Introduction

Chapter 1

INTRODUCTION

1.1 Introduction

Water is an elixir of life. Life, prosperity and civilization revolve around water in the whole world. The availability of a water supply adequate in terms of both quantity and quality is essential to human existence. Early people recognized the importance of water from a quantity viewpoint. Civilization developed around water bodies that could support agriculture and transportation as well as provided drinking water. Recognition of the importance of the water quality developed more slowly. (Subba Rao N., 1997)

Karnataka state is located in the south-western part of India and covers an area of 191761 sq.km. Major part (99%) of the state is occupied by hard rock aquifers leaving a small part of the coastal terrain, which is occupied by alluvium (CGWB, 2012). The ground water scarcity, decline in water levels, over-exploitation, deterioration in quality and related problems are encountered in the areas east of Western Ghats. The aquifer systems in Karnataka are classified into nine major groups depending upon their hydrogeological characteristics namely Banded Gneissic Complex (BGC), Basalt, Schists, Granites, Charnockites, Limestones, Laterites, Sandstones and Alluvium (CGWB, 2012). Each of the aquifer is typical in its water bearing characteristics and quality aspects. Due to complex and erratic nature of ground water occurrence in hard rock terrains, ground water developments without the necessary pre-drilling hydrogeological investigations (Olutoyin. A, et al, 2014) usually results in failure. These pre-drilling hydrogeological investigations will be cost effective (Sivaramakrishnan. J, et al, 2013) by reducing the drilling depth and by higher success rates.
Water is a chemical compound and may occur in a liquid form or in a solid form or in a gaseous form. All these three forms of water are extremely useful to man, providing luxuries and comforts in addition to fulfilling his basic necessities of life. Every one of us knows how important and precious the water is. Whenever there is no water in our taps, we become helpless. No life can exist without water, since water is as essential for life as air is. It has been estimated that two-thirds of human body is constituted of water. Water is absolutely essential not only for survival of human beings, but also for animals, plants and all other living beings. Further, it is necessary that the water required for their needs must be good and it should not contain unwanted impurities or harmful chemical compounds or bacteria in it. (Burrough PA, McDonnell., 1998).

Landscape constitutes a heterogeneous area comprising of different interacting ecosystems, including land (mountains, hills, soil, forests) and water (streams, rivers, oceans, lakes, etc). These interactions among the components of ecosystems result in the flow of nutrients, minerals and energy, which contribute to the functioning of the landscape. Watershed, an integral part of any landscape, can be defined as an area that supplies water by surface or subsurface flow to a given drainage system or body of water, be it a stream, river, wetland, lake or ocean (World Bank 2001). Groundwater is the water under the earth’s surface that flows freely through tiny pores and cracks in rocks and soils called aquifers and that can be pumped from wells. Groundwater contamination by anthropological activities and/or infiltration of polluted surface waters has become a ubiquitous problem in many aquifers across the world in recent decades (Gustafson 1993, Fetter 1999).

Bangalore district and the surrounding areas are entirely underlined by Precambrian granite and gneiss of the Indian Precambrian Shield which are part of the peninsular granitic complex. Migmatite and gneiss are
dominant, but there is a zone of granite and grano-diorite ranging up to 20 km wide trending in a north-northwest direction across the far western part of the district. Minor areas of charnockite occur in the far south western part of the city and there are some small elongated bodies of amphibolites and schist aligned along a north-south trend through the central part. The Geological and Mineral map of Karnataka and Goa (Anonymous, 1981) show numerous dolerite dykes to the north, west and southwest of Bangalore city.

Groundwater movement and its properties are unique with reference to its place of occurrence. Karnataka State can be considered as having three major hydrogeological provinces Viz. Archaean crystalline province, Metamorphosed sedimentary province, and Deccan Trap province. Groundwater occurs in these provinces under unconfined to semi-confined conditions and under confined conditions in depth. The rock units in these provinces do not have the primary porosity, therefore, the occurrence and movement of groundwater is through secondary porosity developed from the weathering and structural deformity undergone by the rocks (Sivaramakrishnan, J et al. 2015)

Remote sensing data can be used as a reconnaissance and features identification tool for identifying surface and sub-surface water potential zone. The present study has been carried out to evaluate the potential zones for groundwater targeting using an integrated remote sensing data, Survey of India (SOI) topographical sheets and field verification. Four features (geomorphologic units, slope, drainage density and lineaments density) that influence groundwater occurrence were extracted and integrated to evaluate the hydrogeomorphological characteristics of the study area and demarcate the groundwater potential zones. Thematic maps of the extracted features were prepared and integrated through geography information system (GIS) environment. The groundwater
potential map was prepared by overlaying the thematic layers. Weightage percentages were assigned to the different parameters according to their relative importance to groundwater potentiality. (Ndatuwong, L. G.).

