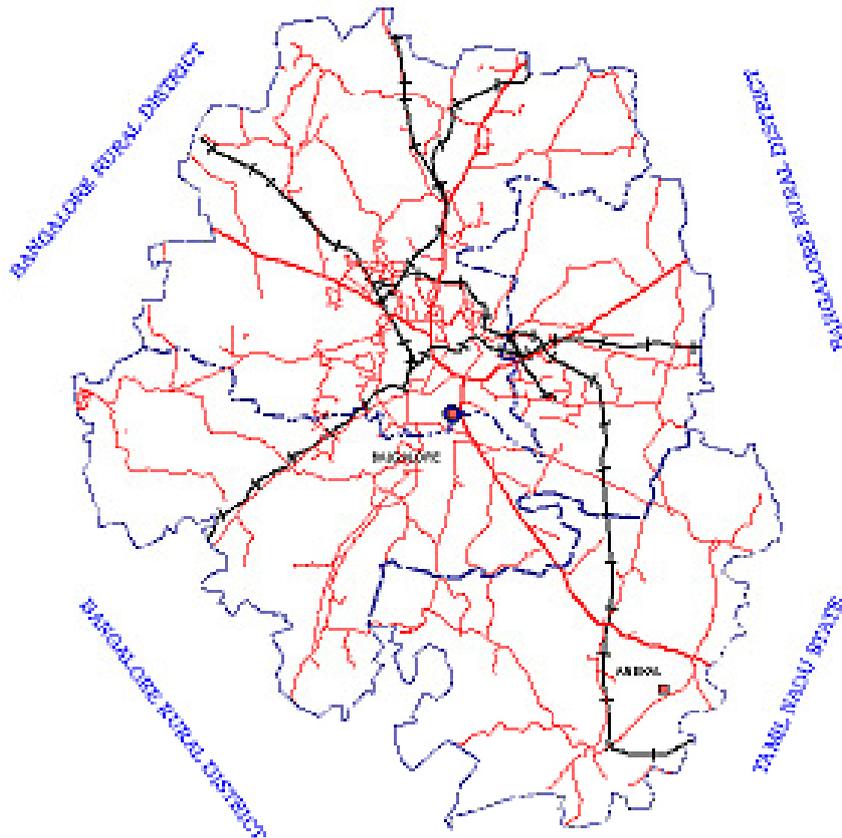




स्वच्छ सुरक्षित जल - सुन्दर खुशहाल कल
CONSERVE WATER - SAVE LIFE



**GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD
GROUND WATER INFORMATION BOOKLET
BANGALORE URBAN DISTRICT,
KARNATAKA**



**SOUTH WESTERN REGION
BANGALORE
DECEMBER 2008**

FOREWORD

Ground water contributes to about eighty percent of the drinking water requirements in the rural areas, fifty percent of the urban water requirements and more than fifty percent of the irrigation requirements of the nation. Central Ground Water Board has decided to bring out district level ground water information booklets highlighting the ground water scenario, its resource potential, quality aspects, recharge – discharge relationship, etc., for all the districts of the country. As part of this, Central Ground Water Board, South Western Region, Bangalore, is preparing such booklets for all the 27 districts of Karnataka state, of which six of the districts fall under farmers' distress category.

The **Bangalore urban** district Ground Water Information Booklet has been prepared based on the information available and data collected from various state and central government organisations by several hydro-scientists of Central Ground Water Board with utmost care and dedication. This booklet has been prepared by **Smt. Veena R Achutha**, Assistant geophysicist, under the guidance of Dr. K.Md. Najeeb, Superintending Hydrogeologist, Central Ground Water Board, South Western Region, Bangalore. The figures were prepared by S/Sri. H.P.Jayaprakash, Scientist-C and K.Rajarajan, Assistant Hydrogeologist. The efforts of Report processing section in finalising and bringing out the report in this format are commendable.

I take this opportunity to congratulate them for the diligent and careful compilation and observation in the form of this booklet, which will certainly serve as a guiding document for further work and help the planners, administrators, hydrogeologists and engineers to plan the water resources management in a better way in the district.

(T.M.HUNSE)
Regional Director

BANGALORE URBAN DISTRICT AT A GLANCE

SL NO	ITEMS	STATISTICS	
1	GENERAL INFORMATION		
	i) Geographical area	2174 Sq.Km	
	ii) Number of tehsils/ blocks/ taluks	Three taluks Bangalore North Bangalore South and Anekal	
	iii) Number of panchayats/villages	122/699	
	iv) Average annual Rainfall (mm)	831 mm	
2	GEOMORPHOLOGY		
	Major physiographic units	Rocky upland Plateau and Flat topped hills	
	Major drainages	Cauvery and Ponnaiyar basins	
3	LAND USE (ha)		
	a) Forest area	5055	
	b) Net area sown	73600	
	c) Cultivable area	99389	
4	MAJOR SOIL TYPES	Red loamy soil and Laterite soil	
5	AREA UNDER MAJOR CROPS (As on 2005-06)	47503 ha	
6	IRRIGATION BY DIFFERENT SOURCES (AREA and NO. of STRUCTURES)		
	Dug wells	581 ha	628 dug wells
	Tube wells/Bore wells	10814 ha	12756 wells
	Tanks/Ponds	2369 ha	517 structures
	Canals	-	
	Other sources	-	
	Net irrigated area	13764 ha	
7	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (AS ON 31.3.2007)		
	No. of Dug wells	22	
	No. of Piezometers	13	
8	PREDOMINANT GEOLOGICAL FORMATIONS	Granite Gneiss	

9	HYDROGEOLOGY	
	➤ Major water bearing formations	Granite Gneiss
	➤ Premonsoon depth to water level during 2006	2.00 to 10.47 mbgl
	➤ Postmonsoon depth to water level during 2006	1.77 to 12.02 mbgl
	➤ Long term water level trend in 10 years (1997-2006)	<p>Premonsoon water levels show a general rise in the range of 0.0426 to 0.3848 m/year in Bangalore south and North taluks and falling trend is indicated in the range of 0.0602 to 0.3253m/year in Anekal taluk.</p> <p>Post monsoon water level behavior show a general rise of 0.0354 to 0.1256 m/year in few wells of Bangalore south and parts of Bangalore north taluks. Falling trend is indicated in 13 wells in the range of 0.0106 to 1.2115 m/year in parts of Bangalore south, most of Bangalore north and Anekal taluks.</p>
10	GROUND WATER EXPLORATION BY CGWB (AS ON 31.3.2007)	
	No. of wells drilled(EW, OW, PZ, SH-Total)	EW-12, OW-09 PZ-13 (Under HP-I), Total- 34
	Depth Range	17.24 - 264.73 mbgl
	Storativity	2.8×10^{-3} to 8.4×10^{-4} .
	Transmissivity	10 to 65m ² /day- Moderate zone 15 to 280m ² /day - Deeper zone
11	GROUND WATER QUALITY	
	Presence of chemical constituents more than permissible limit (EC, F, AS, Fe, NO ₃)	Nitrate in shallow ground water
	Type of water	Sodium Chloride type
12	DYNAMIC GROUND WATER RESOURCES (2004) IN HAM	
	Annual replenishable Ground water resources	17508
	Gross Annual ground water draft	33027
	Projected demand for domestic and industrial uses	2186
	Stage of ground water development	197%

13	AWARENESS & TRAINING ACTIVITY	
	Mass Awareness programmes organized	01 Date - 8.2.2005 Place- Kendriya Vidyalaya, Malleswaram No.of participants-900
14	Water Management Training Programme	02 1) Date 23.2.2001(Rain water harvesting) Place- Kendriya Sadan, Bangalore No.of participants-40 2) Date - 3 rd &4 th February 2005 Place- PSTI, Bangalore No.of participants-40
	EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING	
14	Projects completed by CGWB (NO. and Amount spent)	Bangalore university Phase I & II under central sector scheme Total amount spent- Rs. 46 lakhs.
	Projects under technical guidance of CGWB (No.s)	4 schemes under Freshwater year activity 2003. 1) BDA Complex 2) IIHR Hesaraghatta 3) Rajbahwan 4) APTS/PDMS Total amount spent- 49.87 lakhs
15	GROUND WATER CONTROL & REGULATION	
	No.of OE blocks	03
	No.of Critical Blocks	-
	No.of Blocks notified	03
16	MAJOR GROUND WATER PROBLEMS AND ISSUES	1) Deterioration of ground water quality due to industrial and sewage pollution 2) High Nitrate content in ground water 3) Over exploitation of Ground water resources

BANGALORE URBAN DISTRICT

1.0 INTRODUCTION

Bangalore urban district was formed in the year 1986. Bangalore urban district especially, Bangalore city being capital city of Karnataka is central point for running the state administration. It is now known as BBMP, is the biggest urban area with an areal extent of 850 sq.km.

