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PROBLEMS OF VISUAL PERCEPTION OF KINETIC RAIN MAPS IN BABIL GOVERNORATE

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Abstract:
Maps are a crucial tool for conveying information and data in a miniature form. This tool must be easy to understand and comprehend for the reader. Therefore, achieving optimal perception when representing any geographical phenomenon is essential. This study aimed to produce the most accurate maps possible using GIS software and rainfall data to create dynamic rainfall maps for Babil Governorate for the period from 2001 to 2023. Additionally, a questionnaire was used to assess levels of visual perception. The study is divided into three main sections: the first covers the theoretical framework, the second focuses on dynamic rainfall maps in the study area, and the third examines the levels of visual perception of these dynamic rainfall maps in Babil Governorate.

The study, which included rainfall data from 2001 to 2023, represented the annual total rainfall and the total rainfall for January and September, the months with the highest and lowest rainfall, respectively, using colour and shape variables. It was found that the maps most easily understood and visually clear to readers were those that used colour as a variable. Specifically, the isohyets map representing total rainfall with the colour variable achieved the highest level of perception at 86.6%. In contrast, the map showing spatial variation in total rainfall with the shape variable had the lowest perception level at 64.91%.

Keywords: visual perception, rain maps, kinematic maps

- **Introduction**

Cartography is one of the most important tools for addressing the numerous spatial problems by innovating, analysing, and transforming real-world subjects into maps to gain new knowledge about these phenomena. This is achieved through all analytical processes within the GIS (Geographic Information System) environment, relying on spatial analysis tools to produce digital outputs without the need for statistical software to obtain results.

Climatic maps are subject to continuous change, especially given the environmental changes in the study area. Therefore, it is essential to monitor and illustrate these changes. The simplest way to achieve this is by creating a miniature representation containing a vast amount of climatic data, facilitating the observation, analysis, and interpretation of these dynamic changes in climatic elements, including rainfall quantities.

- **Problem of the Study** :The article discusses many problems, they are representing the questions of the study.

1. Do the current study maps suffer from issues in understanding and perception among readers?
2. How can we identify visual perception problems in dynamic rainfall maps in the study area?
3. What are the optimal variables representing rainfall quantities in the study area?

- **Hypothesis of the Study :**The study puts forward a set of hypotheses, namely:

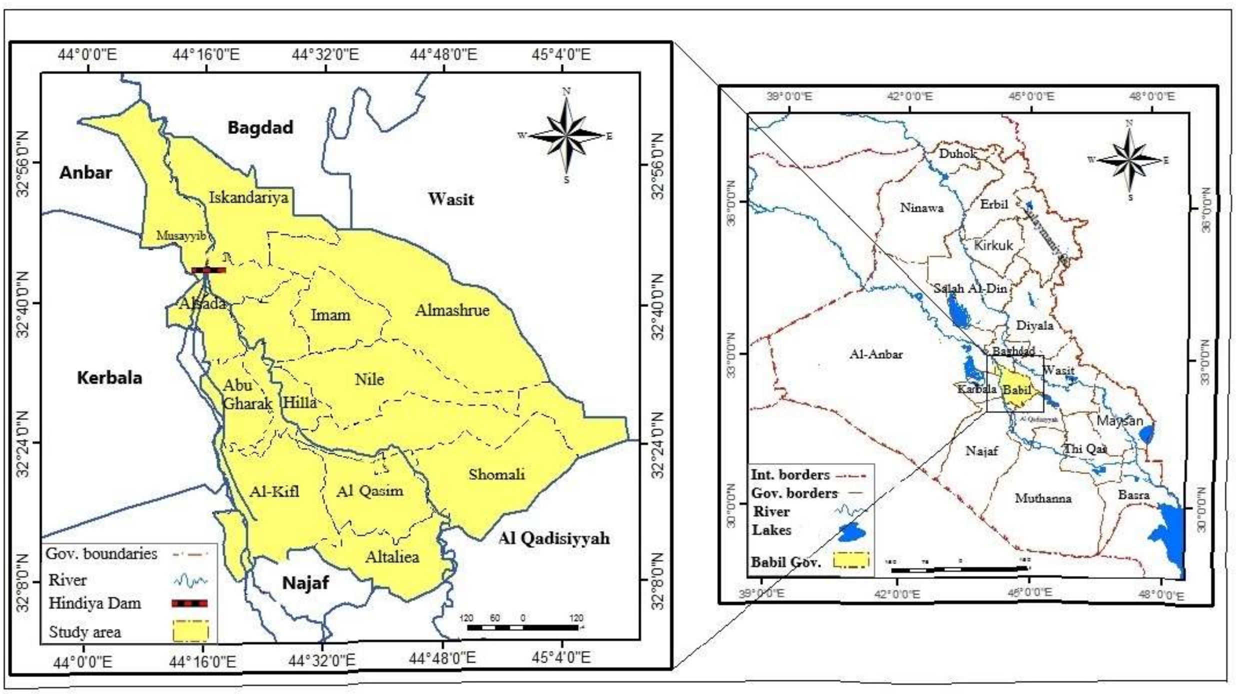
1. The current study maps vary in levels of understanding and perception among readers according to several criteria.
2. Visual perception problems with dynamic rainfall maps in the study area can be identified through a series of experimental tests.
3. The colour variable is the most effective for representing rainfall quantities in the study area.