Application of remote sensing data, because of its repetitive and synoptic coverage capabilities, made it possible to study the changes in land cover in a time and cost effective manner in association with Geographical Information system (GIS) which provides suitable platform for data analysis, update and retrieval (Andersen et al., 1976; Kachhwaha, 1985; Nayak et al., 1985, 1986, 1989; Rasch, 1994; Green et al., 1994; Kam, 1995; Star et al., 1997; McCracker et al., 1998; Chilar., 2000; Luque, 2000, Maselk et al., 2000; Yang and Lo, 2002). Application of remote sensing data remote sensing and GIS provides efficient methods for land use planning and management.

1.2 Bangalore Metropolitan Region

The structure plan for the Bangalore Metropolitan Region (BMR) has been prepared in terms of Section 9(1) (ii) of the Bangalore Metropolitan Region Development Authority Act. 1985. Physical Setting – The Bangalore Metropolitan Region (BMR) is constituted by three districts namely Bangalore Urban, Bangalore Rural and Ramanagara (Ramanagara is a newly created district carved out from Bangalore Rural district that includes Ramanagara, Channapattana, Magadi and Kanakapura taluks) Map (1.1).In terms of the structure plan, the complete BMR excluding the planning area of the Bangalore Development Authority has been classified into five Area Planning Zones (APZs) and six Interstitial Zones (IZs). (Table 1.1) The approach for a balanced and regulated all round development of each of these zones has been indicated in the Structure Plan document. However, the respective Local Planning Authorities (LPAs) are required to prepare detailed Master plans for their respective planning areas in terms of the Karnataka Town and Country Planning Act 1961 and other relevant
legislation/regulations. Topographically, the Bangalore region is an ecologically sensitive region with respect to water resources. It is one of the handful urban agglomerations in the World to be situated above the 3000 feet MSL. Bangalore Urban district is located on the Deccan Plateau in the south eastern part of Karnataka. It is situated in 12° 39’ to 13° 18’ North Latitude and 77° 22’ to 77° 52’ East Longitude. The District is ranked as one of the top Five Information Technology Clusters in the world.

Ramanagara district is located approximately 50 km southwest of Bangalore. It is situated in 12° 54’ to 13° 53’ North latitude and 75° 04’ to 76° 21’ East longitude. It has four taluks viz. Ramanagara, Channapattana, Kanakapura and Magadi. The District is known for its silk production and has Asia’s largest cocoon market.

**Map1.1**: Bangalore Regional Setting – Sphere of Influence
Table 1.1: Authorities functioning within Bangalore Metropolitan region  
(Source: BMRDA)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Authorities Functioning within Bangalore metropolitan region</th>
<th>Area in Km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bangalore Development Authority (BDA)</td>
<td>1219.50</td>
</tr>
<tr>
<td>2</td>
<td>Bangalore – Mysore Infrastructure Corridor Area Planning Authority (Part)-BMICAPA</td>
<td>426.24</td>
</tr>
<tr>
<td>3</td>
<td>Ramanagara - Channapatna Urban Development Authority (RCUDA)</td>
<td>63.06</td>
</tr>
<tr>
<td>4</td>
<td>Anekal Planning Authority (APA)</td>
<td>402.30</td>
</tr>
<tr>
<td>5</td>
<td>Nelamangala Planning Authority (NPA)</td>
<td>735.00</td>
</tr>
<tr>
<td>6</td>
<td>Magadi Planning Authority (From IZ -2)</td>
<td>501.52</td>
</tr>
<tr>
<td>7</td>
<td>Hoskote Planning Authority (HPA)</td>
<td>535.00</td>
</tr>
<tr>
<td>8</td>
<td>Kanakapura Planning Authority (From IZ-1)</td>
<td>421.78</td>
</tr>
<tr>
<td>9</td>
<td>Bangalore International Airport Area Planning Authority (BIAAPA)</td>
<td>792.00</td>
</tr>
<tr>
<td>10</td>
<td>Area Planning zone –1 (APZ-1)(Excluding RCUDA &amp; BMIAAPA)</td>
<td>462.60</td>
</tr>
<tr>
<td>11</td>
<td>All Interstitial Zones in Bangalore Metropolitan Region (IZ’s BMR)</td>
<td>2455.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>8005.00</strong></td>
</tr>
</tbody>
</table>

**1.3 Study Area**

The study area is situated in the political boundary of Southern part covers about 4,125 Sq.kms comprising Bangalore South and Anekal taluk of Bangalore urban district and Ramanagara, Kanakapura and Channapatna taluks of Ramanagara district. Geographically lies between the Longitude 77°2'50.00" to 77°50’39.39" E and Latitude 13°8’1.33"N to 12°13’46.322”N. The Survey of India (SOI) Toposheet bearing number 57G/4,8,12,16 57H/1,2,3,5,6,7,9,10,11 and 13 on 1:50,000 scale (Map 1.2) The study concentrates mainly on the hydrogeological aspects and change in the groundwater level due to the over exploitation.