Bangalore, the fastest growing city in Asia, has recently attained the fame of 'Silicon City', due to its progressive trend in Information technology. The city, which was known as Garden City, is losing its lung space (greener patches) due to rapid urbanization and multifaceted industrial development.

Now, after the IT boom the city has suddenly overgrown its size and the district administration is facing a challenging task for providing necessary infrastructures to the related economic activities, trade, commerce and housing facilities. Especially, the enormous pressure on water supply needs scientific planning and effective management of water resources, particularly ground water in the district.

1.1 Administrative divisions:

The district is located in the southeastern part of Karnataka. It is having an areal extent of 2174 sq.km and is located between the north latitude 12°39' 32": 13°14' 13" and East longitude 77°19'44": 77°50'13". The district is bounded in all the directions by Bangalore rural district except in southeast, where the district is bounded by Dharmapuri district of Tamil Nadu state (Fig-1). The district is divided into three taluks namely Bangalore north, Bangalore south and Anekal taluks and is very well connected to all parts of the country and to different parts of world through air ways (With newly built international Air port), railways and road ways. There are 699 villages in the district with 112 grama panchayats.

1.2 Population:

As per the 2001 census, total population of the district is 65, 37,124 with population density of 2985 persons per sq.km. Majority of population have settled in urban areas with urban population of 57,59,987 and population density in Bangalore city alone is 19,435 persons per sq.km. Literacy rate of the district is 83.91%.

1.3 Drainage:

Major part of the district is drained by Shimsha and Kanva rivers of Cauvery basin i.e., Bangalore north and South taluks (Catchment area of 468 sq.km which includes Nelamangala and Magadi taluks of Bangalore rural also). Anekal taluk is drained by South Pennar river of Ponnaiyar basin, which takes its birth from Nandi hills and flows towards south (Catchment area is 2005 sq.km which covers Devanahalli and Hoskote taluks of Bangalore rural district also. (Fig-2)

1.4 Irrigation:

Ground water is the major source of irrigation in the district along with few tanks and lift irrigation schemes. Paddy and Ragi are the major crops grown in the district along with other subsidiary crops such as Maize, Cereals and Groundnut.

1.5 Studies carried out by CGWB:

Central Ground Water Board has carried out multifaceted studies in the district such as.

- Systematic hydrogeological surveys & Reappraisal hydrogeological surveys (I & II Phase)
- Ground water exploration I & II phase upto 260m depth through hydrogeological, geophysical surveys and drilling of exploratory and observation borewells
- Monitoring of water levels and quality of ground water through a network of Ground water monitoring wells and purpose driven piezometers, established under Hydrology project I
- Effects of Industrial pollution on ground water regime in Bangalore city.
- Artificial recharge scheme under central sector in Bangalore university-Phase II & I.
- Artificial recharge & RWH schemes under Fresh water year (2003) scheme in Rajbhavan, BDA head office, IIHR- Hesaraghatta, PDMA & APTS campus.
- Geophysical Studies carried out for recommending suitable area for municipal dumping (Solid waste) for NEERI in Kannahalli and Seegehalli area of Bangalore north taluk.
- Urban Hydrogeology of Bangalore
- Hydrogeological and geophysical surveys for water supply investigation and advice for rainwater harvesting to various state, central and public sector undertakings on request basis.

These studies have brought out enormous scientific data related to ground water regime in the district.

2.0 RAINFALL AND CLIMATE

For studying the rainfall pattern 10 years actual rainfall from 1996-2005 is considered. As per the data, normal annual rainfall Bangalore urban district received is 831mm. During the year 2005, Bangalore urban district received actual rainfall of 1342.7 mm in 69 rainy days.

Of the total rainfall, contribution from southwestern monsoon is 54.18% and 26.53% is from northeastern monsoon. In addition to this, Premonsoon showers contribute significant rainfall of 18.53%.

A perusal of the departures of actual rainfall from respective normal reveals that the Premonsoon season rainfall is highly variable. In case of

monsoon season, the rainfall is either normal or above normal in most years. Post monsoon rainfall is also highly variable on annual basis.

Typical monsoonal climate prevails in the district with major contribution of rainfall during southwest monsoon. In general, pre-humid to semi arid climatic conditions prevail in the district. Average temperature is 23.1°C.

3.0 GEOMORPHOLOGY AND SOIL TYPES

3.1 Geomorphology:

Physiographically the district can be divided into rocky upland, plateau & flat topped hills at an general elevation of about 900amsl with its major part sloping towards south and south east forming pediplains interspersed with hills all along the western part. The pediplains form the major part of the district underlain by granites and gneisses with the highest elevation of 850 to 950 m.amsl. Major part of the pediplain constitute low relief area having matured dissected rolling topography with erosional land slope covered by a layer of red loamy soil of varied thickness. Major part of the pediplains is dissected by streamlets flowing in southern direction.

3.2 Soils:

The soils of the districts can be broadly grouped into red loamy soil and lateritic soil.

Red loamy soils generally occur on hilly to undulating land slope on granite and gneissic terrain. It is mainly seen in the eastern and southern parts of Bangalore north and south taluks

Laterite soils occur on undulating terrain forming plain to gently sloping topography of peninsular gneissic region. It is mainly covered in Anekal taluk and western parts of Bangalore North and south taluks.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology:

Ground water occurrence, movement and recharge to aquifers are controlled by degree of weathering, fracture pattern, geomorphological setup and rainfall. Granites and Gneisses of peninsular gneissic group constitute major aquifers in the urban district. Ground water occurs in phreatic conditions in the weathered zone and under semi confined to confined conditions in fractured and jointed rock formations (Fig-3). Laterites of Tertiary age occur as isolated patches capping crystalline rocks in Bangalore north taluk and ground water occur in phreatic condition. Alluvium of 20m thick, which occur along the river courses, though of limited thickness and aerial extent possess substantial ground water potential.

4.1.1 Behavior of ground water level

Behavior of ground water level is essentially controlled by physiography, lithology and rainfall. Ground water level behavior is analysed based on monitoring of ground water level at representative network hydrograph stations established by CGWB in all the districts. In Bangalore urban district there are 22 NHS and 13 piezometers, which are monitored four times in a year during April/May (Premonsoon), August (Postmonsoon), November & January. (Fig-2)

In a normal year deepest ground water level is generally recorded during April-May and shallow water level during October-November. The water level in general shows recession from November to May.

Depth to water level during 2006

In general, premonsoon depth to water levels ranges from 2.00 to >10.00 mbgl. Larger part of the district has water levels ranging from 5-10mbgl, except for a smaller portion of south of Bangalore north, central part of Bangalore south and northeast of Anekal taluk. A small isolated patches in north and northeastern part of Bangalore north taluk and south east of Anekal taluk shows deeper water level of 10-20mbgl. (Fig-4).

