SIMULATION OF FARMERS' PRACTICES FOR GROUNDWATER EXTRACTION IN PUNJAB

By

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The most serious problems in the Indus basin are salt upcoming due to unregulated use of groundwater, salinity and water logging. Amongst various measures to control water logging and salinity in the Indus basin, the use of skimming well is considered appropriate as: (1) it provides relatively fresh groundwater for irrigation purposes, and (2) it is an economical way of drainage to prevent water logging. Many authors such as Saeed et al. (2002a,b), Asghar et al. (2002), Saeed et al. (2003), Ali et al. (2004), Saeed and Bruen (2004), Saeed and Ashraf (2005) and Ashraf et al. (2011) highlighted that the performance of skimming wells are dependent on a large number of parameters like strainer diameter, penetration depth ratio, distance between strainers, horizontal distance of strainers from suction point, the thickness of fresh water lens below the strainers and so on. Their "conclusions" depict the absence of proper design, technical specifications, installation procedures and operational methodologies in the Indus basin of Pakistan. Much work has been done on skimming wells, yet the scientific criteria of skimming well design, installation and operation are still missing, which sometimes cause inappropriate selection and operation of wells resulting in high cost on one hand and environmental problems on the other.

This article evaluates the feasibility of skimming and other well techniques for irrigation purposes, identifies the gaps in the existing practices and suggests appropriate long-lasting options for the future. This paper further investigates and simulates the farmers' practices and suggests the suitable well technology, effective design, pumping rates and operational modes in a physically accurate and useful manner using the present hydro-salinity analyses at local scales. Our study area is the Chaj Doab, which is enclosed between rivers Jhelum and Chenab in the Pakistani Indus Basin. It spans about 1.3 million hectares between longitude 72°00□ - 74°15□ E and latitude 31°00□ - 33°00□ N. The principal cities are Jhelum, Gujrat, and Sargodha and agriculture is the major economic activity. The natural gradient of Chaj Doab ranges from about 0.4 m / km in the northeast to 0.2 m/km at the southwest and averages about 0.3 m/km, excepting the piedmont areas.

We use the recent time-domain electromagnetic (TDEM) investigations (Alam, 2011) in Mithalak farm (Figure 1) to ascertain the current situation of the salt concentration in the groundwater. We model the farmer's existing practices of groundwater withdrawals using USGS-based density-dependent SEAWAT code (Weixing and Langevin, 2002; Langevin et al., 2003) invoked through mf Lab (Olsthoorn, 2013). We develop MATLAB-based axisymmetric and three dimensional models using the aquifer parameters as described in Bennett et al. (1964) and calibrated by Alam (2014). Moreover, we evaluate the feasibility of scavenger wells, recirculation wells and horizontal wells for onward utilization in a typical farm in Pakistani Punjab. TDEM-based resistivity measurements, at Mithalak farm, are used to introduce the initial salinity conditions in models. Many different configurations as well as design are simulated to see their affect under the recent hydro-salinity situation. These designs are tested under the worst situation of Mithalak farm, where the thickness of freshwater lens was very thin (Figure 2) so that the output could be implemented on other sites in an effective way.

Saeed et al. (2002) and Saeed and Ashraf (2005) have described the existing practices of the farmers in the doab. Farmers operate skimming wells having discharge rate between 1,950 and 2,600 m3/d with target discharge as 2,420 m^3/d (Saeed et al., 2002). Our model results indicate

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that farmers will not be able to extract groundwater of acceptable quality on the long run if they continue the existing practices. Our model studies suggest that farmers will either opt for recirculation and horizontal wells or alternatively limit the extraction rate to 1,000 m^3/d.

Figure 1. Geographical location of TDEM survey site - Mithalak farm (32.11297° N □ 72.77218° E) : the red squares represent the transmitting loop with its location identity and blue lines mark the geoelectric sections.

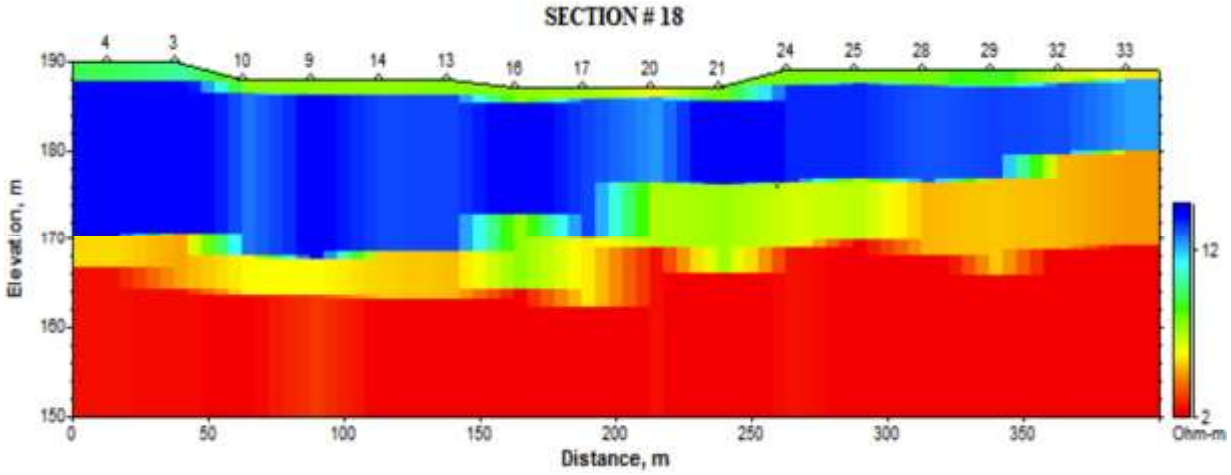

Figure 2. Modeled geoelectric-section of resistivity, constructed by collating 1D layered interpretation of soundings (see Figure 1 for cross-section reference)

NOTES

This article is extracted from Alam (2014) and was presented at MODFLOW & More (2013) at Colorado School of Mines, Golden, Denver, Colorado, USA.

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