- **Importance of the Study**: Studying climatic elements in general, and rainfall maps in particular, is essential for understanding the extent of changes over specific periods, identifying the direction of these changes, and determining which months receive the most rainfall. This information is crucial for water collection and utilization, especially given the current water scarcity in the study area
- **Limits of the Study :**The study is confined to the administrative boundaries of Babil Governorate, located in the central part of Iraq within the central alluvial plain, between latitudes ˚ 33.5— ˚ 32.9 N, and longitudes ˚45.12— ˚ 43.97E (Map 1). The study area is bordered by Baghdad to the north, Wasit to the east, Karbala and Anbar to the west, and Najaf and Al-Qadisiyyah to the south. The governorate roughly forms a triangular shape with its base in the south, narrowing in the northern part, and extends longitudinally from the northwest to the southeast (Map 1).

The area of the governorate is 5119 km², constituting about 1.2% of Iraq's total area of 435,052 km² (Republic of Iraq, 2007).

The study relied on three climate stations, one of which is located within the study area. Karbala and Diwaniyah stations are controlled stations, Table (1).

Map (1): Location of the study area in Iraq



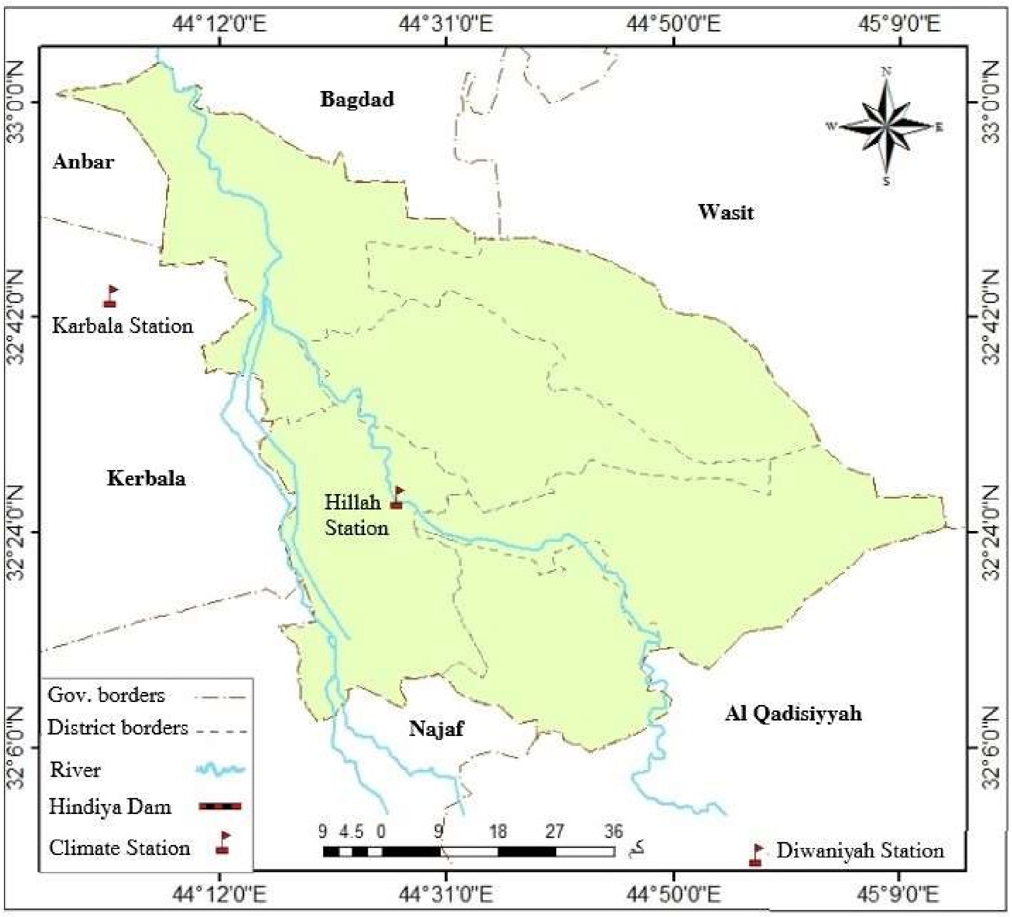
Source: *General Authority for Survey, Administrative Map of Iraq, scale 1/100,000, 2010.*

Table (1): Locations of stations in the study area

Station	Elevation above sea level (m)	Longitudes	Latitude
Hilla	27	44 27	32 27
Karbala	29	44 03	32 43
Diwaniyah	20	44 57	31 57

Source: *Republic of Iraq, Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.*

Map (2) Locations of the climate stations adopted in the study.