Postmonsoon depth to water level ranges from 1.77 to 12.02 mbgl showing general rising trend in central and southern part of the district. In southeastern part of Anekal taluk, where water level was deeper (10-20mbgl) during Premonsoon, there is substantial rise of 2 to 5m. Similarly northwestern part of Bangalore north taluk has shown a rise in water level. However, water level has fallen in southwestern parts of Bangalore south taluk (10-20mbgl). At some of the NHS stations, water levels of more than 12 mbgl were recorded in Bangalore north taluk. (Fig-5)

The water level fluctuation during 2006 study reveals that, there is a rise of 0.18 to 5.89 m in parts of Anekal and Bangalore south district and marginal fall of 0.18 to 1.27m in Bangalore north district.

Long-term water level trend

The behavior of long-term water level trend in ground water level has been arrived at based on NHS data during the decade 1997-2006.

Premonsoon water levels show a general rise in the range of 0.0426 to 0.3848 m in Bangalore south and North taluks and falling trend is indicated in the range of 0.0602 to 0.3253ml in Anekal taluk.

Post monsoon water level behavior shows a general rise of 0.0354 to 0.1256 m in few wells of Bangalore south and parts of Bangalore north taluks. Falling trend is indicated in 13 wells in the range of 0.0106 to 1.2115 m in parts of Bangalore south, most of Bangalore north and Anekal taluks.

From the above, it is deciphered that there is a general rise in water level annually in the range of 0.0261 to 0.2310 m/year in parts of Bangalore south and pockets of North taluks and fall in the range of 0.1028m/year in Bangalore north to 0.2956m/year in (Gottigere), Anekal taluk.

General rising trend in ground water level during Premonsoon season in urban pockets of Bangalore South and North taluks may be attributed either to good pre monsoon showers and non-usage of ground water with good supply of municipal supply. Falling trend in the same parts of the district and Anekal taluk during post monsoon may be due to erratic monsoon and rapid urbanization and increase in concrete surface thus minimizing recharge to ground water.

4.1.2 Aquifer parameters:

First phase of drilling was commenced during 1990 and completed in 1996 to assess the potentialities of hard rock aquifers. Totally 21 wells were drilled under ground water exploration programme which includes 12 EW and 09 OW.

Taluk wise break up is given below.

SI no	Taluk	EW	OW	Total
1	Bangalore North	03	03	06
2	Bangalore South	06	04	10
3	Anekal	03	02	05
	Total	12	09	21

Depth of Exploratory wells ranged from 119.45 to 264.23 mbgl and that of Observation wells ranged from 17.24 to 205.27 mbgl. Static water level ranged from 5.45 to 33.50 mbgl. Weathered zone ie, shallow aquifers in granites and gneisses ranges from 2 to 25m depth. Depth of semi confined to confined aquifers varies. General fractures are encountered in the depth range of 35-80m, 100-125m and deeper fractures upto 213 & 250m depth were also encountered in the district during ground water exploration programme. In general, discharge of the exploratory wells ranged from < 1.0 lps at Hesaraghatta to 8.4 lps at Bangalore university.

The aquifer in Bangalore urban district can be divided onto three zones namely, shallow zone, moderately deep zone and deep zone.

Shallow zone: Aquifer occurring within depth of 25m below ground level comprises of weathered and shallow fractured granites and gneisses and ground water occur in phreatic condition. Ground water development is mainly through dug wells, dug cum bore wells and shallow bore wells. Weathered thickness generally ranges from 5 to 10m in 60% of the area in Bangalore south taluk and part of Bangalore north taluk. In Anekal taluk weathered zone thickness is deeper generally upto 25m depth. About 90% of ground water structures tapping shallow aquifers are yielding less than 1 lps and yield of more than 2 lps is recorded in Bangalore south taluk.

Moderately deep zone: (Upto 60mbgl) Aquifer of this category consists of weathered and fractured granites and gneisses. Yield of the wells ranged from 2 to 6 lps. Transmissivity ranged from 10 to 65m²/day.

In Deeper aquifers: Yield ranged from 2 to 8 lps in parts of Bangalore north and Anekal taluks. Transmissivity ranged from 15 to 280m²/day and storativity varies from 2.8*10⁻³ to 8.4*10⁻⁴.

Also, during Hydrology Project-I, total of 22 piezometers were constructed in the district tapping mainly the phreatic aquifers of gneisses to a depth ranging from 30 to 90mbgl. The casing depth varied from 6.89 to 48.78m and discharge varied from 43.2 to 678m³/day. Depth to water level varied from 5.40 to 28.40m.bgl. The ultimate aim of the project was to construct the purpose built piezometers for long term monitoring purpose.

4.2 Ground water resources:

Ground water resource of the district has been assessed keeping view, the sustainable and optimum development of the resource. The estimation has been done based Ground Water Estimation methodology (GEM)-1997. This method is more refined than earlier methodologies and it is based on water balance techniques. Assessment is done water shed wise, then appropriated for administration units i.e., taluk. and average stage of development was computed. Taluk wise resources are computed on pro-rata basis as on March 2000 and the same is projected for March 2004. Net annual groundwater availability of the district is 16769 ha.m, total ground water draft for irrigation, domestic and industrial uses is 33027 ha.m with projected draft of 2186 ha.m.

Thus, draft exceeding the total available ground water resources leaving absolutely nil ground water resources for future use. Stage of ground water development is quite alarming with an average of 197% for the whole district. Hence all the taluks have been categorised as per stage of development as Over exploited. Therefore, Central Ground Water Authority has notified these taluks during March 2006 for registration of ground water abstraction structures. Talukwise resources as on March 2004 and categorization is given in table 1 and is shown in Fig- 6.

Table-1. Talukwise resources and categorization as on March 2004.

TALUK	Net Ground water Availability	Irrigation draft	Domestic and industrial draft	Total annual ground water draft	Projected domestic and industrial draft 2025	Ground water availability for future irrigation	Average Stage of development	Stage of Development as on March 2004			
								Safe area (%)	Semi-critical area	Critical area (%)	OE area (%)
	HAM	HAM	HAM	HAM	HAM	HAM	(%)				
Anekal	3852	7556	399	7954	561	0	206				OE
Bangalore North	6650	12619	557	13176	781	0	198				OE
Bangalore South	6267	11295	602	11896	844	0	190				OE
Total	16769	31470	1557	33027	2186	0	197				

4.3 Ground water Quality:

Ground water quality for the district has been arrived at based on hydro chemical data of NHS wells and exploration bore wells. Ground water in the district shows wide variations in its chemical composition. The shallow and deep groundwater is alkaline with pH value ranging from 7.8 to 8.5. Total hardness varies from 100 to 600 ppm. Flouride content in general is less than 1 ppm.

Major part of the district is having fresh water with EC ranging from 250 to 2000 micromhos/cm at 25° C. In Anekal taluk EC varies from 1000 to 2000 micromhos /cm at 25°c except for small part in the centre of Anekal taluk where salinity is more with EC> 2000 micromhos /cm at 25° c. In Bangalore North and south taluks larger part of the taluks are having fresh ground water with EC ranging from 500 to 1000 micromhos /cm at 25°c. Isolated patch in NE corner of Bangalore north taluk and centre of Bangalore south taluk shows EC in the range 2000 to 3000 micromhos /cm at 25° c.

Larger part of Anekal taluk, isolated patches in the eastern part of Bangalore north, southwest and eastern part of Bangalore south taluk is having Chloride in the range of 250 to 1000 mg/l.

In shallow ground water high values of chloride and EC are likely to be due to the local sources of pollution.

