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The decrease of underground water surface, subsidence and ground drying in Minab plain: A horrible catastrophe

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Abstract

Minab Plain is one of the most significant plains of Hormozgan province. The increase of population, development of agriculture and consecutive droughts have led to excessive withdrawal and pressure on the plain's water resources as well as the fall of the level of underground waters. Due to the decrease of underground water's level, any exploitation of this plain has been prohibited since 2007. The fall of the level of underground waters has led to subsidence of the ground and numerous fractures of the plain. The vegetation of the plan is destructing. The palm trees with an age of thirty to forty years have dried and numerous cracks on many of the surrounding buildings are evident. The channel of wells has "lengthened", the local access roads have been destructed and power poles are falling. The subsidence of the ground in the villages of Gavmish, Chello-Gishno, Gourzang, Nasirai and Tomback is evident. The results of initial studies show that the most severe drop of the level of underground water has occurred since 2001.

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Introduction

One of the most significant problems regarding the excessive withdrawal of underground water is the reduction of the level of water reservoirs and densification of layers and depositions. The drop of the underground water level leads to decrease of the hydrostatic pressure of the reservoirs and as a result, the solid component or matrix of the reservoir might lose its stability. This leads to compaction of particles and removal of useful inter-particle spaces, especially between silt and sand particles (Khalkhali, 1995). The phenomenon of ground subsidence might cause many problems such as destruction of buildings and channels, downfall of the walls of wells, cracks and fractures of the ground and its change of surficial slop as well as increase of probability of flood, gradual sinking of structures, modification of slope of the rivers and roads of the region. Usually, the phenomenon of ground subsidence does not occur immediately with the exit of the fluid but in a long time after the withdrawal of the water (Scott, 1979).The level of ground subsidence ranges from 1 to 50 cm per 10 m of fall of water level the extent of which depends upon the thickness and compression of the layer, loading duration, type and rate of stress (Lofgren, 1969).

The phenomenon of ground subsidence might cause many problems such as destruction of buildings and channels, downfall of the walls of wells, cracks and fractures of the ground and its change of surficial slop as well as increase of probability of flood, gradual sinking of structures, modification of slope of the rivers and roads of the region (Lashkaripur, Rostami, Barani, Kohandel and Tarshiri, 2006).The compaction of soil context leads to the decrease of penetrability during the rainfall which not only influence the instability of the ground and existing structures but also makes the catchments unusable for the next rains and as a result, the region will be perpetually deprived of the potential to use underground waters (Milani, 1995). In Iran, the study of ground subsidence dates back to thirty five years ago and if this phenomenon occurred solely in some provinces such as Kerman and Yazd, most of the other provinces are currently facing the problems of subsidence of the ground too. This problem becomes evident in the increasing number of regions in the country. The subsidence of Mashhad Plain is due to unchecked withdrawal of underground water in the region which occurs through drilling unauthorized and illegal wells (Rahnamarad, Farhang and Hosseini, 2009). In regard to all the cases of subsidence occurring in Iran, the withdrawal of underground water is the sole factor or the most important one behind the subsidence (Haghighat-Jo, 2011). This phenomenon has occurred in most of large cities of the world such as Kolkata in India (Chatterjee, 2006) and Bangkok in Thailand (Phien-wej, 2006) the reason of which was unchecked withdrawal of underground waters.

Minab Plain is one of the most significant plains of Hormozgan Province. The significance of this plain is due to supply of a significant share of drinking water for Bandar Abbas, Minab, Bandar Khamir and agricultural channels of Minab. The unauthorized and continuous exploitation of underground water resources of the plain leads to decrease of underground water level, the shortage of water in the reservoirs and their loss of quality. Based on the figs, the plain faces the reservoir's water shortage of 182.137 x $10^{6}km^{3}$ from November of 1986-87 to November 2006-7. About 9.107 x 10^{6} km^{3} is annually added to the shortage of the reservoir (Regional Water Company of Hormozgan, 2008). The aim of this study is decrease ofunderground water surface, subsidence and ground dying in Minab plain and The results of initial studies show that the most severe drop of the level of underground water has occurred since 2001.

Materials and methods

Studying Region

Based on the national divisions, the studying region is located in Minab town of Hormozgan Province in the south of Iran. The Minab Town leads to Bandar-Abbas Town in the west, Rodan in the north, Beshagerd and Visiric in the east and southeast and Hormoz Strait in the south. Minab Plain is located between 56 degrees and 48 minutes to 57 degrees and 15 minutes East and latitudes of 26 degrees and 1 minute to 27 degrees and 27 minutes North the vastness of which amounts to 1378.18 km^2. The area of the plain is about 788 km^2. The Minab Plain is an alluvial plain which leads to the sea through the depositions of the fourth era with a significantly low slope (0.5 %). The maximal height of the plain is 50 m and its minimal height is zero. The main river flowing into it is Minab River the upstream of which originate from the highlands of Rodan, Manoan, MosaferAbad, Fariab, Glashgard, etc. The Minab Plain leads to Kerman in the north, the regions of Shemil-Takht and Ghale-Ghazi in the west, and Persian Gulf in the south. The location of the studied region in Iran, Hormozgan Province and Minab Town is shown in Fig.1