The South Bangalore Metropolitan region encompasses Cauvery and Krishna Basin. Eastern Part of Bangalore south and Anekal taluks fall under the catchment of Cauvery to Palar. Ramanagara, Kanakapura, Channapatna taluks and part of western portion of Bangalore south and
Anekal falls under the catchment of Cauvery. Pennar River flowing towards Eastern side and Cauvery River flowing towards Southern side.

1.4 General

Historically known as Bayaluseeme, the upland of Bangalore and its surrounding areas are parts of Mysore plateau; being a part of cratonised shield area, Bangalore and the adjoining areas are considered seismically stable (Seismic Zone-II), free from intense earth tremors of higher order.

1.4.1 Topography and Relief

The highest point within the study area is Δ 1042 hill and the lowest level is around 800 m above m.s.l. The erosional surface around Bangalore is at 900 m, varying from 800 m to 1000 m with a gentle slope towards east; this erosional plane was attained during Miocene Period. The oldest basement rock suite called Peninsular Gneisses were denuded to the base level of erosion since Archaean times, leaving remnants of isolated hillocks and ridges. The region around Ramanagara and further south are studded with a series of such topo features aligned and trending in N-S direction. The granitic mass is seen rising abruptly from the surface level resulted from circumdenudation; knolls, koppies and inselbergs are the terms used to describe these isolated rocky peaks. Those with exfoliated surfaces are called bornhardts in case of gneissic rocks. Rock mass of granitic composition with well pronounced sets of joint surfaces look like a piled up mass, surrounded by scattered blocks of boulders on the slope surface. Such features speaks of a prolonged semi-arid like climatic conditions. These isolated barren hills devoid of vegetation are referred as tors, whereas low mounds of linear granite bodies are called whalebacks. The area bearing such above described profile is mostly undulatory; consequently the low lying zones are endowed with micro aquifers whereas the hilly slopes are dry. The eastern segment of the study area is mostly planar draped with a thick blanket of lateritic soil cover.
1.4.2 Pedology

Lateritic soil is a product of the insitu weathering of the underlying crystalline rocks. At the interface of the bedrock with soil, lithomargic clay is mostly absent; murrum/gruss, a semi-weathered, residual bedrock is noticed which serves as a good road fill material. In the areas adjacent to the granitic country, low order ephemeral streams transport quality sandy soil and contribute to excellent beds of river sand deposits.

1.4.3 Drainage

Water course in the southern part drains due N-S to NNW-SEE to debouch into the Cauvery River through its main tributary river Arkavathi. Flow trends of both these rivers are influence by a set of lineaments trending N-S and E-W in general. The major segment of the area under study is part of Cauvery river basin. The other two important water courses forming the tributaries of Cauvery draining further west are Kanvahalla and Simsha River in the same N-S trend. A clear cut water divide is recognized along the northern edge of the study area. A cymatogenic warp along the 13°N latitude is responsible for this geomorphic feature (Radhakrishna and Vaidyanathan, 1997)

Prominent joint surfaces in the bed rocks distinctly developed gneissosity in the rock texture, local fault planes are responsible for the well documented trellis drainage pattern; radial to sub-radial pattern is recorded in the areas within the massive granite basements and its surrounding hill slopes. Some of these observations are further elaborated and discussed in detail with full analysis and results later.

1.4.4 Climate

This table land along 13°N parallel enjoys a climate akin in Savanna zone with distinct cold and hot weather cycles in a year, mostly supporting a natural grass land with scattered low shrubs, save the tilling habits of local inhabitants since long ago. The temperature varies from 15°C to 30°C.
during winter periods of December to February, summer seasons of April to May months respectively. Summer heat is moderated by frequent thunderstorms. Pre-monsoon rain in the months of March and April are accompanied by moderate gale; otherwise light to moderate breeze is experienced throughout the year. The mean annual rainfall precipitations through well-defined monsoon from South-west during June to October and a weaker NE monsoon in November to January months of the year are around 800 to 850 mm.

1.5 Objectives of the study area

A detailed hydrogeological investigation has been attempted in a part of South Bangalore Metropolitan Region (SBMR) which is a part of Cauvery and Krishna Basin and Catchment of Cauvery to Palar. In the present study, appropriate groundwater management and development strategies has been suggested through the following objectives:

- To assess the hydrogeological set-up using Geoinformatics.
- Geomorphological studies
- To study the morphometric characteristics of the watershed to understand the hydrological process;
- Digital Elevation model studies for the present Drainage pattern of the area.
- To generate a spatial database of ground water.
- Time Series Analysis of Rainfall.
- Land use and Land cover studies.
- To study sub-surface layer parameters;
- Predictions of Soil Erosion in the Nelligudda Watershed.
- Comparison of Surface water studies using Survey of India Toposheet of 1:50000 scale and 2013 LISS III Image using Remote Sensing and GSI Techniques.
➢ To prepare a set of thematic maps for demarcating groundwater prospect zones for artificial recharge zones using Remote Sensing and GIS techniques.

