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Research Article **Open Access**

Natural Ingredients in the Jimen Basin Using Remote Sensing Technology

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ABSTRACT

The scarcity of water resources constitutes a real problem facing man on an ongoing basis, especially with the exacerbation of environmental degradation and drought that affected large parts of the globe. With the increase in the number of the earth's population, the world is in need of more water sources for various activities. The study of the importance of water harvesting in its economic and environmental advantages lies in the impact on increasing and improving the productivity of agricultural crops by providing additional water at a low cost using supplementary irrigation. Remote sensing and applications of informatics systems are used to detect the best sites for the application of rainstorm water collection methods. This study aims to produce a map of the optimal sites for water harvesting methods to benefit from the water at the site of its fall without waiting for it to reach the downstream in Jimen Basin. This site is characterized by the presence of geological formations that have an important role in the application of water harvesting such as solid formations that allow the construction of dams within the basin. The study analyzed a lot of data on air temperature, solar radiation, relative humidity, evaporation, and rainfall amount. The geological formations, natural plants, and types of soil were also studied. It was found that Jimen Basin is very suitable to be used as a water harvesting basin to develop the region around the basin which is semi-arid. In conclusion, the proposed lake can help provide the possibility of establishing a residential city and also be a promising tourist site.

KEYWORDS: GIS, water harvesting, hydrology, Jimen basin.

الخلاصة

شكلت ندرة الموارد المائية مشكلة حقيقية تواجه الإنسان بشكل مستمر، خاصة مع تفاقم التدهور البيئي والجفاف الذي أصاب أجزاء كبيرة من الكرة الأرضية. مع زيادة عدد سكان الأرض، يحتاج العالم إلى المزيد من مصادر المياه لمختلف الأنشطة. تكمن دراسة أهمية حصاد المياه في مزاياها الاقتصادية والبيئية في تأثيرها على زيادة وتحسين إنتاجية المحاصيل الزراعية من خلال توفير مياه إضافية بتكلفة منخفضة باستخدام الري التكميلي. تستخدم أنظمة الاستشعار عن بعد وتطبيقات النظم المعلوماتية للكشف عن أفضل المواقع لتطبيق طرق تجميع مياه الأمطار. تهدف هذه الدراسة إلى إنتاج خريطة للمواقع المثلى لطرق حصاد المياه للاستفادة من المياه في موقع سقوطها دون انتظار وصولها إلى المصب في حوض جيمن. يتميز هذا الموقع بوجود تكوينات جيولوجية لها دور مهم في تطبيق الحصاد المائي مثل التكوينات الصلبة التي تسمح ببناء السدود داخل الحوض. حللت الدراسة الكثير من البيانات الخاصة بدرجة حرارة الهواء، والإشعاع الشمسي، والرطوبة النسبية، والتبخر، وكمية هطول الأمطار. كما تمت دراسة التكوينات الجيولوجية والنباتات الطبيعية وأنواع التربة. وجد أن حوض جيمن مناسب جدًا لاستخدامه كأحواض لتجميع المياه لتنمية المنطقة المحيطة بالحوض الشبه القاحل. وكخلاصة، يمكن ان تساعد البحيرة المقترحة في توفير امكانية انشاء مدينة سكنية وأن تكون ايضاً موقعًا سياحيًا واعدًا.

INTRODUCTION

Water harvesting study is important now to understand the relationship between the natural factors controlling the shape of the landscape and the study of morphometric characteristics that affect the hydrological variables. Through remote sensing data and applications of geographic information systems through research and detection of the best sites for the application of water harvesting methods. To understand how to collect rainstorm water that the basin is exposed, it is essential to study the environmental data and

the geological and tectonic processes of the region. The proposed water harvesting site must take into account the development of the area by studying the natural characteristics in terms of soils, analyzing water samples, and studying the natural vegetation [1]. Many studies were done on water harvesting in Iraq. One of the studies addressed the hydrological assessment of the possibility of rainwater harvesting in Al-Muthanna desert [2]. Assadi et al. 2016, analyzed the relationship of hydrological and geomorphological variables of Abadan plane and the impact of the water harvesting [3]. Rain intensity and its impact on the peak discharge of Abu Maris Basin-Iraq was studied using information systems [4]. Salar studied the urban geomorphology of Darbandikhan District using GIS and RS in the Iraqi Kurdistan Region [5]. Al-Masoudi et al., 2021 studied a designing of a rainstorm over AL-Zafran Valley Basin and modelling surface runoff using modern geographic techniques [6]. Nafeh, 2017 studied water harvesting technologies for the development of Iraqi water resources [7].

