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RESEARCH ARTICLE - ATMOSPHERIC SCIENCES

Verification of the amount of Annual rainfall using satellite images and GIS analysis in Iraq

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Abstract

The amount of rainfall appreciation is considered one of the most important data that affects many aspects of development and Sustainability in Iraq. Remote sensing (RS) is the study of gathering and analyzing data remotely using sensors that are not near the thing viewed. The dataset came from the UK's Natural Environment Research Council (NERC) and the US National Centre currently provides - the Department of Energy Long-term support for Atmospheric Science with high-resolution (120) satellite images. The study area was exposed to several climatic factors that led to a large difference in amounts of rainfall. It analyzed for the large period (2011 - 2020) to extract an annual average. The northwestern regions received the most rain, while the western and southern regions received the least. The images analyzed were widely used for the Geographic Information Systems (GIS) program that served digital analysis and kriging interpolation. The number of images provides a multi-image. Each image represented a month of the year for ten years and was collected to extract the annual rainfall as a ratio for one year. The results showed that the digital analysis method displayed for rainfall, the highest value recorded (729.22 mm); the lowest value was (79.48 mm). The kriging indicator showed values close to the first method while providing data for the amounts of rain in every part of the study area. Knowledge about the uncertainties may record the applicability of these items for quantifying and proceedings these items' behavior characteristics essential to make applications simplification. Whereas the comparison between the kriging indicators with observed annual rainfall yield performed by linear equation (LQ) the value of its constant was (8.49). The GIS was a very good and efficient tool for calculating the amount of rainfall from satellite images Predicting rainfall patterns and the assessment of the amount of rainfall in the general circulation contributes to a better understanding of the ecosystem, biodiversity, and treatment of key crisis issues.

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Keywords: Rainfall, Digital analysis, GIS, Kriging, Iraq.

1. Introduction

Rainfall is one of the most challenging meteorological parameter observations due to its temporal and geographical variability. The three primary methods for measuring precipitation are satellites, radar, and rain gauges. Every strategy has benefits and drawbacks [1]. The watershed modeling approach may employ the mean annual rainfall over an area as its basis parameters, particularly for surface runoff processes, since rain is the only meteorological indicator that can account for rapidly rising flow [2]. Given their efficiency, accuracy, and time-saving nature, remote sensing and GIS have become increasingly important tools for managing natural resources [3]. It provides strong evidence for atmospheric depression in terms of fluxes, relative humidity,

geoelectric height, and relative vortex, as well as an explanation for the variable rainfall conditions over Iraq since the area is impacted by many differential patterns [4]. Geographical information systems creating an accurate and comprehensive map should include developing suitable rules, combining them with geographical data, and adaptively implementing categorization algorithms [5]. High-resolution satellite images are used to calculate climate variables and provide data for unknown areas or match them with observed data [6]. The data outputs demonstrated how Iraq's geographic position varies and influences the climate, in addition to global warming, there is a decline in the quantity of water entering Turkish and Iranian rivers and streams, less precipitation and snowfall, and a rise in population [7]. Rainfall rates are impacted by the seasonal climatic variable behavior of monthly surface air temperatures brought on by climate change [8]. Rainfall high-resolution data from satellite images were acquired from the UK's Natural Environment Research Council (NERC) and the US Department of Energy Long-term support is currently provided by the UK National Centre for Atmospheric Science (NCAS) [9]. The advantage of estimating rainfall is to utilize it instead of the portion of municipal water delivered to regions in need of it [10].

