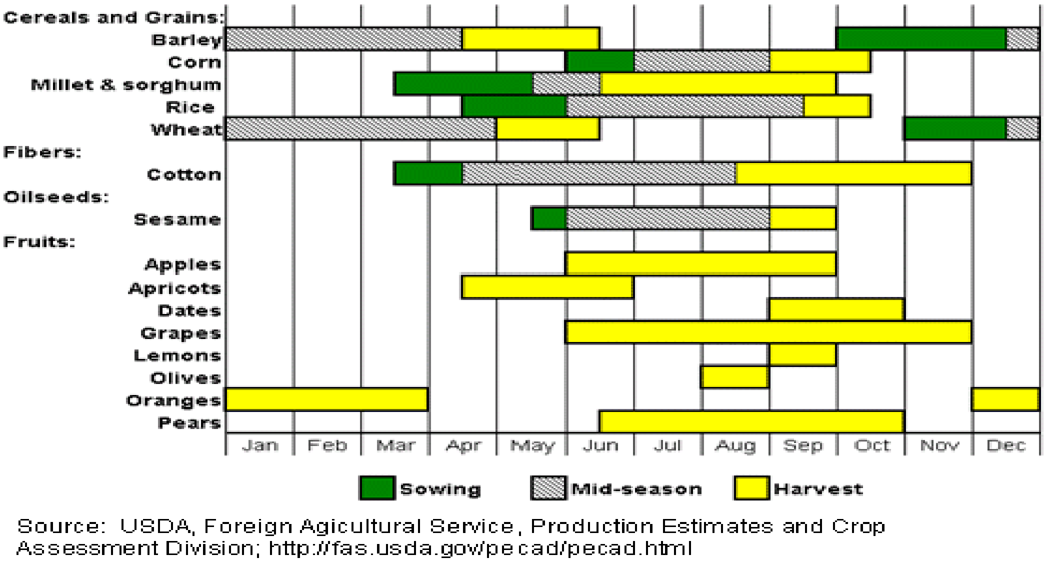


Figure 1.9. Iraq’s Crop Calendar [47]

In the current crop condition, the production of barley is expected to decline dramatically. It has been forecasted that there will be approximately 710,000 metric tons of barley will be produced. However, this preliminary estimation must be revised to incorporate the changing situation, as approximately 40% of the barley crop was totally dependent upon spring rainfall in 2012.

In addition, as atmospheric water demand for the cultivation of crops exceeding the amount of rainfall during summer, it is important to assume that most of the summer crops need irrigation. Many of the crops grown in the summer will, therefore, be cultivated in the southern and central Iraq. Rice is the important and main crop produced in summer in Iraq. The Iraqi rice production will be continuously limited by the availability of the irrigation water in the summer. It is important to note that the winter rains are greater in the Euphrates river basin than the Tigris river basin, although they will not be enough to enhance the rice plantation area in the summer. Therefore, the forecasted plantation area was the same at 55,000 hectares in the year 2012 [48].

There are four provinces in southern and central areas in Iraq, with a huge concentration around the Najaf, are mainly producing rice. There is a high demand for the aromatic long-grain varieties in Iraq. Beginning of the July is the starting point of the growing season of rice which ends in October-November.

The selection of the surveyed districts was based on agro-climate zones to capture the spatial distribution of climate variability across the provinces.

1.3.2. Agro-Climate Zones in Iraq

With the north-eastern and north region of the mountains having a Mediterranean climate, the general climatic condition in Iraq is semi-arid subtropical and continental. There are seasonal rainfalls which generally occur in the season of winter starting from December to February. However, in the northeast and north region of the country, rainfall starts in November and ends in April. The estimated average rainfall is 216 mm but could be range from 1200 mm in the northeast to lower than 100 mm over 60% of the south region of the country. During November to April, more than 90% of Iraq's rainfall occurs [49]. However, the precipitation could differ from one year to another in frequency, timing, and intensity. In general, from lower to a higher elevation, the level of precipitation increases. For instance, rainfall in the northwest foothill at Mosul (higher elevation) is around 408 mm and the precipitation at Nasiriya in the southern lowland's averages only 112 mm (4.4 in.) in each year. Winters in Iraq are cold to cool in general, where the night temperature is around 2 °C with a possibility of frost and increase at day time up to 16 °C. However, summer seasons are hot and dry to extremely hot. The temperature in the extreme summer could be up to 43 °C during July and August at daytime yet drop to 26 °C at night. There is high evaporation from the plants, lands, and water surfaces during the dry period from May-October because of dry north-west wind coupled with extremely high temperatures. Soil salinization and the water shortage in the irrigated areas are increasing because of these reasons [42,50]. According to FAO, there are mainly four agricultural-ecological zones in Iraq (Figure. 1.10) [23]:

- ❖ The areas under irrigation which extend between the Euphrates and Tigris rivers from the south Basra to the north of Baghdad. Grave problems in this area for agriculture are salinity and poor drainage system. Majority of the country's rice, sunflower, and vegetables are grown in this zone.
- ❖ The zone of the desert with very high temperatures in the summertime and annual rainfall is less than 200 mm. This zone is extended from north of

Baghdad to Jordanian and Saudi Arabian borders. The population in this zone is very light and there are few irrigated spots to grow few crops.

- ❖ Steppes where the annual rainfall is around 200–400 mm. Although winters are cold, summers are extremely hot. The desert zone and Mediterranean areas fall in this zone. It includes the feed barley production areas, limited wheat production, and it has limited irrigation.
- ❖ Mediterranean climate with semi-arid and arid zones. In this zone, the growing season is around nine months. More than 400 mm rainfall is expected each year in the winter and mild/warm summers prevail. This zone covers mainly the northern governorates of Iraq.

  Although other field crops are also produced in smaller quantities, chickpea, rice, barley, and wheat are the major crop in this zone. From bores, streams, and springs there is some irrigation in this zone as well.

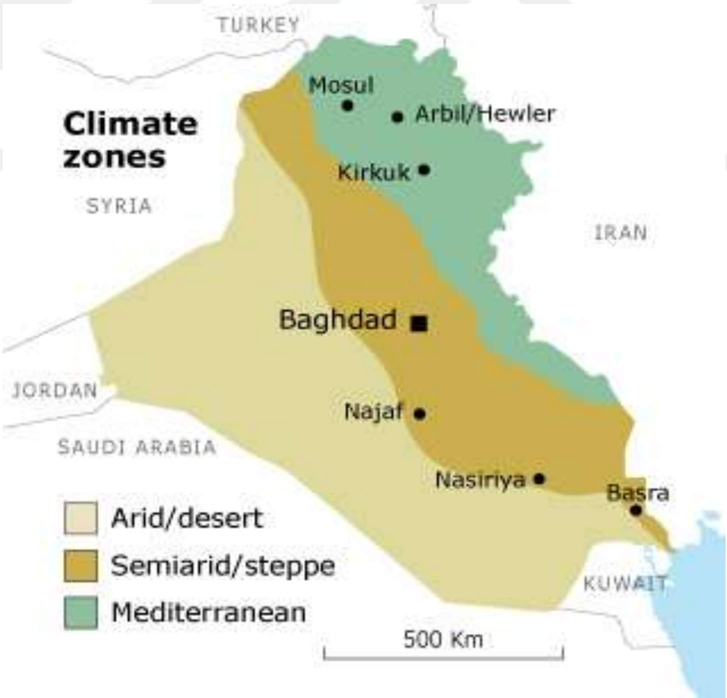


Figure 1.10. Agro-Climate Zones in Iraq [23]

The soil of Iraq is generally fertile and can be cultivated easily for the agricultural purpose. There are two major types of soil can be seen- lighter soils which lack in humus and clay content but contain wind-deposited nutrient and heavy alluvial deposits of the Tigris-Euphrates Plain containing a significant amount of clay and humus.

1.3.3. Surface Water Resources and Irrigation in Iraq

Because of the presence of the Euphrates and Tigris river system, compared to other Middle Eastern countries, Iraq has more water. While Tigris tributaries are also fed by water sources in northwest Iran, from Eastern Turkey, both rivers are fed by rainfall and snowpack. The upstream release of a large volume of water in the Euphrates and Tigris rivers from Turkey and Syria are heavily influencing Iraq's irrigation development. The more northerly Tigris briefly runs along Syria's most north-eastern border before entering Iraq from the North. The more southerly Euphrates travels through Syria before entering Iraq from the West with an average annual flow estimated at 30 km^3. Although numerous rivers and streams running out of Iraq's northern foothills feed into the Tigris, its capacity of water flow is small estimating at slightly over 21 km^3. That's why the flow of Tigris is slightly depended on foreign countries. More than 90% of Euphrates water comes from foreign countries while only about 50% of the Tigris water comes from outside [10, 51].

Both the Euphrates and the Tigris are experiencing significant variation in the flow of water throughout the year. The flow of Euphrates shows the highest level of differences between 10 and 40 km^3 annually. In the April to May, the discharge of water is highest for both rivers, coinciding with the harvest of the crop of winter when the requirement of irrigation is generally very low and potential flood losses very high. In general, the flow of the Tigris starts earlier and is more violent than the Euphrates and carry more silt from the denuded hillsides of northern Iraq. After that, there is a rapid decline of the flood water levels and there is a consistently low supply of water remains from July through November. While the cultivation in winter is restricted by extremely low river water flow at the beginning of the winter crop season in October and early November, the high rate of evaporation and transpiration, summer crops are heavily restricted [42].

1.3.4. Iraqi Population

The total population is about: 36,030,823, among them approximately 34% are living in the rural area [47]. Although the density of population varies greatly from most inhabited Babylon province in the center of the country to almost uninhabited Anbar province in the desert in the western part of the country, the estimated density of the population is 66 inhabitants/km^2 (Table 1.1). Due to the severe economic hardships, war, the emigration of foreign workers the birth rate reduced although the average population growth was estimated at 3.6% during 1980–90 [52]. In 1991 the supply of safe water reached only 54% in rural areas, 100% in most of the urban areas were covered by safe water. Because of the wars, among other things owing to shortages of chlorine imports for water treatment, the sanitation and water supply situation has deteriorated [53]. In 2006, access to the sources of improved drinking reached 77% of the population (88 and 56% of the urban and rural population, respectively). The sanitation coverage was 76 percent (80 and 69%, respectively) [21, 54].

Table 1.2. Estimates of the Iraqi Population for 2017 with the Area of Study.

Province	**Urban**			**Rural**			**Total**		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Mosul	1179660	1124265	2303925	758413	731644	1490057	1938073	1855909	3793982
Kirkuk	605726	599952	1205678	214608	209339	423947	820334	809291	1629625
Diyala	410961	407254	818215	427579	414213	841792	838540	821467	1660007
Anbar	463258	436896	900154	459699	436704	896403	922957	873600	1796557
Baghdad	3686694	3594684	7281378	534252	503066	1037318	4220946	4097750	8318696
Babylon	509285	503144	1012429	548465	532522	1080987	1057750	1035666	2093416
Karbala	418505	412408	830913	207655	202705	410360	626160	615113	1241273
Wasit	426530	418110	844640	280960	275842	556802	707490	693952	1401442
Salahaddin	367919	362162	730081	448331	437512	885843	816250	799674	1615924
Al Najaf	535035	537664	1072699	217275	210584	427823	752310	748212	1500522
Qadisiyah	378898	373665	752563	282210	276926	559136	661108	650591	1311699
Muthanna	190559	184750	375309	223930	225592	449522	414489	410342	824831
Thi Qar	686940	683329	1370269	383246	378634	761880	1070186	1061963	2132149
Maysan	419836	419261	839097	145585	150286	295871	565421	569547	1134968
Basra	1215245	1200185	2415430	277853	278879	556732	1493098	1479064	2972162
Erbil	798910	781055	1579965	158661	158127	316788	957571	939182	1896753
Dohuk	489174	488059	977233	171483	169742	341225	660657	657801	1318458
Sulaymaniyh	936399	938943	1875342	170177	166580	336757	1106576	1105523	2212099
Total	**13719534**	**13465786**	**27185320**	**5910382**	**5758861**	**11669243**	**19629916**	**19224647**	**38854563**

Source: (MoP) Ministry of Planning (Baghdad) [47].

CHAPTER TWO

MATERIALS AND METHODS

This study aims to investigate the Interactions between paddy production and climate change and its Impact on rural development in Iraq.

The methodology chapter will show how this paper sizes up the big changes in the environment, precipitation (rain), temperature and rivers levels and how affected in the agriculture (especially paddy production), water resources of the study area, and how the decreasing or increasing in paddy yields affected the rural livelihood in Iraq.

This paper will try to explain the phenomena, analyze the cause-effect and recommend the policies suitable for Iraq. Both qualitative and quantitative designs methods are used in this study as a questionnaire which included matters relating to the agricultural production system and climate change was used in the interviews. In addition, after the face to face interview with the farmers, focus group discussions were conducted. Paddy farmers are the target group of this survey and were interviewed at their door house. Primary data were obtained from interviews with the household head using a questionnaire. It is important to note that the secondary data were obtained primarily from recognized the internet, books, journals, research articles, international and national organizations, and the data were described with Pearson correlation coefficient analysis and appropriate descriptive statistical methods.

2.1. Research Design

The goals of this paper are to give the right answer to the questions or even give the nearest solutions. This study chose to depend on fact data from some Iraqi ministries and other studies and carried out based on exploratory research design to show the effects of the climate change in Iraq, with doing a questionnaire to prove the second part in this study, for two reasons. First, there is no debate on there is climate change in the entire world. Second, this will need a scientific model to prove it and it is so far from the public policy. At the same time issue, it takes good attention in the world hot issue map beside the fiscal crisis and the poverty and other things. So, it is good to strike it. The main approach is qualitatively more than quantities design. We took the data which are already settled from credible sources and analyzed that information according to other similar cases and liking that information makes it serve one aim and start a policy to serve this aim.

Moreover, the objective of the second part of this study was to find out the effects of paddy production on the rural livelihood of communities, effects on income and health condition of the rural people. The figure below (Figure 2.1) indicates interactions between climate change, paddy production, and rural development and how strategy intervention can assist in the study fields.

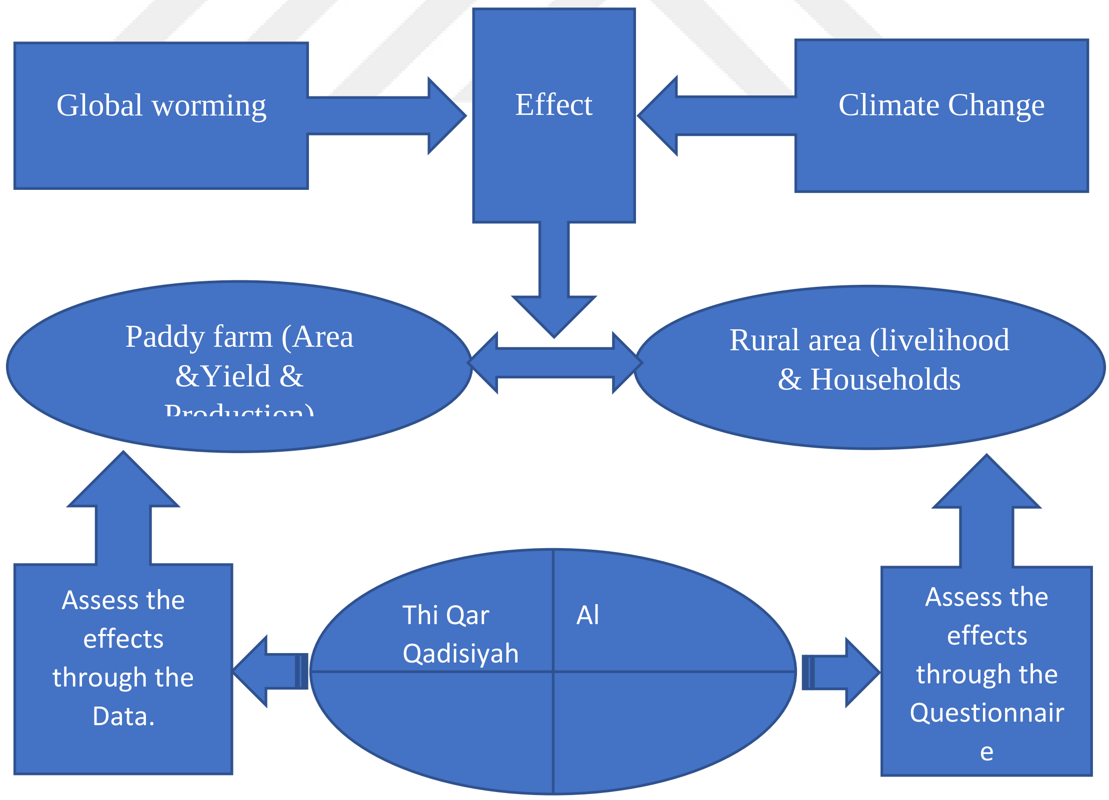


Figure 2.1. Research Methodology

2.2. Description of the Research Site

Four communal areas of the south of Iraq namely Thi Qar, Al Muthanna, Al Qadisiyah, and Al Najaf Governorates where the research was carried out**.** Figure 2.2.

Figure 2.2. Research Site.

- Al Najaf area is the largest area cultivate paddy crop in the whole of Iraq. This area is in southwestern Iraq, (Latitude 32 N, longitude 44 E), and borders Saudi-Arabia. There are internal borders of Najaf with other cities including Muthanna, Qadisiyah, Karbala, Babel, and Anbar. The total area is 28.824 km^2 where the plains of the desert dominating the landscape of the governorate. Along the course of the Euphrates River, there is ribbon farmland under irrigation which also intersects with the governorate near its eastern border. The climate of Najaf is typical dry desert type. While precipitation is very low and limited to the winter months, the summers are hot and dry, average low temperatures: 6°C (January) to 29°C (July) and average temperatures are 14°C (January) to 45°C (July). The average rainfall is only 99 mm in the year in this governorate. The farmers of this Governorates mainly produce vegetables, dates, rice, and wheat. The rice is the main crop in this area. Population is 1.500.522 people 427.823 people (28. 9%) in rural and 1.072.699 people (71. 1 %.) in urban (Table 1.1).

- The second largest area of paddy production in Iraq is Al Qadisiyah, which is also pronounced as Qadisiyah or Kadissiya, is in the plains of central and southern areas of Iraq. The total area of this region is around 8153 km^2. The governorates of Thi-Qar, Wasit, Babel, Najaf, and Muthanna are bordered with Qadisiyah. The Euphrates and the Shamiya River, both run through the governorate. This rich fertile soil and abundance of water make this governorate most fertile area of the country. With hot, dry summers, Qadisiyah has a typical desert climate type. Average temperatures were 15°C (January) to 45°C (July-August) and cooler winters, with average low temperatures: 6°C (January) and 27°C (July). There is a limited rainfall of 110 mm yearly in this governorate. The number of Population is 1.311.699 people (559,136 people) (42.62%) in rural and 752.563 people (57.38 %.) in urban (Table 1.1).

- The third study area is Al Muthanna governorate is in the southwestern Iraq. Muthanna shares internal boundaries with the governorates of Basrah, Thi-Qar, Qadisiyah, and Najaf and international borders Saudi-Arabia. Although there is a narrow ribbon of irrigated farmland along the Euphrates River in the north, the governorate's landscape is dominated by desert plains. A Salt Lake called Lake Sawa is located to the west of the governorate's capital Samawah. The total area around 51.740 km^2 and population is 824.831 people, (449.522 people (54.49%) in rural and 375.309 people (45.51 %.) in urban (Table 1.1). The climate of this study area is mainly dry desert type. While rainfall is very limited and restricted to the winter months, in summer days the temperature could easily surpass 45°C.

- The last area of this study is Thi Qar which is also spelled Thi-Qar alternatively. This governorate situated in the southeast of Iraq which has internal borders with Nissan, Wasit, Qadisiyah, Muthanna, and Basrah. The Hammar marshes in this study area are fed by the Euphrates River. It is important to note that this marsh covers one-third of the governorate's surface. However, there is a drastic shrinking following the draining campaign of the 1990s. For the oil exploration and clear the land, in the 1970s and 1980s, parts of the marshlands had already been drained. However, more than 90% of the marshland vanished by the time of the 2003 invasion. It is important to note that there were several efforts to increase the flow of water in this marshland which is partially successful.

However, the full restoration is hampered by the decreasing water levels in the Euphrates and Tigris and the drought. It is also very important to point out that the draining of water into the marshland also increasing the level of salt in the water and soil of the area. Thi Qar total area around 12900 km^2 and the population is 2.132.149 people (761.880 people (35.73%) in rural and 1.370.269 people (64.27 %.) in urban (Table 1.1).

The region of Thi Qar has a typical dry desert climate. While the winters are mild, the summers are dry and hot, with an average high temperature of 45°C. Limited rainfall of around 100 mm in the months of November to April is the characteristics of this area.

2.3. Sources of Data collection

Using the questionnaire survey method, the primary data were obtained directly from the farmers. However, in the case of secondary data which were obtained through searching related websites, organizations related to the environment, experts, from individuals, published and unpublished documents, presentations, and different reports. Parameters related to humidity, rainfall, and temperature of past 50 years (from 1966 to 2015) for the selected four districts were gathered from the Meteorological Services of Iraq. 50 years of data regarding percent area planted, production, tons, and Paddy yield was acquired from the Ministry of Agriculture, Baghdad. Before the questionnaire survey, permission was obtained from the respective district offices to conduct a questionnaire survey. The following local area was visited: 4 Governorates with 10 Sub-districts, as a following: Al Najaf 3 Sub-districts, Al Qadisiyah 3 Sub-districts, Al Muthanna 2 Sub-districts, and Thi Qar 2 Sub-districts. The survey targeted 223 farmers in the area study Subdistricts. This number was a result of 3% of a total of paddy farmers in each area (Table 2.1).

Table 2.1. Paddy Farmers' Samples According to the Sub-districts.

Governorates	Sub-districts	Total Paddy farmers in Subdistricts	3% of Total farmers
Al Najaf	Qadisiyah	1246	37
	Mushkhab	1000	30
	Abbasiyah	756	23
Al Qadisiyah	Shammiyah	1456	44
	Ghammas	1270	38
	Sallahiyah	431	13
Al Muthanna	Rumaitha	310	9
	Al warkaa	229	7
Thi Qar	Al Tarr	450	14
	Gurmat bin Saeed	260	8
Total	10 Subdistricts	7408	223

Four districts mentioned above were requested to give the farmer lists to the respective municipalities. To select 223 respondents, the purposeful sampling method was used to carry out the interview process and to maintain homogenous and uniform characteristics of farmers. The questionnaire was covering mixed issues included matters related to agricultural (paddy) production, rural households, and climate change. In general, a meeting was conducted with NGO's, local councilors, and chiefs before the interviews started in a village. The contents of the questionnaire and the nature of the research were explained to them. After the face to face interview, a focus group discussion was conducted.

Once both quantitative and qualitative were collected through various methods, the data were synthesized and analyzed using Excel and SPSS software. Inference and descriptive analyses were applied to quantify the perception of farmers for household interviewing. A statistical method was chosen to analyze the questionnaire data.

2.4. Questionnaire Survey on Interaction of Climate change with Paddy farming in Rural areas of the Research Sites

Awareness of climate change issues has increased along with the breadth of studies on the impact of climate change and global warming on various sectors. In addition to the environmental field, other sectors that are directly related to human activities, such as economic, social, and governance, also facing barriers and obstacles to climate change issues. One of the systems likely to be affected by the climate condition is agriculture.

Climate change affects agricultural production due to the presence of extreme weather, temperature changes, humidity, rainfall fluctuation, and seasonal patterns shift. The changes and anomalies in climate can also be troublesome to predict the schedule of planting and harvesting, as well as the water availability for irrigation. Cropping pattern in the study area still highly depend on agro-climate condition, especially for paddy farming systems which became the main food crops and agricultural commodities featured for most farmers in the rural area.

A questionnaire survey will be conducted to provide the basic quantitative information of paddy farmer's knowledge of climate change, affected paddy production on rural households, perception and risk perception of climate variability, also the adaptation measure that has been taken by farmers**.** A total (223) paddy farmers have responded from (10) sub-district. The characteristic of farmers was also identified through the questionnaire on the level of education, farming experience, agricultural skill, land ownership, cultivation area, type of rice field, and the field distance to the water resource. The questionnaire form is presented in Annex. It has four sections; each one has many specific factors. The first section represents the common personal information, the second section is talking about the land information, the third and fourth about a specific question about climate change, paddy production and rural households in the study area (Figure 2.3).

Figure 2.3. Questionnaire Processes in Al Muthanna.

2.5. Validity and Reliability

This study will use the government official documents and database in Iraq. These official papers will provide the needed information about how the government deals with this problem. In addition, it uses the face to face questionnaire and research papers from international bodies. These are considered as the foundation information providers in the world. The thesis and the intellectual studies supply the same purpose, so that the academic studies, the international institutes, government documents, books for some authors and facts advocated by scientific opinions will all improves the credibility and the reliability for this study to reach the international standards. This study will depend on the international facts, factors, and measures. By following the same path to reach the same goal which proves the dangers of climate change and global warming on our lives, especially paddy production and water resources for the rural economy, rural population, and rural area in Iraq.

2.6. Limitations and Challenges to the Study

People in villages were particularly skeptical and they thought that the data would be used for the wrong purposes, even though it was pointed out that the survey is totally anonymous and that the only purpose of the survey was writing of Doctorate thesis. I have identified myself with a student card but some of the respondents thought the survey was a type of a check of the financial status by non-governmental organizations that might have political intentions or by the banks itself. This situation had an effect on the number of respondents, it was planned for more than 223 households, 50 in each municipality, but only 223 respondents were interviewed.

This study will try to change the government policies to reduce impacts of climate change on rural human health and the environment and improve the economic sector in a rural area (agriculture and water resource) through reduced or at least improved the methods to deal with it, and it is not a simple task. There are a series of influential actors that display complex relations within themselves. In the same time targeting this issue will have some an acceptance from many sides, especially Iraq and the entire world interring a new and critical situation through the war against terrorism, so the general idea about the climate is much less important than terrorism.

Nevertheless, this study managing to identify some elements of approaches to agriculture especially rice production, and some economic policies that potentially reduces negative side-effects from climate change at least in some area in Iraq. The resulting policy conclusions take into shown in a country case study and the probable future development that could have an impact on paddy production in rural area policies. The government also has provided a concrete example of specific policies and programs, some of this experience under specific needs. The policy will conclusion later are based on analytical results and aim at promoting environmental and economic sustainability.

2.7. Statistical Analysis

The questionnaire and primary data were analyzed by using the Statistical Package for the Social Sciences (SPSS, version 21.0). One-Way and Two-Way Analysis of Variance test (ANOVA) were used to compare data regarding studied factors. The levels of significance were 5% ($p < 0.05$) and 1% ($p < 0.01$).

CHAPTER THREE

RESULTS AND DISCUSSION

3.1. Extreme Precipitation Trends and Indices of Temperature for Study Areas

Iraq faces a unique set of environmental challenges, considering that it is one of the most vulnerable countries in the Arabic region. In recent years, the impact of changing weather pattern has already made themselves felt (temperature increasing and rainfall decreasing), with rising environmental degradation and higher intensity and frequency of the events of extreme weather throughout the country.

While monthly rainfall data were used to compute rainfall indices, the monthly mean, minimum, and maximum temperature were used to compute the different extreme temperature indices in the areas studied. The data were obtained from the Iraqi Meteorological Services Department.

3.2. Rainfall in Iraq

The in most of Iraq the climate is semi-arid and subtropical. It is important to note that the rainfall in Iraq is very seasonal. Rainfall distribution is temporally and spatially uneven. Roughly 90% of the annual rainfall happens in the month of Octobers to May. The highest level of precipitation was recorded in the month of December and February. The remaining months are dry, particularly the hottest ones from June to August.

It has been estimated that the average annual rainfall is 154 mm, but it could range from less than 100 mm in the south (60% of the country) to 1,200 mm in the mountainous region of the countries north-eastern region. It is important to note that the central or southern desert region receives less rainfall than northern Iraq’s mountainous region. In the northeast of the country, there is a higher practice of rain fed agriculture. There is very little rainfall and agriculture is primarily dependent on the irrigation system in the plains, where most of the population lives. This is due to the fact that in recent years Iraq is facing very cold winters, but with a shortage of rainfall. Because of that, Iraq faced very hot summers resulting in a high rate of evaporation in the Southern Plains (10 to 17 mm per day in the summer). Variations in rainfall in Iraq have contributed to the development of four Agro-ecological zones, according to FAO [39]. Table (3.1) presents the average annual rainfall estimated at 154 mm in the First of the study areas at different years.

Table 3.1. The Average Yearly Rainfall in Al- Najaf Province 1966-2015:

years	Jan.	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Total
1966	15.8	12.1	6.9	4.4	0.001	0.0	0.0	0.0	0.001	38.2	1.2	0.001	78.6
1967	15.2	25.9	2.2	1.4	11.8	0.0	0.0	0.0	0.0	8.7	64.3	1.3	128.1
1968	2.4	0.001	0.001	41.1	47.1	0.0	0.0	0.0	0.0	0.001	7.4	17.9	115.9
1969	30	1.3	1.5	16.5	0.001	0.0	0.0	0.0	0.0	0.0	5.2	1.5	56.0
1970	94.1	26.7	1.9	0.001	0.001	0.0	0.0	0.0	0.0	0.0	8.4	7.0	138.1
1971	13.9	3.1	5.2	58.5	0.001	0.0	0.0	0.0	0.0	0.001	4.0	14.9	99.6
1972	11.1	3.0	53.1	21.9	10.2	0.001	0.0	0.0	0.0	0.0	2.2	9.2	110.7
1973	7.0	1.1	0.0	2.1	2.2	0.0	0.0	0.0	0.0	0.0	4.2	48.8	65.4
1974	24.8	41.6	80.5	6.5	0.6	0.0	0.0	0.0	0.0	0.0	2.2	10.3	166.5
1975	52.4	38.9	0.0	21.1	7.9	0.0	0.0	0.0	0.0	0.0	0.001	25.1	145.4
1976	35.3	27.0	22.6	9.2	4.0	0.0	0.0	0.0	0.0	2.2	0.0	5.2	105.5
1977	40.8	11.7	9.8	1.2	4.6	0.0	0.0	0.0	0.0	3.4	8.5	33.6	113.6
1978	7.8	0.8	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	37.4	53.7
1979	40.4	1.4	23.5	0.0	1.2	2.0	0.0	0.0	0.001	3.9	7.7	11.1	91.2
1980	4.1	74.4	3.7	2.4	1.0	0.0	0.0	0.0	0.0	0.4	21.4	9.0	116.4
1981	14.5	7.5	22.9	0.0	0.001	0.0	0.0	0.0	0.0	0.0	2.5	8.6	56.0
1982	48.7	14.4	9.5	35.1	22.1	0.0	0.0	0.0	0.0	23.8	8.3	7.8	169.7
1983	1.0	2.1	4.3	3.1	31.0	0.0	0.0	0.0	0.0	0.0	5.1	45.4	92.0
1984	9.3	0.7	12.6	0.5	15.5	0.0	0.0	0.0	0.0	1.8	55.4	13.7	109.5
1985	19.5	1.7	13.2	0.4	2.3	0.0	0.0	0.0	0.0	0.0	1.8	19.9	58.8
1986	6.0	45.4	15.4	9.2	7.5	0.0	0.0	0.0	0.0	0.0	34.0	0.2	117.7
1987	0.0	7.8	46.6	0.0	0.0	0.0	0.0	0.0	0.0	11.3	16.5	77.1	159.3
1988	34.6	13.5	30.7	44.7	0.0	0.0	0.0	0.0	0.001	0.001	0.001	29.5	153.0
1989	3.2	64.5	31.6	0.001	3.8	0.0	0.0	0.0	0.0	0.001	8.6	0.6	112.3
1990	8.9	18.1	3.1	0.001	0.0	0.0	0.0	0.0	0.0	0.001	0.2	0.001	30.3
1991	M	M	(M)	(M)	(M)	0.0	0.0	0.0	0.0	6.6	4.0	12.2	(M)
1992	3.5	6.2	19.5	13.7	1.2	0.001	0.0	0.0	0.0	0.0	41.9	25.9	111.9
1993	34.7	23.5	0.5	89.8	7.1	0.0	0.0	0.0	0.0	1.8	10.5	2.1	170.0
1994	27.0	3.5	8.1	4.2	0.6	0.0	0.0	0.0	0.001	18.9	62.2	23.1	147.6
1995	2.6	17.0	8.7	23.8	0.3	0.0	0.0	0.0	0.0	0.0	6.2	5.5	64.1
1996	40.0	14.3	25.1	4.7	3.2	0.0	0.0	0.0	0.0	0.0	0.8	3.2	91.3
1997	12.8	0.7	10.9	4.1	0.6	0.001	0.0	0.0	0.0	33.0	53.9	26.9	142.9
1998	32.5	18.4	32.9	0.001	0.001	0.0	0.0	0.001	0.0	0.0	0.001	0.0	83.8
1999	19.2	7.8	3.7	0.001	0.0	0.0	0.0	0.0	0.0	0.0	6.0	12.1	48.8
2000	10.0	1.6	0.3	1.5	0.0	0.0	0.0	0.0	0.0	5.4	25.8	10.0	54.6
2001	12.1	9.9	4.0	25.7	1.4	0.0	0.0	0.0	0.001	0.4	2.2	19.3	75.0
2002	5.0	4.5	9.3	23.3	4.0	0.0	0.0	0.0	0.0	0.4	5.3	12.4	64.2
2003	M	0.0	0.4	M	M	0.0	0.0	0.0	0.0	0.001	25.3	20.4	M
2004	24.8	1.2	1.0	4.4	7.2	0.0	0.0	0.0	0.0	0.001	11.1	1.7	51.4
2005	27.7	9.7	12.8	12.4	0.2	0.0	0.0	0.0	0.0	0.001	6.6	2.0	71.4
2006	25.5	43.3	0.001	36.6	11.3	0.0	0.0	0.0	0.0	2.8	27.1	44.1	190.7
2007	12.4	2.4	0.001	8.3	0.001	0.0	0.0	0.0	0.0	0.001	0.001	12.8	35.9
2008	19.6	1.0	0.5	0.2	2.0	0.0	0.0	0.001	0.0	28.8	0.5	19.8	72.4
2009	0.001	5.8	19.5	16.8	0.2	0.0	0.0	0.0	0.0	7.4	5.1	9.5	64.3
2010	2.7	14.8	5.9	13.4	8.6	0.0	0.0	0.0	0.0	0.0	0.0	4.9	50.3
2011	21.8	19.8	4.8	21.9	1.6	0.001	0.0	0.0	0.0	0.3	0.001	1.1	71.3
2012	0.2	3.9	2.8	0.2	1.7	0.0	0.0	0.0	0.0	2.4	15.7	21.9	48.8
2013	27.6	3.2	0.001	0.001	20.0	0.0	0.0	0.0	0.0	1.9	103.3	0.1	156.1
2014	37.7	2.6	26.3	12.6	0.001	0.001	0.0	0.0	0.0	2.9	16.0	1.8	99.9
2015	4.8	5.5	3.4	1.6	6.7	0.0	0.0	0.0	0.001	38.4	46.6	32.7	139.7

*| (**M**) means (Missing Data). [55].

According to the above table, the yearly total rainfall of Al Najaf in 1966-1990 (first 25 years for study period) was higher than the yearly total in 1991-2015(second 25 years) to the same area, it was 105.7 and 66.9 mm respectively. That means average rainfall decreased over the last 3 decades in this area (Figure 3.1).

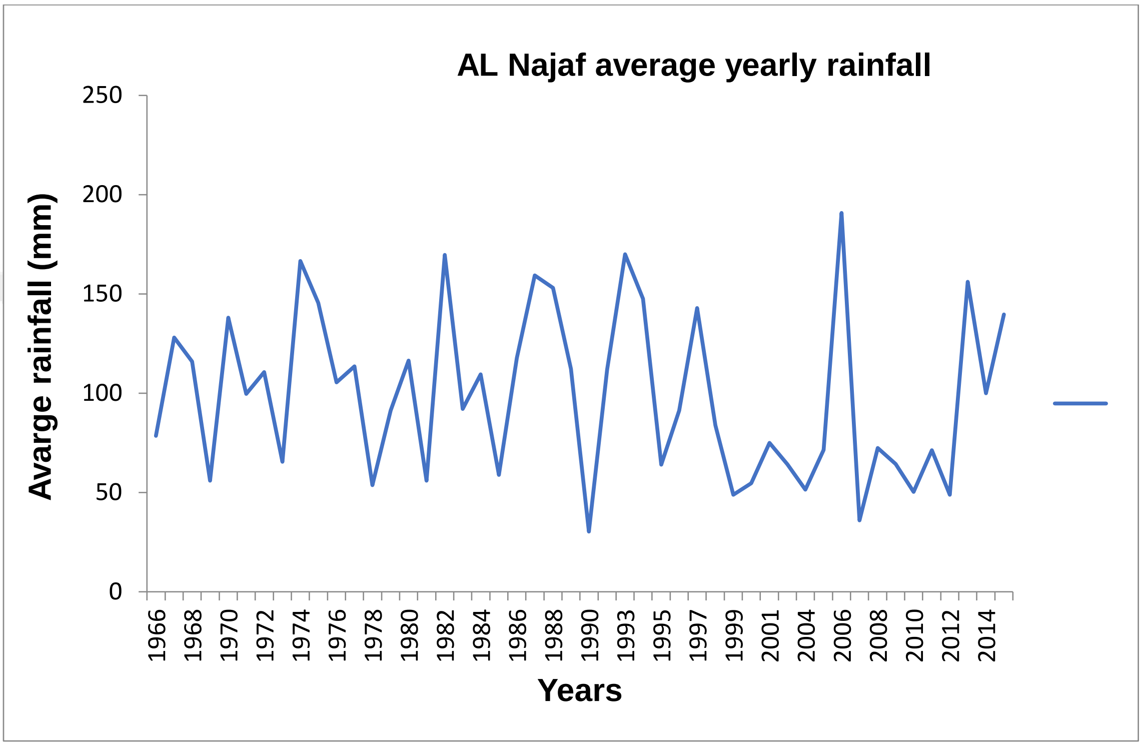


Figure 3.1. The Average Yearly Rainfall in Al- Najaf Province 1966-2015: [55]

Moreover, the next Table (3.2) will present the average yearly rainfall in Al Qadisiyah province started from 1966 till 2015.

Table 3.2. The Average Yearly Rainfall in Al Qadisiyah area 1966-2015:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1966	25.8	10.6	12.4	4.3	0.001	0.0	0.0	0.0	0.001	27.8	0.001	2.1	83.0
1967	18.3	20.5	3.3	1.7	10.3	0.0	0.0	0.0	0.0	43.6	51.6	2.0	151.3
1968	2.9	1.2	0.001	64.9	3.2	0.0	0.0	0.0	0.0	8.0	37.3	24.2	141.7
1969	37.0	5.5	0.001	9.7	0.001	0.0	0.0	0.0	0.0	0.001	7.1	5.9	65.2
1970	71.2	25.1	0.4	2.4	0.001	0.0	0.0	0.0	0.0	0.4	3.2	4.4	107.1
1971	13.2	1.0	13.3	30.6	15.6	0.0	0.0	0.0	0.0	0.6	14.3	24.3	112.9
1972	22.9	5.2	66.5	17.8	11.3	0.0	0.0	0.0	0.0	0.0	9.0	23.4	156.1
1973	13.7	3.0	0.1	5.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	46.6	68.7
1974	45.8	60.3	70.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	19.6	197.1
1975	52.4	52.1	0.001	47.6	7.3	0.0	0.0	0.0	0.0	0.0	2.0	16.9	178.3
1976	15.8	14.1	21.1	9.5	10.5	0.0	0.0	0.0	0.0	2.5	0.001	48.9	122.4
1977	13.4	28.8	11.4	1.2	3.3	0.0	0.0	0.0	0.0	17.7	11.2	27.0	114.0
1978	1.6	2.1	3.0	0.0	0.001	0.0	0.0	0.0	0.0	0.0	13.6	51.3	71.6
1979	34.2	2.4	15.8	0.001	0.9	0.001	0.0	0.0	0.0	0.5	17.8	19.5	91.1
1980	2.7	58.3	6.5	4.8	0.6	0.0	0.0	0.0	0.0	0.001	13.5	3.3	89.7
1981	15.3	18.4	22.0	0.001	1.7	0.0	0.0	0.0	0.0	0.0	5.6	3.1	66.1
1982	38.9	13.0	10.7	20.5	30.7	0.0	0.0	0.0	0.0	0.001	1.9	3.1	118.8
1983	7.2	1.8	1.7	6.5	20.8	0.001	0.0	0.0	0.0	0.0	2.1	18.4	58.5
1984	4.7	1.9	13.6	11.5	10.9	0.0	0.0	0.0	0.0	0.001	38.5	11.5	92.6
1985	18.8	9.1	6.0	18.0	2.2	0.0	0.0	0.0	0.0	0.0	9.1	20.9	84.1
1986	93.4	101.5	1.6	1.8	0.0	0.0	0	0	0.0	0.0	18.0	12.0	228.3
1987	M	M	2.5	2.5	3.2	0.0	0.0	0.0	0.0	31.0	14.0	24.6	77.8
1988	25.9	16.1	28.3	25.9	0.0	0.0	0.0	0.0	0.001	0.001	1.2	25.8	123.2
1989	4.6	36.8	45.5	0.7	17.5	0.0	0.0	0.0	0.0	0.001	10.3	1.9	117.3
1990	79.3	18.3	0.001	3.2	0.001	0.0	0.0	0.0	0.001	18.3	33.6	70.7	223.4
1991	40.7	17.4	17.2	1.8	0.0	0.0	0.0	0.0	20.0	7.9	0.001	20.0	125.0
1992	1.6	8.0	16.6	5.1	0.4	0.0	0.0	0.0	0.001	0.0	65.3	14.7	111.7
1993	54.2	13.8	1.9	79.5	7.5	0.0	0.0	0.0	0.0	2.8	25.6	6.9	192.2
1994	26.1	1.8	4.4	3.8	0.001	0.0	0.0	0.0	0.001	3.9	79.0	28.5	147.5
1995	4.4	17.5	22.0	48.3	0.001	0.0	0.0	0.0	0.0	1.6	0.001	9.5	103.3
1996	32.1	28.1	36.1	10.5	0.9	M	0.0	0.0	0.0	0.0	6.2	3.3	117.2
1997	23.6	0.001	15.1	1.9	0.001	0.001	0.0	0.0	0.001	14.7	31.6	25.7	112.6
1998	41.3	18.6	44.5	0.001	0.001	0.0	0.001	0.0	0.0	0.0	4.0	0.0	108.4
1999	29.8	14.0	13.4	0.0	0.001	0.0	0.0	0.0	0.0	5.2	6.5	29.8	98.7
2000	14.3	15.5	0.2	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	37.8
2001	27.6	16.0	8.9	25.5	0.001	0.0	0.0	0.0	0.001	0.001	0.001	15.4	93.4
2002	14.4	20.5	7.7	109.3	0.2	0.0	0.0	0.0	0.0	19.0	4.0	11.0	186.1
2003	8.5	0.0	1.4	0.8	0.001	0.0	0.0	0.0	0.0	0.001	56.9	42.1	109.7
2004	29.2	1.6	0.001	14.9	0.001	0.0	0.0	0.0	0.0	2.9	3.2	4.8	56.6
2005	37.9	11.2	12.1	6.6	0.001	0.0	0.0	0.0	0.0	0.0	32.8	0.001	100.6
2006	29.9	27.4	8.1	8.9	4.9	0.0	0.0	0.0	0.0	2.3	17.0	8.4	106.9
2007	12.4	9.2	0.6	4.5	1.9	0.0	0.0	0.0	0.0	0.001	0.001	15.0	43.6
2008	22.9	0.9	0.3	3.1	0.001	0.001	0.0	0.0	0.0	7.8	8.5	0.7	44.2
2009	0.001	2.7	7.8	9.9	0.001	0.001	0.0	0.0	0.0	5.5	2.8	17.5	46.2
2010	3.3	4.8	5.1	18.4	8.2	0.0	0.0	0.0	0.0	0.001	0.001	9.3	49.1
2011	27.1	17.6	1.8	26.0	2.0	0.4	0.0	0.0	0.0	1.4	0.001	5.1	81.4
2012	4.8	5.6	0.6	0.001	0.8	0.0	0.0	0.0	0.0	4.0	57.0	26.0	98.8
2013	25.6	4.3	0.001	0.1	31.6	0.0	0.0	0.0	0.0	0.001	61.1	1.3	124.0
2014	46.1	1.5	19.3	12.6	1.5	0.0	0.0	0.0	0.0	2.2	20.7	1.5	105.4
2015	2.2	8.5	10.8	5.5	1.5	0.0	0.0	0.001	0.0	3.4	69.5	38.3	139.7

Source: Meteorological Organization and Seismology of Iraq

From the collected data in the Table (3.2) it's clear that the higher average yearly rainfall was ranged between the year of 1966 – 1990, and the lowest yearly rainfall was between the years of 1991-2015 in the same area as it was presented in the Figure (3.2).

