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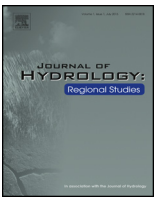

Groundwater management options in North district of Delhi, India: A groundwater surplus region in over-exploited aquifers

Shashank Shekhar*, Roger S.K. Mao, Esther B. Imchen

Department of Geology, University of Delhi, Delhi 110007, India

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ABSTRACT

Study region: North district of Delhi, India.
Study focus: The North district of Delhi has mostly shallow water levels and is a groundwater surplus region in contrast to the over-exploited aquifers of the region. The surface runoff and flood waters during monsoon season in the district either causes water logging in lower elevation areas or they join drains and rivers as rejected recharge. This study aims to understand groundwater dynamics of the region in perspective of the aquifer architecture and proposes groundwater management options to meet local water requirements.
New hydrological insights in the region: Three distinct hydrogeological domains are identified with subtle differences in groundwater occurrence. Insights are obtained in stream–aquifer interaction and baseflow to the Yamuna River is quantified. The salinity enrichment in groundwater has been attributed to water logging in clay rich formations under semi arid condition. The viability of limited dewatering of shallow aquifers and its replenishment by enhanced recharge from surface runoff and flood waters during the monsoon period have been established.

* Corresponding author. Tel.: +91 11 921260038.
E-mail address: shashankshekhar01@gmail.com (S. Shekhar).

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1. Introduction

The state of Delhi is supplied with around 1066 million m^3/day of potable water against a demand of 1476 million m^3/day (Shekhar and Prasad, 2009). This domestic water requirement is increasing at an exponential rate in tune with the population growth of the city. The deficit in water supply at the level of individuals is met by exploiting easily available groundwater resources. This has lead to over exploitation of groundwater resources in seven out of nine districts in Delhi (Chatterjee et al., 2009). The two districts which do not have overexploited groundwater resources are north and central district (Fig. 1). The groundwater exploitation in central district is 1.65 million m^3 compared to the net groundwater recharge of 1.88 million m^3 (Chatterjee et al., 2009). Hence if groundwater exploitation in the district is increased by small amount, the aquifers would be overexploited. In contrast to all other districts, the groundwater exploitation in north district is 2.55 million m^3 compared to net groundwater recharge of 7.36 million m^3. In perspective of sustainable urban water management strategy in Delhi region, it is proposed that the water requirements of the district could be met by groundwater sources. This would facilitate diversion of treated river water currently being supplied in the district to other water scarce areas of Delhi.

A similar water supply project is operational in Palla well field to the north of the present study area, where a battery of ninety tubewells and Ranney wells in shallow water level areas extract around 41–49 million m^3/year of groundwater. The water augments drinking water supply of Delhi. These exploited aquifers get replenished by recharge during monsoon rains and floods (Shekhar and Rao, 2010).

The north district is one of the highly urbanized districts of Delhi covering an area of 60 km^2 (Fig. 1). The district is for nearly 37% of its area covered by urban paving (roof, road, pavement and other concretized areas) (Chatterjee et al., 2009). Some cultivation is done in parts of the district falling within the active flood plain (Fig. 2). The average annual rainfall is 887 mm (Period 1980–2003) in the district (CGWB, 2006b; Singh et al., 2005). This is highest average annual rainfall for a district in Delhi. Thus the rainfall recharge to groundwater system during monsoon period is 4.89 million m^3, while in non monsoon season it is about 1.23 million m^3 (Chatterjee et al., 2009). The densely vegetated North Delhi ridge (Alwar Quartzite) roughly occupies 3.6 km^2 area and active flood plain of the river Yamuna roughly occupies 17.4 km^2 area (Fig. 2). The older alluvium and fluvioaeolian deposits occupy nearly 39 km^2 in the rest of the district (Fig. 2). The active flood plain of river Yamuna has younger alluvium of recent age underlain by older alluvium. The older alluvium of river Yamuna varies in age from 1.56 to 82.2 thousand years (Sinha et al., 2009). The depth to bed rock map (Fig. 3) and the observations in field hint at the presence of a fault on the western margin of the Alwar quartzite in the district. This is a regional fault extending to other parts of Delhi (Shekhar et al., 2005; Shekhar, 2006d; CGWB, 1996; Shekhar and Sarkar, 2013).

The aquifer parameter values published by different authors for the Hard rock formation (Delhi ridge/Alwar quartzite), the younger and older alluvium are presented in Table 1.

Table 1
Aquifer parameter values.

Aquifer parameter	Hard rock formation (Delhi ridge/Alwar quartzite)	Younger alluvium	Older alluvium
Transmissivity (m^2/day)	8 (Purohit, 2000) 5–135 (Shekhar et al., 2009)	600–2000 (Shekhar et al., 2009)	43 (Purohit, 2000) 130–403 (Shekhar et al., 2009)
Hydraulic conductivity (m/day)	–	9.8–20 (Rao et al., 2007)	9.8 (Rao et al., 2007)
Specific Yield	0.015 (Shekhar, 2006d)	0.2 (Shekhar and Prasad, 2009)	0.1 (Shekhar, 2006d)
Average tubewell yield (m^3/hour) (Shekhar et al., 2009)	2–10	50–180	20–60