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Impact of structural geology on integrated water resources modeling improvement; a case study of Garesoo river basin, in Doab-Merek station, Kermanshah, Iran

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ABSTRACT

Garesoo river basin in Doab-Merek, as studying area of this research, located in northwest of Kermanshah province in west part of Iran. There is long-term hydro climatologic data in this basin about rainfall, temperature, etc. (more than 50 years) and main river data (about 35 years). Due to intense fall down groundwater level and seasonal river drying, in the past 10 years .It was necessary that studies be done to the management water resources of region. Studies performed at first by linking MODFLOW to WEAP model with information and initial understanding of the geology and the others information of the area. The results were not satisfactory especially regarding the prediction runoff basin in outlet, despite the long term data. After these initial studies, and based on complete studying, it was cleared that complicated geological conditions with new Tectonics activities were key to the adaptation of the model to reality. In addition, geophysical surveys using radar approach showed that the fault is in match with the trend of river, and it can creat hydrolic interaction between Karstic and fractured bed rock and porous medium and also river in outlet. Finally we achieved a good acceptance matching between calculated and observed discharge of river in Doab-Merek station with satisfactory results.

1- Introduction

Water supply with various consumption and also consideration priority as optimization, needs integrated water resources management approach, this method has started since 1961; on the other hand this approach established on groundwater and surface water modeling, and so on, it is necessary to proper understanding of geological aspect of system, for representation proper conceptual modeling of system.

The assessment and implementation of this necessity based on geological and geophysical investigation has done in numerous articles which discussed as below:

Rivera (2007) expressed 3d maps especial the 3d geological maps development as widespread. He explains in the article with title" from geology to hydrogeology", Geology three dimensional maps have very extensive use to analyze and understanding phenomena in studies, such as Geophysics, Geostatistics, Geothermal ,Energy resources, and … etc. In this regard, for create and run three dimensional groundwater models, interaction groundwater and surface water, radioactive waste and etc. Is much needed. In spite of this necessity, there is disaffiliation and lack of communication between three dimensional maps planners and groundwater modelers. But unfortunately these two expert groups study separately.

Atkinson (1977) regarding conduit and diffused flow in Karst aquifer, at first determined the catchment area of 15 great springs, which has been confirmed through water balanced calculation. Natural recharge also considered as 50% for quick flow and similarly amount relative to base flow. Hydraulic conductivity in the diffuse flow is about 0.9 meter per day and coefficient of storage is about 0.92 %has

been estimated. In this research, it seems that geological understanding has an important role.

Canora et al. (2008) have done interesting research about in change of infiltration according to various type of land use in Karstic lands. This research has shown that the changes in land use, effects, in surface water and infiltration and it can change in water balance and also how increasing fractured in limestone and creation unconsolidated rocks to 42% during 1950-2001.

Daher et al. (2011) has researched artificial recharge through Karstic cavities. It is the same evidence that has occurred in this study's area. And it is currently ongoing. Barthel et al. (2008) has researched through integrated model in two areas, one in Nekar in Germany and another in Benin in western Africa .The results showed that, none of the models with respect to infrastructures, didn't have acceptable results, and also failed to properly carry out management duties. The lack of data and the complexity geological conditions and cluttered, such as crystalline rock aquifers and non-continuous, cannot be useful to solve the problems of water resources management. Although it must be considered, Neckar basin of the infrastructures is better than Queme basin in Benin relatively, but the results were not acceptable. Final conclusion as researchers have declared that regional scale groundwater modeling and integrated water resources management is difficult and imprecise.

Linares et al. (2017) investigated the sinkholes has done during periods of drought. The study has done in part of the Valley of Fluvia River located in northeastern Spain. In this study it has been found that the time schedule for creation sinkholes is harmonic with drought periods.

Kaufmann (2014) studied In the case of Karst development and expansion of voids and the collapse of overburden. In this studying geophysical investigation has done in Karst structures with Gravimetric, Geoelectrical, and Magnetic approaches.

