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Study The Interaction Between Surface and Groundwater In Alshirqat Closed To Tiger River

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Abstract

The interaction between surface and groundwater is considered as an important component in the water cycle in any watershed. The interaction is always occurred seasonally and spatially. The current study deals with the seasonal and spatial impact of the surface water of the Tiger river and groundwater on the western bank of the river from the points of water levels and quality considering the phenomena of river bank filtration. The study area is located from km 210 to 211.5 at the western side of the Tiger river, Alshirqat, Salah Aldin, Iraq. The study included the measurements of groundwater depth along three distances between km 210 to 211.5 km. The groundwater depths were measured for 24 wells distributed as six cross section perpendicular on the different identified distances.

The research evaluates the hydrogeological conditions of the aquifer in the study area through the measured well data, as well as statistical analysis of monitoring data for groundwater and surface water quality, and preparing specialized maps. The results showed that the groundwater levels in the region range from 139.9 m near the river and increase in the western direction to 141m as a result of topographic conditions. Statistical analysis of the groundwater quality data also showed that the overall salinity of groundwater TDS was low closed to the river bank and increase with the increasing distances of the well from the river due to the interaction between surface and groundwater. Log equation was presenting the behavior of the R2 which equal 0.9939.

Keywords: Water Resources, Ground Water, Tiger River, Drinking Water, Wells, TDS, Bank Filtration.

1. INTRODUCTION

Due to the increased water demand and the instability brought on by climate change, over-exploitation of groundwater is currently a global issue [1]. A solvent that can serve as both a water storage area and an energy-efficient treatment process is required due to the unpredictable availability of water resources [2]. A low-cost, naturally occurring process for managed aquifer recharge (MAR), river bank filtration (RBF), also known as bank filtrate or filtration (BF), is highly effective at removing contaminants [3-5]. River bank filtration (RBF) is defined as a process, where the river water is induced to infiltrate through a river bed into the pumping boreholes located on the bank at a short distance from the river [6]. In comparison with other water treatment system, RBF is cheaper and natural filtration process which has some benefits to eliminate suspended contaminants, such as particles, biodegradable compounds, bacteria, viruses, parasites and organic matter in river or lake water [7]. In addition RBF is not required of large infrastructure cost. Nature offers practical, sustainable solutions to improve the quality of the water. Iraq's surface and groundwater quality is declining as a result of a lack of water resources, climate change, rising population, expanding urbanization, and non-point sources of water pollution [8-10]. In developing nations like Iraq, where access to healthcare facilities and clean water is frequently lacking, waterborne pathogens continue to be a significant global health concern, leading to significant morbidity and mortality [11-13]. It is well known that waterborne pathogens are the main carriers of diseases like diarrhoea, cholera, dysentery, salmonellosis, shigellosis, and typhoid [12,13]. Additionally, according to the [14], contaminated drinking

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water contributes to 502,000 cases of diarrhea-related deaths annually. By making improvements to the water supply, sanitation, hygiene, and management of water resources, nearly ten percent of the global disease burden could be avoided [15]. Some countries rely on wells that are close to rivers and lakes for their drinking water, such as Switzerland (80%), France (50%), Finland (48%), Hungary (40%), Germany (16%), and the Netherlands (7%) [16]. In order to maintain the quality of water supplies, which are dependent on vertical and horizontal wells next to riverbanks and intermountain basins, the RBF process is widely used throughout the world [17]. When river water is refilled into the aquifer, it goes through hydro geochemical processes like mixing, cation exchange adsorption, and water-rock interaction. By changing the components of the groundwater, these processes can affect its chemistry [18–20]. The infiltration of river water into the aquifer is affected by factors such as temperature and redox potential, resulting in changes in the concentrations of major ions and TDS in groundwater [21,22]. Because of their high production potential, close proximity to areas of demand, ease of access, and low cost of extraction, alluvial aquifers are widely used as a source of groundwater in many nations [23]. It is possible to create a hydraulic gradient by pumping wells in an alluvial plain that are hydraulically connected to a river, forcing surface water to flow through the river's bed and banks Fig. 1. A decrease in the concentration of pollutants occurs during this procedure, known as riverbank filtration (RBF), thanks to physical, chemical, and biological interactions between the surface water and the groundwater as well as with the substrate [24].

