Investigation the impact of flood spreading project on groundwater level

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Abstract
Percolation of flood waters into the bed and banks of ephemeral streams provides one of the key mechanisms responsible for transmission loss.The purpose of this paper is to delineate and explain variations of groundwater quality and groundwater discharge in relation to flood spreading. A total of 10 dug wells were sampled from the study area. Groundwater level was measured after any floods spreading in 10days interval for 3 month and also in the day that flood evevent was occurred. Depth of study dug wells range from 40 to 65 m below ground level in the study period . Our results indicate that the floodwater spreading can influences groundwater level. These results shows that floods water can interact with the neighboring aquifer during flood spreading projection. Stream water levels that rise in response to runoff may result in lateral water flow into the neighboring floodplain.

Key words: *Flood spreading projection, Groundwater quality, Groundwater level*

Introduction
Floodplain associated with streams is of particular importance because of the significance of their cumulative impacts on downstream water quality and groundwater level. Knowledge of the exchange between groundwater and surface water bodies is essential for evaluating the role of riparian floodplain processes on water quality and groundwater level variation (Angier et al., 2005; Rassam et al., 2005).

In the arid and semi-arid areas, rainfall distribution is bimodal and highly skewed with the highest, rainfall amounts and intensity, being received in the winter and spring. The annual evaporation is high, and exceeds annual rainfall for most part of the year (Stephen et al, 2008).The high intensity and short duration convective of rainfall cause the extensive overland flow.

High evapotranspiration and low rainfall in arid area is the most limiting factor to socioeconomic development in the river basin (Kithinji and Liniger 1991). Excess evapotranspiration and low precipitation during subsequent dry seasons has been conduced to increased groundwater abstraction for enhance crop production (Stephen et al, 2008). Ground-water abstraction increases from 20% in the wet season to over 70% in the dry season (Aeschbacher et al. 2005). The water demand has been increasing continuously due to population growth, and cause farmers immigration to adjacent high agricultural potential .Subsequently, immigration has resulted to land use change in the lower zones from natural vegetation to small-scale agriculture, which have led to increased ground-water abstraction. Hedelin (2007) and Xia et al. (2007) indicated that pressure on the world's water resources is increasing, restraining social and economic development in many countries, and threatening ecological values in others. Moreover, in arid and semiarid area, bimodal and highly rainfall leads to infrequent flood that can be extremely damaging (Kowsar, 1992).

To reduce the impacts of persistent intra-seasonal drought and also to reduce flood damaging, rainwater storage is a prerequisite in arid and semiarid area that keeps water far from evapotranspiration, increase groundwater level and decrease flood hazards (Kowsar 1992, Rejani 2008).

There are several techniques for implementation of water harvesting based on farming and watershed management policy.Flood spreading is one of the suitable methods for flood management and water harvesting that increase the ground-water recharge (Dhruva et al.,1990). Flood spreading and management would not only reduce negative environmental effects such as soil erosion through reduced runoff, but also reduce water pressure and direct stream flow abstractions during the dry seasons (Al-Qudah,2009). Floodplain associated with low-order streams are of particular importance because of the significance of their cumulative impacts on downstream water quality (Angier et al., 2005; Rassam et al., 2005). Knowledge of the exchange between ground-water and surface water bodies is essential for evaluating the role of riparian floodplain processes on water quality and groundwater level variation. Flood-water directly can influences groundwater flow level in the area with high groundwater level. Surface water may interact with the neighbouring aquifer during flood events. Stream water levels that rise in response to runoff may result in lateral water flow into the neighbouring floodplain. In the area with high ground-water level, this water is slowly released back to the stream when the stream water level drops (Todd, 1955., Kondolf et al., 1987., Peterjohn and Correll, 1984).

In lowland rivers, water is continously exchanged between the river and its floodpalin through groundwater.In arid and semiaride regions, modification to this exchange (through flood spreading, dams,etc) have been implicated in ground-water level and ground-water chimical properties of river and floodplain.However, the impact of modifying the groundwater-surface water regime on groundwater level and groundwater quality is not as well know.The purpose of this paper is to delineate and explain variations in groundwater rechaarge and groundwater quality along a ephemeral stream that has been modified by canalizations.

Study site

The study site named Hajitahere (latitudes 28°52' 28" N, longitudes 54°41'30" E) located in a catchment 25 km west of Darab, Fars, Iran. Darab has been located in arid and semi-arid zone with hot and dry summer and cold and dry winter.

The main study area, which FSP located there, has 2.2 km long and 1.5 km wide. General slope in the flood plain is between 1- 5 percent.