Geology of Studied Plain

The plain is controlled by the significant faults of Zendan and Minab. These faults have northwest-southeast direction which cross the western highlands of the plain and after passing through the lake of Esteghlal Dam of Minab, they lead to Kerian Plain and southern regions. The northeastern highlands of the pain are covered by a colorful set (Jurassic-Cretaceous) made of sandstone, siltstone, and limestone. The eastern highlands are made of calcareous sandstone (Eocene- Oligocene) covered by a Flysch sequence of sandstone, siltstone and lime. The green-unit eastern highlands (Miocene) is covered by a lithology of shale, sandstone, calcareous mudstone with gypsum.

The eastern and southeastern highlands is covered by Macron-like unit (Miocene- Pliocene) which includes four units of ear marl, Khago's sandstone, Tiab's sandstone, and conglomerate of Minab. The southeastern mountains is covered by a palamy conglomerate (Miocene - Pliocene). The alluvial depositions of the plain in the eastern borders, especially in the entry of large-grained Minab River, is generally made of gravel and sand which is accompanied by gradual reduction of diameter of the particles towards the sea (i.e. the west) and change into fine-grained depositions of silt, sand and clay with a content of saline water.

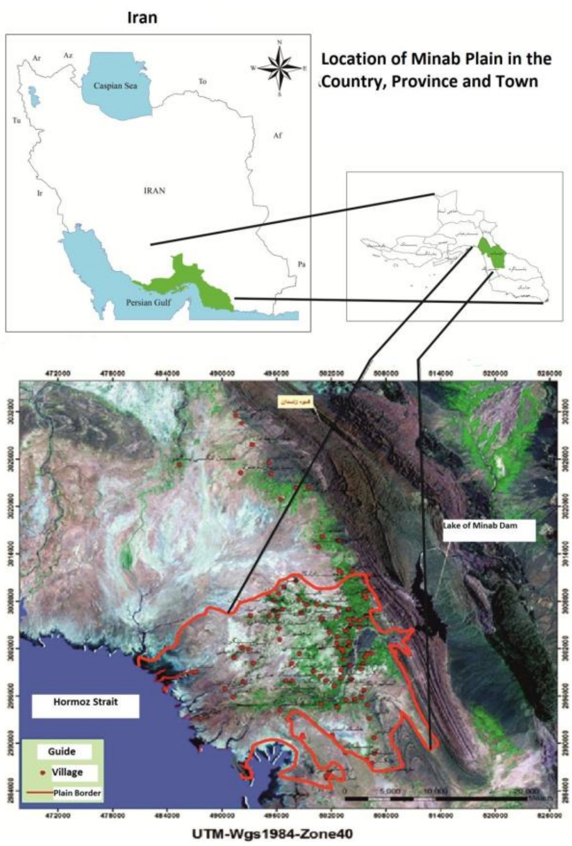

Fig. 1. Location of Minab plain in country, province and town.

The risk of ground subsidence occurs due to reduction of underground water. Based on studies, the subsidence occurs in a longer time of underground water withdrawal. Because of the significance of the phenomenon of subsidence and dryness of the land due to subsidence of underground water level, the present study examined the hydrographic diagram and hydrologic plan of the plain during the past 20 years.

Result and discussion

Analysis of Decrease of Underground Water Level of Plain

Minab Plain is a part of catchment basin of Minab River at the terminal section of the river. The river's water enters the plain and pours into the lake of Esteghlal Dam. The Minab River directly enters the catchment area of Minab Plain from Northeast and leads to the lake behind Esteghlal Dam with southern direction. The river continues its flow in southwestern direction which finally pours into Oman Sea. The direction of underground flows relatively follow the surficial flows and topographic slope of the region. The underground waters flow towards the center of the plain from northeastern direction towards the southwest of the plain. The slope of underground flows, gradually decreases from the surroundings to the center and southwest of the plain. The general slope of underground waters is from northeast to southwest.

Computation of Hydrologic Plan of the Plain

Based on the characteristic hydrograph of the plain (Fig. 2), the level of subsidence from the initiation of the plan in the November 1986-87 to the end of the period in November 2007-2008 in a statistical length of 20 years showed general reduction and the level of underground water of the plain decreased from 10.86 m to 6.37 m which showed a drop of 4.49m in 20 years or averagely 0.224 m per year. By considering the area of the plain (579.5 km^3) and the storage coefficient of 7%, the deficiency of the reservoir from 1986-87 to 2007-2008 is estimated to be 182.137 x 10^6 m^3 (with mean annual variance of 9.107 x 10^6 m^3 of underground water reservoir).

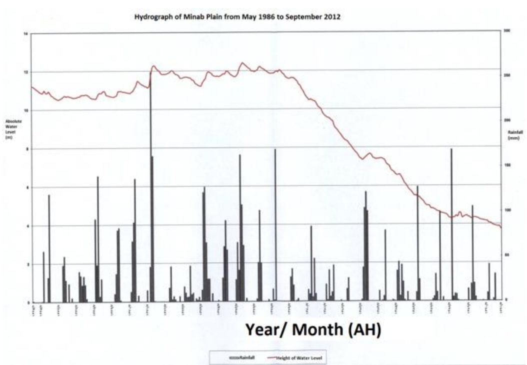

Fig. 2. Histographic diagram of Minab plain.

