

Geohydrology and structure: groundwater resource estimation



Correlation
of
Geohydrolo
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Structure
for
Groundwate
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: Estimation
in and
Around
Nandurbar
Area,
Nandurbar
District,
Maharashtr
a, India.

Name of
the Bobby P.
Candidat : Mathew
e

Name : Dr.
and Hrishikesh
Designati P. Samant,

Associate
Professor &
Head,
Department
on Of
Guide of Geology,
St. Xavier's
College,
Mumbai,
PIN-400001.

SYNOPSIS

The past few decades have witnessed an ever increasing demand for groundwater and its scarcity related problems, particularly in semi-arid hard rock terrains, are well known and draw attention of many geoscientists. Deccan Volcanic Province (DVP) comprises a sequence of basaltic lava flows of Cretaceous to Eocene age which are covering an estimated areal extent of 5, 00, 000 Km² in west central part of Peninsular India. Groundwater potential of the basaltic aquifers (considered to be 'multiple aquifer systems' due to the flow characteristics) constituting DVP is highly variable and inconsistent due to the heterogeneity and anisotropy in the aquifer characteristics (Deolankar, 1980; Duraiswami, 2008; Duraiswami et al., 2012). Presence of basic dykes in such an environment makes the hydrologic characteristics of the basaltic aquifers more complex. There exists a characteristic pattern in the distribution of the dykes and distribution of simple and compound lava flows in DVP (Deshmukh and Sehgal, 1988; Ju et al., 2013; Ray et al., 2007; Vanderkluysen et al., 2011). A wide variation in <https://assignbuster.com/geohydrology-and-structure-groundwater-resource-estimation/>

the climate, physiography and rainfall is also an important aspect while estimating the groundwater potentiality of the DVP area.

An attempt is made to study the effect of the dyke intrusions on hydrogeology of Nandurbar area, which is located near the Narmada Tapi Rift zone. Approximately 640 Km² in Nandurbar district (primarily a tribal district in Maharashtra state) around Nandurbar city was considered for detailed study. A detailed study was carried out to estimate the groundwater resources, keeping in mind the marked growth in agricultural activities and human population over the last decade in the study area and its proximity to Narmada Tapi rift zone and presence of dyke intrusions. The area under study is located around the city between East Longitude 74° 05' 00" to 74° 25' 00" and North Latitude 21° 15' 00" to 21° 25' 00" and included within the Survey of India topographical map numbers 46 K/3 and 46 K/7.

The main objectives of the present work are:

- To describe the general trend, and structure of the lineaments (fractures and dykes) using field evidences, topographical maps and satellite imageries.
- To understand the effect of dykes and fractures on the permeability and porosity of rocks in the study area depending on their distribution, orientation and density.
- Analysis and integration of remote sensing and ground based hydrogeological data through Geographic Information System (GIS) to prepare groundwater potential zonation map for the study area.

- To analyze the water samples covering the entire area to understand the groundwater quality and its related problems.
- Evaluation of the groundwater potential zones and resource estimation in relation to the structures (mainly dykes) in the area together with the quality zonation mapping would be useful for strategic planning and management of groundwater resources in the DVP.

The study was carried out with the help of six components:

1. Input from remote sensing data
2. Topographic maps
3. Data collected from field visits
4. Groundwater quality analysis.
5. Preparation of thematic maps
6. Integration and analysis of the results in a GIS platform.

As this area is intruded by dyke swarms, identification of lineaments and preparation of the thematic maps were carried out using topographical maps, satellite imageries and field data. Field work included water level measurement, litho-log preparation, collection of water from wells for quality analysis, well inventory etc. The geological and geomorphological maps were prepared and cross checked during field works and final maps were prepared with necessary modifications. Compilation of the observation from well data, rainfall data and the previous records collected from GSDA and CGWB were carried out to know the long term trend of the groundwater conditions. Laboratory analysis of the water samples and the petrographic studies of the rock samples reveal the quality and geological aspects.

Geology, geomorphology and the hydrogeological characteristics of the rocks have considerable effect on controlling the occurrence and movement of groundwater. Geological investigation of the area reveals that the area is mainly constituted by simple and compound basaltic flows. Quaternary alluvial deposits of moderate thickness are located in the north eastern part of the study area. Dykes' being the major structural features present in the area stands out as prominent ridges due to the resistance to weathering and are mainly trending in the ENE-WSW directions. Dykes are of basaltic to doleritic composition and are of varying length, mainly exposed in the central and southern part of the study area.

