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| RESEARCH ARTICLE

Investigation of the Water Basins of Kalafgan District with GIS Analysis

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| ABSTRACT

The rapid and unpredictable growth of the population, the development of cultivation, and the lack of surface and underground water management have caused problems in the irrigation and hydrological system in Kalafgan city. In this region, the lack of sufficient water diversion dams and the canalization system, at the same time as the rapid development of cultivation and agriculture, have caused problems for the residents of this city. To solve the water shortage, there is a need to increase the number of water diversion dams, manage surface water, and determine and identify water sources and drainage patterns. Determining and stabilizing the location construction of suitable dams and channels in the regional study is determined by using a geographic information system. One of the effective sciences in the field of earth and environmental science studies is the use of geographic information systems, which is very useful in the accurate estimation of hydrometric parameters of watersheds. In this research, as an example of hydrometric studies of the water basins of Kalafgan city in the geographic information system, the digital elevation model (DEM) has been used with the help of geographic information system software for the studied basin.

| KEYWORDS

Geographic Information System, Hydrology, Water Basins, Water Streams

| ARTICLE INFORMATION

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1. Introduction

The growth of population in Asian countries has increased compared to all continents. As such situations continue, humans are facing serious problems due to a lack of water for agriculture and drinking. With the increase in population and the extent of agriculture in the world, especially in Afghanistan, the decrease and shortage of water are considered huge problems. To solve this problem, a better water resources management system should be designed for development and efficiency in order to provide better service. Of course, this problem is considered in advanced and developed countries, but in some countries, it is not considered due to political and economic problems. So, one of the most important water resources management systems is surveying and collecting surface water(Borges et al., 2014).

Afghanistan is a country with arid and semi-arid weather, cold winters and hot summers. Afghanistan is a mountainous and landlocked country located in the heart of Asia; Afghanistan is an agricultural country where eighty percent of the nation is engaged in agriculture and farming.

Agriculture is impossible without water. Plant cultivation in this country is wet and dry, but most of the wet cultivation takes place in the northern provinces of Afghanistan. In the last few decades, surface water resources in many parts of the world, especially in arid and semi-arid regions, are facing a serious decline. Therefore, in this case, to use management solutions for surface water is considered an important task. In the present research, geographical information system software was used to investigate the water flows of Kalafgan city. One of the advantages of using GIS software is the ability to detect and estimate water flows remotely by interpreting field photos. Kalafgan city is located about 50 km from Taluqan city, Takhar province. It is the capital of Takhar province, and it is also the border between Badakhshan and Takhar provinces(Ahmad, 2018).

Problem Statement: Afghanistan is a country that has been involved in political, social, and economic problems for many years, and less attention has been paid to the field of infrastructure. On the other hand, due to the population density and the development of agriculture, this country is facing water shortage problems, including the city of KALAFGAN, which is an agricultural area that is facing problems of water shortage due to the lack of sea and lakes. The purpose of this research is to determine and identify the water flows of the city and to prevent the loss of water that is caused by the melting of snow from the mountains of Takht Suleiman and Cheshmesar, located in the valley of This mountain and the construction of dams for the accumulation of these waters using the geographic information system.

The Importance and Necessity of Research: Water is a vital and decisive substance in human life; all living beings, such as humans, animals and plants, are directly dependent on it; water is not only for drinking and daily work but also plays the main and major role for solving the problems of industries and agricultural applications.

Lack of water in the city of Kalafgan, especially on the farm, has become one of the basic problems of this society, which requires the investigation and management of water and the creation of water dams. Geographic information system software was used to manage this research properly.

Research Purposes: The general goals of this research are to prepare the topography, show the direction of water flows, determine the snow catchment areas, and get the water volume of Kalafgan city in different valleys where each valley contains a village. Discovering suitable water locations that will provide the possibility of creating engineering facilities considering the condition of land charges such as bridges, culverts and power dams for the people of this city.

Hypotheses: This research seeks to answer the following hypotheses:

1. doing this research will solve the problem of water shortage in Kalafgan city.
2. It is effective to use geographic information systems to manage existing waters and identify other sources.
3. Interpretation and analysis of field photos using a geographic information system will control the cost of field surveys.

