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Field evaluation of abandoned open well for recharging surplus canal water

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Punjab is predominantly an agricultural state and about 70% of irrigation demand is fulfilled by groundwater. Consequently, the water table is declining. Recent studies conducted by CGWB and Water Resources and Environment Directorate, Punjab have concluded that if the present rate of extraction continues, the available ground water resources will exhaust within 20 to 25 years.Paddy and wheat are the major crops of Punjab covering 75 and 87 % of cultivable area whose water requirement is very high. During the last decade, there has been evident increase in extreme rainfall events and the findings of the climate change support increased winter rainfall. Fundamentally, wheat requires 4 to 6 irrigations in growing season. However, the reception of desired amount of rainfall at suitable timing during *rabi* season may reduce this requirement to one or two irrigations only. The state has a good canal network, so at these times, farmers do not consume their canal water share. As a result, canal water drained back to river without any beneficial use. However, this surplus canal water can be used to recharge groundwater.The abandoned wells that have gone dry due to continuous lowering of water table can be used for groundwater recharging the surplus canal water, with little cost and minor land modifications on the farm.Keeping in view the discussion, present study was undertaken to evaluate the performance of abandoned open well for groundwater recharge using canal water on long term basis.

Location of abandoned well

This study was conducted at the Research Farm, Department of Soil Science, Punjab Agricultural University, Ludhiana in 2017. Geographically, Ludhiana is situated in Indo Gangetic basin where subsurface formation comprises of sand, silt, clay and khanker in different proportion. Water table depth varies between 4.32 to 31.22 m below ground surface before the onset of monsoon and remains within 2.89 to 27.30 m after the monsoon season. Analysis of the long-term water table data shows thatthe water table is declining at a rate of 0.11 to 1.34 m/year in the region.Average annual rainfall of Ludhiana district is 681 mm, (CGWB 2013) 78% of which is contributed by south west monsoon between June to September and rest 22% is received in non monsoon period due to western disturbences. In general unconfined aquifer occur in this region.

Selection of abandoned well was based on its nearness to canal and availability of aquifer with good hydraulic parameters. Initially, the well was filled with agricultural waste like paddy straw. After removing the filled up waste material, top few centimeters thick sand layer of aquifer is also removed.

The dimensions of open well are presented in (Fig 1). The open well was covered with iron grill for safety. The inner surface of abandoned open well chosen for study was lined up to aquifer bed.

Recharging through well

A 10.16 cm size PVC pipe of length 7.11 m was used to convey water from water course (getting it supply from main canal) to the recharging site. A water meter was installed at a distance of 3 m from the open well to monitor the volume of water recharged through it. To restrict the entry of tree leaves and other organic matter into water meter, a net of suitable mesh size was fixed at the entry of water into pipe.

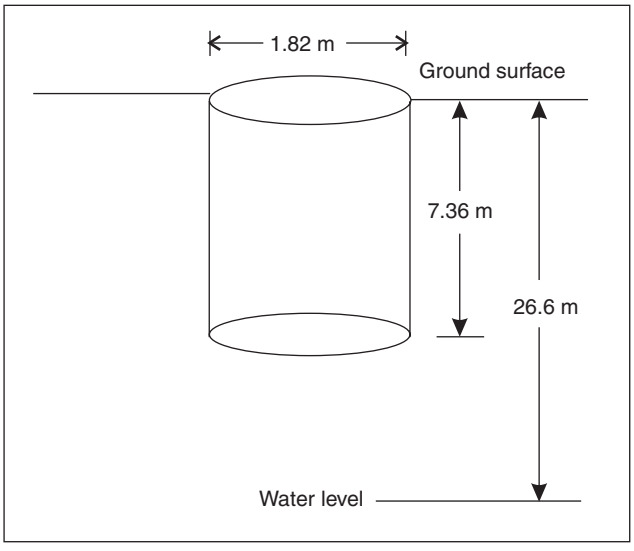

Fig 1 Dimensions of open well

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Open well was filled up to depth of 6.35 m. Flow into the open well can be regulated by using flow control valve fixed at inlet. For maintaining the constant head recharging conditions, overflow pipe was fixed in the well at a depth of 1.01 m from the ground surface. An observation well of 10 cm diameter was installed at a distance of 2.5 m from the open well centreto monitor water table fluctuations during recharging operation. Water table depth was monitored using water level indicator.

Water quality of recharged water

Canal water quality was tested for total suspended solids (TSS) because it affects the rate of recharge. Using the standard procedure, TSS in canal water was monitored daily during the recharging operation.

Groundwater recharging through abandoned well

Recharging operation through abandoned well was performed for net 24 days (from 9:00 to17:00 hours daily). For the complete experimentation, average recharging rate varied from 4.2 to 2.7 l/s. Normally, the TSS in canal water was in the range of 10 to 20 ppm. However, on 22nd day of recharging, it was monitored equal to 60 ppmwhich has drastically reduced the recharging rate. Rinck-Pfeiffer *et al.* (2013) and Bloetscher *et al.* (2014) reported that clogging was major problem for reduction in recharge rate which leads to failure of artificial recharge structure.To overcome this problem a six-inch layer of brick blast was kept at the bottom of the well which absorb most of the silt load coming with the water.

Water table depth

Water table fluctuation with respect to time for eight days during the experimentation is presented in (Fig 2). Maximum rise of 12 cm in water table for 8 hr was observed on 1st day of recharging that reduced to 3 cm on 24th day of recharging. This reduction in rise of water table can be attributed to the decrease in recharging rate.

