CHAPTER 1

INTRODUCTION
1. INTRODUCTION

Groundwater is an important source of water supply throughout the world. The growth and decline of various civilizations have been affected by the adequacy and utilization of the water resources. The shortages of groundwater in areas where excessive withdrawals have occurred emphasize the need for accurate estimates of the available groundwater resources. Therefore, the schemes for the proper management of this natural resource are to be drawn for its continued availability.

The systematic hydrogeological investigations have received its usefulness particularly in the area of hard rock terrains, where the requirement of sub-surface water is on the increase. In the consolidated rocks, the availability of groundwater resources depends largely on the nature and type of aquifers which control the occurrence and movement. Thus, a systematic study will enable the delineation of potential areas for recharge and its sub-surface movements from place to place. It further helps in suggesting the control over water quality and its conjunctive uses. The rapid development of industrialization in and around Raipur and the increasing demand of water for agricultural and domestic purposes have necessitated more and more harnessing of groundwater, as the surface water resources are unable to fulfil the requirement. This has lead to choose the area for a detailed investigation so that an attempt may be made to evaluate the available groundwater potential for its future development and utilization. Apart, the present study shall also provide a proper assessment of available groundwater resources from various aquifers which may be utilized in the formulation of the most rational plan of future development as some parts of the study area are still facing shortage of water supply for irrigation purposes.
1.1 LOCATION OF THE AREA:

The area under investigation (Fig. 1.1) covers about 843 sq.km. and is confined between latitudes $21^\circ 26'$ to $21^\circ 47'$-N and
longitudes $81^\circ 47'$ to $82^\circ 13'$E which falls in Survey of India
topographic sheet nos. 64 G/14, 64 G/15, 64 K/1 and 64 K/2. The
area is well connected by Bombay-Howrah broad gauge line of
South-Eastern railways. Tilda, Bhatapara, Hathbandh, Hirmi and
Rawan are the important places located within the study area and
are approachable throughout the year (Fig. 1.2). Tilda and
Bhatapara are the block headquarters, situated about 40 and 70 kms,
from Raipur town respectively, fulfil all the basic community needs
like Tahsil office, Agricultural office, Educational institutions,
Hospitals etc.

1.2 PHYSIOGRAPHY AND DRAINAGE:

Physiographically, the area enjoys tropical to subtropical climate, and in general a plain country with
imperceptible gradient. The highest elevation of the basin is 310m.
above M.S.L. while the lowest is 240m. above M.S.L. Entire drainage
basin is characterised by the absence of any structural hill. The
lateritic capping overlying the limestones and shales form smooth
uplands dissected by streams. The general slopes are very low,
ranging from 1 to 1.5m/km. The soil is black and brown yellow in
colour, fine grained and occurs along the bank of stream sections
which are locally called matasi and kanhar soil. The very recent
deposited silts, consisting of very fine particles are called
kachhar.

The Jamunia river flowing principally in north-eastern
direction forms a major drainage system within the area and joins
the Sheonath river near Parsadih village of Baloda Bazar block. The
Banjari nala is a major tributary of the Jamunia river, forming a
FIG. 1.1 LOCATION MAP.
sub-basin. The Jamunia is partly perennial, whereas the Banjari is an intermittent stream flowing in low lying area. It originates near Kumhari village of Tilda block and later joins the river Jamunia in the northern part of the basin. Apart, a large number of ponds and reservoirs are located within the area. The Kumhari and Manpur tanks are the two principal reservoirs which supply water for irrigation purposes in the region.

The vegetation of the area includes huge trees of Babool, Pipal, Baniyan, Neem, Mango, Ber and Eucalyptus. The study area is devoid of any dense forest. The main crops of the area are paddy, wheat, and seasonal vegetables e.g. ladyfinger, brinjal, tomato, palak, cauliflower etc.

1.3 HYDROMETEOROLOGY:

Data pertaining to various hydrometeorological parameters e.g. rainfall, evaporation, relative humidity and temperature (Weisner, 1970), were collected and the analysis has been attempted.