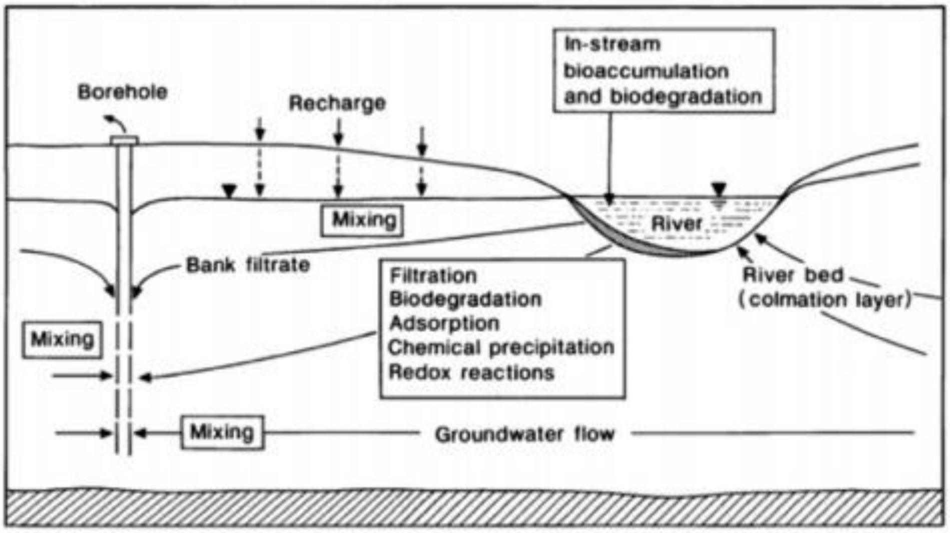

Fig. 1. Basic scheme of riverbank filtration and main attenuation processes [25]

The aim of this study is to review the hydrogeological condition of the study area and illustrate the interaction between surface and groundwater in the study area closed to Tiger River though the measured data wells besides the Tiger River, and identify the area length of active filtration of river bank.

2- MATERIAL & METHODS

2-1 The study area

The study area is located at the eastern side at the tigers river Alshirqat, Salah Aldin, Iraq. The study area is extended from km210 till km 211.5, from the north to the south direction. The lithology of the soil profile extended to a depth of 23m at the kms of 210, 210.5, 211, 211.5. Fig. (2) is the location of the study area where twenty-four monitoring wells were implemented in lines perpendicular to the river at lines. It is clear that the distances between each well and the other 5,10,15,20, 100 and 200 meters from the river bank of the River.

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Fig. 2: the location of study area

2-2 Field Measurements

The ground surface and groundwater depths of twenty-four piezometers distributed closed to Tiger River were measured and recorded, in addition to water level of Tiger River. Fig. 3 illustrated the distributed location of the piezometers. Tables (1,2) present the ground surface and depth to groundwater in the study area. GIS used to analysis the measured data and produce specific maps. Fig. 4 presented topographic map of the study area which illustrated that ground surface level varies from 140m to 145m above mean sea level and increase towards the east direction.