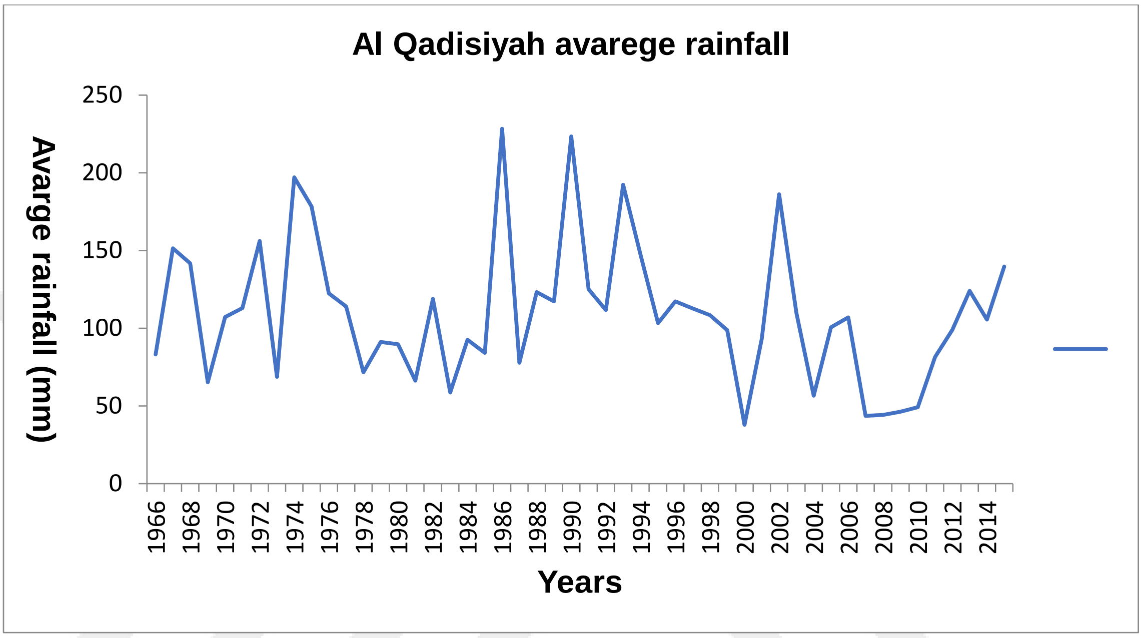


Figure 3.2. The Average Yearly Rainfall in Al Qadisiyah Province 1966-2015

Source: Meteorological Organization and Seismology of Iraq

In addition, the below Table (3.3) will show us the average yearly rainfall in Al Muthanna province started from 1966 till 2015.

Table 3.3. The Average Yearly Rainfall in Al Muthanna area (South Iraq) 1966-2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Total
1966	0.0	14.0	0.0	40.6	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	57.1
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.5	0.0	45.5
1968	0.0	0.0	0.0	22.9	9.4	0.0	0.0	0.0	0.0	0.0	19.9	55.9	108.1
1969	53.6	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	7.6	73.4
1970	19.1	7.5	32.4	36.8	0.0	0.0	0.0	0.0	0.0	0.0	71.4	29.5	196.7
1971	67.2	77.5	68.2	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5	237.7
1972	58.2	1.9	12.5	3.0	2.1	0.0	0.0	0.0	0.0	10.2	80.8	25.7	194.4
1973	89.2	40.8	66.8	9.8	7.3	0.0	0.0	0.0	0.0	0	1.2	4.9	220.0
1974	12.1	45.0	71.8	0.001	1.4	0.0	0.0	0.0	0.0	0.001	6.9	25.2	162.4
1975	38.1	46.3	0.001	16.5	8.3	0.0	0.0	0.0	0.0	0.0	0.001	16.3	125.5
1976	34.1	22.8	6.5	8.2	4.6	0.0	0.0	0.0	0.0	0.001	0.4	47.0	123.6
1977	9.7	10.9	15.8	1.1	16.9	0.0	0.0	0.0	0.0	21.9	8.0	22.9	107.2
1978	0.4	7.2	3.4	0.001	0.9	0.0	0.0	0.0	0.0	0.0	1.4	7.1	20.4
1979	45.8	0.001	7.6	0.001	4.0	1.4	0.0	0.0	0.0	0.001	0.3	24.9	84.0
1980	1.8	72.8	2.4	2.8	1.9	0.0	0.0	0.0	0.0	0.001	11.3	4.7	97.7
1981	18.1	5.0	43.6	1.2	0.001	0.0	0.0	0.0	0.0	1.4	0.8	3.0	73.1
1982	30.3	6.0	3.5	7.6	15.8	0.0	0.0	0.0	0.0	0.3	8.2	3.6	75.3
1983	4.9	2.0	2.5	2.3	27.9	0.0	0.0	0.0	0.0	0.0	1.8	7.5	48.9
1984	12.2	0.4	11.7	4.1	4.0	0.0	0.0	0.0	0.0	0.4	36.2	5.5	74.5
1985	22.6	0.4	0.9	1.0	0.001	0.0	0.0	0.0	0.0	0.0	1.2	2.4	28.5
1986	13.4	30.1	21.0	3.5	0.001	0.0	0.0	0.0	0.0	0.0	51.5	0.6	120.1
1987	0.0	4.4	24.4	0.4	6.0	0.0	0.0	0.0	0.0	14.9	16.7	20.6	87.4
1988	13.8	6.3	11.6	21.1	0.2	0.0	0.0	0.0	0.0	0.001	0.001	15.8	68.8
1989	0.7	18.9	25.6	1.4	1.9	0.0	0.0	0.0	0.0	0.001	3.7	1.7	53.9
1990	23.4	0.6	38.7	66.6	0.0	0.0	0.0	0.0	0.0	2.5	1.4	67.0	200.2
1991	43.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	5.8	10.4	15.3	6.6
1992	10.4	7.1	34.4	4.9	0.7	0.001	0	0	0.0	0.0	49.0	22.1	10.7
1993	45.3	18.9	4.4	38.8	11.9	0.0	0	0	0.0	6.1	15.5	2.0	142.90
1994	40.2	0.3	6.3	1.8	0.001	0.0	0	0	0.001	9.9	31.4	31.0	120.90
1995	44.9	20.7	2.3	42.2	3.5	0.6	0	0	0.0	0.0	0.0	23.2	137.40
1996	27.5	37.8	37.8	4.7	0.0	0.0	0	0	0.0	0.0	3.7	5.0	116.50
1997	22.1	0.001	20.4	4.5	0.001	0.0	0	0	0.0	39.8	52.1	24.2	163.10
1998	34.0	6.2	111.3	9.6	4.5	0.0	0	0	0.0	0.0	0.0	0.0	165.6
1999	93.4	101.5	1.6	1.8	0.0	0.0	0	0	0.0	0.0	18.0	12.0	228.3
2000	39.6	11.2	0.8	0.8	0.8	0.0	0	0	0.0	14.6	25.6	21.6	115.0
2001	9.0	6.8	20.4	9.0	6.6	0.0	0	0	0.0	0.0	3.1	21.3	76.2
2002	23.0	1.8	18.8	27.2	0.001	0.0	0	0	0.0	0.6	2.3	8.9	82.6
2003	M	M	M	M	M	0.0	0.0	0.0	0.0	0.0	9.7	19.5	29.2
2004	2.0	1.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001	18.0	23.8
2005	15.3	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	30.1
2006	17.9	26.9	10.4	0.6	2.0	0.0	0.0	0.0	0.0	3.1	19.6	85.4	165.9
2007	7.9	1.0	19.5	16.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	17.6	62.3
2008	24.1	2.4	0.5	0.2	2.4	0.0	0.0	0.0	1.0	24.1	2.3	0.0	57.0
2009	0.001	6.5	8.7	5.0	6.0	0.001	0.0	0.0	0.0	8.5	1.7	17.7	54.1
2010	0.6	6.2	3.4	18.5	10.6	0.0	0.0	0.0	0.0	0.001	0.6	7.1	47.0
2011	8.6	23.7	4.8	20.5	0.4	0.0	0.0	0.0	0.0	0.4	0.001	0.001	58.4
2012	7.6	5.3	3.1	0.001	0.7	0.0	0.0	0.0	0.0	13.8	41.0	33.7	105.2
2013	21.5	0.6	1.2	0.001	58.5	0.0	0.0	0.0	0.0	0.2	164.8	1.1	247.9
2014	40.0	3.2	17.7	25.9	1.2	0.0	0.0	0.0	0.0	5.7	14.4	3.1	111.2
2015	2.9	26.8	10.7	3.0	1.4	0.0	0.0	0.0	0.0	0.6	16.4	39.4	101.2

Source: Meteorological Organization and Seismology of Iraq

According to the above table, the yearly total rainfall of Al Muthanna in 1966-1990 (first 25 years for study period) was higher than the yearly total in 1991-2015(second 25 years) for the same area, it was 107.3 and 98.3 mm respectively. That means average rainfall decreased over the last 3 decades in this area (Figure 3.3).

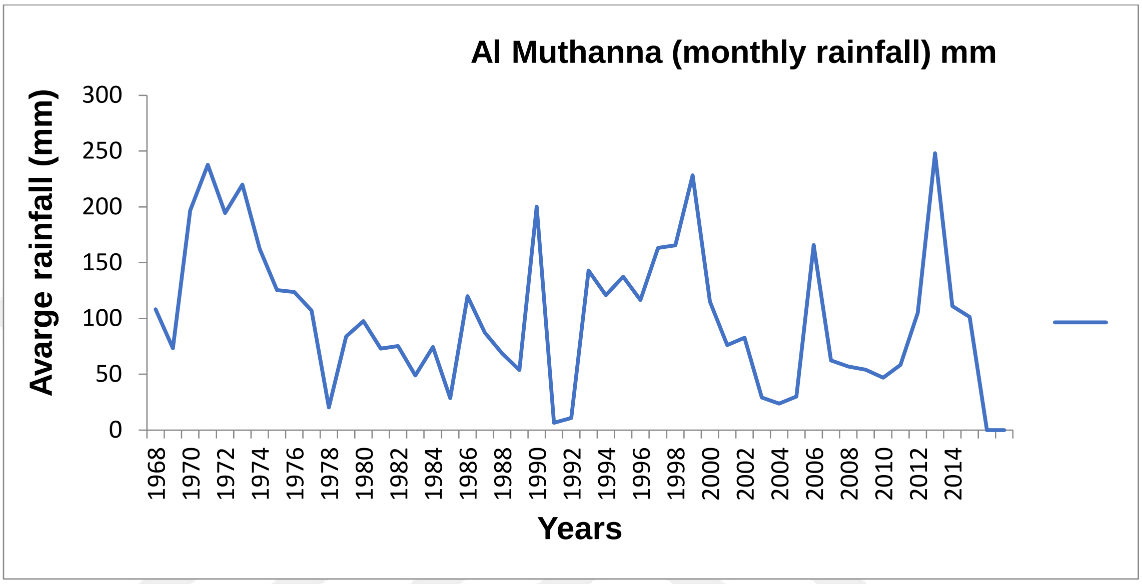


Figure 3.3. The Average Yearly Rainfall in Al Muthanna Province 1966-2015:

Source: Meteorological Organization and Seismology of Iraq

Finally, Table number (3.4) shows the average yearly rainfall in Thi Qar province started from 1966 till 2015 too.

Table 3.4. The Average Yearly Rainfall in Thi Qar area (South Iraq) 1966-2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Total
1966	4.5	51.3	15.8	6.3	0.001	0.0	0.0	0.0	0.0	4.5	0.001	3.1	85.5
1967	23.4	14.6	0.001	0.001	25.6	0.0	0.0	0.0	0.0	7.1	27.2	10.6	108.5
1968	0.8	1.8	0.001	52.1	20.2	0.001	0.0	0.0	0.0	1.3	19.4	5.1	100.7
1969	64.6	10.1	12.0	39.5	30.5	0.0	0.0	0.0	0.0	0.001	2.4	3.5	162.6
1970	36.6	5.5	10.5	2.0	0.0	0.0	0.0	0.0	0.0	0.001	1.5	13.0	69.1
1971	7.3	5.8	10.7	33.4	8.0	0.0	0.0	0.0	0.0	0.1	21.0	8.7	95.0
1972	66.0	3.4	17.1	22.1	0.6	0.001	0.0	0.001	0.001	0.001	13.8	32.9	155.9
1973	0.9	51.7	2.6	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.001	31.2	87.6
1974	20.5	41.3	71.5	5.2	1.7	0.0	0.0	0.0	0.0	0.5	1.7	23.6	166.0
1975	76.2	26.3	0.001	9.5	26.2	2.5	0.0	0.0	0.0	0.0	4.5	45.4	190.6
1976	31.8	32.6	23.0	27.6	12.9	0.0	0.001	0.0	0.0	0.001	2.1	38.3	168.3
1977	12.3	4.6	43.1	4.3	1.7	0.0	0.0	0.0	0.0	29.7	22.9	43.2	161.8
1978	7.0	14.4	6.3	0.001	0.3	0.0	0.0	0.0	0.0	0.001	10.0	7.9	45.9
1979	29.1	1.9	3.0	2.8	3.9	3.6	0.0	0.0	0.001	7.0	1.7	21.3	74.3
1980	13.4	80.9	6.7	1.7	0.1	0.0	0.0	0.0	0.0	0.001	18.0	1.9	122.7
1981	18.1	3.8	27.2	1.5	0.0	0.0	0.0	0.0	0.0	3.2	1.4	4.6	59.8
1982	92.7	12.3	20.8	8.4	22.2	0.001	0.0	0.0	0.0	32.3	0.001	4.3	193.0
1983	11.6	3.3	22.8	10.5	32.1	0.0	0.0	0.0	0.0	0.0	0.3	2.1	82.7
1984	17.8	0.2	8.7	5.7	0.001	0.0	0.0	0.0	0.0	0.3	87.5	34.4	154.6
1985	41.9	0.001	4.4	10.7	15.1	0.0	0.0	0.0	0.0	0.0	2.0	9.0	83.1
1986	39.1	22.5	41.6	4.0	5.6	0.0	0.0	0.0	0.0	0.0	93.0	36.4	242.2
1987	0.0	4.4	30.0	0.001	3.7	0.0	0.0	0.0	0.0	17.8	2.9	15.8	74.6
1988	24.0	11.5	10.5	44.1	0.0	0.0	0.0	0.0	0.0	0.001	0.2	19.6	109.9
1989	0.6	32.6	32.5	0.001	2.1	0.0	0.0	0.0	0.0	0.001	18.4	17.4	103.6
1990	14.8	27.1	15.9	4.5	0.001	0.0	0.0	0.0	0.0	0.5	0.001	1.3	64.1
1991	1.6	18.1	16.3	10.1	2.7	0.0	0.0	0.0	0.0	0.0	0.001	8.4	57.2
1992	11.5	11.9	28.8	0.4	0.001	0.001	0.0	0.0	0.0	0.0	31.0	31.4	115.0
1993	30.4	26.5	1.6	32.1	5.7	0.0	0.0	0.0	0	9.6	6.5	5.2	117.6
1994	26.3	0.001	2.5	11.1	0.6	0.0	0.0	0.0	0.001	4.1	38.2	26.7	109.5
1995	30.2	22.8	11.6	17.3	8.6	0.2	0.0	0.0	0.0	0.0	0.001	21.3	112.0
1996	72.5	30.8	52.2	6.4	1.2	0.0	0.0	0.0	0.0	0.0	11.5	6.2	180.8
1997	27.6	0.001	22.0	10.6	0.0	0.0	0.0	0.0	0.0	14.2	48.3	37.2	159.9
1998	34.8	5.7	90.2	21.6	0.6	0.0	0.001	0.0	0.0	0.0	0.001	0.2	153.1
1999	21.1	69.8	23.7	0.001	0.0	0.0	0.0	0.0	0.0	0.001	14.8	27.6	157.0
2000	21.5	4.1	1.5	1.0	1.3	0.0	0.0	0.0	0.0	4.0	7.6	67.0	108.0
2001	5.0	3.1	9.1	0.001	0.2	0.0	0.0	0.0	0.0	0.1	3.0	42.4	62.9
2002	10.4	7.4	11.4	105.7	1.0	0.0	0.0	0.0	0.0	1.0	8.7	5.4	151.0
2003	2.5	4.1	1.7	0.0	8.5	0.0	0.0	0.0	0.0	0.0	79.4	28.8	125.0
2004	28.5	0.3	0.8	25.9	0.0	0.0	0.0	0.0	0.0	0.0	26.5	16.6	98.6
2005	45.2	0.9	33.7	3.9	0.001	0.0	0.0	0.0	0.0	0.0	0.2	21.8	105.7
2006	2.5	2.1	41.8	42.1	0.001	0.0	0.0	0.0	0.0	36.5	23.7	9.1	157.8
2007	9.2	0.1	75.8	5.5	0.001	0.0	0.0	0.0	0.0	0	0.001	21.9	112.5
2008	19.4	10.8	0.4	1.4	0.2	0.2	0.001	0.0	0.2	32.2	0.7	0.0	65.5
2009	0.3	7.1	18.6	4.6	1.5	0.6	0.0	0.0	0.0	0.2	1.7	22.3	56.9
2010	2.6	2.7	0.5	29.2	14.8	0.0	0.0	0.0	0.0	0.1	0.4	7.3	57.6
2011	7.5	19.9	13.8	21.2	9.7	0.0	0.0	0.0	0.0	0.001	13.0	0.0	85.1
2012	6.2	21.6	1.3	6.7	0.001	0.0	0.001	0.0	0.0	2.6	58.5	19.3	116.2
2013	8.8	0.2	0.3	0.001	36.0	0.0	0.0	0.0	0.0	1.8	126.4	1.7	175.2
2014	1.9	27.8	5.5	1.6	0.5	0.0	0.0	0.0	0.0	2.7	30.5	44.1	114.6
2015	0.9	14.4	7.2	1.0	0.9	0.0	0.0	0.0	0.0	24.4	8.3	36.1	93.2

Source: Meteorological Organization and Seismology of Iraq

As well as the case with the province of Thi Qar, the yearly total rainfall of this area in 1966-1990 (first 25 years for study period) was higher than the yearly total in 1991-2015(second 25 years) to the same area, it was 118.4 and 113.9 mm respectively. That means average rainfall decreased in this area (Figure 3.4).

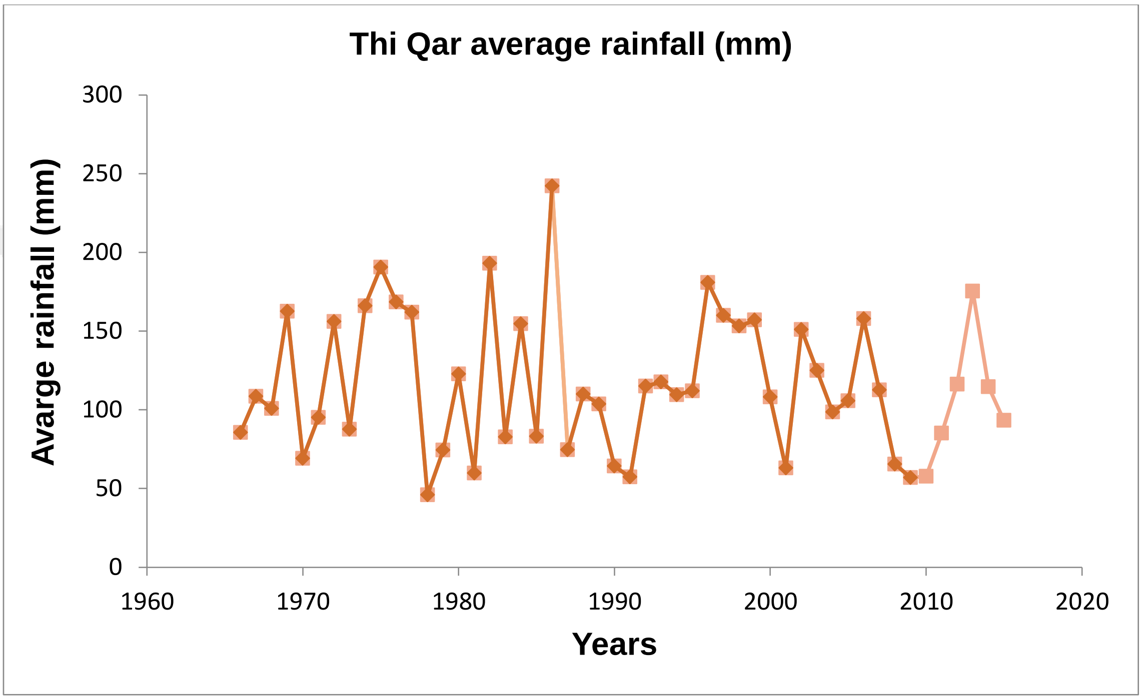


Figure 3.4. The Average Yearly Rainfall in Thi Qar Province 1966-2015:

Source: Meteorological Organization and Seismology of Iraq

This study indicated that the total yearly rainfall is decreasing clearly with the time passing. The yearly total rainfall of Al Najaf, Al Qadisiyah, Al Muthanna and Thi Qar in 1966-1990 was higher than the yearly total in 1991-2015 to the same area (Table 3.1, 3.2, 3.3, and 3.4 respectively). That means average rainfall decreased over the last 3 decades in the study area. This scenario explicitly indicates how Iraqi agriculture (especially paddy production) and irrigation sectors are suffering from the scarcity of rainfall because Iraqi agriculture and irrigation systems are largely dependent on rainfall.

3.3. The Temperature in Iraq

Similar to Middle East countries, there are four seasons Iraq: winter (December, January, and February), Spring (March, April, May), summer (June, July, and August), and autumn (September, October, and November). It is important to note that the climate in Iraq is similar to the southwestern US with a pleasant spring, cold winters, hot, dry summers, and fall throughout the summer, Iraq is hot and dry. The hottest part of the country is the desert. Because of the fact that it cannot retain heat after sunset and the air is so dry, diurnal temperature spreads are the widest of the year in summer. In the July-August, the average temperature in Iraq is more than 48 ºC (120 Fahrenheit) and to below freezing in January. It is comparatively cooler in the mountains because it can respite the underlying heat. The temperature in the mountain provided below is for inhabited areas, commonly valleys. Although the October is still quite warm, temperatures cool from the blistering heat of summer. Combination of humidity and extreme temperatures in addition to the water scarcity will affect both men and equipment. Vehicle movement induced clouds of dust will increase the detection ability in the desert region during the dry season.

Who lived in Iraq before 1970 to the current time, saw clearly the difference in Iraqi climatic especially temperature, rainfall and dust storms. For example, it is evident from a recent incident, the Iraqi Government declared holidays for the all government's offices in Baghdad, central and southern areas of Iraq due to the extremely elevated temperature over 51 ºC for a few days in August 2017 (Al Iraqi a Iraqi Government channel, in Monday 1st of August 2017 at 7:30 pm). From this incident, we can understand how rising temperature is affecting the normal lifestyle of the Iraqi people.

The next tables show the average minimum and maximum temperatures in the study area (Al Najaf, Al Qadisiyah, Al Muthanna, and Thi Qar) in different years. First, Table 3.5 and 3.6 presented the minimum and maximum temperature in Al Najaf province respectively.

Table 3.5. Average Yearly Minimum Temperature for Al Najaf area from 1966-2015.

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	6.7	8.6	10.8	16.3	21.9	28.2	27.9	28.6	24.0	18.3	13.2	6.3	17.5
1967	4.3	4.8	8.8	14.0	21.1	32.7	27.8	26.2	23.5	18.7	12.5	6.1	16.7
1968	3.4	5.1	10.5	16.2	23.0	25.7	30.0	26.5	24.4	19.5	13.1	8.8	17.1
1969	7.4	6.8	14.3	15.5	32.2	27.4	28.1	28.0	24.8	20.4	9.4	8.1	18.5
1970	6.6	8.9	12.3	18.6	21.3	25.4	28.0	26.4	22.8	17.5	14.3	5.0	17.2
1971	5.4	6.9	12.2	15.2	23.4	24.8	27.6	26.9	23.5	16.9	11.3	4.8	16.5
1972	3.6	3.6	10.9	18.4	20.7	26.5	26.9	29.3	24.5	20.3	11.1	3.3	16.5
1973	2.9	9.2	10.8	16.2	22.2	24.8	27.6	28.5	24.8	19.3	9.0	5.6	16.7
1974	4.9	6.4	12.5	15.9	21.8	26.1	27.3	26.9	23.1	18.3	12.3	5.4	16.7
1975	4.0	7.0	10.3	17.1	21.9	26.1	28.0	26.3	24.8	16.2	11.1	5.6	16.5
1976	4.9	6.3	9.5	16.8	21.3	26.7	27.2	26.5	22.8	18.9	11.1	8.5	16.7
1977	3.1	9.4	12.6	16.3	22.1	26.3	28.4	27.9	24.4	16.1	10.2	8.1	17.0
1978	6.5	8.4	11.7	16.8	21.8	25.7	29.0	25.3	23.6	18.6	7.2	8.4	16.9
1979	8.0	9.6	11.2	18.4	22.9	26.8	27.7	27.5	26.3	20.2	14.0	6.3	18.2
1980	4.6	6.7	12.7	17.7	21.7	26.7	27.4	25.2	21.7	17.5	12.5	6.8	16.7
1981	6.0	7.9	11.7	15.4	20.4	25.7	28.5	27.9	24.3	19.0	9.9	8.5	17.1
1982	6.3	5.4	10.1	17.6	22.9	23.7	27.5	27.1	25.1	18.1	8.6	4.0	16.3
1983	2.3	5.2	9.2	15.5	22.6	26.6	27.9	27.1	23.5	16.5	14.4	7.4	16.5
1984	6.3	7.4	12.6	17.4	21.0	25.8	28.7	24.3	23.2	17.8	13.5	5.6	16.9
1985	7.5	5.7	8.8	17.3	23.2	25.8	26.3	28.1	24.1	17.0	14.0	6.2	17.0
1986	5.7	8.9	12.0	18.6	22.7	25.2	29.1	28.7	25.5	20.7	10.4	4.8	17.6
1987	3.8	9.7	10.1	16.9	23.7	26.4	29.2	29.5	24.7	18.5	11.6	9.3	17.7
1988	2.7	7.7	11.6	16.8	22.5	26.0	28.9	28.4	24.5	20.6	11.7	8.2	17.4
1989	2.7	4.8	13.2	19.1	23.9	26.3	29.1	28.3	24.1	19.7	13.8	6.4	17.6
1990	4.3	7.4	11.3	16.8	22.3	26.7	29.6	27.2	24.2	19.2	13.6	7.7	17.5
1991	6.9	7.1	12.5	18.9	21.5	27.6	27.0	27.5	24.6	19.9	13.3	7.1	17.8
1992	2.2	5.8	7.4	14.8	21.1	26.2	27.6	27.8	24.0	17.3	11.7	6.5	16.0
1993	4.7	6.8	11.6	16.7	22.5	26.4	29.2	28.2	24.5	20.1	11.3	8.4	17.5
1994	8.7	8.3	12.8	19.6	23.7	26.7	27.9	27.2	25.3	21.0	13.2	5.1	18.2
1995	7.5	9.2	12.7	17.3	23.9	27.6	28.6	27.8	23.3	17.5	11.0	6.5	17.7
1996	7.8	9.2	11.4	16.4	25.0	26.8	30.2	29.0	24.8	18.4	12.3	9.8	18.4
1997	6.2	3.4	8.6	15.1	23.3	27.3	28.8	26.3	22.9	19.8	13.3	8.6	16.9
1998	5.5	7.7	11.2	18.0	23.3	29.5	29.9	30.3	25.6	18.4	14.0	9.2	18.5
1999	7.2	9.2	12.1	17.7	24.1	27.2	29.8	29.9	24.6	20.2	11.4	7.2	18.3
2000	5.1	6.1	10.3	20.9	22.4	26.4	31.5	29.9	24.3	18.0	11.1	8.0	17.8
2001	6.0	7.9	14.4	18.4	23	26.9	28.7	30.6	25.7	19.5	10.9	8.8	18.4
2002	5.8	8.0	12.6	17.3	22.6	27.2	29.5	28.3	25.8	21.6	12.0	6.1	18.0
2003	MISS	MISS	10.5	18.5	23.9	27.4	29.2	30.6	24.5	21.6	12	7.3	20.5
2004	8.1	8.3	13.7	21.7	23	26.9	30.2	26.9	24.7	21.5	17.9	4.7	18.9
2005	5.4	7.1	12.5	18.2	22.7	26.6	30.7	26.8	24.1	18.6	9.8	9.3	17.6
2006	6.2	9.5	13.4	18.5	24.4	28.4	27.7	29.3	24.5	21.9	9.7	4.7	18.1
2007	4.1	9.2	12.0	17.1	25.3	27.9	29.6	29.3	26.0	21.0	12.6	6.4	18.3
2008	3.4	7.2	15.2	19.8	23.2	28.2	27.4	27.4	27.1	20.5	12.1	6.0	18.1
2009	3.8	10.5	12.6	17.7	24.6	28.4	28.4	28.9	25.0	20.7	12.1	9.2	18.4
2010	7.9	10.3	14.6	18.9	24.5	28.6	30.7	31.7	27.6	22.1	12.9	8.1	19.8
2011	6.2	8.3	12.0	18.3	23.7	23.7	30.7	29`7	26.1	18.7	9.2	8.1	17.8
2012	5.9	7.2	10.6	19.7	25.0	28.2	30.7	29.4	25.7	21.7	14.9	9.2	19.0
2013	7.8	10.0	14.0	18.2	23.1	28.0	29.6	30.5	25.4	17.3	14.6	8.8	18.9
2014	7.5	8.2	14.8	19.7	25.0	28.1	30.3	31.0	27.1	20.9	12.0	9.6	19.5
2015	6.9	9.5	12.7	17.1	25.1	28.0	31.4	30.4	29	23.6	13.1	10.2	19.7

Source: Meteorological Organization and Seismology of Iraq

According to the above table (Table 3.5), the yearly average minimum temperature of Al Najaf in 1966-1990 (first 25 years for study period) was lower than the yearly average in 1991-2015(second 25 years) to the same area, it was 17.0 and 18.3 °C respectively. That means the average minimum temperature increased within the last 3 decades in this area (Figure 3.5).

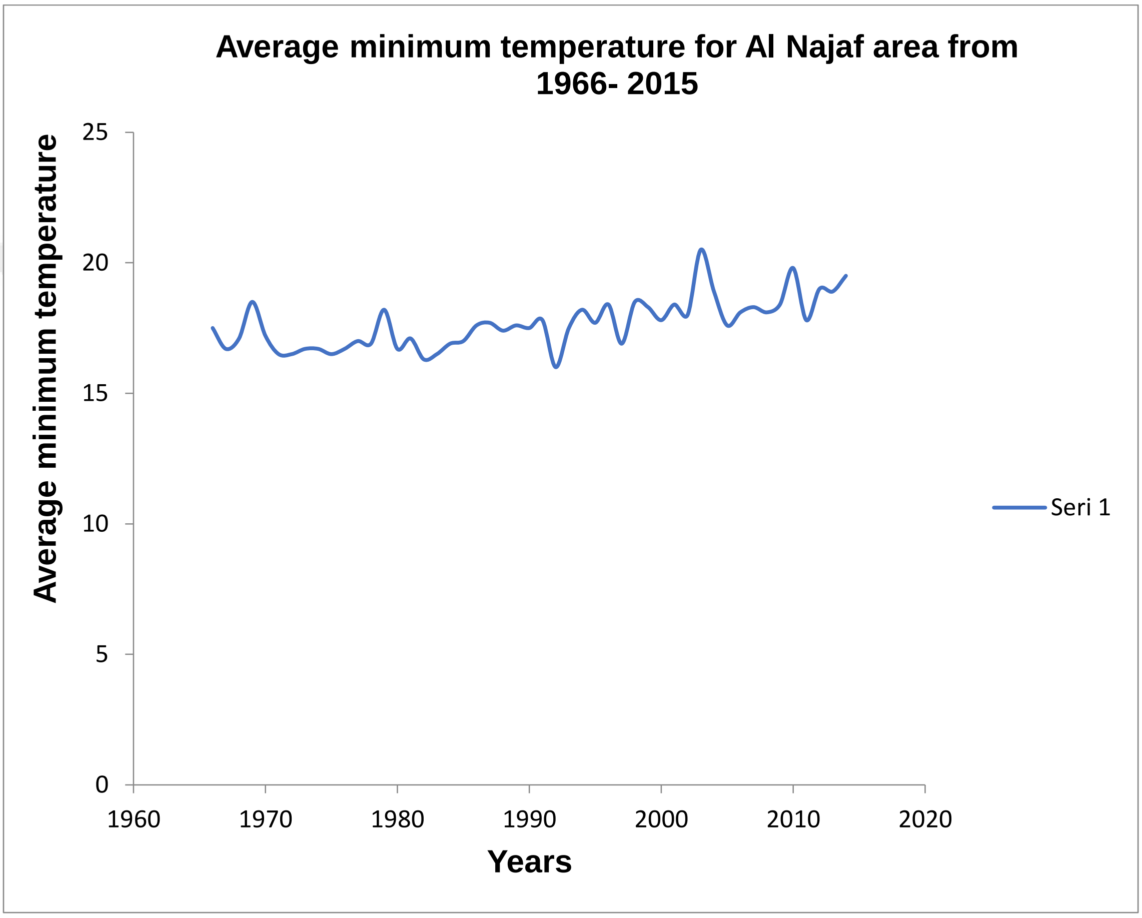


Figure 3.5. Average Yearly Minimum Temperature in Al Najaf from 1966-2015

Source: Meteorological Organization and Seismology of Iraq

Second, Table (3.6) presented the maximum temperature in Al Najaf province.

Table 3.6. Average Yearly Maximum Temperature for Al Najaf area in Iraq from 1966-2015.

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	19.6	21.1	24.2	30.8	37.3	43.0	44.1	45.2	40.8	32.4	28.0	19.9	32.2
1967	16.6	15.8	22.3	29.0	35.8	39.0	43.4	42.2	39.3	33.1	21.5	17.2	29.6
1968	14.9	18.9	24.6	29.3	36.6	39.7	45.2	42.0	40.6	34.8	25.9	19.4	30.9
1969	16.7	20.0	28.4	28.7	38.2	43.6	43.4	44.0	41.3	35.4	23.5	20.2	31.9
1970	16.3	21.3	26.2	33.4	37.6	42.3	43.2	42.8	39.9	32.9	27.1	16.9	31.6
1971	18.0	19.2	25.5	28.3	37.7	40.1	43.3	43.0	41.4	32.8	23.5	15.8	30.7
1972	13.4	15.9	22.7	31.6	33.7	41.3	42.8	44.5	40.8	36.3	25.0	15.4	30.2
1973	16.5	22.0	25.6	30.6	38.4	40.7	43.5	45.6	41.4	36.7	22.0	16.8	31.6
1974	13.5	16.0	22.6	29.0	38.0	42.8	44.5	43.2	40.4	35.9	26.5	16.6	30.7
1975	14.4	17.9	24.7	31.9	37.1	42.6	45.1	43.3	41.8	33.0	25.4	15.5	31.0
1976	15.7	17.3	21.6	30.8	36.1	42.2	42.7	42.9	39.4	34.0	26.0	20.3	30.7
1977	13.0	22.7	25.7	30.3	37.2	42.1	43.8	44.5	40.8	29.9	23.7	17.2	30.9
1978	18.3	21.2	25.8	31.5	37.7	40.7	44.6	41.2	39.9	34.8	20.3	18.2	31.1
1979	17.7	22.2	24.0	31.5	37.0	41.5	43.0	43.1	42.3	33.6	26.9	17.0	31.6
1980	15.6	17.4	24.3	30.4	36.8	42.1	44.5	42.1	38.6	32.2	24.6	18.2	30.5
1981	17.2	19.7	25.1	29.7	34.9	40.5	43.9	43.3	41.0	34.2	23.0	19.7	31.0
1982	14.9	14.8	21.7	30.1	35.7	40.7	42.7	41.8	40.5	31.3	20.2	14.8	29.1
1983	13.1	17.3	22.5	28.7	36.9	40.6	43.5	41.8	39.1	31.8	27.0	17.7	30.0
1984	16.8	20.5	24.9	31.2	35.2	40.4	43.3	39.7	39.6	32.6	23.2	15.3	30.2
1985	17.9	18.1	22.1	31.2	37.8	40.7	42.1	45.2	40.1	32.0	25.7	17.1	30.8
1986	17.3	20.4	23.4	30.9	35.6	39.7	44.7	45.3	42.6	34.0	21.7	16.4	31.0
1987	18.8	22.9	21.5	30.3	37.5	40.8	44.8	43.6	40.9	31.1	23.5	18.9	31.2
1988	14.0	19.0	22.2	28.8	36.4	39.2	42.9	43.3	40.1	33.9	22.9	18.2	30.0
1989	14.0	16.7	23.4	33.4	38.1	40.9	44.8	44.1	39.2	34.0	24.7	18.6	30.9
1990	14.6	17.8	24.6	30.4	37.7	41.9	44.6	41.2	40.1	33.5	27.1	20.3	31.1
1991	15.4	18.2	23.9	33.1	35.8	43.3	44.0	42.4	39.5	31.9	26.1	17.1	30.8
1992	13.7	16.2	19.8	29.3	35.1	40.8	42.0	43.3	39.6	33.7	22.7	15.3	29.2
1993	14.5	17.5	23.5	28.8	34.8	41.1	44.0	43.8	40.2	34.1	22.2	20.2	30.3
1994	18.3	20.2	25.4	33.0	38.2	41.6	43.1	42.6	40.3	33.8	22.9	14.5	31.1
1995	17.3	19.6	24.9	30.3	38.6	42.5	42.6	43.7	39.5	33.0	23.6	17.2	31.0
1996	16.9	19.8	22.8	30.2	40.1	42.2	46.6	44.8	39.7	33.3	24.5	21.4	31.8
1997	17.4	17.7	21.5	30.1	39.0	43.6	43.5	41.5	39.6	32.8	23.2	17.3	30.6
1998	14.6	18.5	22.1	32.5	38.3	44.5	45.8	46.2	40.9	34.7	28.3	21.6	32.3
1999	18.3	21.6	25.8	32.3	39.4	43.1	44.4	45.1	40.0	35.0	24.6	18.4	32.3
2000	16.1	18.7	24.6	33.3	38.4	42.5	47.3	46.0	40.4	31.5	23.0	17.8	31.6
2001	16.9	20.2	27.3	31.3	37.2	42.1	45.2	46.3	41.9	34.6	24.1	19.2	32.1
2002	17.7	21.1	26.7	29.6	37.4	42.2	45.5	43.3	40.8	35.4	24.9	16.1	31.7
2003	MISS	MISS	23.4	31.9	38.5	43.3	44.6	46.2	40.7	35.2	24.1	16.2	34.4
2004	17.6	20.8	28.8	31.2	38	43.7	46.5	46.3	42.8	36.8	23.9	16.9	32.7
2005	17.2	19.3	25.9	33.2	38.5	43.3	46.6	45.6	41.2	34.3	24.2	22.6	32.6
2006	17.4	20.8	27.6	32.3	40.1	45.6	45.1	47.0	41.8	34.8	24.0	15.6	32.6
2007	15.6	20.9	25.5	30.1	42.3	44.4	46.1	46.1	43.2	36.7	27.3	19.4	33.1
2008	13.5	20.0	30.9	34.6	38.7	43.4	46.1	46.1	42.3	33.6	26.4	19.6	32.9
2009	17.9	22.8	25.9	30.8	38.6	44.3	44.5	45.5	40.2	35.4	24.7	21.5	32.6
2010	21.8	23.2	28.8	32.0	39.3	44.9	46.8	46.3	42.6	36.4	28.3	21.6	34.3
2011	16.4	19.3	25.2	31.3	37.6	37.6	45.4	45`1	39.6	23.3	21.9	18.2	30.0
2012	17.4	18.7	23.6	33.3	39.0	44.0	46.6	45.1	41.7	35.2	25.8	19.5	32.4
2013	18.0	22.2	27.3	32.4	35.8	42.4	44.9	44.8	44.1	33.8	23.3	21.4	32.5
2014	15.6	19.1	24.8	31.0	37.1	39.8	40.7	41.0	36.6	30.1	22.3	19.8	29.8
2015	17.2	19.7	24.2	30.2	37.9	40.6	42.7	41.9	39.3	32.8	22.3	16.3	30.4

Source: Meteorological Organization and Seismology of Iraq

Yearly maximum temperature for Al Najaf area in 1966-1990 (first 25 years for study period) was lower than the yearly average in 1991-2015(second 25 years) to the same area, it was 30.8 and 31.8 °C respectively. That means the average maximum temperature increased within the last 3 decades in this area (Figure 3.6).

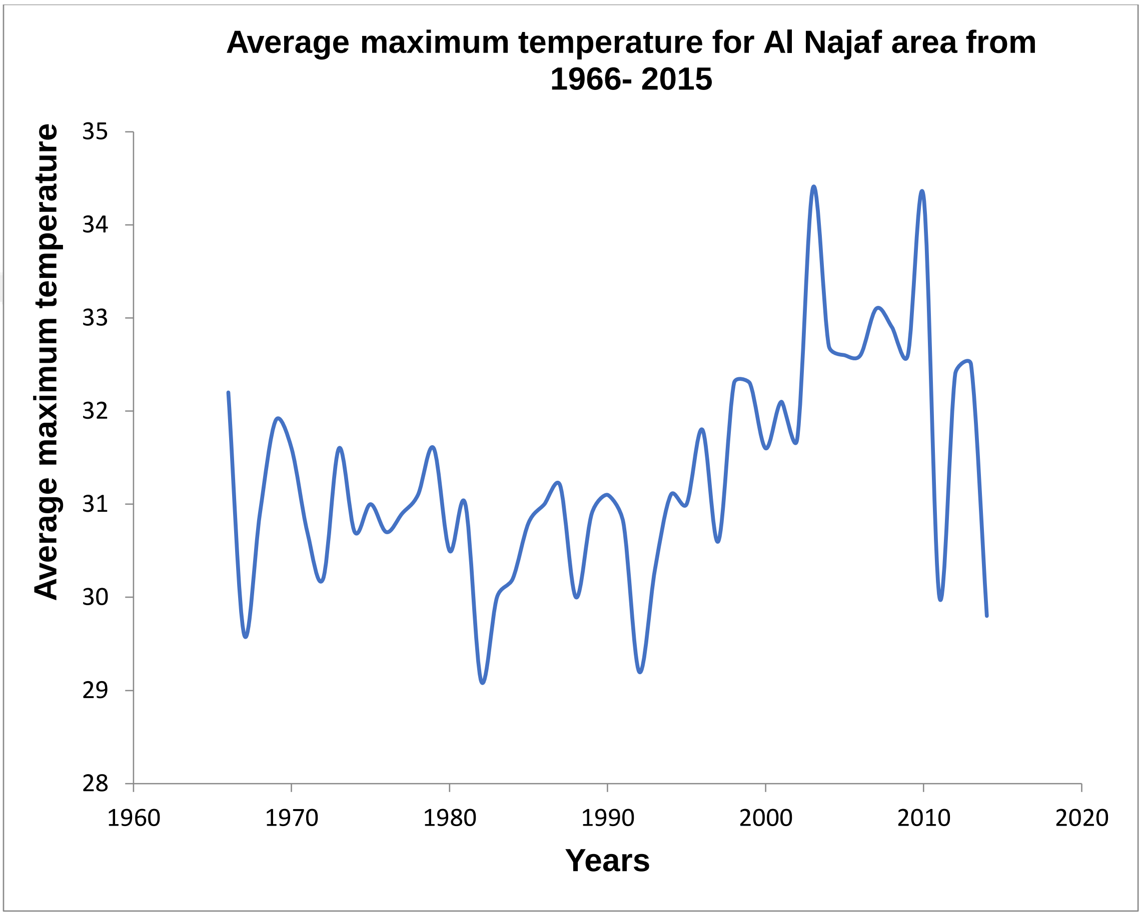


Figure 3.6. Average Yearly Maximum Temperature in Al Najaf from 1966-2015:

Source: Meteorological Organization and Seismology of Iraq

Moreover, the next Table (3.7) will present the average yearly minimum temperature in Al Qadisiyah province started from 1966 till 2015.