MATERIALS AND METHODS

This study aims to achieve the field investigation of the validity of the interpretation of the terrestrial phenomena and to note the interrelationship between the types of geomorphological processes and geomorphological phenomena spread in the logic of the study and linking them to the sites they occupy through several tools. Geological maps were acquired through a facilitation letter addressed to the General Authority of Geological Survey, satellite visualization. A satellite image of the Jemen Valley basin was relied on from satellite data, a GPS device to project the coordinates during the field visit, avc gis 10.8, global mappek V16, a photographic camera device to take natural pictures, the 3D digital terrestrial model (DEM) extracted from the satellite.

Study Area

The study area is considered part of the Kirkuk Governorate in Iraq, which is about 250 km to the north of the capital (35°29'48" N to 35°42'53" N - 44°25'9"E to 44°49'15"E), as shown in Figure 1.

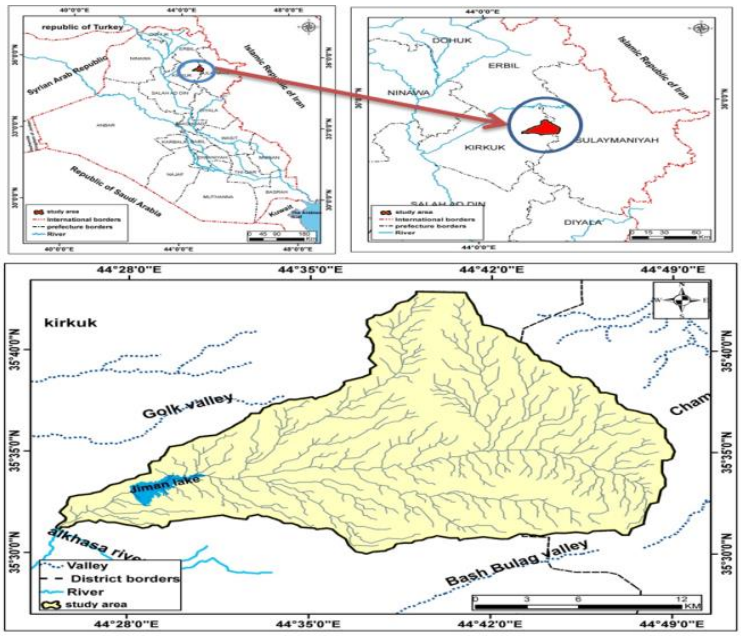

Figure 1. The location of the study area of Iraqi and the provinces.

RESULTS AND DISCUSSION

The climatic conditions are considered of the natural elements of the study area, which have direct and indirect impacts on the humans and the location of the study area in the application of water harvesting. These include the following:

1. Air temperature

The rise of air temperatures during summer months (June, July and August) affects both stations, Kirkuk and Chamchamal. The rain amounts reach 334.1 mm and 929.2 mm in Kirkuk station and Chamchamal station, respectively (See Figure 2). This rise coincides with the highest

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temperatures for the months [2]. There is a variation in the number of hours of theoretical solar irradiance between summer and winter seasons causes air temperature difference. Winter months lead to lower temperatures in both stations, and this in turn affects the structural characteristics of the rocks. Rocks is in shrinkage and expansion and the activity of geomorphological processes represented by weathering and fragmentation of the outer crust in summer and the erosion processes, especially due to rainfall during the rainy months. These places represent the best areas for water collection and utilization application of hydroponic harvesting [3].