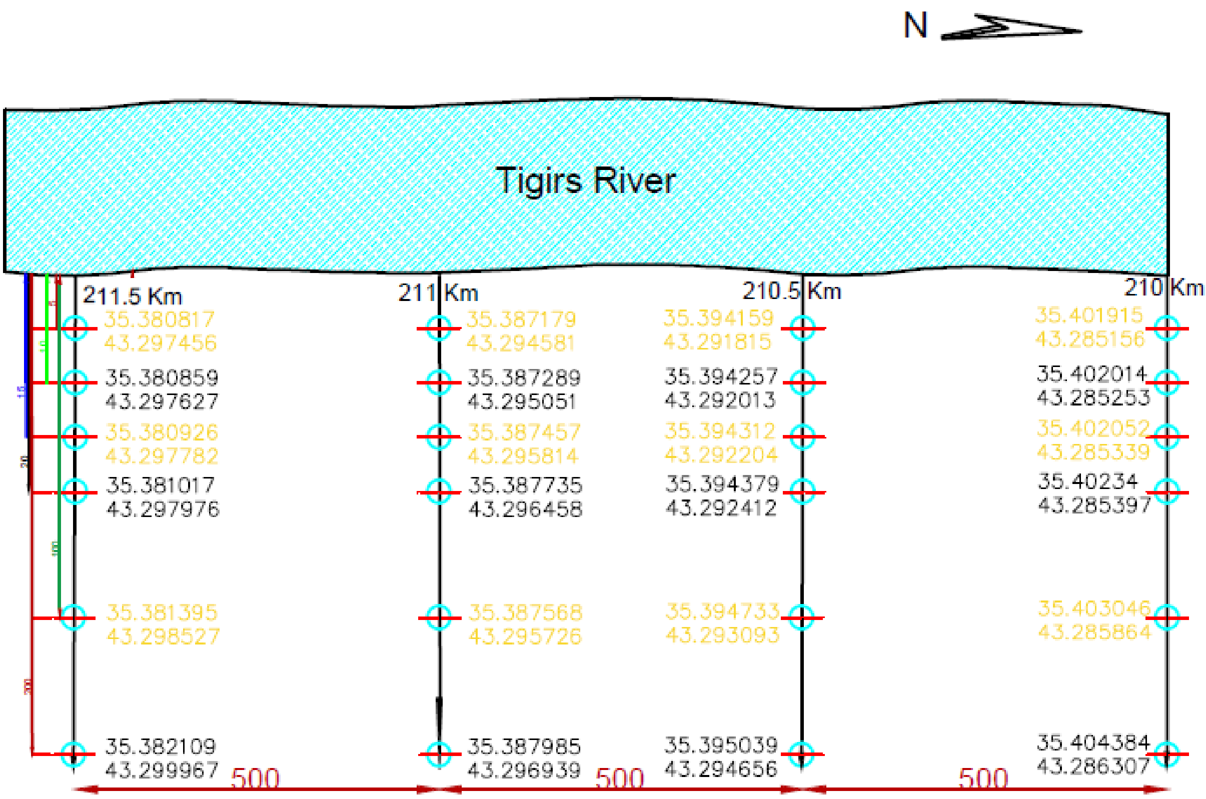

Fig. 3 Distribution of the groundwater piezometers closed to Tiger River (24 piezometers)

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Table (1) Ground surface levels of the study area

The distance from the surface of the well to sea level				
Km / Well (m)	210	210.5	211	211.5
5	142	142	142	142
10	142	142	142	142
15	142	142.5	142	142.5
20	142	142.5	142.5	142.5
100	144.5	145	145	145
200	145	145.5	145.5	145.5

Table (2) Depth to groundwater of the study area

The depth of groundwater above the earth's surface.				
Km / (m) Well	210	210.5	211	211.5
5	2.8	2.8	2.8	2.8
10	2.75	2.75	2.75	2.75
15	2.75	2.75	2.75	2.75
20	2.75	2.75	2.75	2.75
100	4.2	4.2	4.25	4.25
200	4.35	4.4	4.45	4.45

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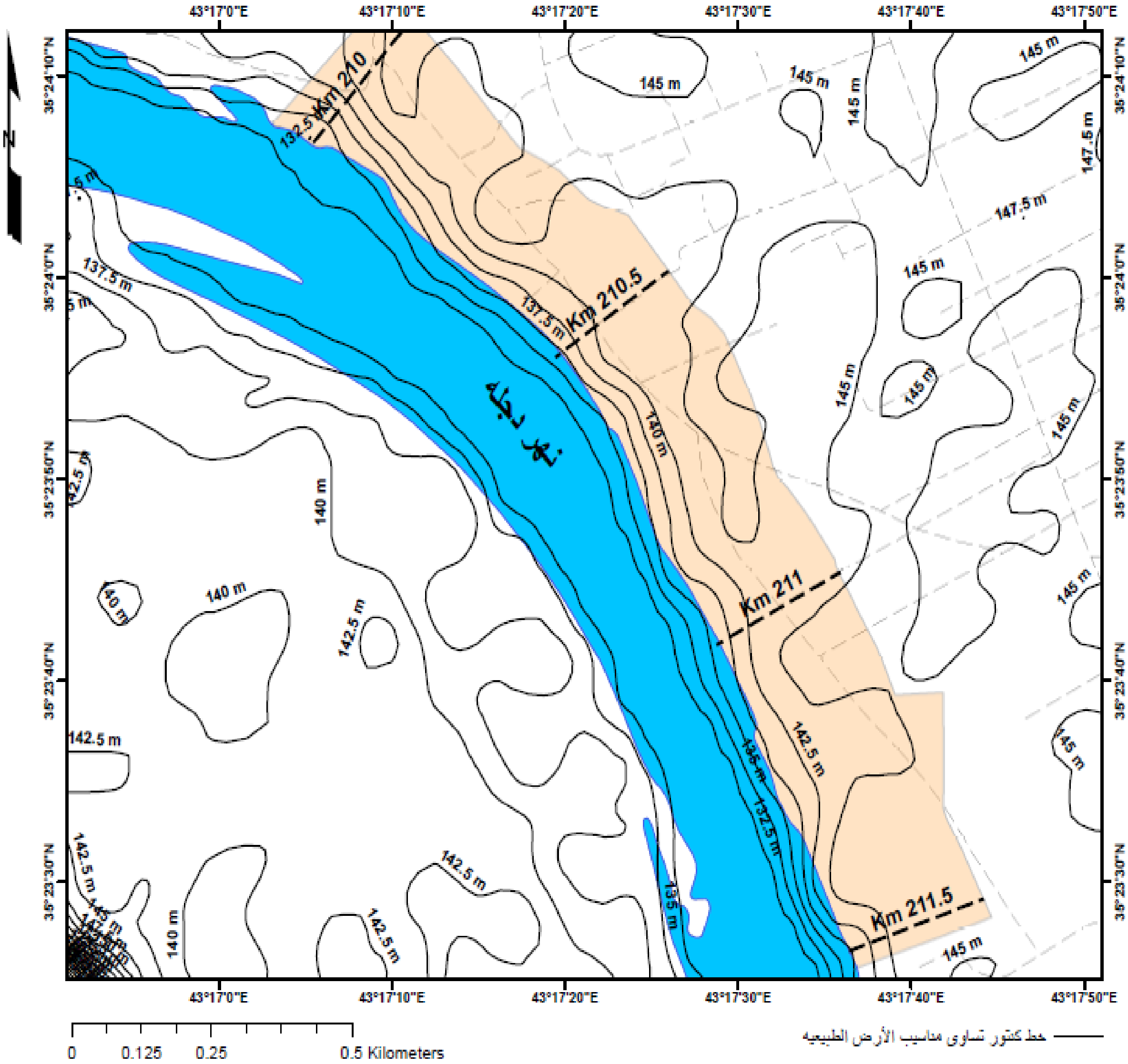