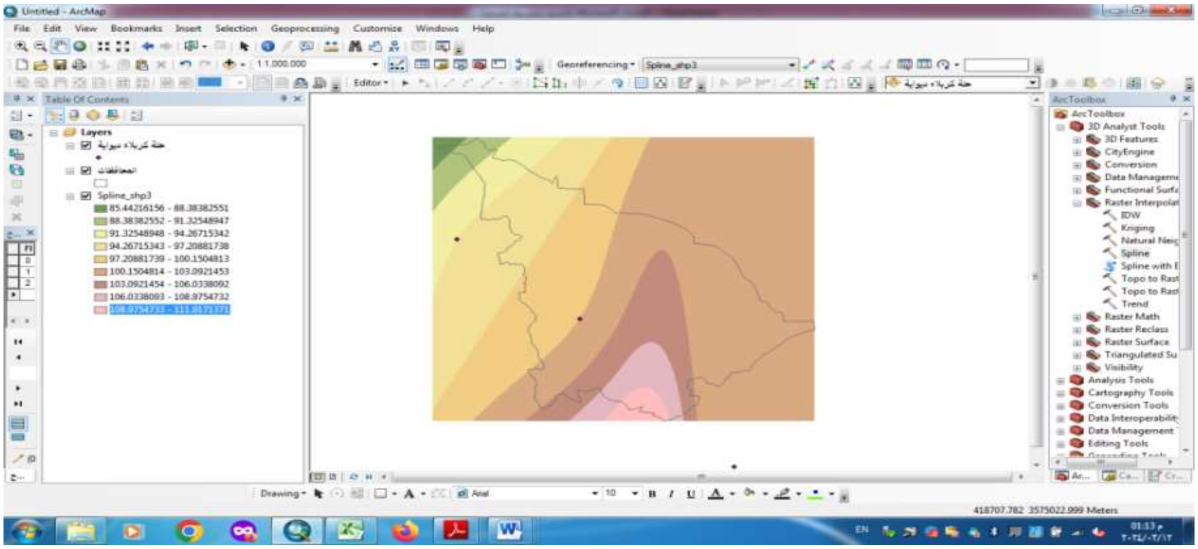
Source: *Based on Table (1)*

1-1- Derivation of digital maps of temperatures in the study area.

The process of deriving climate maps goes through a number of steps in the program (1 ARC MAPV.10.3.) After performing the initial processing of climate data, the astronomical locations of the climate stations were linked to the values of rainfall amounts for each station. The derivation stage comes, and the steps for deriving maps of annual rainfall rates are as follows:

Arc Map 10.3.1 ➔ Arc toolbox ➔ 3D Analyst Tools ➔ Raster Interpolation ➔ Spline.

Image (1): Raster layer derivation of the amount of rain in the study area

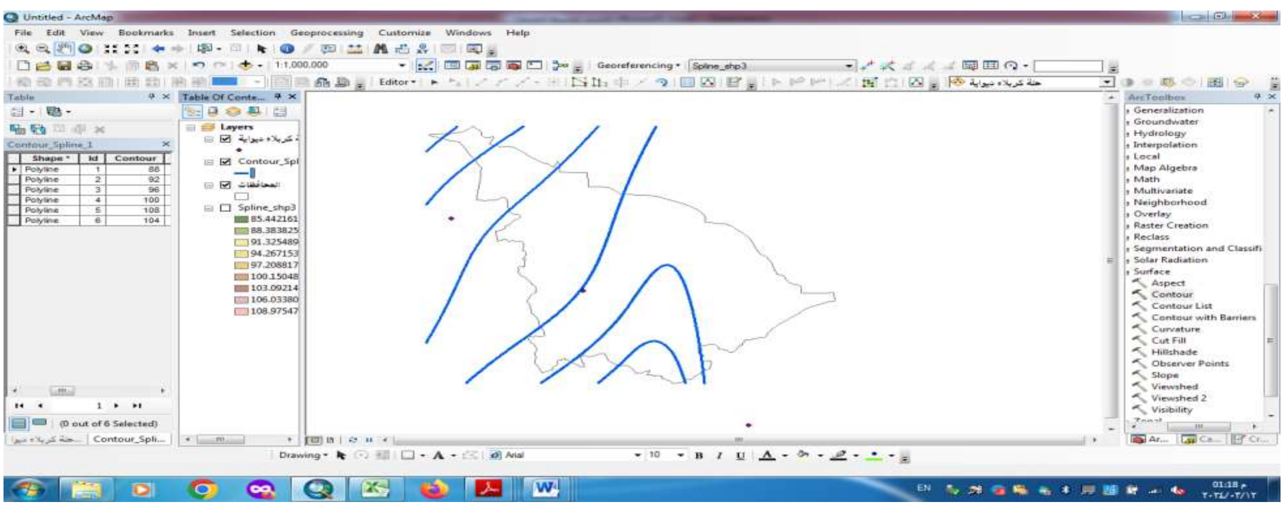


Source: *Based on Arc Map.10.3.1 program.*

After implementing the previous steps, a Raster map will be produced for us. We move to the second step, which is the process of deriving the isotherm lines. We follow the following steps: -