1.1 METHODOLOGY AND DATA

Iraq is a country in the Middle East) area, which is situated in the northeastern part of WANA As shown in Figuer 1. Iraq occupies 438,320 square kilometers and lies between 38 º 45’, 48 º 45’ East longitudes, and 29 º 5’ to 37 º 22' North latitudes. Of this area, 0.21% is made up of water planes, which include rivers, lagoons, and marshes [11]. The study area is one of the Middle Eastern countries most affected by climate change and has the lack of effective management of the water file based on optimal use, as there are two rivers, groundwater and lakes. natural water resources. It is also located in a water-stressed area [12]. The research aims to use high-resolution satellite images to calculate the amount of rainfall using the Geographic Information Systems program with (NERC) data. The treatment showed the spatial distribution of the areas where the amount of rain fell and showed the variation between the amounts of rain. Compared to the northern regions, the southern part of Iraq has a rainfall amount of less than 10% of the annual rainfall. The wetlands also referred to as "the marshes," have had droughts since the early 1980s. Furthermore, by the late 1990s, a large percentage of the marshes had dried up, devoid of life in the saline and parched regions, especially in areas with large bodies of water and considerable human activity [13]. The results show that, as agriculture is the main user of water, it is necessary to minimize consumption, practice appropriate water resource management, and ascertain the water requirements and water footprint of important crops [14].

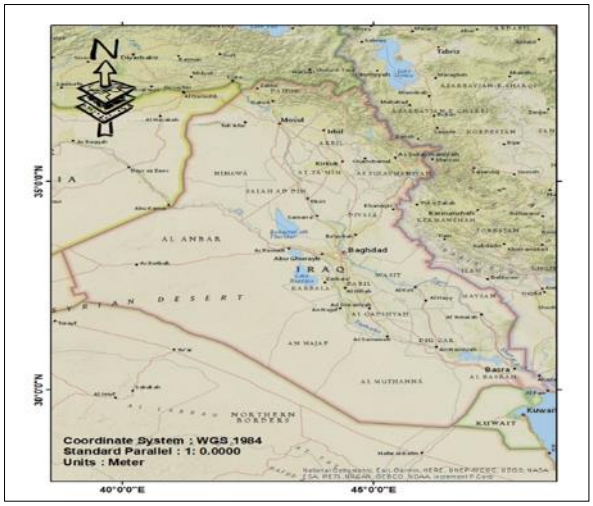

Figure 1: Iraqi Geographical Map of the Study Area.

Data obtained from (NERC) collected data for satellite images 0.5°*0.5 High-resolution 2011-2020 to analyze rainfall areas over Iraq. The 120 images merged, with each band representing one month for a

total of ten years, covering all parts of the study area. Extracting the Rester Figure 2. layer can be analyzed in two ways (digital analysis) and analysis using the (Kriging) indicator through the GIS program. The visual based on calculating the wave spectra analyzed through satellite images and targeting the spectra for calculating rain by converting the images into pixels to be dealt with a metric raster system from which the required results can be extracted[15].

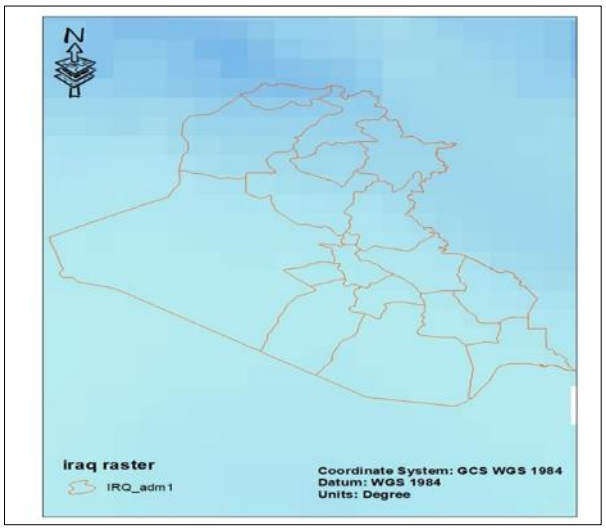

Figure 2: Map of Iraq raster shadowed.

where 10 stations were identified in a way that covers the largest possible amount of regular distribution from north to south and from east to west to make a comparison with the observed data as in Table 1.

Table 1: Location of station area.