Fig. 4 Topographic map of the study area

2-3 Water Quality

Groundwater samples were collected from the different wells for 24 piezometers. table (3) presents the measured groundwater salinity TDS of the piezometers distributed in the study area.

Table (3) Groundwater Salinity (ppm) closed to river bank in study area

Distance	Groundwater salinity (TDS) ppm			
	210km	210.5km	211km	211.5km
5	230	210	235	250
10	280	260	285	215
15	310	350	360	350
20	390	400	400	400
100	730	750	740	750
200	810	800	815	750

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3. Groundwater hydrogeology

Geological, structural, and lithological conditions govern spatial distribution and extensions of hydrogeological components in terms of aquifers and aquitards, and their hydrological characteristics. Depending on the above-mentioned parameters and on the relationship with the geological formations that storing the groundwater, fourteen major aquifers (or group of aquifers) have been recognized and classified by fig. 5. Fig. 5 Illustrates that the study area cover with the conglomerates aquifers in the Quaternary and Pliocene within the formation of Bai Hassan, in the synclines in northeastern Iraq, within the range of foothill and parts of the high fold zone [26].

4. Hydrogeology of the study area

The succession of sediment in the study area shows a variety of grain size. Generally, the grain size of sediments becomes coarser with depth. The data of four drilled wells (named zone_01 to zone_04) were used to construct a cross section for the successive layers Fig. 6. The surface layer consists of silt loam with maximum thickness 8 m. Then, there are intercalation of fine with medium sand, fine s

