

The environmental impact of climatic characteristics on the pollution of agricultural soils of the Qurna

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Abstract. The research aims to analyze the climatic elements and indicate their role in the pollution of agricultural soils in the Qurna district in 2024 by identifying the data of the climatic elements specific to the area and indicating their role in changing the physical and chemical properties of the soil. The statistics of climatic indicators in the 2014-2024 period were analyzed. The climatic peculiarities of the studied area were identified. According to the obtained data, it was concluded that the studied climatic elements significantly impact on the resources of the natural environment, especially soil and concentration of pollutants in it, and have a great role in its degradation and changing its characteristics, which negatively reflected on its productive capabilities.

1 Introduction

The climate is a natural factor that affects the characteristics of the natural environment, and controls the quality and quantity of pollutants in the soil through a direct impact on the reactions that occur inside the soil, such as decomposition, oxidation and evaporation, in addition to determining the type of weathering prevailing in the area, as it determines the quantity and quality of what the soil this trend has been called agroclimatic [1]. The temperatures in Iraq in general and the Qurna in particular were characterized by their rise during the long summer season due to Iraq's relatively remote location from water bodies and the supremacy of the continental climate, the great extremes in temperatures between the summer and winter seasons cause the activity of atmospheric processes and then the exposure of the soil to erosion and the emergence of the phenomenon of dust, which serves to transport and deposit pollutants on the soil surface, as the lack of rain and high temperatures during the long summer months affect the concentration of salts in the soil of the study area, as the prevailing type of climate is one of the factors affecting the concentration of pollutants in the soil, areas with a dry climate a little rain will be the amount of pollutants inside [2]. The soil is thin due to its exposure to many reactions and weathering factors, due to the disintegration of soil parts, compared to areas with a rainy and humid climate where pollutants are concentrated due to the cohesion of soil particles [3]. The problem of the study is to identify the impact of the climatic characteristics on the pollution of agricultural soils in the Qurna

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district, Iraq. The study aims to reveal the climatic characteristics and the extent of their impact on the concentration of pollutants in the agricultural soil. Studied is the north-eastern part of Basra and the area of Qurna district, it is 61.62% of Basra governorate [4]. The time limits are the period between 2014-2024.

2 Results and discussion

After the data on the climatic elements of the study area were collected from the General Authority of Meteorology and Seismic Monitoring Department of climate soil in 2024, it was found that the soil of the study area is directly affected by climatic conditions at all stages of its formation, the climate of the study area is affected by the climate change witnessed by the globe, which has created climatic conditions different from semi-dry, which is characterized by long summer months with high temperatures Heat up to (49 m), which increases the decomposition of organic substances inside the soil and turns them into toxic substances polluting the soil, as for the fluctuation of the amount of rainfall and its lack has a role in the concentration of pollutants in the soil as a result of the lack of exposure of the soil to washing .drought also helped in the disintegration of soil particles and ease of stripping, so the characteristics of the soil changed depending on the change in climatic characteristics and helped in the concentration of pollutants in it [5-7].

Solar radiation is one of the climatic elements directly affecting the temperatures responsible for the energy source that helps to heat the Earth's surface, as it controls the processes occurring in the soil, including the process of photosynthesis and the formation of acids and oxidation, effect of this factor on the soil is shown by the amount of solar radiation reaching the Earth's surface [8, 9].

The number of hours of actual brightness and the apparent movement of the sun, and the amount of rays reaching the soil is affected by its location from the circles of latitude and the degree of slope, they determine the angle of incidence of solar rays and the length of the day, the difference in the intensity of illumination, whether increasing or decreasing affects the events occurring inside the soil results in a rise or decrease in the values of some elements, which changes the physical and chemical properties of the soil. Table (1) and Figure (1) show the variation of the angle of incidence of solar radiation from one month to another, as it begins to increase gradually from March, its average reaches (57.7) degrees, due to the apparent movement of the sun in the northern hemisphere after March 21, due to the apparent movement of the sun towards the Tropic of cancer in the northern part of the Globe, noting that the highest values of the monthly rates of the angle of incidence of solar radiation begin from May to the end of August, and the rates of these months are (78.7 and 82.7 and 80.7 and 73.7), respectively, and then these rates gradually decrease from September because the sun retreats to the southern hemisphere until it reaches the lowest value in December and the second Scored (35.7 - 36.7) respectively.