2. Literature Review

Hydrology, which is sometimes called the Science of studying water, in the broadest sense of the word, is the science of water. It means the science that discusses the origin, characteristics and distribution of water in nature, But practically, the term hydrology refers to a branch of physical geography that examines the circulation of water in nature(Peng et al., 2013).

Based on the definition chosen by the American Government Association of Science and Technology, hydrology is the science of studying water on the earth and discusses the origin, circulation and distribution of water in nature, the physical and chemical properties of water, the reactions of water in the environment and its relationship with living organisms(Reis et al., 2015). Water distribution is on the surface of the earth, but at the same time, part of the water cycle in nature takes place below the surface of the earth, of which underground water resources are considered as one of its components. Of course, what is called underground water should not be considered the same as subsurface water. Although both water bodies are located under the surface layers, there is a general difference between them since they have different uses and are actually studied by separate experts. In fact, subsurface water is referred to as water that is located under the surface layer of the earth, but underground water is only that part of the water that exists underground and can move freely due to the force of gravity in pores or seams and cracks, so Groundwater can only exist in the saturated parts of the subsurface layers(Williams et al., 2013). Now, according to the definition, subsurface water refers to all water that is placed inside the earth's crust in any way. The study of the physical, chemical, movement, distribution and exchange of underground water with air and surface water, as well as its economic and social aspects, is in the realm of underground water hydrology or hydrogeology(Huang, 2018).

Water resources are water roots that are useful or have the capacity to be useful for humans. Water consumption includes agricultural, industrial and environmental activities. 96.6% of all water on the earth or ground is salty, and the remaining 4% is fresh water. More than 2.3 of fresh water is located in natural glaciers and the north and south poles of the earth (Intelligence & Neuroscience, 2023).

Water flowing in rivers, lakes and wetlands is called surface water. It is supplied naturally through precipitation (snow and rain), and by entering the seas, evaporation or deep penetration into the underground water table, it is removed from the access cycle (Intelligence & Neuroscience, 2023). Fresh water that exists in the pores of soil and rocks is called underground water. Also, the water that is in the water layers (underground water tables) below the water table is also included (Kannan et al., 2018). Oceanic watersheds consist of rivers, lakes, and other catchment areas that eventually drain into the ocean. Almost half of the globe is drained by the Atlantic basin.

Determining the course of waterflows in watersheds is of special importance in the raster data for determining the course of surface water flow (Liu et al., 2015). In general, one of the major problems in using the waterflows networks of topographical maps is their complete mismatch with the water flow direction maps (Nigatu, Dick, & Tveite, 2014). In such a situation, the use of such maps will stop the process of determining the flow of water and will cause the project to face problems.

3. Methodology

In order to investigate and analyze the area to be researched using the geographic information system for the hydrology of the researched area, in the first step, the elevation model (DEM) of Afghanistan was imported into the geographical information system; since the imported DEM is from all the provinces of the country, in order to separate the DEM of the present research with District Ship File Boundary help was done. After entering the Ship file boundary of Kalafgan city, it was selected and converted into graphics. After specifying the studied area, enter the Spatial Analyst Tools option from the ARC Toolbox section, select the Hydrology option, and using the sub options of this option, the water flows are corrected in terms of heights, and the Flow Direction is determined. Also, large areas were identified using FLOW ACCUMULATION, and a 3D model was also drawn for better recognition.