Thery et al. (1999) researched about the role of recent Tectonics relative to Karstic landforms such as sinkholes. The study area is under a heavy rainforest .Based on microfossil investigation, middle Pleistocene is accordance for the age of most recent Karstic formations. On the other, based on Stratigraphy investigation this age is relative to upper Lutetian to middle Pleistocene with Tectonics occurrence during Oligomiocene to Pleistocene.

Atzori et al. (2015) analysis and evaluated in temporal and spatial condition, gradual sinkholes in compared collapsed sinkholes through Geo radar techniques as in SAR.

Another survey base on geophysical investigation as Radar has done by Comut et al (2015), Parise (2015), Cigna (2014).

Fakri and Kalliola (2015) investigated land subsidence in Larissa in Greece through Geo radar as in SAR .

The study area is located in northwestern part of Kermanshah province which it is the west side of Iran. This location has shown in figure 1.

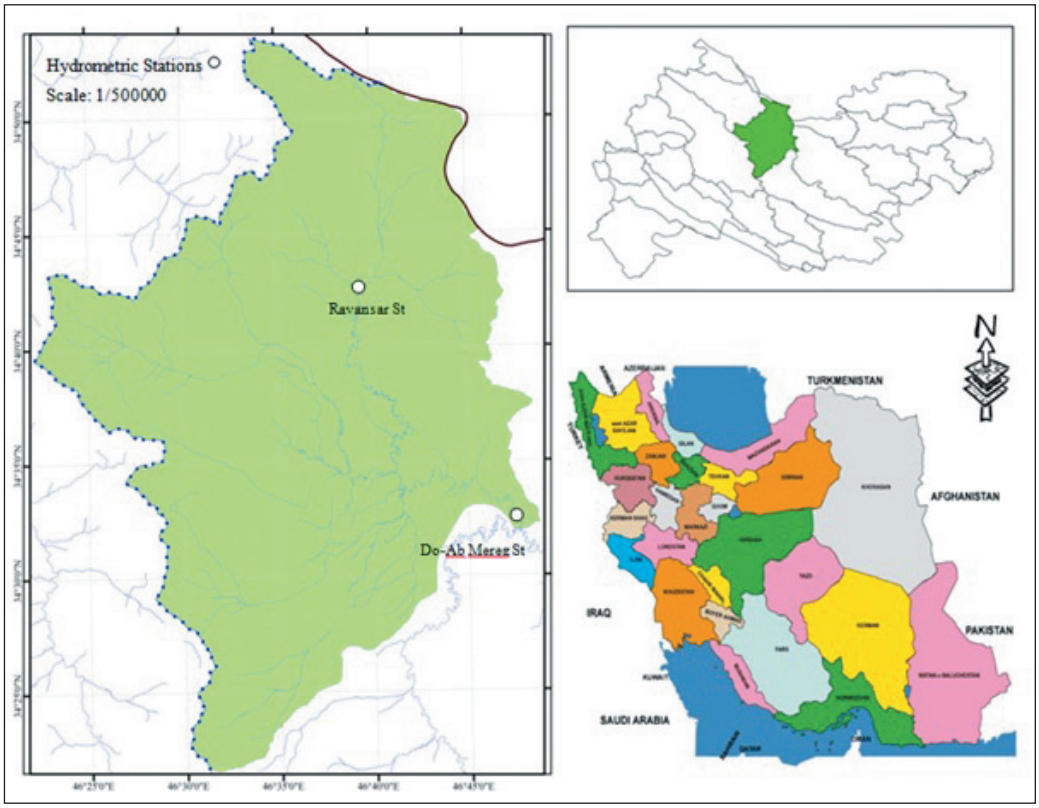

Fig. 1- location of study area relative to Kermanshah province and Iran.

