केंद्रीय भूमि जल बोर्ड
जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग, जल शक्ति मंत्रालय
भारत सरकार
Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

DEVADURGA TALUK,

RAICHUR DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर
South Western Region, Bengaluru

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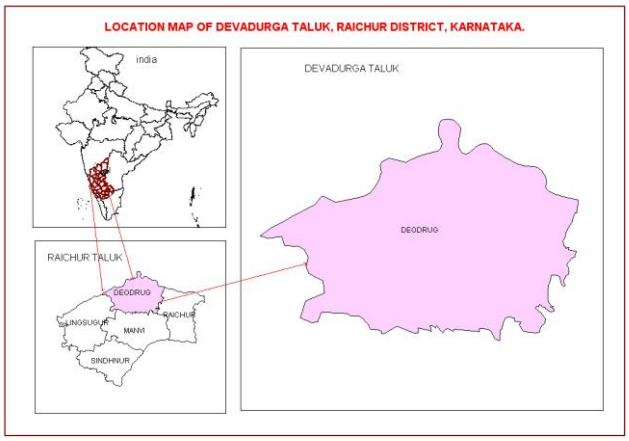
GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPT. OF WATER RESOURCES, RD &GR
CENTRAL GROUND WATER BOARD

AQUIFER MANAGEMENT PLAN OF DEVADURGA TALUK, RAICHUR DISTRICT, KARNATAKA STATE



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BANGALORE

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AQUIFER MANAGEMENT PLAN OF DEVADURGA TALUK,RAICHUR DISTRICT, KARNATAKA STATE

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AQUIFER MANAGEMENT PLAN OF DEVADURGA TALUK, RAICHUR DISTRICT, KARNATAKA STATE

1.0 SALIENT INFORMATION

Name of the taluk: Devadurga

District: Raichur

State: Karnataka

Area: 1504 sq. km

Population: 2,80,606

Annual Normal Rainfall: 726 mm

1.1 Aquifer management study area

Aquifer mapping studies have been carried out in Devadurga taluk, Raichur district of Karnataka, covering an area of 1504 sq.km under National Aquifer Mapping Project. Devadurga taluk of Raichur district is located between north latitude 16^0 10 '46" and $16^0$33' 36" & east longitude $76^0$39'00" and 79^0 13' 48", and is covered in parts of Survey of India Toposheet Nos. 56D/7, 56D/8, 56D/11, 56D/14 and 56D/16. Location map of Devadurga taluk, Raichur district is presented in **Fig.1**.

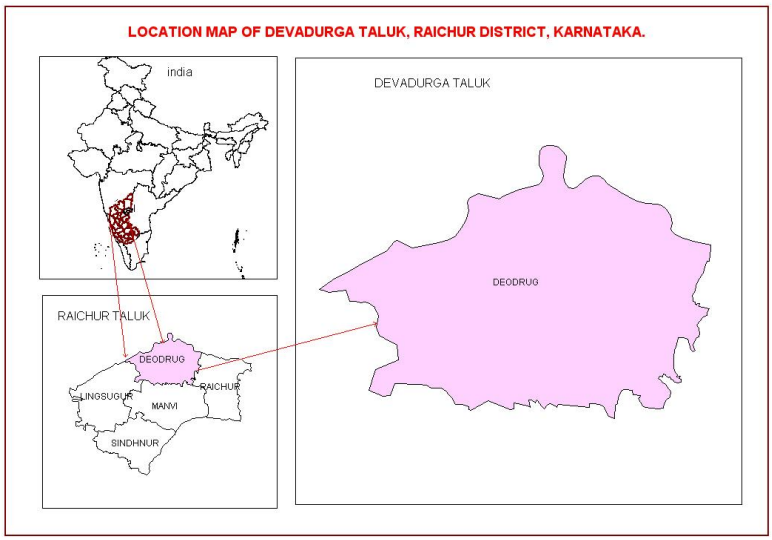


Fig.1: Location map of Devadurga taluk, Raichur district

1.2 Population

According to 2011 census, the population in Devadurga taluk is 2,80,606, out of which 2,51,677 constitute the rural population and 28,929 constitutes the urban population. The taluk has an overall population density of 373 persons per sq.km. A decadal growth of 9.3 % in population of the taluk is recorded during 2001-2011. Projected population (15 % growth) of the taluk for the year 2021 is 310999.