Arc Map.10.3 .1 ➔ Arc toolbox ➔ Spatial Analyst Tools ➔ Surface ➔ contour

Image (2) Derivation of the contour line layer of rain in the study area



Source: *Based on Arc Map.10.3.1 program.*

Then the final stage is the process of cutting the contour lines

Arc Map. 10.3 .1 ➔ Arc toolbox ➔ geoprocessing ➔ Clip

2- Rainfall kinetic maps in the study area

Climate, with its various elements, undergoes continuous changes from hour to hour and month to month.

It is essential to depict these changes over a specific period on a single map. However, several issues can make climatic maps in general, and specifically maps showing spatial rainfall variations, unclear to the reader. Therefore, this research focuses on identifying, highlighting, and addressing these issues to produce a comprehensible map. This was achieved by collecting annual and monthly rainfall data from the study stations and comparing the changes between the highest and lowest rainfall amounts for the period 2001-2023 using two variables:

1. Colour Variable: This variable represents phenomena based on the colour that matches the actual phenomenon. Every colour used on the map has a specific meaning and implication, making it understandable and readable regardless of the language used on the map (Hossam El-Din Gad El-Rab, 2012).

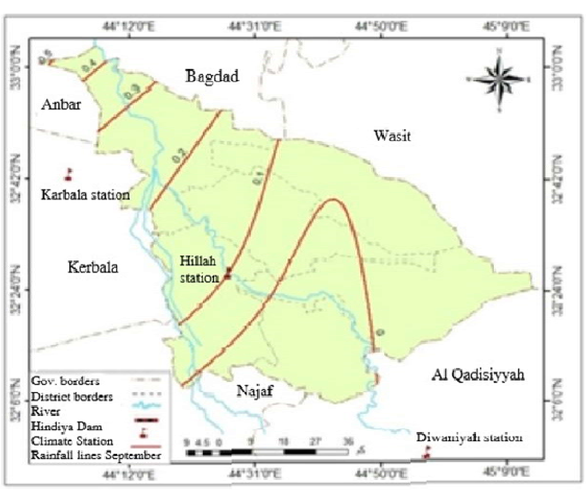
For example, the data for January were represented using isohyets (lines of equal precipitation) with a single colour, purple, to denote rainfall lines in the study area, ranging between 15-24 mm (Map 3). September, which records the least rainfall, was also represented using a single colour, red, indicating rainfall lines between 0-0.5 mm (Map 4). The total average rainfall for the period 2022-2023 recorded at the study stations is shown on a map with blue isohyets, indicating rainfall lines between 0-180 mm (Map 5). Map (6), which includes three layers of rainfall amounts for January, September, and the total average rainfall, illustrates the spatial variation in rainfall quantities in a consistent direction.

Table (2) Rainfall amounts at the climate station for the study area and the control stations.

Station Months	**Diwaniyah**	**Karbala**	**Hilla**
K2	22.1	17.5	20.7
February	14	13.8	13
March	11.4	14.7	13.3
Nissan	14.4	12.5	11.8
Mace	4.5	3	2.1
June	0	0	0
July	0	0	0
Now	0	0	0
September	0.5	0.29	0.1
T1	3.8	4.1	4.05
T2	17.9	14.01	17.98
K1	13.89	14.3	17.13
Rate	102.49	94.2	100.16

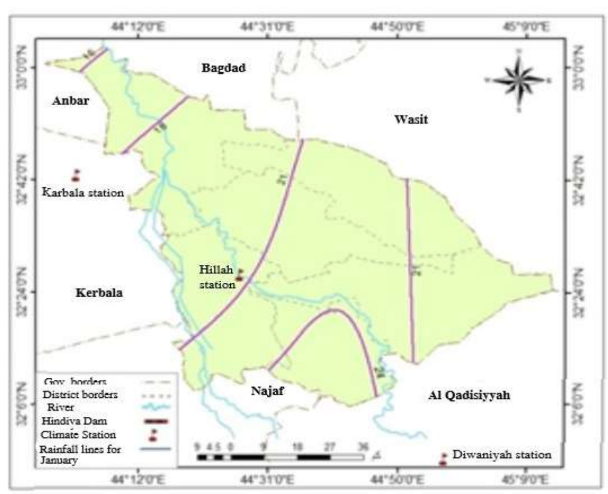
Source: *Republic of Iraq, Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.*

