Terrain and Aquifer Characterization for Groundwater Potential Evaluation in Bata Watershed (HP) using Remote Sensing and GIS Techniques

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ABSTRACT

Groundwater is a precious resource of finite extent. In order to ensure the judicious use of groundwater, proper evaluation is required for which a large volume of multidisciplinary data from various sources have to be analysed. Integrated Remote Sensing (RS) and GIS techniques provide the appropriate platform for convergent analysis of diverse data sets for decision making in groundwater management and planning. Keeping this in view, the present study has been undertaken in the Bata watershed falling in Sirmaur District of Himachal Pradesh (H.P.) State with a primary aim to evaluate the groundwater potential. In order to active this goal, RS and GIS tools in conjunction with conventional methods have been used to: (i) characterise the terrain based on different groundwater controlling/indicative parameters like lithology, structure, geomorphology, slope, drainage texture and land cover, (ii) characterize the nature, extension and performance (including water quality) of the aquifers, (iii) prepare the groundwater prospects map by integrating different controlling/indicative terrain and aquifer parameters in GIS, and (iv) to estimate/quantify the groundwater resource based on GEC (1997) guidelines for futuristic planning.

The synopticity, multispectral nature and high spatial resolution of PAN-sharpened LISSIII image of IRS-1D and Resourcesat-1 helped a great deal in terrain characterisation, i.e. in mapping the geomorphology, lithology, structures and land cover of the area. Geologically, the area comprises of the rocks of Subathu (Eocene), Lower and Upper Siwaliks (Middle Miocene to Early Pleistocene) formations, and younger sediments (Late Pleistocene to Holocene), Doon gravels and alluvium. The main boundary thrust (MBT), Markanda thrust and Yamuna tear fault are the important geological structures/ discontinuities. A number of other lineaments have also been mapped. Active flood plains, channel/braid bars, river terraces (T1, T2 and T3), lower and upper piedmont, and residual, structural and denudational hills are the geomorphic units/landforms mapped in this area. The piedmont zone, especially lower piedmont, forms the main aquifer in the area.

The ground surveys and the existing data provided the information about the depth to water table, nature, thickness, yield of aquifers and quality of the groundwater. Based on the IV study of sub-surface lithologs, it is found that groundwater occurs multi-tier aquifer system under unconfined and semi-confined to confined conditions. Well data have been analysed to prepare water table maps of unconfined and semi-confined to confined aquifers. The depth to water table in phreatic/unconfined aquifers ranges from 3m to 42m from ground level during pre-monsoon

period, and 1m to 35m from ground level during post-monsoon period. The water table fluctuation varies from 0.5m to 12m. The groundwater movement is primarily from west to east/southeast, i.e. towards Yamuna river. The discharge of tube wells tapping multiple aquifers varies from less than 500 lpm to more than 2500 lpm with drawdown ranging from 2 m to 60 m. The pH, TDS (total dissolved solids) and chloride (Cl) contents in the groundwater indicate that overall the groundwater quality is potable, barring some isolated places, where pH and Cl are beyond permissible limits.

The terrain and aquifer parameters have been integrated using the weighted index overlay method in GIS domain to delineate the groundwater prospective zones. The groundwater prospects are mapped in five categories: excellent, good, moderate, low and runoff zone. Excellent and good groundwater prospects zones fall in the flood plain, younger, and older terraces, and lower piedmont; moderate to low prospects zones occur in the upper piedmont. The denudational, structural and residual hills mainly act as runoff zones, wherein the groundwater occurs in localised pockets, i.e. along narrow valleys, faults and fractures. The groundwater resource estimation carried out in the study area based on GEC-97 guidelines indicates that the net annual groundwater recharge and availability are about 14,200 ha.m and 13,700 ha.m, respectively.