As Table (1) shows the average theoretical sunshine hours in 2024 amounted to (12.3) hours/day, and the average actual sunshine hours amounted to(8.98)hours /day, brightness hours vary from month to month as they began to increase from May and reached (10.0) hours/ day, reaching their highest rates in the summer months (June, July, August), the month of July and August recorded the highest values of theoretical and actual brightness hours by (14.6-14.9) hours/day, and the actual brightness hours are(12.4-12.1) hours/day, while the lowest average was recorded in December, reaching (10.1) hours/day, an hour of theoretical brightness and (6.3) hours of actual brightness.

Table 1. Monthly and annual rates of theoretical and actual brightness hours (hour/day) and radiation angle in the Qurna for the period (2014-2024), Republic of Iraq Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2024.

Months	Solar radiation angles Degree	Solar radiation Hour /day Consideration	%Solar radiation Hour /day actual
January	36.7	10.2	4.5
February	46.7	11.0	6.9
March	57.7	11.8	7.6
Nissan	69.7	12.5	9.0
May	78.7	13.4	10.0
June	82.7	14.3	13.0
July	80.7	14.6	12.4
Father	73.7	14.9	12.1
September	63.7	12.22	10.6
October	51.7	12.0	7.9
November:	50.7	10.4	7.5
December	35.7	10.1	6.3
Annual rate	60.7	12.3	8.98

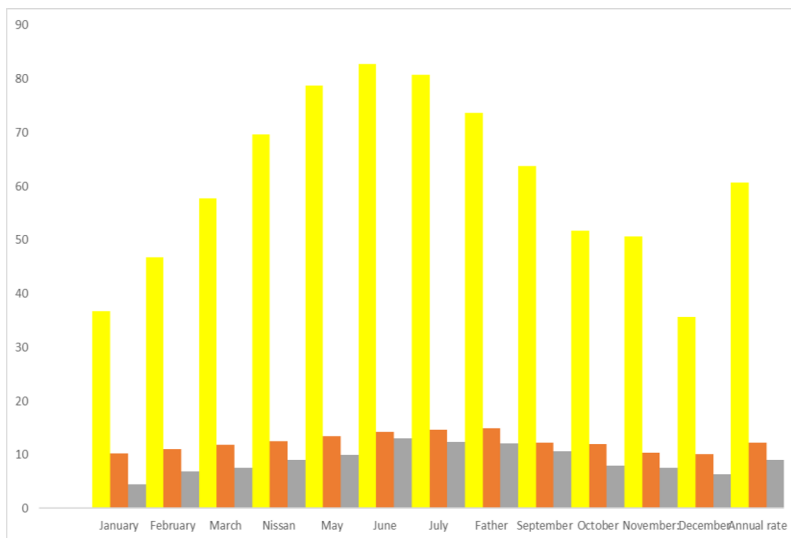


Fig. 1. Monthly and annual rates of theoretical and actual radiation hours in Qurna district for the period of 2014-2024

This energy is responsible for the movement of physiological and vital processes of plants such as respiration, photosynthesis, and the decomposition of elements and organic matter [10]. Any increase or decrease in temperature affects the totality of these events and causes a defect in the properties of the soil, leading to its pollution.

The studied area is affected by high temperature (40+ M) in summer. Thus, it causes increased evaporation and low moisture content of the soil, that leads to its drying, disintegration and exposure to the erosion process. High temperature also causes an elevated decomposition of organic matter and accelerates chemical processes.

The higher the speed of chemical reactions inside the soil increases by (2-3) times and high temperatures affect soil contamination with salts due to the activity of the capillary property as a result of increased evaporation and drying of the soil, which leads to an increase in the concentration of salts in the soil as for soils contaminated with liquid pollutants, high temperatures will increase the concentration of toxic substances in The temperature is due to a decrease in the rate of solar radiation angle and a decrease in the incident radiation with a decrease in temperature.