Map (4): Equal rain lines during Septemb



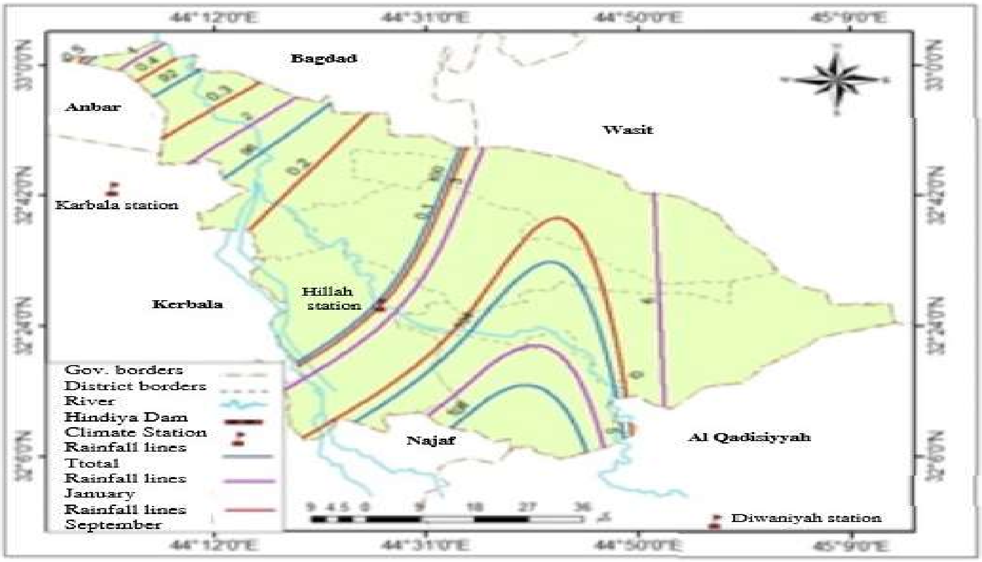
Source: Based on Table (2).

Map (3): Equal rain lines during January



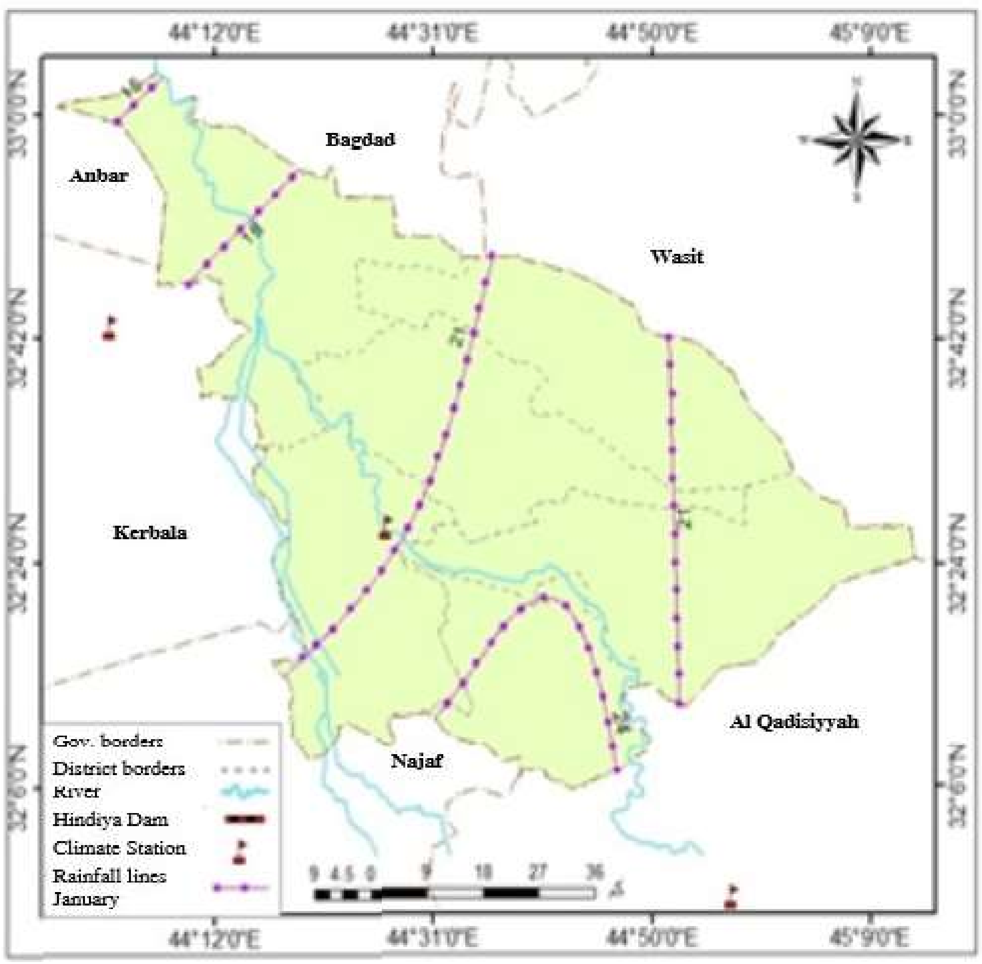
Source: Based on Table (2).