Data monitoring

In the flood projection area, some dikes have been made on isoaltitude lines. There are some overflows for leading extra floodwater to the other dikes. The distance of overflow spacing is about 50m. Immediately after each dike, a settlement basin (spreading channel) was made for water relaxation and suitable time for more penetration. Water spreading designed as the water was transported by transition channel to the first diffusion channel and separated behind of the first dike . After inflowing of water to this basin, water will reach to a particular level (0.2 m) for spreading inside the FSP region. When the level of water behind of the first dike reaches to a level that all soil surfaces were irrigated, water will be transferred to the second diffusion channel by the overflows. Hajitahere is an ephemeral river that its flow (about 10 yearly peak flows) distributes on FSP area. The mean yearly flood water of this river is about 1 million m^3.

A total of 10 dug wells located in downslope of FSP area were sampled from the study area. Figure (1) indicat the schematic of study area and location of wells. Studied welles were located in different distance from FSP area and also in different distance from main river.Groundwater level was measured after any floods spreading in 10 days interval for 3 month and also in the day of floods events .Based on gerounds-water mesurement, monthly change in groun-water level was calculated and compared .

Results

The study area has a mean annual rainfall of 290 mm of which 85 % was occurred in the autumn–winter period, 13% in the spring and only 2% in the summer (Figure 1). The mean annual air temperature is 22° C, ranging from 9.6° C in January to 34° C in July.Ground-water level was maximum in the summer and increased with increasing of rainfall. Maximum ground-water level was observed in February. In the wet season,with increasing of rainfall , ground-water obstraction for irrigation decreased and in the same time flood storage increased , consequently ground-water level from soil surface decreased (Figure 2) .

Ground-water level dropped continuously throughout the study periods. The means of ground-water level was about 45m in hydrological years 2004-2005 and increased to 65m in 2008-2009 . Because of the sharp decreas of rainfall and during studied years , ground-water recharge by surface water has been decreased (Figure 3a). Mean of yearly rainfall was 375mm in 2004-2005 hydrological years and decreased to 147, 275, 87.5, and 175mm respectivly for 2005-2006 to 2008-2009 hydrological years.Morevore,irrigation water requirements were increased with decreasing of rainfall and so more wells were dug and ground-water abstraction extracted each year. Due to imbalance between extraction and supply, the groundwater level dropped at an annual rate of 3 to 5 m. The water table depth from soil surface was about 42m, 45m, 42m, 48m and 61m respectively for 5 hydrological study years.

Table (1) shows ground-water level change for 10 wells located at different distance of FSP area for 3 month interval after flood evevents compared to ground-water level in the days that flood spreading area was irrigiated by flood.Results shows that ground-water level rise after flood spreading in all wells. Recharge of ground-water was maximum in 2th month after flood events (figure 4a shows the results of 5 studied wells) and decrease with increasing distance from FSP area (figure 4b). No scignificant different was observed due to distance of studied wells from main rivers(figure 4c)

Discusion

Ground-water level decreased continusely during 5 hydrological studiedyears.The Increasing of ground-water level from soil surface in the studied basin is alarming and urgent attention is required to reverse the trend. The cumulative effect of water abstractions in this area is reflected by dropping of ground-water level. The case study, which is representative of water crisis in other sub-basins in arid and semi arid area, was used to demonstrate this scenario. The water crisis is aggravated by poor water governance system, which has led to over abstraction of irrigation water and low water use efficiency. This has led to high proportions of unauthorized water abstractions.Results show that ground-water level can affected by groud-water spreading in the upstream of wells. The results show that flood storage can provide a feasible water management option, which may reduce the demand on ground-water abstraction during dry and wet seasons. This means that excess runoff and flood flows would be stored and used for ground-water recharge during wet period of years.

Flood storage ensures water availability throughout the dry season. Another positive impact of flood storage is runoff reduction, which would reduce land degradation related to soil erosion. Soil erosion depletes agricultural lands of fertile top soil and also leads to sedimentation of water bodies. This FSP designed also for decreasing number of point that needed for flow transfer from road located in downstream of FSP area. This project increased the number of point to half and so increased costs of road construction.

Finally, flood storage and management can be one of the sustainable solutions for ground-water recharge if supported by responsive policies and institutions that will adopt integrated water resources management principles and embrace direct and indirect actors and stakeholders.

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Table 1: Ground-water level change in tree month interval after flood event

Well sample No.	Distance from FSP	Distance from river	Ground-water level change after flood event (cm) One month	Two month	Three month
1	250	120	0.196	0.452	0.386
2	262	510	0.165	0.354	0.345
3	271	420	0.154	0.279	0.258
4	310	270	0.165	0.325	0.278
5	460	152	0.145	0.241	0.123
6	480	570	0.12	0.16	-0.11
7	1100	105	0.06	0.19	-0.41
8	1600	180	0.06	-0.19	-0.31
9	1670	410	0.05	-0.16	-0.46
10	2050	345	0.03	-0.11	-0.48

