II－3 LAND SUBSIDENCE DUE TO WITHDRAWAL OF GROUND WATER IN RAFSANJAN PLAIN, IRAN

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INTRODUCTION

The importance of land subsidence due to withdrawal of ground water over the world has been realized, such as the cases in, Venice in Italy, Mexico city in Mexico, San joaquin valley and Santa clara valley in California USA, Wariake in Newzeland, Far west land in South Africa, Latrobe valley in Australia (Poland, 1984), Tokyo, Osaka, Niigata, Saga, Chiba, Mie, Fukushima and etc in Japan (Tohno, 1992).

In Iran, the overdraft of ground water produce major ground water problem in Rafsanjan area today. It is a subbasin that is located in the nearly central of Iran, having an area of totally 10905 square kilometer and with a general elevation between 1400-1500 meter above sea level (Fig.1). Since about 1980 the use of ground water for irrigation in this area has increased rapidly. In Rafsanjan area recognize many problems such as ground water table depletion, increase the salinity of ground water, land subsidence and consequently earth fissures and cracks in buildings, because of overdraft of ground water. This paper present information on status of land subsidence in Rafsanjan area, describe the geological and hydrogeological condition, and suggest further work needed as a basis for making plans to alleviate or minimize the various problem caused by land subsidence.

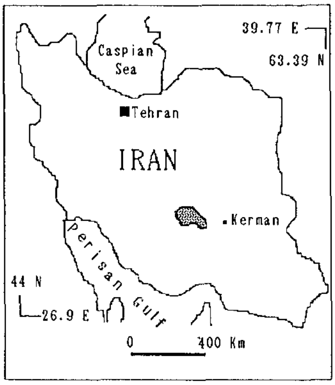

Fig. 1 Location map of Rafsanjan plain

GEOLOGICAL SETTING

The broader area is a grabben that surrounded by Paleozoic to Paleogene rocks that filled with material eroded from these rocks. Also included in the basin are lacustrine sediments. In general, alluvial materials deposited in the Rafsanjan basin consist of heterogeneous unconsolidated mixture of clay, silt, sand and gravel that locally contain cobble, salt, and gypsum. These materials grades from coarser to finer grained with increasing distance from their sources in the surrounding rocks mentioned above.

On the basis of geophysical investigations, the average thickness of alluvium is 180 meters in Southern parts, 100 meters in the NW, and 20 meters in the North. The maximum thickness of alluvium is 320 meters in this area (RWO)

GROUND WATER UTILIZATION

Since ancient time, ground water has been used for irrigation and drinking by under ground channels (Kariz or Qanat) and handmade wells. Total number of wells have increased from 209 to 1359 in the period of 1969 to 1989 , and consumption of ground water in Rafsanjan plain increased about five times from 1969 to 1989 (Table 1) Ground water level has dropped due to increasing pumping rates. This excessive pumping of ground water for agriculture has caused the ground water level to decline about 17 meters in the Rafsanjan plain. Since 1973, the ground water level has been monthly measured in the basin. It is measured in 76 wells at present. Figures 2 shows annual and monthly variation of ground water level at some measuring wells.

LAND SUBSIDENCE AND EARTH FISSURES

Subsidence of land surface has been noted in whole area of Rafsanjan plain that cause serious obstacles to agricultural development and urban areas and ascribed to various causes. The phenomena were firstly reported by farmers in 1977, and since then were gradually increased resulting to increase salinity of ground water due to compaction of lacustrine sediments and intrusion of existing saline water in these sediments with ground water, earth fissuring and consequently infiltration of irrigation water to these fissures, and cracks in buildings. Unfortunately, there is not any systematic instrumentation for measuring ground level changes. The only available information is from farmers that must cut the casing of their wells. It seems that the ground surface has been subsided more than 80 centimeters.

Earth fissures exist throughout of Rafsanjan plain. The trends of large earth fissures are more and less parallel to trend of surrounding mountain. The depth of measured fissures in Rafsanjan plain range from 0.2 meter to more than 6 meters. In general, conspicuous characteristics of the earth fissures in Rafsanjan plain are: a)they first appear as narrow cracks and water flow and erosion then led to widening, deeping and interconnection of the cracks, ultimately producing fissures more than one kilometer in length, several meter wide and several meter deep, b)most of the fissures trend NW-SE and parallel to the trend of surrounding mountain, c)large fissures almost form either between or immediately adjacent to agricultural areas, d)they are generally narrow and shallower across roads as compared to adjacent undisturbed lands.

Table 1 Total discharge of ground water

Year	Discharge (million cubic meter)	Number of wells
1969	148.9	209
1971	337.5	587
1973	320	625
1974	432.6	786
1975	392.9	908
1976	424.3	1032
1981	712.8	1503
1983	651.5	1258
1986	686.9	1478
1989	759.3	1359

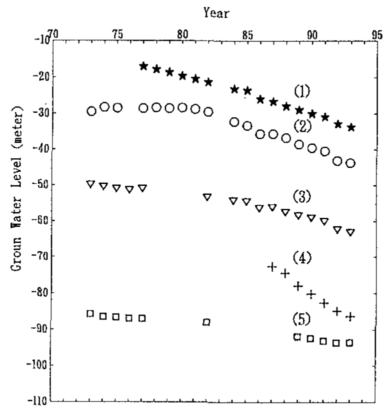

Fig. 2 Annual change of ground water level in some investigation wells in Rafsanjan plain

CONCLUSION

In arid area, like Rafsanjan plain, due to regional aridity the recharge of available local ground water will soon be more than offset by pumping, resulting in an overdraft. Large scale withdrawal of ground water to meet the needs of agriculture and population growth in Rafsanjan plain has resulted in about 17 meters depletion of ground water level. These ground water decline has caused aquifer compaction that has resulted in land subsidence accompanied by earth fissures. Earth fissures presents serious problems for urban, rural and agricultural areas.

If rates of ground water withdrawal from the alluvial deposits in the studied area continue to exceed inflow, like present condition, continued land subsidence accompanied by earth fissures can be expected and existing fissures will enlarge and extend. Therefore, the reduction of ground water pumping volume must be considered in the area. For further study, the following items are necessary: 1) drilling of some boreholes up to bedrock associated with sampling and testing to provide needed parameters for recognition of sediments capable of creating subsidence prediction the amount of subsidence under different conditions including compressibility, initial stress and change in stress, number and thickness of compressible soil layers, and permeability of soil layers, 2) instrumentation for measuring the land subsidence in the area.

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