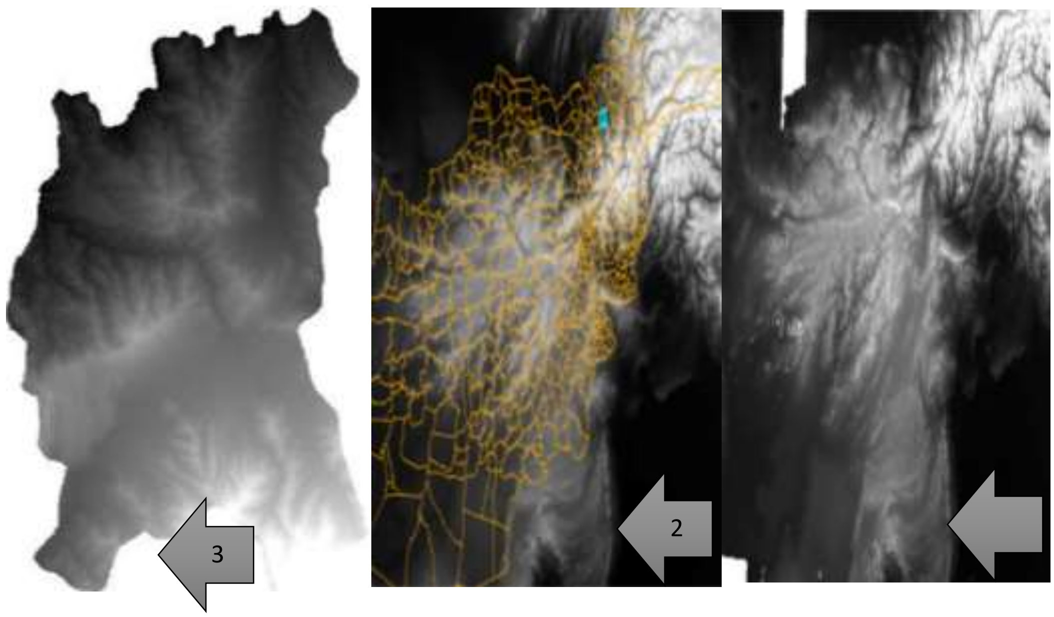


Figure 1: DEM, defining the scope of research and graphic design

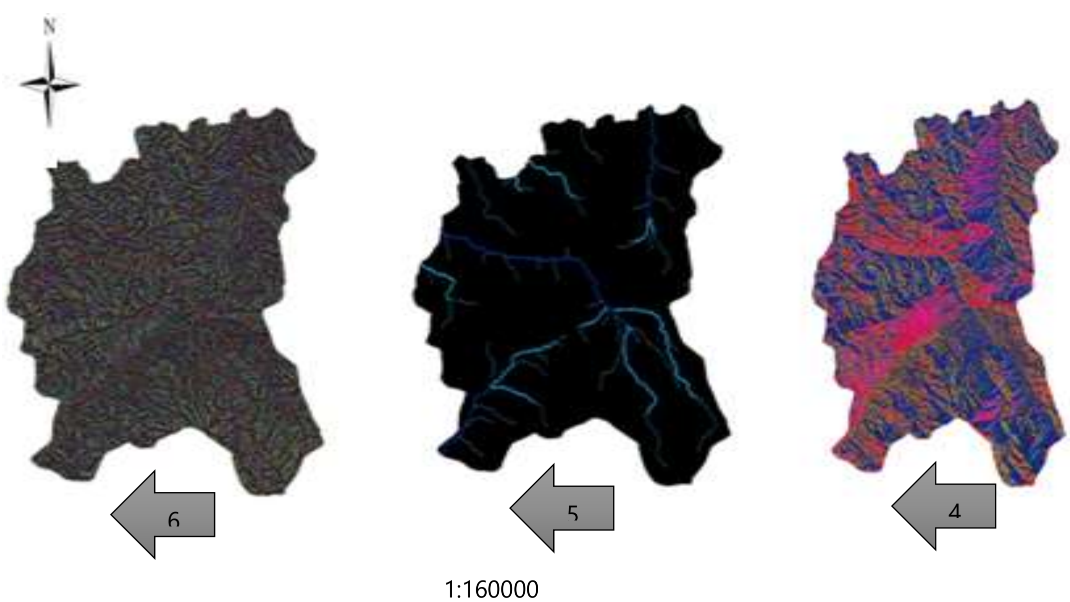


Figure 2: Determination of water flows in general, large and small

