The Climatic Regions and Desertification Level for Diyala River Basin in Iraq

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Abstract

The current study a accounts for the climate of the Diyala River Basin in Iraq where the climate is assessed depending on the most well–known climatic classification. According to these classifications, it has been discovered that the area is located under Three climatic zones. The first zone is the semi humid or moderate, which covers the northern parts of the area. The second zone is the semi –dry climate which spreads over the middle part of the region. The third one, it extends over the southern parts and it is described as being dry .some maps were drawn to show the depth of rain fall for two successive periods. These maps indicate increase in the area of lands affected by the dry climate on account of the lands that used to lie under the effect of the semi – dry climate.

Keywords: climatic zones, Diyala river Basin, Iraq, desertification.

الاقاليم المناخية ومستوى التصحر في حوض نهر ديالى في العراق

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الخلاصة:

تم في هذا البحث إجراء تقييم نوعي للمناخ في حوض نهر ديالى داخل الاراضي العراقية . والذي اعتمدت فيه اشهر ثلاث تصانيف مناخية عالمية واكثرها شيوعا بالاستخدام من قبل الباحثين المهتمين بمجالات الطقس والمناخ وعلوم المياه . ومن النتائج تبين بان المنطقة تقع تحت تاثير ثلاث اقاليم مناخية (مناخ معتدل او شبه رطب يغطي الاجزاء العليا من المنطقة) ، (مناخ شبه جاف يغطي الاجزاء الوسطية منها) فيما تقع الأجزاء الجنوبية تحت تأثير المناخ الجاف. وبعد اعتماد عنصرالساقط المطري كااحد اهم العوامل في دراسات الهيدروميتيورولوجيا والتصحر،في تحديد اثر ظاهرة التصحر في المنطقة وذلك بعد تقسيم مدة المراقبة الى مدتين تبين منها وبشكل واضح زحف الاقليم المناخي الجاف على حساب الاقليم شبه الجاف وخاصة ضمن الاجزاء العليا في العشر سنوات الاخيرة .

1- Introduction:

The climate can be defined as the average of the distribution of the climatic elements such as solar radiation, temperature, pressure, winds, rainfall, humidity, air masses as well as other climatic phenomena such as cloudiness and dust storms [1]. It depends on the range and variation of showing the climatic element nature. Despite the existence of some simple differences in the definition of the climate, all scholars agree on the main features that characterize the weather cast in a particular region and for a long period of time. The climate is considered one of the most important components of the natural environment affects the other components such as natural plants, to graphical parameters and soil.

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In most cases , it becomes a reason for local changes that may occur within the general framework of the local environment because it plays a vital role in the biological exercises and activities of living creatures whether they were biological or botanical entities. Hence, the importance of studying climatic circumstances evidently appears as the basis on which the complete portrait of the prevailing natural circumstances that dominate the place or the Territory leader study .As mentioned above, the climate is one of the components of the complex natural environment.

It can be composed of several elements each of which has its own direct impact in the other . more over, each one of these elements forms a part of the comprehensive situation that prevails in a particular climatic zone[2] . However , the elements of the climate by themselves such as heat , atmospheric pressure , humidity ,condensation and rainfall are in fact but a result of interaction between several factor that dominate the climatic circumstances that prevail in particular place or territory such as its position with regard to latitudes and distance from the water bodies , its topography , its plant cover and other different dominating factors that play a major role in deciding the climatic characteristics and merits of the place or the territory . This means that the climatic zone is responsible for the reasons that had made that climate hot , cold or moderate and that caused the fact that a particular territory to be rich with heavy rain throughout the whole year or during a particular season in the year , while another territory could be dry with poor rain proportions. Thus , we should investigate other factor and reveal their influence on the variation in the distribution of the climatic elements and their similarity from one direction to another on the surface of the earth .The factors that illustrate the study of the climate and the variation or similarity in the climate of a particular zone or direction or even the general distribution of the climate elements are usually known as the factor that control the climate. on the margin of climatic changes their zones , there emerged a problem that can be regarded as one of the most serious challenges that are conformed by human beings in the current century .That problem has become more and more threatening where man began to interfere in the climate causing nude liberate defect in the natural environmental balance. This defect is the desertification which can be considered one of the dangerous environmental phenomena since it has a direct connection with the food secure that reflects the deterioration of agricultural lands in arid and semi –arid in addition to dry and semi –humid regions due to various factors among which are climatic variation and human activity. As a result , wide areas of lands have become worse and worse and their productivity has decreased and this has ultimately led to the spread of poverty on a wide range in these areas . in the time being ,many countries in the world are suffering from the problem of desertification and Iraq is one of these countries due of the fact that it lies under the influence of the dry and semi – dry climatic zone in wide areas of its lands .[3].