1.2 Rainfall

Devadurga taluk enjoys semi-arid climate. It is falling in Eastern Dry Agroclimatic Zone. Dryness and hot weather prevails in major part of the year. The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post-monsoon season covering the months of October and November and dry or winter Season from December to February.

There is one rain gauge station located in Devadurga taluk **(Table. 1).** The data in respect of this station from the year 1981 to 2010 is analysed and presented in **Table 2**. The data pertaining to these gauges is of long term nature and are well maintained. It is presumed that they are representative of the taluk and the same is used for analysis. Normal annual rainfall in Devadurga taluk for the period 1981 to 2010 is 726 mm.

Table 1: Rain gauge and its location in Devadurga taluk

Station	Latitude	Longitude	Altitude
Devadurga	16.42	76.93	756

Table 2: Statistical Analysis of Rainfall Data of Devadurga Taluk, Raichur District, for the Period 1981 to 2010

STATION		JAN	FEB	MAR	APR	MAY	PRE MONSOON	JUN	JUL	AUG	SEP	SW MONSOON	OCT	NOV	DEC	NE MONSOON	ANNUAL RAINFALL
Devadurga	Normal Rainfall (mm)	3	4	13	14	46	80	93	113	138	149	493	107	39	7	153	726
	STDEV	8	14	37	18	58	74	80	73	98	76	174	83	55	12	85	157
	CV%	305	367	283	135	126	94	86	64	71	51	35	77	141	175	56	22

Computations were carried out for the 30 year blocks of 1981- 2010 on Mean, Standard deviation and coefficient of variation of each month pre-monsoon, monsoon, post-monsoon and annual and are shown in **Table.2**.The mean monthly rainfall at Devadurga taluk is ranging between 3 mm during January to 149mm during September. The CV percent for premonsoon, monsoon and post monsoon season is 94, 35 & 56 percent respectively. Annual CV at this station works out to be 22 percent.

Assessment of Drought

Rainfall data has been analysed for 45years using IMD method to assess the drought condition in Devadurga taluk. The results of the classification are listed in the **Table 3**. It is observed that the Devadurg taluk has experienced alternating no drought to severe drought conditions over the years.

Table 3: Classification of drought and its periodicity (IMD, 1971)

% Deviation (Di)		>0	0 to -25	-25 to -50	-50 to -75	<-75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	Acute	
		Years					
Taluk	Devadurga	9	27	8	1	0	Once in **5** years

The details of the drought assessment are discussed as herein under. Out of 45 years of analysis in Devadurga taluk, “No Drought” condition is experienced in 9 years, “Mild Drought” condition is experienced in 27 years and “Moderate Drought” condition experienced in 8 years. Further it is observed that “Severe Drought” condition is experienced in 1 year i.e., during 2011 in Devadurga taluk. Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at each station has been studied. It has been observed that the frequency of occurrence of drought is **once in 5 years** at Devadurga taluk.

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Devadurga taluk. Oilseeds is grown in 41.7% of the total crop area (124119 ha) followed by oil seeds which accounts for 25.5% of the net sown area (93075 ha). Jowar and paddy cover about 15 % of the total crop area each followed by Bajra and vegetables which account for 2.8% of total crop area of taluk. Water intensive crops like Paddy (16.36%) and sugarcane (5.04%) are grown in 21.4% of total crop area **(Table-4).**

Table 4: Cropping pattern in Devadurga taluk 2014-2015 (Ha)

Year	Paddy	Maize	Bajra	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
	Area under cultivation (in ha)									
2014-15	15830	0	11379	19507	23125	400	6961	35790	45	15813

Source: District at a Glance 2015-16, Govt. of Karnataka

It is observed that net sown area accounts 61.65% and area sown more than once is 16.15% of total geographical area in Devadurga taluk **(Table 5 & Fig.2).** Area not available for cultivation and Fallow land cover 7.83% & 5.90% of total geographical area respectively. 61.9% of the net area irrigated is through bore wells, 0.74% of the net area is irrigated through lift irrigation, and remaining 37.26% of net area irrigated is through other sources **(Table 6).** Cropping intensity is 133.35%.