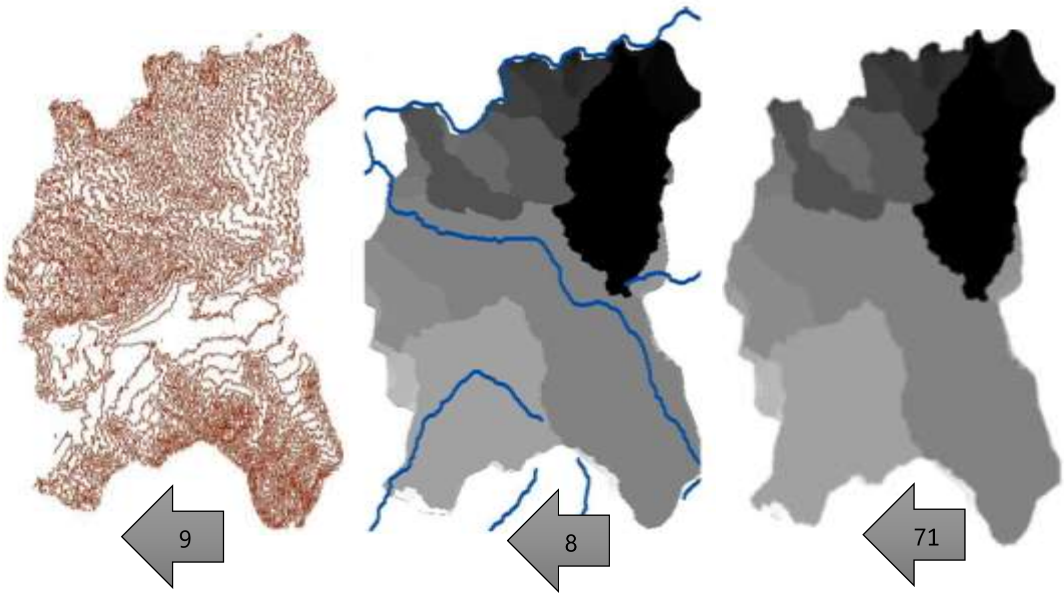


Figure 3: Display of basins with water flows, basins with topography of the research area

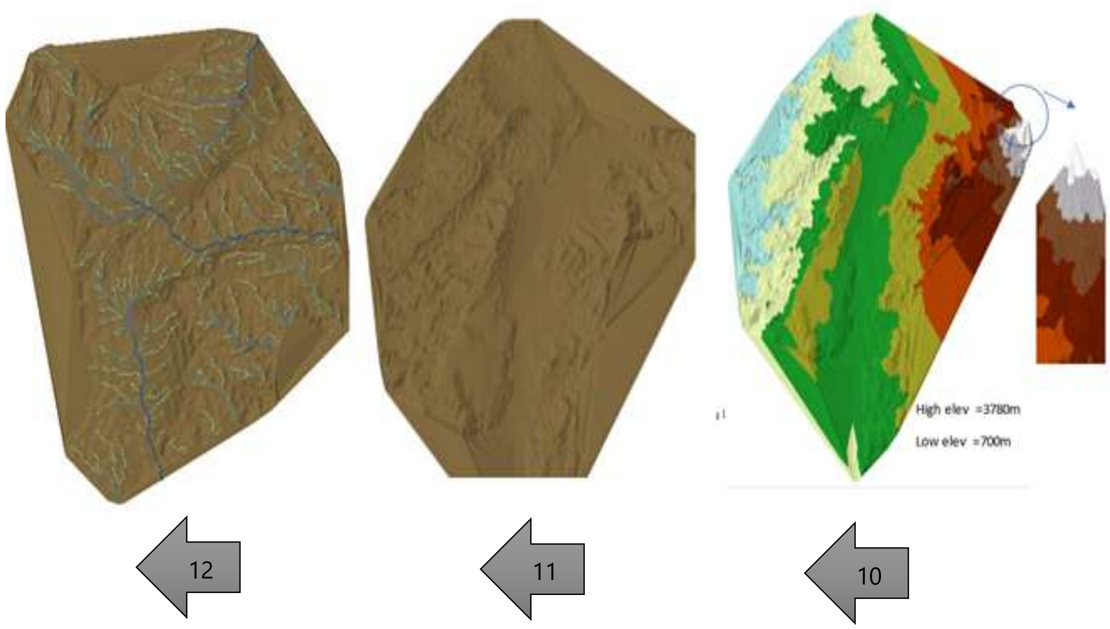
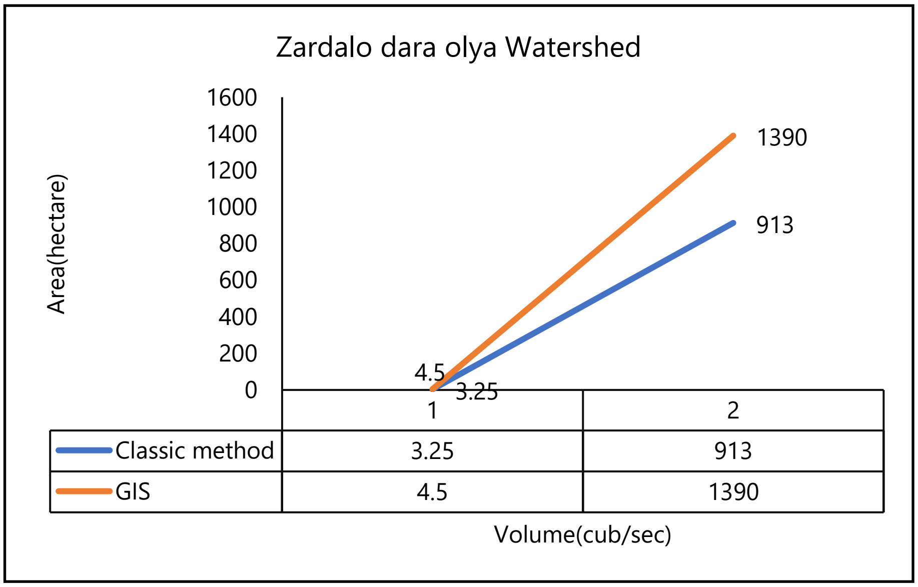