Major part of the area of Anekal taluk and in Bangalore south taluk, major part towards north and north east is having nitrate content more than the permissible limit of > 45mg/l. In Bangalore north taluk only small portions in southwestern part and northeastern part, ground water is affected by high nitrate content.

In general ground water in the district is of sodium Chloride type (Fig-7).

4.4 Status of ground water development:

In Bangalore district ground water is mainly developed through dug wells, dug cum borewells, borewells for irrigation, industrial and domestic purposes.

Out of the net irrigated area of 13764 ha in the district, major part of 11395 ha. is irrigated through ground water and only 2369 ha is from surface water. Ground water is used for all kinds of irrigation such as drip irrigation, sprinkler irrigation, underground and open canal irrigation. As per minor irrigation census, there are about 728 dug wells in the district with 100 being abandoned and dry wells. Highest dug wells are in Bangalore north taluk. In dug wells, depth to water varies from 5 to 20mbgl and yield of the dugwells varies from 15 to 50m³/day and sustain 4 hrs of pumping.

There are about 1,30,023 shallow/deep bore wells in the district. Depth of the borewells range from 30 to 200m and each well irrigate about 1 to 5 ha. All these wells are energized and fitted with 4 to 6 HP pump.

As per ground water exploration data of CGWB, total 21 deep bore wells were drilled. The depth ranges from 119.45 to 264.23 mbgl and yield ranges from less than 1.0 lps to 8.4 lps.

Present water supply to urban area is mainly through surface water schemes of Cauvery river. Everyday around 810 MLD Cauvery water is pumped to Bangalore through a distance of 120 Km which costs nearly 500 crore rupees per year for electricity alone. The other two sources for water are T.G.Halli Tank and Ground water Resource. Around 120 MLD from T.G.Halli and 50 MLD from ground water resource are used. In addition, flourishing ground water market exists in the city and its environs, where tankers selling ground water cater the emergency requirement of city population. On a rough estimate, there are about 3000 tankers with a capacity of 3000 liters, which sell about 85 lakh litres per day.

However, in recent years, due to haphazard urbanization, exponential growth in population and industrial units, demand for water has resulted in indiscriminate drilling of bore wells by individual households, business establishments and industries. This has resulted in depletion of ground water levels & over exploitation of the ground water resources in the district.

From the assessment of ground water resources, it is seen that all the taluks are categorized as Over exploited with stage of development being more than 196-200% and in principle there is no balance ground water resources left for future development.

5.0 GROUND WATER MANAGEMENT STRATEGY

5.1 Ground water resource development:

In view of the over exploitation of ground water resources in all the three taluks, instead of recommending additional ground water abstraction structures, methods of augmenting the resources such as artificial recharge methods, rain water harvesting and water shed management practice, drip irrigation and sprinkler irrigation system are the present and future strategies for minimizing ground water withdrawal and building up of ground water resource. However, shallow dugwells are recommended with 1.1.hp pump in peak requirement period. Additional borewells are not feasible due to OE categorization of the taluks. , However, in case of severe requirement, spacing of wells (200m) is very important, as spatial distribution greatly influence the quantum of recoverable recharge in the borewell.

5.2 Water conservation and Artificial recharge:

In view of the notification of all the three taluks as Over exploited, methods of augmenting the resources such as artificial recharge methods, rain water harvesting and water shed management practice should be made mandatory. Some of the Artificial recharge studies taken up by CGWB are as below.

1) **Bangalore University:** The Central Ground Water Board (2002-2005) implemented a scheme of artificial recharge under the Central Sector Scheme in association with Bangalore University in 2 phases with financial incurrence of 46 lakhs. Under phase I, 2 check dams, one combination structure of check dam and subsurface dykes were constructed with 3 observation wells. Under phase-II, 2 check dams, one vertical shaft, 3 gully plugs and 4 observation wells were constructed. Also, Rooftop rainwater harvesting was facilitated in the civil engineering department in the university.

The natural surface water run-off has been harnessed to recharge the depleting aquifer system instead letting it into a drainage course (Vrishabhavathi). The observation wells in the catchment area were monitored to study water level behaviour. The productivity of the bore well in the university and Sports authority of India campus has increased during the post project period. As per the observations, it is seen that there was no decline in water level trend after the implementation of the scheme in the observation wells. The possible intrusion of polluted Vrishbahavthi waters into aquifers is prevented and the chemical quality analysis of the ground water samples collected in the area reveals that there is no deterioration of ground water quality in the area. Apart from water conservation through artificial recharge, the complete catchments area of the micro watershed has been treated with contour trenches. Tree saplings have been planted all along the contour trenches to have a green canopy for the area.

(2) Schemes completed under Fresh Water Year Activities during 2003.

Four schemes on Artificial Recharge and Rain water harvesting were implemented wherein CGWB provided technical and Financial assistance and the beneficiary agency implemented the project. Completion and Utilisation certificate was obtained from the beneficiary.

- BDA head office, Bangalore (12.50 lakhs)
- Armed Police Training School and Police Driving Maintenance School, Bangalore (13.50 lakhs)
- Raj Bhawan, Bangalore-Phase II (12.20 lakhs)
- Indian institute of Horticulture Research, Bangalore (11.17lakhs)

Also, rainwater harvesting was implemented at the rented CGWB office building at Jayanagar.

3) In addition, rendered technical expertise on Rain water harvesting to various govt and public sector buildings list of which are as follows.

Vikas Bhavan in Bangalore, ITI industry, International Airport at Devanahalli, Aeronautical Development Agency (ADA), Karnataka State Sericulture Research and Development Institute, Corps of military Police & School at Neelasandra, Quarters of CPWD at Koramangala and HSR layout, Kendriya Sadan, Koramangala, Teachers training Institute, KPC -Bidadi power corporation ltd., Sri Jayadeva Institute of Cardiology, Staff quarters at HMT, Jalahalli.

Educational institutions viz., Kendriya Vidyalaya at Malleshwaram, National Law School at Nagarbhavi, Unani Institute of medicine, Bangalore were rendered technical expertise on Rain water harvesting

In order to take up water conservation and artificial recharge to ground water in the district, areas such as isolated pocket in northern part of Bangalore north taluk, entire stretch of eastern part of Bangalore south taluk and Half of Anekal taluk towards east are earmarked for taking up future schemes on Artificial recharge and water conservation (Fig- 6)

6.0 GROUND WATER RELATED PROBLEMS

All the three taluks constitutes urban agglomeration in the district. Bangalore city is located on a high mound of 900 mamsl with Arkavathy in the west and Ponnaiyar in the east. It is mainly covered under BBMP with 6 City Municipal corporations and one taluk municipal corporation with an urban population of 57,59,987. Urbanization has increased rapidly in the last two decades paving way for layouts and industries, which have wiped out many tanks and lakes, which were helpful in maintaining the ground water level.

In urban area of Bangalore district, main problems affecting ground water are

- a) Sewage pollution and Industrial pollution.
- b) High Nitrate concentration in ground water.
- c) Over exploitation of ground water resources.

Rapid urbanization, IT boom, related economic activities, trade and commerce have exerted enormous pressure and this has increased the sewage waste into the lakes. Improper environmental planning has given room for establishment of new residential layouts without proper sewerage system and even if such systems have been provided, the same have not been connected to trunk sewers of BWSSB. The municipal effluents from such natural drains leading to tanks and lakes deteriorate the quality of the water. Sedimentation of the pollutants has not only reduced the surface area of the water which in turn has increased evaporation rate, but has also reduced ground water levels on account of poor permeability with more and more silt, clay deposits, trash and toxic waste accumulation in the lakes year after year.

