

Effects of Illegal Wells on Groundwater Level in the Central Sub-basin, Erbil Basin, Erbil, Kurdistan Region-Iraq

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Abstract

Groundwater is the basis for socioeconomic stability in the Kurdistan region of Iraq because it is the main source of water there. Locals depend on groundwater for almost all their needs. For example, people rely on this water for irrigation, domestic, and industrial purposes. The groundwater is extracted by drilling wells into the aquifers spread throughout the Kurdistan Region. The region is made up of four provinces, including the Erbil Province. This study examines the Erbil Basin, which is the province's significant basin. The Erbil Basin is itself divided into three sub-basins; the Northern (Kapran) sub-basin, the Southern (Bashtapa) sub-basin, and the Central sub-basin. This study is based on data drawn from the Ministry of Agriculture and Water Resources and seeks to determine the legality of wells located in the Central sub-basin and to examine their impact on groundwater degradation. The total number of water wells in the Central sub-basin is much higher than its legally permitted number of wells. Previous research has shown that the Central sub-basin's water table has suffered the most degradation. As a result, people in this area are facing very serious problems because of water shortage, and many wells have dried up in this sub-basin. These results are related to the highest number of illegal wells being located within this sub-basin. The findings of the present research, depending on the well data provided by the Ministry of Agriculture and Water Resources, indicated that in the Central sub-basin out of the 803 wells provided by the Ministry of Agriculture and Water Resources the author could only use 650 wells because the rest of the wells had wrong coordinates and the author had to discard them. In fact, the number of wells in the Central sub-basin is much more than the wells provided in the data set, but most of the illegal wells are not recorded in the data base. Out of the 650 wells that the author used to conduct this research; 46.6% (303 wells) were found to be illegal.

Key words: Erbil Basin; Central sub-basin; legality of the wells; Groundwater.

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1. Introduction

Groundwater is a vitally important element of the Erbil Province of the Kurdistan region of Iraq. The Erbil Province is one of the most important agricultural regions in Iraq. Groundwater is an important resource for socioeconomic sustainability and stability because it is the main water resource for agriculture, domestic production, industry, etc. Furthermore, the study area lies beneath mostly cultivated lands where groundwater is the main resource used for irrigation purposes. This research specifically examines the Central sub-basin in the Erbil Basin. The Erbil Basin is the most significant basin in the Erbil Province. The depth of this basin is approximately 800 meters and covers an area of 3,200 km² [1]. It is divided into three sub-basins; the Northern (Kapran) sub-basin (915 km²), the Central sub-basin (1400 km²), and the Southern (Bashtapa) sub-basin (885 km²) (Figure 1). These sub-basins are distinguished by the hydrogeological characteristics of the area [2]. The Central sub-basin was selected for this research because it is larger than the other two sub-basins. In addition, most cultivated lands of the Erbil Province lie above this sub-basin. It also has the highest number of wells, both legal and illegal. Furthermore, according to the Kurdistan Region Ministry of Agriculture and Water Resources, the water table has sharply decreased in the area, and a number of wells have dried up in the last decade. Due to the very rapid urbanization and economic growth in the Kurdistan Region, water management is necessary to protect aquifers in the area [3]. In fact, most of the wells drilled in the Erbil Basin face challenges in terms of their legality. The fundamental issues regarding water resources management in the Kurdistan Region are that rules and regulations for drilling water wells are neither well developed nor well implemented, thus leading to enormous failure in terms of groundwater management. The main aims of this paper are to determine the legality of the wells in the Central sub-basin and to examine whether the sharp decrease in the water table is related to the high number of wells.

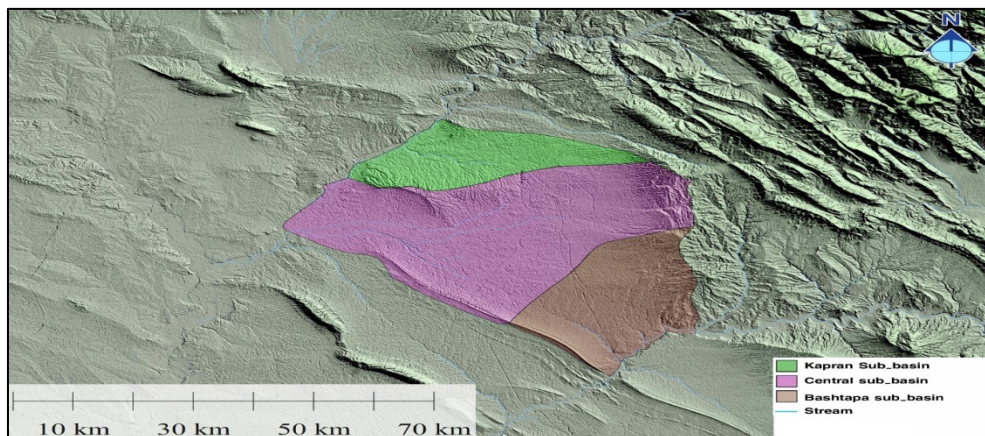


Figure 1: Erbil Basin map with the sub-basins labeled. Modified from [4]

