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ORIGINAL PAPER

GIS applicability to assess spatio-temporal variation of groundwater quality and sustainable use for irrigation

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Abstract Sustainable and safe use of groundwater requires periodical monitoring of its quality. Because of the presence of multiple contaminants, spatial variation of overall groundwater quality is difficult to describe. The present study describes the overall groundwater quality for irrigation using a multi-criteria quality assessment system and sustainability of water use by incorporating the aspect of temporal variation of groundwater quality. The GIS-based multi-criteria system effectively amalgamated different quality parameters into an easily understandable format and assessed the spatial variation of groundwater quality for irrigation in west Delhi, India. The rate of spatial increment of poor quality groundwater within the study period was 3.7 km^2 per year. It has been observed that there is deterioration of groundwater quality from south-west to east, along the general groundwater flow direction, and improvement of groundwater quality from west to north-east, due to less urbanization and availability of groundwater recharge zones with good quality water. Temporal variation of groundwater quality is high (V>20 %) at northern part, moderate (V=10–20 %) at middle and southern parts, and less (V <10 %) at some pockets of southern part of the study area. The overall groundwater quality coupled with its variation reveals that while the groundwater use is mostly unsustainable in the southern part, groundwater sustainability is constrained by relatively poor and variable quality in western and northern fringes of the study area.

Keywords Delhi · GIS · Groundwater quality · Spatial variation · Sustainable use · Temporal variation

Introduction

Optimum planning for judicious use of water resources is important to meet the demand of the ever-growing population in a city like Delhi, where demand of fresh water always exceeds supply. The study area forms a part of peri-urban areas, west Delhi, wherein rapid change of agricultural pattern, increase of agro-based industry, and use of polluted drain water for irrigation cause significant deterioration in the quality of groundwater (Adhikary et al. 2010). The contaminated groundwater cannot cleanse itself of degradable wastes very rapidly as flowing surface water does (Poonam and Namita 2001). Groundwater movement being very slow hinders effective dilution and dispersion of contaminants. It may take hundreds to thousands of years for contaminated groundwater to cleanse itself of degradable wastes on a human time scale.

The concept of sustainable use appeared in the early 1980s, which was based on judicious resource utilization to sustain over a long period. Sustainable groundwater use is commonly defined as development and use of groundwater resources in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences (Alley and Leake 2004). In recent years, research