Sewage pollution is seen in the western part of the city where all the sewage is let into Vrishbahvathi river valley and most of the tanks are also polluted from sewage source due to haphazard urbanization. As per CGWB studies, most of the open wells/borewell situated in the vicinity of Vrishbhavathi river is polluted due to sewerage discharging into the river. However, impact assessment of Artificial recharge structures in Bangalore university has shown that, there is improvement in the quality of ground water in and around Vrishabhavathi valley.

Regarding **industrial pollution**, study of CGWB shows that, in Industrial belt of Peenya, Rajajinagar and Hoskote area, Ground water is slightly alkaline and indicated high concentration of chloride and magnesium in ground water and high nitrate in all the industrial belts of Peenya, Hoskeote, Rajajinagar and Kanakapura road. However water is free from bicarbonates.

Nitrate concentration is the single major constraint for suitability of ground water for drinking is concerned. Major part of the shallow ground water ie., 45 % of the area is affected by high nitrate content which may be due to natural sewage and industrial pollution whereas, deeper aquifer is not affected to that extent by high nitrate content.

Over exploitation of ground water Resources: Rapid and unplanned urbanization has taken its toll on water resources of the district, especially the ground water with increased exploitation by borewells dug up in all possible terrains. In view of the stage of the ground water development to the tune of 196-200% and over exploitation of ground water resources water level has gone deeper thereby leaving the only solution of building up of ground water resource through artificial recharge and rainwater harvesting.

7.0: AWARENESS AND TRAINING ACTIVITY

7.1 Mass awareness and Water management training programme organized by CGWB:

CGWB has conducted two Water Management training programmes and one mass awareness programmes in the district.

Water management Training programmes:

1) Training programme on Roof top Rain water harvesting at Kendriya sadan, Bangalore on 23.2.2001, 40 trainees from different state departments, NGOs and individuals attended the two days training programme.

2) Water Management Training Programme was conducted at Bangalore during 3rd -4th of February 2005(During RWH week-2005) wherein about 40 trainees from different state departments, NGOs and individuals had the benefit of technical talks and field visit.

Mass awareness programmes:

Awareness programme was organized at Kendriya Vidyalaya, Malleswaram, Bangalore during RWH week on 8.2.2005. Drawing competitions were held for school children on the theme of water conservation, models were exhibited. About 900 students and teaching staff participated in the programme.

7.2: Participating in Exhibitions, Mela, Fair etc:

- Participated as guest of honour and delivered talk on water conservation in the mass awareness programmes organized by Department of Mines and Geology, govt.of Karnataka at Anekal and Devanahalli during 2004 and 2006.
- On account of World Water Day celebration by CWC during June 2006, CGWB put up a stall on Water conservation wherein; His Excellency President of India visited the stall.
- Participated in Jaladhara caravan organized by NGO-Rashtrabandhu in Bangalore during April 2006.
- Participated in "Save Water" campaign organized by NGO-Eco watch in Bangalore during April 2007.
- Organized World water day independently and in coordination with CWC, Institute of Engg.and project Agasthya in Bangalore every year.
- As a part of Rain Water Harvesting week celebrations, prepared working models on Artificial Recharge and Rainwater harvesting, hoardings, documentaries and posters on water conservation. Hoardings were displayed at vantage points in Bangalore city and posters were distributed to various state, central agencies and educational institutions and NGOs for campaign. Also, during first week of February 2005 exhibited working models and posters at
 - Dr.Ambedkar Institute of Technology &
 - St.Joesph,s college of commerce
 - At the inauguration of first housing demonstrative project by Govt.Of India at Laggere.
 - At campaign by Indian society of environmental studies, Karnataka State Council of Science and technology and Bharat Education society

7.3: Presentation & lectures delivered in public forum/Institution of repute and Academic institutions etc:

As resource personals officers of CGWB delivered lectures on various themes of water conservation and water science in seminars/workshops, training programmes organized by State govt./central Govt organizations, NGOs, educational institutions such as,

State Govt. departments: Department of Mines and Geology, Land Use Board, RDPR, State Educational Research and Training Directorate, Agro Industries, Karnataka Milk Federation, Regional Institute Of Cooperative Management Of Govt.Of Karnataka

Educational Institutions: Indian Institute of Science, Bangalore university, Geological society of India, National Institute of Advanced Studies - IISc, RV Engg college, Dayanad sagar college, SSMRV college, Univ. of Agriculture, Bangalore.

NGOs and other institutions: INSTRUCT, RashtraBandhu, Geological Society of India etc.

Central Govt. departments: CPWD, Airforce campus, Central silk board

8.0: AREAS NOTIFIED BY CGWA

In view of the stage of the ground water development to the tune of 196-200% and over exploitation of ground water resources in all the three taluks, CGWA for regulating the over exploitation of ground water resources, all the three overexploited taluks viz., **Bangalore north, Bangalore south and Anekal** have been notified under CGWA Act during March 2006. This notification has brought out through various public notices published in the daily newspapers across the country where registration of all the ground water abstraction structure is mandatory. Under this, CGWA has identified State administrative heads (DC of the district) for taking up registration work of all ground water abstraction structures in OE area.

In this regard, meetings have been held with Deputy Commissioner of Bangalore urban district and bilingual application form for registration has been supplied to the agency. Revenue officials/Village accountants have been imparted training for taking up registration work. However, due to absence of Ground water legislation bill at the state level, which is under consideration, this work has been hampered.

Also, as per Directives of CGWA, all Industries seeking NOC for ground water abstraction are required to submit a referral letter from statutory organizations such as State Pollution Control Boards, Ministry of Environment and Forests, Bureau of Indian Standards, etc. In Critical/ Over-exploited areas, It is considered on case to case basis and in case of severely over-exploited areas which are devoid of any deeper potential aquifers NOC for industrial use of ground water may be denied as per the policy. **Whenever permission/ NOC for ground water withdrawal is accorded by CGWA, a mandatory clause for**

Rain Water Harvesting and Artificial Recharge to ground water by the Industry/ Infrastructure projects is included.

9.0 RECOMMENDATIONS

In view of the Over exploited situation of ground water resources in the whole district following recommendations are made.

1) Artificial recharge to ground water through structures like recharge trenches, percolation tanks, check dams, sub surface dykes, infiltration wells, point recharge structures should be implemented based on site specific scientific investigation.

In order to take up water conservation and artificial recharge to ground water in the district, areas such as isolated pocket in northern part of Bangalore north taluk, Entire stretch of eastern part of Bangalore south taluk and half of Anekal taluk towards east are earmarked for taking up future schemes on Artificial recharge and water conservation.

2) Roof top rainwater harvesting should be made mandatory in all the urban and rural establishments including individual households. Also major road structures like High ways, Flyovers and bridges in the city, Government buildings and business establishments with big buildings should invariably adopt rainwater-harvesting structures.

3) Lakes were created basically for hydrological reasons for checking floods, recharging, and maintaining the ground water table. They also act as sediment traps, prevent clogging up of natural valleys and reduce erosion by regulating run off. Lakes and Tanks belong to wetland ecosystem and have a larger biological and ecological role. Due to urbanization most of the tanks/lakes in the districts have been erased from the map. **Hence, measures for rejuvenation of tanks and lakes in the district will definitely build up ground water resources. In this regard, already efforts are being made by State authorities (BBMP) to conserve and rejuvenate major tanks in Bangalore city**

4) Ground water legislation bill at the state level, which is under consideration, should be implemented at the earliest to save ground water.

5) Last and important recommendation is waste water recycling for secondary uses like gardening, industrial cooling, flushing and other secondary purposes through municipal supply, which will definitely help to keep a check on over exploitation of ground water sources and thus building up the ground water resources in the district.

These recommendations can be implemented through public awareness and enactment of law through Central/ State administration, which will go in long way in realizing the civic responsibility towards very important element of life "water".