Stations	Longitude °E	Latitude °N
1. Basrah	47.48	30.48
2. Muthauna	45.21	30.20
3. Maysan	47.16	31.85
4. Najaf	44.35	32.01
5. Kut	45.82	32.52
6. Baghdad	44.40	33.30
7. Rutbah	40.44	33.07
8. Kirkuk	44.37	35.45
9. Sulaymaniyah	45.43	35.57
10. Mosul	43.12	36.34

Kriging Interpolation

The digital analysis used in ArcGIS is an effective tool for integrating digital datasets into an accessible framework that is suitable for interactive public engagement [16]. That possible to combine images and bands and turn them into a single image or band that can manipulated and the results produced. Numerical interpolation conformed from a collection of original dataset grid values for estimating other points. An estimated surface may be obtained by overlaying the region which depends on the nature of the dataset with a grid that is organized uniformly time and spaced [17]. Relies on the distance to the anticipated location, the fitted model to the observed points, and the spatial correlations between the measured values close. The framework for the program used in the research, a Figure 3. Included to illustrate data entry, the method of processing it, and extracting the results. Cognitive network algorithms bear resemblance to the human mind in terms of their structure and functioning. They operate by transmitting, processing, and analyzing information, drawing conclusions, identifying patterns, and making predictions. We can apply some of the same principles that the human mind employs. Scientists are still uncovering additional details about neural networks and have not yet fully comprehended all aspects of their operation [18].

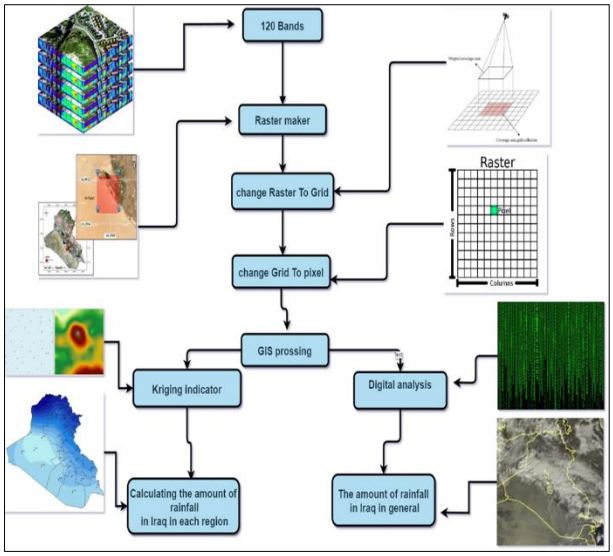

Figure 3: GIS Processing operations.

RESULTS AND DISCUSSION

Rainfall affected by the climate pattern of Iraq, as it a subtropical, dry continental climate with hot, dry summers and cold winters, with a low percentage of precipitation in the center and south of the country, and moderate precipitation in the north of the country. The GIS program used for the combined 10-year Rester-data converted into one year of rainfall, and the image (0.5 * 0.5) High-resolution system converted into pixels in Figure 4. Raster data uses a grid of cells, or pixels, to represent information. In a raster dataset, every pixel has a unique value that corresponds to a property, such as temperature, height, land cover, or any other geographical data.

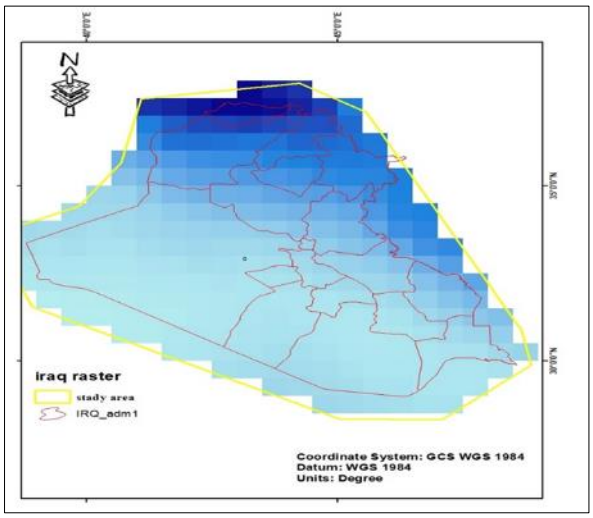

Figure 4: Mapping of Iraqi Rester converts to shadowed grade pixels.

