SUMMARY

The current research study entitled “Hydrogeological analysis using satellite imagery in Pat River basin area, Meghnagar block, Jhabua district, Madhya Pradesh” has been designed with a target of generation and interpretation of the data related to groundwater system of the Pat River basin area. The collected and generated data have been analyzed and interpreted to demarcate groundwater potential sites and development of the groundwater resource. The entire spectrum of research study has been presented in a thesis containing eight chapters elaborating the observation and interpretation of research investigation. The salient features of research study have been recorded herein.

CHAPTER - 1
INTRODUCTION

The first chapter incorporates a concise description of research problem and objectives of the research study area. It provides information in respect of the background information, location and physiographic environs of study area, fauna and flora, review of previous investigation, research methodology, and the scope of present work. Meghnagar study area is confined within latitude 22° 55’ to 23° 1’ N and longitude 74° 26’ to 74° 40’ E, and covering 328.9 km². National highway No. 59 is located at a distance of nearly 24 km. and can be approached via Indore-Jhabua-Ahmadabad (Survey of India Toposheet No.46 J/9, 46 J/5, 46 I/8 and 46 I/12). The study area is generally drained by Pat River system, which is the main source of surface water supply. The main objective of present study includes analysis and interpretation of various data. The scope of the present research study has also been incorporated.

CHAPTER – 2
GEOLOGICAL SETTING OF STUDY AREA

The second chapter provides a brief account of the geological setting of study area, which is occupied by Aravalli formations of Archaeans age and lava flows of Deccan Traps (Upper Cretaceous to Lower Eocene span). The generalized account of the geological features, Jhabua district, has been described herein. The Jhabua region is
occupied by different rocks ranging from the Archaean to Recent. The study region is comprised of rocks such as the granite, gneiss, schist, phyllite, quartzite, limestone, sandstone, coralline limestone, nodular limestone, Nimar sandstone and basalt.

The Jhabua region is rich in mineral resources such as manganese, phosphorite, quartzite, and dolomite. Basaltic lava flows are vertical and horizontal exposed in the study area. Two lava flows have been delineated. The region is characterized by the structural features such as fold, fault, joint and foliation. The groundwater in the study area occurs under both unconfined and confined conditions.

CHAPTER- 3
GEOMORPHOLOGICAL ANALYSIS

The third chapter contains an elaborative account of geomorphic analysis. The qualitative analysis includes salient features of landforms such as plateau, hill, and valley. The quantitative analysis has been conducted with the help of drainage map of the study area. The linear, areal and relief parameters have been determined to delineate the characteristics of the drainage basin, which has been classified into eleventh sub-basins.

The morphometric parameters have been determined in respect of present study area and results are described herein. Morphometric parameters such as stream order, bifurcation ratio (2.0 to 8.0), stream length (22.8 to 128.5 km), area of sub-basin (8.67 to 64), basin perimeter (15.28 to 29.77), length of basin (5.1 to 10.46), drainage density (1.454 to 4.036), stream frequency (1.988 to 16.608), form factor (0.305 to 1.0), elongation ratio (1.960 to 3.544), circulatory ratio (0.466 to 0.994), lemniscate ratio (0.25 to 0.817), length of overland flow (0.123 to 0.404), relief ratio (0.66 to 7.84), ruggedness number (9.895 to 161.44) and ground surface slope (19.79 to 322.88). The relationships between different variables have also been described.

The geomorphic analysis indicates that the basin is more or less elongated and reveals that dendritic to sub-dendritic drainage pattern existing in the study area. The hypsometric curve is a plot of the continuous function relating to the dimensionless variables, relative height and relative area and the properties of the curves tend to be similar in similar geologic and climatic conditions.
CHAPTER - 4

RAINFALL DATA ANALYSIS


The statistical analysis of rainfall data of Meghnagar area indicates values of mean (896 mm), median (875 mm), mode (1118.18 mm), standard deviation (352.72 mm), coefficients of dispersion (0.393), coefficients of variation (39.36), coefficients of skewness (0.059 and -0.629). The statistical data provide accurate data, which help in the interpretation of rainfall trend. The time series analysis of the rainfall data has been conducted to estimate of future rainfall trend for the next six years, which indicates a positive trend of recharge. The rainfall data indicate environmental impacts on the recharge phenomena of groundwater system.

CHAPTER- 5

SATELLITE DATA ANALYSIS

The fifth chapter deals with the analysis of remote sensing satellite data obtained from available source (Landsat-TM, IRS-P6 (LISS- III). The software packages Arc GIS 9.2 and Erdas Imagine 9.1 have been used for analysis. The examination of satellite image by visual technique provides features identification. Deferent maps such as geomorphological, geological, lineament pattern and others have been prepared with help of indentified satellite data. The indentified features have been confirmed by conducting ground truth verification.
The lineaments numbering (402), have been identified, which can be divided in two groups having (1.) L1 group (187), lineaments indicating direction of North-East, South-West, and (2.) L2 group (215) lineaments exhibiting direction of North-West, and South-East. The Meghnagar study area, statistical analysis procedure of the lineament has been included, the mean direction (49° 52', 47° 94'), resultant length (0.9313, 0.8783 and circular variation (0.687, 0.1217). The existence of lineaments is significant in delineation of groundwater potential zones. The drainage map of Meghnagar basin reflects important information such as nature of drainage area, drainage pattern and indicates hydrogeological response of the area. The determined geomorphic units include valley, plain area, shallow buried pediment, pediplain and hills. The characteristic features of geomorphic units helps in identification of groundwater potential and recharge zone of the study area.