Landforms are classified mainly into structural, denudational and fluvial origin. Dykes being the major structural features in the study area, are studied in detail and analysis of their orientation, thickness, length and density were carried out. Slope, slope aspect, digital elevation model, curvature and topographic wetness index parameters were used to generate results to understand the relationship between the geomorphology and hydrogeology, which is indicating towards a greater control of dykes on hydrogeological setup of the area. Tributaries of Tapi River drain the study area and follow the regional slope from South to North and which intersects dykes at many locations. This structural relation is of great importance and it reveals a significant control of dykes on groundwater occurrence and movement. Drainage textural analysis is used to analyze their control on permeability characteristics of the terrain and also to demarcate the potential recharge zones. Hypsometric analysis of the watersheds

constituting the study area helped to understand the erosional susceptibility of different watersheds and their stages of evolution.

The role of lineaments can be of great importance while carrying out hydrogeological investigation of an area. Due to varying aquifer characteristics basaltic flows in the study area shows wide variation in the occurrence and movement of groundwater. Observation wells were monitored for the spatial and temporal variation in water levels and quality. Input from eighty eight (88) observation wells were used to generate various hydrogeological maps and to analyze the hydrogeological setup of the area. Analytical results indicate the occurrence of three different types of aquifers namely, basaltic, alluvial and dyke aquifers. Wells tapping the dyke aquifers or which are located near the dykes observed to be more productive compare to the rest, indicating the significant influence of the dykes. Dykes also show unique joint pattern and can be correlated with their lithology; i. e. doleritic (characterized by moderately to largely spaced joints) and basaltic (closely spaced joints).

Evaluation of the groundwater flow direction and hydraulic gradient results of the study area shows a close correlation with the lineaments. Lineaments which are parallel to the hydraulic gradient located in the south eastern part of the study area have little influence on groundwater movement. However lineaments located perpendicular to the hydraulic gradient has considerable effect on the occurrence and movement of groundwater. Such dykes in the study area can also used as artificial recharge structures, which in turn could promote the recharge of groundwater. Time series analysis of four

observation well data of past twenty years were analyzed to understand the rising and falling trend of water levels in the study area.

The chemical qualities of the groundwater sample collected during two seasons were analyzed from the state level water testing laboratory of Tamil Nadu Water supply and Drainage (TWAD) Board at Chennai. Analysis of the results shows that groundwater chemistry is controlled mainly by the climatic and rock water interaction and there exists a spatial and temporal variation in groundwater quality. The cationic values in groundwater show increasing trend from higher elevations to lower elevations indicating the control of basaltic rock lithology. Nitrate, sulphate and chloride concentration in groundwater is mainly indicative of the anthropogenic factors. Analysis based on drinking water standards (BIS, 2012) indicates the degradation of groundwater quality in this area due to nitrate contaminations and groundwater hardness. Nitrate levels exceeding the desirable limits were observed in major part of the study area can be correlated with the increased agricultural activities and other anthropogenic factors. Thematic maps based on various chemical parameters were generated to understand the spatial and temporal variation in the groundwater chemistry. Suitability of groundwater for irrigation was verified using United States Salinity Laboratory's (USSL) graphic classification, Sodium Adsorption Ratio (SAR), Sodium percentage, Conductivity (Todd, 2003) and Kelly's Ratio (Kelly, 1957). Analysis helped to delineate areas exceeding the permissible limits and such areas need proper care and management while selecting the crops and suitable method of irrigation.

Dykes which stand out as ridges were also noted by characteristic joint pattern. Nature of boulders present on the dyke surfaces were used to analyze the joint pattern of the dykes using high resolution satellite imagery and field evidences. This approach found to be useful in delineating the carrier and barrier stretches of dykes in the groundwater exploration stage and shows significant correlation with their water bearing characteristics. Topographic lows in the dykes proven to be of significant importance in groundwater development. Data acquired through remote sensing of the study area was also used to generate different thematic maps. Thematic maps generated and validated through field work (i. e, Lineament map, dyke density map, geomorphological map, drainage density, Land Use/ Land Cover map etc.), were integrated using multi criteria analyses in GIS platform to delineate the groundwater potential zones. Integration of water quality maps generated for different parameters based on groundwater chemistry were used to prepare groundwater quality zonation map and has been used to delineate the spatial and temporal variations of groundwater in the study area. Results obtained from this analyzes can be used effectively while planning and managing the groundwater resources of similar areas globally.

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