This study area due to greatly reduce in groundwater storage and dry seasonal main river in last decade, and it's economic and social condition too, has particular importance, and so has been investigated, for achievement to sustainable development through integrated model with WEAP software that has linked to MODFLOW computer code and the implementation various scenarios. The goal of this research is about to solve a problem occurred during create and run the above model.

The problem was about incompatibility between observed and calculated discharge in outlet station under named Doab-Merek.

The revised model implemented as various review such as, change surface water model, checked data had used for MODFLOW model and field data of sub basins, unauthorized exploitation, and all data which used for calculation, but there was still the problem of incompatibility. Following the review model the researcher team noticed the lack of deep understanding of the geological structure of the area is the main cause of incompatibility.

Further review based on geological and geophysical investigation of the area with the help of experts and reports required was as follows.

2- Geology and Tectonic setting

Base on Nazari et al. (2015) research for Ministry of energy, Water Resources Management co., Kermanshah Regional Water co., KRWC's Research Committee No: 109. With Tectonic and New Tectonic context, in studying area as a part of entire researched area, valuable information of Geological aspects of area was obtained.

The research has a simplified map as below which shows general geology of region.

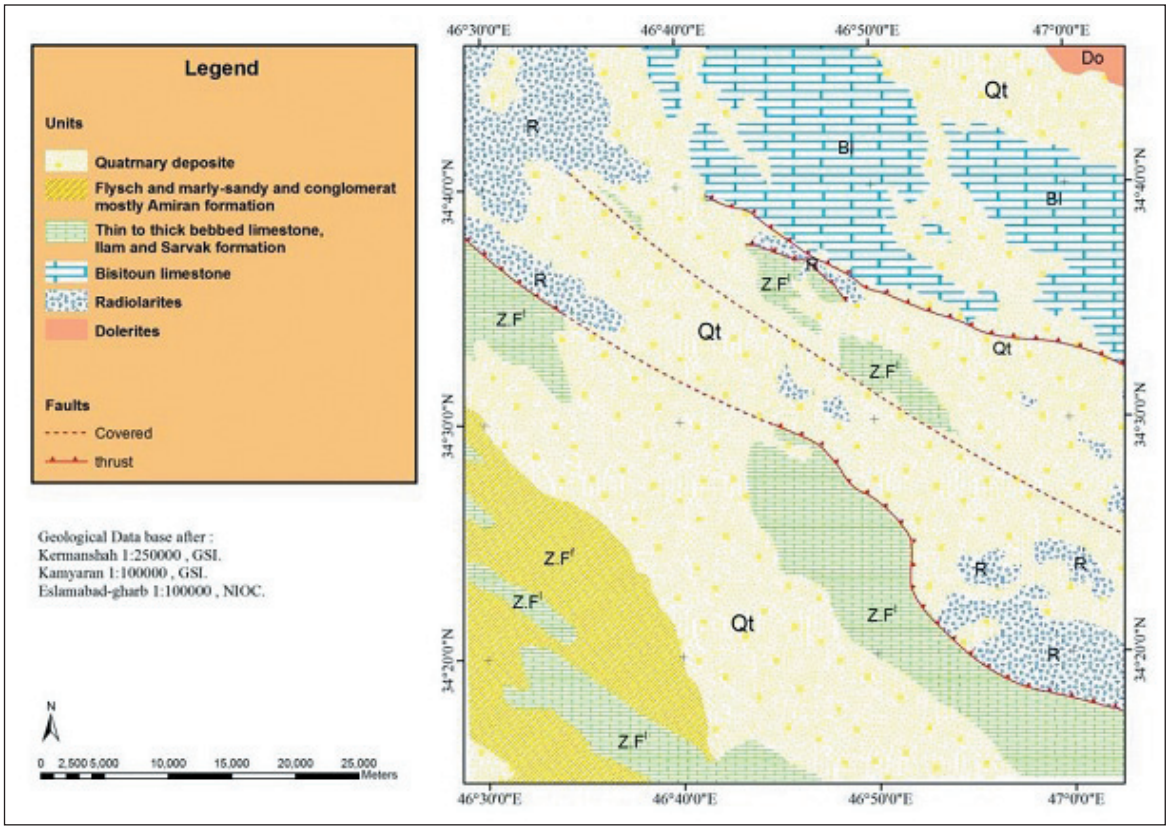

Fig. 2- Simplified Geological map of Ravansar-Sanjabi studying area, based on KRWC's Research Committee No: 109.