Then work verification on converting the pixels into points to treat them as coordinates in Figure 5. According to these results the resolution of the dataset role a significant issue in easements the amount of rainfall. This vectorization-to-vector conversion method is often used in GIS for a variety of purposes. The verification procedure guarantees that the transformed vector data is trustworthy for further analysis or applications while also assisting in the preservation of data integrity.

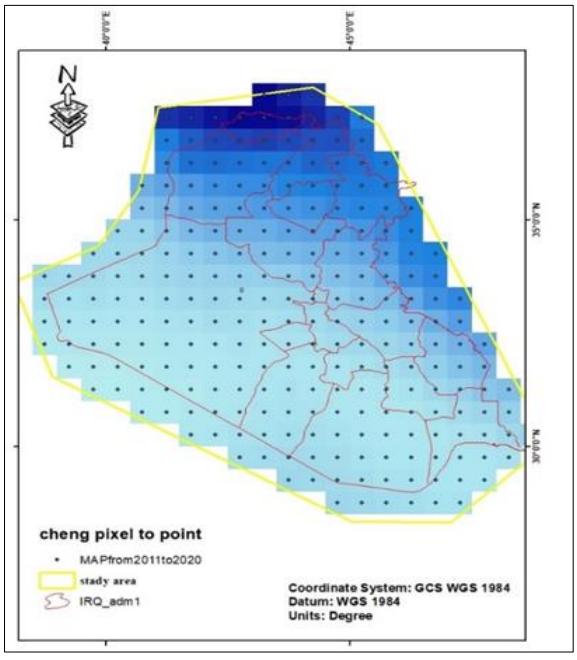

Figure 5: Mapping grids point of image pixel convert to spectral area.

The process of calculating completed after collected the amount of annual rainfall, the coordinate system converted to the metric system (UTM) to calculate the amount of rain falling in each pixel, as one pixel represents the longitude and latitude of each area present on the map in the study area, as in Figure 6. Through this procedure, was able to cover the study area, analyze the radiation spectrum, and extract the amount of rain.

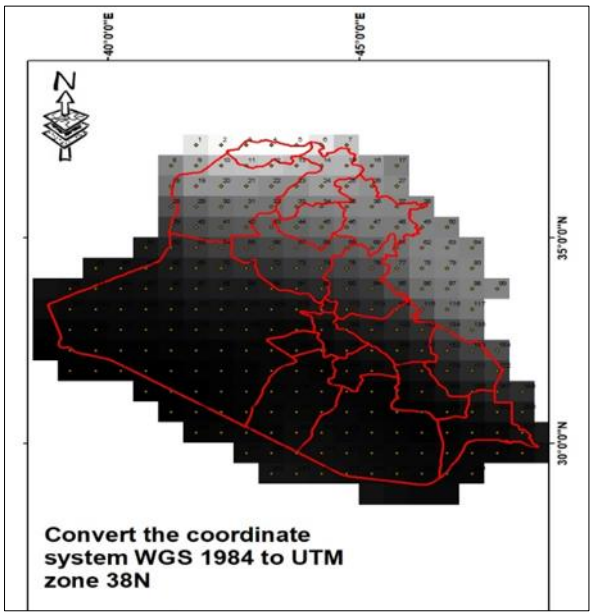

Figure 6: Coordinate system to UTM.

The data application implemented using the GIS program, which provides algorithms for processing images taken from the satellite. The first protocol was based on digital analysis, as it showed the amount of rainfall randomly and showed the highest percentage and the lowest percentage without specifying the area exposed to rainfall or its scarcity, Figure 7.