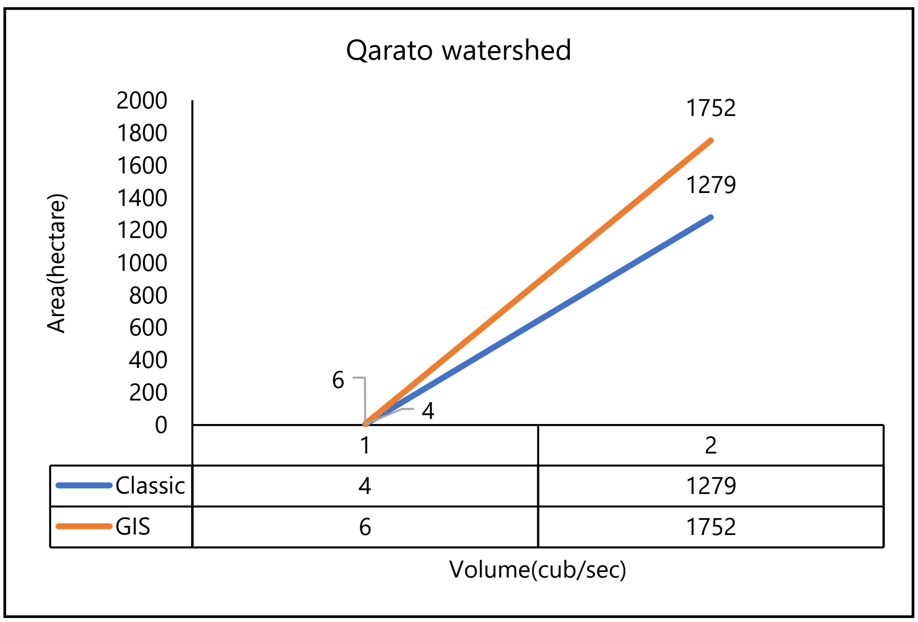
Figure 4: 3D field, 3D models of natural state, display of water flows on 3D model

Zardalo dara olya Watershed: In the traditional survey, the average amount of water in these watersheds is about (2.5-4) cubic meters per second, and it irrigates about 913 hectares of agricultural and horticultural land. The capacity of Zardalo-Dara watershed is 4.5 cubic meters per second, and it irrigates an area of 1390 hectares of land.