As it was shown in Fig 2, Karstic limestone is known as Bistoon with the symbol B contrasted with Radiolarit formation with symbol R and a thrust fault, and ZF formation (relative to folded zone of Zagros) placed by a thrust fault from R . In other words B formation trusted over R formation and R formation also trusted over ZF formations. B on lithological characteristics includes bioclastics and oolitic limestone with the age of upper Triassic to upper cretaceous, this formation is intensity crushed, and generates mature Karst in the region, and also R formation includes two upper and lower with alternating of Chert, Conglomerate, Marl, and then microbereccited, bioclastic Limestone, respectively.

The lithostratigraphy of ZF formation is Lime clay with micro-granular texture in the name of Ilam formation and Gourpi formation with granular limestone, and then shale in upper and lower respectively, explain that Gourpi formation is younger than Ilam formation.

Based on the above, one can conclude that, apart from upper part of R formation and lower part of Gourpi formation, the other formations can creates Karstic reservoir ,and have been hydraulic connection with porous medium.

3- Morphotectonical investigation

Morphotectonical evidences in region have shown in figure 3, that due to activity of a recent fault relative to Main River of region in the name of Garesoo, moving the direction of river in Northwestern– Southeastern near the Khoramabad village. In the other words fault movements has caused displacement of river trend to NW-SE. This event has shown in figure3.

Other evidence in the above case is existence a group of recent faults with normal mechanism in alluvium deposits, which it can be seen in figure 4.