1.3.1 Precipitation:

Under the present investigation, the annual and monthly rainfall data of 34 years (1961-1994) from the Raipur rain gauge station (Appendix-1a) have been analysed to understand the trend of precipitation. The average annual rainfall of the area is around 1200mm with a maximum record of 1972mm (1970) and a minimum of 709.11 (1988) (Fig. 1.3).

The available rainfall records indicate that about 80-90% of the total rainfall is received during monsoon period, while 10-20% is recorded during the non-monsoon period. The plotted bar diagram (Fig. 1.4) reveals higher intensity of rainfall between
Fig. 1.4: Average Monthly Rainfall of Raipur (M.P.)
From (1961 - 1994)
June to September every year which seems to be the most suitable period for the groundwater increment through recharge.

The critical analysis of the rainfall data (Appendix-1a) for the past five years (1990-1994) clearly reveals that the maximum rainfall for the earlier three years (i.e. 1990-1992) used to be in a month of August. Whereas in 1993 and 1994, the maximum had occurred in the month of July (499mm and 545mm respectively), exhibiting a shifting trend in the rainfall pattern.

1.3.2 Evaporation:

The mean monthly evaporation data (Appendix-1b) with respect to the study area, clearly indicates that the evaporation is gradually increasing from January to May, while its gradual decrease is observed between June to December (Fig. 1.5).

1.3.3 Relative Humidity:

The mean monthly relative humidity percentage for the past 10 years (1985-1994) have been collected (Appendix-1c). The plot of mean monthly humidity percentage (Fig. 1.5) shows a decrease (45%) in the relative humidity during summer and increase (92%) during the arrival of south-west monsoon.

1.3.4 Temperature:

The study area shows a great fluctuation of temperature during summer and winter. The monthly maximum and minimum temperature range is shown in Appendix-1d. The temperature starts rising rapidly from March and reaches at its peak during May (Fig. 1.5) which indicates that May is the hottest month with maximum temperature rise up to 47°C while December is the coldest month with minimum temperature of 10.3°C.
FIG. 1.5 PLOT OF MONTHLY AVERAGE EVAPORATION, HUMIDITY, & TEMPERATURE OF RAIPUR (M.P)
1.4 METHODS OF STUDY:

The various geological, geomorphological, hydrochemical, hydrometeorological data from the basin under investigation were collected, processed and interpreted. The methodology adopted is as follows:

1. The field study includes the investigation of rocks and preparation of geological map on 1:50000 scale by regional traverses and limited ground truths.

2. From the available meteorological data, the detailed rainfall pattern for 34 years were plotted to understand the trend of precipitation. Variability in temperature, evapo-transpiration factors, relative humidity etc. have also been analysed.

3. Representative rock samples were collected and their petrography have been studied.

4. Well inventory have been carried out to measure the diameter and depth of wells, height of parapet walls, depth of water levels during pre-and post-monsoon periods. Computer programme has been designed to prepare water table maps which establish the occurrence and movement of groundwater.

5. For geomorphological study, a drainage map of the basin was prepared on 1:50000 scale, the morphometric analysis and slope category have been studied.

6. Using remote sensing techniques, detailed geomorphological, and structural maps, based on Landsat-5 TM data, were prepared on 1:50000 scale.

7. Vertical electrical soundings were conducted in accordance with Schlumberger arrangement to determine the resistivity and thickness of the overburden and sub-surface formations. The VES interpretations have been carried out and the possible lithologs were prepared.

8. For the quality of groundwater, 68 representative water samples from the entire area were collected and analysed for major cations, Na, K, Ca and Mg, and anions CO_3^2-, HCO_3^-, Cl, SO_4^2- and
The trace element analysis was possible only for limited number of samples due to lack of laboratory facilities. The above study helps to classify and establish the geochemical behaviour of groundwater of the area.

Pumping tests were carried out in the existing energised wells, to determine the various aquifer parameters, e.g. transmissivity, storage co-efficient and specific capacity of the wells. The rate of drawdown and discharge have also been determined.

The total annual recharge and discharge (as groundwater draft) have been computed, adopting ARDC norms, CGWB and Ground Water Survey Deptt. M.P. and the water balance studies have been carried out. This study helps to understand the groundwater development and management for future planning.