Table 3.7. Average Yearly Minimum Temperature for Al Qadisiyah area from 1966-2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	5.9	9.2	12.1	18.1	25.1	26.6	24.9	23.6	21.1	15.0	11.6	4.7	16.4
1967	3.0	7.7	12.0	16.9	22.1	24.8	24.1	23.7	19.9	18.1	13.2	7.1	16.0
1968	5.3	5.4	8.6	14.1	22.3	23.1	24.9	23.5	20.9	18.3	14.7	8.7	15.8
1969	5.8	6.3	13.1	15.0	20.8	25.0	24.7	22.6	21.2	16.7	14.7	6.8	16.0
1970	4.6	6.5	10.7	16.5	22.5	21.5	24.0	24.0	22.3	16.1	12.4	9.1	15.8
1971	4.7	6.6	11.3	14.9	23.2	23.4	25.6	24.7	21.7	14.8	11.4	5.2	15.6
1972	3.4	3.2	10.7	17.6	20.5	26.5	25.4	26.9	23.3	18.5	9.1	2.8	15.6
1973	2.5	8.8	9.3	15.0	21.2	23.5	25.7	25.3	21.2	17.3	8.0	5.3	15.2
1974	5.0	6.2	12.2	15.1	20.8	23.4	24.3	23.9	20.8	16.0	10.8	4.9	15.2
1975	3.5	6.5	9.4	17.0	21.5	24.4	25.6	24.1	23.2	14.6	10.5	5.2	15.4
1976	4.7	5.9	9.3	16.4	20.9	23.5	25.0	24.3	21.4	17.5	9.7	7.7	15.5
1977	2.5	8.4	12.1	15.9	21.8	24.7	25.6	25.3	22.5	15.7	9.9	7.7	16.0
1978	6.1	7.8	10.7	15.3	20.7	23.4	26.9	23.5	21.3	17.2	6.2	8.2	15.6
1979	7.2	9.1	10.8	17.8	22.4	25.4	25.7	25.5	23.8	18.5	13.4	6.3	17.1
1980	4.6	5.7	12.1	17.5	19.3	24.5	26.4	23.4	20.2	16.9	13.1	6.4	15.8
1981	6.5	8.2	12.6	15.6	19.8	24.4	26.9	25.6	22.2	17.7	9.8	8.7	16.5
1982	6.0	4.9	9.5	17.1	23.1	23.9	25.3	24.5	23.1	17.8	8.0	4.2	15.6
1983	2.4	5.3	8.7	14.8	27.6	24.9	25.8	24.0	21.0	15.0	13.1	7.7	15.8
1984	6.6	7.0	13.1	17.0	20.3	25.1	27.3	23.9	21.6	17.3	14.1	6.0	16.6
1985	7.6	5.4	8.9	17.4	22.8	24.4	25.2	26.9	22.6	16.5	14.3	7.1	16.5
1986	6.2	9.3	11.9	18.6	22.2	24.8	27.0	28.2	23.0	22.8	11.1	5.0	17.5
1987	4.8	10.5	10.9	16.8	23.9	25.9	28.1	27.8	24.1	18.8	12.2	9.5	17.7
1988	6.4	8.6	12.0	16.9	22.7	25.3	28.1	27.7	23.3	20.6	11.1	8.7	17.6
1989	3.4	5.5	12.9	19.7	23.9	25.2	27.2	26.6	23.4	19.7	14.3	7.0	17.4
1990	4.9	7.7	11.4	16.9	21.6	25.7	27.9	25.5	23.1	19.0	13.8	8.2	17.1
1991	6.9	7.1	12.5	18.9	21.5	25.9	27.0	26.2	23.3	20.5	13.9	8.0	17.6
1992	3.1	6.0	8.5	16.0	21.8	26.0	26.1	26.9	23.9	17.6	12.8	7.3	16.3
1993	5.2	7.3	12.5	17.5	22.9	25.7	27.9	27.5	23.5	20.4	12.0	9.5	17.6
1994	9.5	8.5	13.4	19.7	23.5	22.3	26.8	25.9	24.9	21.2	14.1	5.7	17.9
1995	7.8	9.9	13.3	17.9	24.0	26.5	27.1	26.4	23.4	18.3	11.4	7.1	17.7
1996	8.7	10.0	12.1	16.7	25.3	25.5	29.1	28.2	23.7	18.2	13.1	10.8	18.4
1997	6.9	4.5	9.1	16.7	23.7	26.9	27.9	25.2	23.3	20.5	14.1	9.2	17.3
1998	5.9	7.8	11.2	18.0	22.8	27.4	28.6	29.0	24.6	18.3	14.6	9.4	18.1
1999	7.7	9.8	12.7	18.4	23.8	26.5	28.5	28.7	24.3	20.3	11.9	7.9	18.3
2000	5.6	6.0	10.1	20.8	22.4	24.7	29.6	28.5	23.7	17.9	11.4	8.5	17.4
2001	5.9	8.4	13.6	17.4	22.2	24.9	27.6	29.0	25.1	19.4	11.0	8.9	17.7
2002	5.2	7.7	12.4	16.9	22.3	25.3	27.6	27.4	24.6	21.7	12.8	7.1	17.5
2003	MISS	MISS	11.3	18.5	23.9	26.8	27.2	28.0	23.5	20.6	12.4	8.3	20.0
2004	5.0	8.7	13.8	16.9	23.3	26.0	27.9	26.7	23.3	21.5	14.4	5.3	17.7
2005	6.2	7.3	12.9	19.0	23.4	26.2	28.7	27.3	29.9	18.3	10.1	9.6	18.2
2006	6.9	10.1	12.9	18.6	24.0	26.7	29.1	28.2	22.8	22.1	10.3	4.8	18.0
2007	3.8	8.9	11.7	17.6	24.8	26.2	27.8	27.5	24.1	20.1	11.4	6.6	17.5
2008	3.3	7.0	14.4	19.2	23.0	26.8	28.0	29.5	26.9	20.6	12.7	6.8	18.1
2009	4.9	11.3	13.3	18.0	25.0	26.8	28.0	26.7	24.3	20.6	12.5	10.2	18.4
2010	8.8	11.2	15.1	18.8	23.9	28.0	28.2	28.4	25.6	21.2	11.8	9.6	19.2
2011	5.6	8.0	11.7	17.6	23.8	27.1	29.3	27.6	24.5	18.4	9.4	8.9	17.6
2012	8.5	10.2	9.9	17.7	25.0	27.5	31.5	29.7	26.6	22.5	13.5	10.5	19.4
2013	8.5	11.3	12.6	17.0	21.8	25.7	26.1	24.9	22.1	15.6	14.3	6.3	17.1
2014	7.5	7.9	13.9	18.7	23.9	25.4	26.9	27.6	22.5	17.2	9.6	8.8	17.4
2015	6.2	7.9	11.0	16.0	23.6	25.2	27.4	27.8	26.1	21.3	12.7	6.5	17.6

Source: Meteorological Organization and Seismology of Iraq

From the above data in the Table (3.7) that the average yearly minimum temperature of 1966 – 1990 was 16.2 ºC and the value for 1991 - 2015 was 17.9 ºC in the same area. It’s clear to see an increase in the average minimum temperature for the last 25 years as it presented in Figure (3.7).

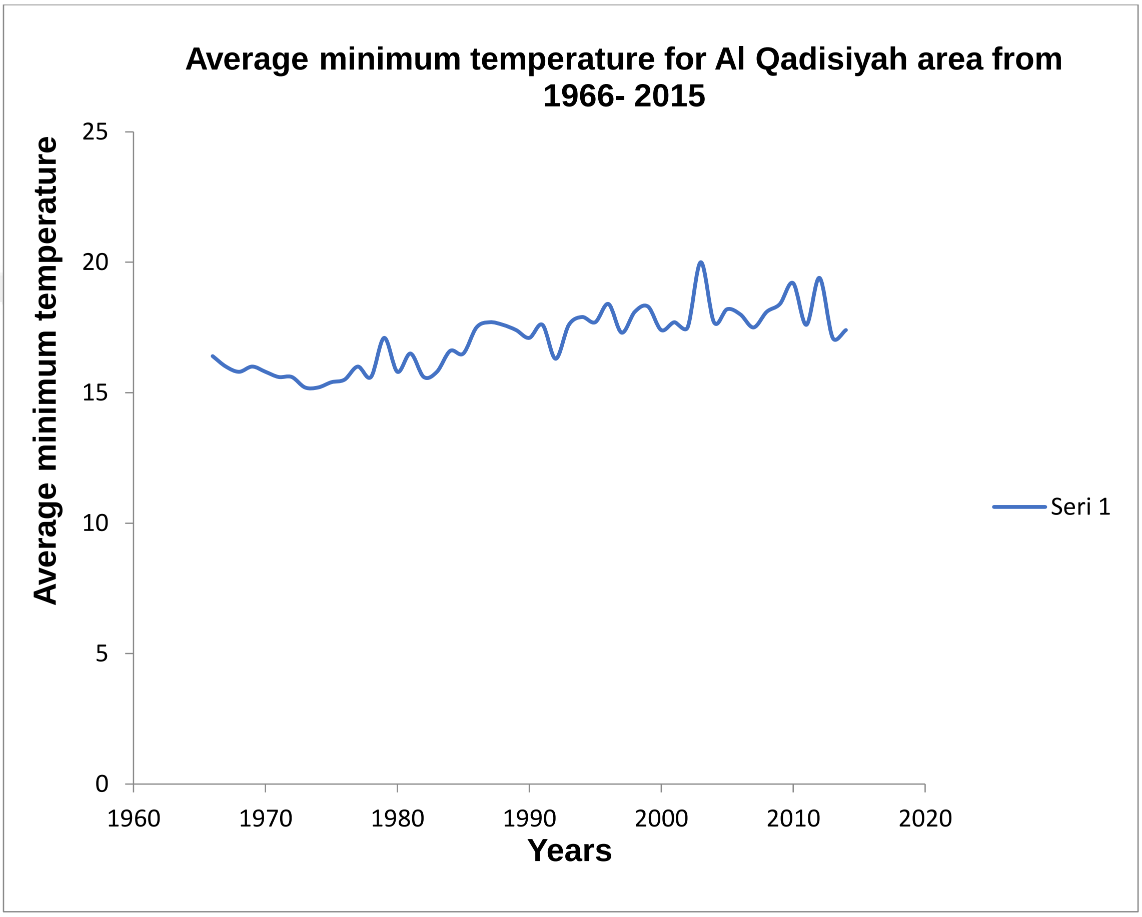


Figure 3.7. Average Yearly Minimum Temperature in Al Qadisiyah from 1966-2015:

Source: Meteorological Organization and Seismology of Iraq

Table 3.8 Average Yearly Maximum Temperature for Al Qadisiyah area from 1966-2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	15.6	19.0	20.2	29.3	37.4	41.5	45.1	43.7	41.4	35.6	24.0	18.2	30.9
1967	13.7	16.5	22.9	32.4	38.3	42.4	46.1	45.0	40.5	34.9	24.9	24.9	31.8
1968	14.2	17.4	24.2	30.0	38.6	42.9	45.4	43.9	41.6	34.7	27.5	20.6	31.7
1969	13.4	16.1	19.5	28.9	35.3	42.0	43.3	44.3	41.2	34.9	23.7	15.5	29.8
1970	16.7	19.3	24.8	34.0	38.8	42.6	47.4	46.6	40.9	32.8	23.5	18.5	32.1
1971	18.3	19.7	25.5	28.4	37.5	39.2	42.0	41.6	40.6	32.6	23.9	16.1	30.4
1972	13.6	16.4	23.0	30.6	32.9	40.4	41.2	43.3	39.7	35.8	24.5	14.7	29.9
1973	16.5	21.4	24.9	29.4	36.8	39.3	42.1	44.8	41.2	36.8	23.0	17.6	31.1
1974	13.9	16.3	22.7	28.1	37.6	42.0	43.2	43.0	40.3	36.0	27.4	16.4	30.5
1975	14.9	18.1	24.9	31.9	37.2	42.0	44.6	42.9	41.9	33.1	25.9	15.6	31.0
1976	19.5	17.5	21.5	30.1	35.5	41.7	41.8	42.3	39.4	34.2	26.7	20.8	30.9
1977	13.4	22.9	26.0	30.4	37.4	42.0	43.7	44.4	41.3	33.8	24.1	17.9	31.4
1978	18.7	21.7	26.1	31.1	37.7	40.6	44.8	41.4	40.5	35.8	21.3	19.0	31.5
1979	18.2	22.7	24.7	32.3	37.4	41.9	43.5	43.8	43.2	34.7	27.7	17.7	32.3
1980	16.3	17.9	25.0	31.3	37.5	43.0	45.3	43.3	39.9	33.7	25.6	19.1	31.4
1981	18.2	20.6	25.7	30.8	35.4	41.7	44.8	44.4	42.5	35.3	24.7	20.9	32.0
1982	16.0	15.4	22.6	31.3	36.7	41.5	43.2	42.9	42.1	32.7	21.9	15.8	30.1
1983	14.0	18.7	23.4	29.5	37.9	41.5	44.4	42.9	40.2	33.9	27.9	18.9	31.1
1984	17.9	21.5	25.5	31.7	33.6	41.1	43.6	40.7	40.5	38.2	23.8	16.2	31.1
1985	18.5	18.3	23.1	31.6	38.4	41.8	42.9	45.8	41.1	33.3	26.5	17.8	31.5
1986	18.0	19.6	24.0	31.8	36.5	39.7	44.8	46.0	43.2	34.6	22.5	17.0	31.4
1987	18.2	23.3	21.6	31.3	38.3	41.7	44.9	44.2	40.6	31.4	25.4	19.5	31.7
1988	16.1	19.5	22.9	29.7	36.9	41.0	44.5	43.3	39.1	35.2	23.5	18.3	30.8
1989	14.4	17.1	23.5	31.4	37.9	41.1	45.0	44.2	40.0	35.1	25.5	18.5	31.1
1990	15.2	18.4	24.9	31.3	38.9	42.5	45.1	43.3	40.9	34.7	27.8	21.0	32.0
1991	15.4	18.2	23.9	33.1	35.8	42.9	42.9	42.1	39.9	32.8	26.8	17.6	30.9
1992	13.9	16.4	20.1	29.6	35.3	41.1	42.1	43.1	40.2	34.0	22.2	16.2	29.5
1993	15.3	18.3	24.5	29.2	35.2	41.4	43.9	43.8	40.6	34.5	22.8	20.6	30.8
1994	19.0	20.5	25.6	33.4	38.5	41.6	42.7	42.6	40.3	34.4	23.7	14.7	31.4
1995	18.0	20.1	25.1	30.2	38.7	41.8	41.9	42.9	39.0	33.3	24.6	17.8	31.1
1996	17.4	20.4	23.3	30.3	40.3	42.4	46.4	43.7	39.9	33.6	25.3	22.2	32.1
1997	17.9	18.4	21.7	30.5	38.8	43.6	43.6	41.3	40.6	33.7	24.3	17.9	31.0
1998	15.2	19.5	22.7	32.3	38.1	44.4	45.5	46.2	40.6	35.1	29.2	22.4	31.8
1999	19.0	21.6	26.0	32.8	39.5	43.2	44.3	45.5	41.2	36.2	25.3	19.3	32.8
2000	16.7	19.3	24.8	34.0	38.8	42.6	47.4	46.6	40.9	32.8	23.5	18.5	32.1
2001	17.6	21.0	28.3	32.7	38.0	42.3	45.2	46.8	42.2	36.0	25.4	20.5	33.0
2002	16.4	22.1	27.7	30.0	38.2	42.6	45.4	43.6	41.4	36.3	25.3	16.9	32.1
2003	MISS	MISS	26.6	31.9	38.5	42.9	43.9	45.6	40.4	35.8	23.4	17.6	34.6
2004	20.4	20.9	28.2	31.6	37.8	43.3	45.4	43.1	41.5	36.9	24.5	16.5	32.5
2005	17.9	18.5	25.4	32.6	37.5	41.7	44.6	43.7	39.8	34.5	23.7	22.3	31.8
2006	17.3	20.6	26.9	31.9	38.9	43.7	42.1	45.2	40.1	34.4	23.4	15.4	31.6
2007	15.4	20.4	25.0	30.0	40.0	42.6	44.2	44.6	41.4	36.5	26.5	19.2	32.1
2008	13.7	19.8	30.8	33.7	37.8	42.2	44.5	45.8	41.6	33.4	25.5	19.5	32.3
2009	17.8	22.5	29.7	30.4	38.5	43.3	43.5	45.1	40.0	35.4	24.5	21.5	32.6
2010	21.6	23.2	28.7	32.7	38.6	44.3	46.2	44.2	42.7	36.8	29.3	22.4	34.2
2011	20.4	27.2	25.9	37.3	38.2	43.0	45.6	45.2	42.6	33.8	23.6	19.3	33.5
2012	18.6	20.4	24.2	33.5	39.6	44.7	47.2.	45.2.	43.1	35.2	25.6	20.5	33.1
2013	18.7	23.9	26.8	33.7	39.4	41.8	43.7	45.1	44.1	33.8	23.3	21.4	32.9
2014	17.3	22.2	26.4	33.4	38.3	42.7	45.3	46.2	44.8	33.8	24.0	21.5	32.9
2015	18.5	21.2	26.1	31.8	39.8	42.8	45.6	45.8	42.7	35.8	24.1	16.9	32.5

Source: Meteorological Organization and Seismology of Iraq

The yearly average maximum temperature of Al Qadisiyah in 1966 -1990 was lowest than the yearly average in 1991-2015 to the same area, it was 31.1 and 32.2 °C respectively. That means the average maximum temperature increased within the last 3 decades in this area (Figure 3.8).

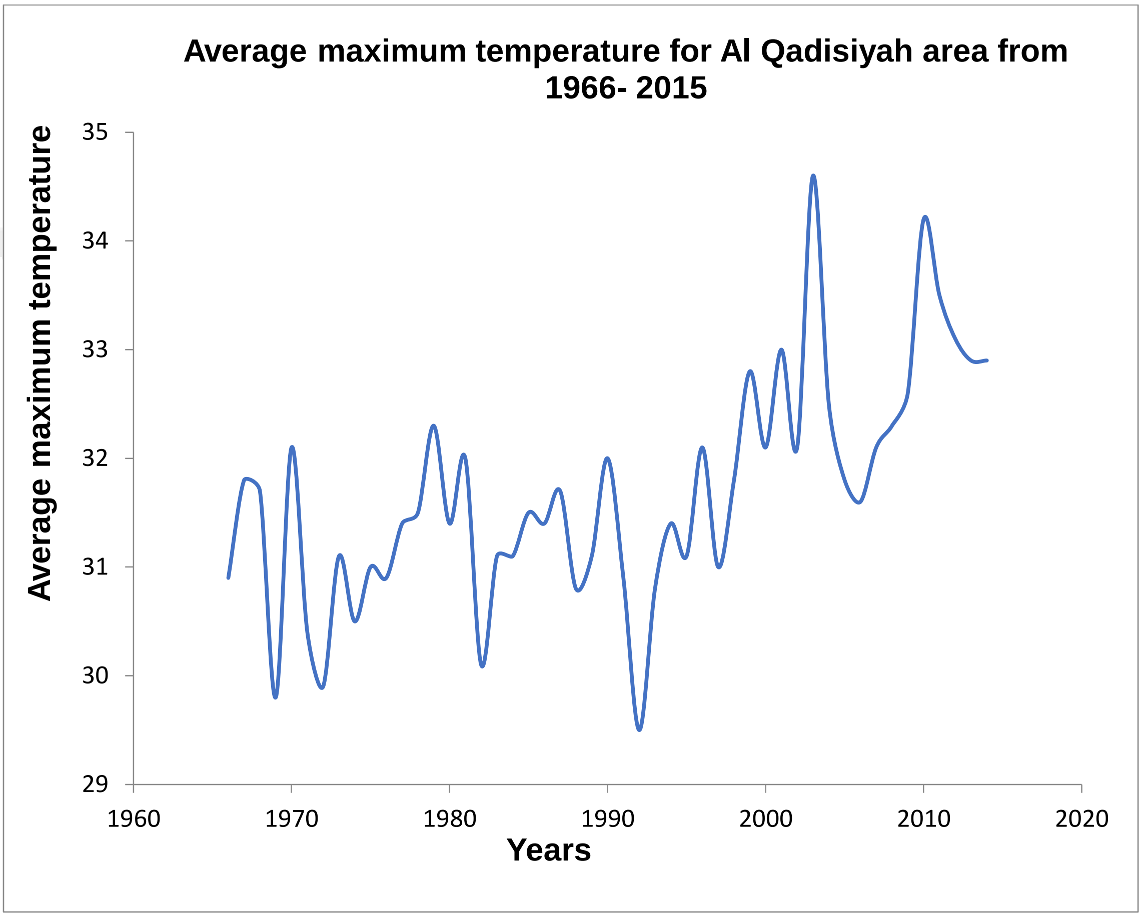


Figure 3.8. Average Yearly Maximum Temperature in Al Qadisiyah from 1966-2015:

Source: Meteorological Organization and Seismology of Iraq

The next two tables (3.9 and 3.10) will show us the average yearly minimum and maximum temperatures, respectively in Al Muthanna province started from 1966 till 2015.

Table 3.9. Average Yearly Minimum Temperature for Al Muthanna area from 1966-2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	7.8	8.9	11.8	15.6	21.8	26.1	26.7	27.5	23.5	18.5	13.0	7.7	14.3
1967	5.3	4.5	8.8	13.8	20.7	23.1	27.2	25.0	22.3	18.6	13.6	6.2	15.6
1968	4.8	6.4	10.7	16.0	22.0	24.2	27.4	25.4	22.8	18.8	13.9	9.6	16.8
1969	8.0	7.8	14.6	16.1	21.6	25.0	26.0	25.6	23.0	20.0	9.5	8.1	17.1
1970	7.3	9.0	12.1	17.6	21.9	25.3	26.5	25.5	22.4	17.3	14.6	5.4	17.0
1971	5.8	7.9	11.7	15.2	23.3	23.6	26.4	25.6	22.9	16.5	13.0	6.7	16.5
1972	5.0	4.8	10.9	17.6	19.6	25.1	25.7	26.4	23.2	19.4	11.0	4.3	16.0
1973	4.2	9.8	10.4	15.5	21.0	24.1	25.9	27.5	23.3	17.7	9.2	6.6	16.2
1974	5.4	7.0	12.4	15.4	21.4	25.0	26.1	26.1	22.6	17.2	12.6	6.7	16.4
1975	4.9	6.7	9.9	17.0	21.1	26.2	27.4	26.0	24.1	15.4	10.5	5.9	16.2
1976	5.2	5.9	9.1	15.8	20.4	24.4	25.9	25.5	22.1	17.6	10.5	8.0	15.8
1977	2.7	7.4	11.2	13.7	20.1	26.0	28.3	26.9	23.3	15.3	10.4	8.6	16.1
1978	7.0	8.6	11.7	16.1	21.5	24.8	28.1	25.7	23.8	17.3	8.2	9.4	16.8
1979	7.9	9.7	10.9	18.2	22.6	26.9	28.5	27.1	24.8	19.6	13.7	6.9	18.0
1980	5.1	6.5	12.7	16.9	21.8	26.1	27.9	25.5	20.1	18.3	13.9	7.3	16.8
1981	6.5	9.1	12.7	16.5	21.3	25.5	27.9	27.1	22.1	18.9	10.4	8.7	17.2
1982	6.9	5.2	10.5	18.5	24.0	26.5	27.6	25.9	23.4	19.5	9.0	4.2	16.7
1983	2.5	4.5	8.0	14.7	22.8	26.9	29.9	26.1	24.6	16.6	14.1	8.5	16.6
1984	6.8	7.8	13.1	17.9	21.1	24.9	28.2	24.4	23.0	19.7	14.9	6.7	17.3
1985	8.5	6.9	10.7	17.6	23.9	25.4	26.4	27.7	23.4	17.5	14.5	7.1	17.4
1986	5.8	9.4	12.3	19.1	23.4	24.8	28.3	28.8	23.3	21.0	10.9	5.8	17.7
1987	5.4	10.6	11.9	17.7	25.3	26.9	29.3	29.2	25.1	19.4	12.5	10.1	18.6
1988	6.0	8.7	12.4	17.5	23.3	26.4	28.6	27.3	24.5	20.4	11.4	8.1	17.8
1989	3.2	5.7	13.2	19.3	24.6	25.8	28.2	26.9	24.4	19.1	14.1	6.3	17.5
1990	4.4	7.1	11.1	17.0	22.3	26.2	28.6	26.3	22.9	19.0	12.6	8.1	17.1
1991	6.6	7.4	13.1	19.2	21.5	28.0	29.6	28.4	23.5	19.7	14.0	7.8	18.2
1992	3.2	5.3	8.7	16.5	22.5	26.5	26.9	27.5	23.0	17.9	13.0	7.3	16.5
1993	5.4	7.1	12.5	17.7	23.1	26.4	27.6	27.7	24.2	20.1	11.6	9.1	17.7
1994	9.1	8.0	11.6	18.0	22.1	24.1	25.4	24.2	23.9	19.4	12.9	5.4	17.0
1995	7.3	8.6	12.0	17.1	23.1	25.2	26.5	25.3	23.2	16.0	10.1	6.7	16.7
1996	7.4	9.7	11.7	16.3	25.1	26.2	28.0	28.0	21.2	16.8	12.1	9.0	17.6
1997	5.7	3.6	8.3	15.6	22.6	26.2	26.5	24.1	23.2	19.4	13.4	8.5	16.4
1998	5.8	7.5	10.7	17.4	22.7	27.1	27.9	28.3	22.5	17.2	12.2	7.3	17.2
1999	6.9	8.4	11.0	16.6	24.6	26.7	27.7	28.0	25.8	18.7	9.4	4.3	17.3
2000	4.4	4.6	10.1	20.1	22.7	25.2	29.9	28.1	22.6	16.4	9.7	8.2	16.8
2001	5.5	6.4	12.5	17.1	21.6	24.0	26.1	28.3	22.1	18.2	9.1	8.7	16.6
2002	4.4	6.5	11.5	16.5	22.4	25.3	27.0	25.7	24.3	19.1	20.3	8.2	17.6
2003	miss	miss	miss	miss	miss	miss	miss	miss	23.2	miss	miss	miss	
2004	7.5	9.9	14.3	16.9	23.9	27.2	29.4	28.1	24.6	21.8	8.4	6.4	18.2
2005	6.9	8.3	12.7	19.3	24.1	27.9	29.2	29.8	25.1	18.4	10.9	9.4	18.5
2006	7.1	10.5	14.0	19.1	25.2	27.0	28.5	28.2	21.5	22.8	10.7	4.7	18.2
2007	4.0	8.9	12.0	17.1	26.0	27.1	28.2	28.3	23.4	19.7	11.6	7.0	17.7
2008	3.4	7.1	14.5	19.7	23.8	27.0	27.5	28.8	24.5	20.0	12.9	6.3	17.9
2009	4.1	9.9	12.6	17.6	24.7	28.1	27.9	28.1	26.0	20.7	13.2	10.2	18.5
2010	8.4	11.2	15.0	19.1	24.6	28.2	28.2	28.3	24.6	20.6	12.2	9.2	19.1
2011	6.4	8.7	12.0	18.3	24.2	27.6	29.2	28.2	23.2	19.8	12.1	9.1	18.2
2012	6.3	5.4	10.6	20	25.9	28	30	28.3	25	21.8	15.1	10.3	18.8
2013	8.3	10.1	14.4	18.9	23.6	26.8	28.3	27.9	25	17.6	15.2	7.7	18.6
2014	8.2	8.4	15.5	19.9	25.3	27.9	29.2	29.8	26	21.0	12.4	10.0	19.4
2015	7.1	10.1	13.3	17.9	25.8	27.9	30.0	30.5	25.9	22.3	13.2	7.7	19.3

Source: Meteorological Organization and Seismology of Iraq

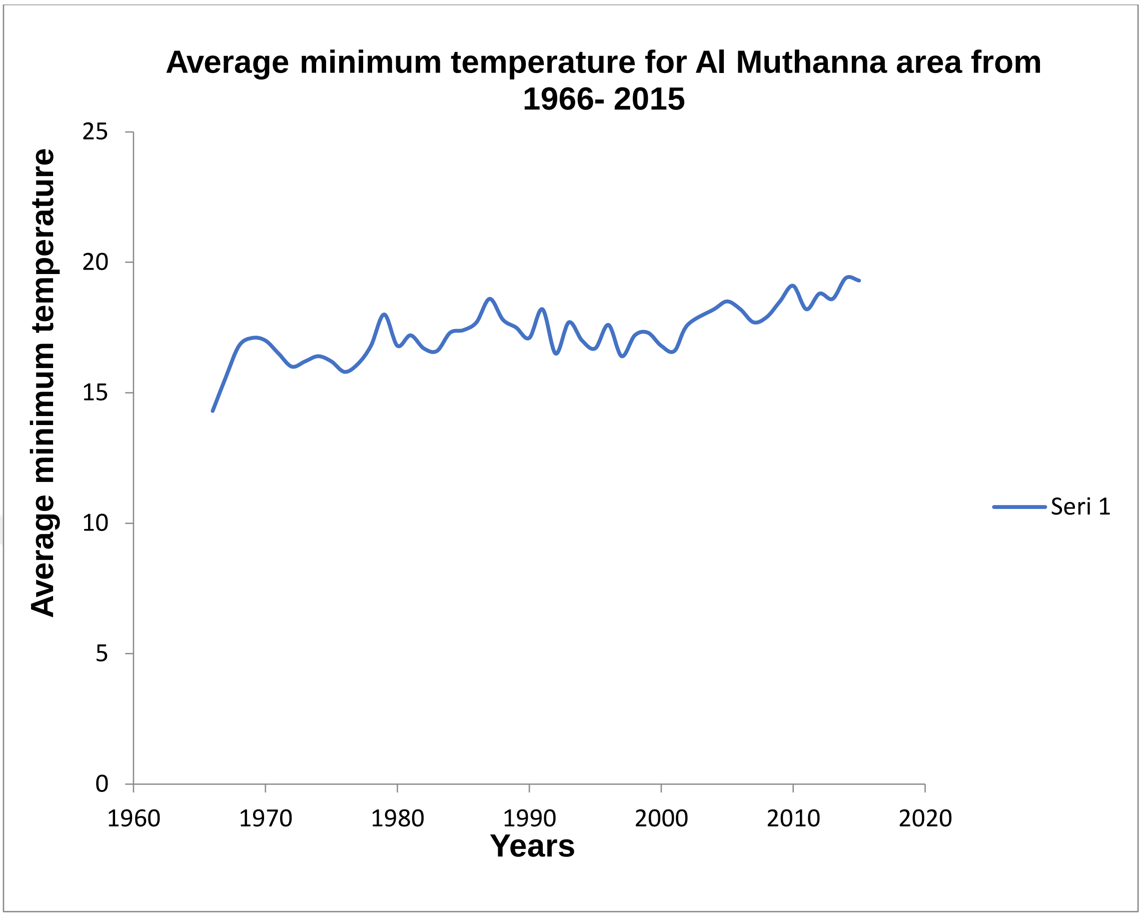


Figure 3.9. Average Yearly Minimum Temperature in Al Muthanna from 1966-2015:

Source: Meteorological Organization and Seismology of Iraq

Table 3.10. Average Yearly Maximum Temperature for Al Muthanna area from 1966-2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	16.7	15.7	23.1	23.9	35.5	37.8	41.0	40.3	39.2	29.9	20.5	12.4	27.9
1967	10.3	12.6	20.1	28.3	30.8	38.1	39.8	41.7	37.7	33.2	21.5	12.1	27.1
1968	13.0	18.2	21.8	26.9	34.9	37.7	41.3	43.0	38.8	33.3	20.2	14.7	28.6
1969	10.5	13.7	19.7	24.9	34.9	39.6	41.9	40.2	37.1	34.2	23.0	13.4	27.7
1970	12.0	15.0	21.9	29.7	34.2	39.1	42.1	40.4	38.2	30.2	22.5	13.0	28.1
1971	14.0	14.4	18.5	26.0	33.1	39.1	40.0	40.3	36.5	31.5	24.9	17.2	27.9
1972	11.1	21.9	24.0	28.3	34.7	39.2	42.4	42.9	38.7	29.4	23.4	15.2	29.2
1973	15.4	19.2	24.1	29.1	35.2	38.4	43.7	39.8	37.8	33.3	19.0	16.5	29.2
1974	15.9	20.3	23.6	28.8	35.0	38.7	41.1	42.0	40.6	31.7	24.2	14.9	29.7
1975	13.0	15.4	21.5	27.3	34.7	38.7	43.7	41.1	37.0	30.8	22.6	15.6	28.4
1976	15.1	17.0	21.4	27.3	31.0	38.9	38.9	42.1	39.9	33.4	21.2	18.3	28.7
1977	13.7	14.3	18.7	28.4	33.8	38.4	40.3	40.5	38.8	29.3	17.6	12.2	27.1
1978	10.3	14.8	20.4	27.1	34.2	38.4	41.6	41.3	38.2	30.0	25.1	15.7	28.0
1979	17.1	20.0	18.2	27.8	35.3	38.5	42.7	41.6	37.9	27.8	21.4	14.9	28.6
1980	16.6	18.4	25.9	32.3	37.8	43.0	45.4	43.0	41.1	33.9	25.9	19.5	31.9
1981	18.3	21.3	26.7	31.5	36.6	43.4	44.7	44.6	40.1	35.9	25.3	21.7	32.5
1982	15.9	15.2	21.3	32.0	37.6	42.9	43.8	44.3	43.0	32.6	22.7	15.6	30.5
1983	14.7	19.3	24.2	30.6	38.5	41.5	44.2	42.6	42.6	33.8	29.1	20.2	31.7
1984	14.5	22.6	26.9	33.1	36.6	41.1	44.3	40.4	40.3	33.9	24.1	16.5	31.1
1985	19.2	19.8	23.7	32.8	39.1	41.5	42.5	45.5	40.5	33.7	27.0	18.5	31.9
1986	18.7	20.3	24.5	32.7	37.1	39.7	45.0	45.7	41.0	36.7	22.6	17.4	31.7
1987	19.8	24.7	23.1	32.4	39.1	41.5	45.1	44.3	43.6	32.2	25.2	20.5	32.6
1988	16.9	20.9	24.3	30.8	38.0	41.5	44.3	42.5	41.2	35.9	24.8	18.8	31.6
1989	15.3	17.8	24.7	34.3	38.9	42.7	44.9	44.3	41.1	35.9	26.1	19.4	32.1
1990	15.7	19.1	26.1	32.5	39.3	42.7	44.9	43.2	40.3	35.4	28.3	22.1	32.4
1991	16.2	15.0	20.4	29.0	36.6	39.8	40.9	43.3	41.1	33.4	28.1	18.3	30.1
1992	14.7	17.4	21.2	30.2	35.8	41.0	41.6	43.1	40.4	34.8	24.2	17.2	30.1
1993	16.0	19.1	24.5	30.7	35.7	41.6	44.0	44.6	40.7	36.0	24.7	21.9	31.6
1994	19.8	21.3	26.2	33.1	38.4	41.9	42.9	43.3	41.6	35.0	24.8	14.9	31.9
1995	18.1	20.1	25.4	30.7	38.9	42.5	42.6	43.8	40.9	34.4	25.8	17.1	31.6
1996	17.7	20.3	23.6	31.3	40.5	43.2	46.3	45.9	40.1	34.9	25.6	22.5	32.6
1997	18.3	18.4	22.4	31.1	40.8	44.4	43.8	41.8	40.7	34.5	24.5	17.6	31.5
1998	15.8	19.8	23.2	31.3	39.0	44.6	45.7	46.3	42.0	35.9	30.0	23.2	33.0
1999	19.8	21.5	26.5	33.1	39.9	44.8	44.8	45.9	42.0	36.5	24.6	18.7	33.1
2000	16.4	19.4	25.1	34.3	39.4	42.6	47.6	46.8	41.3	31.9	23.6	18.3	32.2
2001	17.4	21.2	28.3	33.2	38.2	43.1	45.4	46.9	40.8	35.9	25.6	20.5	33.0
2002	16.0	22.4	27.8	29.9	38.9	43.1	46.0	44.1	42.6	35.1	36.4	21.0	33.6
2003									41.8				
2004	17.6	19.9	27.8	32.5	40.5	46.5	46.2	49.2	42.5	35.7	23.6	16.0	33.1
2005	16.8	19.6	25.1	33.1	39.2	44.1	44.4	44.3	42.0	33.8	23.6	22.2	32.3
2006	17.5	20.2	28.2	32.7	40.1	45.0	44.4	44.5	40.4	35.7	24.0	14.7	32.2
2007	12.6	21.0	24.2	30.3	40.6	43.8	44.0	45.6	41.1	36.7	26.7	19.0	32.1
2008	13.6	20.1	30.6	34.7	38.7	42.8	45.2	46.2	41.9	34.3	25.2	19.8	32.7
2009	17.7	22.4	26.0	30.7	38.8	43.7	43.7	45.0	42.2	35.5	24.9	21.6	32.6
2010	21.6	23.3	29.1	33.3	39.2	43.6	43.8	45.1	40.4	36.6	24.8	20.5	33.4
2011	17.7	19.8	25.5	31.4	38.2	43.8	43.7	45.2	41.0	33.5	24.6	20.6	32.0
2012	17.6	19.4	24.2	34.0	40.1	45.0	47.0	45.6	41.9	36.2	25.6	19.6	33.0
2013	18.2	22.8	27.5	32.3	37.2	41.9	44.4	44.5	40.8	32.8	24.0	17.0	31.9
2014	16.7	20.5	26.7	32.1	39.1	42.7	44.4	46.5	41.8	34.0	25.0	21.6	33.3
2015	19.2	21.6	26.8	32.2	40.5	43.6	47.0	46.9	43.5	34.6	24.5	17.8	33.1

Source: Meteorological Organization and Seismology of Iraq

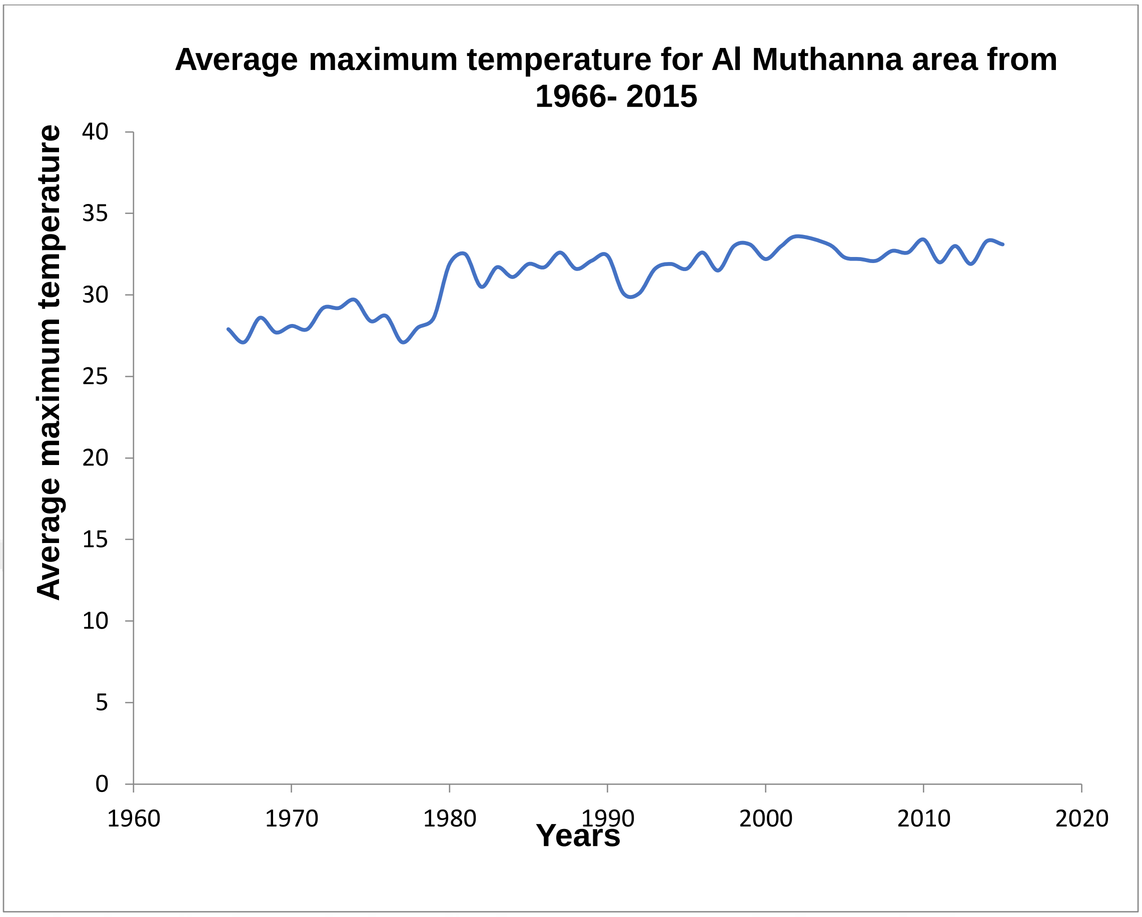


Figure 3.10. Average Yearly Maximum Temperature in Al Muthanna from 1966-2015: Source: Meteorological Organization and Seismology of Iraq

The yearly average minimum temperature of Al Muthanna in 1991-2015 (second 25 years for study period) was higher than the yearly average in 1966-1990 (first 25 years) to the same area, it was 17.8 and 16.7 °C, respectively. Yearly average maximum temperature in 1991-2015 (second 25 years for the study period) was higher than the yearly average in 1966-1990(first 25 years) to the same area, it was 32.3 and 29.8 °C respectively. That means average minimum and maximum temperature increased within the last 3 decades in this area (Figures 3.9 and 3.10).

Finally, the next two tables (3.11 and 3.12) shows the average yearly minimum and maximum temperature respectively in Thi Qar province started from 1966 till 2015 too.