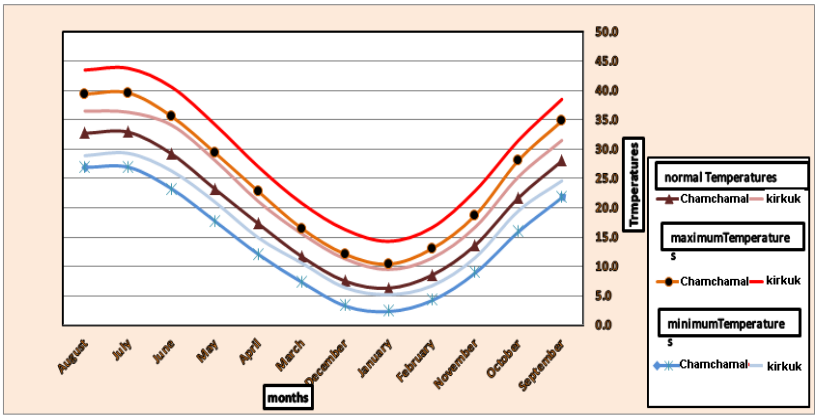

Figure 2. The monthly average of the normal temperature in the governorates of the study area for the period (1987-2019).

2. Evaporation

The effect of the role of evaporation appears through the reduction of the amount of surface water and groundwater. The intensity of evaporation varies according to the characteristics of other factors, especially the nature of the water surface and its characteristics in terms of the amount of water, soil, rock composition, and the variation in the intensity and weakness of solar radiation. It surpassed the Chamchamal station in terms of seasonal evaporation, as it reached the highest seasonal rate of evaporation in summer (796/2700.8 mm)[4][5], while the lowest rate of seasonal total of evaporation for both stations was in the winter, 203.3/125.3, respectively. Previously, the reason for the high amounts of evaporation during summer season is due to the high temperatures during the season, the increase in solar radiation, the lack of moisture rates and the length of daylight hours, which exposes the soil to drying out and disintegration and increases the chances of exposure to profitable erosion processes. All these characteristics, when interacting, increase the evaporation values for both stations during summer season. As for the decrease in the amount of evaporation during winter season, as a result of the decrease in temperature and the decrease in the amounts of solar radiation, as shown in Figure 3.

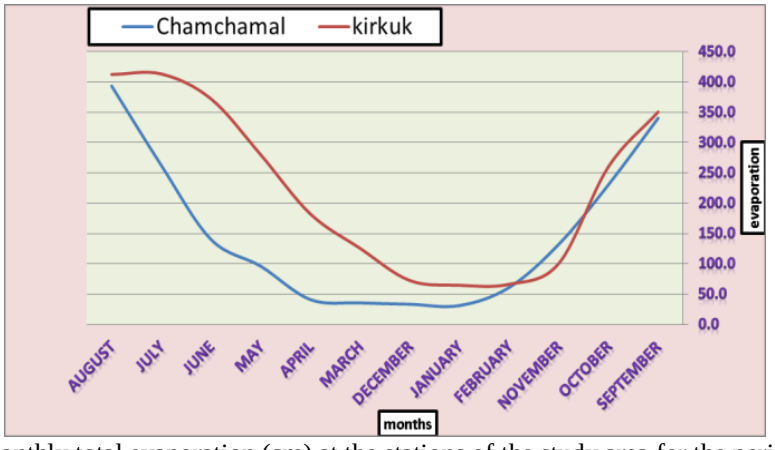

Figure 3. The monthly total evaporation (cm) at the stations of the study area for the period (1998-2021).

3. Rain intensity

Rainfall affects its characteristics (intensity, sustainability, and distribution of the rainstorm), so knowing the number of rainy days helps in knowing the amount of infiltrated water in the soil and that which is drained by surface runoff on the amount of surface runoff volume[6][7]. There is a close relationship between the intensity of the rain and the length of its fall. Therefore, a rainstorm for a short period of time does not cause surface runoff, while a storm of the same intensity and for longer periods of time leads to a large surface runoff, as shown in Figure 4. The rain intensity is considered the main source of water in the study area.