2. Geology and hydrogeology of the study area

The Erbil Basin is a part of the Erbil Plain, which is located in the Low Folded Zone of Northern Iraq [5]. According to the author in [6], this zone is a tectonic unit with limited tectonic activities. The Erbil Basin is located in the syncline formed by the two main anticlines, the Permian Dagh anticline in the north-east (NE) and

the Kirkuk anticlinal structure in the south-west (SW) [7]. The Erbil Basin is surrounded by two water bodies. From the north it is surrounded by the Greater Zab and from the south by the Lesser Zab. The water flow in the Erbil Basin is from NE to SW. Water flows towards the Greater Zab River in a north-northwest direction or towards the Lesser Zab River in a south-southeast direction [8,9]. The area in the Erbil Basin region is characterized by variable water table levels over very short distances. This is due to the fact that the Erbil Basin is topographically variable; this variability impacts the water table's depth [10]. The study area is composed of Alluvium, Mukdadiya and Bai Hassan Bakhtiary Formations. The Bai Hassan Bakhtiary Formation is among the main formations in this area. It is composed of gravel, sand, clay, and conglomerate strata. Furthermore, the Mukdadiya Formation consists of thin beds of gravel, sand, or conglomerate. Alluvium is also very common in the study area, and the composition of Alluvium aquifers is similar to Bai Hassan Bakhtiary formations. However, in the Alluvium aquifers there is silt between the other layers instead of multiple clay layers [11].

3. Data processing and analysis

A data set for water wells from 2008 to 2015 was obtained from the Kurdistan Region Ministry of Agriculture and Water Resources. This data set was presented as including only legally established wells. However, review of this data shows that 6.2% of the wells are identified as illegal. Several programs were used to perform the data analysis, including Microsoft Exceltm, ESRI ArcGIS (Geographic Information Systems), and Blue Marble Geographics Global Mapper. To classify the wells by their location in the Erbil Basin, they were plotted on the basin map by using Blue Marble Global Mapper, while the wells located in the Central sub-basin were plotted on a separate map (Figure 2). This classification is very important because the drilling rules and regulations in each sub-basin is different. There are many programs for computing distances between wells. In this research Global Mapper and ArcGIS software are mainly used to compare the actual distances between wells to the legally permitted distances in the Central sub-basin (Figure 3).