Table 3.11. Average Yearly Minimum Temperature for Thi Qar area from 1966- 2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	8.4	10.2	12.4	18.1	24.4	26.8	27.2	26.7	24.1	19.5	13.7	8.2	18.3
1967	6.0	5.8	9.8	15.3	22.8	25.1	27.3	25.6	23.2	20.2	14.2	6.8	16.8
1968	4.9	7.3	12.0	17.6	24.2	26.9	28.9	25.8	23.7	19.6	14.9	10.4	18.0
1969	8.9	9.2	16.5	18.0	23.8	27.5	27.0	26.5	24.0	20.8	10.8	9.5	18.5
1970	7.5	10.2	13.6	19.5	23.1	24.6	26.1	25.3	21.7	17.8	14.9	5.7	17.5
1971	5.9	8.2	12.0	16.4	24.8	24.6	26.4	25.4	22.2	16.9	13.2	8.6	17.0
1972	5.2	5.4	12.1	18.6	21.5	27.0	26.1	27.1	23.4	19.4	11.6	6.3	16.9
1973	4.3	10.1	10.9	16.7	22.0	24.3	26.1	27.6	23.6	19.2	10.0	4.2	16.5
1974	6.0	7.5	13.5	16.7	22.8	25.8	26.8	26.4	23.5	18.3	13.1	6.6	17.2
1975	4.9	7.3	10.8	17.6	22.8	25.5	27.4	26.1	25.3	15.8	11.6	6.5	16.8
1976	6.7	7.3	10.6	17.8	21.7	25.5	26.2	25.8	23.2	19.6	11.8	7.0	16.9
1977	4.3	9.0	13.8	16.8	22.3	25.5	26.5	24.7	23.9	17.4	11.2	9.1	17.0
1978	6.8	8.9	12.6	16.9	21.4	24.5	27.2	24.2	23.1	17.4	8.1	8.9	16.6
1979	8.3	9.1	11.1	18.2	22.8	26.4	27.4	26.6	24.7	20.1	13.4	8.9	18.0
1980	6.4	7.8	13.6	18.1	21.7	26.0	27.7	25.1	22.1	18.1	13.4	6.8	17.2
1981	6.7	9.1	12.4	16.6	21.4	24.6	27.4	27.1	23.6	17.9	11.1	6.5	17.0
1982	7.5	6.3	10.8	18.8	24.0	25.4	26.9	26.0	24.9	19.6	9.0	8.6	17.3
1983	3.3	5.8	9.5	15.7	22.9	26.1	27.9	26.8	22.6	16.4	14.3	4.8	16.3
1984	6.7	8.0	13.6	17.6	21.4	25.6	28.4	24.8	24.1	17.4	15.5	8.1	17.6
1985	8.8	7.8	10.6	17.7	23.9	26.0	26.6	27.4	23.3	17.7	14.6	6.6	17.5
1986	6.0	9.5	12.2	19.0	23.8	25.5	28.3	29.3	24.6	20.9	10.5	7.2	18.0
1987	5.4	10.2	12.2	18.0	25.6	26.5	28.7	28.6	24.4	19.8	12.2	6.2	18.2
1988	5.7	8.0	12.8	17.3	22.9	25.7	28.2	27.2	24.6	20.5	11.5	9.1	17.7
1989	2.8	4.8	13.8	17.6	24.5	25.6	28.3	27.2	23.5	19.5	14.3	8.2	17.5
1990	4.6	7.7	11.8	33.3	23.3	26.3	28.4	26.6	23.7	18.9	12.8	6.7	18.6
1991	6.8	7.4	14.2	18.8	21.0	25.7	27.0	25.9	24.2	20.5	13.3	7.8	17.7
1992	3.1	6.1	8.9	16.8	22.4	26.6	26.9	27.2	23.9	16.9	12.8	8.2	16.6
1993	5.3	7.5	13.1	17.6	23.4	26.6	28.8	27.9	23.8	20.0	11.8	7.8	17.8
1994	9.5	8.4	13.3	19.7	24.0	26.5	27.9	26.5	25.3	21.0	15.0	8.9	18.8
1995	8.2	10.0	13.1	18.0	24.3	27.5	28.0	27.3	23.5	17.9	11.7	6.0	17.9
1996	8.9	10.5	13.2	17.5	26.0	26.8	29.8	29.0	25.5	18.5	13.1	8.0	18.9
1997	7.4	5.0	10.6	17.2	24.8	27.1	27.8	26.2	24.3	21.3	14.3	10.7	18.0
1998	6.7	8.5	12.6	18.7	23.8	28.4	29.4	30.2	26.1	18.1	13.8	9.4	18.8
1999	8.6	10.2	13.1	19.3	24.7	27.9	28.9	30.2	25.4	20.8	12.5	9.8	19.2
2000	6.5	7.7	11.6	21.4	24.5	26.7	31.0	30.0	24.1	18.6	12.0	8.6	18.5
2001	6.6	8.4	14.4	19.0	23.7	25.9	27.8	30.0	25.9	20.5	11.1	10.9	18.6
2002	5.7	8.7	13.2	18.3	23.8	26.7	29.3	27.7	25.2	21.1	12.5	8.1	18.3
2003													
2004	6.8	7.9	12.9	15.9	22.9	26	28.7	27.5	24.2	21.5	14.7	5.4	17.8
2005	6.4	8.1	12.9	19.5	24.7	27.5	30.3	28.7	23.7	19.2	11.3	9.2	18.4
2006	7.8	10.4	14.0	18.5	25.7	28.1	29.7	30.4	24.5	22.9	11.9	5.5	19.1
2007	4.7	9.6	12.9	19.0	26.5	27.9	29.3	29.4	25.7	21.1	13.2	7.9	18.9
2008	4.0	7.8	15.3	20.7	25.5	28.9	29.7	30.3	27.4	20.7	13.6	6.8	19.2
2009	4.2	11.2	13.5	18.3	25.7	27.1	29.5	30.4	25.3	21.6	13.8	10.1	19.2
2010	9.9	12.1	15.8	20.0	25.4	29.8	30.6	30.8	26.8	22.2	12.2	8.4	20.3
2011	8.6	9.0	12.3	19.1	25.2	28.2	28.2	30.5	27.4	21.8	12.1	10.8	19.4
2012	5.2	7.4	11.7	19.5	25.1	29.0	31.0	26.6	25.6	22.2	15.8	10.4	19.1
2013	7.0	10.0	11.7	15.7	21.0	25.0	25.9	24.3	21.6	14.7	13.5	5.1	16.2
2014	6.4	6.7	12.3	16.8	21.8	24.5	25.9	26.4	23.3	18.6	10.1	7.9	16.7
2015	4.9	7.7	10.7	15.2	22.2	25.3	27.1	27.7	24.4	20.0	11.3	5.5	16.8

Source: Meteorological Organization and Seismology of Iraq

The case with the province of Thi Qar, and according to the above Table 3.11, the yearly average minimum temperature of this area in 1966-1990 (first 25 years for study period) was lower than the yearly average in 1991-2015(second 25 years) to the same area, it was 17.3 and 18.3 °C, respectively. That means the average minimum temperature increased in this area (Figure 3.11).

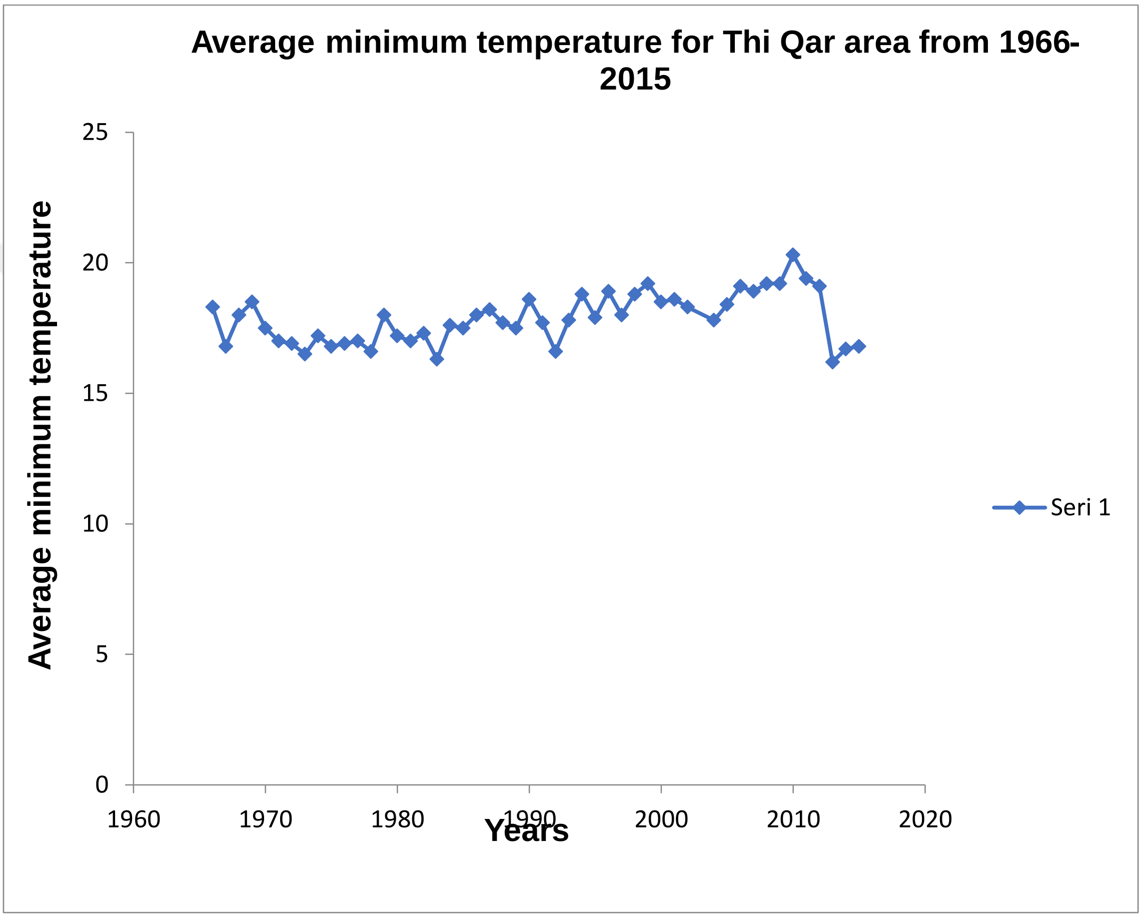


Figure 3.11. Average Yearly Minimum Temperature in Thi Qar from 1966-2015: Source: Meteorological Organization and Seismology of Iraq

Table 3.12. Average Yearly Maximum Temperature for Thi Qar area from 1966- 2015

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	20.5	20.6	24.5	30.8	37.0	40.6	42.0	44.5	41.6	33.2	28.6	20.9	32.0
1967	17.3	16.6	23.4	29.5	35.1	37.2	41.1	40.6	40.2	33.8	23.1	17.7	29.6
1968	15.8	18.1	24.8	28.6	35.4	37.6	42.5	40.2	40.6	35.0	25.9	19.8	30.3
1969	16.7	18.4	26.8	27.4	35.9	40.1	39.2	41.7	40.7	35.3	23.3	20.3	30.4
1970	16.4	21.9	25.9	32.9	37.4	40.9	42.9	43.2	40.4	34.4	28.6	18.4	31.9
1971	19.3	20.5	26.6	29.4	37.9	37.9	40.9	41.7	41.5	34.0	25.0	18.8	31.1
1972	14.6	17.5	24.1	30.9	33.6	40.4	40.2	43.8	40.8	37.5	25.4	17.5	30.5
1973	17.0	22.3	25.4	31.4	38.3	40.9	43.3	45.9	41.7	37.4	24.5	14.5	31.8
1974	14.6	17.8	23.7	29.2	38.2	43.1	44.5	43.6	41.4	35.8	28.4	18.7	31.5
1975	15.3	18.9	25.2	32.0	37.8	42.4	44.9	43.6	42.7	34.0	26.2	17.0	31.6
1976	16.1	18.0	22.3	30.6	36.3	42.7	42.2	43.3	40.6	34.8	27.3	16.5	30.8
1977	13.9	23.3	26.2	30.5	38.5	42.2	43.4	45.2	42.6	31.1	24.1	21.6	31.8
1978	18.4	21.5	26.2	32.2	38.5	41.0	44.4	41.5	41.2	35.9	21.6	18.3	31.7
1979	18.9	23.3	25.7	33.3	37.8	42.5	43.9	43.8	43.5	35.2	28.8	20.7	33.1
1980	16.7	18.1	25.8	31.7	37.6	43.5	45.7	43.5	40.8	34.6	25.6	18.2	31.8
1981	18.5	21.0	26.2	31.2	36.7	42.4	44.3	44.6	42.6	35.3	25.5	19.5	32.3
1982	16.4	15.8	21.9	32.1	37.4	41.8	43.9	42.4	42.5	32.3	22.2	21.5	30.8
1983	14.4	18.9	23.2	29.4	37.7	41.0	44.2	42.9	40.6	33.8	29.1	16.1	30.9
1984	18.5	22.3	26.6	32.7	36.8	41.7	44.9	41.1	41.4	34.3	24.3	20.7	32.1
1985	18.9	19.4	23.8	32.2	39.3	42.2	43.5	45.9	42.2	34.5	27.6	16.6	32.1
1986	18.8	20.1	24.3	32.2	37.4	40.9	45.8	46.6	43.9	37.5	23.1	19.0	32.4
1987	19.4	24.5	23.6	32.3	40.7	42.7	46.1	45.0	42.3	32.9	26.3	17.1	32.7
1988	16.8	20.7	24.3	31.0	37.9	41.2	44.0	43.6	41.0	35.3	24.8	20.8	31.7
1989	14.5	16.7	23.9	32.2	38.3	41.6	45.7	45.3	41.1	35.9	26.1	18.4	31.6
1990	15.7	19.1	25.8	18.8	39.8	43.2	45.8	44.2	42.0	36.0	28.7	18.7	31.4
1991	16.0	18.6	26.9	33.3	36.2	43.5	43.8	43.4	41.0	33.3	27.9	22.2	32.1
1992	14.6	17.1	20.9	30.5	36.1	41.9	42.9	44.0	41.6	35.1	24.3	18.4	30.6
1993	15.5	19.0	24.8	31.0	36.5	42.6	45.1	45.1	42.3	35.8	24.6	17.0	31.6
1994	20.2	21.4	27.0	34.5	39.3	43.0	43.9	44.0	41.8	35.5	26.2	21.9	33.2
1995	19.1	20.7	25.6	31.4	39.8	43.1	43.6	45.0	40.7	35.1	26.1	16.1	32.1
1996	17.8	21.0	24.8	31.5	41.0	43.5	46.7	46.3	41.4	35.0	26.3	18.4	32.8
1997	19.0	18.8	22.8	31.3	39.8	44.6	44.3	42.7	42.2	35.1	24.7	23.2	32.3
1998	15.9	20.3	23.3	32.7	38.8	45.2	46.5	48.1	42.9	36.8	31.1	18.1	33.3
1999	19.9	21.3	25.7	34.0	41.2	44.9	45.5	47.5	42.7	37.9	25.8	23.7	34.1
2000	17.5	20.7	26.3	36.4	40.7	43.9	48.7	48.5	42.1	33.5	25.0	18.8	33.5
2001	18.0	22.4	28.4	34.7	40.2	44.0	46.5	48.6	43.5	37.0	26.8	20.9	34.2
2002	17.0	21.9	28.8	31.8	39.7	44.3	47.0	45.5	43.4	38.3	26.9	18.6	33.6
2003	M	M	M	M	M	M	M	M	M	M	M	M	M
2004	18.2	22.1	29.5	31.7	38.8	43.9	46.9	45.4	41.9	38.2	26.9	19.2	33.5
2005	18.0	19.9	26.3	33.9	39.8	43.7	46.6	46.0	42.0	36.2	24.9	22.7	33.3
2006	18.2	20.4	28.0	33.6	40.1	46.0	45.3	48.3	42.4	36.8	24.1	15.0	33.1
2007	15.7	21.8	25.7	31.6	41.1	44.4	45.7	46.2	43.2	38.0	27.9	19.5	33.4
2008	14.2	20.7	31.2	36.0	40.0	43.8	46.5	47.1	43.1	34.9	25.3	20.2	33.5
2009	18.2	23.0	26.9	31.5	40.0	43.2	44.7	45.9	41.4	36.9	25.9	21.9	33.2
2010	22.4	24.1	30.9	34.5	40.3	45.9	47.2	48.8	44.7	38.9	29.2	23.3	35.8
2011	22.3	21.2	26.6	32.5	40.2	45.8	47.3	48.7	44.6	38.6	28.8	21	34.8
2012	18.4	20.1	25.1	31.4	40.1	44.7	47	48.5	42.7	36.7	26.1	21.1	33.4
2013	18.5	22.9	27.5	31.7	34.6	40.5	43.1	43.1	40.6	32.3	23.9	17.6	31.3
2014	16.5	20.3	25.7	32.1	38.3	42.1	44.2	45.4	41.6	33.9	24.3	21.4	32.1
2015	19.4	21.5	26.4	31.8	39.7	42.8	45.6	46.3	43.0	36.5	24.4	17.9	32.9

Source: Meteorological Organization and Seismology of Iraq

The yearly average maximum temperature of this area in 1966-1990 (first 25 years for study period) was lower than the yearly average in 1991-2015(second 25 years) to the same area, it was 30.2 and 33.0 °C respectively. That means the average maximum temperature increased in this area too (Figure 3.12).

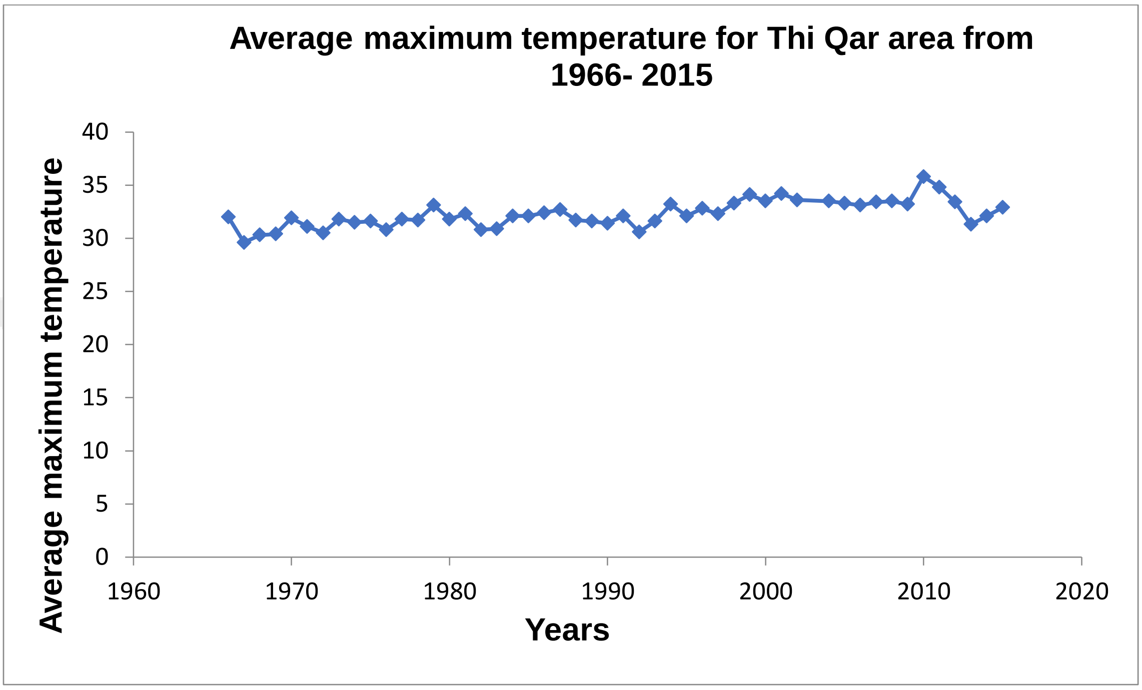


Figure 3.12. Average Yearly Maximum temperature in Al Thi Qar from 1966-2015: Source: Meteorological Organization and Seismology of Iraq

3.4. Relative Humidity

In this research relative humidity data from the Meteorological Organization and Seismology of Iraq (MOSI) were used. In this study, the data are made available for a period from 1966 to 2015.

In fact, the relative humidity considered to be another crucial factor that has a direct influence on the production of paddy in Iraq, and the following figures clearly present those impacts. Tables and figures (3.13, 3.14, 3.15, and 3.16) show the monthly and yearly average mean for a relative humidity of Najaf, Qadisiyah, Muthanna, and Thi Qar. It is interesting to note that there is a decreasing trend of humidity in these four cities during all months of the year. It is important to note that the results are indicating that at the time of summer months and particularly September trends are comparatively not significant compared with those of the other months. This is due to the fact that the driest season in Iraq is the summer.

Table 3.13. Relative Humidity % for Al Najaf area from 1966 to 2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	64	62	47	34	26	20	19	18	24	45	44	57	38.3
1967	63	64	44	35	35	26	20	21	16	40	73	72	42.4
1968	64	55	40	39	38	25	18	21	26	38	57	73	41.1
1969	77	58	46	46	32	18	18	22	24	37	57	65	41.7
1970	79	62	42	33	24	19	18	20	23	29	50	63	38.5
1971	61	52	37	47	28	19	18	19	19	29	57	62	37.3
1972	74	57	57	44	37	24	22	21	29	33	49	67	42.8
1973	53	50	35	33	25	21	19	19	22	25	44	70	34.6
1974	80	73	67	41	23	21	18	19	20	23	49	67	41.7
1975	78	66	41	35	29	18	15	17	20	28	39	67	40.0
1976	69	54	55	43	28	17	17	19	25	34	38	61	38.3
1977	74	52	41	37	28	17	15	16	21	36	51	73	38.4
1978	63	47	39	26	17	16	16	19	21	28	45	76	34.4
1979	69	54	41	30	26	20	16	21	21	40	45	65	37.3
1980	60	62	48	36	24	16	20	22	27	35	63	71	40.3
1981	70	59	56	40	34	28	23	24	27	38	58	72	44.0
1982	81	70	53	54	43	23	20	20	27	47	65	71	47.8
1983	61	52	45	40	34	23	19	24	27	37	56	81	41.5
1984	73	49	53	40	37	24	20	24	28	36	72	73	44.0
1985	72	55	51	41	32	26	23	22	25	39	62	70	43.1
1986	64	65	56	47	28	28	25	26	28	40	62	66	44.5
1987	57	50	57	47	31	27	30	29	31	46	53	67	43.7
1988	74	58	52	51	31	28	28	27	29	40	51	70	44.9
1989	65	56	57	39	31	25	20	22	29	39	61	63	42.2
1990	63	59	39	35	24	20	19	20	29	38	46	58	35.2
1991	76	63	57	34	30	24	26	32	31	54	55	66	45.6
1992	73	63	61	46	35	29	24	27	31	39	66	75	47.4
1993	75	67	49	56	40	24	20	25	28	38	49	66	44.7
1994	72	51	48	36	27	20	20	21	27	43	68	71	42
1995	77	70	54	43	27	25	23	21	28	42	51	67	44
1996	71	59	53	46	34	30	24	22	26	33	51	57	42.1
1997	63	46	44	35	26	23	23	26	29	43	68	79	42
1998	73	65	60	38	30	24	24	24	31	40	50	57	43
1999	71	58	42	35	29	27	26	24	33	38	51	71	42
2000	71	64	50	42	34	24	20	21	26	38	58	73	43.4
2001	71	57	51	43	34	17	17	16	23	33	42	63	38.9
2002	66	54	47	49	33	25	23	24	28	37	53		42
2003	MISS	MISS	48	43	34	31	23	20	24	31	55	70	37.9
2004	66	53	38	37	33	22	23	22	27	32	55	55	38.5
2005	56	53	45	38	24	18	19	21	30	41	59	63	38.9
2006	71	61	48	47	35	24	26	24	33	47	54	73	45.2
2007	69	63	50	48	33	27	23	28	31	39	50	60	43.4
2008	63	55	41	36	33	26	24	27	37	52	64	61	43.2
2009	61	58	50	48	39	30	27	28	35	43	58	65	45.1
2010	57	53	44	43	31	27	22	21	27	36	41	55	38
2011	70	61	42	39	30	30	22	21	31	40	51	55	41
2012	62	52	39	31	26	21	22	25	27	41	65	60	39.2
2013	65	60	40	33	44	25	21	24	28	36	58	66	41.6
2014	73	61	49	54	29	21	22	23	25	34	55	70	43.0
2015	72	57	51	41	26	19	21	24	28	38	45	71	37.7

Source: Meteorological Organization and Seismology of Iraq

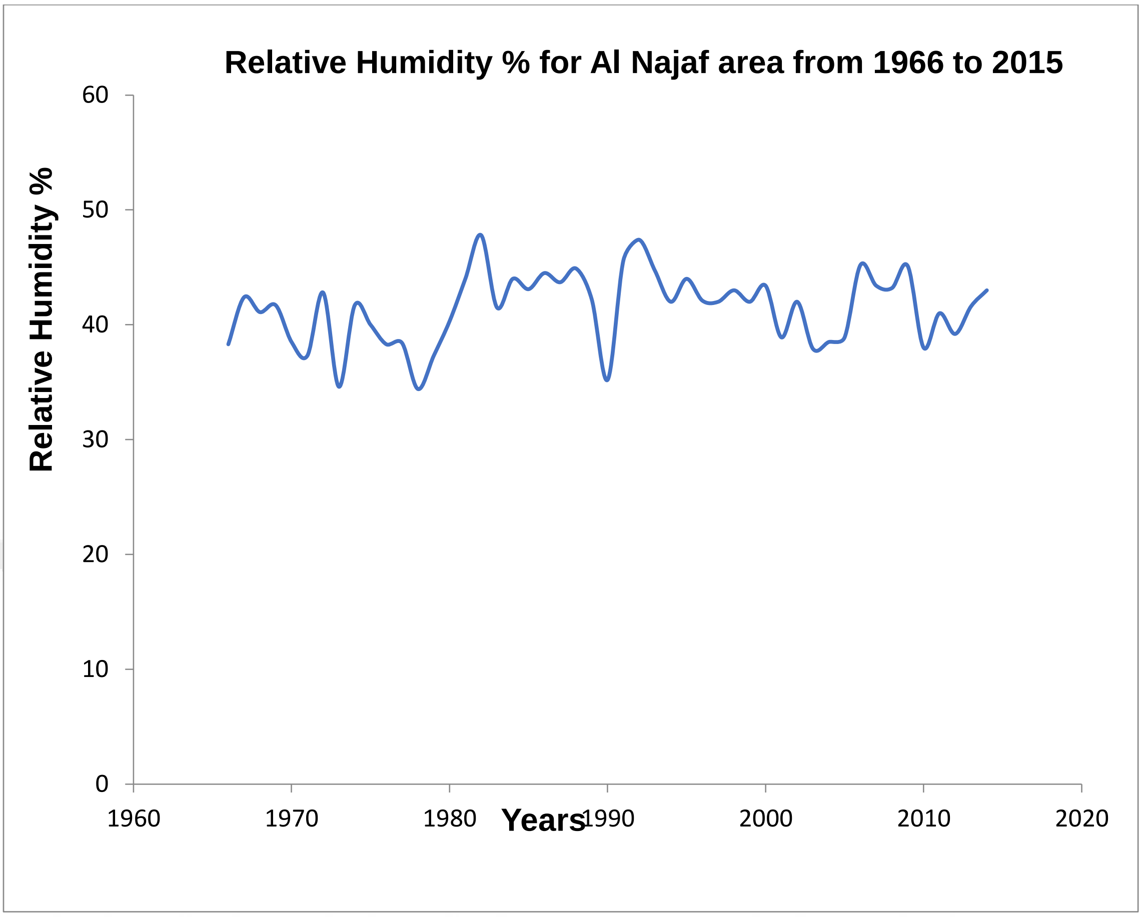


Figure 3.13. Relative Humidity % for Al Najaf area from 1966 to 2015:

Source: Meteorological Organization and Seismology of Iraq

Table 3.14. Relative Humidity % for Al Qadisiyah area from 1966 to 2015:

Years	Jan	Feb	Mar	Apr	May	Jan	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	76	72	62	55	38	31	29	31	37	42	53	66	49.3
1967	79	67	61	44	30	22	21	26	32	42	57	66	45.5
1968	73	61	60	51	37	27	25	30	34	47	72	83	50.0
1969	84	69	67	47	38	28	27	25	29	39	51	89	49.4
1970	76	71	58	42	31	22	21	18	26	34	55	72	43.8
1971	68	53	48	49	32	30	33	32	27	37	61	66	44.6
1972	74	64	62	53	39	36	28	33	35	36	54	71	48.7
1973	58	53	37	34	25	21	22	24	27	31	46	66	37.0
1974	79	74	69	47	30	25	24	27	26	33	50	71	46.2
1975	79	66	46	43	31	23	22	23	25	32	44	69	41.9
1976	72	60	57	49	33	22	23	24	28	37	44	62	42.5
1977	74	58	48	39	30	22	25	26	29	46	56	73	43.8
1978	64	53	45	31	26	24	26	29	29	34	48	74	40.2
1979	69	55	46	32	29	28	23	26	26	41	51	70	41.3
1980	67	68	54	38	31	25	25	28	30	37	56	63	43.5
1981	64	57	50	34	28	27	26	27	28	38	48	68	41.2
1982	79	68	53	49	41	27	26	29	30	47	57	68	47.8
1983	62	55	50	47	42	38	30	28	34	38	53	72	45.7
1984	72	46	44	35	29	21	21	24	25	32	66	66	40.0
1985	65	52	47	39	27	26	24	25	28	35	56	76	41.6
1986	64	69	55	42	27	22	21	20	31	36	57	62	42.1
1987	65	61	62	43	31	27	29	31	30	54	60	69	46.8
1988	79	60	57	51	32	29	28	29	30	38	49	65	45.5
1989	63	58	55	34	29	24	26	26	33	36	59	67	42.5
1990	64	64	43	39	26	23	25	28	31	38	48	59	40.6
1991	76	63	57	34	30	24	26	32	31	53	52	65	45.2
1992	60	55	53	40	33	25	27	29	30	37	65	73	43.9
1993	71	62	54	56	43	33	28	31	32	42	59	68	48.2
1994	73	58	48	39	27	26	30	31	35	46	70	73	46.3
1995	76	66	51	46	32	28	31	34	37	40	49	66	46.3
1996	74	66	60	44	30	29	27	30	35	42	60	66	46.9
1997	68	53	53	48	34	29	29	34	35	49	84	82	49.8
1998	81	72	62	40	36	32	30	33	41	47	60	68	50.1
1999	74	69	54	51	30	29	31	32	42	47	60	74	49.4
2000	73	62	51	39	34	29	26	31	36	52	64	82	48.2
2001	72	57	51	41	26	19	21	24	28	38	45	71	41.0
2002	71	62	47	51	35	28	28	31	34	38	54	78	46.4
2003	66	M	M	33	24	24	26	27	34	38	56	75	40.3
2004	72	56	41	38	32	28	27	34	33	37	57	62	43.0
2005	60	56	46	38	28	25	27	30	34	38	54	57	41.0
2006	62	57	44	43	30	26	28	28	33	42	53	68	42.8
2007	66	57	41	41	30	26	26	28	30	35	47	53	40.0
2008	60	45	35	32	27	24	24	27	31	42	55	52	37.8
2009	54	47	41	40	27	23	26	26	31	41	61	67	40.3
2010	61	52	44	43	33	26	25	26	31	40	46	54	40.0
2011	69	52	44	39	32	26	27	26	32	40	53	56	41.3
2012	76	69	52	40	31	20	21	27	22	34	64	72	44.0
2013	65	71	52	52	30	21	22	25	27	33	60	71	44.0
2014	73	61	49	54	29	21	22	23	25	34	55	70	43.0
2015	72	57	51	41	26	19	21	24	28	38	45	71	37.7

Source: Meteorological Organization and Seismology of Iraq

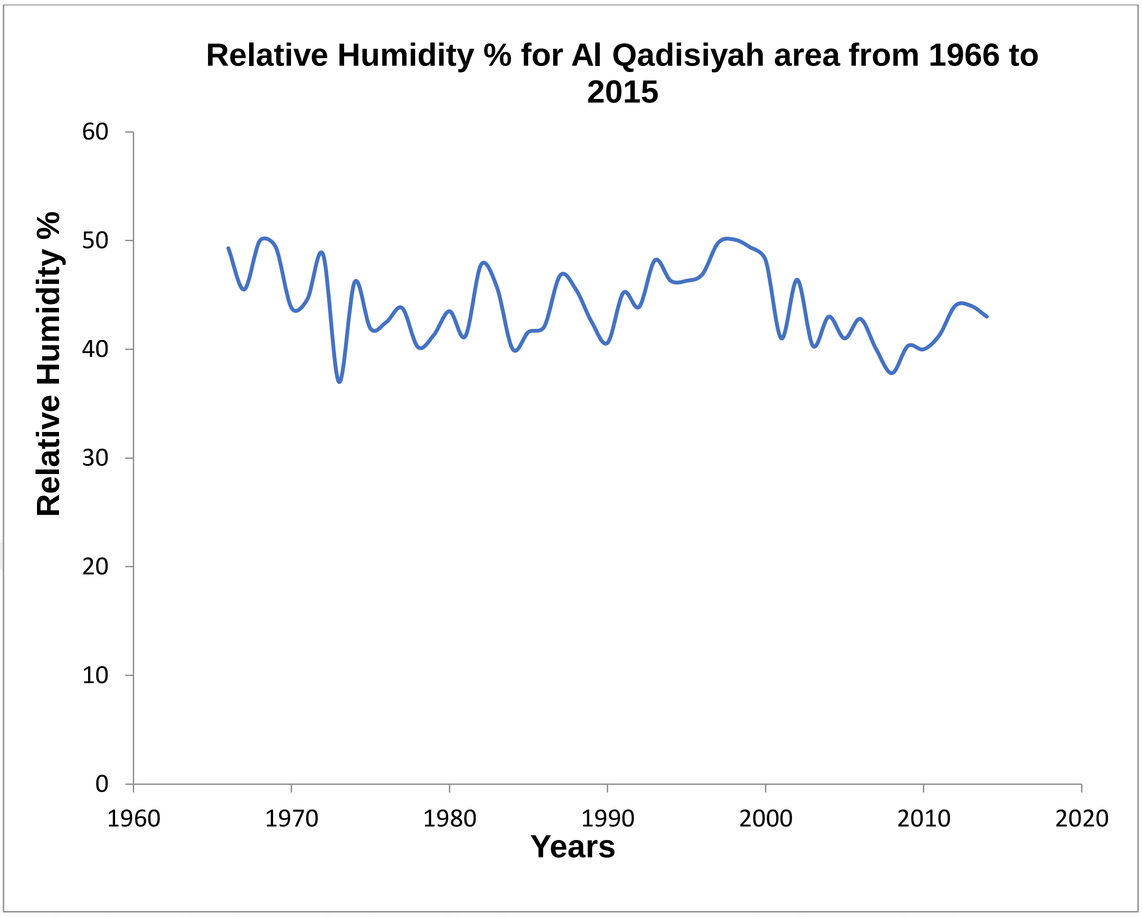


Figure 3.14. Relative Humidity % for Al Qadisiyah area from 1966 to 2015:

Source: Meteorological Organization and Seismology of Iraq

Table 3.15. Relative Humidity % for Al Muthanna area from 1966 to 2015:

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	62	60	48	66	36	25	30	33	33	39	69	73	47.8
1967	83	71	63	58	51	32	31	27	34	38	60	77	52.0
1968	66	67	46	41	30	25	24	28	29	39	50	71	43.0
1969	74	82	80	59	36	31	26	32	32	32	58	87	52.4
1970	87	72	51	48	33	25	23	26	30	38	54	76	46.9
1971	79	71	71	59	42	24	23	25	32	43	49	72	49.1
1972	80	59	48	47	34	25	22	24	31	41	58	79	45.6
1973	80	66	49	33	27	24	25	30	34	39	56	81	45.1
1974	75	64	47	39	33	28	23	29	29	48	62	80	46.4
1975	71	75	62	49	32	30	27	28	33	45	68	79	49.9
1976	78	79	56	43	37	29	24	26	33	43	56	75	48.2
1977	82	67	66	56	44	27	30	26	31	60	77	84	54.1
1978	78	68	60	47	39	27	29	24	33	37	47	74	46.9
1979	88	72	64	60	36	33	27	29	33	45	55	72	51.1
1980	65	68	49	35	24	19	20	24	24	37	56	60	40.0
1981	78	79	43	34	27	26	19	20	26	34	44	64	41.1
1982	73	60	47	44	37	21	22	23	23	44	55	66	42.9
1983	57	49	42	38	33	25	22	25	26	39	54	73	40.2
1984	69	54	51	42	37	24	24	30	29	38	72	71	45.0
1985	71	52	46	38	27	22	21	20	31	31	53	68	40.0
1986	70	77	61	49	28	25	19	21	23	39	64	63	44.9
1987	55	56	54	33	25	22	25	26	25	45	56	53	39.5
1988	73	57	48	45	39	25	23	27	26	35	44	65	42.2
1989	60	56	54	34	29	24	18	19	26	33	55	64	39.3
1990	64	61	58	30	21	20	20	22	26	31	44	57	37.8
1991	80	58	65	47	32	25	25	28	34	47	45	54	45.0
1992	55	55	52	44	37	27	29	28	33	41	62	73	44.6
1993	72	64	49	57	43	28	26	29	29	40	58	66	46.7
1994	73	58	48	42	29	27	24	26	33	40	62	71	44.4
1995	72	66	50	46	27	24	25	27	28	37	46	68	42.0
1996	74	67	58	40	26	23	20	23	30	36	58	62	43.0
1997	66	46	49	40	29	25	27	27	29	44	69	77	44.0
1998	71	62	63	44	32	24	24	27	27	35	48	53	42.5
1999	63	65	46	31	30	23	25	22	32	34	51	64	40.5
2000	66	57	38	31	24	20	17	19	28	42	59	71	39.3
2001	70	56	49	39	28	24	22	21	27	29	40	67	39.3
2002	62	49	41	44	25	21	20	22	24	31	49	66	37.8
2003									23				
2004	71	60	41	36	23	25	26	28	31	43	55	77	43.0
2005	71	53	42	41	28	22	18	24	30	33	52	56	39.1
2006	64	64	44	35	31	20	22	24	31	38	53	72	41.5
2007	67	58	47	34	26	22	22	24	30	31	41	54	38.0
2008	61	43	34	29	24	20	20	23	26	44	56	49	35.7
2009	52	51	39	39	25	23	23	22	29	36	56	49	37.0
2010	61	52	40	40	32	27	24	26	25	38	40	47	37.6
2011	60	56	37	37	33	25	23	25	29	34	45	46	37.5
2012	61	49	33	28	21	19	22	19	26	35	59	67	36.5
2013	62	53	36	27	29	19	21	20	24	38	63	61	37.7
2014	80	53	47	35	22	19	19	20	25	39	51	61	39.2
2015	54	50	42	27	22	22	26	36	24	44	61	63	39.2

Source: Meteorological Organization and Seismology of Iraq

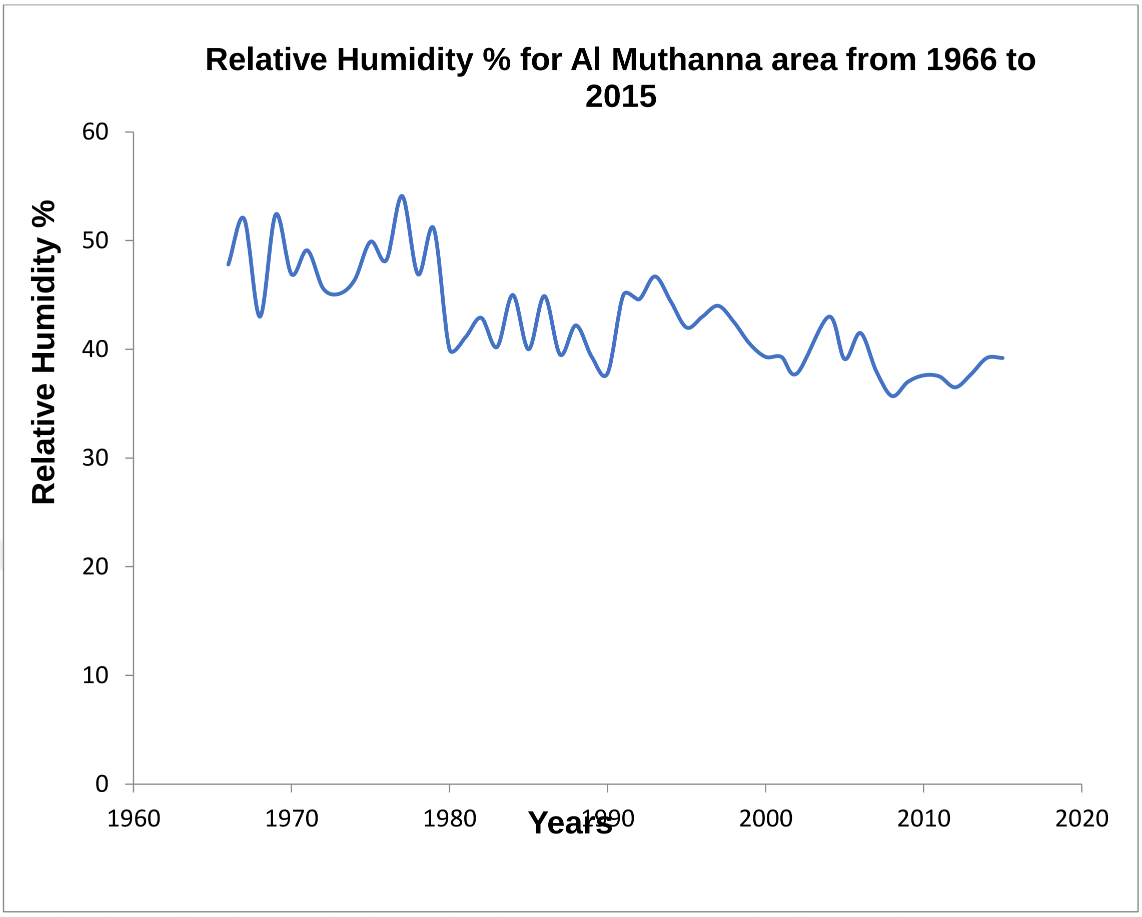


Figure 3.15. Relative Humidity % for Al Muthanna area from 1966 to 2015:

Source: Meteorological Organization and Seismology of Iraq

Table 3.16. Relative Humidity % for Thi Qar area from 1966 to 2015:

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1966	60	65	50	43	34	35	33	28	30	45	49	61	44.4
1967	65	66	46	39	45	37	35	32	35	50	74	70	49.5
1968	62	60	46	57	45	39	35	35	37	44	63	72	49.5
1969	76	63	53	56	46	37	37	36	35	43	58	65	50.4
1970	75	58	50	42	36	39	24	30	24	31	47	59	42.9
1971	60	48	38	44	36	36	35	30	31	35	60	60	42.7
1972	75	60	58	56	59	33	35	34	33	35	46	73	49.7
1973	53	57	37	29	24	18	17	17	22	29	41	62	33.8
1974	75	68	65	45	26	22	17	19	23	33	46	67	42.1
1975	69	61	43	42	30	17	16	18	24	27	44	69	38.3
1976	72	60	55	50	32	17	18	18	23	36	40	59	40.0
1977	71	55	47	41	28	21	20	21	23	45	59	72	41.9
1978	62	55	46	30	21	19	24	18	22	33	43	67	36.6
1979	67	53	43	32	32	25	20	29	32	41	45	66	40.4
1980	65	68	52	38	24	19	20	20	24	31	59	61	40.0
1981	65	55	46	35	31	24	29	28	33	40	54	78	43.1
1982	81	66	58	48	44	28	30	27	43	53	61	69	50.6
1983	67	55	47	45	42	25	24	26	24	30	47	62	41.1
1984	63	45	46	34	26	17	19	21	23	33	74	71	39.3
1985	70	50	46	37	29	19	17	21	21	30	51	65	38.0
1986	61	67	44	45	28	21	18	21	25	33	61	70	41.1
1987	57	52	53	32	24	19	20	22	24	45	48	64	38.3
1988	72	61	52	48	32	31	28	29	32	44	49	66	45.3
1989	61	59	56	45	40	29	21	21	26	37	56	69	43.3
1990	71	63	43	38	25	20	19	20	22	37	47	53	38.1
1991	77	61	50	29	24	23	24	23	26	53	50	68	40.5
1992	64	61	60	43	38	27	23	26	30	36	63	75	45.5
1993	74	66	50	60	38	25	21	25	28	38	58	65	45.6
1994	71	53	45	39	27	22	22	23	29	46	63	70	42.5
1995	76	66	50	44	28	23	23	25	32	34	43	65	42.4
1996	76	71	64	46	35	21	20	22	27	35	53	62	44.3
1997	67	48	56	47	31	25	22	26	29	46	71	81	45.7
1998	77	67	63	47	34	26	26	25	32	38	50	55	45.0
1999	73	69	58	44	27	21	21	21	29	37	55	72	43.9
2000	68	56	42	38	30	23	23	25	27	40	58	80	42.5
2001	73	51	42	41	30	34	28	27	26	41	49	84	43.8
2002	68	57	45	49	31	24	22	24	27	36	52	77	43.8
2003	M	M	M	M	M	M	M	M	M	M	M	M	
2004	70	61	42	39	32	26	21	23	25	37	59	68	41.9
2005	67	61	52	43	30	23	19	23	28	37	52	62	41.4
2006	67	67	45	44	29	19	19	22	27	39	57	73	42.3
2007	69	58	46	45	28	20	20	22	24	36	43	60	39.2
2008	65	49	35	28	25	20	19	22	30	45	56	56	37.5
2009	56	52	42	40	28	15	16	16	23	29	50	59	35.5
2010	58	48	35	37	27	18	18	22	24	29	38	48	33.5
2011	57	55	37	32	26	20	19	21	23	28	44	47	34.0
2012	49	46	31	31	25	15	14	20	20	32	58	66	33.9
2013	64	58	45	47	50	35	35	30	28	39	48	60	44.9
2014	67	55	45	42	28	25	20	28	22	31	47	62	39.3
2015	58	54	49	40	33	32	32	26	27	33	53	60	41.4

Source: Meteorological Organization and Seismology of Iraq

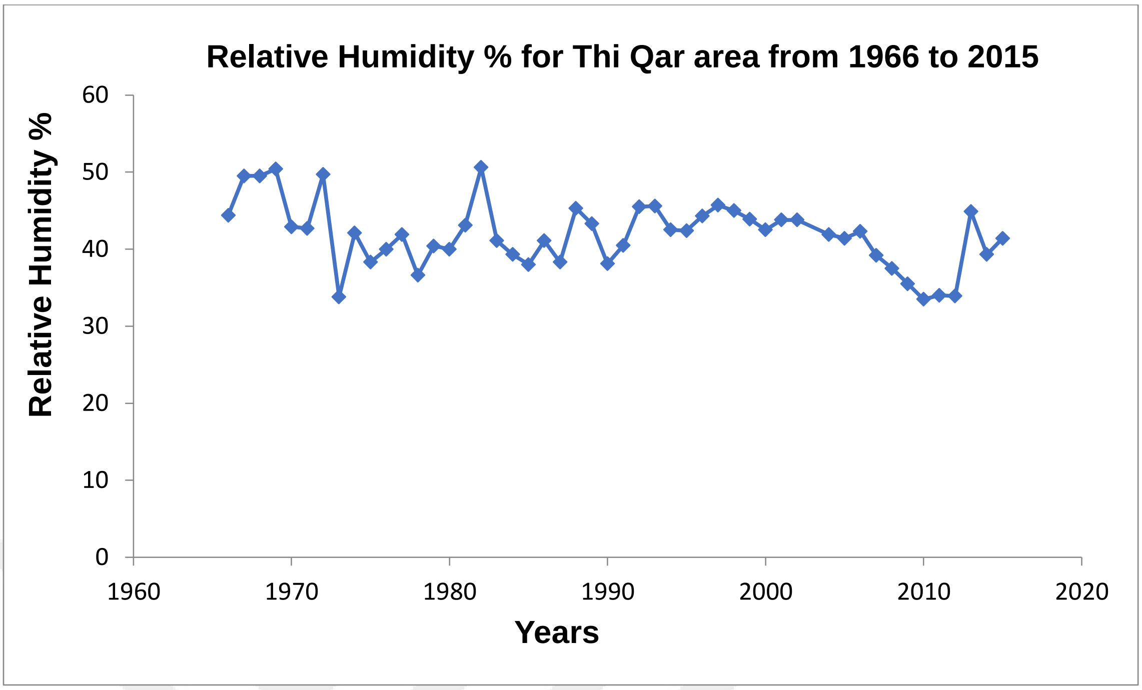


Figure 3.16. Relative Humidity % for Thi Qar area from 1966 to 2015.