2- Methodology:

To achieve the objectives of the current research, the following methodology will be followed:

1. Providing a basic map that covers all the parts of the study area (Diyala River Basin inside Iraq).
2. Pointing the climatic and rainy stations that lie inside the basin and the geographically nearest stations to it because they reflect the climatic reality of the area.
3. Preparing a complete record for the rainfall data and the temperature of the air in all the stations and through the whole typical observation period (30 years) . In this respect , five relevant stations are included (Sulaimaniya ,khanaqin ,Tuzkhurmatu , khalis and Baghdad).
4. After obtaining the general monthly and yearly averages during the observation period (1984 - 2014) Table-1 and after counting the available data in the records of each of the above mentioned stations , some results were recorded . Table-2 and Table-3.
5. Using some of the most well-known and most important international classifications in order to determine the type of the climatic territory . This has been done through tables used to show collected data and maps used to indicate the extentions of each territory .
6. In order to limit the phenomenon of desertification within the area under the study , the period (30 years) of recording the main stations in the area was classified in three stations (Sulaimanya station , khanaqin station and Baghdad station) into two main periods . The first period extends from 1984-1994. and the second is from 1995 to 2014 .This was achieved through observing the location of lines equal to the rainfall (isohytal line) in the above mentioned periods .
7. Drawing two maps ; the first period (1984 – 1994) and the second map for the (1995 – 2014).

Table 1- Periods of Recording the selected climatic stations in the Area Under   study for the period 1984 – 2014

Climatic station	Reordering period
Baghdad station	1984 – 2014
Sulaimaniya station	1984 – 2014
khanaqin station	1984 – 2014
Tuz khurmatu station	1994 – 2014
Khalis station	1994 – 2014

Table 2- Monthly and yearly averages of the Rainfall in the climatic zone of the study Area (1984 – 2014)

Months	Main stations 1984 – 2014			Secondary stations 1994 - 2014	
	Baghdad	Sulaimania	khanaqin	Tuz	Khalis
Jun	29.6	109.81	61.4	57.4	29.6
Feb	19	115.1	45.3	35.1	21.8
Mar	20.6	115.6	51.1	35.5	20.2
Apr	15.6	93.64	28	31.5	22.2
May	3.1	45.1	7.1	6.2	5.6
June	0.1	1.6	0.3	0.8	0.6
July	0	0	0	0	0
Aug	0	0.01	0	0	0
Sep	0	1.34	0	0.3	0.1
Oct	11.6	32.77	12.8	11.6	8.3
Nov	11.6	84.81	34	26	18.2
Des	20.6	112.91	55.7	41.3	29.4
Sum	126	712.6	265.6	245.4	156

Table 3- Monthly and yearly Averages of Temperatures in the study area (1984 -2014)

Months	Main stations 1984 – 2014			Secondary stations 1994 - 2014	
	Baghdad	Sulaimania	khanaqin	Tuz	Khalis
Jun	9.2	5.50	9.4	9.1	9.2
Feb	12	7.10	11.4	11.3	11.5
Mar	16.1	10.20	15.6	15.6	16
Apr	22.6	16.60	21.3	21.9	21.8
May	28.6	22.30	28.4	28.2	27.5
June	32.6	28.80	32.9	33.4	31.8
July	34.8	32.80	35.8	35.7	33.9
Aug	34.1	31.80	34.7	35.3	33.2
Sep	30.4	28.90	30.6	30.8	29.1
Oct	24.2	20.80	25	25.2	23.8
Nov	16	13.20	16.7	16.4	15.6
Des	10.9	7.10	11.2	11.4	11
Av	22.6	18.76	22.7	22.8	22
Max	34.80	32.80	35.80	35.70	33.90
Min	9.20	5.50	9.40	9.10	9.20