Abandoned wells are suitable infrastructure for augmenting groundwater by using surplus canal water. So these abandoned well can be used for groundwater recharging with little cost and minor land modifications on the farm by using surplus canal water. Narjay *et al.* (2014) reported that recharge wells installed at various locations in the Karnal district has indicated a rise in water table amounting 2.32 and 3.16 m during the years 2009 and 2010, respectively.Water intake rate of aquifer can be enhanced by filtering the water to standard norms. Surely, the groundwater situation in the state can certainly be improved if the farmers adapt this practice as like other agricultural practices.

SUMMARY

Groundwater plays an important role in fulfilling ever-increasing demand for water by agricultural, industrial and domestic sectors. Due to its availability at the point of use, farmers prefer groundwater for irrigation, which results in over-exploitation of groundwater resources. Analysis made for Punjab's 138 blocks till 2017 has revealed that only 22 blocks were in safer zone (CGWB 2018).Study by (Brar *et al.* 2016) shows that from 1998 to 2015, area having water table

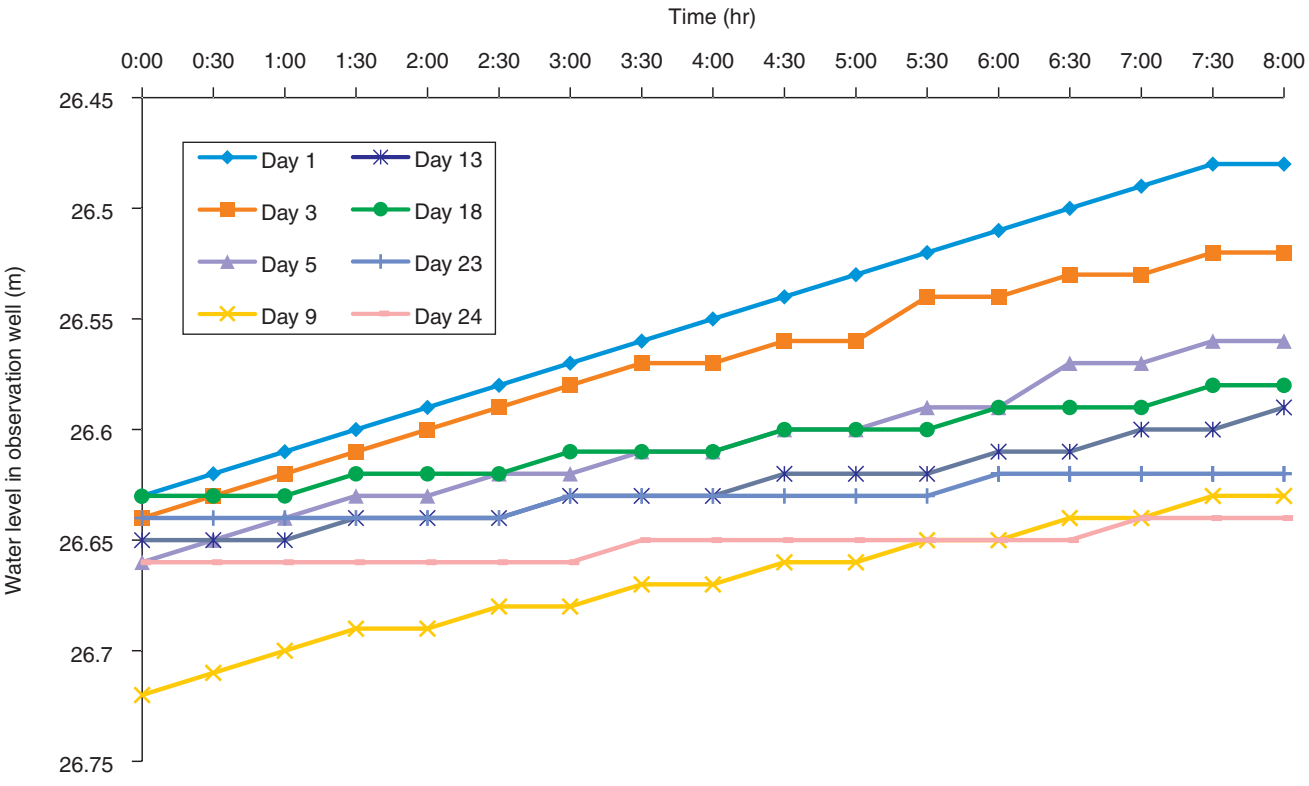

Fig 2 Water table fluctuation

depth greater than 10 m in Punjab has increased from 20 to 69 %so to overcome this problem recharge of groundwater is one of the important viable solution which draw our attention on artificial groundwater recharge.The declining trend of groundwater can only be arrested by augmenting and using it judiciously. Groundwater augmentation is a process of replenishing aquifer by adding excess water (available from canals, storm water or rainwater harvesting (rooftop or surface)) with the assistance of some structure like abandoned well, ponds, pits and injection wells after proper filtration.In Punjab there are at least 1.45 lakhs of abandoned wells present which can be used for recharging purpose (Anon 2003). Emily *et al.* (2016) study shows that the dry wells can be used for aquifer recharge.So, In the present study, field evaluation of groundwater recharge through abandoned well using canal water under constant head conditions in an unconfined aquifer was performed. During 24 days recharging operation, net2000m^3 of canal water was stored in the water table aquifer. However, the recharging rate was decreased from 4.2 to 2.7 l/s during complete operation. Reduction in rate of recharge was mainly due to increase in total suspended solids (TSS) of canal water.

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