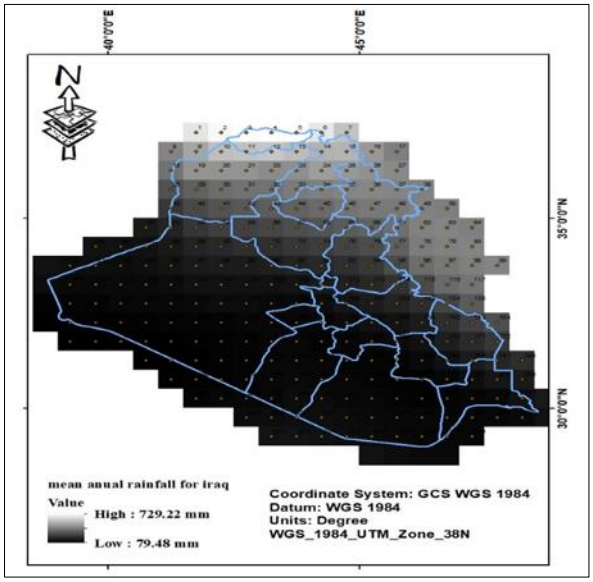

Figure 7: digital analysis of rainfall shadowed.

In addition, the second protocol shows Kriging indicator Details of the amount of precipitation shown, and each region receives a percentage in mm, in addition to specifying the isoquant lines of rain. In addition, the northern and northeastern regions receive the highest amount of rain, similar to the southern and southeastern regions, which receive the least amount of rainfall, as in Figure 8.

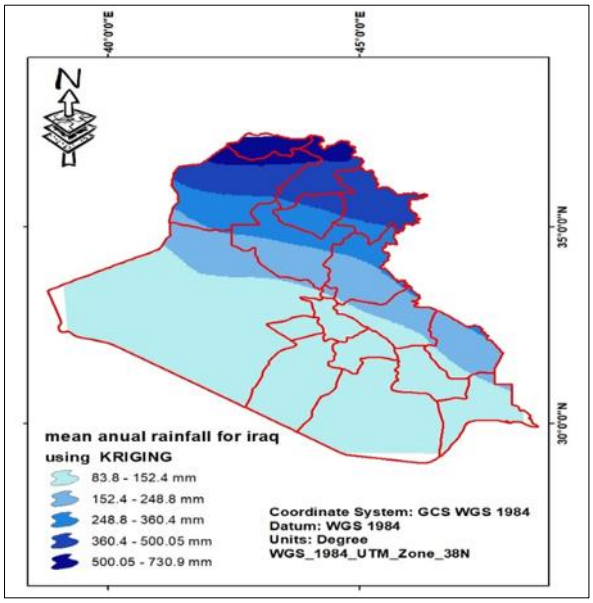

Figure 8: Mapping of Kriging interpolation for rainfall.

Satellite images were obtained from (NCAS) collected for the period from 2011-2020. They processed using a geographic information system program and extracted the average expected rainfall amounts for one year in addition to the observed data from (NASA) for the same period, to calculate the accuracy of the analysis of satellite images and compare them with reality. Table 2.

Table 2: Analysis of Stations.

Stations	NASA Observed (mm)	Kriging analysis (mm)	Digital Analysis for study areas (mm)	
1. Basrah	75.3	81.2		
2. Muthauna	45.6	55.2		
3. Maysan	159.2	164.3	Max. value	729.22
4. Najaf	85.9	99.3		
5. Kut	162.9	170.2		
6. Baghdad	142.3	153.1		
7. Rutbah	71.2	77.1		
8. Kirkuk	277.9	289.2	Min. value	79.48
9. Sulaymaniyah	356.4	366.8		
10. Mosul	313.7	318.9		

The digital analysis method showed rain amounts in general, the largest amount received by the study area was (729.22 mm) and the least amount received (79.48 mm). While the Kriging method showed the largest amount received by study, the area was (730.9 mm) and the least amount received (83.08 mm). Moreover, the distribution of rainfall amounts in every place in the study area, the results of Kriging compared with ten random observed stations in addition a linear equation (C) Figure 9. Was created between the variables, and the value of (C = 8.49). Was demonstrated, varying immediately, following a

consistent pattern, and aiming to produce the greatest outcome possible. By using satellite imagery to determine the amount of rainfall.