Table 2. Monthly rates of maximum and minimum temperatures in the Qurna district for the period 2014-2024

Months	Temperature range Great / degree Celsius	Temperature range Minor/ degree Celsius	Monthly rate
January	16.7	8.6	12.65
February	21.3	8.6	14.95
March	28	15.3	21.65
Nissan	33.7	18.5	26.1
Mace	39.4	24.2	31.8
June	45.4	27.7	36.55
July	48.6	27.9	38.25
Father	48.3	28.9	38.6
September	45.6	23.7	34.65
October	37.4	19.4	28.4
November:	27.1	14.2	20.65
December	23.6	10.8	17.2
Annual rate	34.59	18.93	26.76

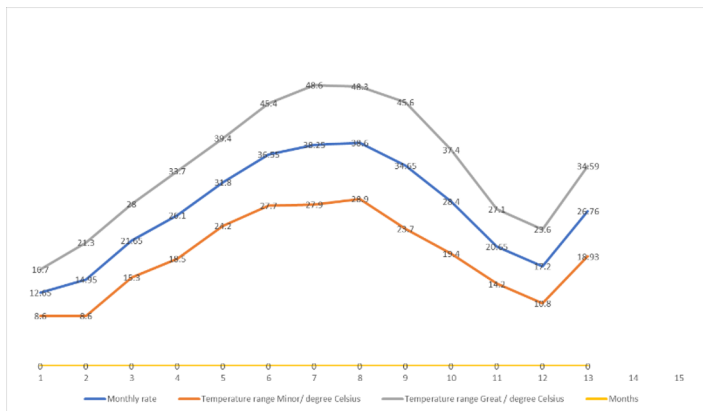


Fig. 2. Monthly and annual rates of maximum and minimum temperatures in Qurna district for the period(2014-2024)

The study area is characterized by the fluctuation of the amount of precipitation in it, as shown in Table (3) and Figure (3), the study area is located within the areas of the sedimentary plain affected by the Mediterranean climate, so the rainfall was limited during the cold season because it is affected by the Mediterranean depressions, if the rainfall starts from October and the amount reaches (8.0 mm) and gradually increases until it reaches its highest level during December, if recorded (25.6 mm) and then begins to gradually decrease until May, if recorded (11.1 mm) and then during the summer definitively, the annual total

amount of rainfall in the Qurna district has reached (124.7 mm), the falling rains wash the atmosphere of dust. This problem increases in the presence of nitrogen oxides and sulfur oxides that react with water vapor and then fall in the form of acid rain represented by nitric acid and sulfuric acid, which are pollutants that degrade the fertility of agricultural soils and the destruction of plants and microorganisms because they contain highly toxic dissolved elements such as lead and mercury found in areas with industrial activity.

Table 3. Monthly rainfall rates (mm) in Qurna district for the period (2014-2024).

Months	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total rainfall	20.4	16.3	14.5	12.0	11.1	0	0	0	0	8.0	16.8	25.6	124.7

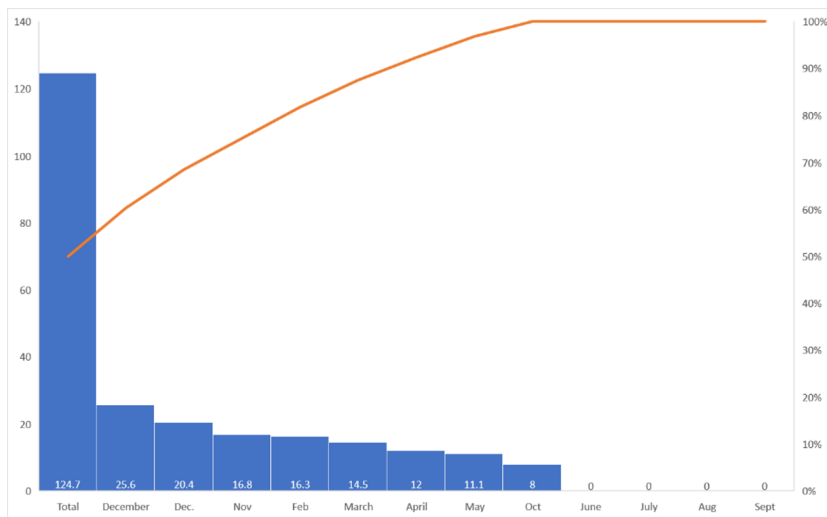


Fig. 3. Monthly and annual rainfall rates (mm) in Qurna district for the period 2014-2024.