Source: Meteorological Organization and Seismology of Iraq

According to the tables and figures above, the annual relative humidity fluctuates around 37 - 47% for the Najaf city and around 37 - 50% for Al Qadisiyah city, and around 35 - 54% for Al Muthanna and around 33 - 50% in Thi Qar in the south of Iraq (Tables 3.13, 3.14, 3.15, and 3.16).

On the other hand, if we look at the previous humidity figures accurately (Figures 3.13, 3.14, 3.15 and 3.16) we can see a clear decrease in the average annual relative humidity from 1966 to 2015, with elevated temperature in the same period and the same areas.

For all these indicators, rice production is expected to decrease due to an average temperature increase of 32 ° C, all studies indicate the ideal temperature of pollen maturity stage for rice flowers were between 28 and 32 °C.

In addition, some of the studies refer that the rise in temperature will have significant effects on the production of rice. The yield of rice will be decreased with the increase of temperature. The impact of the rise of temperature will be in both the irrigated and rain fed paddy fields. The production of rice will be decreased nationally at a level of approximately 11% in the irrigated field while approximately 14.4% production loss in the rain fed field for each 1°C increase of temperature [56].

3.5. Production of Paddy in Different Agronomic and Climate Scenarios for the Study Area

Coping or adaptation strategies, constraints to the production of rice as well as the agronomic practices of farmers in the area of the study were evaluated using both qualitative and quantitative methods. The primary data were collected from a total of 223 farmers using face to face interviews in the household. By contracting with the village head or agricultural office, we first generated a respondent list and from the list using a random systematic sampling method we selected the respondents in the four district areas. To obtain maximum information from the respondent, a questionnaire was tested and developed for the household survey.

In terms of productivity and planting area, rice is the second largest crop cultivated in Iraq. The growing area of rice is not stable in Iraq. Based on the water availability the production area of rice is changing because water is the limiting factor in the cultivation of rice. In the following Tables presented due to change in the water availability how the rice production areas have oscillated in the recent year.

Table 3.17. Paddy production in Iraq for the year 1966 to 2015:

Years	Area/ Ha.	Production/ Ton
1966	108189.25	177424
1967	136938.75	296796
1968	138999	314565
1969	133585	300268
1970	101923.25	213787
1971	151339.75	306136
1972	129552	273579
1973	84999	153587
1974	60026	105699
1975	52615.75	96276
1976	78850	196099
1977	94713.25	273389
1978	93533	250566
1979	57597	155330
1980	54576.5	165002
1981	52950	158600
1982	56625	160800
1983	55825	107400
1984	44775	107800
1985	60500	146700
1986	51951.25	139028
1987	73271	195628
1988	55715.75	140532
1989	78497	231630
1990	84841	228481
1991	96239.75	188764
1992	167383.25	237295
1993	129651.75	261902
1994	162755	382860
1995	164349.5	312804
1996	109145	282935
1997	115239	274255
1998	151186.75	389475
1999	87690.25	218484
2000	4200.75	12398
2001	2813	4900
2002	54127.75	193767
2003	30621.25	81315
2004	87948.25	250275
2005	107060.75	308660
2006	125641.25	363338
2007	124341.25	392803
2008	84760.75	248157
2009	54933.75	173074
2010	47973.75	155829
2011	65952.5	235118
2012	79691.75	361339
2013	95956	451849
2014	79312.25	403028
2015	27608.5	109209

Source: Ministry of Agriculture (MoA). Baghdad [57].

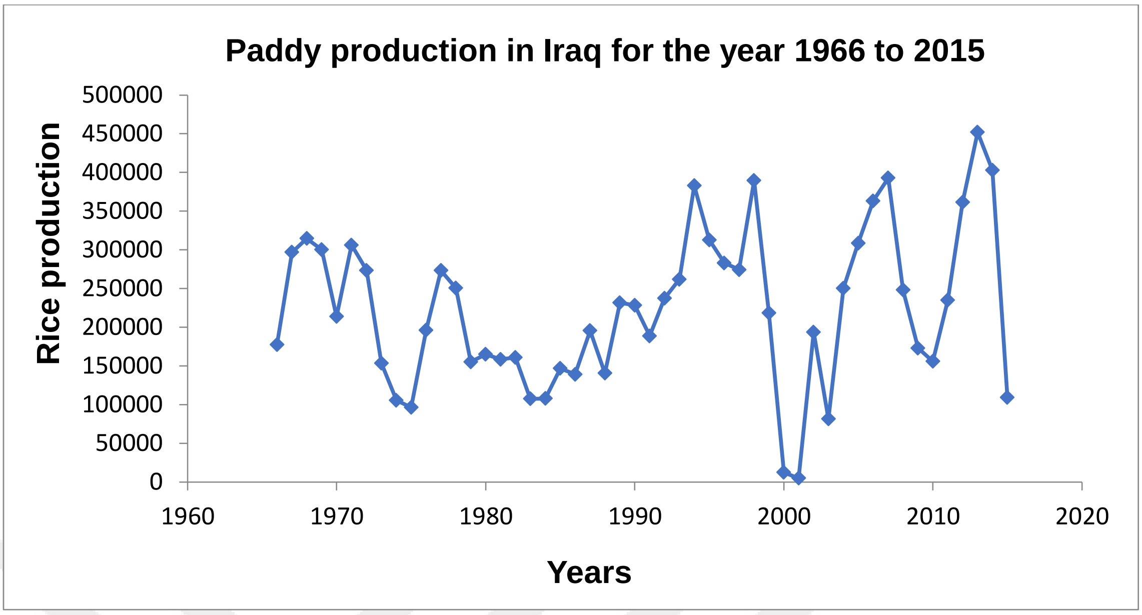


Figure 3.17. Paddy Production in Iraq, 1966-2015 [57].

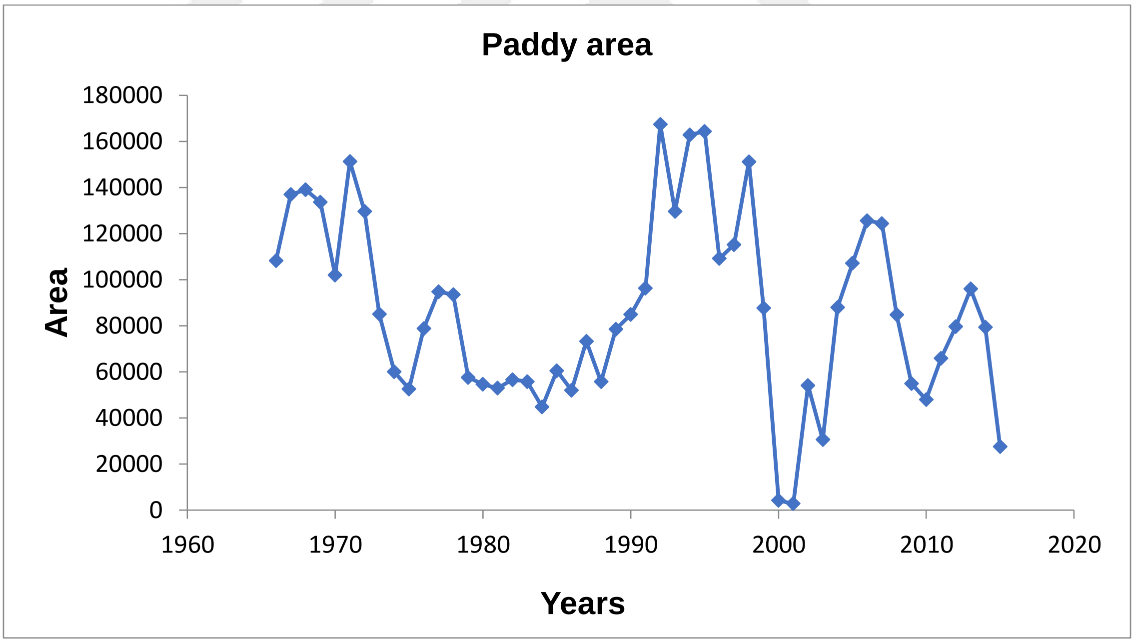


Figure 3.18. Paddy Area in Iraq, 1966-2015 [57].

From the above table, the highest area in 1992 was 167,383.25 hectares and the lowest area and production in 2001 of rice is 2,813 hectares with 4900 tons respectively.

Because of the irrigation facilities from Euphrates River, the majority of the rice producing area is situated in the city of Najaf of Iraq, which is approximately 130 km south of Baghdad (Figure 3.19).

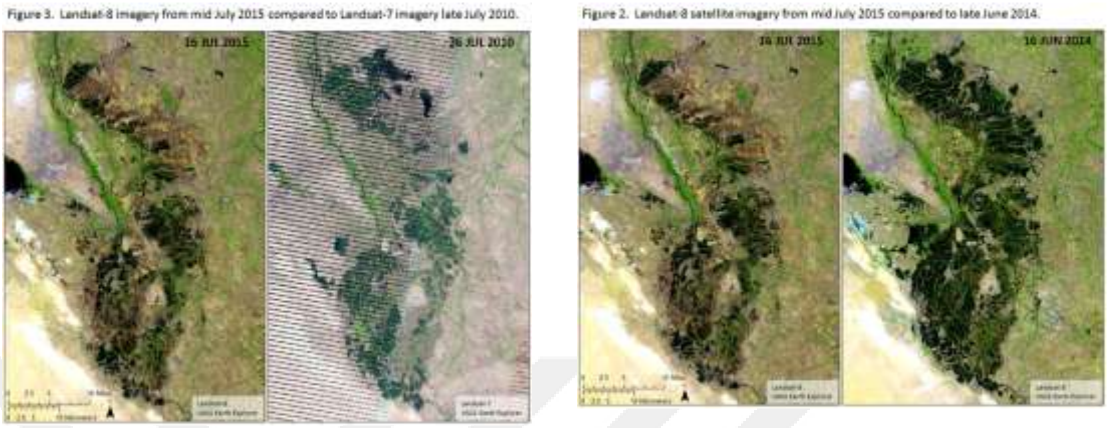


Figure 3.19. Al Najaf Rice Production [48].

It is important to note that in the late June, when the fields are flooded with water, the crops are planted and in the late November they are harvested. In the city of Najaf, rice production is the principal agricultural activity and it influences the economy of the region. It is worth to mention that Iraq is importing the rice from other countries because the national production of rice is well below the consumption level.

Figure 3.20. Rice crop in Al Najaf.

Next table shows us the paddy area and production in Al Najaf for the previous 50 years (Table 3.18).

Table 3.18. Paddy area and production in Al Najaf for 50 years.

Years	Area/ Hectares	Yield/ Ton per Hectares	Production/ Ton
1966	10000	2.60	26000
1967	11250	2.6	29250
1968	11956	2.23	26667
1969	11757	2.23	26288
1970	7250	2.46	17835
1971	17087.5	2.24	38287
1972	17000	2.32	39440
1973	11950	3.83	45768
1974	5913	2.47	14620
1975	6350	2.21	14048
1976	19558	3.5	68453
1977	33930	3.41	115880
1978	35335.5	3.59	127042
1979	25020	3.99	99829
1980	25625	3.46	88700
1981	27400	3.36	92300
1982	28975	2.93	84900
1983	24325	2.47	60100
1984	30525	2.82	86200
1985	36750	2.55	93800
1986	33568.5	2.72	91356
1987	35586.5	2.74	97738
1988	31253	2.72	85066
1989	42871	3.32	142390
1990	40216.75	2.89	116501
1991	43498.25	2.27	98751
1992	50277.5	1.61	81156
1993	40251	2.07	83523
1994	46781.25	2.53	118602
1995	46416.25	2.35	109146
1996	41790.75	2.74	114809
1997	43237	2.60	112628
1998	49400	2.83	140062
1999	44160.75	2.61	115331
2000	4200.75	2.95	12398
2001	M	M	M
2002	25602.25	2.35	60165
2003	18692.5	2.69	50334
2004	36195.25	2.86	103643
2005	44514.25	2.98	132657
2006	46606.75	1.03	48004
2007	46202.5	2.39	110423
2008	43409.75	2.93	127406
2009	22437.5	3.97	89124
2010	24971.75	3.30	82546
2011	39632.5	3.96	157106
2012	42476.5	2.54	107890
2013	45252.75	1.87	84622
2014	41139.75	2.70	111077
2015	12954.75	1.35	17488

Source: (MoA). Baghdad.

In Al Najaf, the average rice yield was decreasing clearly from 2.86 ton per hectare for the period from 1966 – 1990 (first 25 years) to 2.56 ton per hectare for the period from 1991- 2015 (second 25 years) (Figure 3.22).

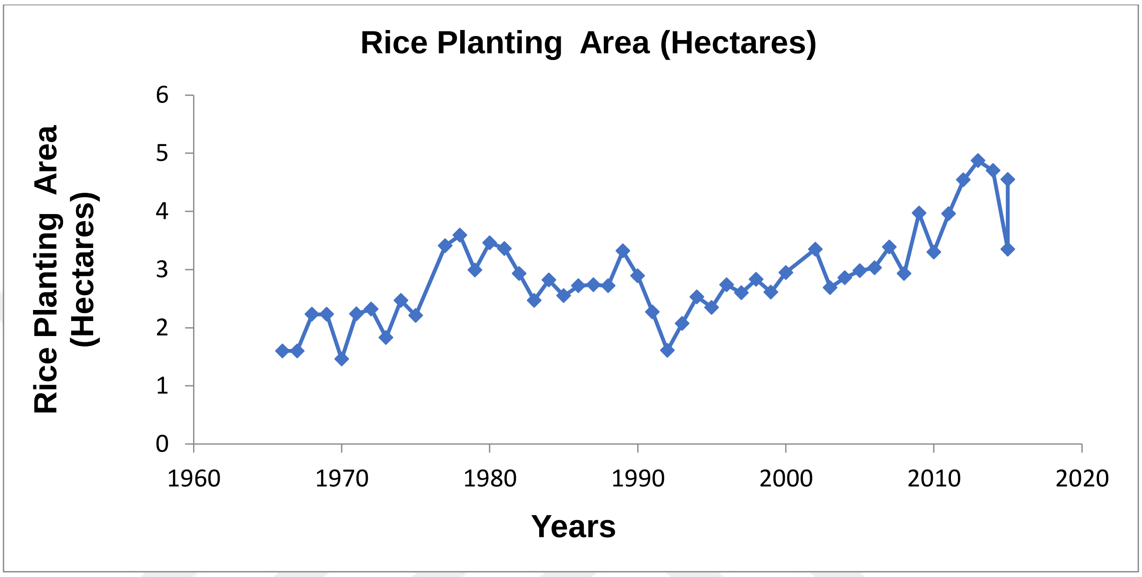


Figure 3.21.Paddy Area and Production in Al Najaf for 50 years. Source: MoA, Baghdad.

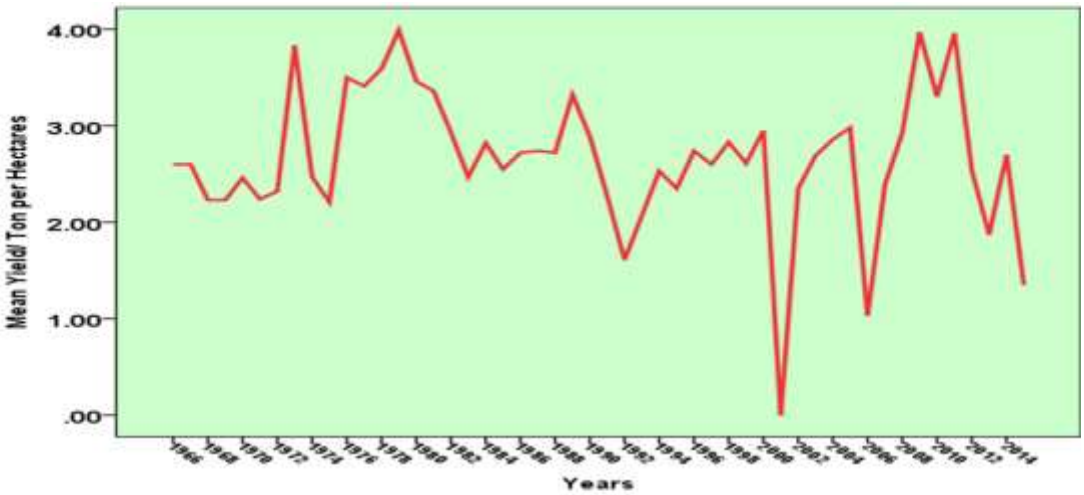


Figure 3.22 Paddy yield in Al Najaf for 50 years [57].

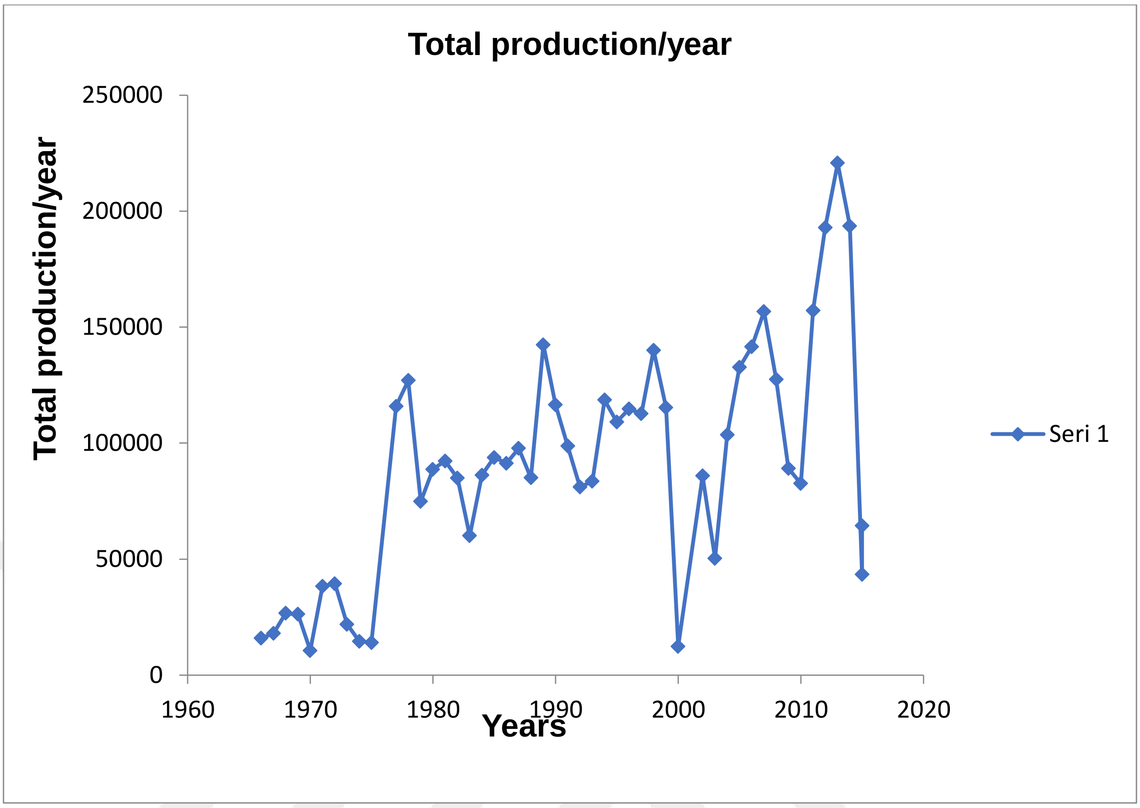


Figure 3.23. Paddy Total production in Al Najaf for 50 years [57].

Table 3.19 shows the area and production of the harvested rice crop in Al Qadisiyah for 50 years as obtained from the MoA data set.

Table 3.19. Paddy area and production in Al Qadisiyah for 50 years.

Years	Area/ Hectares	Yield/ Ton per Hectares	Production/ Ton
1966	29398.75	3.76	110539
1967	36575.5	2.72	99760
1968	40207.25	2.83	114139
1969	40099.5	2.14	85983
1970	22177	2.07	46127
1971	59125	2.16	128243
1972	56250	2.24	126000
1973	29597.5	2.10	62408
1974	4957.5	3.98	19730
1975	6912.5	3.06	21164
1976	13976.5	3.88	54228
1977	27770.5	3.44	95634
1978	22531.75	3.45	75572
1979	12247.5	2.51	30830
1980	15075	3.16	47700
1981	15675	2.96	46400
1982	16575	2.68	44500
1983	12925	3.60	46530
1984	8575	3.94	33785
1985	10500	2.89	30400
1986	11192.25	2.95	33127
1987	25401.5	2.98	75739
1988	14999.5	2.45	36836
1989	21879.25	3.13	68691
1990	23761.25	3.42	81274
1991	20234.75	1.86	37821
1992	32461.5	1.64	53463
1993	25658.25	3.02	77494
1994	33762	3.26	110076
1995	28859.5	2.66	76895
1996	28351	2.19	62088
1997	32975	2.80	92543
1998	35936.5	3.03	108995
1999	30090.75	2.92	87960
2000	M	M	M
2001	111	1.38	154
2002	24608.75	2.12	52170
2003	7716.25	2.81	21710
2004	28224	3.33	94262
2005	35602.25	3.20	114157
2006	35410.75	3.34	118462
2007	35763	2.55	91195
2008	27779.5	3.29	91571
2009	15086.25	2.36	35649
2010	20900	3.15	65930
2011	24315	3.02	73623
2012	33407.75	2.78	92873
2013	46438.5	1.69	78481
2014	35025	2.70	94567
2015	14140.75	2.55	36058

Source: (MoA). Baghdad.

Also, in Al Qadisiyah, the average rice yield were decreasing clearly from 2.98 ton per hectare for the period from 1966 – 1990 (first 25 years) to 2.65 ton per hectare for the period from 1991- 2015 (second 25 years) (Figure 3.25).

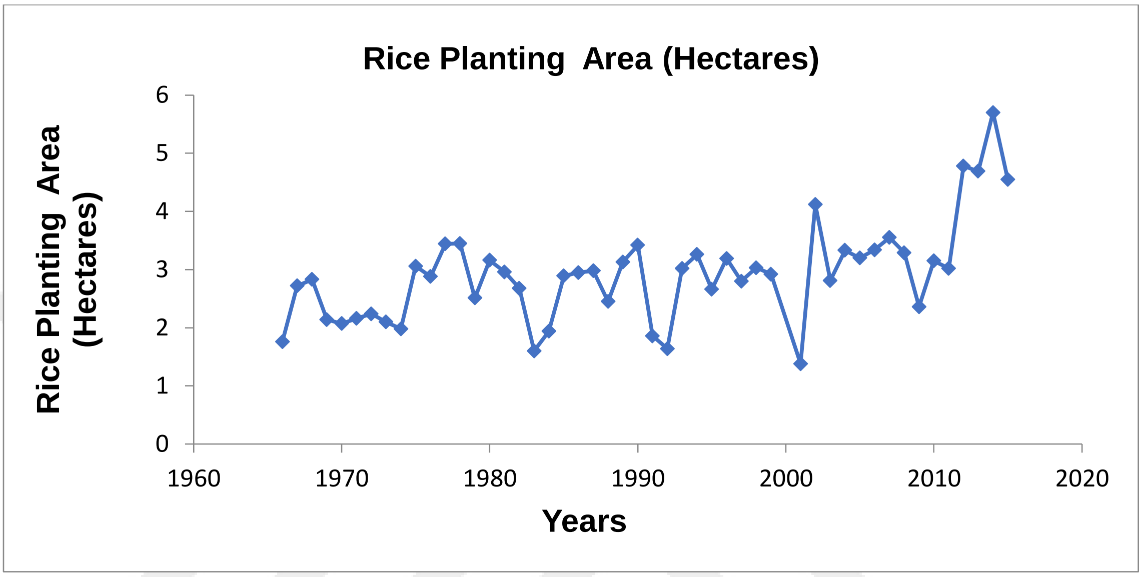


Figure 3.24. Paddy Area in Al Qadisiyah for 50 years. Source: (MoA). Baghdad.

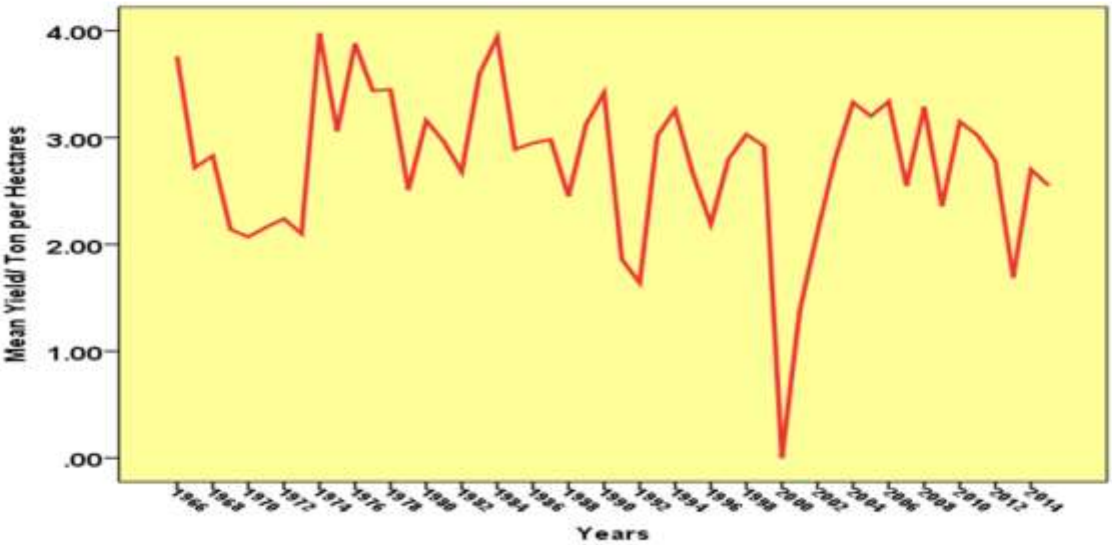


Figure 3.25. Paddy Yield in Al Qadisiyah for 50 years [57].

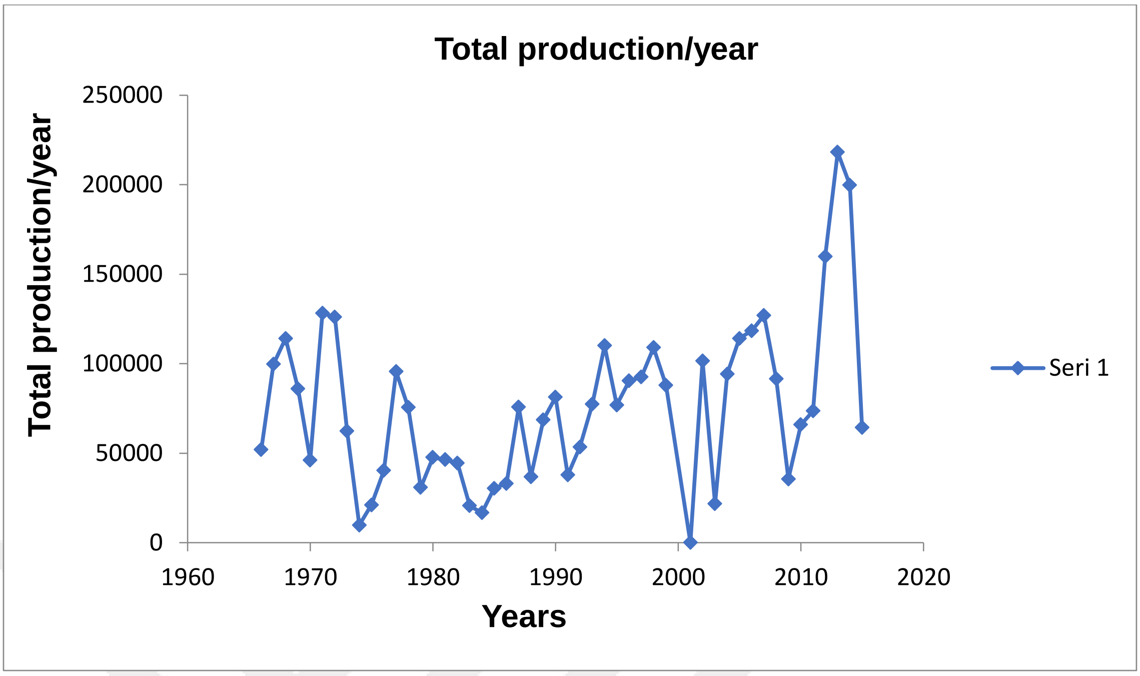


Figure 3.26. Paddy Total Production in Al Qadisiyah for 50 years [57].

Rice planting and production in Al Muthanna were down after 2003, primarily because of a sharp drop in the water resources due to climate change. Table 3.20 shows the area and production for 50 years.

Table 3.20. Paddy area and Production in Al Muthanna for 50 years.

Years	Area/ Hectares	Yield/ Ton per Hectares	Production/ Ton
1966	6851.25	3.95	27062
1967	8514.75	3.11	26517
1968	9370.25	3.32	30341
1969	9345	2.44	22856
1970	5170	2.30	11894
1971	6267.75	2.78	17424
1972	6740	2.92	19680
1973	3717.75	1.59	5917
1974	1862.5	2.58	4805
1975	1475	2.18	3215
1976	2247.5	2.89	6495
1977	4424.75	2.46	10918
1978	3704	2.37	8799
1979	2115	2.00	4230
1980	2100	2.71	5700
1981	2025	2.32	4700
1982	1675	2.62	4400
1983	2125	2.4	5100
1984	925	2.81	2600
1985	850	2.47	2100
1986	1559.5	3.74	5832
1987	2591.75	2.96	7683
1988	2280.5	2.59	5908
1989	2548.25	2.75	7021
1990	2266.5	2.09	4739
1991	1572.5	1.26	1982
1992	2831.75	1.73	4902
1993	2745.5	2.00	5492
1994	2906.5	2.32	6767
1995	2790.25	2.41	6739
1996	3246.75	2.80	9122
1997	4292.25	2.48	10676
1998	4776.5	2.47	11588
1999	210.75	2.17	459
2000	M	M	M
2001	1898.5	2.49	4734
2002	46.5	2.25	105
2003	508.5	2.41	1227
2004	1557.75	2.68	4187
2005	2164	2.64	5728
2006	3933.25	2.60	10255
2007	4009.5	2.42	9715
2008	2727.75	2.37	6484
2009	1236	1.94	2398
2010	1154.75	1.59	1836
2011	1059	2.19	2326
2012	1545.75	2.08	3225
2013	1905.25	2.53	4893
2014	1208.75	2.57	3111
2015	259.75	2.67	695

Source: (MoA). Baghdad.

In Al Muthanna average rice yield decreased clearly too from 2.65 ton per hectare for the period from 1966 – 1990 (first 25 years) to 2.29 ton per hectare for the period from 1991- 2015(second 25 years), (Figure 3.28).

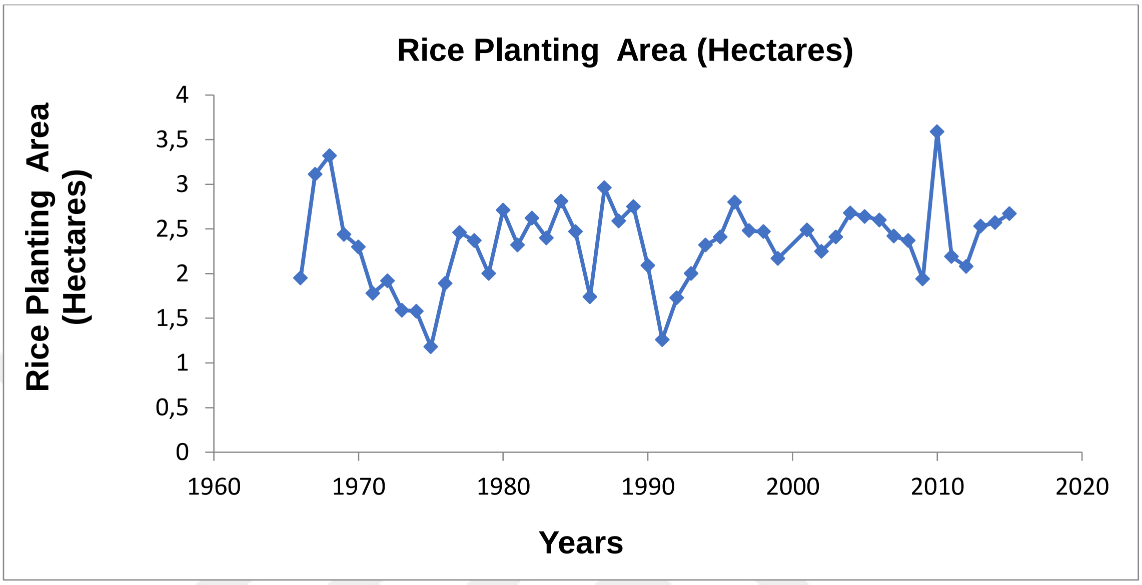


Figure 3.27. Paddy area in Al Muthanna for 50 years [57].

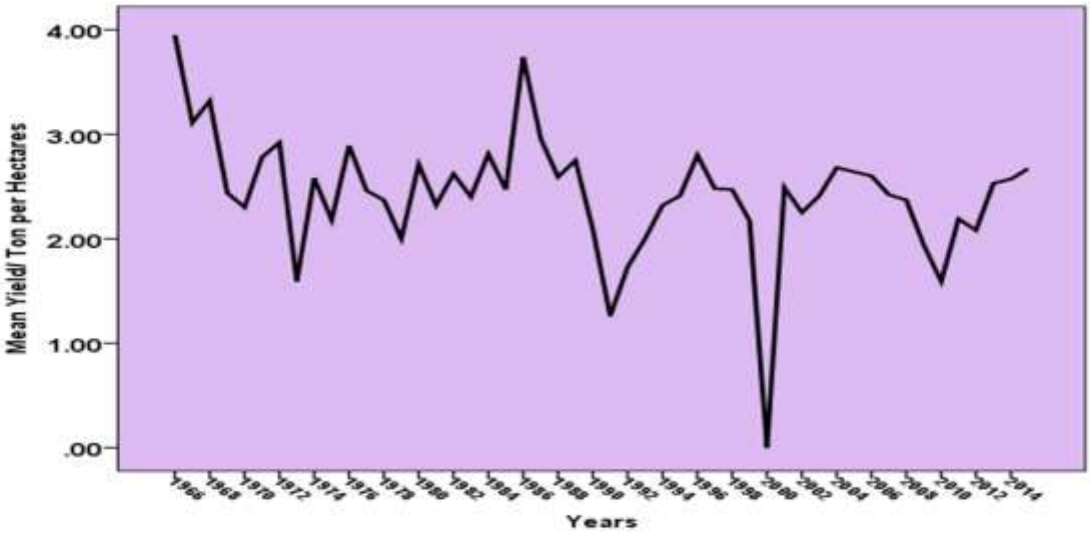


Figure 3.28. Paddy Yield in Al Muthanna for 50 years [57]

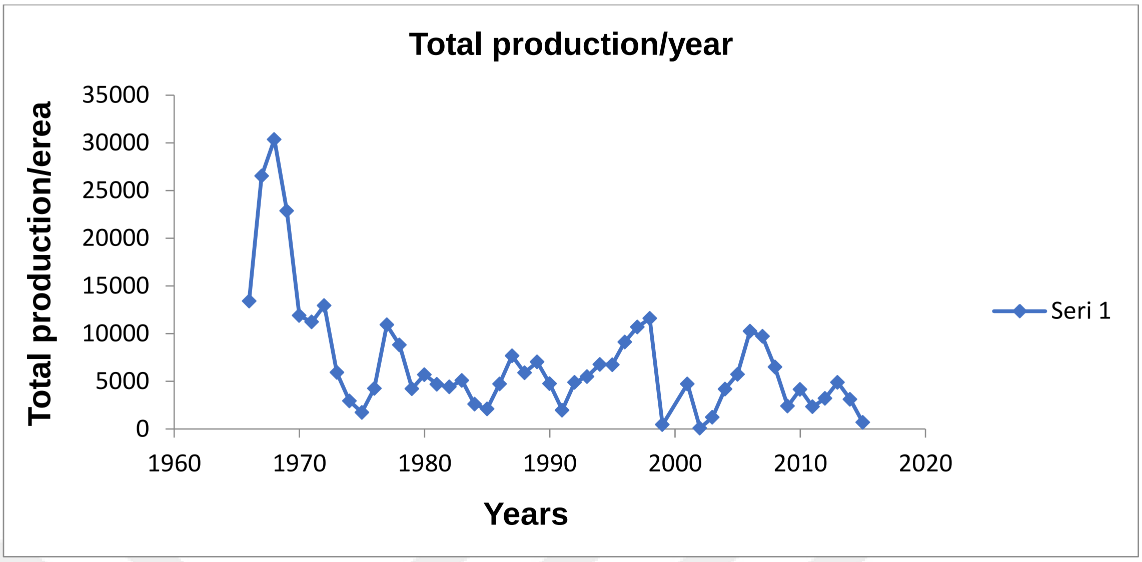


Figure 3.29. Paddy Production in Al Muthanna for 50 years [57]

Figure 3.30 Al Muthanna Rice crop.

The last table (No. 3.21) explain the area and production for rice crop in Thi Qar for 50 years too.

Table 3.21. Paddy Area and Production in Thi Qar for 50 years.

Years	Area/ Hectares	Yield/ Ton per Hectares	Production/ Ton
1966	11650	1.55	18080
1967	11650	1.75	20450
1968	7612.5	2.16	16445
1969	16544	2.16	35843
1970	13337.5	2.40	32059
1971	16070.5	2.47	39784
1972	18500	2.2	40700
1973	5431.25	1.44	7836
1974	5020	1.74	8745
1975	4379	1.38	6052
1976	5824.5	1.44	8429
1977	3270.5	1.30	4258
1978	2449.5	1.55	3799
1979	2280	2.66	6070
1980	1725	2.26	3900
1981	1225	2.53	3100
1982	700	2.42	1700
1983	725	2.20	1600
1984	400	2.00	800
1985	500	3.2	1600
1986	713	3.07	2194
1987	773.25	2.40	1863
1988	622	2.48	1548
1989	871.5	1.57	1375
1990	3616.25	1.60	5787
1991	4334.25	2.39	10371
1992	4428.25	1.44	6401
1993	832.75	1.88	1569
1994	710.5	1.64	1170
1995	1837.75	1.90	3498
1996	1381.75	1.46	2031
1997	4568.25	1.59	7284
1998	5894	1.22	7204
1999	529	1.17	624
2000	840.5	1.18	991
2001	M	M	M
2002	1856.5	1.46	2719
2003	1098.25	1.57	1734
2004	3248	1.47	4775
2005	4614.5	1.62	7519
2006	6562.5	1.79	11799
2007	5253	2.32	12191
2008	1098.5	2.18	2395
2009	541	2.39	1298
2010	228.25	1.39	317
2011	236.75	1.93	457
2012	801.25	1.78	1431
2013	358.25	1.79	644
2014	130.5	2.13	278
2015	161.75	1.21	195

Source: MoA in Baghdad.

Lastly, in Thi Qar, the average rice yield decreasing clearly too from 2.07 ton per hectare for the period from 1966 – 1990 (first 25 years) to 1.70 ton per hectare for the period from 1991- 2015 (second 25 years) (Figure 3.32).