1.5 PREVIOUS WORK:

Medlicott (1866-67) was perhaps the first to study the geology of Chhattisgarh region and considered mainly three types of rocks - 1. Strong bedded quartzite, 2. Massive fine homogenous clays and laminated shale, 3. Flaky, earthy, silicious concretionary limestone. He considered these rocks as equivalent to lower Vindhyan age.

Blanford (1869-70) marked the occurrence of massive sandstone at the base which is followed by limestone, shale and an alternate succession of thinly bedded limestone and sandstone. He noticed these beds as equivalent to Penganga of Wardha valley and assigned lower Vindhyan age.

Ball (1877) described the geology of Chhattisgarh basin and considered the age of sediments to be the same as Vindhyan Group.

Kind (1885) reported the occurrence of laminated silicious and calcareous shales within the area and proposed them as equivalent to the lower Vindhyan age of Son Valley.
Bhattacharjee (1936-38) mapped the western part of Durg Distt. and marked Chandarpur sandstone, shales and phyllites, Raipur Limestone, and Khairagarh Sandstone as Cuddapah rocks.

Dutta (1958-64) carried out geological mapping of the southern part of Chhattisgarh basin. He proposed the stratigraphic succession as "Chhattisgarh Series", and correlated it with the Upper Kurnool group.

Sen and Satyanarayanan (1963-64) mapped parts of Raipur district and suggested that the term Gundedihi shale of proposed geological succession has been extended to include the Khairagarh sandstones and shales of the Raipur shale-limestone of Dutta.

Phadtare (1969-72) carried out the systematic hydrogeological studies in Raipur and Durg districts. He marked the purple shales with lenses of sandstone, stromatolitic limestone and reported that the behaviour of limestone is karstic in nature which acts a good aquifer for groundwater.

Schnitzer (1969-75) studied in detail the lithology of the northern part of Chhattisgarh basin. He proposed the cyclic nature of sedimentation and recognised each cycle by a local geological name.

Adyalkar and Ramanna (1973) recorded the presence of sink holes in Charmuria limestone developed under the Mahanadi alluvium near Dhamtari, which indicates about rich groundwater potential for domestic as well as irrigation purposes.

Chandra and Bhattacharya (1973) noticed the stromatolitic limestone from Mandir Hasaud, located towards east of Raipur, which are formed due to the rapid lithification under sub-tidal conditions.
Kreuzer et al. (1977) carried out the geochronological studies of the Chandarpur Group. The K-Ar age determination of glauconite in the Chaporadhi indicates the age of the formation to be 700-750 m.y.

Verma et al. (1977) studied the palaeomagnetic properties on the Gunderdehi shale and opined that Gunderdehi shales belong to an intermediate position between the age of Rewa and Cuddapah sandstone.

Jairaman and Banerjee (1980) studied the stromatolites of Raipur limestone and observed the abundance of columnar stromatolite rather than branched one.

Adyalkar and Ramanna (1980) carried out the systematic geohydrological work on karstic limestone, their mode of development and evaluation of aquifer characteristics. He reported the majestic development of karstic phenomenon in Raipur limestone.

Murti (1981) carried out the palaeocurrent studies of the Chandarpur Group in the central part of Chhattisgarh basin.

Murti (1987) described the stratigraphy and sedimentation of Chhattisgarh basin and has divided the basin into two groups. The lower Chandarpur Group and the upper Raipur Group. The groups are separated by an unconformity and together belongs to Chhattisgarh Supergroup. The Chandarpur Group is mainly arenaceous while the Raipur Group is predominantly calcareous and argillaceous in nature. He also reported the occurrence of barytes, chlorites and glauconites in Raipur Group which have been formed from the alteration products of volcanic ash in a marine environment.
Recently, Das et al. (1992) modified the stratigraphy of the Chhattisgarh basin. They proposed that the entire succession of Chhattisgarh basin may be classified into three groups. The lowermost Singhora Group developed in an embryonic basin to the east. The middle Chandarpur Group, unconformably overlying the Singhora Group, consists mostly of arenite litho-assemblage. These are conformably underlain by the Raipur Group occurring at the top comprising of argillite-carbonate suite.