From the work of researchers relying on public Meteorological Organization and monitoring seismic data in Baghdad

3- Location and Area

The area under research (The Diyala River Basin) is located in the northern and east - northern parts of Iraq between the longitudes 44,30 and 46,12 and the latitudes 33,12,30 and 35.46,15 is Figure-1. Thus, the eastern borders of the area are the borders between Iraq and Iran , while the northern parts of the area are the mountainous regions of Iraq which reach to 2000 m above the sea

level . from the west and south – western direction the water divide water from the Idheim River Basin.[4] and [5]. Figure-1**.**
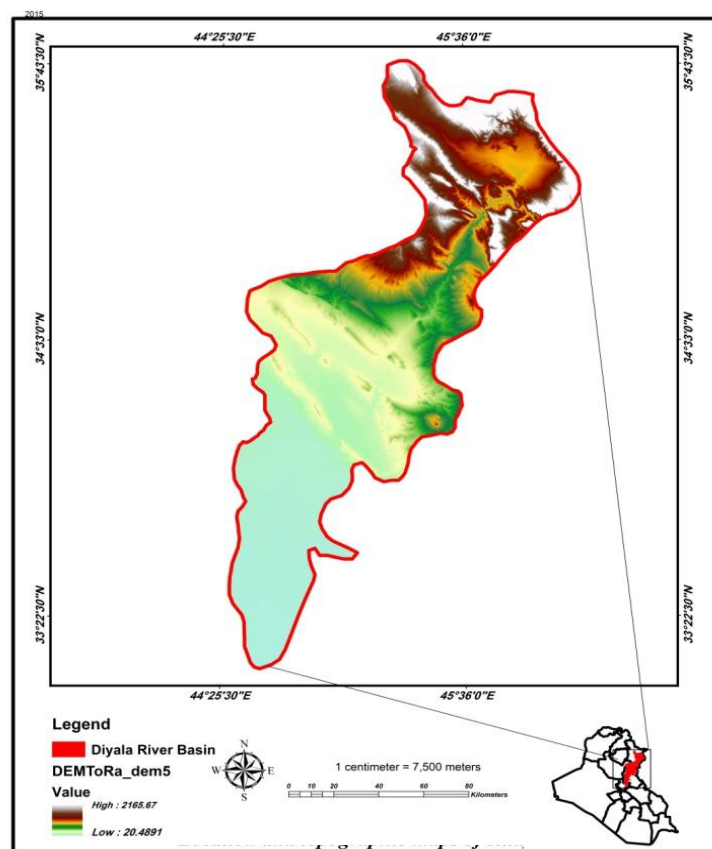

Figure 1- location of the study area

4- Climatic classification of the study area

The climatic classification means gathering similar areas is one region despite the difficulty in finding two areas that are totally similar. However, identity in general characteristics will be dominant in determining climatic zones. It is known that there are no two regions on the surface of the earth are very similar in their climates however small they were [6]. This is ascribed to local small differences that provide each region with its own personality that distinguishes it from other regions Thus; climatic classification does not require complete conformity between the points of a particular territory. Rather, it requires that the general characteristics of put the area with in a particular climatic zone. The climate of any area is a reflection of the be heavier of a group of climatic elements added to the effects of the factors that dominate a particular climate [7]. Classifications aim at collect wide areas that are far from each other in one climatic zone through giving a wider extension for the definition of the climatic zone instead of limiting it within narrow limits. Through the use of rain and heat , we can collect wide areas within the borders of one region. [8] .   Three classifications are adopted in this research because these classification are the most used ones in climatic classification, on the one hand , and because they mainly rely on the elements of heat and rainfall in determining the climatic elements data in the Iraqi climatic stations , on the other hand . These three classifications can be explained as follows : [2]

1 – De Martonne classification

De Martonne used the drought index according to the following equation :

$$\text{Drought Index} = \frac{Annual\,rain\,Quantity\,(mm)}{Average\,of\,annul\,Temperature + 10}$$

On the basis of the results of the equation above , climatic zones could be arranged as follows : Table-4.