Fig-1

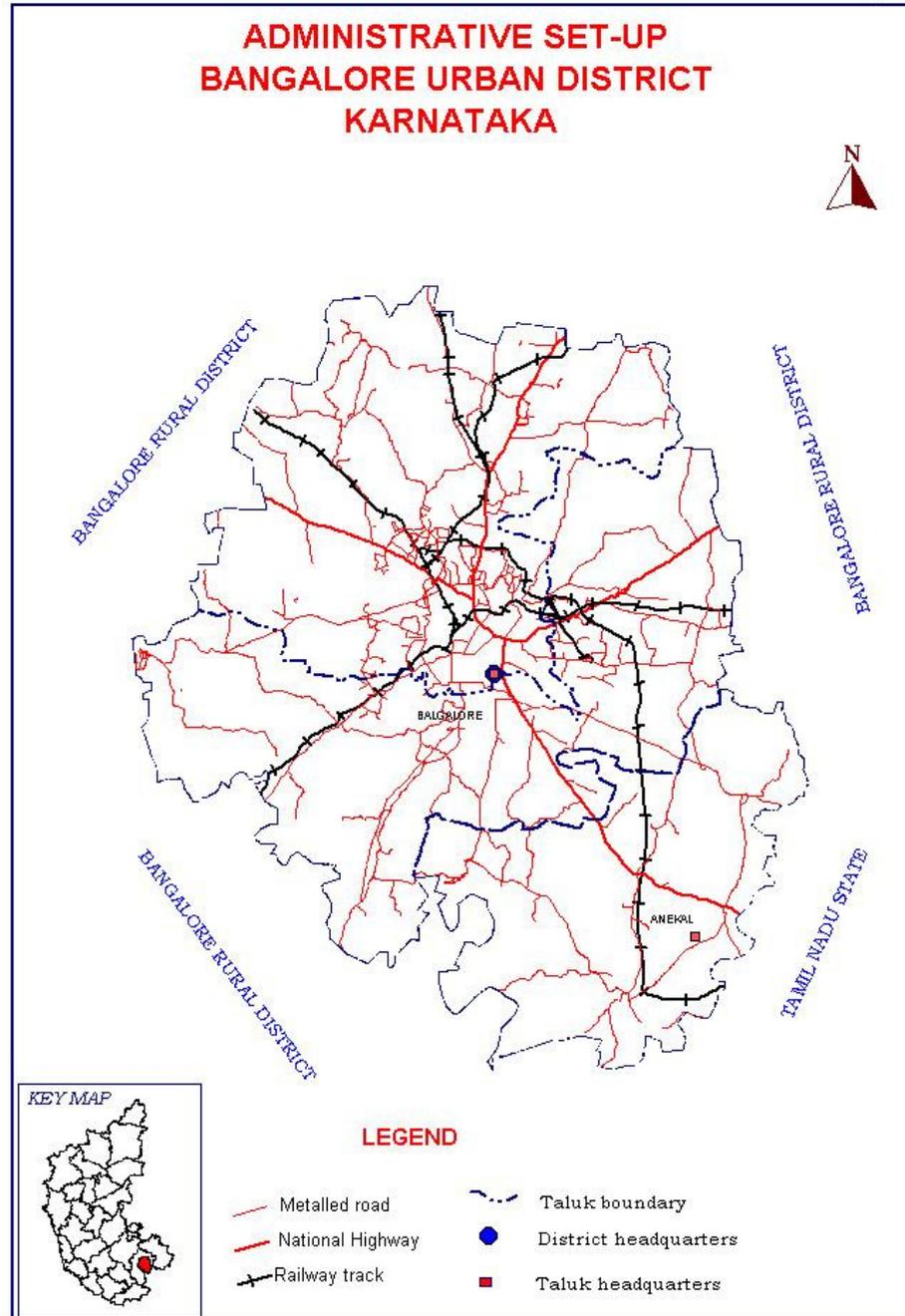


Fig-2

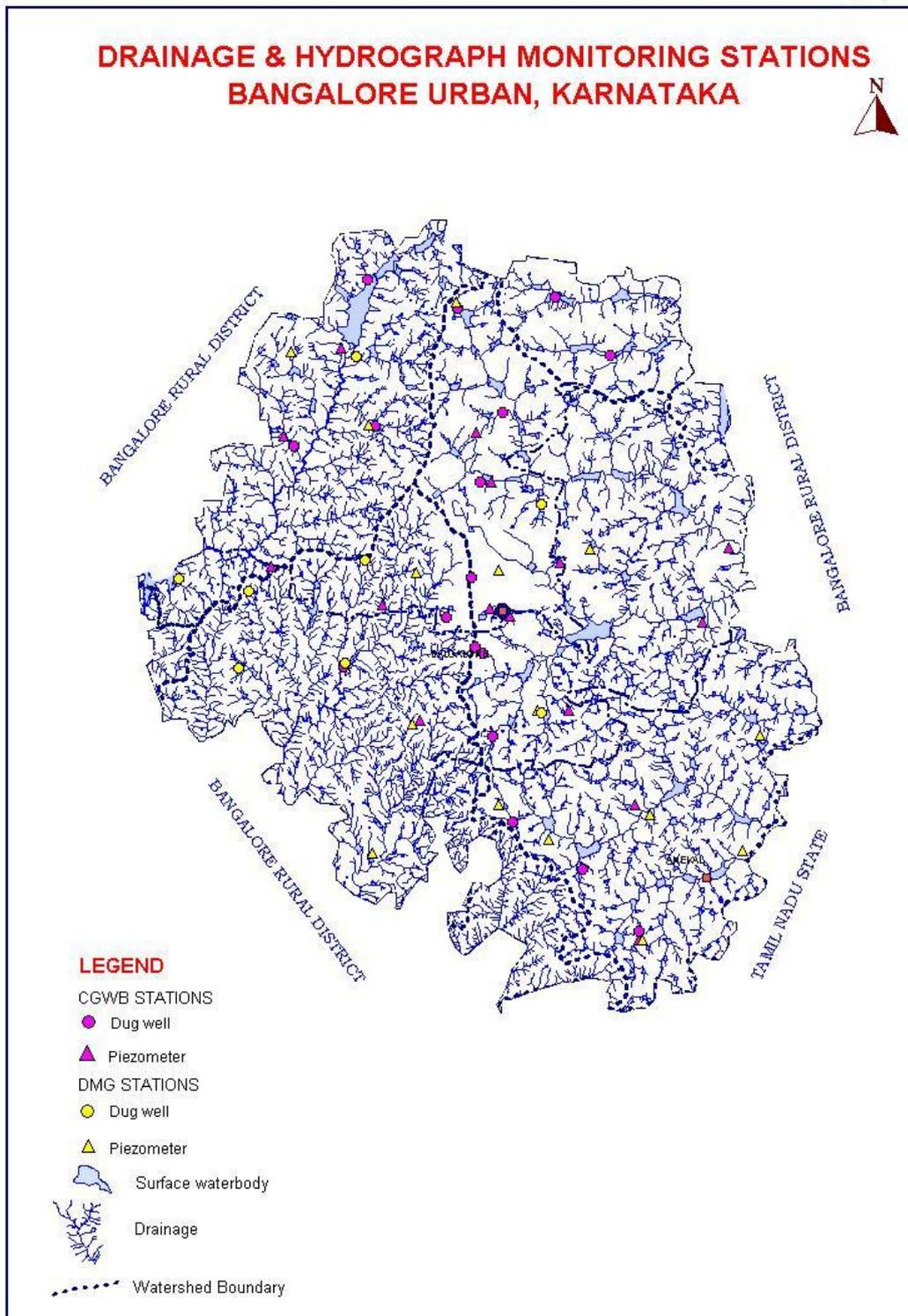


Fig-3