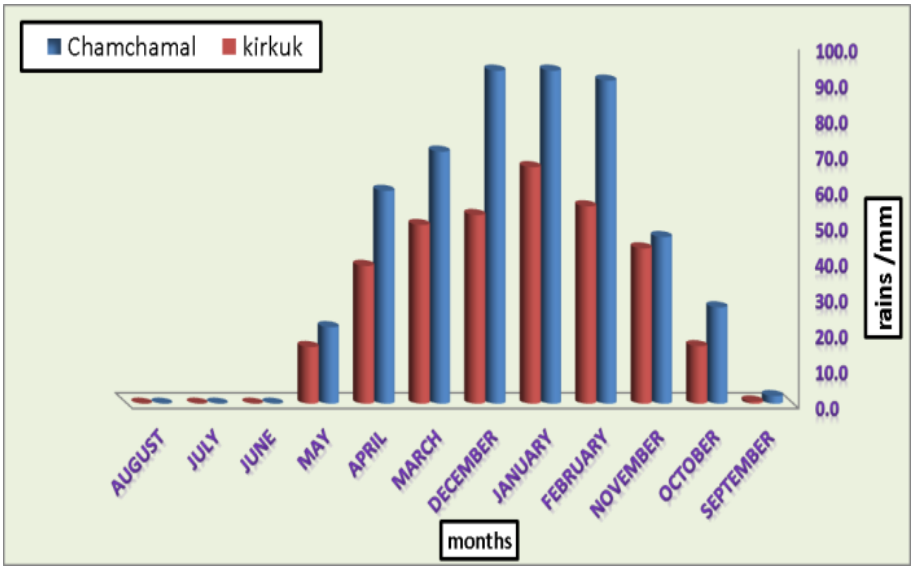

Figure 4. The average monthly total rainfall for the study stations for the period (1989-2021).

The Soil

Soil is a cohesive mixture of organic matter, minerals, gases, liquids, and organisms that together support life. The study of soil is useful in identifying the nature of soil in terms of porosity and permeability and its effect on excess water storage. The nature of the permeability of the types of soils in the (Jimen) basin, as the poorly permeable and porous soils help not to seep water into the ground, and thus help to build dams. The identification of soil types in the study area was accomplished by relying on the classification methodology proposed by the Food and Agriculture Organization. This involved mapping and referring to Table 1 and Figure 5 to determine the various soil types present in the study area.

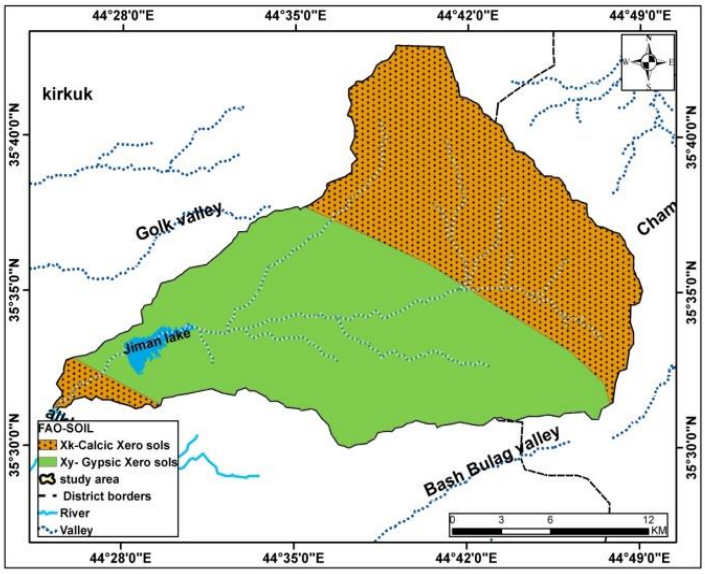

Figure 5. Soil classes according to FAO, study area.

Table 1. The soil classes according to (FAO), study area.