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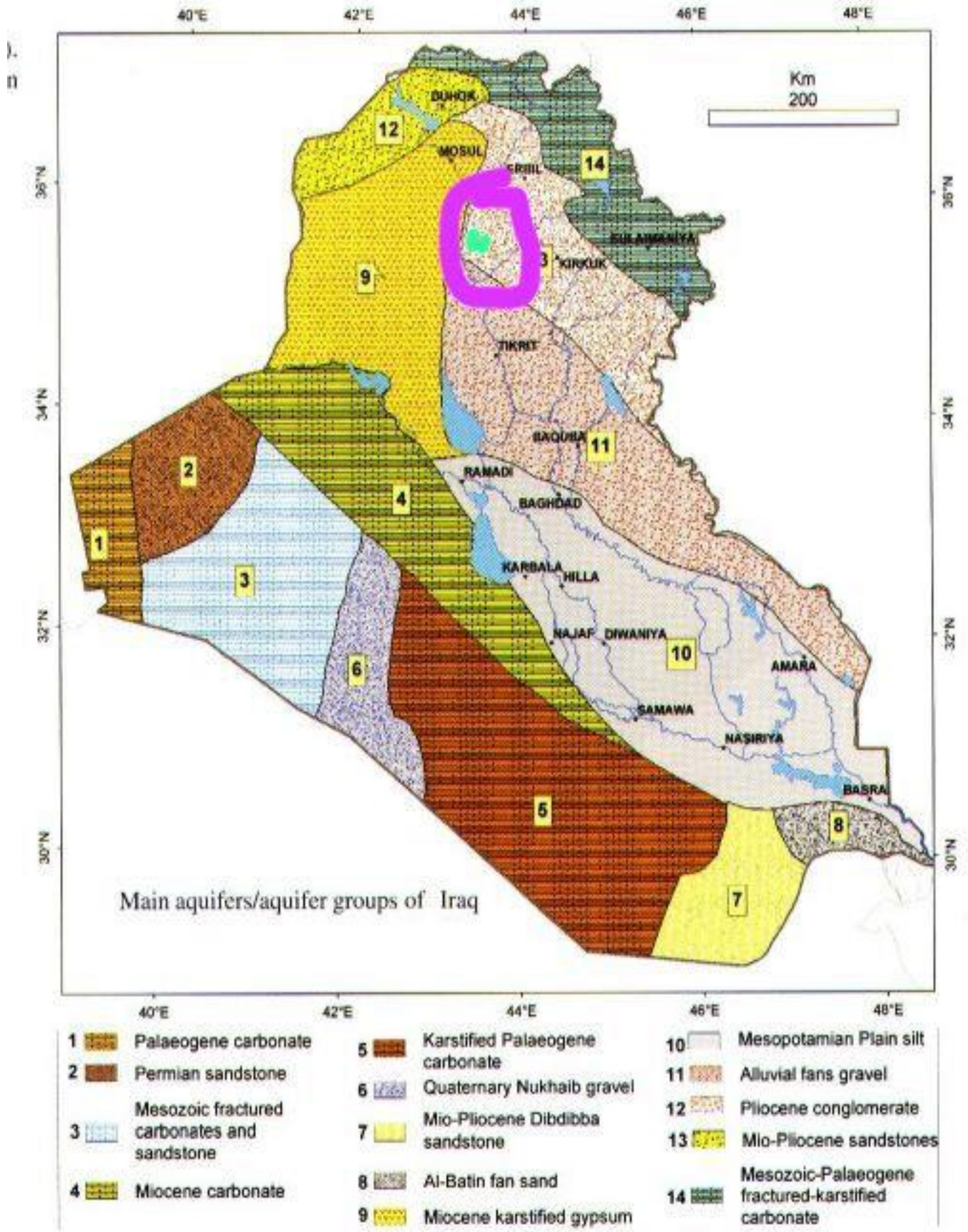
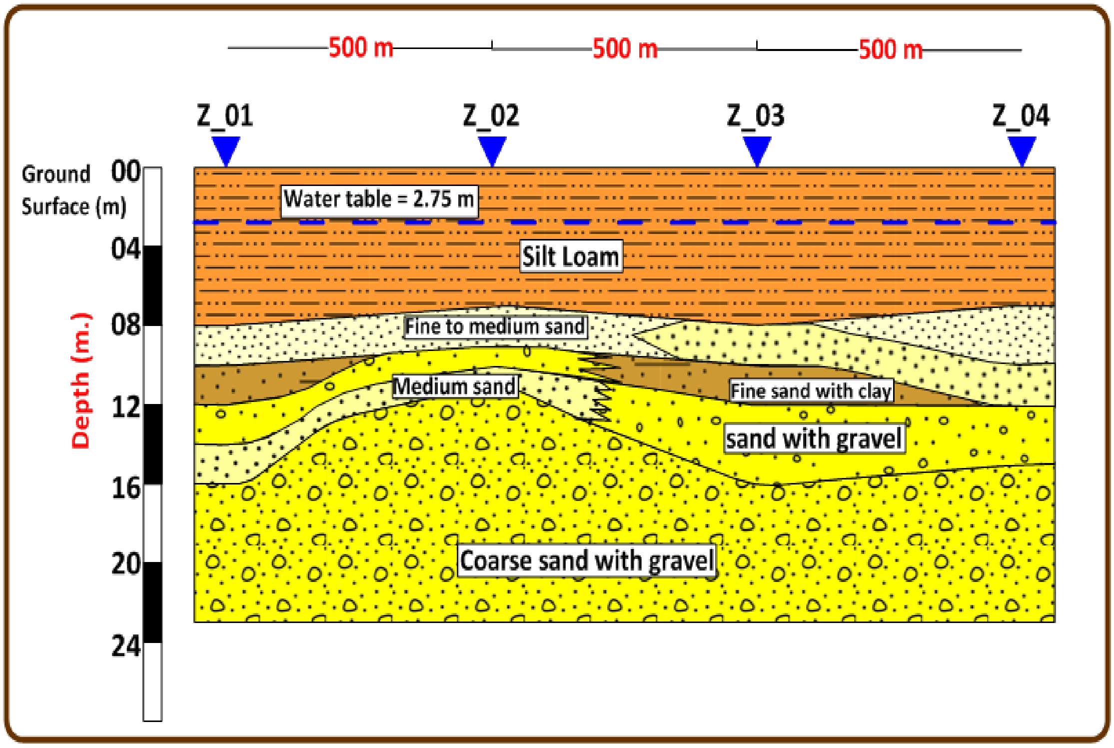


and with clay, medium sand and sand with gravel, with overall thickness ranges from nearly 4 m (as in zone_02) to 8 m (as in zone_03). These four layers are combined only in zone_01, while only three of them are found in the other three wells. The last layer composes of coarse sand with gravel. It is represented in all wells and extended to nearly 23 m depth from earth surface.