Table 5: Details of land use in Devadurga taluk, 2014-15 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Devadurga	150979	5301	4999	4979	93075	14656

Source: District at a Glance 2015-16, Govt. of Karnataka

Table 6: Irrigation details in Devadurga taluk (in ha)

Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	49707	89
Tanks	30	0
Wells	1226	2.1
Bore wells	2463	5
Lift Irrigation	1906	2.5
Other Sources	0	0
Total	**55322**	

Source: District at a Glance 2015-16, Govt. of Karnataka

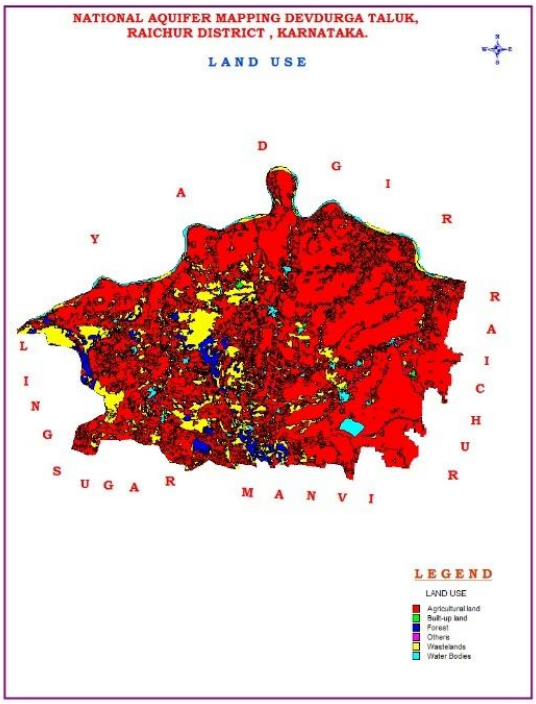


Fig.2: Land use

1.5 Geomorphology, Physiographic and Drainage

Devadurga taluk is in the well-defined Deccan plateau. Devar Gudda, the 2.5 acre of hill covered completely with trees that nobody dares to touch or cut down located about 4km distance from Devadurga taluk of the Raichur district. The Legend has it that cutting these trees would expose them to the wrath of Gods. A 450-year-old Baobab tree stands firmly Devadurga taluk which is one of the oldest tress in the world.

The taluk is covered mostly by hilly areas except with a gently undulating plain on the south western most part of the taluk. The general slope in the taluk is in North East direction **Fig.3**. One of Karnataka's most important rivers - Krishna flows along the border of Devadurga taluk. All the rivers in the taluk together with their tributaries exhibit dendritic drainage pattern and they form part of Krishna main basin. The drainage map of the district is presented as **Fig. 4.**

