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Salahaddin University-Erbil (http://www.su.edu.krd)

College of Basic Education,

Department of General Science

STUDY AND ANALYSIS OF CLIMATE IN ERBIL CITY

The research

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Table of Content:

Title	Page
Cover	1
Table on Content	2
ACKNOWLEDGMNET	2
Abstract	3
Introduction	3
Climate of Kurdistan Region	4
Rainfall of Kurdistan region	4
Temperature in Kurdistan Region	5
Climate Change Indicators	5
Results and Discussion	13
Conclusions	16
References	16

Abstract

In this study 31 years(1975-2006) monthly rainfall data recorded at Erbil meteorological station were collected and carefully studied and analyzed. Also 6 years(2001-2006) monthly mean maximum, minimum and average temperatures recorded at 2 meters above ground surface are studied and analyzed. The results are all shown in both tabulated and graphical forms.

From the results it can be seen that the maximum of 19% rainfall was in the months of January and February while the minimum of 4% rainfall was in the month of May. From the data it is clear that the maximum annual rainfall of 738 mm was in the year 1992 and the minimum annual rainfall of 228.3mm was in the year 1999.

From the results of temperatures it is shown that the maximum and minimum temperatures recorded were 42.6^{o}C in July,1.6^{o}C in January , respectively. From the results it is also obvious that summer of the years 2005 and 2006 were the hottest years in Erbil of maximum temperatures 43.4oC in the months of July and August. while Januaray 2006 was the coldest month of 1.6^{o}C.

Chapter One

1.0 Introduction:

Climatology is the statistical study of the climate of a region in long period of time that is to say more than a month [(1)]. While atmospheric science is the study of the Physical processes and phenomena occurs in the atmosphere on any region on earth [(2)]. Here in this study the climate of the city of Erbil has been taken under consideration.

1.1 Climate of Kurdistan Region

Kurdistan Region is a landlocked country[6]. The geographical location of Kurdistan Region-Iraq lies between latitudes 34.7° N and 37.4° N and between longitudes 42.4° E and 46.3° E. The region shares its borders with Syria in the west, Turkey in the north and Iran in the east .The elevation varies between 250m to 3607m above mean sea level.

The region is surrounded by five water bodies which are the Mediterranean Sea, the Arab gulf, the Caspian Sea, the Red sea and the Black Sea. For historical reasons Kurdistan region is sometimes called the land between the five seas or the Fertile Crescent. Yet only the Mediterranean Sea and the Arab Gulf have major influence on the climate of the region[3].

- Kurdistan Region is almost mountainous and the climate is similar to that found in the mountains of western Iran.
- The climate of Kurdistan region has been identified according to Koppen classification as arid and semi-arid climate (steppe - BSh and Mediterranean – Csa)[5,6] .
- The Climate is hot and dry in summer and cold and wet in winter, with short spring and autumn seasons compared to summer and winter.
- In winter, Kurdistan region falls under the influence of Mediterranean cyclones that moves east to northeast over the region.
- The Arabian Sea cyclones move northward passing over the gulf caring great amounts of moisture causing large amounts of precipitation over the region.
- Occasionally ,the region is also becomes under the influence of European winter cyclones moving eastward to the southeast part of Turkey and

extends over the mountainous region of Kurdistan, bringing substantial amounts of rain and snow.

- In summer, the region falls under the influence of sub-tropical high pressure belts and Mediterranean anticyclones.
- The sub-tropical high pressure centers (Anticyclones) that moves from west to north and northeast passing over the Arabian Peninsula and brings sand and dust to the region.

1.2 Rainfall in Kurdistan Region

- Usually the precipitation occurs as rain at the lower elevations and snow and rain at higher elevation.
- Precipitation increases from the southwest to the northeast with annual average ranging from 300mm in the lower part to 1200mm in the highlands of the region.
- The precipitation seasons begins at mid October and continues to late May.

1.3 Temperature Variation in Kurdistan region

- The maximum daily temperature may reach as high as 50°C in hot summer periods in Makhmoor and in Kfri regions.
- While the minimum daily temperature can drop to -10°C in cold winters in Penjwin region.

Chapter Two

2.0 Climate Change Indicators:

How do we know our climate is changing permanently? Let's look at 10 major changes scientists have seen in our climate system to help set the record straight.

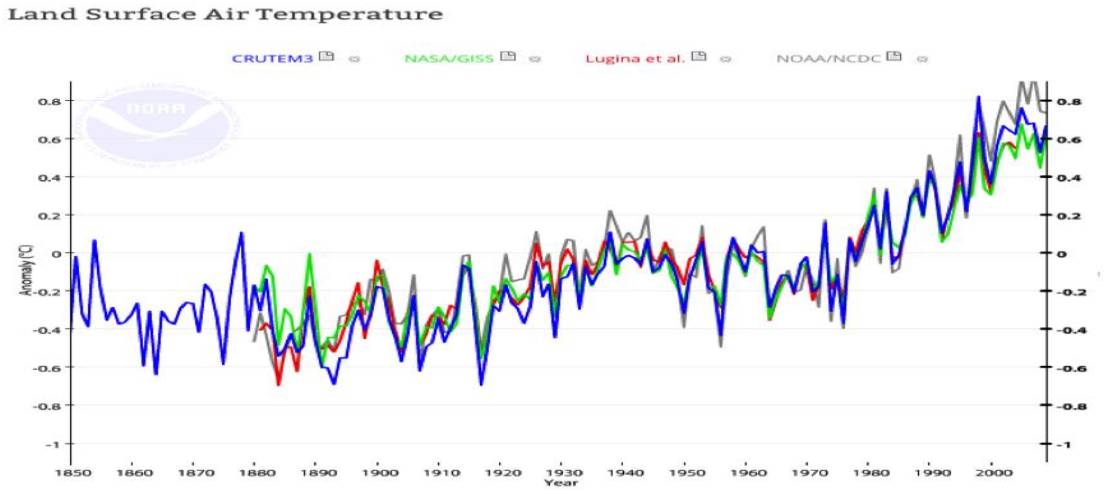
Few global trends have been as controversial as climate change and the Earth's warming. The Earth has gone through many shifts in cooling and warming driven by natural factors like the sun's energy or variations in its orbit, but the trend scientists have seen over the past 50 years is unmistakable.