Fig. 5 Main groundwater aquifer in Iraq



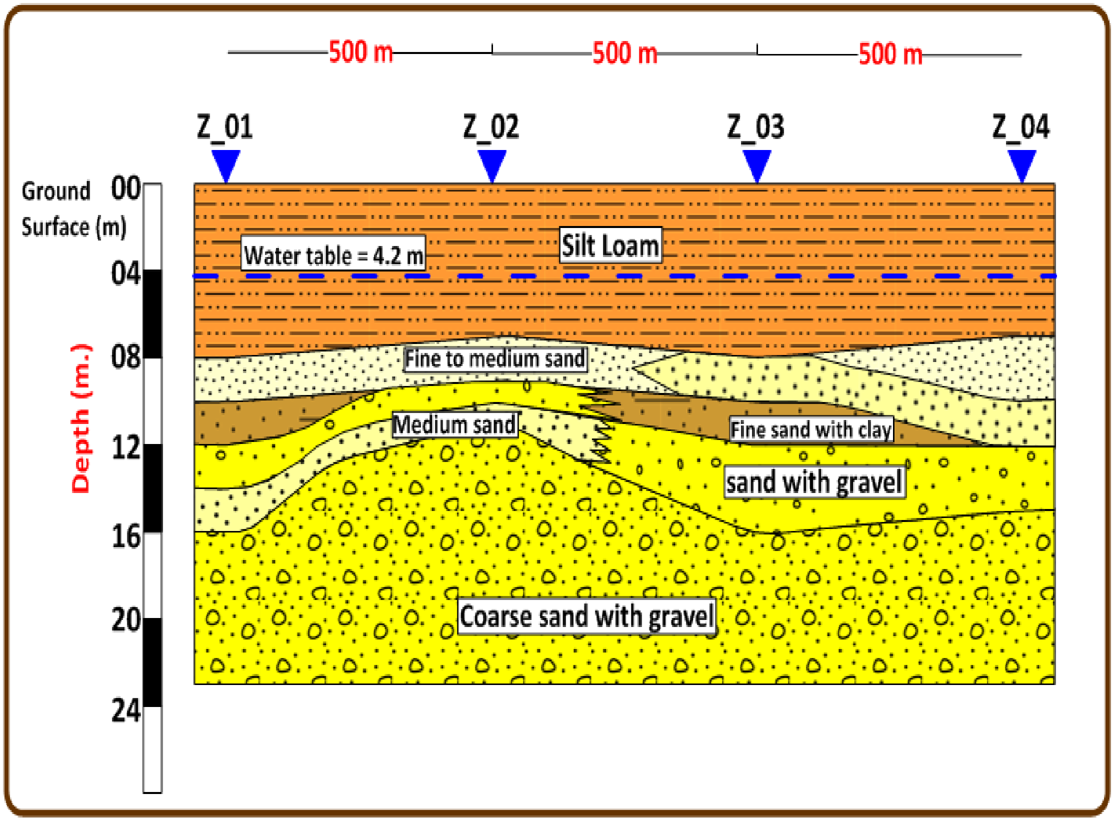


Fig. 6. Hydrogeological cross section of the study area

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5. Interaction between surface water and groundwater in the study area

Groundwater and surface water physically overlap at the groundwater/surface water interface through the exchange of water and chemicals. Nearly all surface-water features (streams, lakes, reservoirs, wetlands, and estuaries) interact with ground water. In the study area where it closed to the tiger river, there is a clear interaction represented in groundwater levels, flow direction and groundwater salinity.

5-1 Groundwater Levels and Flow Direction

According to the recorded groundwater depths of the piezometers distributed closed to the river from the distance of 1.5km, from km 210 to km 211.5, groundwater levels were calculated and represented in the form of a contour map. Figs. 7and 8 present the depth to groundwater and groundwater level contour map. Where the depth to groundwater in the study area varies from 2.75m to 4.45 m and the groundwater level varies from which change from 141m (east) to 139.75m (west) above mean sea level So the local flow direction of the study area from east to west (closed to river), also due to the high topography of the area on the eastern side of the river