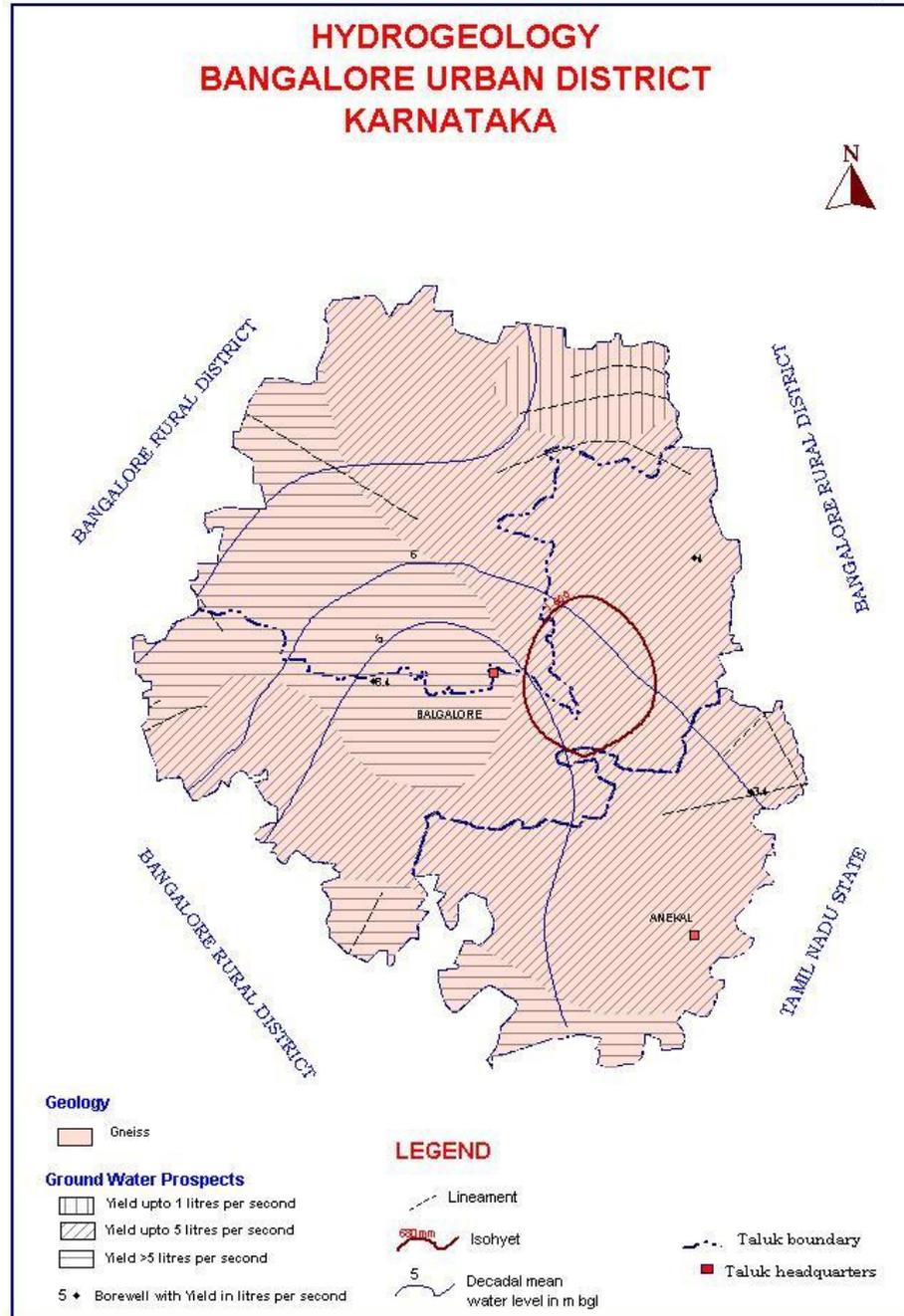
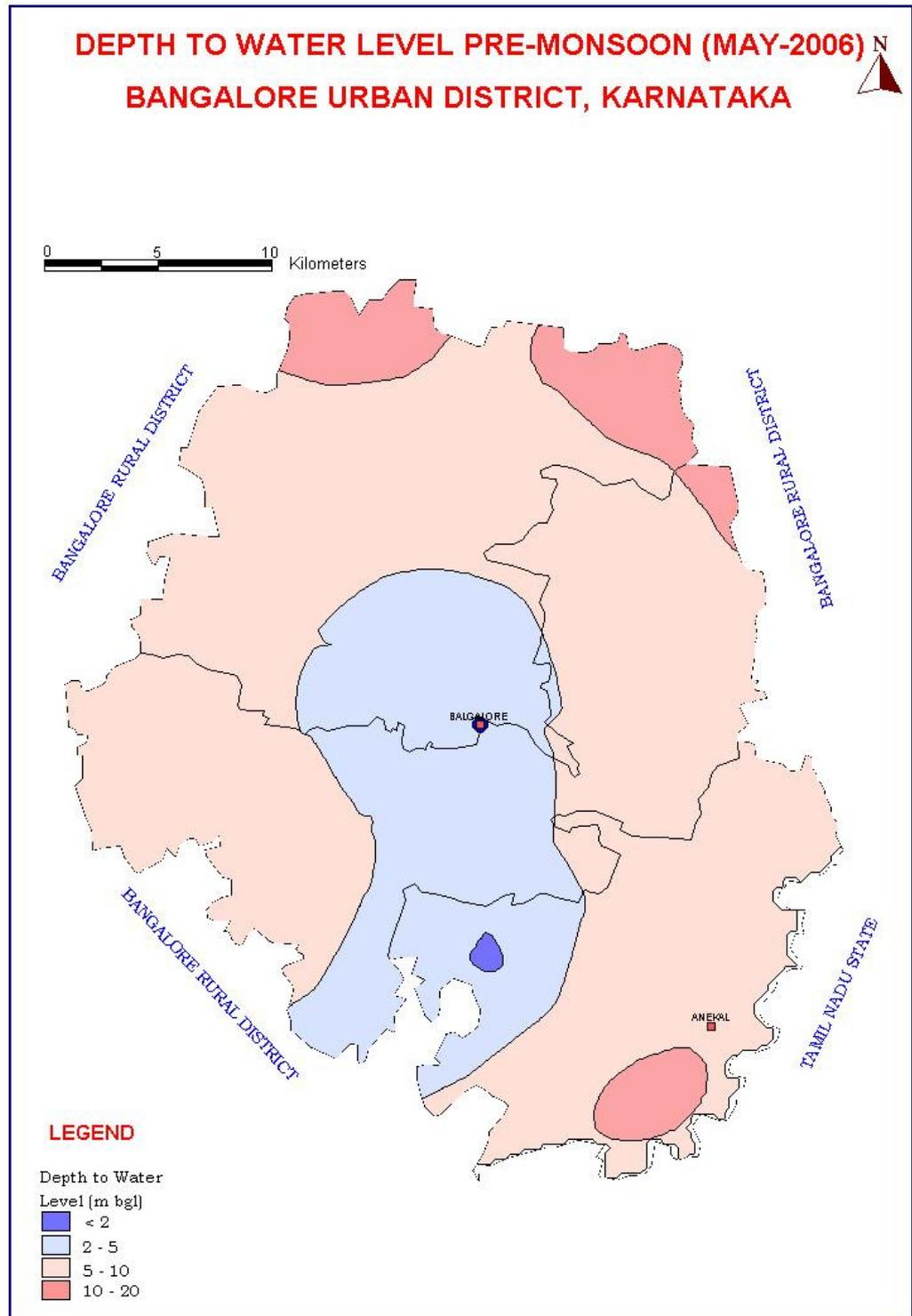
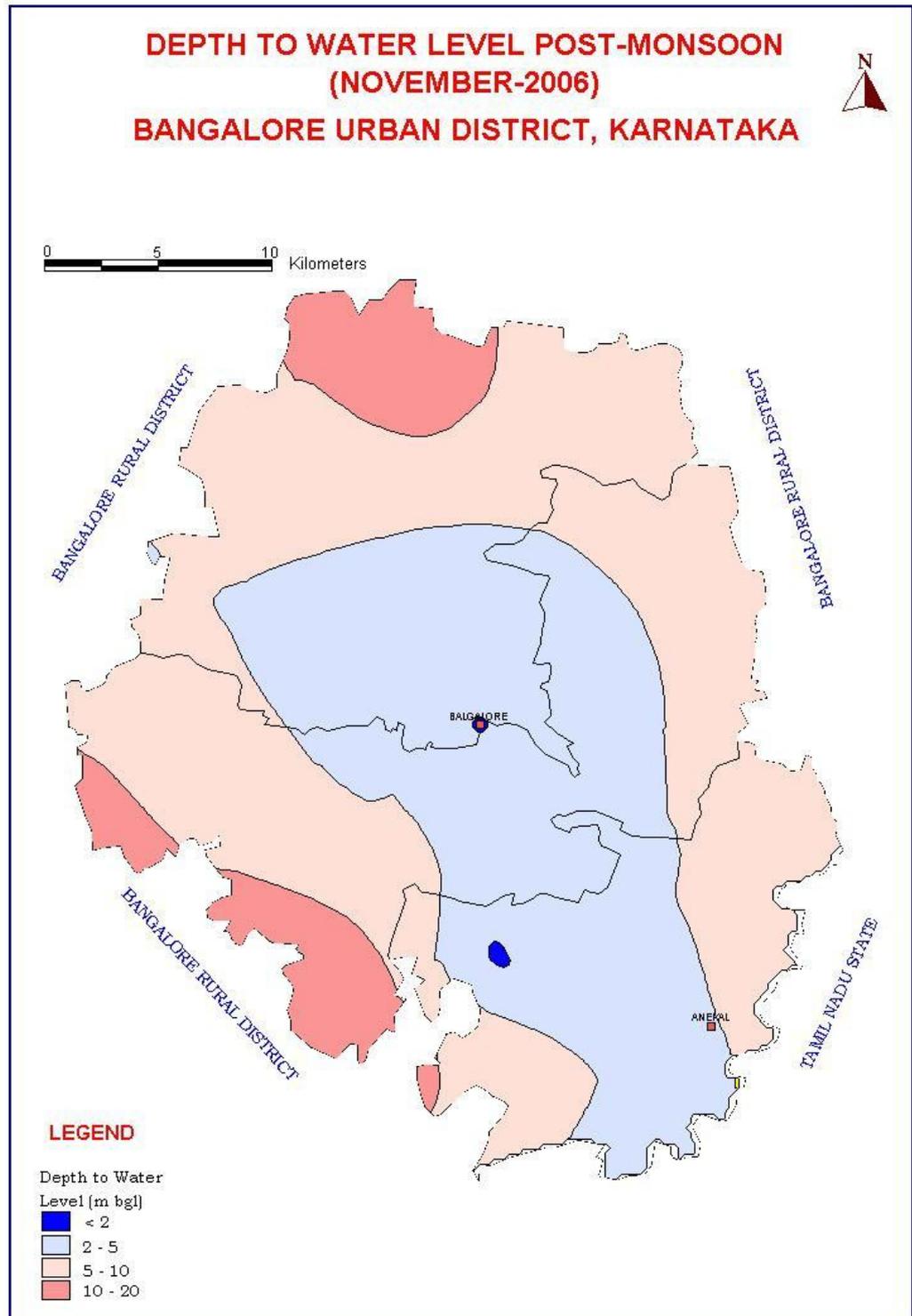