It is the amount of water vapor present in the atmospheric air (absolute humidity) to the water vapor absorbed by the air at a certain temperature and expresses the relative humidity ranging from (0-100%). Relative humidity is an influential factor in the soil as it is responsible for many physical, chemical and biological processes as high humidity affects the soil containing salts (magnesium, chlorides and calcium) of a dark brown color because these types of salts can absorb moisture from the air.

Table (4) shows (4) the annual rate of relative humidity in Qurna district is(38.66)%, which varies During the winter and summer seasons, the highest humidity rate recorded during the winter to reach a maximum in December (87 %) as a result of low temperatures, and this helps to raise the relative humidity, while the relative humidity decreases during the summer as it recorded its lowest level during the months(June, July and August), the soil in the study area suffers from drought, especially in the summer as a result of its loss of moisture content, which makes the soil grains crumbly and loose and are prone to erosion processes, and there are some salts in the soil, it has the ability to absorb atmospheric moisture, as it increases soil moisture and gives it a brown color, such as salts of chlorides, calcium nitrate and magnesium, soil contamination with these salts affects the activity of microorganisms, soil fertility decreases due to the lack of nutrients in it, and the fluctuation of relative humidity

during the months of the year affects some types of soils, such as river shoulder soils, as chemical weathering disperses the cohesive material of the clays forming these densities, leading to their demolition.

Table 4. Monthly and annual relative humidity rates in Qurna district (2014-2024).

Months	1	2	3	4	5	6	7	8	9	10	11	12	Total
Relative humidity rates	87	55	56	37	25	18	14	23	23	35	59	62	38.66

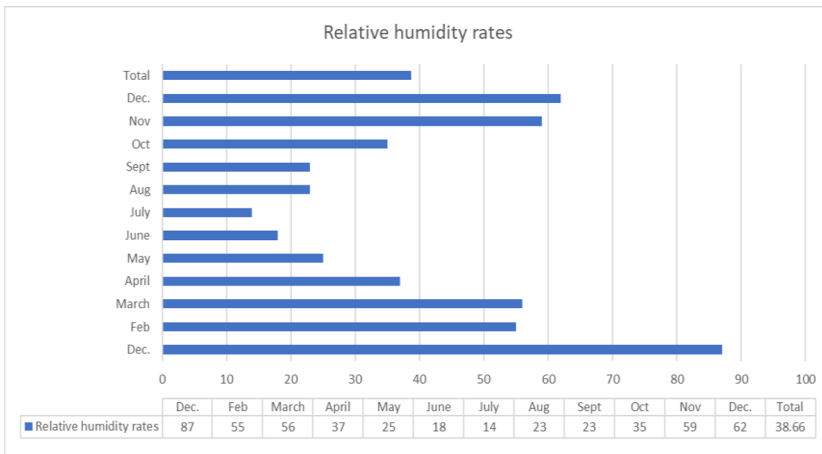


Fig. 4. Monthly relative humidity rates in Qurna district for the period 2014-2024

The amount of evaporation varies depending on" several factors, namely temperature, solar radiation, wind speed, relative humidity and clarity of the atmosphere, Table (5) and Figure (5) show that the annual evaporation rate in the study area of (265.21 mm), the highest evaporation values recorded during the summer in July reached (533.2 mm) due to the length of daylight hours and high temperatures reaching (47 M) due to the air is clear and free of clouds and humidity, in addition to hot dry gusts of wind and the lack of natural vegetation, but in winter, low temperatures.

The heat, the lack of wind speed and the abundance of clouds with high relative humidity reduces the evaporation rate, as the lowest evaporation values were recorded in January reached (45.5 mm), the increase in the evaporation process leads to the activity of capillary property causing soil pollution and degradation as a result of the deposition of salts on the soil surface, evaporation also dries and disintegrates soil grains due to low moisture content, especially when the area is free of vegetation, this helps the emergence of wind erosion and the spread of sand dunes.