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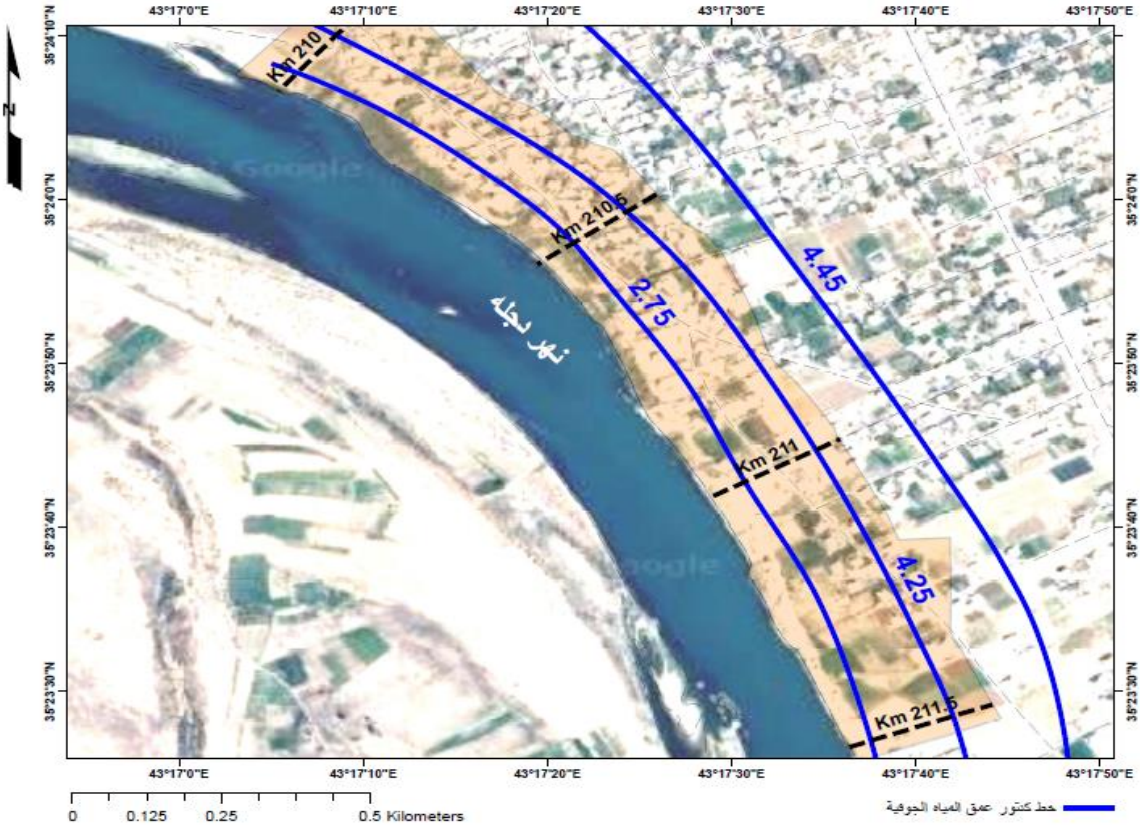

Fig. 7 Depth to Groundwater contour map of study area

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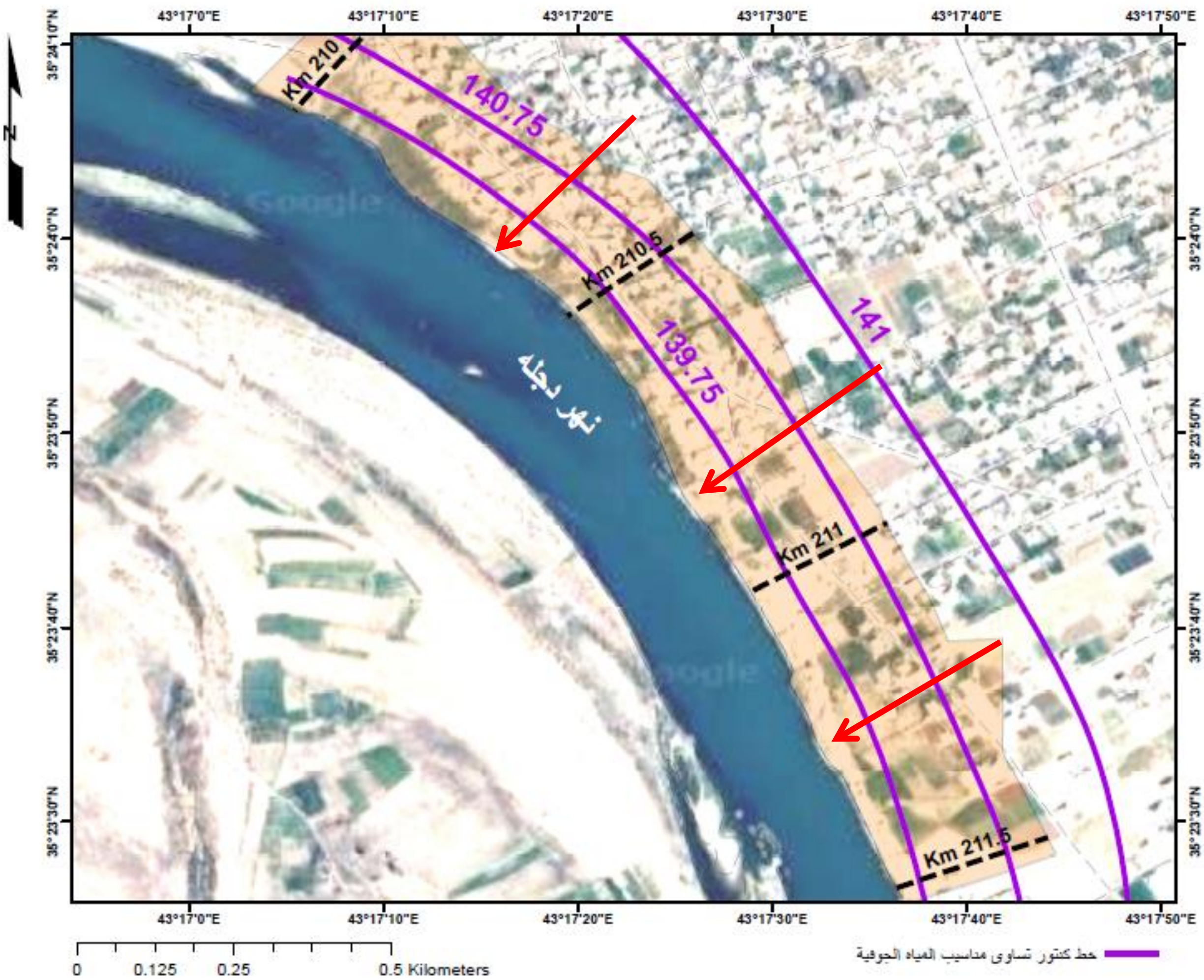