Soil symbol	Soil properties	The area (Km^2)	Percentage%
1. Xk-Calcic Xerosols	Stones, rocks, calcareous layers	193.4	44.0
2. Xy-Gypsic Xerosols	It is covered with Bakhtiyar stone. A layer of gypsum clusters	246.6	56.0
3. The total	_____	440	100.0

The First Class (Xk-Calcic Xerosols)

This item contains accumulations of lime, which starts at a depth of (25 cm)[8]. It is a silty soil mixed with each other and is often shallow and gravelly. The percentage of salts in it is very low, and it is classified from an environmental point of view within grasslands and is considered a suitable soil for pastures. This type prevails within the northern parts of the valleys' sources and within the southern parts at the mouths of the valleys. It occupies an area of (193.4 km) with a rate of (44%) of the total area of the study area[9]. The areas within these parts are characterized by their unfitness for the construction of dams, because they contain a high percentage of lime that is affected by the dissolution process by water erosion. However, these areas can be developed as pastures that are exploited for sheep herders, by applying the methods of water diffusion barriers, or the construction of crescent hills to retain water, and the exploitation of this water in a supplementary irrigation process and the cultivation of some grasses suitable forgrazing.

The Second Class (Xy-Gypsis Xero Sols)

It is a brown-colored soil in its surface layers, which turns into a grayish-brown color covered with pebbles. This soil is considered within the (FAO) classification of soil that is suitable for cultivation, especially for the cultivation of winter crops that depend on rainfall, such as wheat and barley(FAO,1977).This soil occupies an area of (246.6 km) with a percentage of (56%) of the total area of the study area. This type of soil occupies a large area within the central parts of the study area, especially the low-slope, non-moderate lands, which include the plain lands and the stomachs of the main valleys of the study area [10, 11].

CONCLUSIONS

It is clear from the study that there is a discrepancy in temperatures between summer and winter seasons. The evaporation during the summer months, as well as the effect of high temperature. These causes contraction and expansion of rocks and the activity of geomorphological processes represented by weathering and fragmentation of the outer crust during the summer and erosion processes, especially when heavy rains fall during the rainy months. The basin and the presence of low areas represent the best areas for collecting water and benefiting from it by applying water harvesting methods. As for the average monthly totals of evaporation during summer, it is different for both stations. The highest monthly amounts of evaporation during summer were in August in Chamchamal station (393.4 mm). In Kirkuk station, the highest rates of evaporation amounts reached during July. In Winter season, the highest monthly amounts of evaporation in Chamchamal Station occur in December (60.9 mm). Evaporation is the result of high temperatures during summer because of high solar radiation, low levels of relative humidity and length of daylight hours. The increase of evaporation values for both stations occurs during Summer season and the decrease occurs evaporation during winter season as a result of low temperatures, low amounts of solar radiation, and high amounts of relative humidity. The latter leads to an increase in precipitation resulting from cloudy skies. The average annual total rainfall was recorded in both stations (Chemchamal - Kirkuk) (502.3, 337.7 mm) for each of them, respectively. As it is clear from the same table that the average monthly rainfall totals for both stations are spatially and temporally varying, as it recorded the highest average of its monthly totals during winter season at Chamchamal station in January and February to (92.9 mm), then it decreased relatively in December (90.1 mm). As for the monthly totals during the spring season for both stations (Chamchamal- Kirkuk), the highest levels were recorded in March for both stations (70.3 mm, 49.8 mm), respectively. While the lowest monthly totals for the same season for both stations were in May, as they were recorded (21.3, 15.8 mm), respectively. As for the seasonal rain totals, the

highest average of the totals for both stations (Chemchamal-Kirkuk) was recorded during the winter season by (275.8, 173.6 mm), respectively.

It is clear from the foregoing that winter season is exposed to an increase in precipitation, and this coincides with the arrival of the depressions in the Mediterranean that cause rain. As for the surface runoff, it starts from November in the autumn season. This is because the rains of the September and October have been depleted by the saturation of the dry soil at the bottoms of the waterways. This corresponds to an increase in the volume of surface runoff during the rainy season starting from November, and then the values rise and reach their peak in the winter season. The surface runoff continues during spring season, but it is lower in its level in the winter season. It is clear that the northern central parts of the basin are covered by soils with little leakage represented by group (D.C) that allow the emergence of surface runoff. However, category (B) is concentrated in the southern parts within the mouth of the upper basin, which also has little leakage, which increases the ability to apply water harvesting methods within large pelvis.

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Disclosure and Conflict of Interest: The authors declare that they have no conflicts of interest.

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