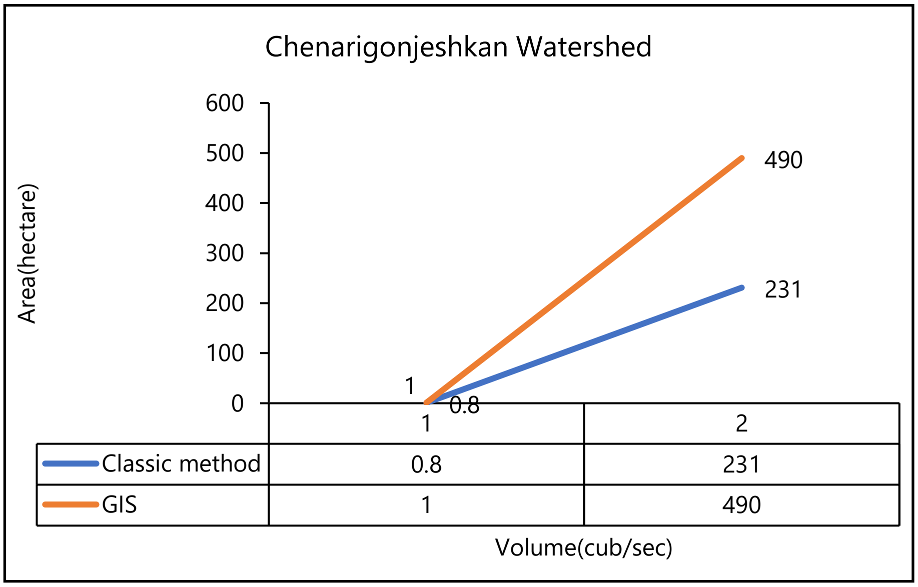
Graph1. Zardalo dara olya Watershed

Qarato watershed: The water capacity of this watershed in the classic survey was about (3-5) cubic meters per second, and it irrigates approximately 1279 hectares of land, but in the present survey, using the geographic information system, it was observed that the capacity of Qarato watershed is 6 cubic meters per second and irrigates 1752 hectares of land.



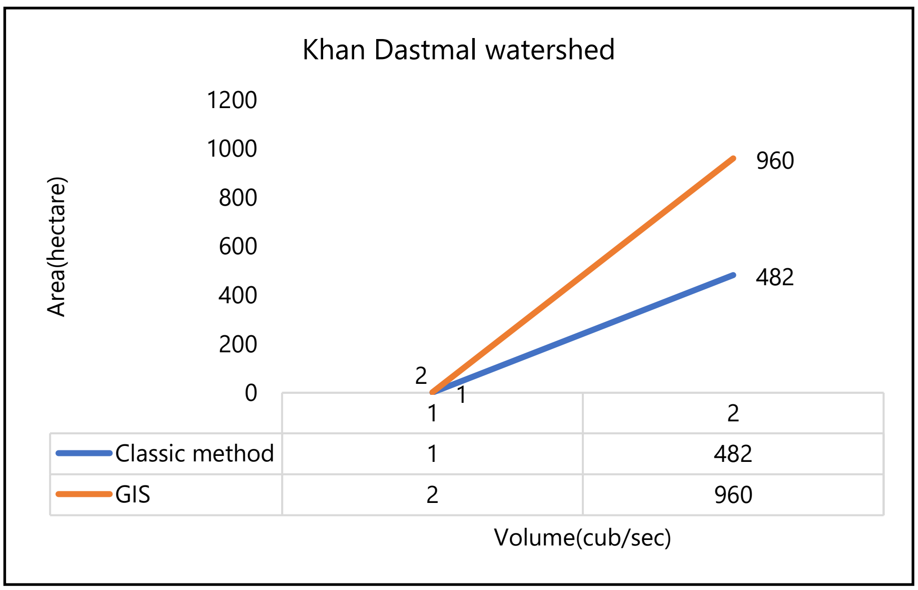
Graph 2. Qarato watershed

Chenarigonjeshkan Watershed: the water volume of this watershed is about 0.8 cubic meters per second in the oldmeasurement method, and it irrigates about 231 hectares of land. In the present study, using the geographic information system, it was observed that the water capacity of Chenarigonjeshgan is one cubic meter per second, and it irrigates an area of 490 hectares of land.