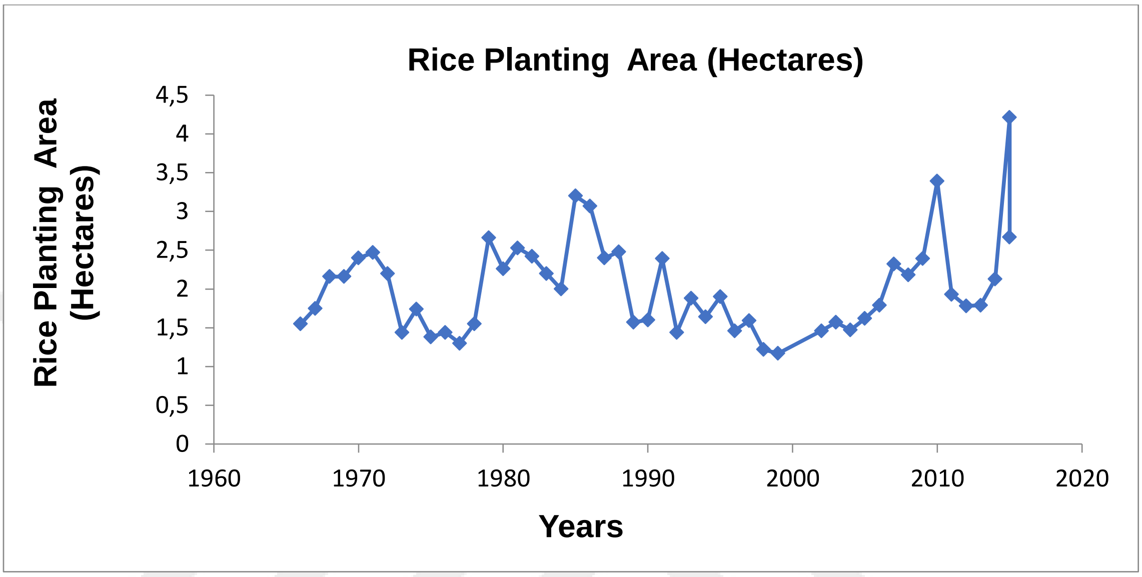


Figure 3.31. Paddy Area in Thi Qar for 50 years [57].

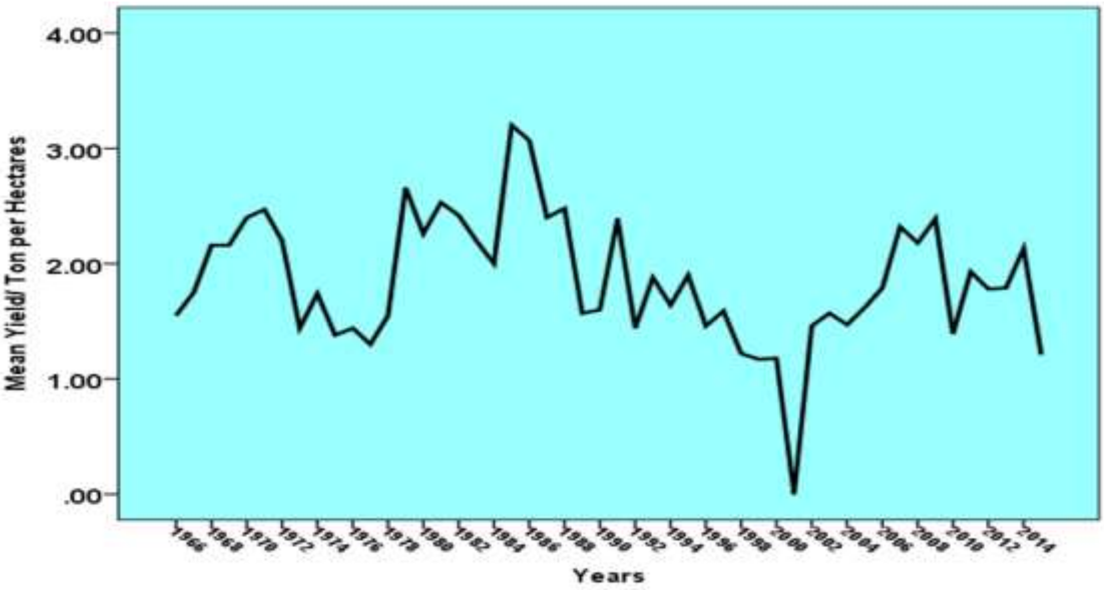


Figure 3.32. Paddy Yield in Thi Qar for 50 years [57].

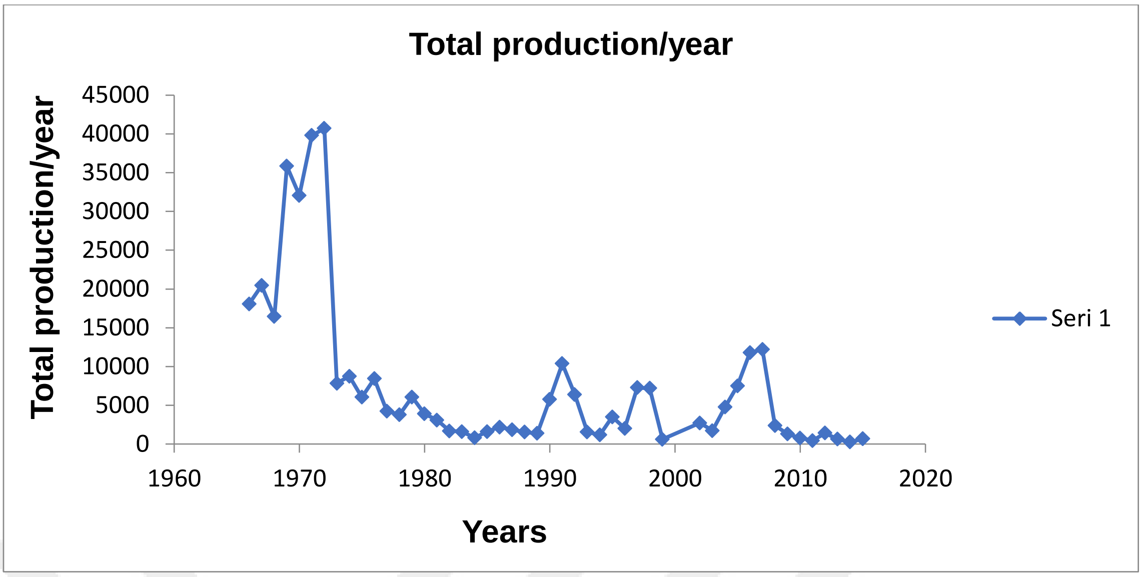


Figure 3.33. Paddy Production in Thi Qar for 50 years [57]

According to the tables above, we can see clearly the average yield for the first 25 years (1966-1990) for all study areas, Al Najaf, Al Qadisiyah, Al Muthanna and Thi Qar, (2.86, 2.98, 2.65, and 2.07 ton per hectares) were higher than the average yield for the second 25 years (1991-2015) in the same areas, (2.56, 2.65, 2.29, and 1.70 ton per hectares respectively).

3.6. River Water Availability for Irrigation and Water Resource in Iraq

The water quality, level of two rivers especially in the years from 1990~2015, fluctuation in precipitations in the same period were at noticeable levels. Three-fourths of the earth is water, and 79.5% of this water is saltwater. The pathway of water in the mountains and forests as also is the pathway of life [49, 58, 59].

Water quality in equation globally, for the UN annual report facts to help a dressing this problem worldwide, the facts that 1/6 of the world population which is around 1 billion people around the world they lack clean drinking water [50, 51,53].

The outcomes of two main rivers (Tigris and Euphrates) are provided in Table 3.22.

Table 3.22. Shows the Percentage of the Outcomes for the Two Rivers for Different Years

Years	**Outcomes for Tigris River. Billion M^3.**		**Outcomes for Euphrates River. Billion M^3.**	
	Dry year.	**Wet year.**	**Dry year.**	**Wet year.**
1966	49.48	96.85	27.4	63.31
1989	27.12	96.85	27.4	63.31
1995	20.35	96.85	27.4	63.31
1999	18.06	96.85	15.06	63.31
2001	18.06	96.85	9.56	63.31
2005	16.72	96.85	8.94	63.31
2007	2.50*	2.81*	1.78*	2.63*
2008	2.22*	2.22*	1.69*	2.09
2009	1.79*	1.89*	1.16*	1.54*
2010	2.06*	2.09*	1.24*	1.92*
2011	1.90*	2.30*	1.25*	2.04*
2012	2.19*	2.24*	1.47*	2.18*
2013	2.30*	2.38*	1.71*	2.22*
2014	2.15*	2.17*	1.64*	2.01*
2015	1.76*	2.07*	1.18*	2.03*

Source: Ministry of water resource (MoWR), Baghdad [60]

(*) These values were directly taken from the sources of Ministry of Water Resources of Iraq

If we look at the previous table (Table 3.22) we can see a clear decrease in the yearly average water outcomes of the two main rivers in the same period.

Tigress River for the wet season in 1966 and 2015 are 96.85 and 2.07 billion m^3 respectively, and if we look at the yearly average water outcomes for the dry season in 1966 and 2015 are 49.48 and 1.76 billion m^3 respectively (Figure. 3. 34). Since several--measurement gages were destroyed during the internal conflicts and clashes, data were able to be taken only a few these gages. Thus, the total value was too low. The decline presented based on these number does not reflect the actual decrease in outcomes of both rivers.

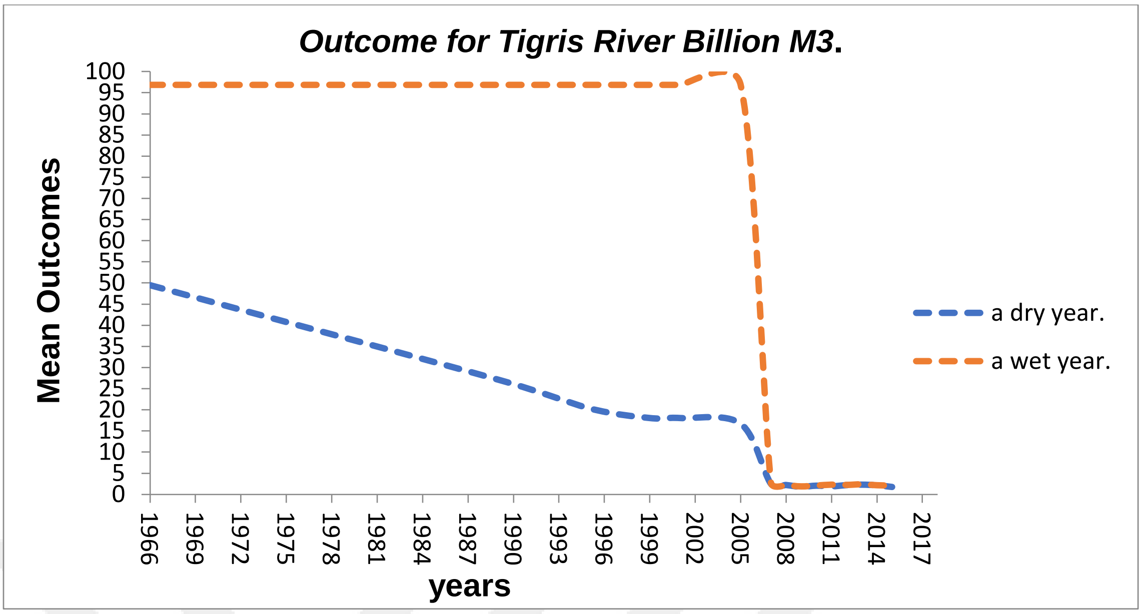


Figure 3.34. Outcomes for Tigris River (dry and wet season) M^3 [60].

Second, if we follow the same process for the Euphrates River, the yearly average water outcomes for the wet and dry year in 1966 and 2015 was 63.31, 2.03 and 27.4, 1.18 billion m^3 respectively (Fig 3.35).

From this incident, we can understand how this water decrease affecting the agriculture and normal lifestyle of Iraqi people, especially in the rural area.

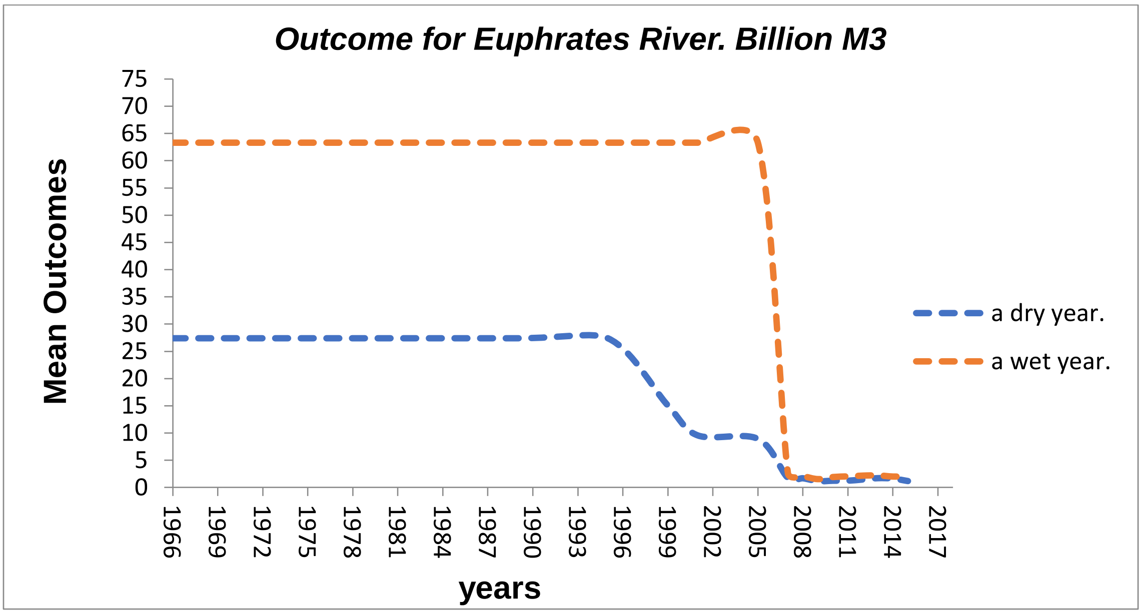


Figure 3.35. Outcomes for Euphrates River (dry and wet season) M^3 [60].

To provide a better understanding on rural development and its interactions with climate change and rice production in South of Iraq, structural and socioeconomic characteristic of the households are presented. There is four main characteristics presented in the questionnaire in addition to the characteristics that were included in the variables of climate change (temperature, rain, humidity, and water quantity): Demographic information, land information, climate change, and rice production and, rice production and rural development. All the characteristics are related to the study objectives in chapter one. Factors of these characteristics will be discussed in the next part of this chapter.

3.7. Data Analysis

Frequency analysis and the descriptive statistics were done for the secondary data. And the analysis of the trend of average annual rainfall, maximum temperature, annual minimum temperature, a relative humidity, rice crop yield, and water outcome for two rivers was carried out for the whole data covering 50 years starting from 1966 - 2015 for four areas (Najaf, Qadisiyah, Muthanna, and Thi Qar).

Average yearly temperature: This study revealed that the average yearly minimum and maximum temperature of the study areas is increasing with the time passing. For example, the average yearly minimum temperature in Najaf, Qadisiyah, Muthanna and Thi Qar was 17.0, 16.2, 16.7, 17.3ºC respectively in the decade of 1966-1990 and 18.3, 17.9, 17.8, 18.3 ºC in the decade of 1991-2015, and the average yearly maximum temperature for the same areas was 30.8, 31.1, 29.8, 30.2ºC respectively in the decade of 1966-1990 and 31.8, 32.2, 32.3, 33.0ºC in the decade of 1991-2015. The average yearly minimum temperature increased by 1.2ºC within 5 decades and average yearly maximum temperature also increased by1.9ºC in the same period.

In addition, some of the studies refer that rising temperature has been negatively affecting the production of rice, in a study by Yuliawan & Handoko, et al, 2016 [56], found that with the temperature rise the production of rice will be decreased.

This trend of increasing temperature adversely affects the agro-climate conditions as well as the economic conditions of rural area and population in Iraq. Increasing temperature not only affects the Iraqi paddy production sector but also enhances the intensity of dust storm which hampers the normal lifestyle.

Average yearly total rainfall: The total yearly rainfall is decreasing clearly with the time passing. The average yearly total rainfall of Najaf, Qadisiyah, Muthanna, and Thi Qar in 1966- 1990 was 105.7, 117.6, 107.3, 118.4 mm respectively, and in the year 1991- 2015, the amount of average rainfall was 66.9, 101.6, 98.3, 113.9 mm respectively. This scenario explicitly indicates how Iraqi agriculture and irrigation sectors are suffering from the scarcity of rainfall because of Iraqi agriculture and irrigation systems largely dependent on rainfall. As the situation (scarcity of rainfall) is worsening day by day, so Iraqi people especially paddy farmers are becoming more frustrated with thinking about the future as well as agricultural sustainability.

Average yearly relative humidity: The recorded mean average yearly humidity in percentage was recorded in the range of 50-55%. It is important to note that a higher level of daily humidity is crucial for the proper growth of the paddy plant and therefore, significantly affects the total production of rice. This condition is particularly true for the offseason planting and production were the areas with a lower level of precipitation. In the area where there is an insufficient percentage of humidity could be affected in terms of the growth cycle of the paddy plant; nevertheless, the ability of the paddy plant to regulate its own microclimate would raise the relative humidity within the crop when enough irrigation is supplied [61,25,62].

Irrigation water: Iraqi irrigation system mainly depends on two main rivers namely the Tigris and Euphrates, but recently river flows of those two rivers are decreasing drastically. In 1966, the total outcomes of water in the dry season of Tigris and Euphrates were 49.48 and 27.4 billion M^3 respectively, whereas the total outcomes in 2015 were 1.76 and 1.18 billion M^3 respectively. in addition to, in 1966 the total outcomes of water in the wet season of Tigris and Euphrates were 96.85 and 63.31 billion M^3 respectively and in 2015 were 2.07 and 2.03 billion M^3 respectively too (ministry of water resource in Iraq). Therefore, the scarcity of river water is increasing day by day by affecting Iraqi agriculture and irrigation sectors adversely. So Iraqi paddy production is decreasing because of the negative effect of climate change.

Paddy Yield (Ton/ Ha): Evidently, the yield (ton per hectare) of the rice crop in Iraq is decreasing noticeably. The average yearly total yield of Najaf, Qadisiyah, Muthanna, and Thi Qar in 1966- 1990 was 2.86, 2.98, 2.65, 2.07 ton per hectares respectively. And in the years 1991- 2015, the average yearly total yield for the same areas was 2.56, 2.65, 2.29, 1.70 ton per hectares respectively.

An alarming result obtained from these data that the yield of paddy production in Najaf, Qadisiyah, Muthanna and Thi Qar decreased by 3%, 3.3%, 3.6%, 3.7% respectively within only 25 years period. In Iraq, the cultivation system of rice mainly depends on climate condition, and therefore their production hampers due to the adverse effects of climate change.

Correlation between Climate Variabilities and Impact on Outcomes for Tigris and Euphrates Rivers:

The variable pairs indicated in Tables below (Tables 3.23, 3.24, 3.25, 3.26) represent the significant correlation for the hypothesis. Perception of climate change indicators has on the river's outcomes and yield of rice in the study area" (use the data analysis of axel).

Table 3.23. Analysis of Coefficient between Climate Variabilities and Rivers outcomes and, Yields of Rice for the Najaf area (1966~2015).

X/Y	**A dry year. Outcomes for Tigris River. Billion M^3.**	**A dry year. Outcomes for Euphrates River. Billion M^3.**	**A wet year. Outcomes for Tigris River. Billion M^3.**	**A wet year. Outcomes for Euphrates River. Billion M^3.**
Average Yearly Rainfall	-0.0181	-0.0044	-0.1038	-0.1029
Average Yearly minimum temperature	-0.2221	-0.2354	-0.1412	-0.1418
Average Yearly maximum temperature	-0.5372	-0.7393	-0.6344	-0.6350
Yield/ Ton per Hectares	-0.0265	-0.0210	-0.0297	-0.0233

Table 3.24. Analysis of Coefficient between Climate Variabilities and Rivers outcomes and, Yields of Rice for Al Qadisiyah area (1966~2015).

X/Y	**A dry year. Outcomes for Tigris River. Billion M^3.**	**A dry year. Outcomes for Euphrates River. Billion M^3.**	**A wet year. Outcomes for Tigris River. Billion M^3.**	**A wet year. Outcomes for Euphrates River. Billion M^3.**
Average Yearly Rainfall	0.190	0.276	0.299	0.300
Average Yearly minimum temperature	-0.506	-0.423	-0.276	-0.277
Average Yearly maximum temperature	-0.712	-0.778	-0.611	-0.611
Yield/ Ton per Hectares	0.137	0.322	0.137	0.137

Table 3.25. Analysis of Coefficient between Climate variabilities and Rivers outcomes and, Yields of Rice for Al-Muthanna area (1966~2015).

X/Y	**A dry year. Outcomes for Tigris River. Billion M^3.**	**A dry year. Outcomes for Euphrates River. Billion M^3.**	**A wet year. Outcomes for Tigris River. Billion M^3.**	**A wet year. Outcomes for Euphrates River. Billion M^3.**
Average Yearly Rainfall	-0.0923	0.0328	0.0267	0.0274
Average Yearly minimum temperature	-0.8756	-0.7623	-0.6900	-0.6901
Average Yearly maximum temperature	-0.7715	-0.6006	-0.3853	-0.3854
Yield/ Ton per Hectares	0.7677	0.5730	0.4646	0.4655

Table 3.26. Analysis of Coefficient between Climate Variabilities and Rivers outcomes and, Yields of Rice for Thi Qar area (1966~2015).

X/Y	**A dry year. Outcomes for Tigris River. Billion M^3.**	**A dry year. Outcomes for Euphrates River. Billion M^3.**	**A wet year. Outcomes for Tigris River. Billion M^3.**	**A wet year. Outcomes for Euphrates River. Billion M^3.**
Average Yearly Rainfall	0.0044	0.1117	0.1057	0.1073
Average Yearly minimum temperature	-0.0798	-0.1475	-0.0466	-0.0474
Average Yearly maximum temperature	-0.3471	-0.4334	-0.2031	-0.2036
Yield/ Ton per Hectares	-0.3821	-0.3094	-0.4912	-0.4918

Increasing hot minimum and maximum temperatures and decreasing precipitation was found to have a significant correlation with the outcomes of water for the two rivers, as we know, the yield of rice depends in mainly on the water.

By inference, excessive water scarcity for two main rivers has an adverse effect on rice yield as in all the areas study (Figures 3.36, 3.37, 3.38, 3.39).

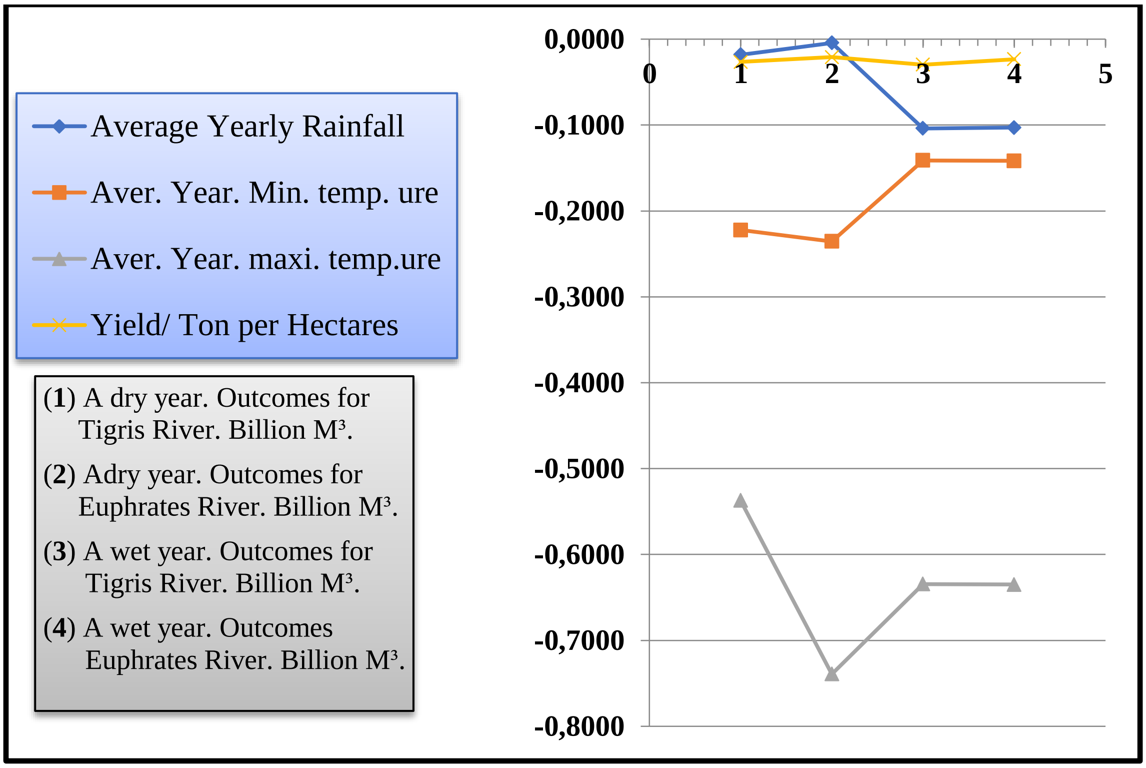


Figure 3.36. Analysis of coefficient between climate variabilities and rivers outcomes and, yields of rice for the Najaf area (1966~2015).

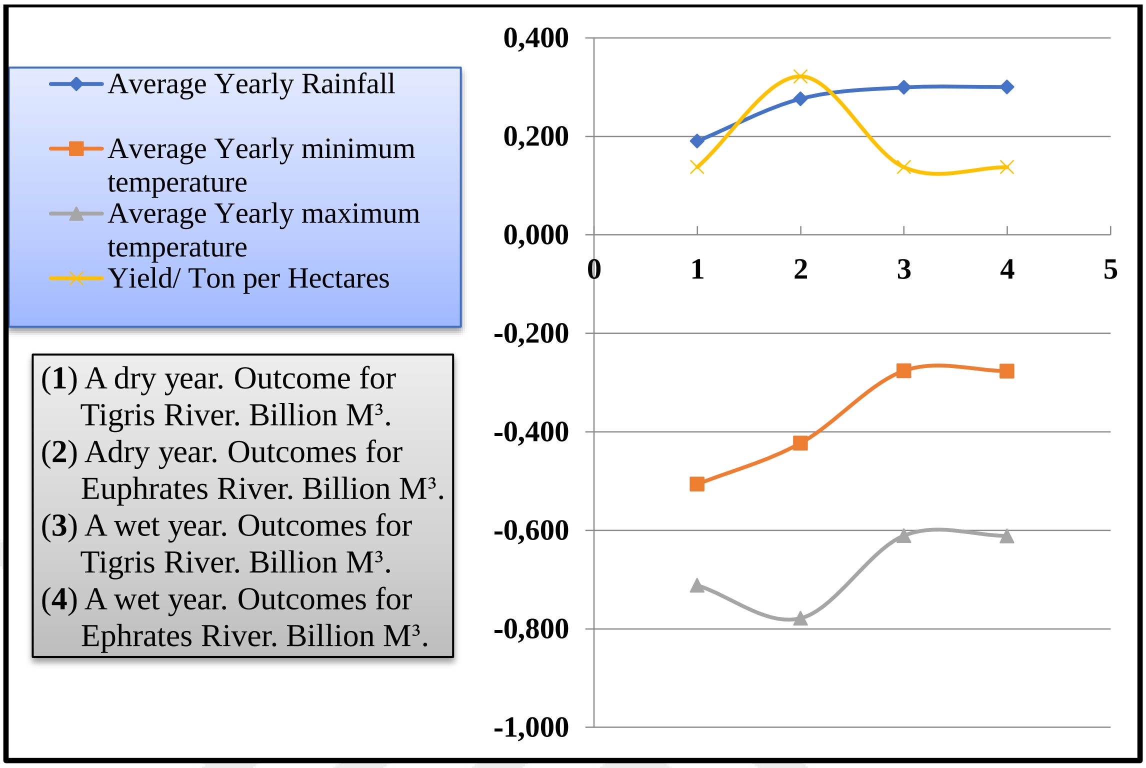


Figure 3.37. Analysis of Coefficient between Climate Variabilities and Rivers outcomes and, Yields of Rice for Al Qadisiyah area (1966~2015).

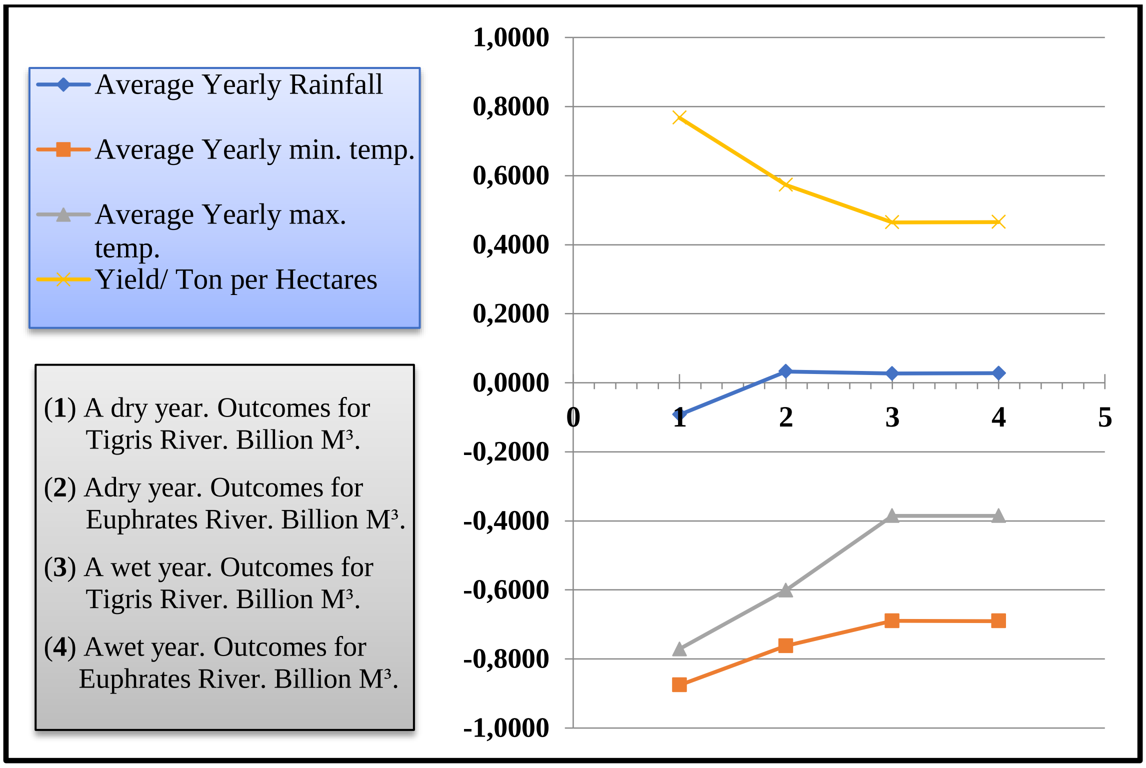


Figure 3.38. Analysis of Coefficient between Climate variabilities and Rivers outcomes and, Yields of Rice for the Al Muthanna area (1966~2015).

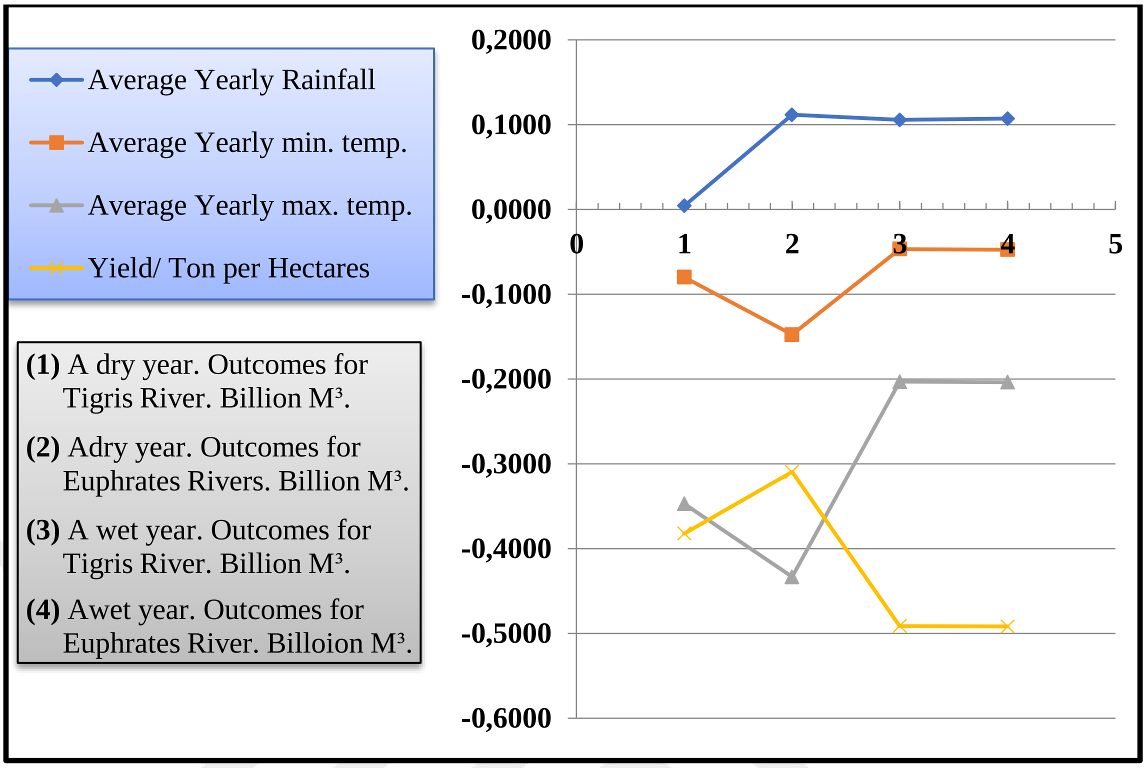


Figure 3.39. Analysis of Coefficient between Climate variabilities and Rivers outcomes and, Yields of Rice for Thi Qar area (1966~2015).

The diseases and pests are also significantly impacted by unpredicted rain. This may suggest that the availability of water, as well as the growth of the crop, are affected by the rainfall. Therefore, any changes in the patterns of rainfall will likely affect the quality and quantity of the availability of water for the production of crops. Both flood and drought could be resulted from unpredicted rainfall and may affect the production of rice adversely.

It has been demonstrated that there is a significant correlation between the rice yield and the perception of climate variability which was confirmed by the Product Moment Correlation Coefficient. There are several reports published earlier which supports this hypothesis. Similar results were obtained in the African country, Ghana, where the authors reported that there was a production drop in rice yield when the temperature was higher and exceeds the optimal level for process biological events [63].

3.8. Analysis of Questionnaire Responses

Socio-Economic Characteristics of Respondents: Results showed the average age of rice farmers in the study area ranged from 55 to 57 years. Of the participant farmers, 3.59% were female and the rest were male (96.41%). This investigation reveals that there is not adequate labor for difficult rice production activities in the study area. The total income of the household was mostly less than 500 $ per month (79.4%), 14.8% had incomes between 500-1000$, 2.7% from 1000 to 3000$, and 3.1% more than 3000$ (Table 3.27). This implies that rice farmers in study areas are generally the house holdings of low-income. This situation could negatively impact the production of rice because of the fact that due to the lack of money the farmer's aspiration to adopt required inputs and improved varieties to combat climate change. In addition, other findings conducted by [64] also support the findings who found that there were positive impacts of farm income on the probability of adoption of climate change strategies in the Nile basin of Ethiopia.

Table 3.27. Monthly Income of Paddy Farmers in Study areas.

Governorate	<500$			500-1000$		1000-3000$		>3000$		P value
	F*	%		F	%	F	%	F	%	
Najaf	83	92.2		6	6.7	1	1.1	0	0	<0.001
Qadisiyah	76	80.0		16	16.8	2	2.1	1	1.1	
Muthanna	5	31.3		2	12.5	3	18.8	6	37.5	
Thi Qar	13	59.1		9	40.9	0	0	0	0	
Total	177	79.4		33	14.8	6	2.7	7	3.1	

(F) Means Frequency.

On the other hand, highly significant differences ($p<0.01$) were observed in household income of the farmers. The highest percentage of Najaf and Qadisiyah farmers were of less than 500$ monthly income, Most of Thi Qar farmers were of two categories (<500$ and 500-1000$), whereas 37.5% of Muthanna farmers have (>3000$) income Fig. (3.40).

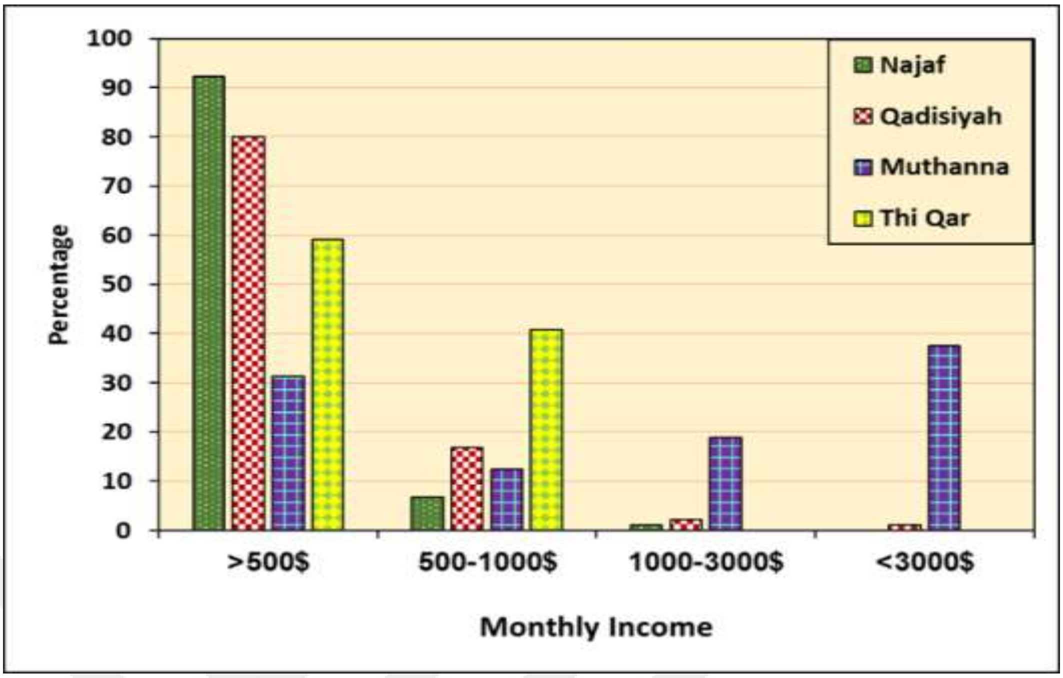


Figure 3.40. Monthly Income for Paddy Farmers in Study areas

The results show that most of the paddy farmers got agricultural skills from untrained (68.61%), and (31.39%) got it from training (Table 3.28).

Highly significant differences ($p<0.01$) were observed in agricultural skills of the farmers. Most farmers in Najaf and Qadisiyah were got skills from untrained, while farmers of Muthanna and Thi Qar got it from training (Fig. 3.41).

Table 3.28. Agricultural Skills for Respondents in the Study area.

Governorate	**Trained**		**Untrained**		**P value**
	F	**%**	**F**	**%**	
Najaf	22	24.4	68	75.6	<0.001
Qadisiyah	26	27.4	69	72.6	
Muthanna	9	56.25	7	43.75	
Thi Qar	13	59.1	9	40.9	
Total	70	31.39	153	68.61	

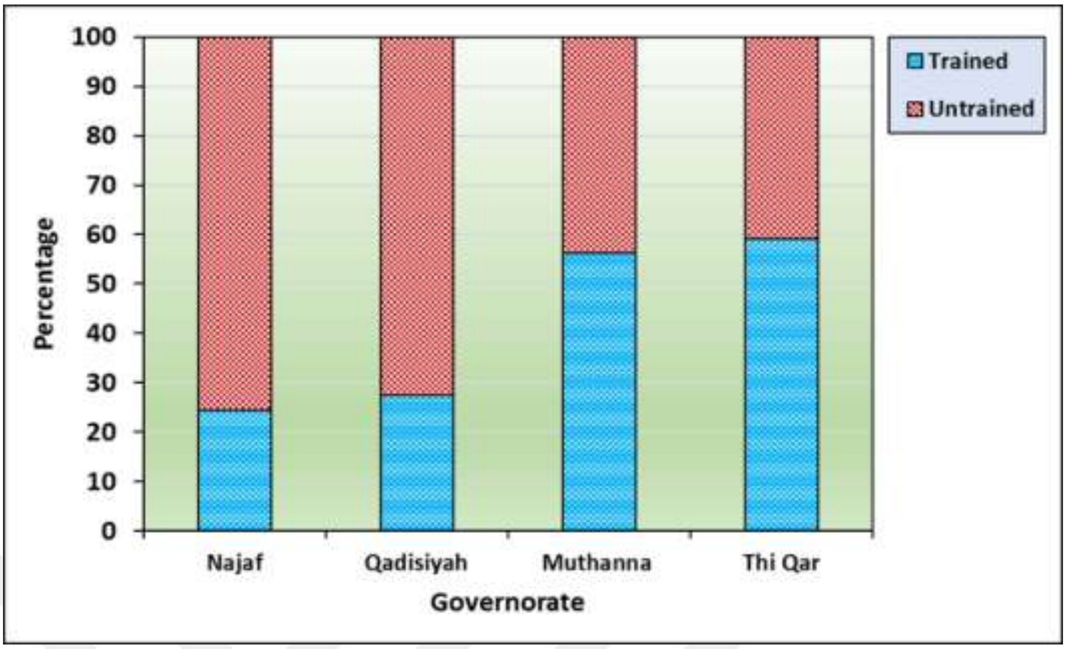


Figure 3.41. Agricultural Skills for Respondents in the Study area

All the farming experiences of the paddy farmers were between 10 – 22 years. Highly significant differences ($p<0.01$) were observed in farming experiences of farmers in studied governorates. More than half of Thi Qar farmers had farming experiences of between (10-20 years), 41.1% and 37.5% of Qadisiyah and Muthanna farmers had more than 30 years farming experiences, while 37.8% of Najaf farmers had 10-20 years farming experiences (Fig. 3.42). The result corroborates with finding from [65] who reported that long farming experience is an advantage for an increase in farm productivity since it encourages the rapid adoption of farm innovation. About 68.61% of land ownership is private.

Table 3.29. Farming Experiences for the Paddy Farmers in the Study areas.