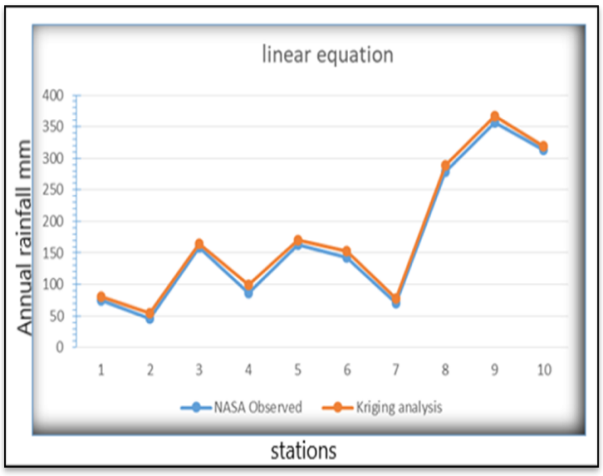

Figure 9: relation between station number and rainfall for LQ.

The analytical method using Kriging indicated that the study area divided into five regions through which each region and its quantity could calculated according to the lines of longitude and latitude. In addition, it showed that the northwestern regions receive the highest amount of rain (up to 350 mm) throughout the country. The central regions receive an amount of up to (150 mm), and the western regions receive an amount of up to (77 mm), while the southern regions have an average annual rainfall of up to (80 mm). Thus, the two analytical methods using the Geographic Information Systems program can use high-definition satellite images to calculate Rainfall amounts and their reliability in areas where Observed data is not available.

1.2 Conclusions

The study was the research region susceptible to a variety of climatic and meteorological elements including the climate change in Iraq has an impact on the quantity of rain that falls. Natural global warming in the atmosphere keeps Earth warm enough for life as well known, but greenhouse gas emissions from human activities have expanded this layer, trapping heat and causing global warming. This is accomplished by employing high-resolution satellite images (0.5°*0.5°) and processing the data using geographic information systems software. This method determines the distribution of precipitation rates by analyzing images from satellite sensors. GIS software facilitates the effective administration and analysis of this dataset, which helps us understand how rainfall is distributed in different locations. Increasing the accuracy of rainfall data is crucial to understanding the impacts of climatic components on Iraq. Since the country is believed to be vulnerable to fluctuations in both the climate and rainfall patterns. By comparing the dataset from satellite photographs with the Observed, one could evaluate the methods' quality and make the requirements corrections to improve the outcomes. This is accomplished by providing a realistic visualization through the integration of satellite imagery and their conversion into a raster application capable of information extraction and analysis. That unclear whether places required more rain than other variables since the computerized analysis method's procedure established the research area's overall rainfall distribution. While the Kriging analysis provided artificial intelligence findings the similar results, it also provided more detailed information about each region by dividing the study area into five regions, with the northern region receiving the most rain and the southern region receiving the least. Climate change-predicted - rainfall - is the goal of this study especially several

attempts to diagnose how increased the frequency of natural disasters like droughts and floods. These phenomena lead to detrimental effects on human lifestyle and health whether directly or indirectly. In order to arrive at a conclusion that is as accurate as possible, that motivated to investigate the process of ensuring annual rainfall using remote sensing techniques. The need for improved rainfall estimates at a finer scale throughout Iraq becomes critical given the light rain events in recent times.

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