Table (5) and Figure (5) show that evaporation rates begin to rise from March to September, that is, for 7 months, when (163.3-232.4 -344.9 -495.5 -533.2 -459.2) mm were recorded, respectively, during these months the soil in the study area suffers from drought and disintegration, which becomes easily affected by the wind erosion process, and this affects the soil texture as well as the bulk and real density, negatively reflecting on its fertility.

Table 5. Monthly and annual evaporation rates in Qurna district (2014-2024).

Months	1	2	3	4	5	6	7	8	9	10	11	12	Total
Evaporation rate	45.5	110.9	163.3	232.4	344.9	495.5	533.2	459.2	388.3	230.9	103	75.5	2652.1

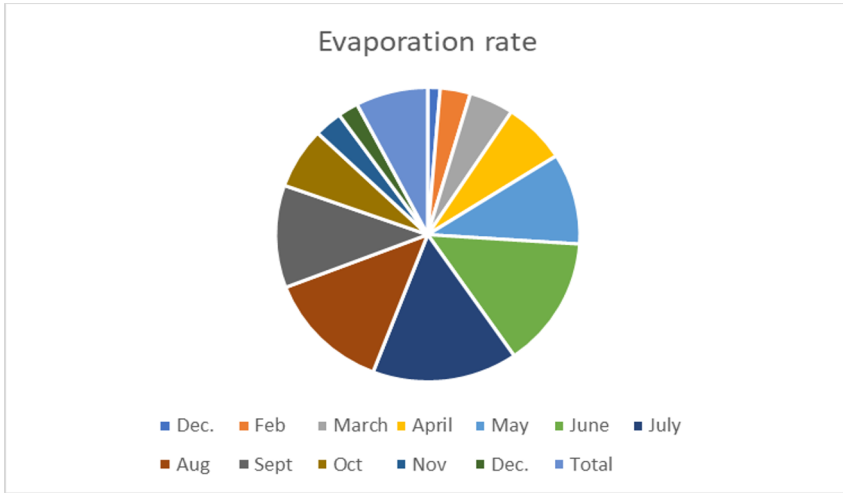


Fig. 5. Monthly rates of evaporation quantities (mm) in the study area for 2014-2024.

The study area is under the influence of the high-pressure range in winter and the low-temperature range in summer, " therefore, the winds blowing over the area were characterized by low speed, unless accompanied by the movement of the Mediterranean depressions, causing atmospheric instabilities, the wind blows as a result of the difference in the pressure slope between two zones, which It is active during the summer, as the north-westerly winds prevail in the study area, which is characterized by drought, heat and high speed, which increases the evaporation process, and this affects the soil, making it dry and loose and easily exposed to wind erosion .it is important to determine the movement of the wind direction, as it is one of the factors that help in the dissemination and distribution of pollutants that pose a danger to agricultural and pastoral lands and irrigation canals nearby, as the winds carrying pollutants pollute the soil of the areas crawling to it.

Table (6) Figure (6) indicates that the average wind speed in the study area varies from month to month, gradually increasing from the annual average of (4.44) M / S, from March to August and reached (4.3-4.4-5-6.5-4.6) then the wind speed rates gradually decrease from September, when it recorded (4.2) M / S, until it reaches its lowest rate in December, amounting to(3.5)M / s. Table (7) and Figure (7) show several types of winds blowing over the study area. The north-west and north winds are prevailing in the region. In summer the winds cause drought and increase the process of soil surface evaporation. The wind directions and their frequency are shown below.

Table 6. Monthly and annual rates of wind speed (M / s) in Qurna district for 2014-2024

Months	1	2	3	4	5	6	7	8	9	10	11	12	Total
Average wind speed	3.5	3.9	4.3	4.4	5	5.5	4.6	4.2	4.4	3.8	4.1	3.5	4.44