Fig. 8 Groundwater level contour map of study area

5-2 Predicting the distance of Riverbank filtration

The measured data of the groundwater salinity (TDS) (table3) of the study area illustrated that TDS valued varies from 210ppm closed to river bank (5m) to 810 ppm at a distance of 200 from river bank as an indication of interaction between surface and groundwater.

Fig. 9 represents the relation between the change in groundwater salinity with its distance from the Tiger river where the groundwater salinity increases with increasing distance from the river where the interaction between surface and groundwater water decreased.

Equation that had been predicted can be used to calculate the distances from the river that the riverbank infiltration can be occurred

$$Y = -0.0229\, x^2 + 7.5708\, x + 210.5 \qquad (1)$$

Where

Y Groundwater salinity (ppm)

x = distance from river bank (m)

Considering that the permissible limit of riverbank filtration for TDS is 500 ppm, the distances of that phenomena can predicted at the distances of about 46 m from the river stream

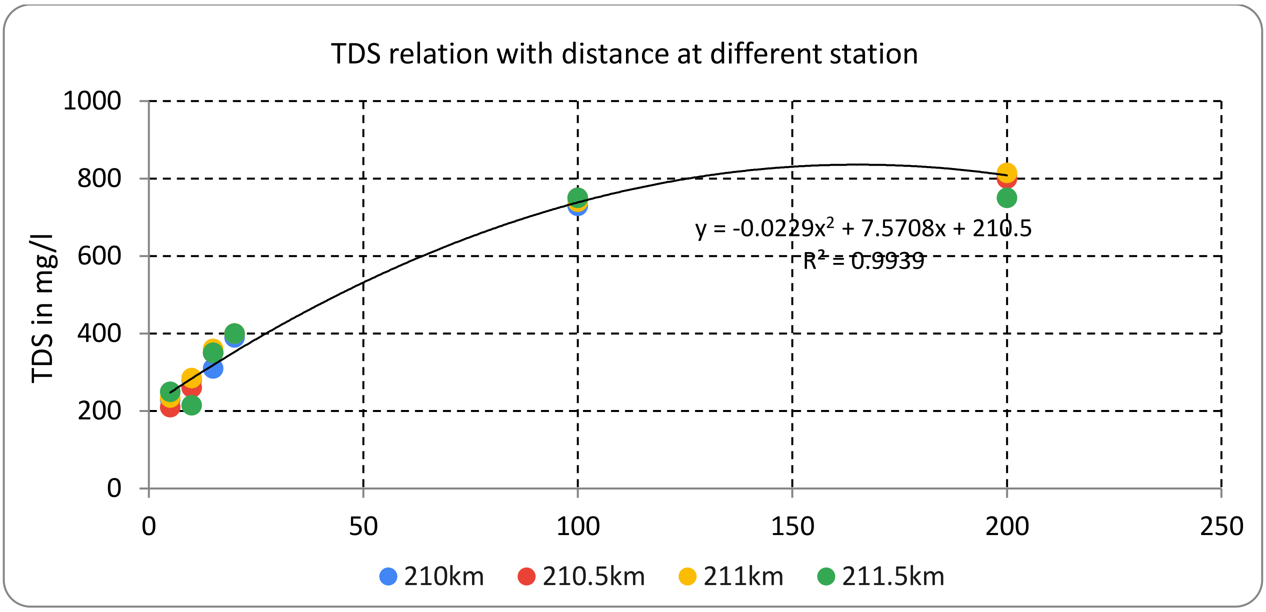

Fig. 9 The change of groundwater salinity TDS with distance from the river

Conclusions

The hydrogeological condition of the study area was reviewed and indicated the interaction between groundwater and surface water in the study area is occurred eastern side of the Tiger's river Alshirqat, Salah Aldin, Iraq.

According to the statically analysis that discussed at this study, Riverbank filtration phenomena RBF might be occurred till the distance of forty-six meter (46m) when the TDS values of the groundwater reach 500 ppm (Iraqi standards)

Finally, this study is helpful to define the area length of RBF at the study area, and due to the importance phenomena of RBF for the drinking water source from both surface and ground water it is recommended to circulate such study throughout the country.

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