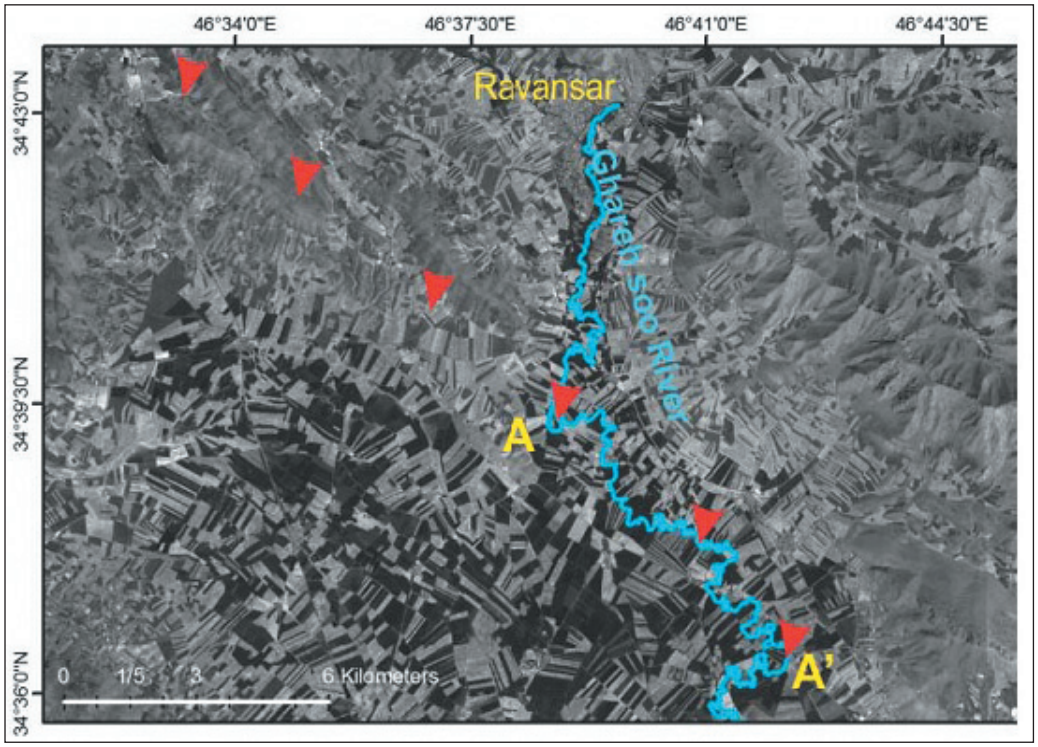

Fig. 3- displacement of Garesoo river trend has defined on the IRS satellite image, based on, KRWC's Research Committee No: 109.

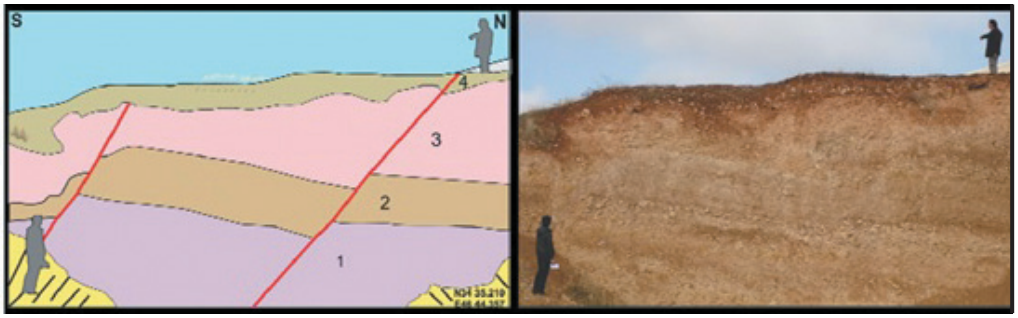

Fig. 4- Fault groups in alluvial deposits, based on, KRWC's Research Committee No: 109.

4- Geophysical investigations

Geophysical studies for understanding the properties of aquifer such as depth and type of bedrock, specific resistance of layers, thickness of alluvial deposits, has done by Ab va Khak consulting engineers (1978) and Zamin Kav Gostar consulting engineers (2012) for Ministry of energy, Kermanshah Regional Water Co. (KRWC), as overall for the porous medium aquifer of region.

In addition, fortunately there was a special geophysical investigation in 2010 through Radar approach by Zamin Abpay consulting engineers for Ministry of energy,

Kermanshah Regional Water Co. (KRWC) to find out surface water loss during the transferring water project in the faulted zone of area near the Garesoo River. The goal of this investigation has been exploration of crushed zone, intensity of fracturing and location of cavities that maybe occurred in underground, as it was shown in Fig 5.

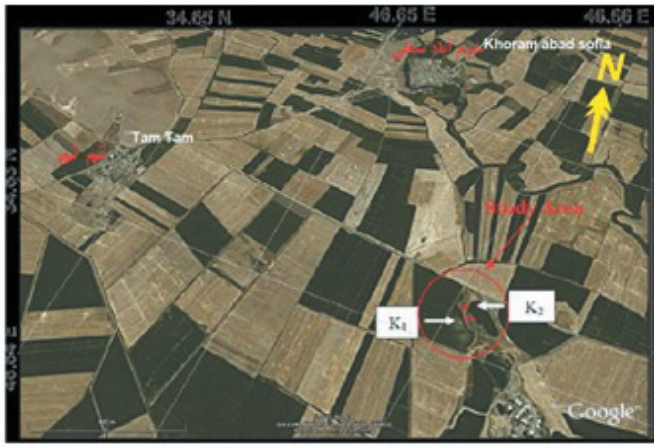

Fig. 5- Location of two geo Radar profiles on Google earth image, based on Kermanshah Regional Water Co. (KRWC).