Let's take a closer look: globally (0.6—0.9 degrees Celsius) between 1906 and 2005. However, it's the rate of temperature change that's especially troubling to scientists; temperatures have risen nearly twice as fast in the last 50 years alone[(4)].

What other ways has our climate system changed in the last century? How do we really know our climate is changing permanently, rather than just going through a normal period of flux? Between opinions from climate deniers and misinformation campaigns from the fossil fuel industry, it can be a challenge to get the unobstructed facts.

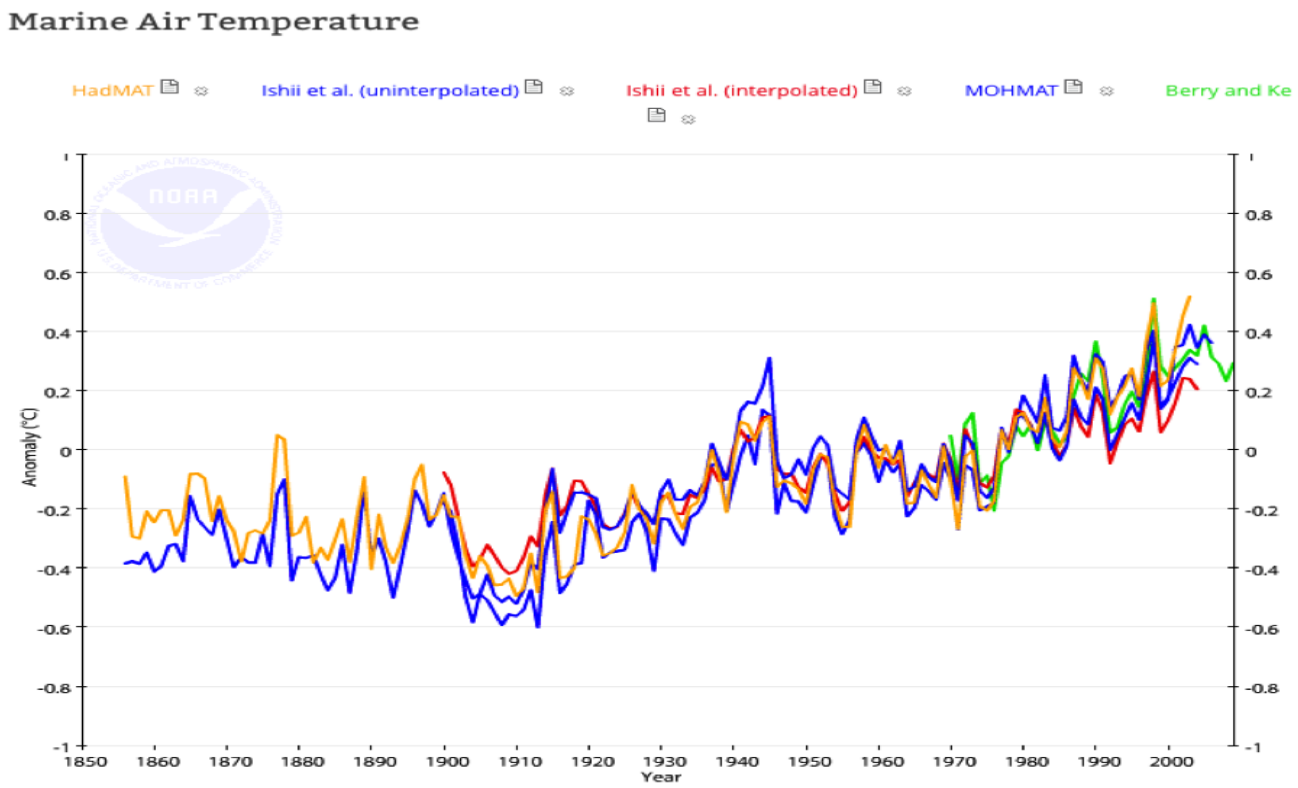
So to help set the record straight, we're going to focus on **10 major changes scientists have seen in our climate system**. Each indicator described below has been extensively studied over the past several decades, and was captured from many different data sets and technologies.

2.1 AIR TEMPERATURES OVER LAND ARE INCREASING:



It's clear that weather stations on land show **average air temperatures are rising**, and as a result, the frequency and severity of droughts and heat waves are increasing. Intense droughts can lead to destructive wildfires, failed crops, and low water supplies, many of which are deeply affecting southern areas of the United States and other parts of the world.