Map 1.2: Location Map of the Study area
1.6 **Scope of Investigation**

Changes in climatic conditions due to increasing atmospheric concentrations of radioactively active trace gases will probably alter land and water resources, their distribution in space and time, the hydrologic cycle of water bodies, water quality, water supply systems and requirements for water resources in different regions. Quantitative estimates of the hydrological effects on climate change are essential for understanding and solving potential water resource problems associated with usage of water in domestic, industry, power generation, agriculture, and transportation and also for future water resources systems planning and management for the protection of natural environment.

Water management in the BMRD Region is vital. The average rainfall in the area is 800mm, the surface water is scarce therefore alternative source is groundwater. This data gives the total information on importance of groundwater. Water is useful for Drinking, Irrigation and Industrial purpose. Surface and subsurface water (Ground water) is importance in the all fields. Water management is important precautionary for erratic rainfall and overexploitation without proper management methodologies.

In the study area rainfall trend is same. But, the infiltration rate is declined and also the water level in the dug-wells is lowered because of rapid urbanisation. The study area is dominated by gneissic rocks, the groundwater bearing properties are controlled by porosity and secondary permeability.

Hydrological investigation of different parameters are extracted and analysed as follows:

- Drainage map of the study area has been digitised by Survey of India 1:50,000 scale Toposheet.
Drainage map delineated from Digital Elevation Model (DEM) and types of drainage patterns are observed in the study area.

The qualitative and quantitative geomorphology compared between Survey of India toposheets and Digital Elevation Model (Dem) and analysing the condition of morphometric parameters.

Geology of the area and detailed field verification using the help of Remote Sensing and Geographic Information System (GIS).

Soil map also delineated from KSRSAC and Geological survey of India Department and detailed study of about soils for infiltration purpose and Agricultural purpose in the study area.

The different types of geology and soils gives the detail information about groundwater movement in the study area depending upon water bearing properties of the study area.

The study area has been five rain gauge stations collected data from 1985-2104. This type of data very useful to understand about hydrometeorological parameters in the study area.

Temperature and Humidity data is very useful to understand about the water balance in the study area.

Hydrogeomorphology map using by satellite image of the study area in the study area these information gives the detail information about geomorphological features and aerial photographic Information System.

Remote Sensing and GIS applications in the study area very useful to understand the concept about land use land cover map and different thematic layers.

Groundwater map prepared using water level data different season wise the water level data information gives the detail information how subsurface water level movement water in the subsurface region and flow net analysis also applied in the study area.
Groundwater potential maps generated using Remote Sensing and GIS software’s different thematic maps like Geology, Slope, Soil, Land use, Land cover, Drainage density and Lineament density and other parameters.

Suitable sites for constructing rainwater harvesting structure are identified so that the available of rainwater does not go wasted. These water also increasing in the well locations.

The water chemistry has been interpreted for agricultural and Drinking purpose analysed different types of physic chemical parameters analysis in the study area like hill piper. Will Cox and Salinity the pictorial information gives the detail information about the suitability of water for drinking purpose and Agricultural purpose.

Vertical electrical Soundings (VES) in the study are through electrical soundings analysed about resistivity of the study area and get the detailed information about the soil zone, weathered Zone and Hard rock Zones.

Conclusions from the above discussion are drawn, further suggestions have been made for the development and management of the available precious water resource.

1.7 Source of Information

The basin map has been prepared from the Geological Survey of India Toposheets on 1:50,000 scale (57G/4,8,12,16,57H/1,2,3,5,6,7,9,10,11 and 13) published by Survey of India.

Rainfall data collected from The Karnataka State natural Disaster Management (KSNMDC), Bangalore and Karnataka India.

Water level data collected from Department of Mines and Geology (DMG), Government of Karnataka, Khanij Bhavan, Bangalore.

Hydromorphic and lineament structures are prepared from Geological Survey of India Toposheets and LIIS III satellite Image.
Meteorological data such as Temperature, Relative Humidity have been collected from The Karnataka State natural Disaster Management (KSNMDC), Bangalore and Karnataka India.

Soil data collected form the Karnataka State Remote Sensing Applications Centre, Bangalore.

Water chemistry data have been collected from the Department of Mines and Geology and Central Ground water Board, Southern Region, Bangalore.

1.8 Review of Literatures


(13). Balasubramanya, S. D. D. N. Development of Water Quality Index (WQI) for Groundwater Covering the Parts of Padmanabhanagar, Bangalore Urban District.


*Bangalore University*