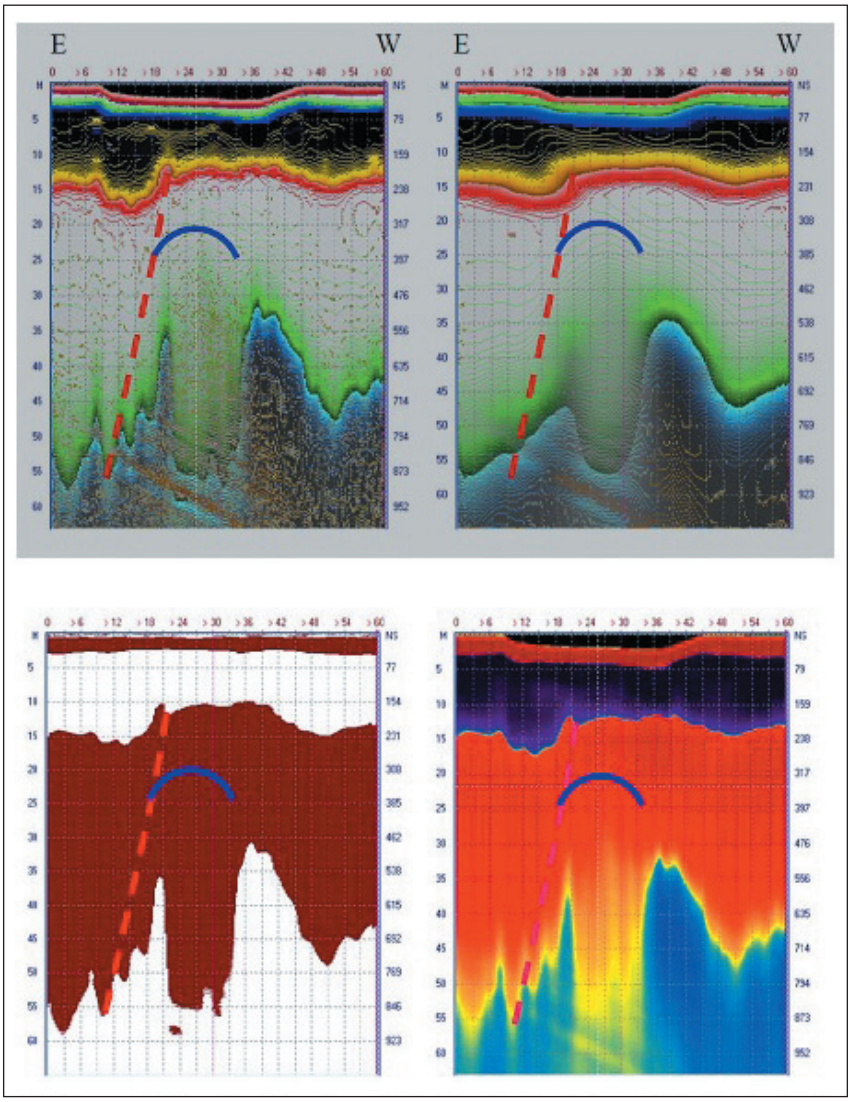

Fig. 6- Process of K1profile, blue hyperbolic identified cavities and fault detected is in dash red, (Zamin Abpay consulting engineers, 2010).