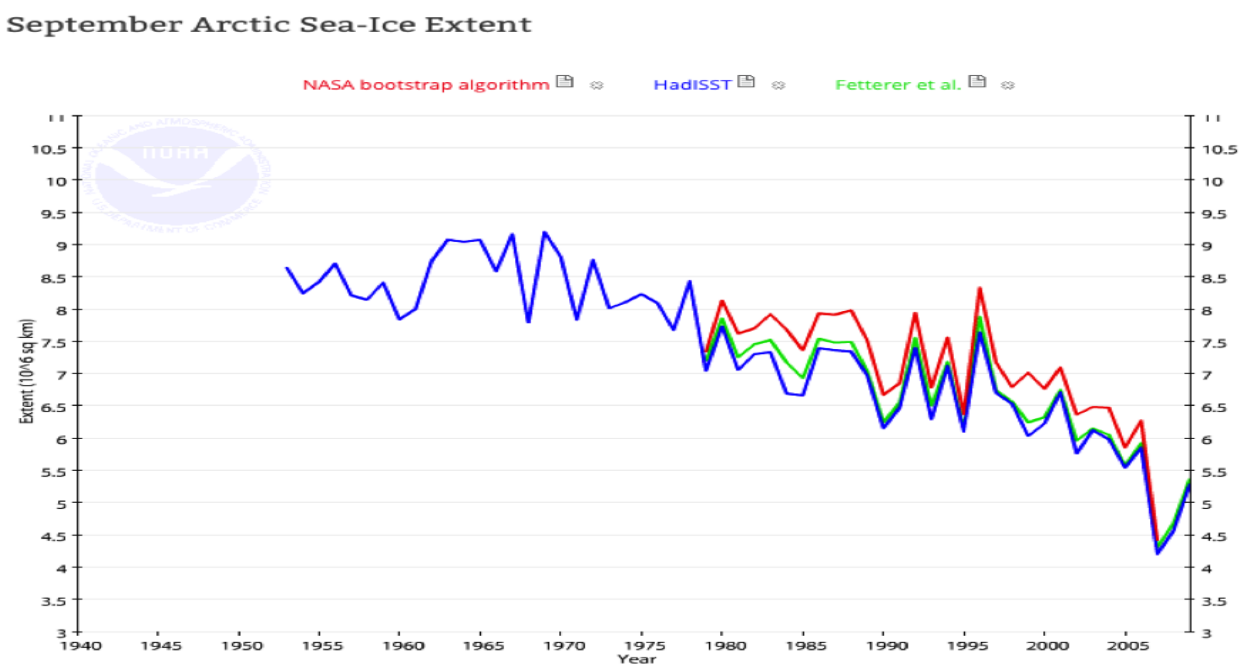
2.1 AIR TEMPERATURES OVER OCEANS ARE INCREASING.



Roughly 70 percent of the world is covered by oceans, so you can understand how hotter air over them could make a vast difference in the climate system.

Oceans evaporate more water as the air right near the surface gets warmer. The results are **More floods, more hurricanes, and more extreme precipitation events**.

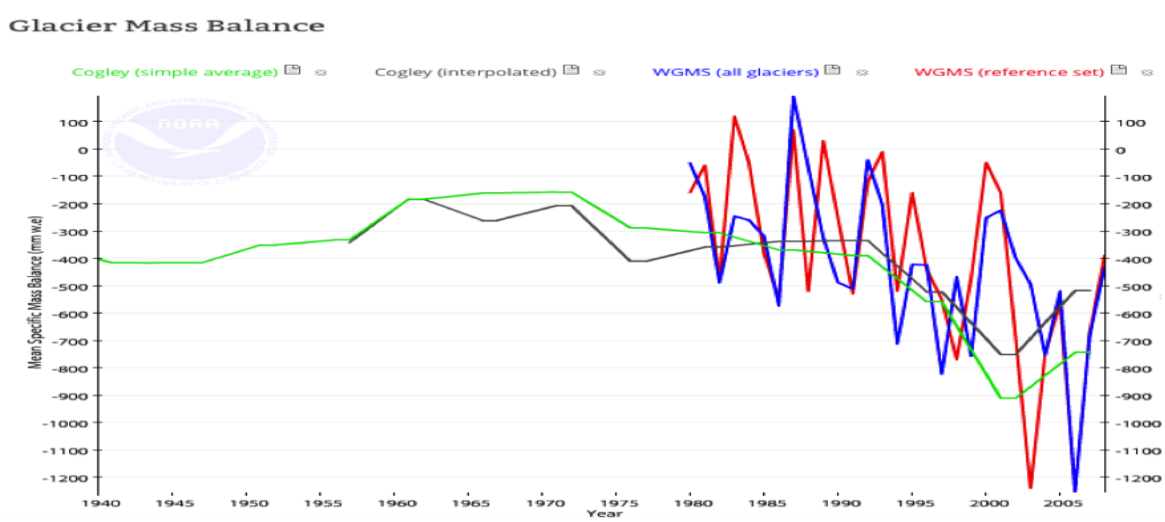
2.3. ARCTIC SEA ICE IS DECREASING.



Satellite images from space show that the area covered by **sea ice in the Arctic is shrinking**, and it's continued a downward trend for the past 30 years. The Arctic ice cap grows each winter when there's less sunlight, and shrinks each summer when days are longer, reaching its lowest point of the year in September.

Some research suggests that the Arctic could lose almost all of its summer ice cover by 2100, but others believe that it could melt completely much sooner than that – in just a few decades.