Map (5): Equal rain lines for the total rainfall in total



Source*: Based on Table (2)*

Map (6) equals rain lines during the month of January

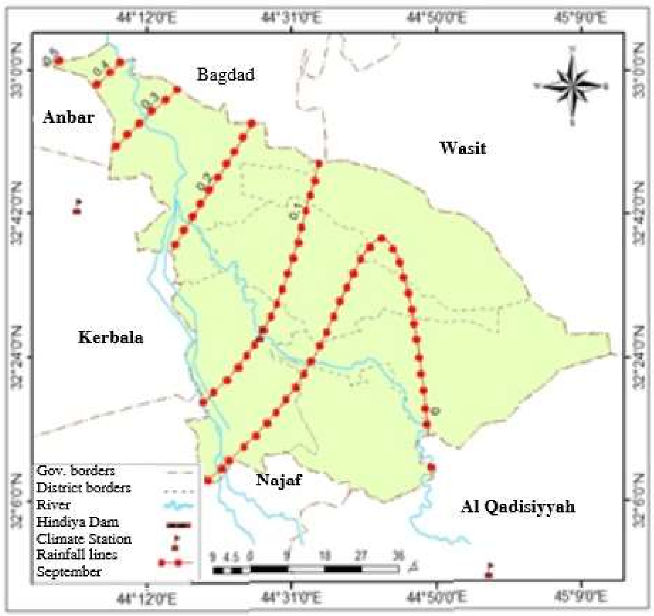


Source*: Based on Table (2*

2- Shape variable. Explanation of this variable

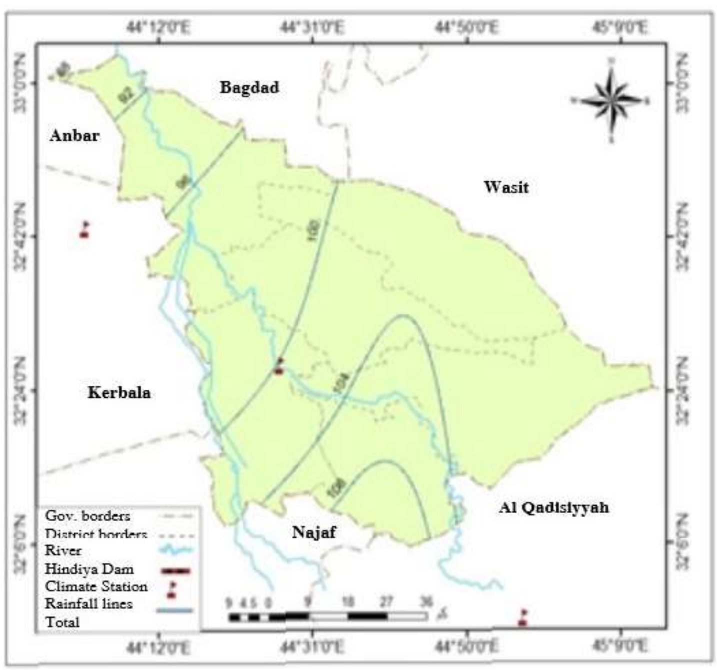
We find that map (7) is represented by the symbol (←k—) to show the amount of rain during January, which is the highest amount. As for the symbol (←k—), which shows the amount of rain in the lowest month, which is September, map (8), and as for the total average, the symbol (▶●—) was used. Map (9) and map (10) included the three previous layers to illustrate the spatial change in rain movement.

Map (7): Equal rain lines during



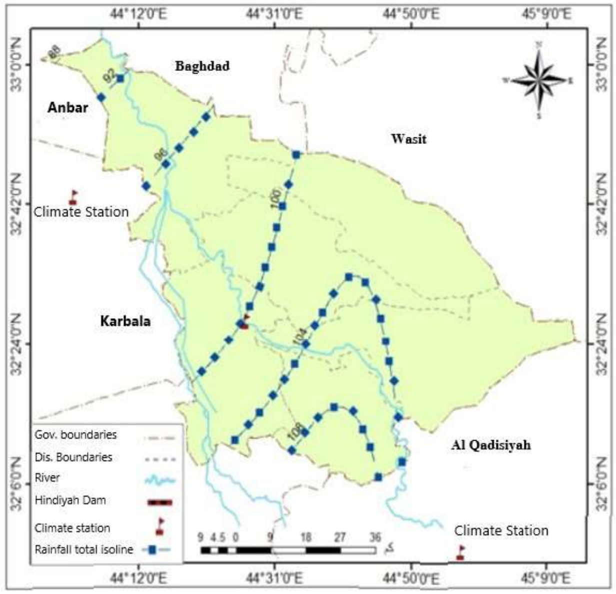
Source: Based on Table (2)