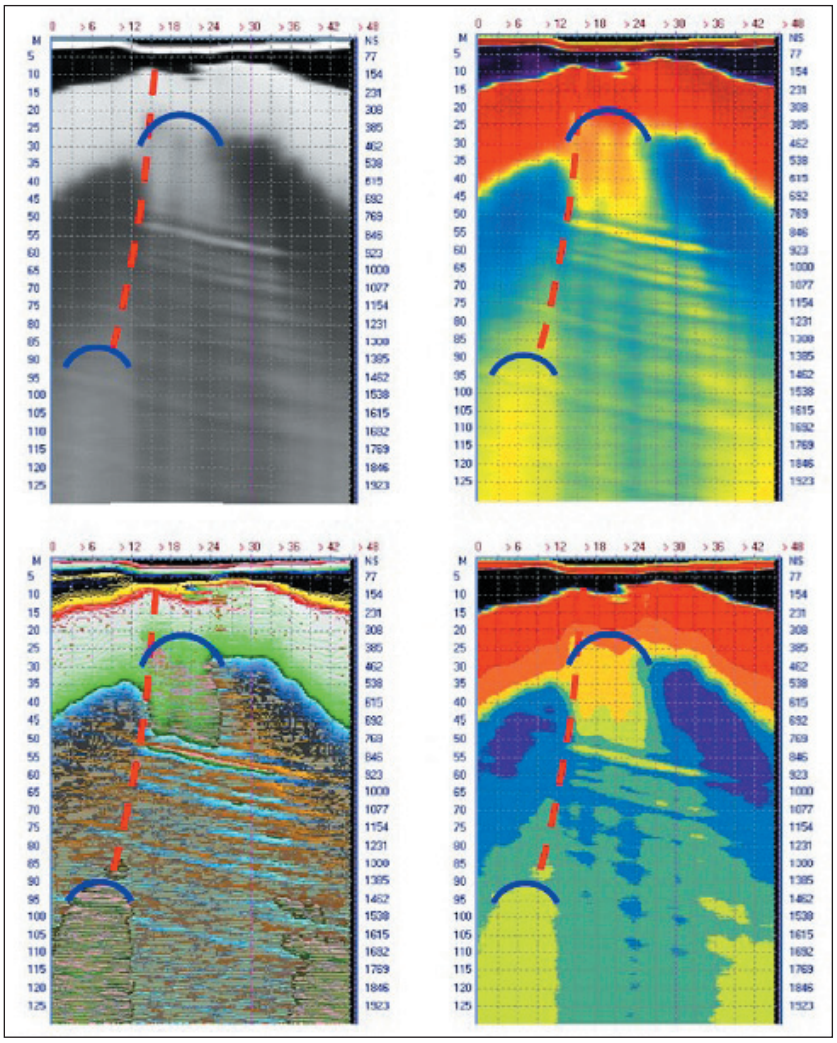

Fig. 7- K2 profile processing, through this process, at least is identified two cavities in 25 and 90 meters depth(it has been shown in blue) and one fault in 25 meter depth with red dash, based on Zamin Abpay consulting engineers (2010).