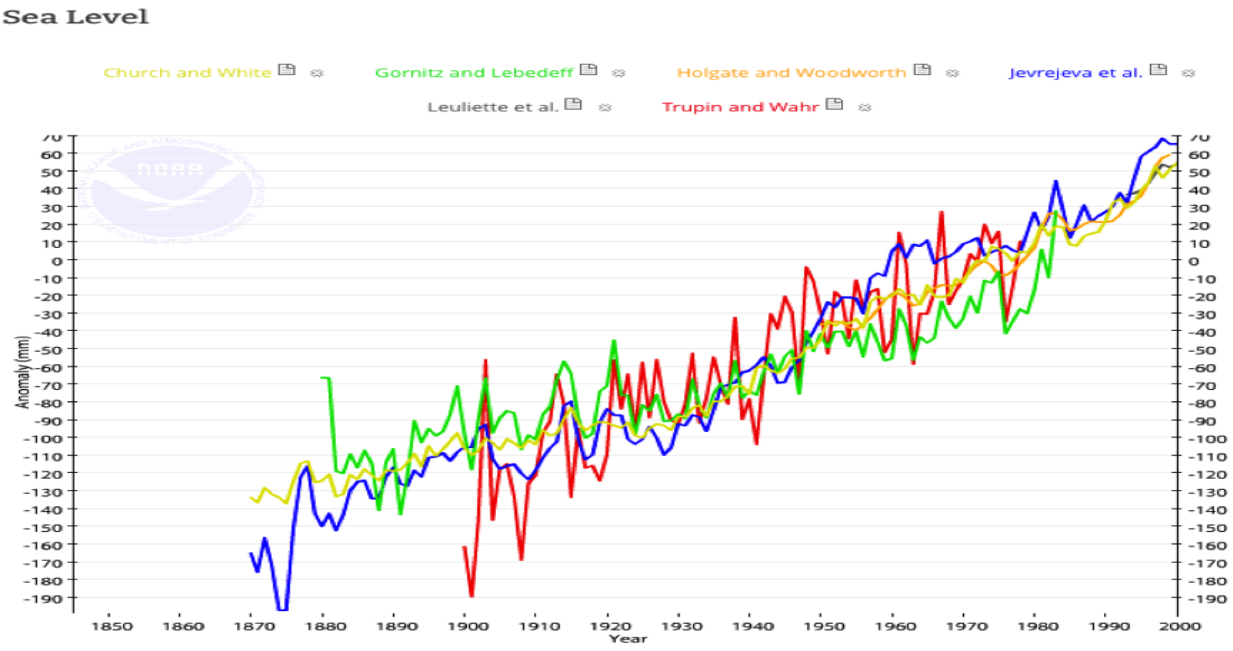
2.4. GLACIERS ARE MELTING.



The **disappearance of glaciers** is one of the clearest signs of climate change. People who rely on melting glacier water are facing shortages, and in many regions, the situation is only getting worse.

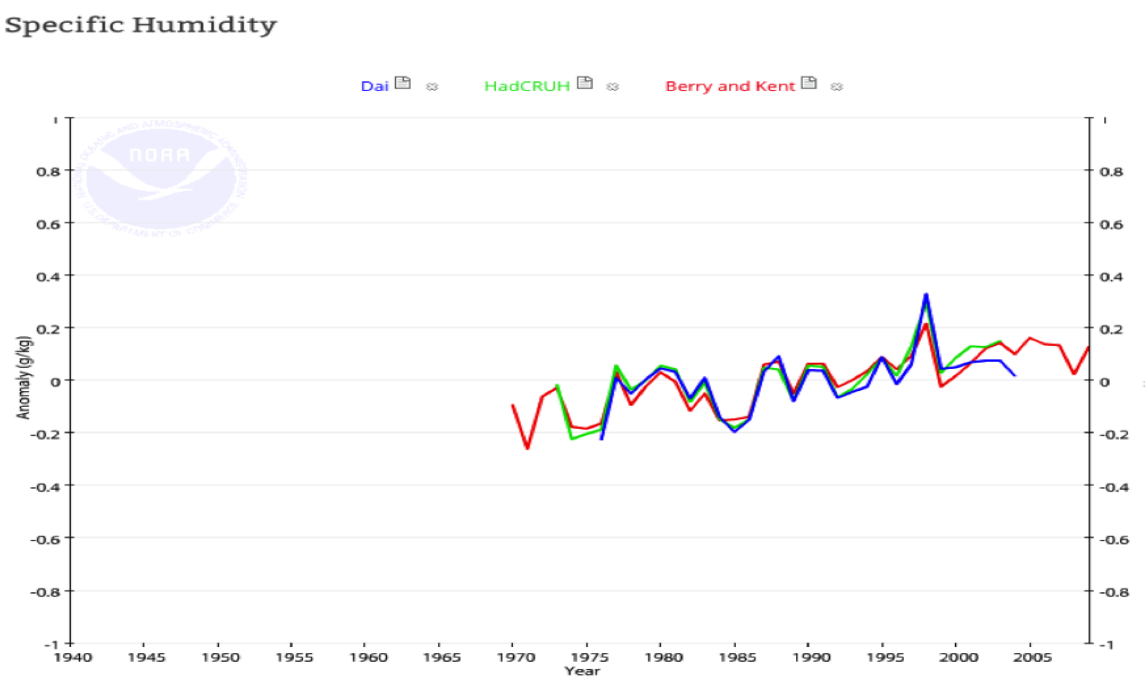
In a world unaffected by climate change, glacier mass stays balanced, meaning the ice that evaporates in the summer is fully replaced by snowfall in the winter. However, when more ice melts than is replaced, the glacier loses mass. And the people who depend on melting ice for water to support their farming and living needs are deeply affected.