Table 4- De Martonne Classification for the climate regions

Drought Index	Type of the climatic zone
5 >	Dry
5 – 10	Semi – dry
10 – 20	Semi – humid
20 <	Humid

   After doing the private records and comparing the results with the data of each station, the following results have been found Table-5:

Table 5- Climatic classification in the study Area depending on De Martonne (1984 – 2014).

Climatic station	Baghdad	khalis	Khanqin	Tuz Khurmatu	Sulaimanya
Drought index	3.70	4.88	9.04	7.48	24.70
Type of climate	Dry	dry	Semi dry	Semi dry	Humid

   Table-5 above shows that the study area falls under the in fluency of three climatic zones: dry, semi – dry and humid . the results are represented on the map of the study area .Figure-2.
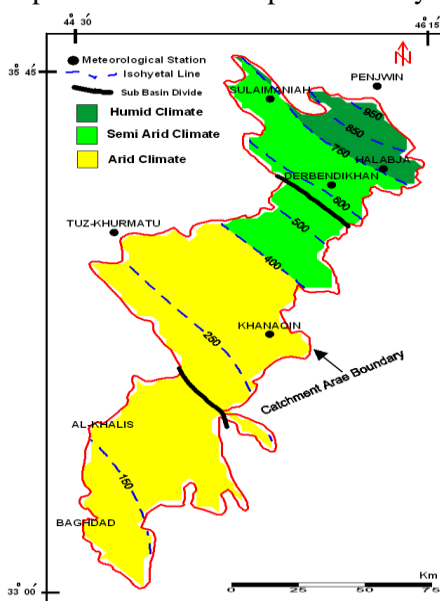

Figure 2- The climatic zones in the Diyala River Basin inside Iraq According to De Martonne classification (1984 – 2014)

2 – Raghunath Classification [9]

   This classification depends on three boundaries for climatic zones [9]. Table-6 shows the classification of the study area after the map drawing. It also shows the depth of rainfall in the study area relying on the general annual average. The results showed that the humid climatic zone extending beyond the contours line 750 mm in a dry climatic zone to the south of that zone, there extends the semidry climatic zone till the contours line 400 mm. Either for the rest of the parts in the basin , they are covered by a dry climatic zone Figure-3.

Table 6- Boundaries of climatic zones classification [9]

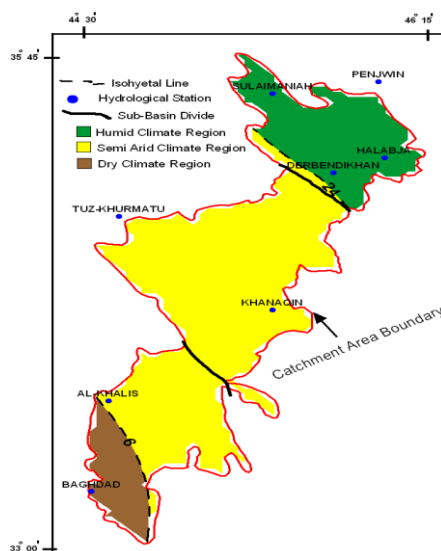| Annual Average of Rainfall (mm)	Climate Type
Less than 400	Arid
400 – 750	Semi – arid
More than 750	Humid

Figure 3- climatic zones in Diyala River Basin Inside Iraq According to Raghunath classification 1984 – 2014.