Governorate	<10 years		10-20 years		21-30 years		>30 years		P value	
	F	%	F	%	F	%	F	%		
Najaf	7	7.8	34	37.8	27	30.0	22	24.4	<0.001	
Qadisiyah	7	7.4	24	25.3	25	26.3	39	41.1		
Muthanna	3	18.8	3	18.8	4	25.0	6	37.5		
Thi Qar	3	13.6	12	54.5	6	27.3	1	4.5		
Total	20	8.97	73	32.74	62	27.8	68	30.49		

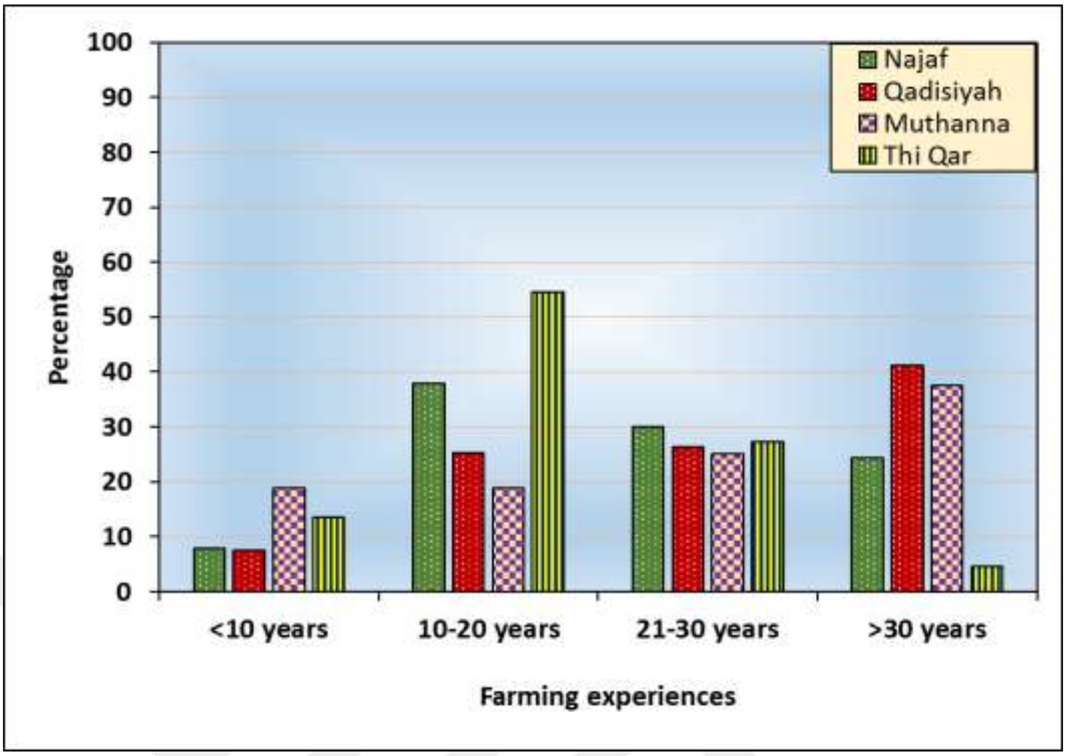


Figure 3.42. Farming experiences for the paddy farmers in the study areas.

In addition, 52.47% of the paddy field area is 3 hectares and 27.8% is between 3 – 10 hectares (Table 3.30).

Highly significant differences (p<0.01) were observed in paddy fields size of the farmers in the study areas. About 62.3% of Muthanna farmers have 3-10 ha, 59.1% of Thi Qar farmers have >1 ha, more than half of studied farmers of Najaf and Qadisiyah have 1-3 ha (Fig. 3.43).

Table 3.30. Total Paddy fields for the Farmers in the Study areas

Governorate	<1 ha		1-3 ha		3-10 ha		>10 ha		P value
	F	%	F	%	F	%	F	%	
Najaf	9	10.0	50	55.6	21	23.3	10	11.1	<0.001
Qadisiyah	1	1.1	53	55.8	30	31.6	11	11.6	
Muthanna	0	0	6	37.5	10	62.3	0	0	
Thi Qar	13	59.1	8	36.4	1	4.5	0	0	
Total	23	10.31	117	52.47	62	27.8	21	9.42	

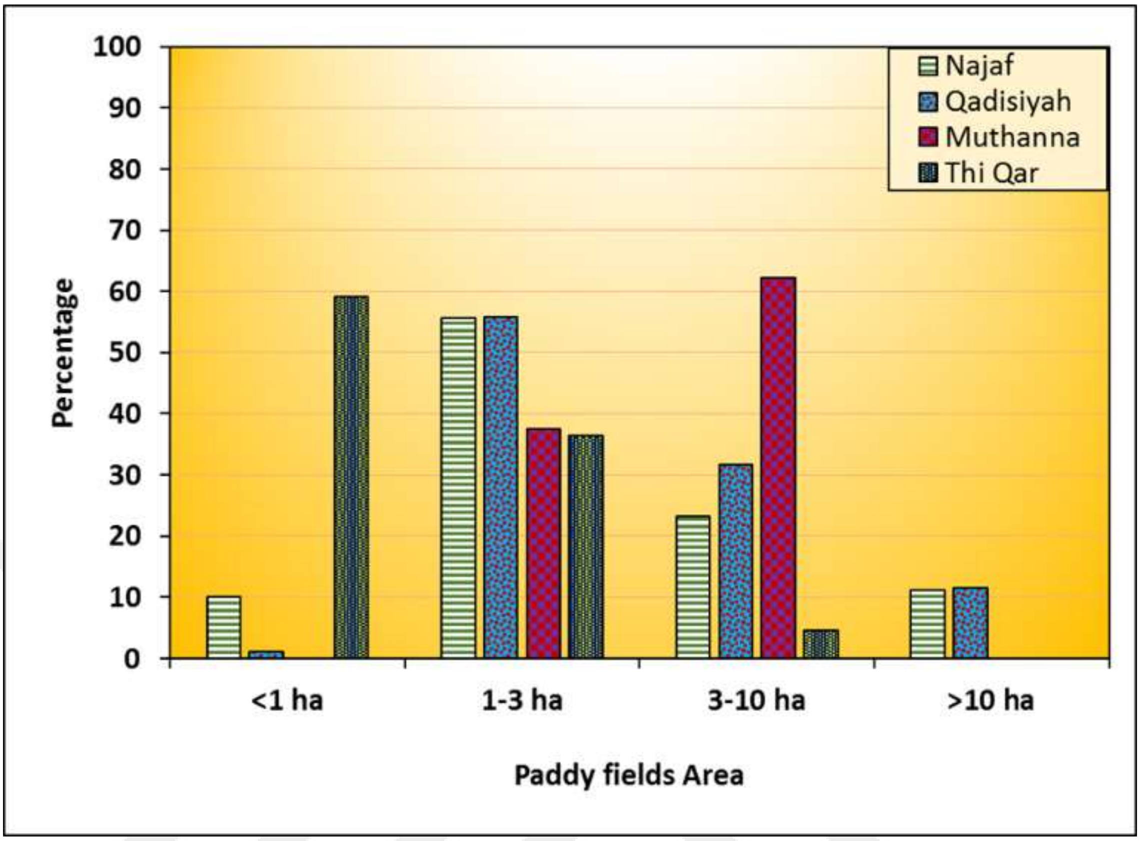


Figure 3.43. Paddy Fields area for the Farmers in the Study areas.

For the paddy fields, more than 96% depend on irrigation. Although the type of rice culture is irrigated in all governorates, Najaf differed from the other studied governorates since a part of it had another method. However, no significant differences ($P>0.05$) were observed (Table 3.31 and Fig. 3.44).

Table 3.31. Type of rice Culture for the Respondents in the Study area.

Governorate	Irrigated		Rainfed		Other		P value
	F	%	F	%	F	%	
Najaf	83	92.2	0	0	7	7.8	0.922
Qadisiyah	94	98.9	1	1.1	0	0	
Muthanna	16	100	0	0	0	0	
Thi Qar	22	100	0	0	0	0	
Total	215	96.41	1	0.45	7	3.14	

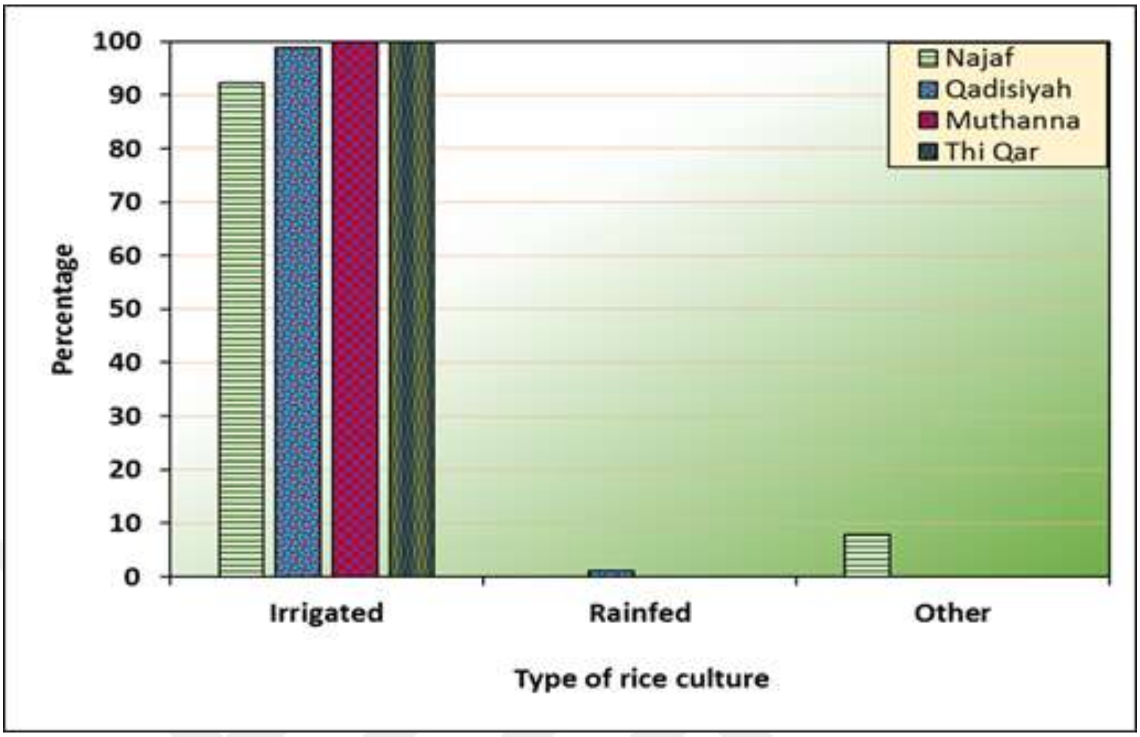


Figure 3.44. Type of Rice Culture for the Respondents in the study area

So, the water available is very important to the rice fields. About 77.13% of irrigated system use technical (by water machine) water supply. Highly significant differences ($p<0.01$) were observed in types of irrigation in the study areas. Most areas in Najaf, Qadisiyah and Muthanna were irrigated technically, areas of Thi Qar irrigated by semi and non-technical methods (Table 3.32 and Figure.3.45).

Table 3.32. Types of irrigation for the rice fields in the study areas

Governorate	Non-technical		Semi-technical		Technical		P value
	F	%	F	%	F	%	
Najaf	7	7.8	15	16.7	68	75.6	<0.001
Qadisiyah	2	2.1	2	2.1	91	95.8	
Muthanna	5	31.3	1	6.3	10	62.5	
Thi Qar	9	40.9	10	45.5	3	13.6	
Total	23	10.31	28	12.56	172	77.13	

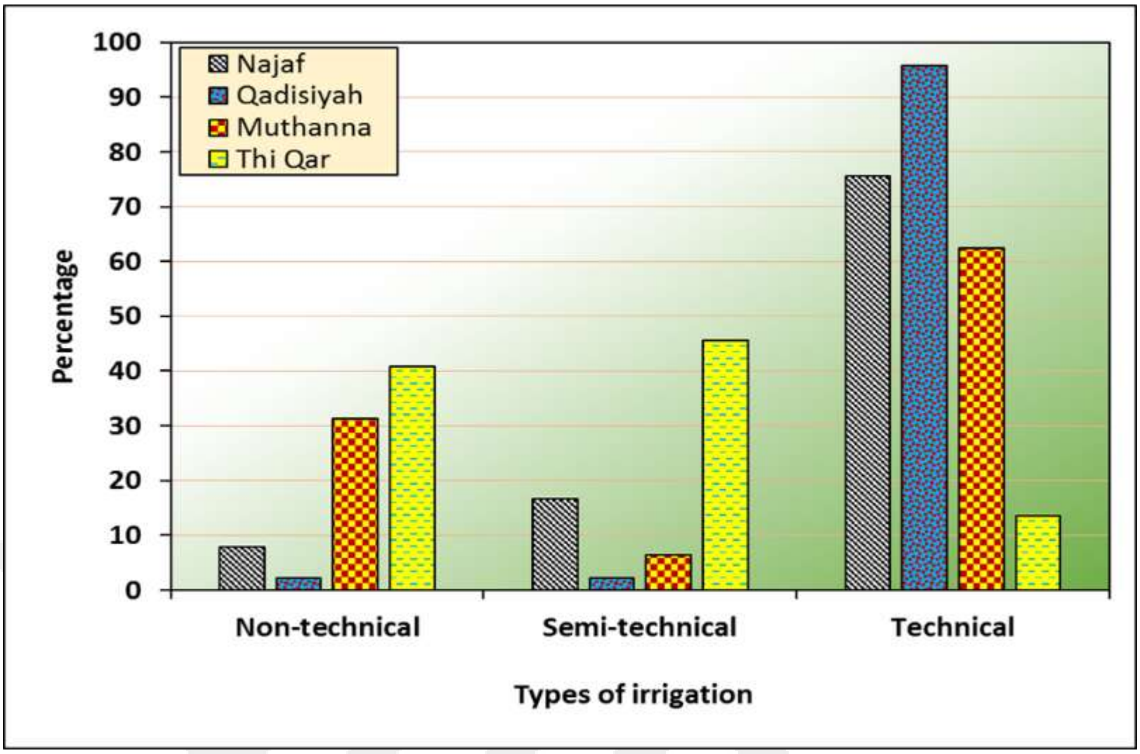


Figure 3.45. Types of Irrigation for the Rice Fields in the Study areas

Around 45.29% of the paddy farmers have no knowledge about water irrigation quality that used to the paddy fields, and 54.91% have this knowledge (Table 3.33). In the answers of respondents, no significant difference ($p>0.05$) was observed about knowledge of farmer in four governorates upon water quality parameters for the irrigation water (Fig. 3.46).

Table 3.33. Knowledge of Water Quality Parameters for the Irrigation Water to the Rice Farmers fields in the Study area.

Governorate	yes		no		P value
	F	%	F	%	
Najaf	**52**	**57.8**	**38**	**42.2**	**0.098**
Qadisiyah	**55**	**57.9**	**40**	**42.1**	
Muthanna	**7**	**43.75**	**9**	**56.25**	
Thi Qar	**8**	**36.4**	**14**	**63.6**	
Total	**122**	**54.91**	**101**	**45.29**	

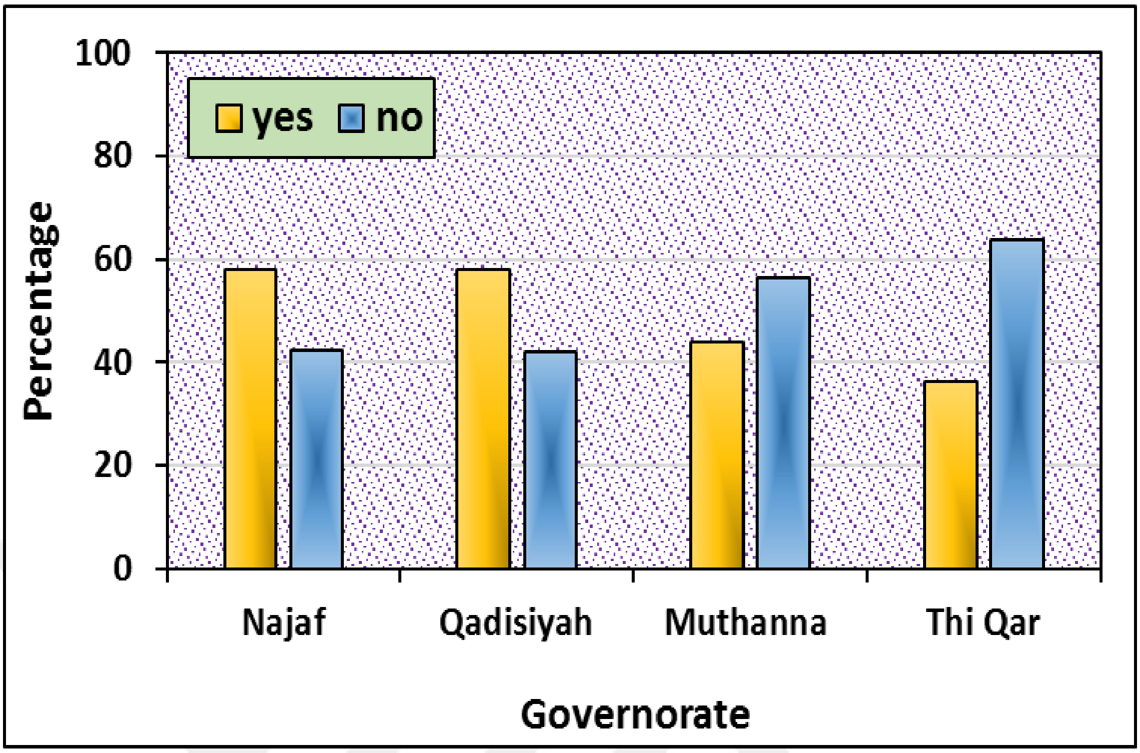


Figure 3.46. Knowledge of Water Quality Parameters

Yields (ton per hectares): Around 184 of respondents have a yield more than 2 tons and the others have less than 2 tons, 88 respondents sell their products to the Government, 40 farmers to the private store, and the others to the both.

The educational levels of the paddy farmers: The analysis of the results revealed that 12.11 % of the farmers had the education up to the bachelor's degree level, 38.57% elementary, 26.01% secondary, and only 21.97% didn't attend school (Table 3.34). On the level of education attained, primary education was completed by the majority of the farmers.

Highly significant differences ($p<0.01$) were observed in educational levels of the respondents in the study area. About 50% of farmers were illiterate in the Muthanna, 50% and 44.2% had got elementary education in Thi Qar and Qadisiyah respectively. On the other hand, 37.8% of Najaf farmers had got secondary education (Fig. 3.47).

It has been indicated by the foregoing patterns that there was a lack of education in the study area. This factor particularly can have severe impacts on the agricultural extension programs on climate change and comprehension of necessary rice production technologies. It is important to note that the finding of this study was supported by other studies [66] where the authors showed that the education may make farmers more responsive to many agricultural policies as well as extensions programs. In addition, [67] found that there was an increase in the adaptive capability of the farmers against climatic change if the attended in the formal education. Therefore, it is obvious that the higher the education level of the rice producer, the more adaptation strategies taken by the farmers against climatic change in rice production in the study area. In a study by Allison et al. (2009) found that the vulnerability and adaptation of a nation to climate change impact depends on the level of education of its citizens.

Table 3.34. Education levels for the Respondents in the Study area

Areas	Illiterate		Elementary		Secondary		Bachelor's degree		Other		P value
	F	%	F	%	F	%	F	%	F	%	
Najaf	9	10	28	31.1	34	37.8	17	18.9	2	2.2	<0.001
Qadisiyah	25	26.3	42	44.2	21	22.1	6	6.3	1	1.1	
Muthanna	8	50.0	5	31.3	3	18.8	0	0	0	0	
Thi Qar	7	31.8	11	50.0	0	0	4	18.2	0	0	
Total	49	21.97	86	38.57	58	26.01	27	12.11	3	1.35	

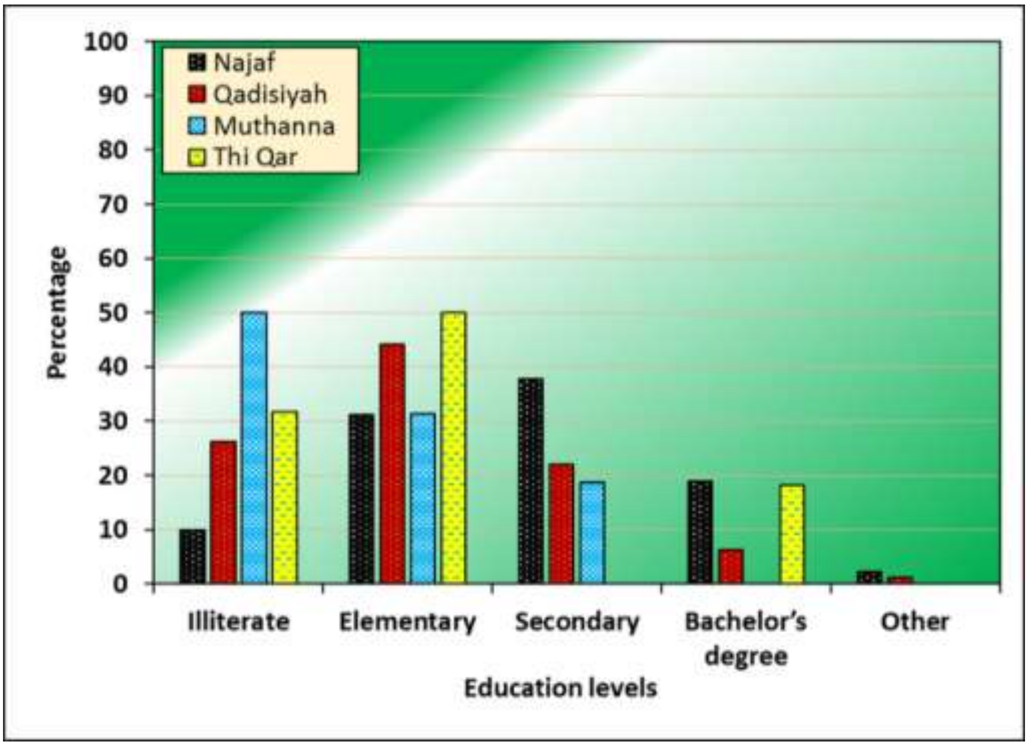


Figure 3.47. Education levels for the Respondents in the Study area

The result showed most farmers (92.38%) heard the term adaptation to climate change, and the rest of them (7.62%) didn't hear that term (Table 3.35). No significant differences (p>0.05) were observed with respect to hearing, about climate change. In Muthanna and Thi Qar governorates, all respondents were hearing about climate change, while some of the respondents in Najaf and Qadisiyah had no idea about climate change (Figure.3.48).

Many farmers had heard of climate change from television (61.42%), Internet (10.39%), Radio (10.09%), friends (8.01%), school (4.45%), newspaper (2.37%), and from Governments agencies (2.08%). Most said that feel the pattern of weather has changed at least of the ten years ago (91.03%).

Table 3.35. Respondents Hearing, about Climate change.

Governorate	Yes		No		P value
	F	%	F	%	
Najaf*	80	88.9	10	10.1	0.357
Qadisiyah	88	92.6	7	7.4	
Muthanna	16	100	0	0	
Thi Qar	22	100	0	0	
Total	206	92.38	17	7.62	

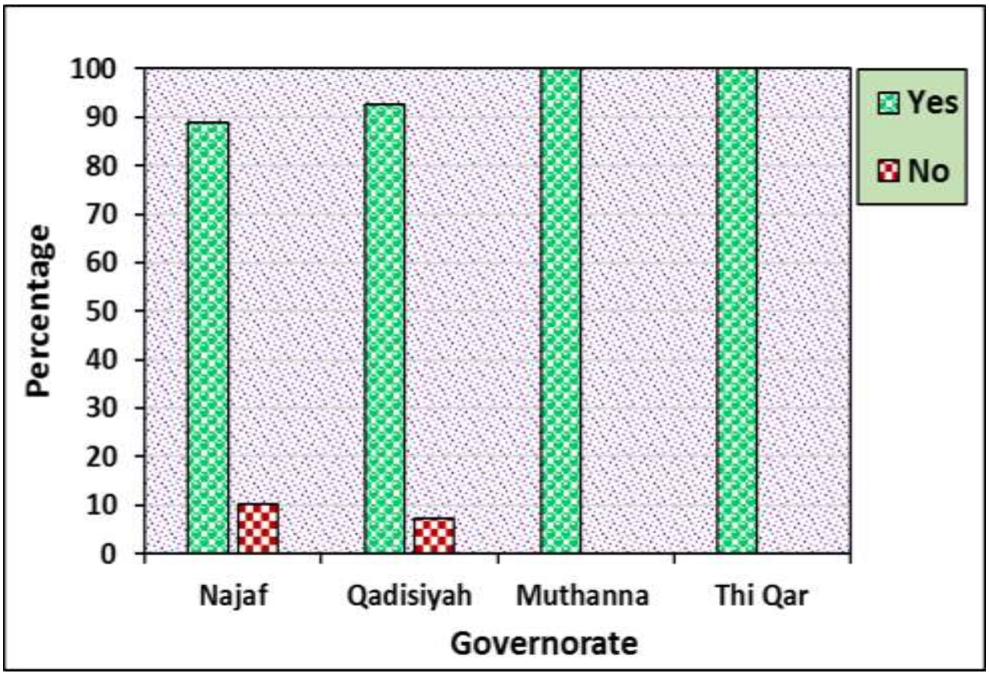


Figure 3.48. Respondents Hearing, about Climate change.

No significant differences (p>0.05) were observed with respect to feeling the pattern of weather changing. All respondents in Muthanna (100%) responded by yes, but some of them in other governorates even have no or don't know in their answers (Table 3.36).

Table 3.36. Feeling the Pattern of Weather changing for the Respondents

Governorate	Yes		No		Don't know		P value
	F	%	F	%	F	%	
Najaf*	78	86.7	5	5.6	7	7.8	0.140
Qadisiyah	89	93.7	2	2.1	4	4.2	
Muthanna	16	100	0	0	0	0	
Thi Qar	20	90.9	0	0	2	9.1	
Total	203	91.03	7	3.14	13	5.83	

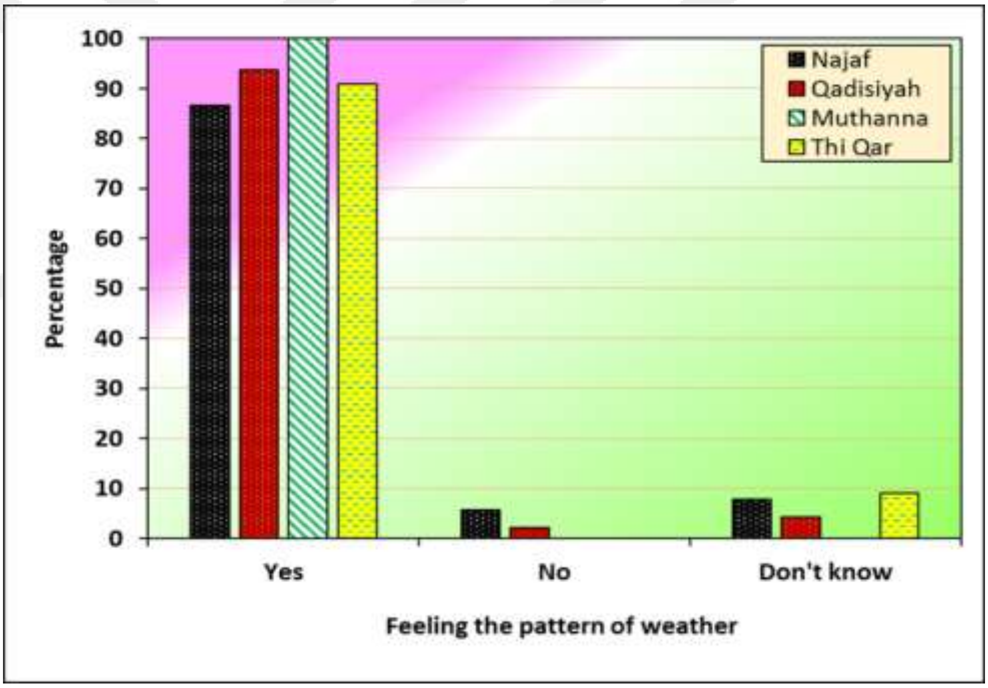


Figure 3.49. Feeling the Pattern of Weather changing for the Respondents

Importance and effects of climate change: In the study area most of the farmers (56.95%) consider climate change to be very important, 34.98% consider it important, and others consider it unimportant (Table 3.37). So, they are highly significant differences (p<0.01) in their thoughts about the importance of climate change. More than 50% of respondents in Najaf and Qadisiyah answered by “very important”, while more than 50% of respondents in Muthanna and Thi Qar answered by “quite important” (Figure.3.50).

Table 3.37. Importance of Climate change for the Respondents in the Study area

Governorate	Very important		Quite important		Not very important		P value
	F	%	F	%	F	%	
Najaf	54	60	33	36.7	3	3.3	0.001
Qadisiyah	58	61.1	24	25.3	13	13.7	
Muthanna	7	43.75	9	56.25	0	0	
Thi Qar	8	36.4	12	54.5	2	9.1	
Total	127	56.95	78	34.98	18	8.07	

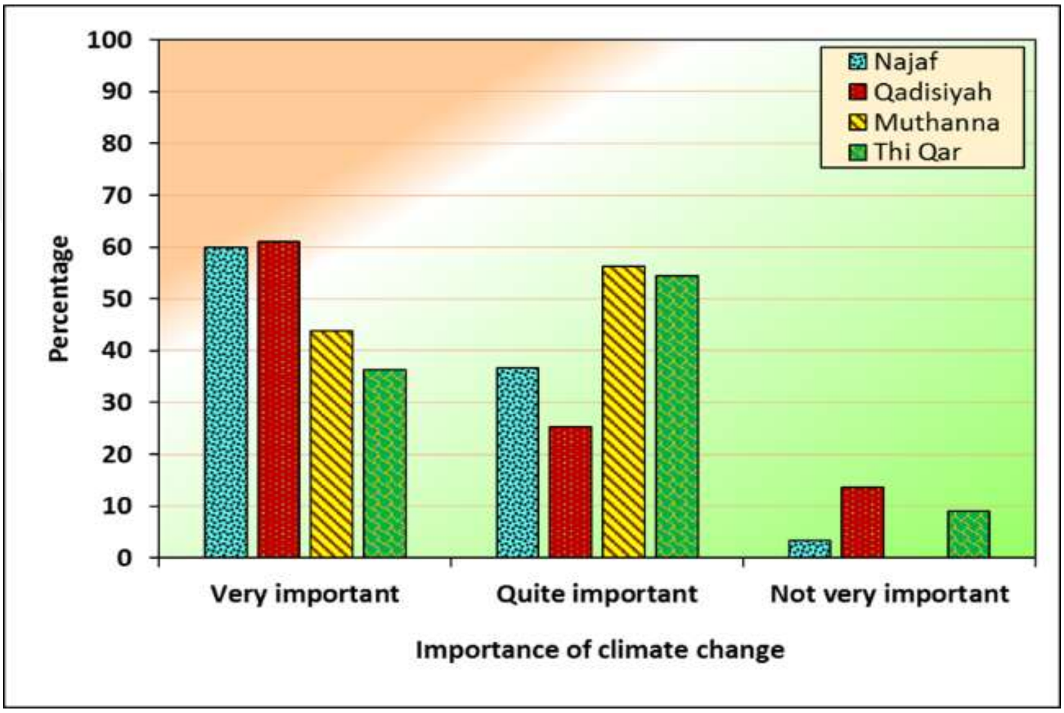


Figure 3.50. Importance of Climate change for the Respondents in the Study area

About, 97.31% of the respondents consider climate had a significant impact on them and their fields through high temperatures and low rainfall and, approximately all respondents in studied governorates had knowledge about the effects of climate change on the rural area, so no significant differences (p>0.05) were observed with respect to their answers. (Table 3.38).

Respondents also believe that the most affected sector by climate change is rice production sector (87%), followed by the rural economy sector (65.02%) (Table 3.39), show us that no significant differences (p>0.05) were observed in answers of respondents in respect to sectors that affected by climate change. Their opinion revealed that rice production was the first sector that affected by climate change, followed by rural economy and health.

Table 3.38. Climate change Effects on the Rural area

Governorate	Yes		No		No idea		P value
	F	%	F	%	F	%	
Najaf*	85	94.4	2	2.2	3	3.3	0.681
Qadisiyah	94	98.9	1	1.1	0	0	
Muthanna	16	100	0	0	0	0	
Thi Qar	22	100	0	0	0	0	
Total	217	97.31	3	1.35	3	1.35	

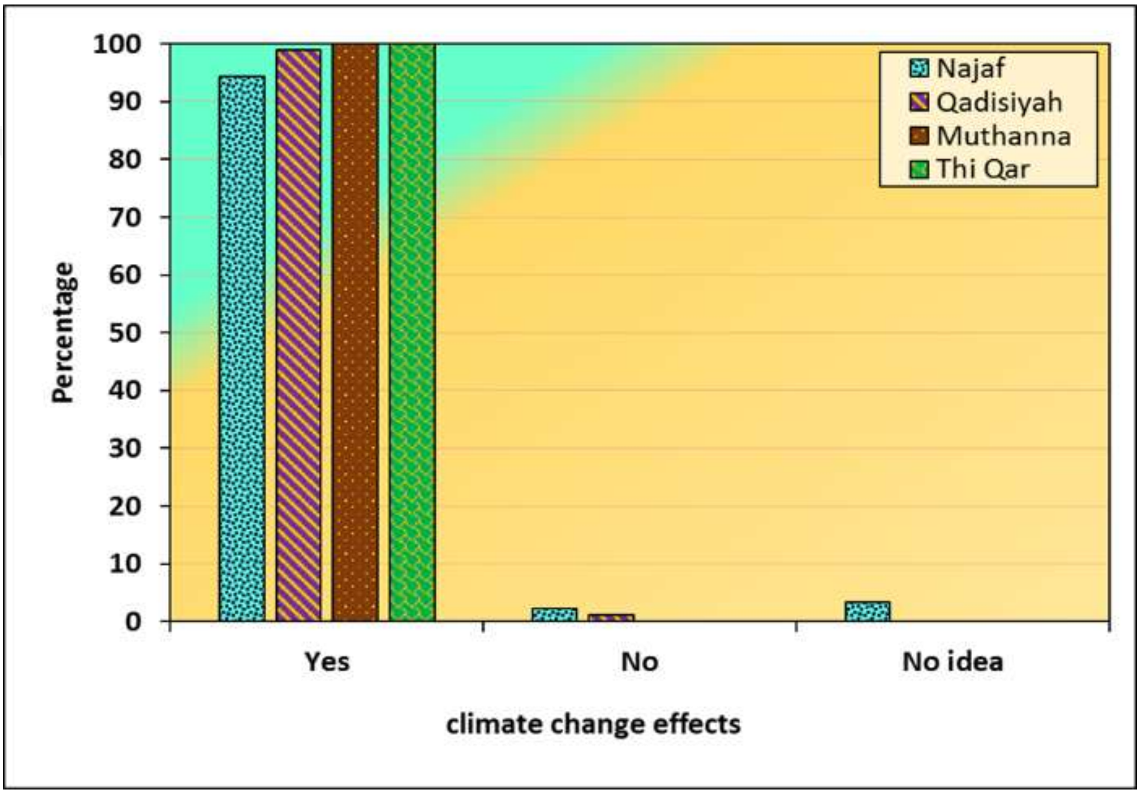


Figure 3.51. Climate change Effects on the rural area

Table 3.39. Sectors that affected by Climate change in the Study area

Sectors	Najaf		Qadisiyah		Muthanna		Thi Qar		Total	
	F	%	F	%	F	%	F	%	F	%
Health	51	56.67	49	51.58	9	56.25	13	59.09	122	54.71
Rural economy	61	67.78	63	66.32	11	68.75	10	45.45	145	65.02
Rice production	85	94.44	71	74.74	16	100	22	100.00	194	87.00
Water quantities	51	56.67	35	36.84	9	56.25	10	45.45	105	47.09
Animal production	29	32.22	32	33.68	8	50	5	22.73	74	33.18
Others	0	0	11	11.58	0	0	0	0	11	4.93
P value	0.087									

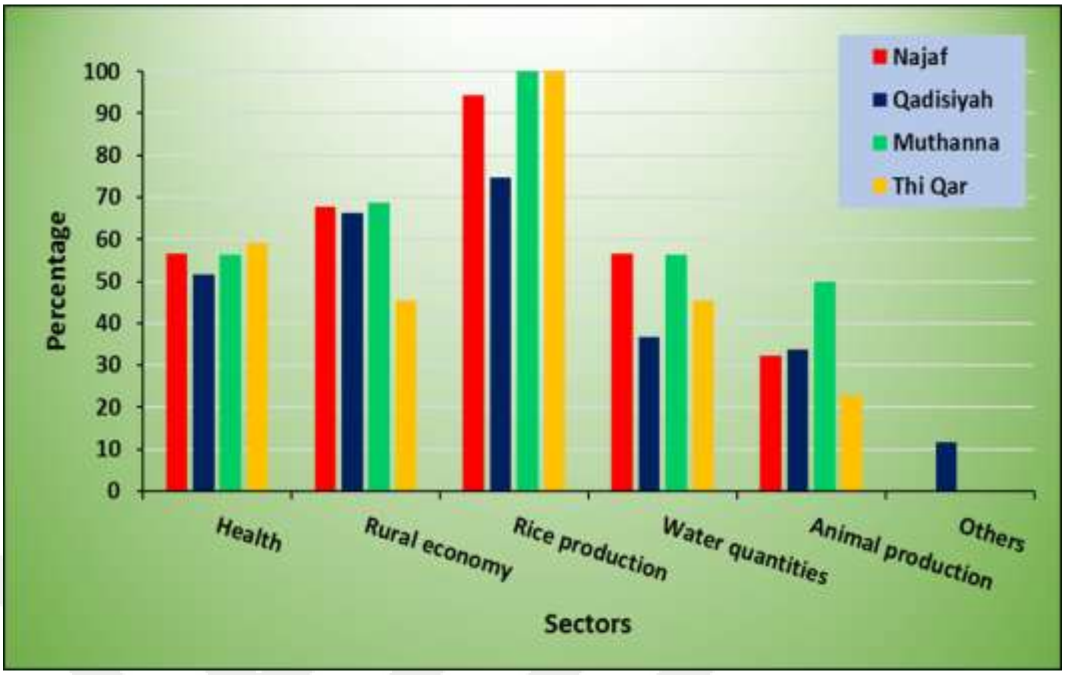


Figure 3.52. Sectors affected by Climate change in the Study area

According to respondents in the survey area, 50 respondents believe that the impact of climate on the rice sector is on the production and the yield followed by crop water consumption and then its impact on the spread of diseases and insects in the rice fields as shown in the Table (3.40) below. The analysis shows us that highly significant differences (p>0.01) were observed in answers of respondents with respect to How climate change affects the rice farms in their study area. Najaf and Qadisiyah farmer answers showed that climate change affects production and yield firstly, Muthanna farmer answers showed that climate change affects water consumption firstly then production, whereas Thi Qar farmer answers showed that climate change affects water consumption firstly then yield (Fig 3.53).

Table 3.40. How Climate change Affects Rice Farms in the Study area

Type of effect	Najaf		Qadisiyah		Muthanna		Thi Qar		Total	
	F	%	F	%	F	%	F	%	F	%
Size of the Farm	20	22.22	33	34.74	0	0	2	9.09	55	24.66
Yield	60	66.67	57	60.00	6	37.5	10	45.45	133	59.64
Production	54	60.00	65	68.42	7	43.75	7	31.82	133	59.64
Disease and insects	40	44.44	38	40.00	8	50	3	13.64	89	39.91
Plant distribution	10	11.11	14	14.74	1	6.25	1	4.55	26	11.66
Plant density	12	13.33	19	20.00	2	12.5	4	18.18	37	16.59
water consumption	45	50.00	47	49.47	9	56.25	13	59.09	114	51.12
All above	8	8.89	7	7.37	6	37.5	3	13.64	24	10.76
P value	<0.001									

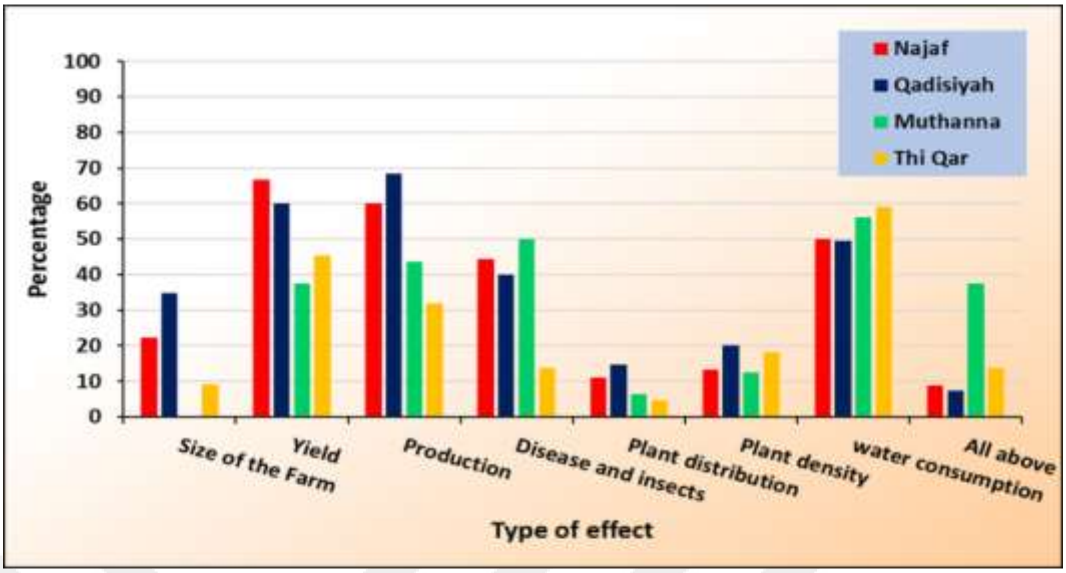


Figure 3.53. Type of Climate change Effects

The adaptation strategies to cope with climate change used by paddy farmers: It has been evident by the results obtained by the analysis of quantitative data indicated that the farmers of the paddy are undertaking different changes in their production practices to mitigate the effects of climate change, although the measures are not the same for every farmer (Tables below). It is important to note that all the respondents used at least one or more adaptation strategy for paddy farming. The adapted practices identified by our study in four areas of Iraq include cultivating the improved rice varieties such as varieties that offer significantly higher yields than the traditional breeds, shifting to drought-tolerant crops and varieties, shifting to shorter cycle crop varieties which is able to produce rice just within three months from planting to harvesting; use water pumps to irrigate the rice fields; use intensive chemical fertilizers and compost for rice fields; change planting time; change soil conservation techniques; and use crop rotation to improve soil structure.

Table 3.41 below (Najaf area), revealed that most of the respondents used intensive chemical fertilizers for rice fields (78.9%). Use water pumps to irrigate the rice fields by 77.8% of the respondents and improve irrigation systems by 62.2%. While in Qadisiyah (Table 3.42) shows that most of the respondents always used the water pumps to irrigate the rice fields (82.1%), use intensive chemical fertilizers for rice fields (67.4%), use certified seeds (50.5%). But, in Al Muthanna area (Table 3.43) revealed that most of the respondents used the water pumps to irrigate the rice fields (100%), use intensive chemical fertilizers for rice fields (56.3%), use certified seeds (50%). And finally, Thi Qar, (table 4.22) revealed that most of the respondents used the water pumps to irrigate the rice fields (68.2%), improve irrigation systems (31.8%), and use certified seeds (22.7%).

Table 3.41. Strategies for Adaptation to Climate change for the Respondents in Al Najaf area

Perceptions	climate change					
	Always		Ever		Never	
	F	%	F	%	F	%
1	24	26.7	50	55.6	16	17.8
2	47	52.2	40	44.4	3	3.3
3	53	58.9	31	34.4	6	6.7
4	29	32.2	37	41.1	24	26.7
5	56	62.2	26	28.9	8	8.9
6	70	77.8	18	20	2	2.2
7	71	78.9	17	18.9	2	2.2
8	23	25.6	27	30	40	44.4
9	39	43.3	26	28.9	25	27.8
10	19	21.1	36	40	35	38.9

1. Change planting time. 2. Use certified seeds. 3. Planning water requirements. 4. Change soil conservation techniques. 5. Improve irrigation systems. 6. Use water pumps to irrigate the rice fields. 7. Use intensive chemical fertilizers for rice fields. 8. Use compost. 9. Intensive use of pesticides. 10. Crop rotation.