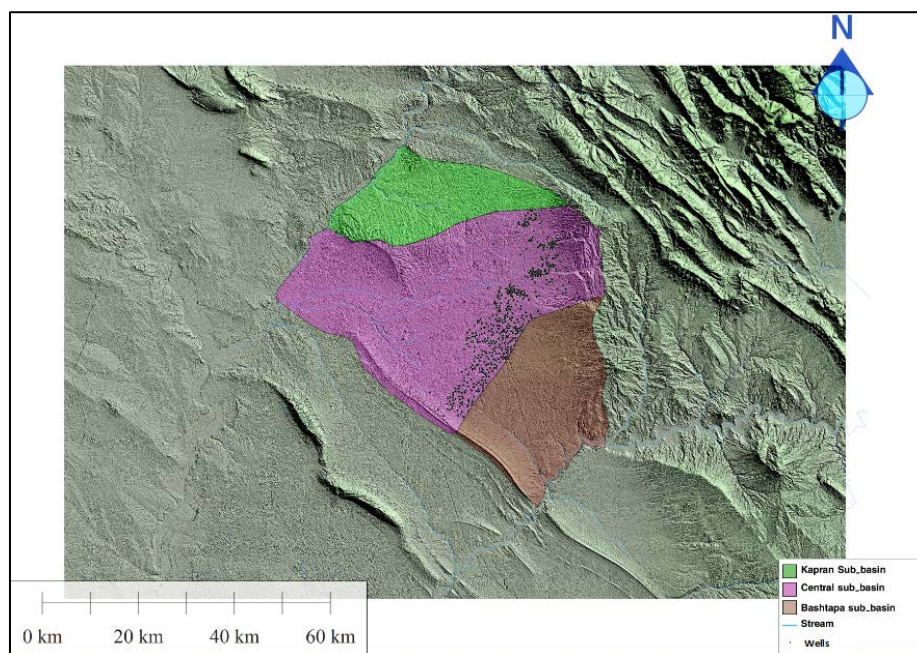


Figure 2: location of wells in the study area

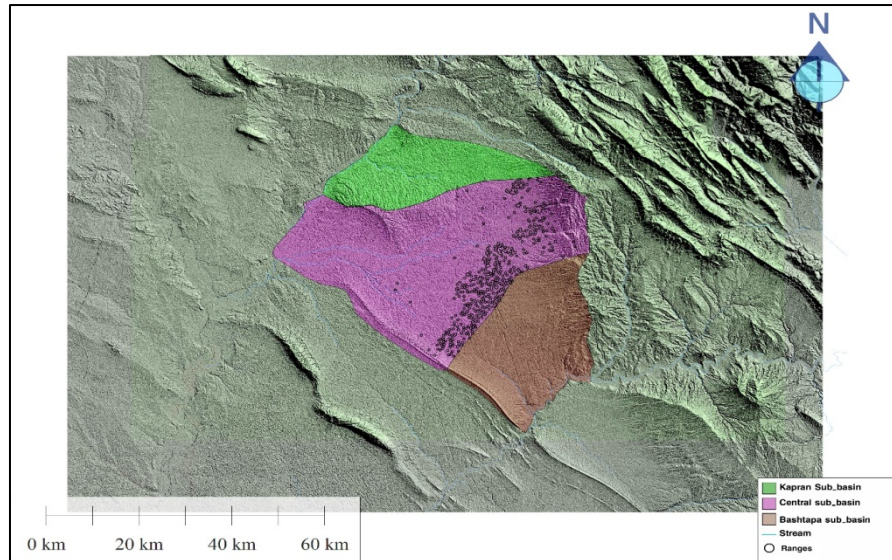


Figure 3: showing the distance range around each well

4. Results and conclusions

The Central sub-basin is located in moderately flat areas. Its location helps in collecting more precipitation than the elevated areas because it runs off the highlands towards flatter areas. However, according to the author in [11], the water table decline in Kapran is 6.83m, 6.02m in Bashtapa, while the Central sub-basin has a decline of 10.452m. This data show that even the favorable geographic location of the Central sub-basin for collecting water does not maintain the water table at a sustainable level.

One of the main factors behind this sharp degradation of the water table in this sub-basin is that it has the highest number of illegal wells compared to the other sub-basins of the Erbil Basin. Among the 650 wells located in this sub-basin, 46.6% (303 wells) of the wells do not meet the regulations. Furthermore, this 46.6% does not mean that the rest of the wells in the Central sub-basin are all legal. While analyzing the maps there was a different case with a number of wells in which in some areas the distances between the wells is much more than the legally required distance. The main reason for this case is the lack of data about most of the illegal wells. Not even the Kurdistan Region Ministry of Agriculture and Water Resources has accurate data about the number of illegal wells in the Central sub-basin. The other reason is that while plotting the data on the maps the author discarded a number of wells due to wrong coordinate information. These reasons yield the conclusion that there might be other, unrecorded wells between identified wells with very large distances between them.

This research shows that some wells are illegal because they are set too closely together. According to regulations established by Ministry of Agriculture and Water Resources, the distance between the wells in the Central sub-basin must not be less than 400 meters. However, by analyzing the maps created by the author and measuring the distance between wells using spatial analysis, the results show that the distance between Central sub-basin wells are variable and not always in accordance with relevant laws. In most cases, the distance between them is less than 400 meters (46.6% of the wells), and in a few locations the distances are even less than 100 meters. It is important to note that most of the illegal wells are not recorded in the ministries data basis

because they are drilled by pile equipment, which is banned by the Ministry of Agriculture and Water Resources.

The lack of strict rules and regulations regarding the drilling process and groundwater preservation has led to many violations in the drilling process. For example, the distances between the wells are not accordance with the permitted distance in each sub-basin. Many illegal wells are drilled into this basin. That said, the total permitted number of deep wells in the Central sub-basin is 738 wells and the distance between two neighboring wells in this sub-basin should not be less than 400 meters [12].

Other possible causes for degradation in the water table could include over-pumping and climate change. According to the author in [11], Erbil is growing in population by 2.9% per year. This fast population growth increases demand on water, so it adds more stress on the already depleted water resources. In addition to the population growth, Erbil is developing very fast, which increases demand on water for industry, agriculture, and domestic use. Moreover, severe drought periods that has hit the region worsened the case because precipitation is the only source of recharge for the Erbil Basin. The first drought period lasted from 1999 to 2003, while a second drought occurred in 2008-2009. Groundwater is a very important element in the Kurdistan Region as it is the main source of water that people rely on. For this reason, proper water management is a vital need in the region as indicated earlier according to the findings of this research 49.6% of the wells in the data set provided for the Central sub-basin were found to be illegal.

5. Recommendations

According to the findings of this research the author recommends;

- The government should start decreasing the number of wells in the Erbil Basin generally.
- The government should take restrictive and very quick actions regarding illegal wells.
- Withdrawal limit should be set to the wells to avoid waste of water.

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Software

ArcGIS (Version 10.1) "Computer Software", Redlands, CA: Esri

Global Mapper (Version 12.00) "Computer Software", Hallowell, Maine: Blue Marble Geographics

Microsoft Excel (Version 2010) "Computer Software", Redmond, WA: Microsoft Corporation