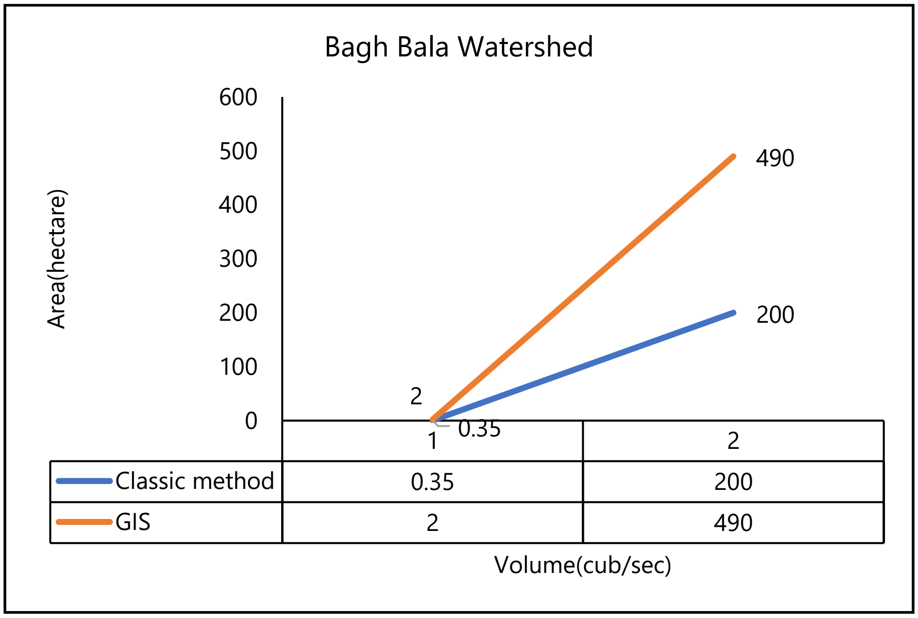
Graph 3. Chenarigonjeshkan Watershed

Khan Dastmal watershed: The amount of water in this watershed is about one cubic meter per second in the traditional way, and it irrigates an area of about 482 hectares of agricultural land. In the present study, using the geographic information system, it was observed that the capacity of the Khan Dasmal watershed is 2 cubic meters per second, and it irrigates an area of 960 hectares.



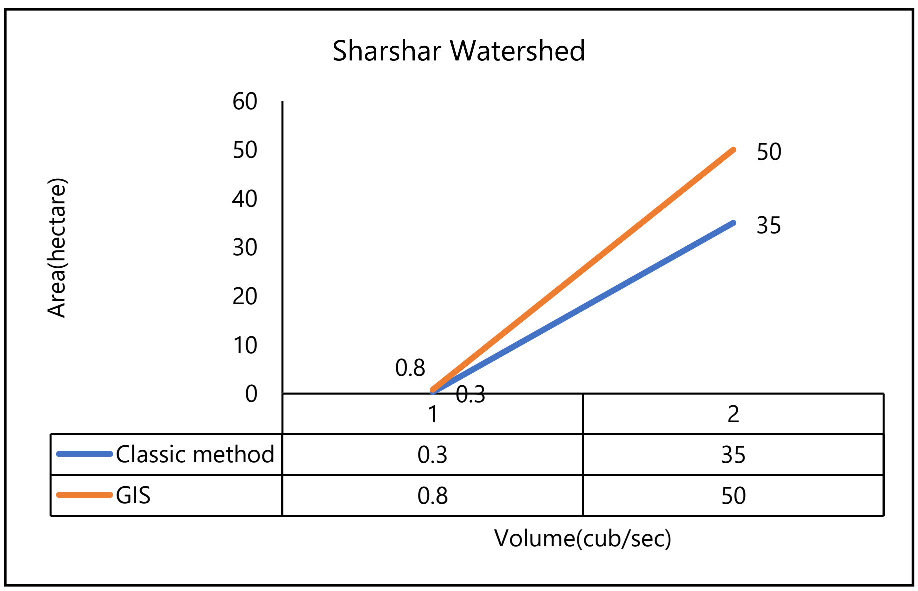
Graph 4. Khan Dastmal watershed

Bagh Bala Watershed: The water volume of this watershed is about 0.2 to 0.5 cubic meters per second, and 200 acres of land is irrigated from it. In the present study, using the geographic information system, it was observed that the water capacity of Bagh Bala is 2 cubic meters per second, and it irrigates an area of 490 hectares of land.