Map (8): Equal rain lines for the total rainfall in total



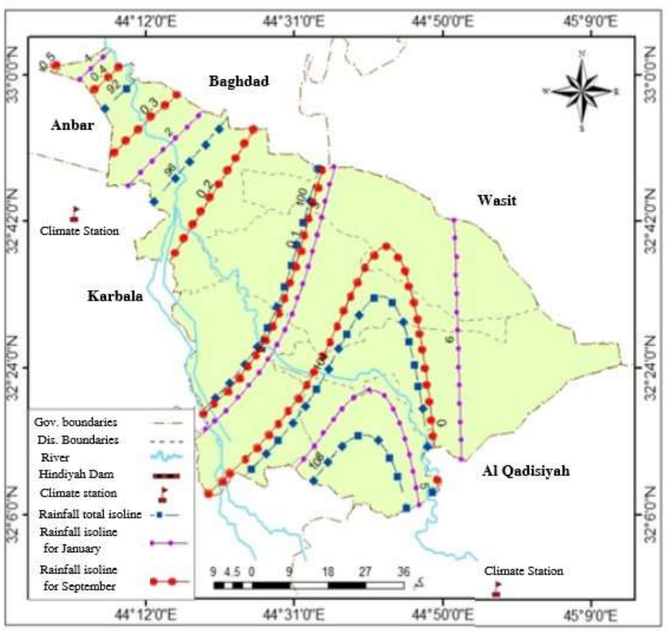
Source: *Based on Table (2)*

Map (9): Movement of spatial change, for rainfall amounts in the study area with the shape variable.



Source: *Based on Table (2)*

Map (10) Equal rain lines for the total rainfall rate for the period (2021-2023) in the study area with the shape variable.



Source: *Based on Table (2)*

3- Levels of visual perception of kinetic rain maps in the study area:

Visual perception is fundamental to the successful creation of maps. The ability of the reader to understand and interpret the map heavily relies on how well they can translate the visible data and information about the studied phenomena from the map of the human eye. Several factors influence this process, including the nature of the image that the cartographer conveys, their choice and classification symbols, the orientation of the cartographer, and the selection of colours. Additionally, perception is affected by needs, desires, and emotions (Najeeb Abdul Rahman and Hussein Mujahid Masoud, 2005).

Field tests are conducted to achieve optimal visual perception. In the current study, the researcher conducted experimental field tests on the study maps using a sample of one hundred individuals from the geographic community. Questionnaires were distributed to assess their ability to understand and perceive the maps and contents. The criteria included the speed of perception between the map creator and the reader, the completeness of map elements, psychological acceptance and clarity of the map, map effectiveness, attractiveness and aesthetics, the type of symbols and indications on the map, and the content and integration of the map with visual variables (Mohammad Ibrahim Mahmoud and Sadiq Mustafa Jassim, 2022).

Each variable accounted for 10% of the total evaluation score for the study maps, except for the criterion of the speed of perception between the map creator and the reader, which was evaluated at 20% due to its importance. This criterion was set to a maximum of 20 seconds for optimal understanding and perception of the map; any longer duration would render the map ineffective (Mohammad Ibrahim Mahmoud and Sadiq Mustafa Jassim, 2022).

Table (3) shows that the perception levels of the criteria according to the experimental test varied from one map to another. This naturally influenced the final evaluation of the study maps. The most visually perceptible map, with elevated levels of understanding and clarity, was the one represented by the colour variable. This map of the total average rainfall with the colour variable achieved the highest perception level (86.6%) because it used the conventional method of representing rainfall maps with the colour blue, closely matching the studied phenomenon. This was followed by the Isohyets map of January's average rainfall with a colour variation (of 83.5%) and the Isohyets map of September's average rainfall with a colour variable (of 80.3%).