4 – **Koppen classification**
Koppen divides plants need for temperature in to five main climates:[3]
  1. The Tropical zone (Megatherms A) : The temperature of the coldest month is not less than 18°c and this temperature is suitable for the growth of trees in to trpical forests
  2. The moderate zone (Mesotherms D) : In this zone , the temperature is less than 18° but it does not go lower than 30°c. In the warmest month , it should raise over 10°c because this temperature is necessary for the growth of tress and herbs .
  3. The cold zone (Microtherms D) : In this zone , the temperature of the coldest month lowers below 30°c and the temperature of the warmest month must exceed 10°c since thin degree represents the line separating between tree growing zones and those that prevents thin growth .
  4. The frozen zone (Hekistotherms E) : In this zone , the temperature lowers below 10° in the warmest month .In this zone , trees never grow.
  5. The Arid zone (xerophytes B) . This zone is not subject to thermal limits only but also to areolation proposed by koppen between the quantity of rainfall and the temperature of the region , Right from the beginning , koppen realized the importance of the season of rainfall. [7] . since there was no equation to register vaporization at that time , koppen looked for a relation between temperature and the quantity of rain fall according to rain season. He could find the following equations :
1-R = 2 T if 70% of rain falls during the six months of winter.
2-R =2 (T+7) if rainsfalls throughout the whole year .
3-R = 2 (T+14) If 70% of rainfalls during the six months of summer.
Where R= the annual average of rainfall for a long period,
T= the annual average of temperature for along period.
In order to decide the arid zone B, the equation can be illustrated as follows:
   If the amount of rain (R) is more than double the level of temperature (T), then the region is humid if rain in concentrated in winter , but if the amount of rain (R) is less than the level of T , then the region is arid. The same applies to the regions of scattered rain and regions of summer rain. To sum , if the right side of the equation is higher than the left side , the region is considered humid , but if the right side is lower than the left side , the region can be called arid B. The reason behind adding a constant coefficient for scattered rain and summer rain is attributed the rise of temperature.In the case of Jcahered[1].rain , koppen found that vaporization resulting from rainfall is doubled in summer two times more than that of winter . For that reason, koppen added the coefficient 14 so that the amount of rain become just as required in order for the region to become humid. This means that the amount of rain should be double the temperature T14. Either for rain that is concentrated in summer, the lost quantity of this rain becomes huge , therefore , the region needs great amount of rain in that season in order to become humid. Thus, koppen supposed for it double the temperature T 28 [6]. After counting

records of the data of the selected stations in the study region, the following results have been elicited as shown in Table-7.

Table 7- Results of Applying koppen's classification of selected climatic stations in the study 1984- 2014

Station	Climate Type	Climatesymbol
Tuz	Semi–Arid climate (winter rain with hot long summer)	Bsha
Khalis	Arid climate (winter rain with hot long summer)	Bwha
Baghdad	Arid climate (winter rain with hot long summer)	Bwha
Khanaqin	Semi–Arid climate (winter rain with hot long summer)	Bsha
Sulaimaniya	Moderate climate (winter rain with hot long summer)	Csha

After doing all the comparisons that concern the expectation of the climatic zone according to the above mentioned classification and after representing the result on the study area map , it because evident that the region is influenced by three climatic zones (the moderate , the arid and the semi- arid climatic) Figure-4.
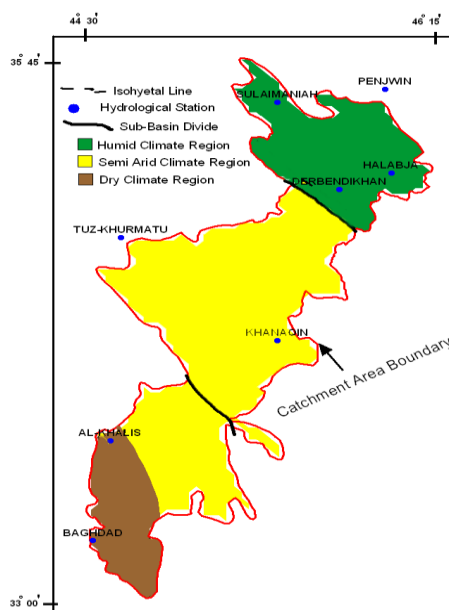

Figure 4- The climatic zones in Diyala River Basin inside Iraq According to koppen's classification for the 1984 – 2014

After that, all the obtained results through the above mentioned classifications were collected. See Table-8:

Table 8- Results of the climatic classifications used in the study area (1984 – 2014).

Climalologied	Type of climatic Regions of study Area		
	upper	middle	lowes
De Martoune	Humid	Semi – arid	Dry
Raghunath	Humid	Semi – arid	Dry
koppen	moderate	Semi – arid	Dry

From the Table-8 we can notice that the study area lies generally under the influence of three climatic regions cover the parts of the Diyala river Basin respectively.