The hydrographic analysis of the plain showed that the decrease of underground water level has increasing trend which was significantly high in 2001. The severe consecutive decrease of underground water level started since 2001 the reasons of which might be brush shortage, drought, increasing number of wells and disconnection of feeding water channels from the Esteghlal Dam of Minab.

Ground Subsidence in Southwest

In the southwestern side of the plain are the villages of Gorzang, CheloGavmishi, Chelo Gishno, Tombak and Nasirai. This area is one of the most significant ones facing severe decline of underground water level, subsidence and existing horrible conditions.

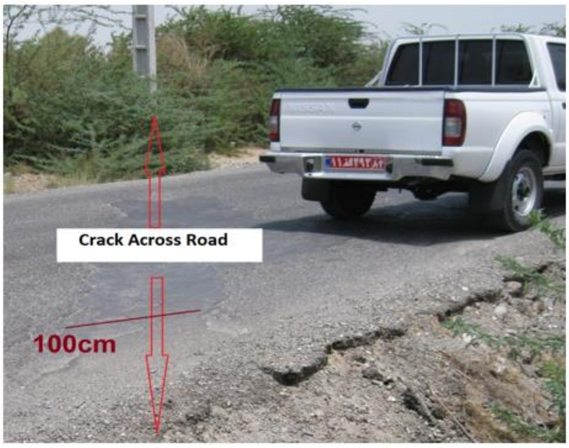

Fig. 3. Passing of crack across road in Chelo Gavmishi village.

Fig. 4. Development of a ditch.

As a result, the cracks, longitudinal fractures, clefs of the buildings and surficial fractures of roads as well as drying of the wells are observed. For instance, the pictures of this phenomenon are representative of this issue which is developing from the southwest to the center of the plain. The analysis of hydrographic diagram of the plain and the existing data of the plain for the past 20 years show the continuous decline of underground water level from 2001 to 2006 is equivalent to 5.02 m for the presumed period.

Fig. 5. Tubing and drying of the well in Gorzang village.

Fig. 6. Catastrophic drought by unchecked withdrawal of water.

Conclusions

In the southwestern side of Minab Plain, the ground sinks along with frequent fractures and ditches are observed which are due to unchecked exploitation and severe reduction of the level of underground waters. This phenomenon has led to subsidence of ground level and significant damage of the surface of the ground. The presence of these issues should be attended to from the design of simple structures such as a local road to large structures and even the development of agricultural lands and farms.

The severe decline of water level started since 2001 so that its level got to less than 4 m in September 2012. The decrease of water level from 2001 to 2012 was about 8 m. The local people believe that from 2002, some fractures emerged on the surface of the ground but their rate of development increased during 2006-7.

To prevent from the resumption of this phenomenon and atone for the negative potentials of underground water resources, we should utilize the mechanized and improved irrigation methods instead of traditional ones. To continuously control the subsidence of the ground, the GPS measurement stations should be installed in the whole area of the plain.

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References

Chatterjee RS, Funeau B, Rudant JP, Frison PL, Lakhera RC, Dahwal VK, Saha R. 2006. Subsidence of Kokata (Calcutta) city, India during 1990s as observed from spacing differential synthetic aperture radar interferometry (D-InSAR) TECHNIQUE, remote Sensing of Environment **102**, 185-176.

Haghighat Jo P, Valdan-Zoj M, Sahebi M, Dehghani M. 2011. Measurement of subsidence of Hashtgerd Plain due to extraction of underground waters through InSAR technique.

Khalkhali G. 1995. The natural characteristics of underground water resources and their significance in Iran. Collection of Papers for the National Conference of Underground Water Resources, Sirjan.

Lashkaripur G, Rostami Barani H, Kohandel A, Tershizi H. 2007. The subsidence of underground water level and drop in Kashmar Plain. Collection of Papers for the Tenth Conference of Geological Science.

Lofgern BE. 1969. Field measurement of aquifer system compaction, Sanjoaquin Balley, California, U.S.A , Proc, of Tokyo, Symp, on land subsidence, IASH-UNSCO, 272-284.

Milani H. 1995. The additional withdrawal of underground water resources and its effects. Collection of Papers of National Conference of Water Resources.

Rahnamrad J, Farhang R, Hosseini SA. 2009. Subsidence of Mashhad Plain due to unchecked withdrawal of underground waters. *Journal of Geology and Environment of Eslam Shahr* **5**,135-146.

Regional Water Organization of Hormozgan Province. 2008. Balance report of hydrology of Minab Plai. Department of Studies of Water Resources of Hormozgan Province.

Scott RF. 1979. Subsidence – revaluation and prediction of subsidence. In Saxema, S, K, Proc. Cnof. ASCE, Gainsville 243- 256.