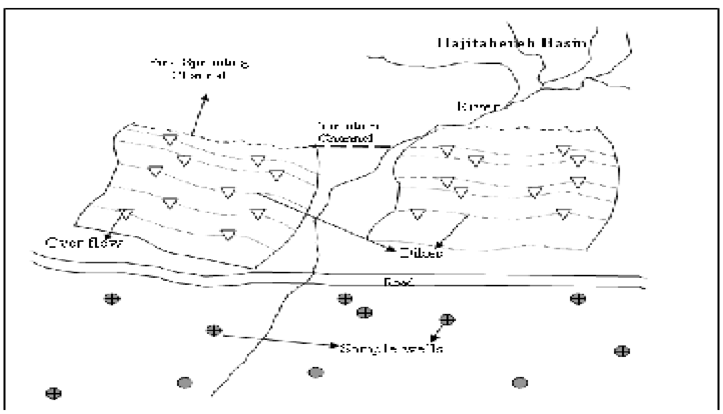

Figure 1. Schematic of study area and sampled wells

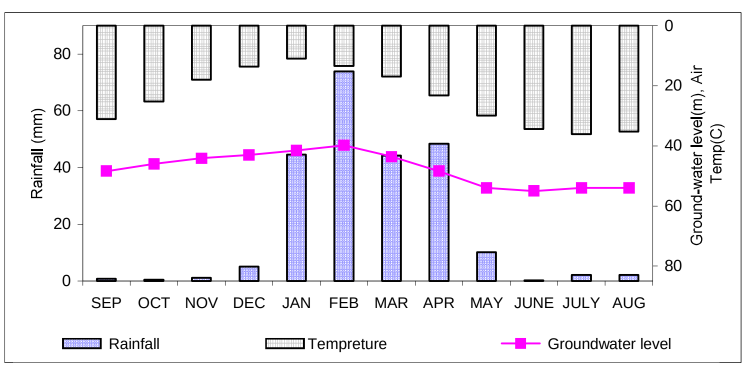

Figure 2: Average monthly rainfall, temperature and ground-water level in study area

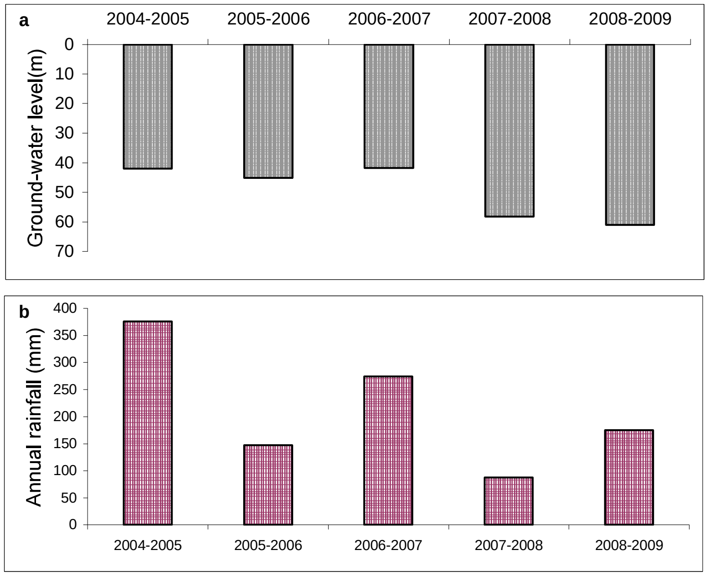

Figure 3. Mean of yearly ground-water level (a) and mean of yearly rainfall (b) during study period

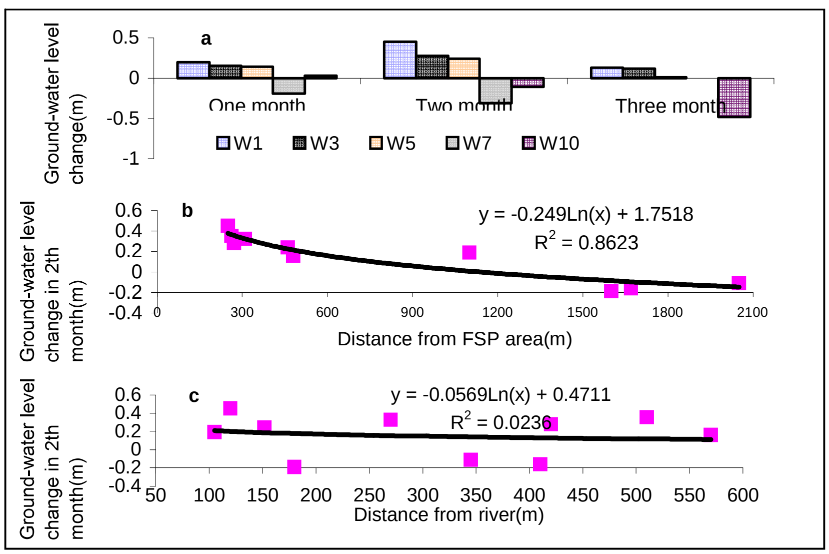

Figure 4. Mean of ground-water level change after flood event (a), in relationship to distance from FSP area (b) and in relationship to distance from main river(c).