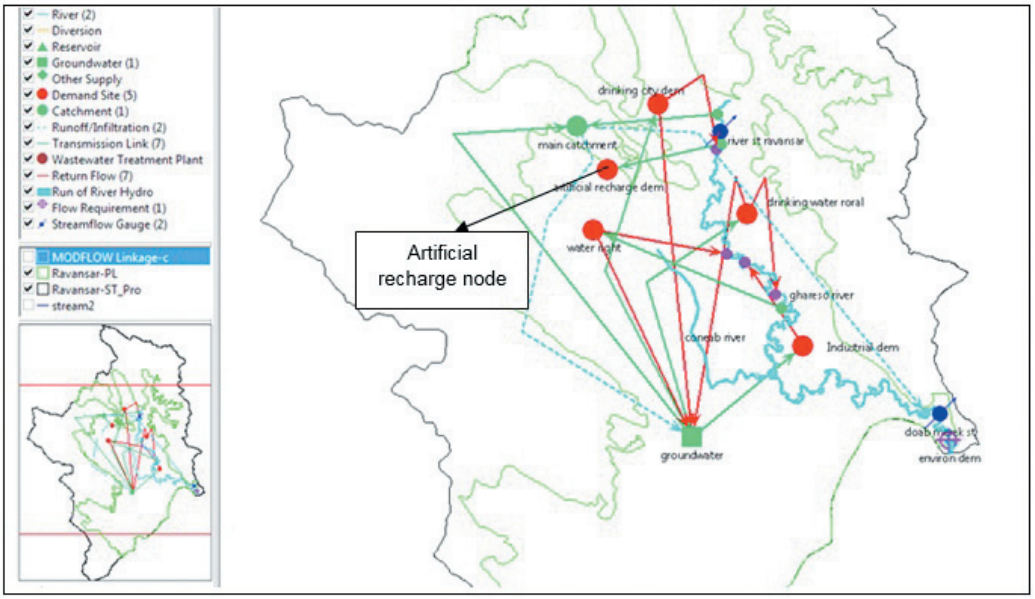

Fig. 8- Schematic of WEAP model after addition artificial recharge node.

5- Geophysics results

Based on process and interpretation of profiles as graph, the results presents as below:

Final results from geophysical studies using Radar are:

1) There are cavities and voids in bed rocks.

2) Certainly there are cavities and sinkholes due to Karst formation.

Based on, Geological, Tectonically and Geophysical investigations, which explained above, we concluded there is an active fault with some cavities and sinkholes which can interaction water between Karstic and fractured bed rock and porous medium and also river in outlet, and then by this reason we have to consider a node for this water as a demand in integrated model (WEAP). These corrections improve the integrated model. In figure 8 it can be seen in Schematic of WEAP model.

It should be explained, that the amounts intended for monthly artificial recharge node were estimated and as approximate based on discharge of river in inlet and outlet with extraction and using of water resources.

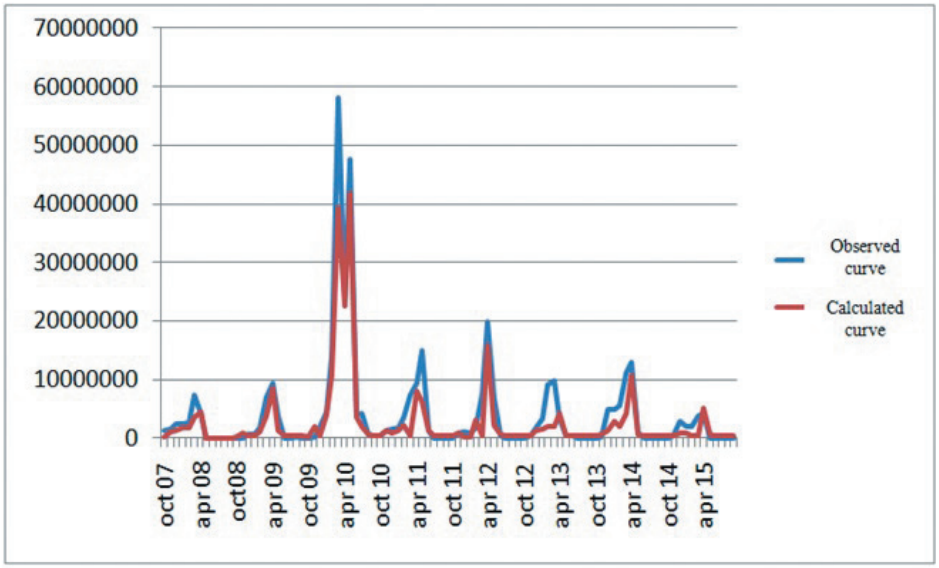

Fig. 9- Comparison between observed and calculated hydrograph of river in outlet station (DOAB-MEREK), after improvement of model.

6- Conclusion

The area under investigation for create and run of integrated model in the name of Ravansar-Sanjabi studying area, Due to complex geological conditions, especially structural Geology, Despite the long-term rainfall and discharge data, The initial model calculated, could not be a good fit with the real world, and It is safe to say that in the lack of detailed geological and geophysical studies, we cannot create and run the proper model in this area. This experience shows, With the exception of a very simple and clear geological and structural condition of a studying area, it is essential, detailed geological and structural and also geophysical studies, about other studying areas, must be done.

In this regard, it must be emphasized being geologist in the researcher groups can be very useful.

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