Geochemistry of groundwater and groundwater prospects evaluation, Anekal Taluk, Bangalore Urban District, Karnataka, India

P. Ravikumar · K. Venkatesharaju · K. L. Prakash · R. K. Somashekar

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Abstract Anekal Taluk lies in the southern part of the of Bangalore urban district, known for Bannerghatta wildlife sanctuary, Jigani industrial estate, silk industry, and the electronics city, the pride of India and hub of Bangalore’s information technology. In the present study, evaluation of geochemistry of 28 representative bore wells samples from Anekal Taluk was undertaken. It was found that most of the samples (92.9%) belong to Ca$^{2+}$–Mg$^{2+}$–Cl$^{-}$–SO$_4^{2-}$ water type with Ca–Mg–Cl and Ca–Cl hydrochemical facies. The groundwater sources were further categorized as normal chloride (32.14%) and normal sulfate (100%) water types based on Cl and SO$_4$ concentrations. Majority of the samples (64.3%) belong to C3–S1 water class, indicating water with high salinity and low sodium. Positive index of base exchange indicates the chloro-alkaline equilibrium in the study area. Groundwater potential zonation map for Anekal Taluk was generated using multiparametric and weighted overlay method using the spatial analyst tool in ArcGIS v9.2. Accordingly, five distinct classes corresponding to good(high), moderate (medium), moderate to poor (low), poor (very low), and poor to nil (very low) groundwater potential zones were identified in the region. Of this, 85.27% of the study area belongs to good/high to moderate/medium groundwater potential and only 14.73% belonging to moderate/poor to nil groundwater potential zones.

Keywords GWP—groundwater potential · GWPZ · RS—remotes sensing · GIS—geographical information system · Index of base exchange · Normal chloride · Normal sulfate

Introduction

Water is the most important natural resource which forms the core of the ecological system, but global water consumption is increasing at twice the rate of population growth, though, only 1% of the earth’s water is available for human consumption. Over the few decades, competition for economic development, associated with rapid growth in population and urbanization, has brought in significant changes in land use, resulting in more demand of potable water for agriculture, domestic, and industrial activities. To meet this escalating demand for potable water, there has been indiscriminate exploitation of groundwater resources particularly in the areas where the surface water...
potential is negligible (Banerjee et al. 2008). It has been estimated that the requirement of the groundwater in 2050 will be about more than three times the present level due to the population explosion (Gupta and Deshpande 2004). In addition, the quality of groundwater is as important as its quantity, owing to their suitability and intended use for various purposes, because the variation in its quality in an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities (Bhagavathi and Thamarai 2008; Subramani et al. 2005; Tatawat and Chandel 2008). The poor quality of water can also adversely affects the plant growth and human health (Wilcox 1948; Thorne and Peterson 1954; US Salinity Laboratory Staff 1954; Holden 1971; Todd 1980; ISI 1983; WHO 1984; Hem 1991; Karanth 1997).

Groundwater being a dynamic, replenishing, and hidden natural resource confined to fractured and weathered horizons in hard rock terrains, which is often extracted unscientifically without proper understanding of its occurrence in space and time. Because, the underlying geological formations, their structural fabrics, geomorphology, and overall climatic condition, etc. are responsible for the occurrence, distribution, and availability of groundwater in an area. In India, 65% of the total geographical area is covered by hard rock formations with low porosity (less than 5%) and very low permeability (10^{-1} to 10^{-5} m/day) (Saraf and Choudhary 1998). Thus, groundwater exploration sometimes may involve a high risk of failure, particularly in complex, hard rock terrain comprising fluvial, denudational, and structural geomorphic units, leading to loss of huge amount of money with difficulty in evaluating the intricate relationship existing among the various terrain parameters that controls groundwater regime. Hence, more accurate, integrated, interdisciplinary, hydrogeological investigation, and reliable spatial and temporal information on water resources is required to arrive at rational decisions for thorough understanding of the strategic exploration, efficient planning, monitoring, and management of groundwater resources in these areas. In this regard, remote sensing (RS) and geographical information system (GIS) has opened new paths/vistas in water resources studies because of their ability to generate subsurface information in spatial and temporal domain, which is very crucial for successful analysis, prediction, and validation (Sarma and Saraf 2002). Among these, RS provides multispectral, multi-sensor, and multitemporal data of earth’s surface (Choudhury et al. 2003) and has widened the scope for detecting the significant earth features with its varying spatial, spectral resolution, and various temporal data. The satellite imageries are increasingly being used in groundwater exploration because of their efficacy in categorizing various ground features like geology, geomorphology, land use and land cover, lineaments, etc., which control the occurrence and movement of groundwater (Saraf and Choudhary 1998; Singh et al. 1993) and may serve as either direct or indirect indicators of presence of groundwater (Bahuguna et al. 2003; Das et al. 1997). In contrast, the GIS has emerged as a powerful spatial environmental data integration tools for natural resource management in order to analyze and quantify such multivariate aspects of groundwater occurrence to delineate the groundwater prospect and deficit zones (Carver 1991; Goyal et al. 1999) in addition to the investigation of groundwater quality (Sweeney 1999). They can provide more realistic picture of groundwater potentiality of an area by means of inclusion/integration of subsurface information in an environment inferred along with collateral data. Thus, the advent of the concept of integrated RS and GIS has proved to be an efficient tool in groundwater studies (Edet et al. 1998; Krishnamurthy et al. 1996; Jaiswal et al. 2003; Meijerink 1996; Nour 1996; Smith et al. 1997; Saraf and Choudhary 1998; Krishnamurthy et al. 1996; Murthy 2000; Srinivasa Rao and Jugran 2003) like hydrological investigations, groundwater prospect evaluation, and exploration (Mollard 1976; Subramanian 1999; Perumal and Roy 1983).

Developmental pressures and increasing human population has made the lakes of the study area vulnerable to sewage flow, solid waste dumping, etc., in turn exerting pressure on the percolation and infiltration processes responsible for the groundwater recharge. Hence, the present study aimed at determining the geochemistry of 28 groundwater samples to evaluate their suitability for drinking and irrigation purposes. An attempt