Fig-4



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Fig-5



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Fig-6

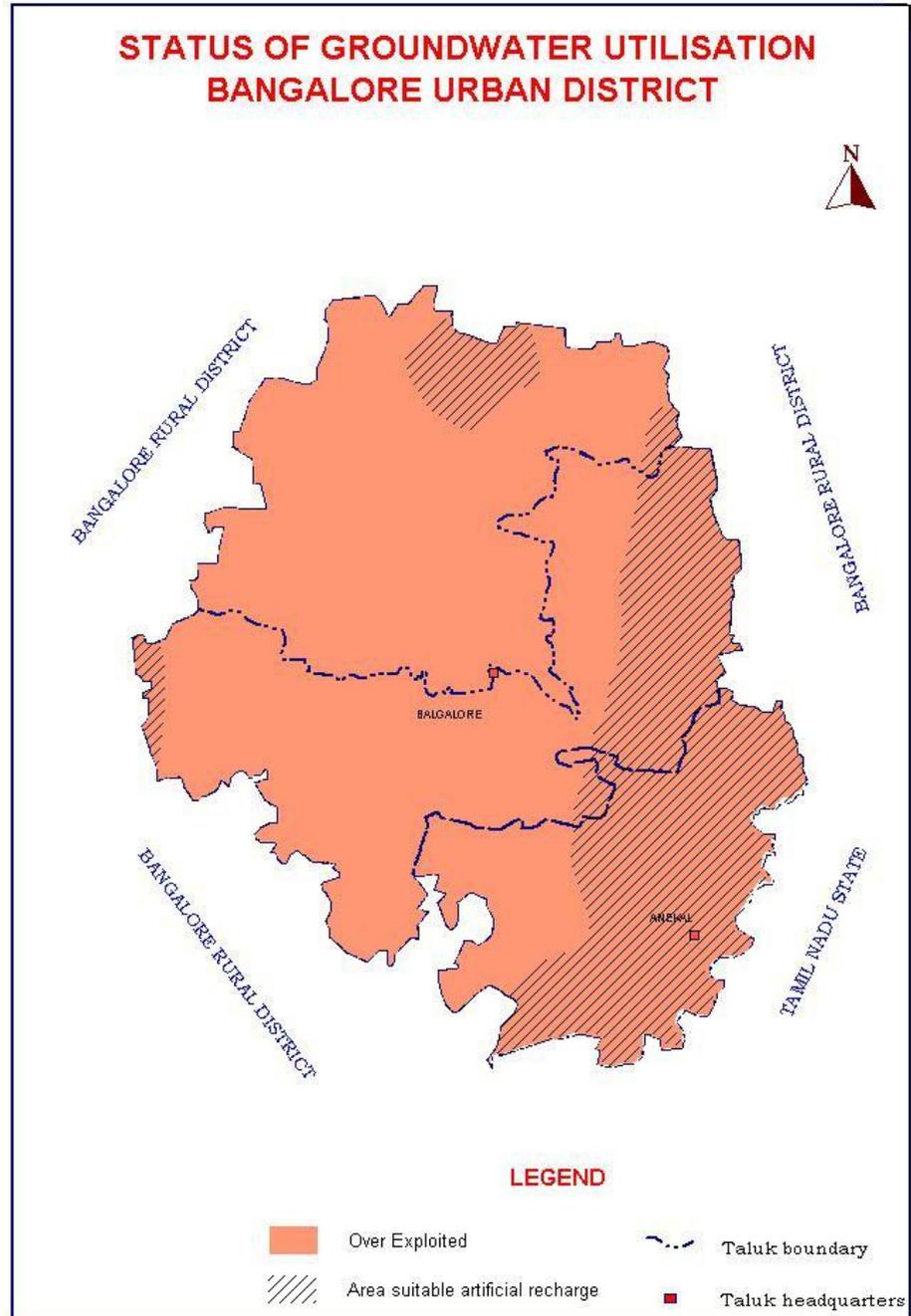


Fig-7