2.5. SEA LEVELS ARE RISING.



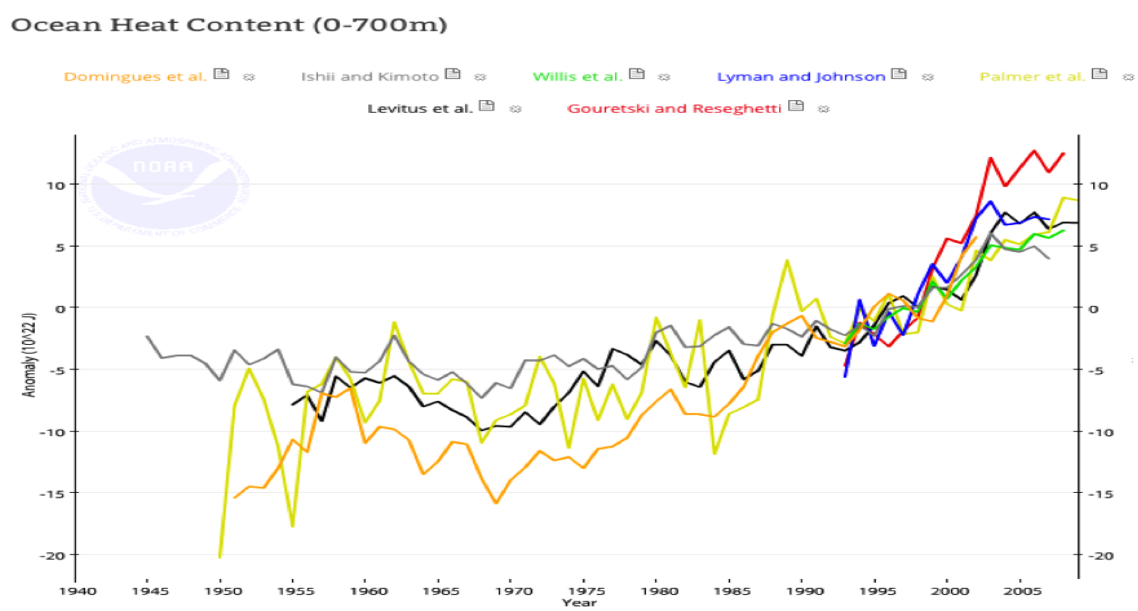
Sea levels have been rising for the past century. And the pace is only increasing in recent years as glaciers melt faster and water temperatures increase, causing oceans to expand.

2.6. HUMIDITY (EVERYONE'S FAVORITE) IS INCREASING



More humidity means more water vapor is in the air, making it feel stickier in hot weather. Water vapor itself is an important part of the water cycle, and it contributes to the earth's natural greenhouse effect. Air conditioners have to work much harder to make us feel cool as the amount of water vapor in the air increases. Which means more energy use, which can in turn contribute to more climate change.

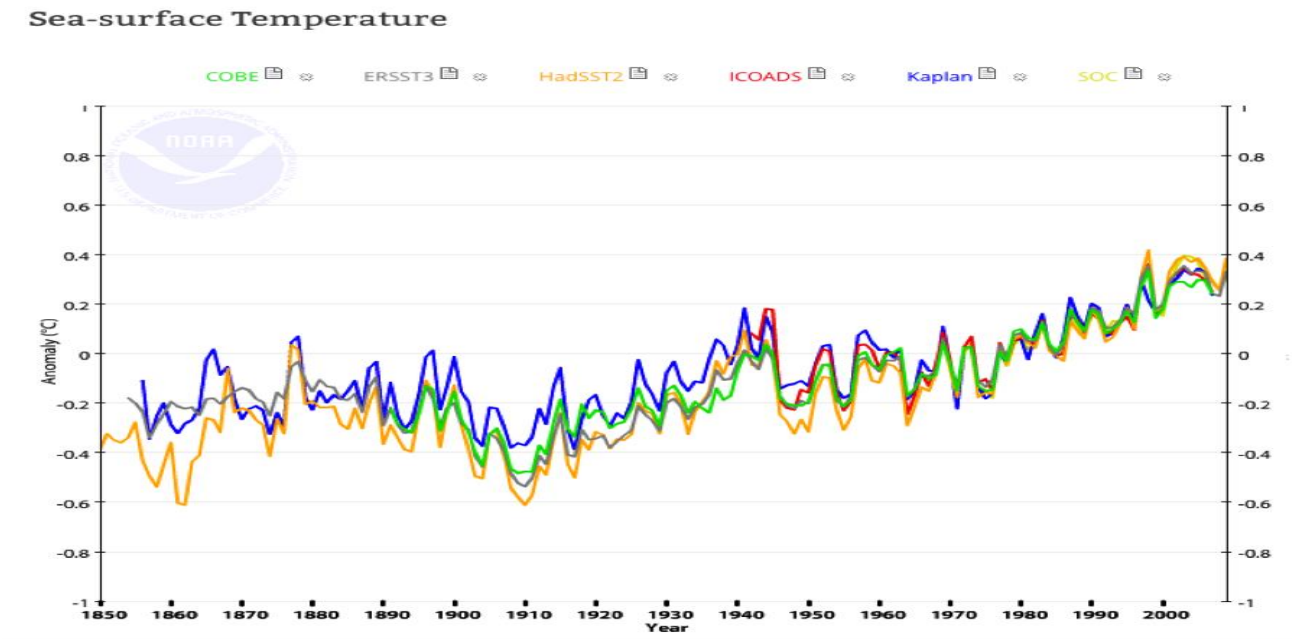
2.7. OCEAN HEAT CONTENT IS INCREASING.



The ocean stores and releases heat over long periods of time. This is a natural and important part of stabilizing the climate system. Natural climate patterns occur regularly because of warmer ocean waters and influence areas like regional climates and marine life.