CHAPTER - 6
HYDROGEOLOGICAL ANALYSIS
The sixth chapter provides a concise account of the hydrogeological analysis of the study area. Systematic hydrogeological surveys are conducted to determine the nature of groundwater conditions of a particular area or basin. The procedure for the systematic hydrogeological surveys of study area have been carried out with the help of topographic sheet, which include detailed well inventory in respect of existing different 87 dug wells. The well data analysis indicates that the diameter ranges from 3.90 m. to 7 m., total depth of dug wells from 5.57 to 20.2 m. b. g. l. (below ground level), depth range of static water level within 1.20 to 7.70 m. b. g. l. and the water level fluctuation of ranges from 1.30 to 5.20 m. The causes of fluctuation have been assigned to over draft of groundwater, topography, climate and amount of rainfall.

The groundwater level contour maps during post- and pre-monsoon periods were prepared and observed the seasonal trends of groundwater level contours. The important villages in the area are Itawa, Hatyadeli, Garawara, Gopalpura, Chainpura, Shivgarh, Mahura, Jarat, Rajpura, Tallauli, Parnali, Kachaldara and Thandla, which indicate that widely spaced groundwater level contours point out the favorable zone of groundwater recharge. In Itawa and Thandla the groundwater flow is in the opposite direction of Pat River indicating the presence of groundwater barrier. It has been noted that the groundwater, in general, moves towards Pat River. The hydrogeological
analysis provides important clues that enabled the location of groundwater potential horizons in Meghnagar area.

CHAPTER 7

CHEMICAL QUALITY OF GROUNDWATER

The physico-chemical qualities of selected 25 dug well samples have been conducted in laboratory by determination of ionic concentration using standard methods. All the analyzed data have been displayed by tabular and graphic methods of representation herein.

Physical properties indicate that all samples are colourless, odourless, tasteless, having turbidity range from 0.85 to 3.50, pH value range from 7.00 to 8.02, electrical conductivity range from 305 - 920 μ mohs /cm, total dissolved solids range from 250 - 468, total hardness range from 240 to 420 have been determined. The determination of chemical parameters include ionic concentrations (values expressed in ppm), Ca (75 - 200), Mg (50 - 180), Na (40 - 71), K (0.35 - 2.65), Cl⁻ (67 - 250), SO₄²⁻ (62 - 220), CO₃⁻ (---), HCO₃⁻ (90 - 265), NO₃⁻ (10 - 42), and F⁻ (0.25 – 1.05). The chemical parameters variation range recorded as (values expressed in epm), Ca (3.742 - 9.98), Mg (4.113 - 14.806), Na (1.74- 3.088), K (0.008 - 0.067), Cl⁻ (1.890 - 7.052), SO₄²⁻ (1.290 - 4.580), CO₃⁻ (--) and HCO₃⁻ (1.475 - 4.343).

In the Meghnagar study area chemical analysis of groundwater samples indicate suitability for irrigation has been determined on the basis of chemical parameters such as Kelley’s ratio (0.105 to 0. 263 epm), Sodium percentage (9.672 to 21.022 epm), Sodium adsorption ratio (0.708 to 1.266 epm), Residual sodium carbonate (-9.107 to -21.836 epm) and Mg- hazard (32.653 to 75.555 epm).

The determination of chemical quality of groundwater includes computation of different parameters using Piper’s trilinear diagram, pie diagram, U. S. salinity diagram, Wilcox diagram and comparison with the standard values recommended by Bureau of Indian Standard (BIS), and World Health Organization (WHO). The assessment of chemical quality indicates that the groundwater of Meghnagar study area is Ca, Mg, CO₃, HCO₃ and SO₄, type, and in general, it is suitable for domestic, drinking, agriculture (irrigation purposes). In general, groundwater is suitable for domestic, drinking and irrigation uses in the study area.
CHAPTER-8

DEVELOPMENT AND MANAGEMENT OF GROUNDWATER RESOURCE

The eighth chapter provides a concise account of the development and management of groundwater resource of the study area. The development of groundwater is mainly achieved by using artificial recharge techniques and the construction of artificial recharge structures such as stop dam, pond, contour bunds, trench, percolation tank, recharge well and rainwater harvesting system. The scheme of implementation of standard development suggestions would provide augmentation of the groundwater resource.

The management of groundwater involves both the quantity and quality of groundwater resource. The estimation of groundwater potential indicates that the study area is experiencing a state of over draft and shortage of sustained water supply. The quality of groundwater is favourable for domestic, drinking, agriculture and irrigation uses. It has been suggested that the groundwater quantity can be increased by implementation of scheme for construction of rainwater harvesting structures, artificial recharge structures and a forestation.

The environmental impacts caused by the construction of artificial recharge structures can be controlled by adopting appropriate remedial measures. It is visualized that the data generated during the tenure of the study would provide valuable guides in the preparation of a development and management plan in Meghnagar study area, to resolve the existing problem of regular water supply. The estimated values of groundwater recharge (2970.32 × 10^4 m^3) and annual draft (3024.008 × 10^4 m^3) of the study area indicate the over draft of groundwater as ( -53.688 × 10^4 m^3). The present status of the area is reflecting over exploitation of groundwater resource, which needs proper management of the resource.

The present study provides important information regarding groundwater regime of the Meghnagar area for the preparation of a plan for the development and management of groundwater resource. It is visualized that the results of the study would be of considerable help to the planners and hydrogeologists engaged in the adjoining and other areas.