Table 3.42. Strategies for Adaptation to Climate change for the Respondents in Al Qadisiyah area

Perceptions	climate change					
	Always		Ever		Never	
	F	%	F	%	F	%
1	28	29.5	55	57.9	12	12.6
2	48	50.5	44	46.3	3	3.2
3	27	28.4	29	30.5	39	41.1
4	4	4.2	29	30.5	62	65.3
5	19	20.0	33	34.7	43	45.3
6	78	82.1	16	16.8	1	1.1
7	64	67.4	29	30.5	2	2.1
8	0	0.0	23	24.2	72	75.8
9	19	20.0	62	65.3	14	14.7
10	2	2.1	13	13.7	80	84.2

Table 3.43. Strategies for Adaptation to Climate change for the Respondents in Al Muthanna Area

Perceptions	climate change					
	Always		Ever		Never	
	F	%	F	%	F	%
1	0	0	0	0	16	100
2	8	50	8	50	0	0
3	7	43.7	0	0	9	56.3
4	7	43.7	1	6.3	8	50
5	7	43.7	2	12.6	7	43.7
6	16	100	0	0	0	0
7	9	56.3	0	0	7	43.7
8	1	6.3	6	37.5	9	56.3
9	0	0	10	62.5	6	37.5
10	7	43.7	0	0	9	56.3

Table 3.44. Strategies for Adaptation to Climate change for the Respondents in Thi Qar area

Perceptions	climate change					
	Always		Ever		Never	
	F	%	F	%	F	%
1	0	0	8	36.4	14	63.6
2	5	22.7	13	59.1	4	18.2
3	4	18.2	13	59.1	5	22.7
4	2	9.1	5	22.7	15	68.2
5	7	31.8	11	50.0	4	18.2
6	15	68.2	6	27.3	1	4.5
7	3	13.6	16	72.7	3	13.6
8	3	13.6	8	36.4	11	50
9	0	0	11	50.0	11	50.0
10	0	0	9	40.9	13	59.1

On the other hand, we see that all respondents in the study areas agree that climate change has clearly affected water management standards and policies in that region. The results of the survey showed that 88.9% in Najaf, 83.2% in Qadisiyah, 93.7% in Muthanna, 77.3% in Thi Qar, responded that changes in the climate had significant impacts on water management policies and standards in their areas, that means approximately all respondents in studied governorates had knowledge about climate change influencing criteria of water management, so no significant differences ($p>0.05$) were observed with respect to their answers (Table 3.45).

Table 3.45. Climate change Influencing Criteria of Water Management

Governorate	Yes		No		Don't know		P value
	F	%	F	%	F	%	
Najaf	80	88.9	4	4.3	6	6.7	0.964
Qadisiyah	79	83.2	4	4.3	12	12.6	
Muthanna	15	93.7	1	6.3	0	0	
Thi Qar	17	77.3	0	0	5	22.7	
Total	191	85.65	9	4.04	23	10.31	

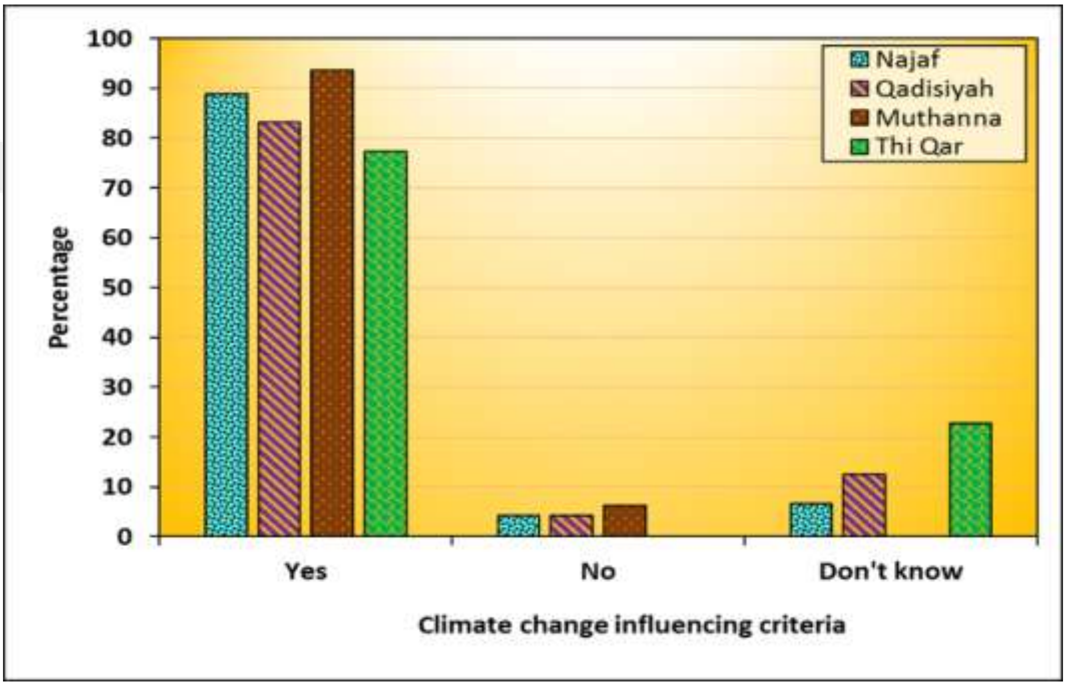


Figure 3.54. Climate change Influencing Criteria of Water Management

It is clearly evident from the current study that the paddy producers have different, in most cases negative, opinion/attitude regarding the current status of the climatic condition during the period and witnessed many changes in the climatic condition that took place in the region over the time. This means that the hypothesis that made in the first chapter is fully consistent with the findings of analyzed data and the results of the questionnaire analysis about the impacts of climatic change on the Rural people, production of rice and water quantities, because of, the production of paddy remains a primary income source in the selected areas as well as in the rural communities in Iraq. Data analysis and the obtained results from the questionnaire clearly showed a rise in temperature with a very low rainfall. This change affected the yield of rice as well as water quantities.

Rice production and rural development: Results of the last section in the Questionnaire revealed that 92.8% of the farmers believed that the rice production affects the livelihood of rural people in the study area (Table 3.46). It is important to note that there are no significant differences (p>0.05) in knowledge of farmer in four governorates about the effects of rice production on livelihood of rural people (Figure.3.55).

Table 3.46. Rice Production affects the Livelihood of Rural People in the Study area

Governorate	Yes		No		Don't know		P value
	F	%	F	%	F	%	
Najaf	81	90	6	6.7	3	3.3	0.627
Qadisiyah	91	95.8	1	1.1	3	3.2	
Muthanna	16	100	0	0	0	0	
Thi Qar	19	86.4	3	13.6	0	0	
Total	207	92.8	10	4.9	6	2.7	

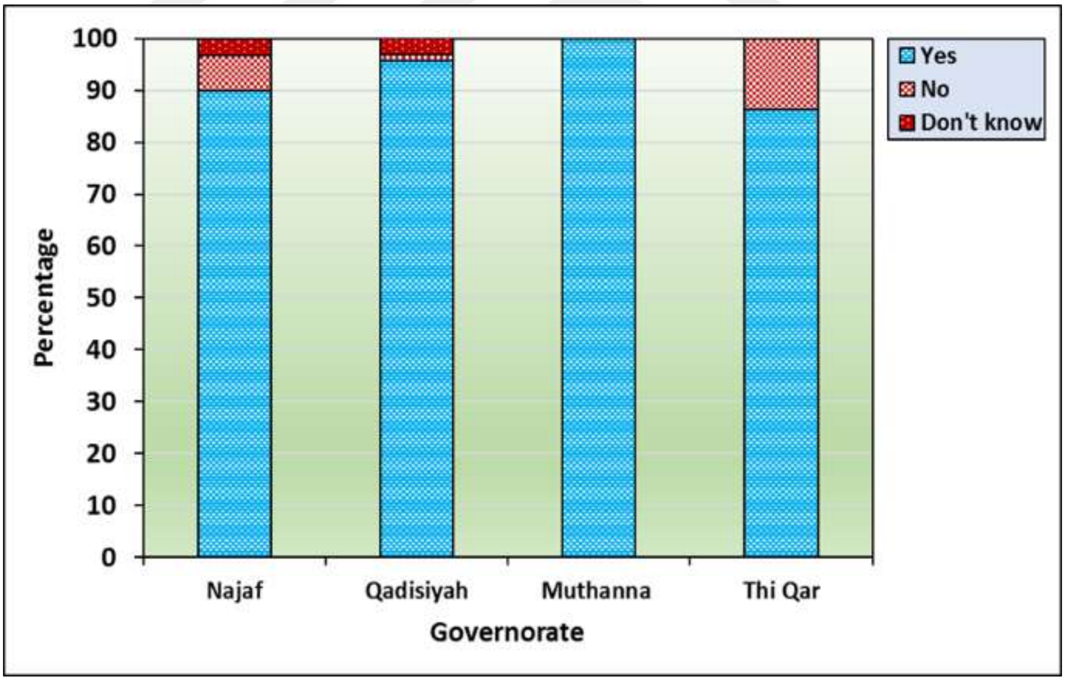


Figure 3.55. Rice production affects the Livelihood of Rural People in the Study area

And, 97.3% of them believed that the decline in rice production directly affects the lives of rural people in rural areas because they depend on rice production for their livelihood (Table 3.47).

So, there are no significant differences (p>0.05) in knowledge of farmer in four governorates about effects of declining rice productions on the rural area (Figure. 3.56).

Table 3.47. Decline in Rice Production affects the Rural area

Governorate	Yes		No		Don't know		P value
	F	%	F	%	F	%	
Najaf	88	97.8	2	2.2	0	0	0.795
Qadisiyah	95	100	0	0	0	0	
Muthanna	16	100	0	0	0	0	
Thi Qar	18	81.8	4	18.2	0	0	
Total	217	97.3	6	2.7	0	0	

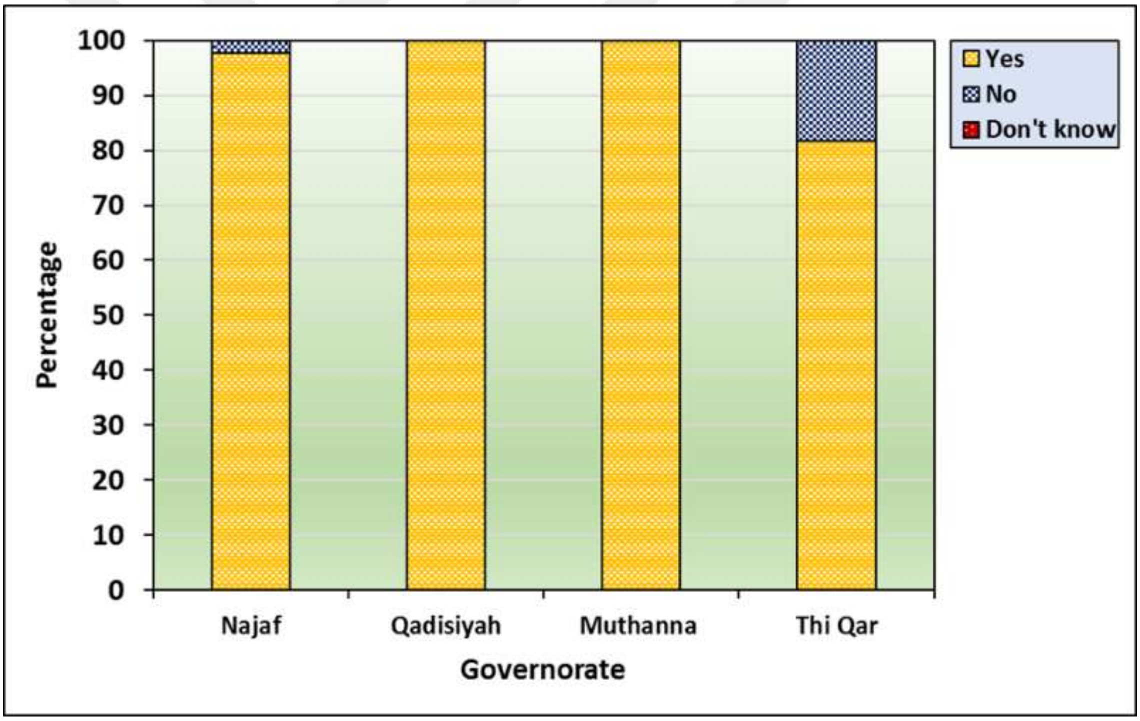


Figure 3.56. The Decline in Rice Production Affects the Rural Area

Effects of declining rice production on the rural area was identified as poverty (74.4%), migration (45.74%), and health deterioration (13%) (Table 3.48). A higher level of significant differences (p>0.01) was seen in answers of respondents with respect to how the decline in rice production affects the rural people in the study area. Most Najaf and Thi Qar farmers thought that decline in rice production leads to poverty, Qadisiyah farmers thought that decline in rice production leads to poverty and migration, While

Muthanna farmer thought that decline in rice production leads to poverty and health deterioration (Figure. 3.57).

Table 3.48. How the Decline in rice production affects the rural people in the study area

Governorate	Poverty		Migration		Deterioration		Other		P value
	F	%	F	%	F	%	F	%	
Najaf	61	67.78	13	14.44	8	8.89	8	8.89	<0.001
Qadisiyah	78	82.11	77	81.05	10	10.53	2	2.11	
Muthanna	12	75	4	25	9	56.3	0	0	
Thi Qar	15	68.2	8	36.4	2	9.1	0	0	
Total	166	74.4	102	45.74	29	13	10	4.5	

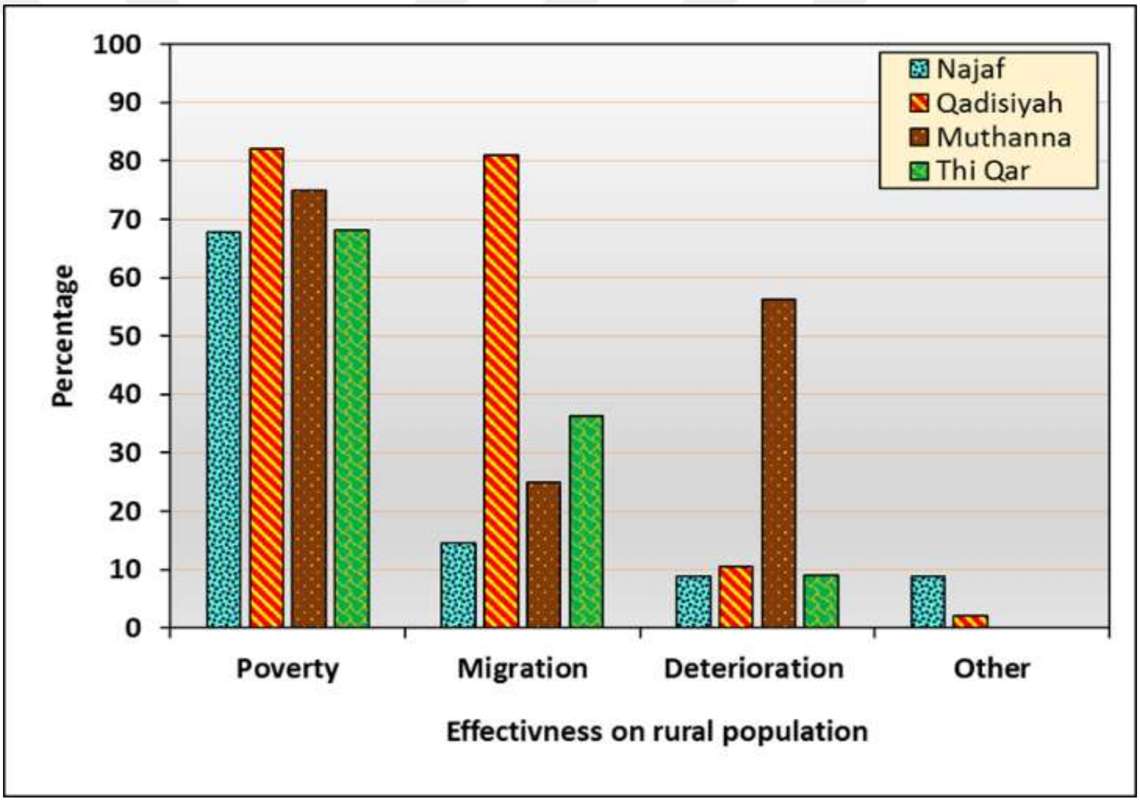


Figure 3.57. The Decline in rice production affects the rural people in the study area

According to the respondent's answer, we can see that there was a significant difference (p>0.01) in answers of respondents in respect to the condition of rice production over the last 10 years in the study area. The rice production declined dramatically, where 46.19% of them see production has decreased and, 20.18% as a significant decrease (Table 3.49). Most Najaf, Qadisiyah, and Muthanna farmers postulated that rice production over the last 10 years decreased, while Thi Qar farmers thought that rice production over the last 10 years significantly decreased. However, a number of farmers in Najaf, Qadisiyah and Muthanna have different answers. Table 3.49: for rice production over the last 10 years in the study area (Figure. 3.58).

Table 3.49. Rice Production over the Last 10 Years in the Study area

Governorate	Sig. increase		Increase		Decrease		Sig. decrease		P value
	F	%	F	%	F	%	F	%	
Najaf	**10**	**11.11**	**17**	**18.89**	**47**	**52.22**	**16**	**17.78**	**<0.001**
Qadisiyah	**17**	**17.89**	**25**	**26.32**	**36**	**37.89**	**17**	**17.89**	
Muthanna	**1**	**6.3**	**3**	**18.8**	**12**	**75**	**0**	**0**	
Thi Qar	**0**	**0**	**2**	**9.1**	**8**	**36.4**	**12**	**54.5**	
Total	**28**	**12.56**	**47**	**21.08**	**103**	**46.19**	**45**	**20.18**	

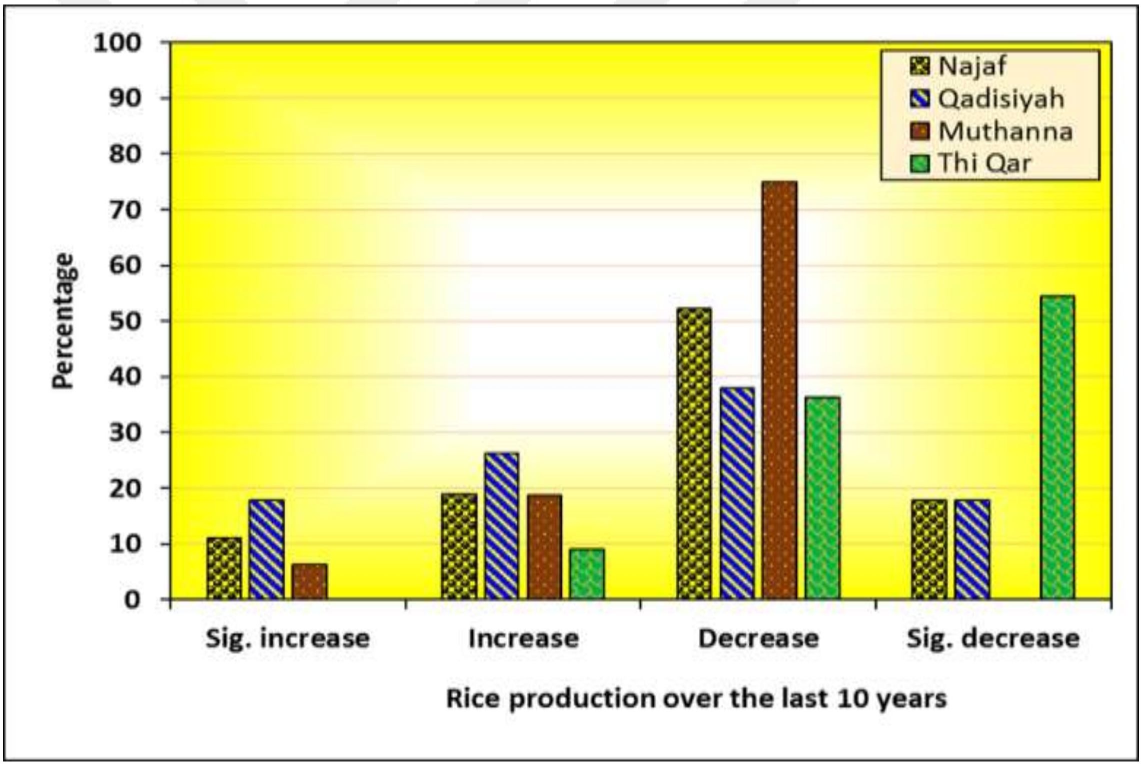


Figure 3.58. Rice Production over the last 10 Years in the Study area

In addition, according to the questionnaire results, we can see a highly significant difference (p>0.01) in answers of respondents about the main reasons for the low productivity in the study areas. Approximately most farmers of Najaf and Qadisiyah revealed that the low water quality was the main reason for the low productivity of rice in their areas, while about half of Muthanna farmers thought that the elevated temperature and lack of rain were the main reasons for the low productivity of rice, on the other hand, Thi Qar farmers thought that elevated temperature, lack of rain, low water quality, and labor migration were the main reasons for the low productivity of rice (Table 3.50, and Figure 3.59 below).

Table 3.50. The Main Reasons for the low productivity in the study areas

Reasons	Najaf		Qadisiyah		Muthanna		Thi Qar		Total	
	F	%	F	%	F	%	F	%	F	%
Elevated temp.	31	34.44	25	26.32	9	56.25	2	9.09	67	47.53
Lack of rain	15	16.67	54	56.84	8	50	2	9.09	79	52.47
Low water quality	74	82.22	83	87.37	12	75	8	36.36	177	8.97
Labor migration	42	46.67	60	63.16	0	0	5	22.73	107	41.70
All above	6	6.67	5	5.26	0	0	13	59.09	24	10.31
Others	0	0	0	0	1	6.25	2	9.09	3	0.90
P value	<0.001									

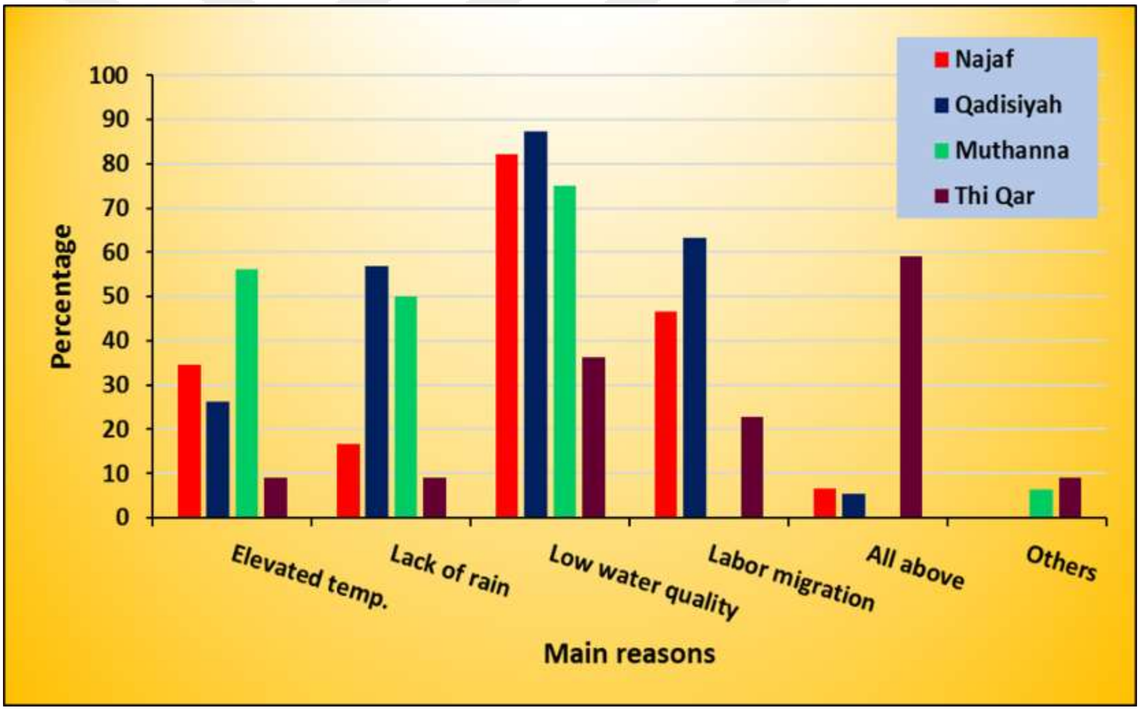


Figure 3.59. The Main Reasons for the low Productivity in the Study Areas

On the other hand, the number of rice farmers who considers paddy production in the rural area today is more important than other crop productions to the rural people are 178 farmers (79.8%), and the number of them that disagree was 36 farmers (16.2%). And the number of those who say “If paddy production caused water scarcity problems, I’d rather quit paddy farming “was 72 farmers (32.3%), and the number of disagreeing was 99 farmers (44.4%) (Table 3.51). This shows the importance of rice cultivation in rural areas of Iraq, where it was noted in the results that 81.2% of the rice farmers consider rice cultivation as their main occupation, in the study area.

Table 3.51. Agree or Disagree Statements

Governorate	Statements	Score					
		Agree		neutral		Disagree	
		F	%	F	%	F	%
Najaf	1	76	84.4	4	4.4	10	11.1
	2	40	44.4	20	22.2	30	33.3
Qadisiyah	1	89	93.7	1	1.1	5	5.3
	2	8	8.4	32	33.7	55	57.9
Muthanna	1	0	0	0	0	16	100
	2	16	100	0	0	0	0
Thi Qar	1	13	59.1	4	18.2	5	22.7
	2	8	36.4	0	0	14	63.6
Total	1	178	79.8	9	4	36	16.2
	2	72	32.3	52	23.3	99	44.4

1. Paddy production in the rural area today is more important than other crop productions for rural people. 2. If paddy production caused water scarcity problems, I'd rather quit paddy farming.

CHAPTER FOUR

CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

Changes in the climate could alter the intensity and frequency of the events of weather which will highly challenge the natural and human ecosystem more than baseline variability in climate and weather. It has been shown by the World Bank (2013) that there are a 0.8°C differences (warmer) between the pre-industrial era and now. It has also been predicted that there will be approximately 2°C increase in the temperature in one generation. It has been reported that the Iraqis drought-prone areas are drier and warmer compared to the situation 50 years earlier. Furthermore, the current projection and predictions suggesting that many of Iraq's agricultural land will face frequent drought and will become hotter due to the lack of rainfall. There will be adverse impacts on food security, poverty, production of paddy, overall agricultural productivity due to the changes in the climatic variability.

It is true that in the current socio-economic settings in Iraq, agriculture is highly vulnerable industry to any change in the climatic condition. The primary objective of the current study is to determine the impacts of climatic change on Iraqi agriculture especially paddy production and irrigation sectors and its interactions with rural development on four rice production area (Najaf, Qadisiyah, Muthanna and Thi Qar).

It is worth to mention that there is no substantial estimation of the impacts caused by climate change on the productivity of the paddy. Although there are a few studies that estimated the global impact of climatic change, temporal and local/regional variations were not taken under consideration in their studies. Therefore, in the current study, we planned to accumulate a unique set of data representing the periods from 1966-2015 (50 years). Using year fixed and regional effects, we have estimated different impacts of the climate changes on rice production in the study areas. Characterization of the socioeconomic condition of the farmers is one of the major findings that we also described in this study.

It is important to note that we obtained the primary data through face to face interview of a total of 223 farmers in the study area using a structured questionnaire. The respondents were selected randomly. On the other hand, the secondary data were collected from the much official organization in Iraq. The data were analyzed using both inferential statistics and descriptive statistics. The data obtained through the questionnaire were analyzed through the Statistical Package for the Social Sciences (SPSS, version 21.0). To compare data regarding the studied factors, One-Way and Two-Way Analysis of Variance test (ANOVA) were used. Differences at 5% ($p < 0.05$) and 1% ($p < 0.01$) levels were considered as significant. It is important to note that the size and sign of the estimate are significantly changing when we consider the regional variations. While the inferential statistics used product Moment Correlation coefficient, the descriptive statistics include means, percentages, and frequencies.

When this about people than a number, it is extremely hard to summarize their experiences and thoughts in a thesis. In my opinion, the most important findings of my thesis are aligned with in-depth interviews and the experiences and events in their life that 15 farmers shared with me.

This study revealed that the average yearly minimum and maximum temperature of the study areas is increasing with the time passing. This trend of increasing temperature adversely affects the agro-climate conditions as well as the economic conditions of rural area and population in Iraq. Increasing temperature not only affects the Iraqi paddy production sector but also enhances the intensity of dust storm which hampers the normal lifestyle.

This study also indicated that the total yearly rainfall is decreasing clearly with the time passing. This scenario explicitly indicates how Iraqi agriculture and irrigation sectors are suffering from the scarcity of rainfall because of Iraqi agriculture and irrigation systems are largely dependent on rainfall. The scarcity of rainfall is also enhancing the desertification process by creating a great threat to Iraqi agriculture. As the situation (scarcity of rainfall) is worsening day by day, so Iraqi people especially paddy farmers are becoming more frustrated with thinking about the future as well as agricultural sustainability.

Iraqi irrigation system mainly depends on two main rivers namely the Tigris and Euphrates, but recently river flows of those two rivers are decreasing drastically. Therefore, the scarcity of river water is increasing day by day by affecting Iraqi agriculture and irrigation sectors adversely.

As temperature, rainfall and availability of irrigation water have cumulative effects on paddy production and all those components are adversely affected by climate change, Iraqi paddy production is decreasing with the negative effects of climate change. Evidently, the yield (ton per hectare) of the rice crop in Iraq is decreasing noticeably.

Around 34% population of the study areas live in a rural area and their livelihood directly or indirectly dependent on agriculture and rice production. Therefore, the negative trend of agricultural and rice production will not only hamper the food security of these areas but also will affect rural livelihood at large.

Moreover, the current study was aimed to identify the impacts of climatic change on the production of the rice crop and rural farmers in four districts of Iraq, used the questionnaire survey. Because of the fact that the cultivation and production of paddy is the primary source of the income in the rural communities in the selected areas as well as in Iraq, it is necessary to take adaptation strategies by the farmers to mitigate the impacts of climatic change in order to ensure food security and to improve their livelihoods. However, it is extremely important to develop policies aimed to promote successful strategies of adaptation in this sector, a thorough understanding of the adaptation strategies adopted by the paddy farmers, and ongoing impacts are crucial.

Questionnaire results revealed that 3.59% of farmers were Female and the rest were Male (96.41%). the average age of rice farmers in the study area ranged from 55 to 57 years. The high percentage for the total income of the household was less than 500 $per month, a larger proportion of the farmers had primary education. The results from the current study indicating that many of the farmers (approximately 92.38%) are familiar with the term climate change adaptation, and others (7.62%) don’t know about the term and had never heard about it. Approximately 61.42% of the respondents said that they learned about climate change from television programs.

There were highly significant differences ($p<0.01$) in income of the household, agricultural skills, farming experiences of farmers, paddy fields size, types of irrigation, and education levels. Significant differences were also observed in farmer attitudes toward to importance of climate change, how climate change affects the rice farms, how the decline in rice production affects the rural people, condition of rice production over the last 10 years, and main reasons for the low paddy productivity in the study areas. On the other hand, there were no significant differences ($p>0.05$) in the type of rice culture, knowledge of farmer upon water quality parameters, hearing about climate change, feeling the pattern of weather change, knowledge about the effects climate change on the rural area, sectors that affected by climate change, about the effects of climate change on water management, knowledge of farmer about the effects of rice production on the livelihood of rural people, and the effects of declining rice production on the rural area of the study areas.

Considering the above-mentioned issues, the Iraqi government has taken some initiatives to mitigate the negative effects of climate change on rice crop, but those policies and programs are not enough to cope with the severity of the climate change. So, the government of Iraq should give more emphasis on policy formulation and to find out the ways of adaptation and mitigation of adverse effects of climate change.

In the summary, based on the primary and secondary data, I am confident enough to conclude that due to the increase in the temperature in the last few decades, the paddy farmers in Iraq is facing several challenges such as shortage of water for irrigation, lower level of rainfall, and longer dry periods. Because of the fact that the water is the limiting factor for the production of paddy, these problems are severely affecting the production of paddy in the selected four study areas. It is important to note that similar problems exist throughout Iraq. To mitigate the challenges arose due to climate changes farmers are adopting different strategies. One of the common strategies is changing the varieties of rice from traditional breed to high producing breeds. Some farmers are also interested in growing drought tolerant rice varieties as this is the major problem in the rainfed paddy farming. In addition, farmers are also preferring the variety that can be cultivated within three months (seeding to harvesting). From the analysis of the secondary data and the primary data, it is clear that climate change is real, and the paddy farmers of Iraq is already suffering from the impacts of climate change.

4.2. Recommendations

Based on the results of the current study, we can propose some recommendations that can be used by other farmers in Iraq, as well as the farmers under similar environmental conditions throughout the world. Furthermore, these recommendations can be used by the government offices in order to develop policies to protect the paddy farmers from the effects of climate change.

- The Extensional centers must have different programs to train farmers on how to adapt to climate change, by teaching them to change the planting time, use certified seeds, improve irrigation systems, and use a Crop rotation.
- Different development actors, as well as the government, should develop trustable meteorological centers in rural Iraq disseminate the information to farmers through television and radio programs.
- Proper and adequate training of the extension workers of the extension organizations and research centers.
- Develop a vigorous dissemination program as well as the strategic communication to provide accessible information regarding climate change.
- The programs should be developed in such a way that the rural illiterate farmers can understand the main message.
- There should be a balance between the measures to cope with climate change and measures to determine the causes of climatic change.
- Paddy production adaptation may be grouped as farm financial management, farm production practices, government programs, and technological developments to mitigate the impacts of climate change in the rural areas of Iraq.
- It is necessary to build cooperation across the administrative sectors, agricultural sectors, and meteorological sectors across the country to mitigate or create adaptation strategies to cope with the changes in climate.
- Introduction of new rice varieties that are adaptable to a wide variety of climatic conditions by the governmental office in the study area.

- NGOs and government agencies should work together to boost the production of rice by encouraging rice cultivation through the provision of incentives.
- Due to the high temperatures during the rice crop planting time, the agricultural extension workers should inform the farmers about the delay in planting the rice so that the date of flowering is within the appropriate temperature.
- Proper training of the paddy farmers to cope with the high temperature and dry climate in the study area as well as in Iraq through vigorous extension programs.
- The production practices of farms and individual farmers need to be updated with the changes of climate factors.
- Farmers should be informed about the benefits of crop substitutions, crop portfolio, and crop rotation to enhance the production of paddy and to adapt with the changed climatic condition.
- The paddy farmers must be careful about the proper management of irrigation water and should be aware of the uncertainty of heavy rainfall as well as low rainfall
- It is also important to understand the exact timing and quickly move forward with the sign of rainfall and warning.
- Finally, the paddy farmers must take initiatives for cooperative activities, insurance, hedging, forward rating, and crop sharing.
- NGOs and government should take initiatives in order to boost the production of rice in the rural area by youth participation through the provision of incentives.
- The Government should assist in the opening of advanced centers for the education of adult women and men in rural areas in which agricultural workers participate.
- Creating a proper drainage system in the rural area for agricultural use.
- Dramatic improvement is necessary in the mechanization of agriculture in the rural areas of Iraq in order to have significantly higher production of paddy as well as other important crops.
- Control measures should be taken by the government in order to limit the level of migration from rural to urban areas.

- It is necessary to build modern facilities including a bank, agricultural offices, climate, and weather-related offices, supermarkets, schools, and other facilities in the rural areas of Iraq to prevent the rural migration towards cities.
- Introduction of high productive seeds that are adapted in a wide range of climatic condition.
- The agricultural offices in the respective areas and the paddy farmers in the rural areas must work together in order to decrease the waste and loss of water during the paddy cultivation.
- The proper balance would necessary to promote non-farm economic activities alongside climate change resilient forms of agriculture.
- Training must provide to improve the soil texture using soil compost, causing poor soil texture, due to overlapping with rice and wheat cultivation in some areas, thus non-response increases yield.
- To improve the financial management and production at the farm level, the government must carefully identify its priority zones to provide subsidy supports and incentive programs.
- The government must ensure the proper price of the produced paddy nationally to protect the paddy farmers from the middlemen in the rural areas.
- The government must introduce improved rice varieties to the paddy farmers in the rural areas that are adaptable to the flood and drought conditions.
- New research centers must be established in rural areas in order to discover the problems faced by farmers in the area due to climate change and find coping strategies.
- The government should reinvigorate national research and extension programs in the optimal use of water sources.
- The water allocation in different farm activities must be reconsidered by the Iraqi government and priority should be given to the paddy farmers to promote paddy production.

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APPENDIX

Questionnaire about Climate Change and paddy production in the Rural area

My name is **Jawad Hassan Humaidy** and I am currently working on a research project about climate change and paddy production in the rural area. Most of this research is being carried out in the Al Najaf, Al Qadisiyah, Al Muthanna and Thi Qar area, and your address has been selected by a scientific sampling method to ensure a representative picture of people's views. Your help and assistance in completing the enclosed questionnaire will be invaluable for the study.

If you agree to participate, **all the information you provide will be completely anonymous and confidential.**

The questionnaire starts by asking you about a range of climate change and paddy production issues that may affect you and moves on to ask you how you feel about global warming problems. If you don't want to answer all the questions, you don't have to - please just do what you can. It shouldn't take long to complete, and I hope you'll enjoy it.

Once you've completed the questionnaire, please could you return it to me?

Thank you very much for your kind help and assistance.

Yours faithfully,

Ph.D. candidate

Jawad Hassan Humaidy

Section One: Demographic Information

1- Date of interview: / / 2018

2- Name:

3- Gender of respondent: ☐ Male ☐ Female

4- Age: ☐ years.

5- Province:

6- District:

7- Village:

8- Educational level:

☐ Illiterate.

☐ Elementary.

☐ Secondary.

☐ Bachelor’s degree.

☐ Other.

9- Monthly household income

☐ <$500

☐ $500-1000

☐ $1000-3000

☐ >$3000

Section Two: Land information

10. Land ownership:

☐ Combination ☐ Lease/ Profit sharing ☐ Private

11. Agricultural skill:

☐ Trained ☐ Untrained

12. Farming experience:

☐ < 10 years.
☐ 10-20 years.
☐ 21- 30 years.
☐ > 30 years.

13. Distance from water resource:

☐ < 100 m.
☐ 100- 500 m.
☐ > 500 m.

14. What is the total area of all the land used for the agricultural purpose?

☐ <1 ha
☐ 1-3 ha
☐ 3-10 ha
☐ >10 ha

15. Paddy field area:

☐ < 1 ha.
☐ 1-3 ha.
☐ 3- 10 ha
☐ > 10 ha.

16. Type of rice culture:

- ☐ Irrigated. (Go to Question 17).
- ☐ Rainfed.
- ☐ Other.

17. Type of Irrigation:

- ☐ non- technical irrigation.
- ☐ Semi-technical irrigation.
- ☐ Technical irrigation.

18. Do you know about the water quality parameters?

- ☐ Yes (go to question 19)
- ☐ No

19. What do you look for as the quality parameters of irrigation water?

- ☐ PH
- ☐ EC (salinity)
- ☐ SAR
- ☐ ESP
- ☐ Anion- cations
- ☐ Heavy metals and trace elements

20. Amount of irrigation water used in paddy irrigation (seasonal)

- ☐ <100 m^3/ha
- ☐ 100-500 m^3/ha
- ☐ >500 m^3/ha

21. Yields

- [ ] < 1 t/ha
- [ ] 1-2 t/ha
- [ ] >2 t/ha

22. Where do you sell your products?

- [ ] To government
- [ ] To private buyers
- [ ] To both
- [ ] I do production for myself

Section three: climate change and rice production

23. Do you feel the pattern of weather is generally changing?

- [ ] Yes (go to question 24).
- [ ] No.
- [ ] Don’t know.

24. If yes, why do you think this might be? ---

25. Have you heard of “climate change”?

- [ ] Yes (go to question 26).
- [ ] No.

26 - What do you know about it? --

27. Where have you heard about climate change? (Tick as many as you fell apply).

- [ ] Television.
- [ ] Radio.
- [ ] Newspaper.
- [ ] Internet.
- [ ] school, college, University.
- [ ] Government agencies.
- [ ] Friends, family.
- [ ] Others.

28. How important is the issue of climate change to you personally?

- [ ] Very important. (Go to question 29).
- [ ] Important. (Go to question 29).
- [ ] Not important. (Go to question 30).

29. Why is it important to you? ---

---

30. What do you think causes climate change? ---------------------------------------

---

31. What impacts, if any, do you think climate change may have? -----------------

---

32. Do you think climate change is something that affecting or going to affect you, and rural households?

- [ ] Yes. (Go to question 33).
- [ ] No.
- [ ] No idea.

33. If yes, in what way(s) is it affecting you or rural households? (Tick as many as you fell apply).

☐ Health.

☐ Rural economy.

☐ Rice crop production. (Go to question 34).

☐ Water quantities.

☐ Animal production.

☐ Others (specify).

34. How do you think climate change affect the rice farm? (Tick as many as you fell apply).

☐ Size of the farm.

☐ Yield.

☐ Production.

☐ The spread of diseases and insects.

☐ Distribution of plants in the field.

☐ Plant density in the field.

☐ Crop water consumption.

☐ All of the above.

35. What are the types of processes have you made to adapt to climate change?

	Processes	Climate change		
		always	ever	Never
1	Change planting time			
2	Use certified seeds			
3	Planning water requirements			
4	Change soil conservation techniques			
5	Improve irrigation systems			
6	Use water pumps to irrigate the rice fields			
7	Use intensive chemical fertilizers for rice fields			
8	Use compost			
9	Intensive use of pesticides			
10	Crop rotation			

36. Has hot temperature ever affected the health of any of your family or friends?

☐ Yes.

☐ No.

☐ No idea.

37. Have you encountered in the past five years, any form of flood damage or Typhon?

☐ Yes. (Go to question 38).

☐ No.

☐ Don't know.

38. If yes, is this damage including your home, garden or vehicle?

☐ Yes.

☐ No.

☐ Don't know.

39. In your opinion, is expected climate change already influencing criteria of water management policies in your region/ basin?

☐ Yes.

☐ No.

☐ Don't know.

40. Who do you think should have the main responsibility for taking measures against climate change?

- ☐ International organizations (e.g. the UN).
- ☐ Local governments.
- ☐ Business and industry.
- ☐ Environmental organizations.
- ☐ Individuals.
- ☐ Other (please write in) ---------

Section four: Rice production and Rural Development

41. Do you think rice production affects the livelihood of rural people?

- ☐ Yes. (Go to question 42).
- ☐ No.
- ☐ Don't know.

42. How? ---

43. Has the decline in rice production affected the rural area?

- ☐ Yes. (Go to question 44).
- ☐ No.
- ☐ Don't know.

44. How does the decline in rice production affect rural people? (Please tick on the best one).

- ☐ Poverty.
- ☐ Migration.
- ☐ Deterioration of people's health.
- ☐ Other.

45. How was rice productivity been on your farm over the last 10 years?

- ☐ Significantly increased.
- ☐ Increased.
- ☐ Decreased. (Go to question 46).
- ☐ Significantly decreased. (Go to question 46).

46. In your opinion, what is the main reason for the low rice productivity? (Please tick as one or many as you feel apply).

- ☐ Elevated temperature.
- ☐ Lack of rain.
- ☐ Low water quantities.
- ☐ Labor migration.
- ☐ All of the above.
- ☐ Other. (Please write on): ----------------------------

47. Is rice farming your main occupation?

- ☐ Yes.
- ☐ No.
- ☐ Don’t know.

48. Now please indicate how much you agree or disagree with the following general statements by ticking on the box on each row:

General Statements	Rows		
	Agree	Neutral	Disagree
a. Paddy production in the rural area today is more important than other crop productions for rural people.			
b. If paddy production caused water scarcity problems, I'd rather quit paddy farming.			

If you have anything to add to the issues raised in this questionnaire or any comments about the questionnaire itself, please write them here: ---------------------

It's really kind of you and I would like to thank you for giving up your time and attention to complete this questionnaire.

It is very much appreciated.

CURRICULUM VITAE

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EDUCATION

Degree	**Institution**	**Date of graduation**
Ph.D.	Institute of Science and Technology	2019
M.Sc.	Hankyong National University- South Korea	2012
B.Sc.	Baghdad University	1991
High school	Al Abbasiyah secondary school	1987

FOREIGN LANGUAGE

Arabic

English

Korean

Turkish