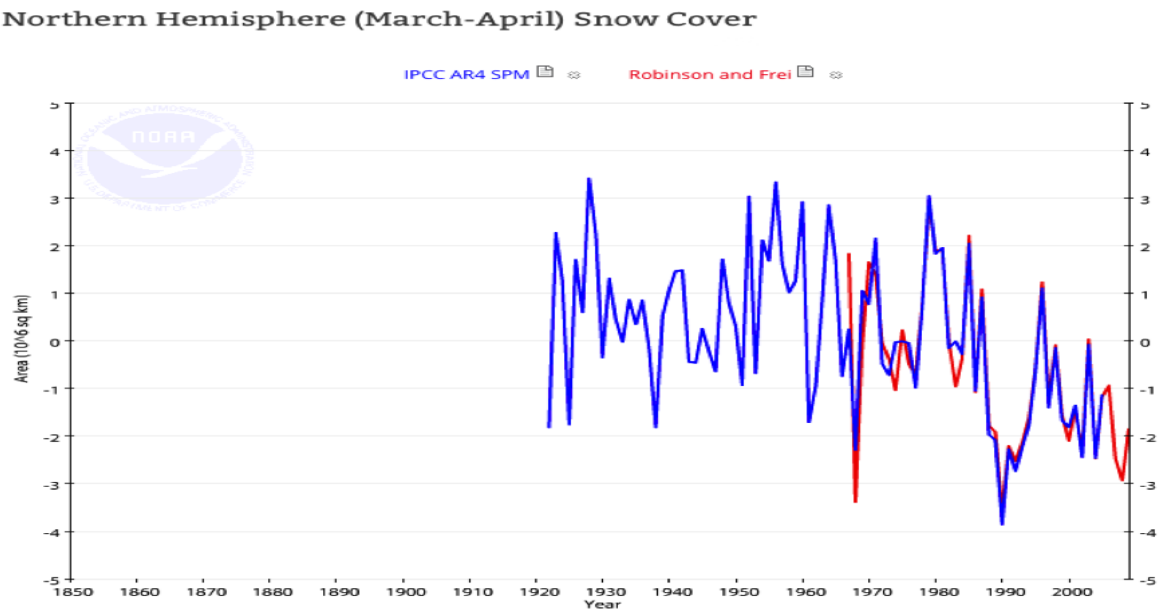
But it's when short-term, natural climate patterns occur at the same time as oceans are becoming warmer .The increased heat content leads to higher sea levels, melting glaciers, and stress to marine ecosystems.

2.8. SEA SURFACE TEMPERATURE IS INCREASING.



Measuring instruments show that **water temperatures at the ocean's surface are going up**. To some extent, this is a normal pattern: the ocean surface warms as it absorbs sunlight. The ocean then releases some of its heat into the atmosphere, creating wind and rain clouds. However, as the ocean's surface temperature continues to increase over time, more and more heat is released into the atmosphere. This additional heat can lead to stronger and more frequent storms like tropical cyclones and hurricanes.

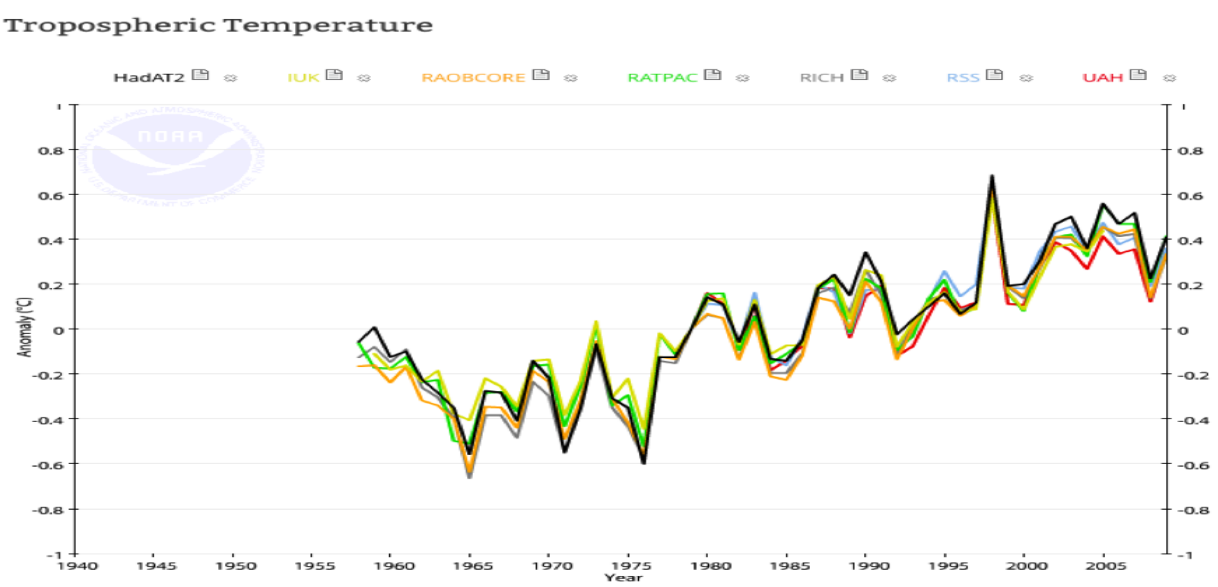
2.9. SNOW IS DECREASING.



Satellites show **areas covered by snow in the Northern Hemisphere are becoming smaller**. Snow is important as it helps control how much of the sun's energy Earth absorbs. Light-colored snow and ice reflect this energy back into space, helping keep the planet cool.

However, as the snow and ice melts, it's replaced by dark land and ocean, both of which absorb energy. The amount of snow and ice loss in the last 30 years is higher than many scientists predicted, which means the Earth is absorbing more solar energy than had been projected.

2.10. EARTH'S LOWER ATMOSPHERE TEMPERATURE IS INCREASING.



The lowest layer of the atmosphere, called the troposphere, is the layer we're most familiar with – it's where we live and where our weather occurs. Satellite measurements show that this lowest layer of the atmosphere is warming as greenhouse gases build up and trap heat that radiates from the Earth's surface.

Scientists tell us that human activity, particularly the burning of fossil fuels, caused this increase in atmospheric temperatures. In fact, carbon dioxide levels have increased about 40 percent since the Industrial Revolution began in 1750.

Chapter Three
3.0 Results and Discussion

In this study 31 years (1975-2006) monthly rainfall data recorded at Erbil meteorological station were collected and carefully studied and analyzed. Also 6 years (2001-2006) monthly mean maximum, minimum and average temperatures recorded at 2 meters above ground surface are studied and analyzed. The results are all shown in graphical forms.