5 – Desertification in the study Area

The rain fall is regarded as the most influencing climatic element in the emergence of the phenomenon of desertification in the dry and semi – dry climatic regions which are the most evident in the study area. For that reason, the observation period was divided into to periods:

The first one is form (1984 to 1994) and the second extends from 1995 to 2014. In addition, their data was represented on maps that equal the rainfall by the surfer software from which it was revealed that the region falls under the influence of three climatic zones (humid, semi – dry and dry). Fiqure-6 shows that the humid climatic region lies within the farthest northern parts of the region. Then, data of the second period was represented. The map Figure-6 shows clearly the extension of the humid

climatic region beyond the boundaries of the study area. It also shows the clear existence of the phenomenon of desertification in the study area in particular and Iraq general.

In order to make a clear comparison the two Figures A and B were collected in order to show the influence of the desertification phenomenon through time right from the beginning of the period (1984) up to its end (2014).
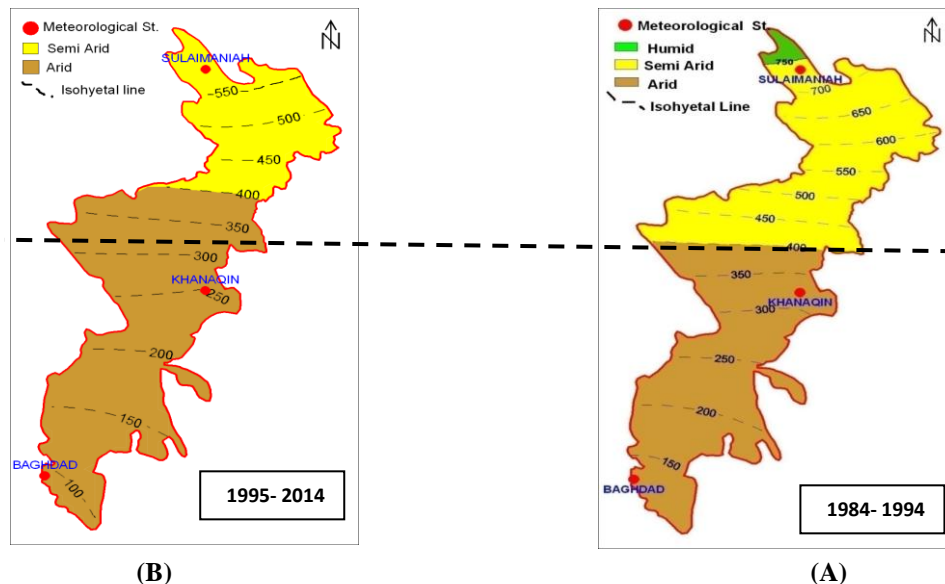

(B)   **(A)**

Figure 6- Comparison of Rainfall in the study Area for the period 1984 – 1994 and 1995 – 2014.

6 – Summary and conclusions

 1. The annual averages of temperature (T) in the study area for the selected climatic stations range between 18.76 at the Sulaimania station 22.8 at Tuzkhermatu station. The annual average of rainfall at Baghdad station 12.6 mm.
 2. Depending on three climatic classifications (koppen's , Demarton and Raghunath) the study area is located under the influence of three climatic zones (humid, semi-dry and dry) .
 3. After drawing the two rain climates maps (isohytal maps) in the study area for the two selected periods, it is found that the region is affected by the phenomenon of desertification where the humid climate disappears during the second period as compared with the first period.

7 -Recommendations:

After finishing the current research, the researchers propose the following recommendations**:**
 1. Adopting the current research for the sake of climatic classification for relevant studies which will be carried out in the coming years within the parts of the study area.
 2. Applying the classification adopted in the current study to the neighboring river basins within a short period in an attempt to merge similar climatic zones in order to prepare a more evident imagination about the climatic conditions in Iraq.
 3. Depending on the outcome of modern technology (satalites , radars) in observing the movement of air masses and rain storms since they are very important in predicting the future climatic behaviors.
 4. Adopting koppen's classification in the future in the classification of climates in subsequent studies because it adopts many variables. As a result, its findings are more accurate in comparison with other climatic classifications.
 5. Observing the cases of desertification through relying on satellite images with continuous chronological order for the parts of the study area in particular and the whole Iraq in general.

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