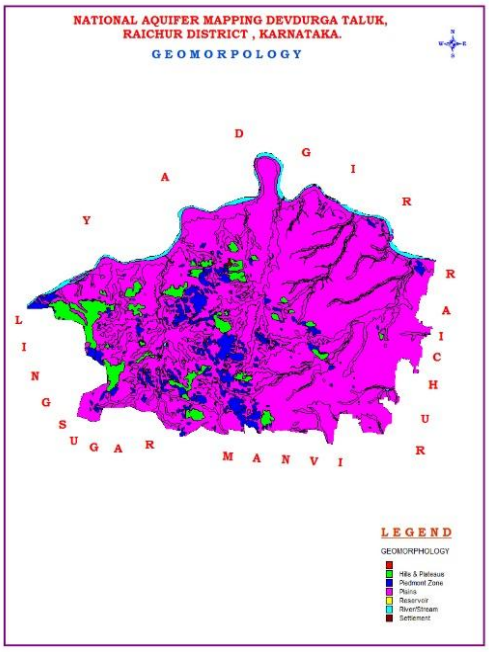


Fig.3: Geomorphology

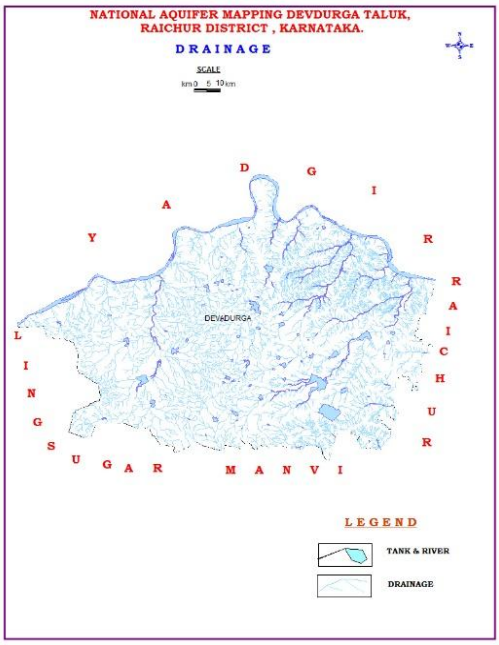


Fig.4: Drainage

1.6 Soil

Major part of the taluk is covered by three types of soils namely: Clayey soil, Clayey Mixed soil and Clayey skeletal soil**(Table 7).** The red loamy soil and lateritic soil are seen in very small parts of the taluk **(Fig. 5)**.

Table-7. Range of infiltration rate in different types of soils

Sl.No	Type of soil	Initial rate of infiltration (cm/hr)	Constant rate of infiltration (cm/hr)
1	Loamy soil	7.2 – 32.46	0.86 - 3.2
2	Clayey Skeletal soil	25.0-30.0	3.0-7.0
3	Clayey soil	29.0	2.0-4.0

Source: Studies carried out by CGWB 2012-2013

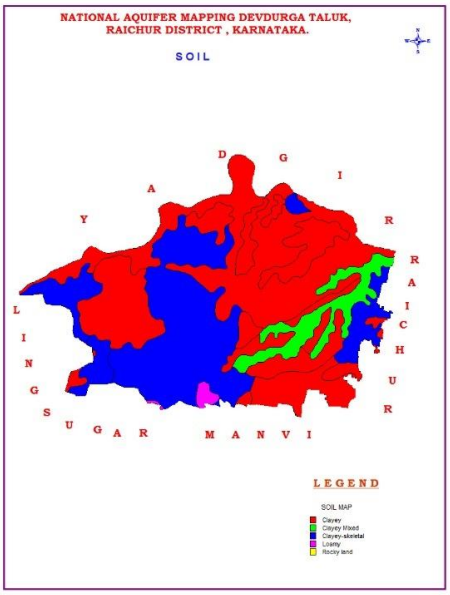


Fig.5: Soil Map

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth is given in **Table-8** below.

Table-8: Total Ground Water Resources (2017) in Ha m

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200 m)	Dynamic + Phreatic in-storage + fractured
Devadurga	4730	9256	898	14,884

1.8 Existing and future water demands (as per GEC-2017)

- Existing irrigation draft : 4164 Ha m
- Existing Domestic and Industrial sector demand : 529 Ha m
- Limited scope for further irrigation from ground water except few patches where ground water levels are still shallow throughout the year.
- Accordingly, an allocation of 226 Ha m is earmarked for future irrigation and 583 Ha m for industrial and domestic use up to 2025.

1.9 Water level behavior

(a) Depth to water level

Aquifer - I

- Pre-monsoon: 2.40– 7.75 m bgl (Fig.6)
- Post-monsoon: 0.25 – 10.9 mbgl (Fig.7)

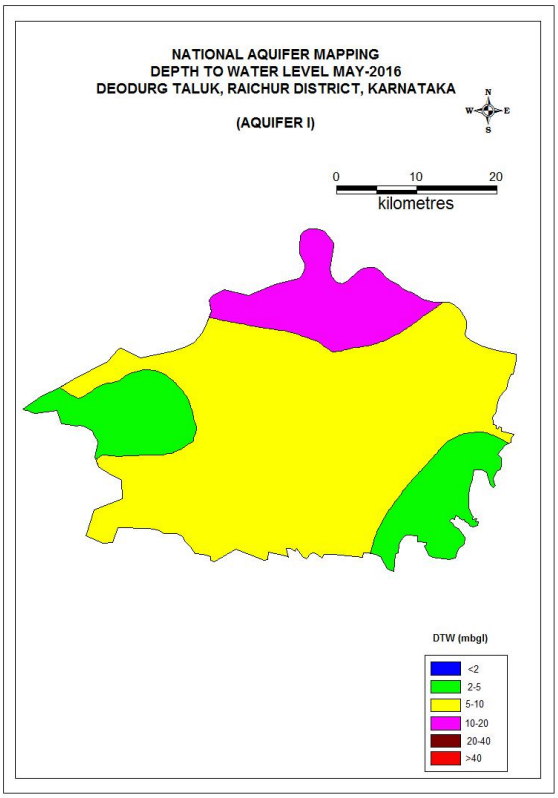


Fig 6: Pre-monsoon DTW (Aq-I)