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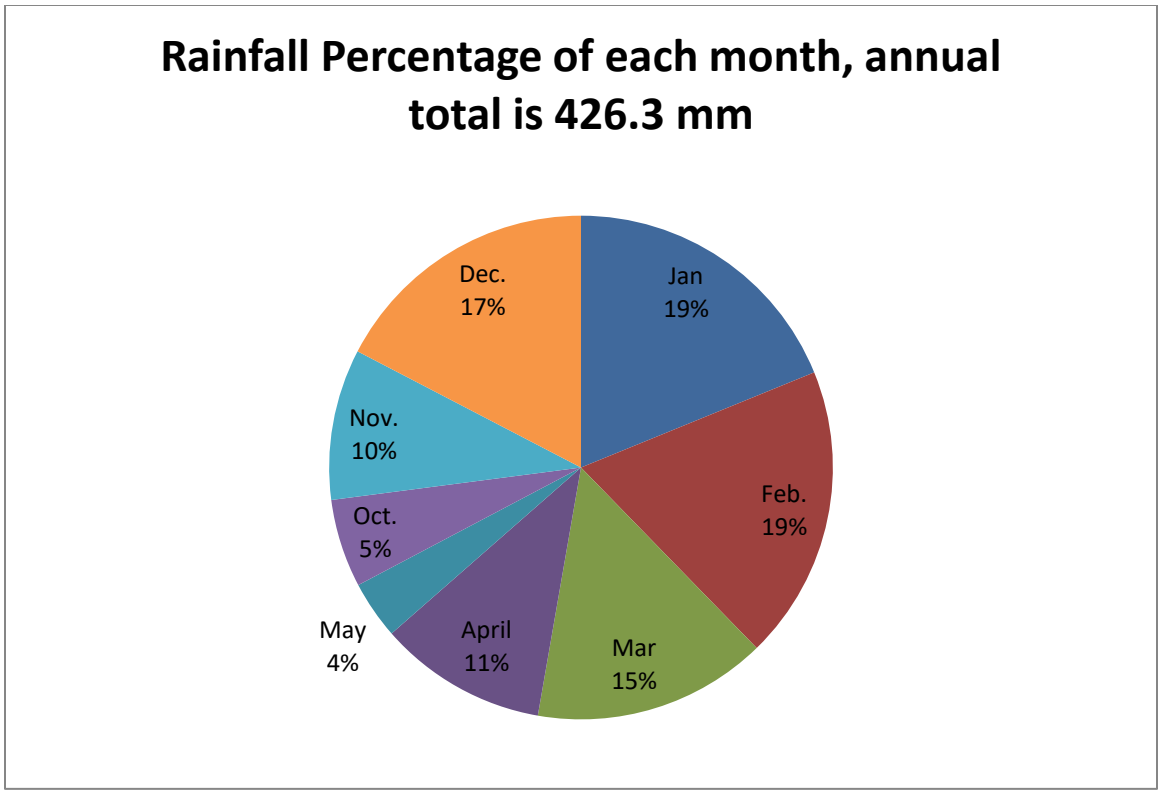
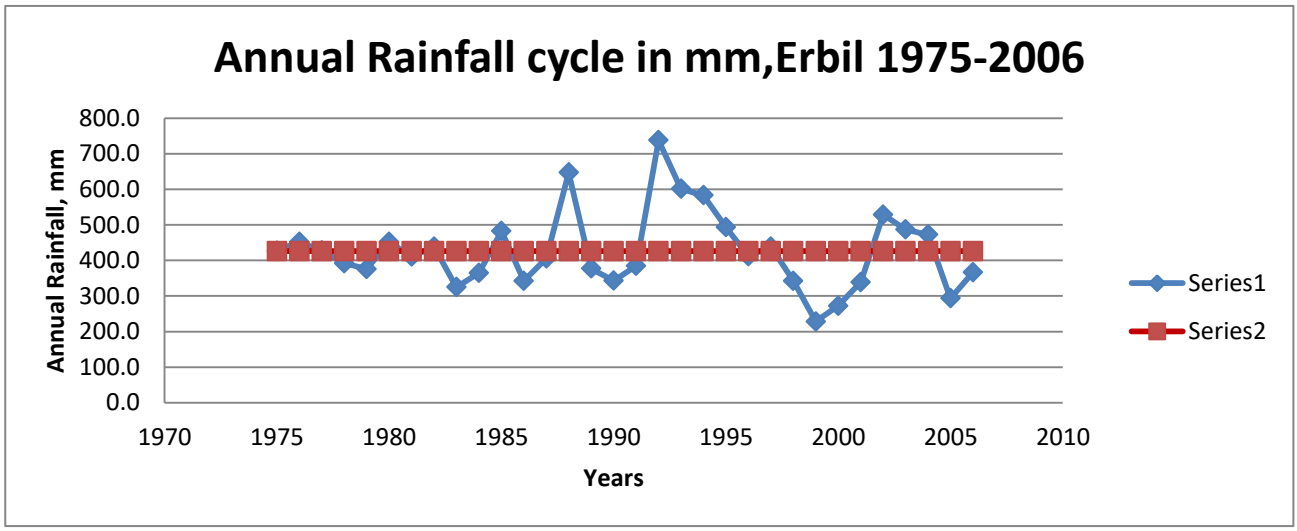
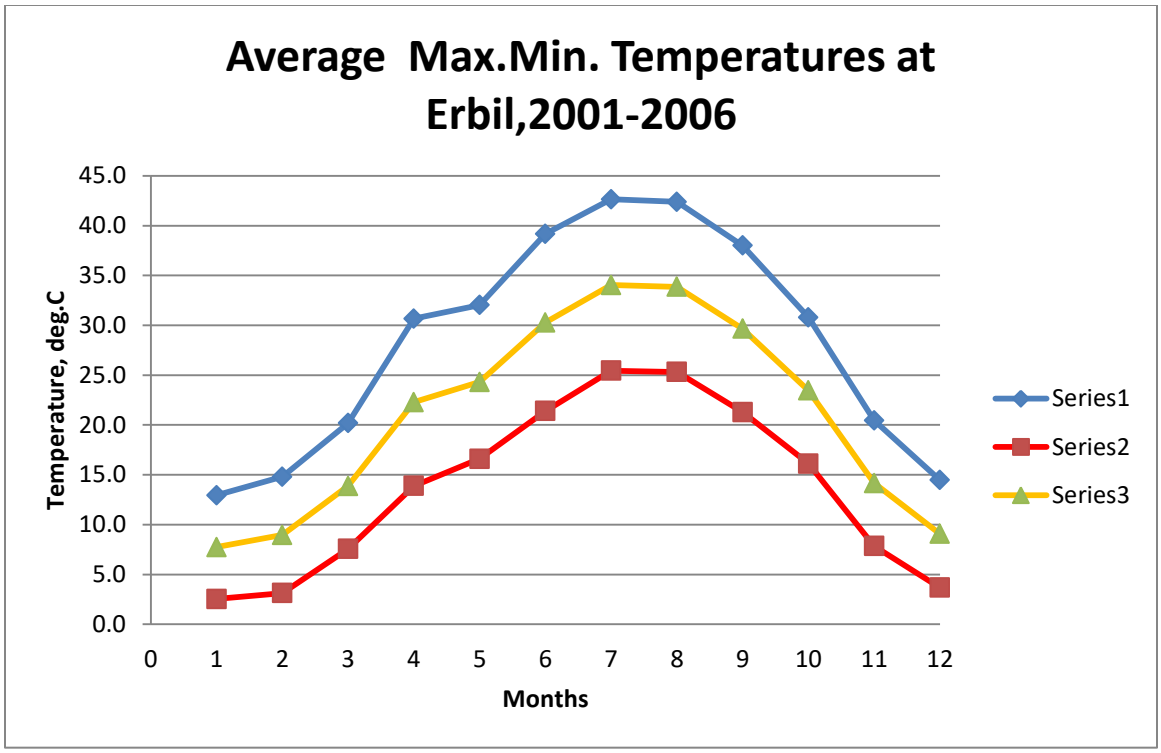