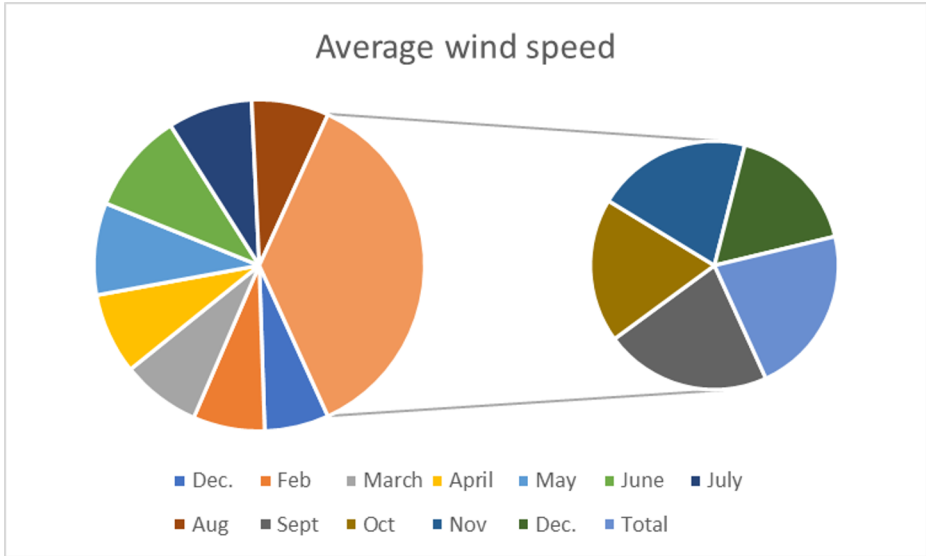


Fig. 6. Monthly rates of wind speed (M/s) in the study area for the period 2014-2024

Table 7. Percentage of annual wind trend recurrence rates in Qurna district for the duration 2014-2024

Direction	North - West	Western	Southern	Southern Eastern	Southern	South - west	Western	North - West	Dormancy
Repetition rate	14.9	3.4	4.4	6.9	7.5	2	14	37.3	10.6

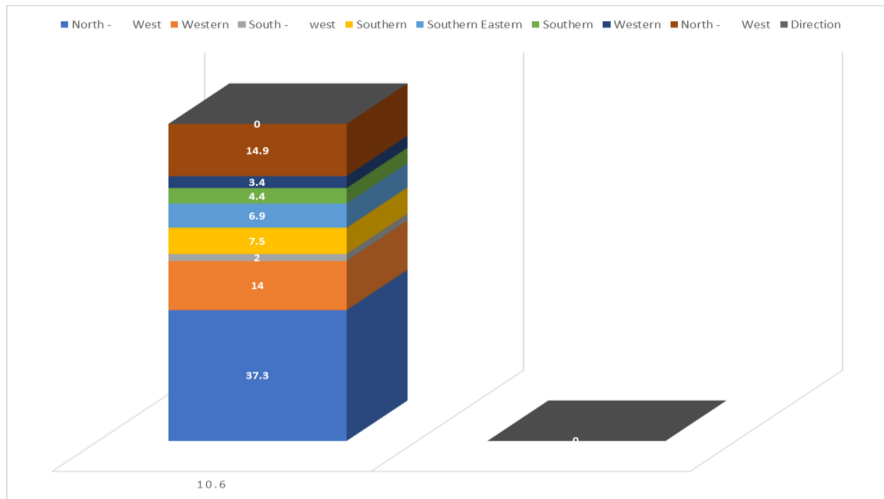


Fig. 7. Wind directions in Qurna district

3 Conclusions

It turned out that there is a significant impact of climate elements in the pollution of agricultural soils to spend Qurna influenced by its astronomical location, as it is located between two circles of latitude (30.36 to 31.18 North and arcs of longitude 47.10 to 47.42 East), which increased the angle of incidence of solar radiation reaching the Earth's surface at a rate of (60.7)m, so the study area was subjected to the continental climate, which is characterized by high annual average temperatures during the hot season (summer), the predominance of dry north-west winds, low humidity and increased evaporation intensity, the lack of precipitation and its fluctuation during the cold season (winter).

Therefore, these factors together were reflected in exposing the soil of the study area to the problem of salinity. Surface soils are more polluted compared to subsurface soils due to their direct impact on climate elements such as solar radiation, temperatures, humidity and evaporation, which increase the concentration of pollutants on the soil surface.

The prevailing climatic conditions in the study area helped the activity of the capillary property, which has a role in soil contamination with salts, and the wind also has a role in the frequent occurrence of dust storms that work to transport and spread pollutants.

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