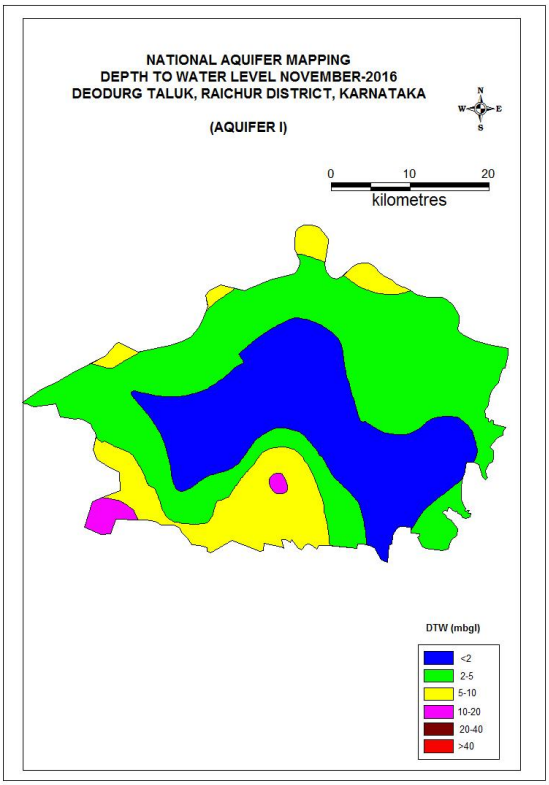


Fig 7: Post-monsoon DTW (Aq-I)

Aquifer - II

- Pre-monsoon: <2– 5.34 m bgl (Fig.8)
- Post-monsoon: < 5.34 ->10m bgl(Fig.9)

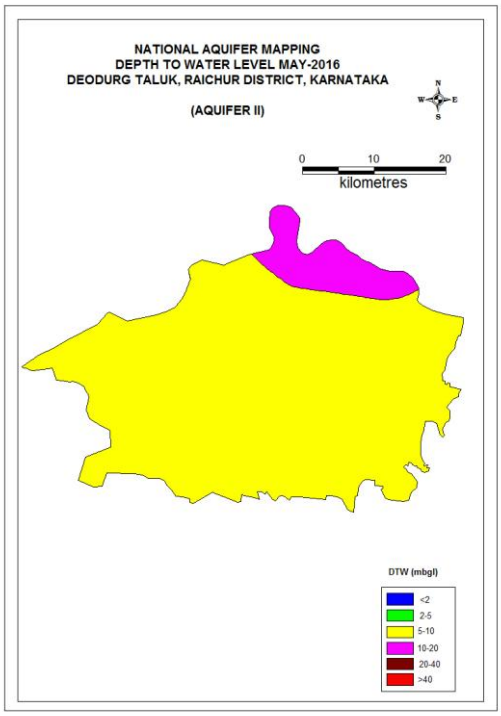


Fig 8: Pre-monsoon DTW (Aq-II)

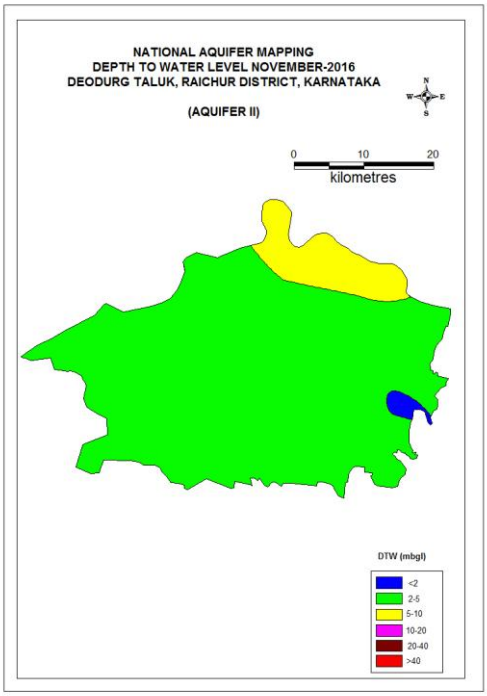


Fig 9: Post-monsoon DTW (Aq-II)

b) Water level fluctuation

Aquifer-I(Fig.10 a)