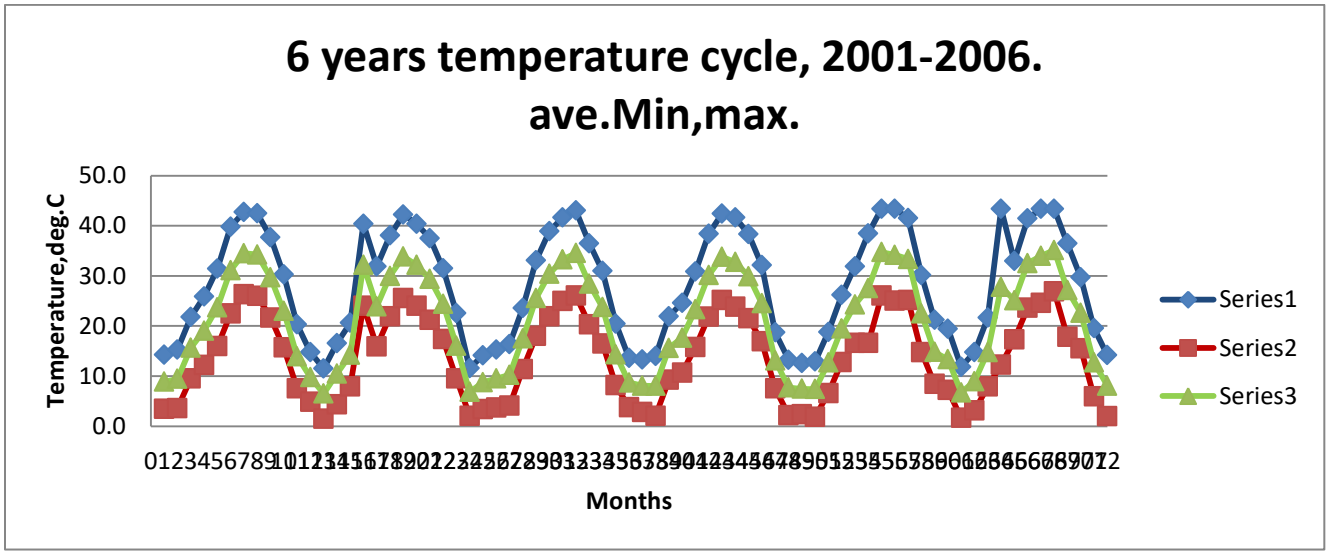
Figure(1): Rainfall percentage of each month, annual total is 426.3mm



Figure(2): Annual Rainfall cycle in mm, Erbil 1975-2006



Figure(3): Average, maximum and Minium temperatures,Erbil 2001-2006



Figure(4): Six years temperature cycle,2001-2006: max., Average, Min.

3.1 Conclusions:

From the analysis and the results obtained in this research project we conclude that the climate of Erbil city is a part of the general climate of Kurdistan Region, which in turn follows the general

climate of the Middle East as a Mediterranean climate. This climate is classified as Semi-Arid Continental, that is to say hot and dry in summer months and cold and wet in the winter months. During the period of the study, the overall annual mean total rainfall was 426 mm. The hottest years were 2005 and 2006 with highest temperatures in July and August. While the lowest temperature was recorded in the month January in the year 2006.

3.2 Suggestions for future works:

For future research work in the field of Climatology, we recommend to carry out the following;

1- Collect longer period recorded data especially the temperature.
2- Extend the area to include more cities in Kurdistan region and the will consider wider area.
3- Include wind speed and direction
4- Include surface pressure which is an important factor for indicating regions of low and high pressure centers.
5- Use world recognized formulas to define and classify climate of Kurdistan region.

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