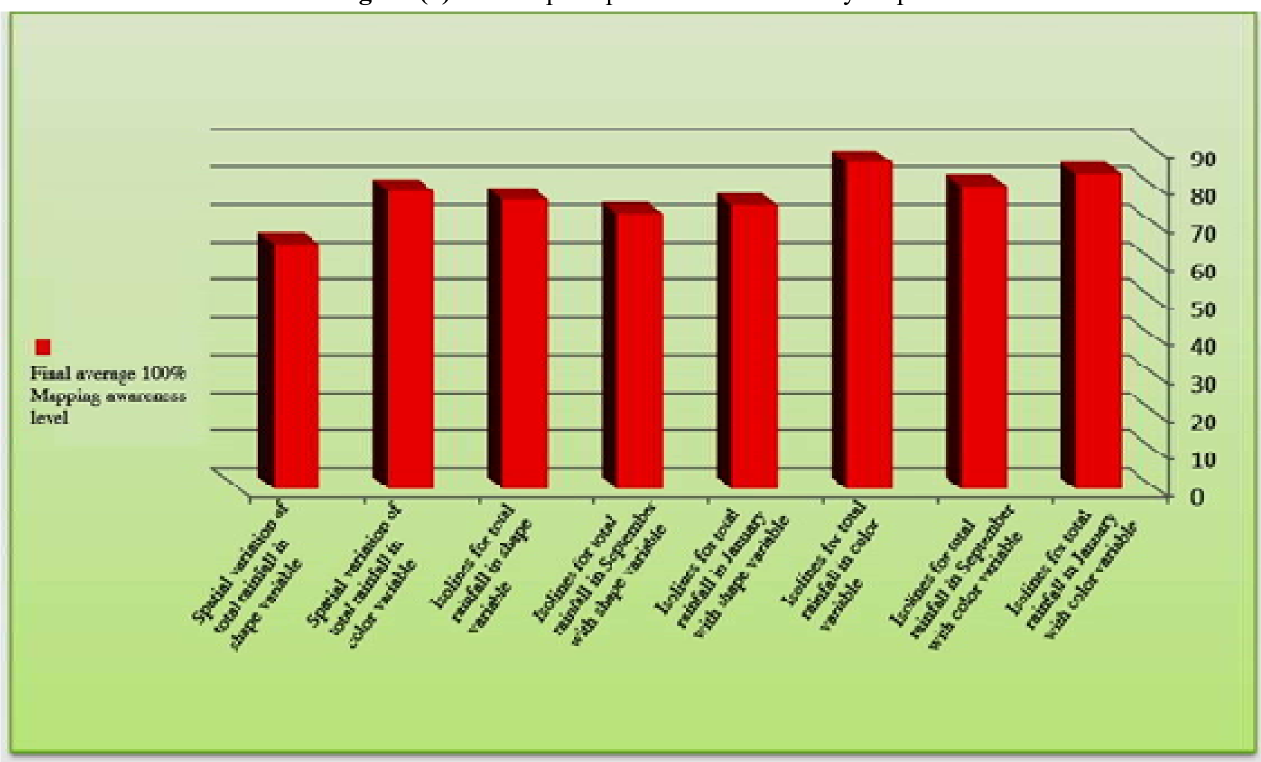
Table (3): Visual perception rates in the study maps

The final average is 100%, the level of cartographic awareness	Rate visual variables	Map content rate and integrity	Type of symbols and meanings on the map	Attractiveness and aesthetics of the map	Effective map rate	Psychological acceptance rate and clarity of the map	The rate of color matching with the phenomenon	The rate at which map elements are completed	The rate of perceptual speed between the creator of the map and its reader	Map	
83.5	7	7	8	9.5	8	9	8	8	19	Isolines, for total January rainfall rates with color variations	1
80.3	6.5	8	6	8	7.5	9.5	8.5	8.3	18	Isolines, for total September rainfall rates with color variations	2

86.6	9	7	9	9	8.6	8.5	9.5	7.5	18.5	Isolines, for total rainfall rates with color variations	3
75.3	8	8.1	7	8	7	7	6.6	8.5	15.1	Isolines, for total January rainfall rates with variable shape	4
73	7	7.9	6.4	7	7.3	8	7	7.4	15	Isolines, for the sum of rates in September with variable shape	5
76.7	8	7	7.2	7.1	7.2	7.5	7.5	8.2	17	Isolines, for total rainfall rates with variable shape	6
78.9	7.5	8	8.3	8.1	8	7.1	8.1	8.8	15	Spatial change movement of total rainfall rates with color variations	7
64.91	8	7.9	6.8	7.3	7.1	7.3	7.9	8.4	4.21	Spatial change movement of total rainfall rates with variable shape	8

Source: *Based on Appendix (1).*

Figure (3): Visual perception rates in the study maps



Source: *Based on Table (3).*

Conclusions:

1- There is a clear variation in rainfall amounts from one month to another, but in the same direction.

2- The one represented by the colour variable received the highest perception in the study, because it is a common effect of the maps that were represented by the shape variable, which received less perception.

3- The difficulty of mapping the spatial movement of rain with variable colour and shape, in order to merge the cartographic layers (January - September - total rates) with each other on a map.

Recommendations:

1- Establishing special laboratories for geographic information systems within universities to develop the capabilities and skills of students in mapping.

2- Encouraging researchers to conduct cartographic studies concerned with climate maps in general and rain maps in particular and creating an integrated climate data base on rainfall amounts.

3- Holding education and awareness seminars to increase the geographic community's ability to read the map with all its variables, colour or shape.

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