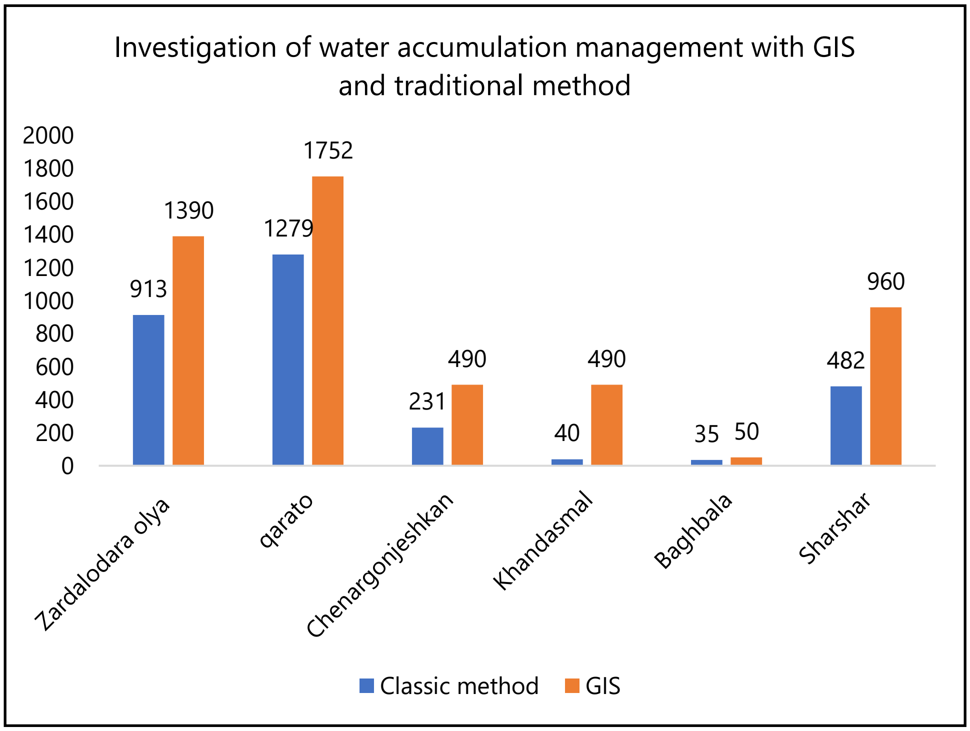
Graph 5. Bagh Bala Watershed

Sharshar Watershed: The amount of water in this watershed is 0.3 cubic meters per second, measured using the old measurement method, and it has irrigated an area of 35 hectares of land. In the present study, it was observed using a geographic information system that the capacity of the Shar Shar watershed is 0.8 cubic meters per second, and it irrigates an area of 50 hectares of land.



Graph 6. Sharshar Watershed

The findings of the research show that the method of receiving water flows and the amount of irrigation have significant changes compared to the traditional method and provide satisfactory results.



Graph7: General findings of the research

4. Results and Discussion

In the research conducted, the investigation of water basins based on the traditional method and through a geographic information system, it was concluded that Kalafgan has six water basins, and the water volume of each water basin of this district and the area covered by this water were determined by Directorate of Marine Affairs. It was investigated that the water basin of Dara Zard olya has four cubic meters of water and irrigates an area of 913 hectares of land, but this investigation that was done by the geographic information system is 4.5 cubic meters, and it covers an area of It irrigates 913 hectares of land, and other water basins have been irrigated with a significant difference, in the total water volume of these six water basins checked by the Directorate of the marine Affairs, they have 12 cubic meters of water and cover an area of 2,980 hectares of land but these six water basins that were investigated by the geographic information system have 15.3 cubic meters of water and irrigate an area of 5132 hectares of land. The result of the research showed that management with modern methods, such as geographic information system software, is extremely accurate compared to traditional methods and causes low-cost consumption in a short period of time.

5. Conclusion

Afghanistan is a landlocked country and faces water problems in different places. On the other hand, agriculture needs surface water management, which has not been done for many years due to a lack of security.

In this research, the amount of irrigation in the watershed of Kalafgan district of Takhar province was investigated with modern methods and with the help of geographic information system software, which includes Zardalo Dara Olia, QaraTo, Chanar Ganjshkan, Bagh Bala, Sharshar and Khan Destmal watersheds. The purpose of this study is to compare the traditional method with the Geographic Information System method and determine the actual size of the area; it was observed that the geographic information system method has high accuracy compared to the traditional method, which is 2980 hectares with the traditional method and 5132 with the geographic information system method. A hectare of land is irrigated, and it shows significant changes of about 2152 lands, so it is recommended that the management of water areas in different parts of the country be done with the most modern methods and updated software such as geographic information systems.

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