- Seasonal Fluctuation: Rise ranges 0.5– 7.05m ; Fall ranges > 1 m to > 6 m

Aquifer-II (Fig.10 b)

- Seasonal Fluctuation: Rise ranges 2– >6

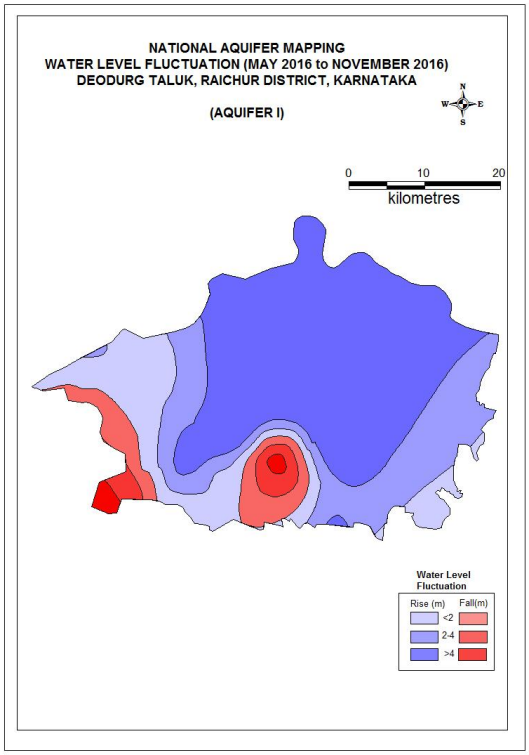


Fig 10: (a) Water Level fluctuation (Aq-I)

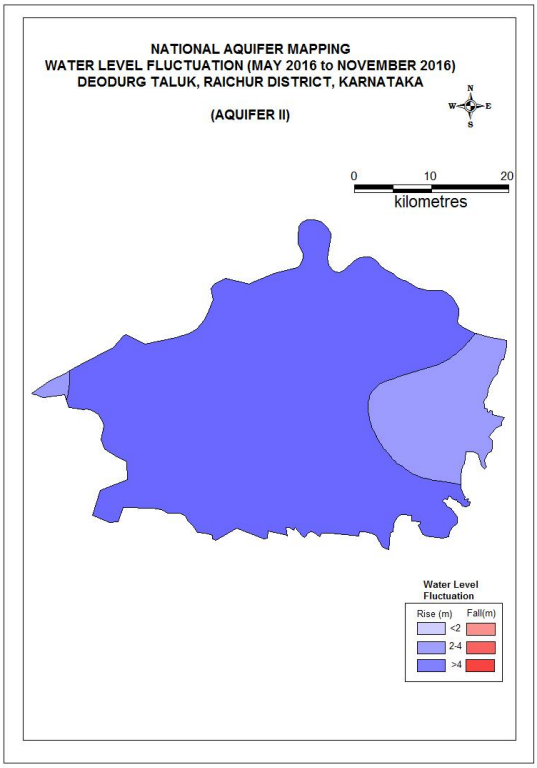


Fig 10(b) Water Level fluctuation (Aq-II)

Water level fluctuation in phreatic aquifer ranges from less than 1 mto 7m(isolated pockets) Water level fluctuation map has been prepared based on water level fluctuation between pre and post-monsoon period. **(Fig-10 a &b)**. Fall in the range of <1 m to 5.25m observed for phreatic aquifer In Deeper confined aquifer,water level fluctuation is classified as follows in to various zones of for rise and fall of water level. In Devadurga taluk rise in the range of 2->4 observed in confined aquifer during 2016.

1) Area with water level fluctuation less than 2m
2) Area with water level fluctuation ranges between 2mand 4m
3) Area with water level fluctuation more than 4 m

2.0 AQUIFER DISPOSITION

2.1 Number of aquifers: In Devadurga taluk, there are mainly two types of aquifer systems**;**

i. **Aquifer-I (Phreatic aquifer)** comprising weathered gneiss and granites

ii. **Aquifer-II (Fractured, multi-aquifer system)** comprising fractured gneiss and granite

Devadurga taluk, except, for small part occupied by Schist, exhibits the Gneissic formations comprised of Banded Gneissic Complex, Granitic formations, etc. These formations are traversed by various intrusive rocks. Geology map is presented in **Fig.11**.

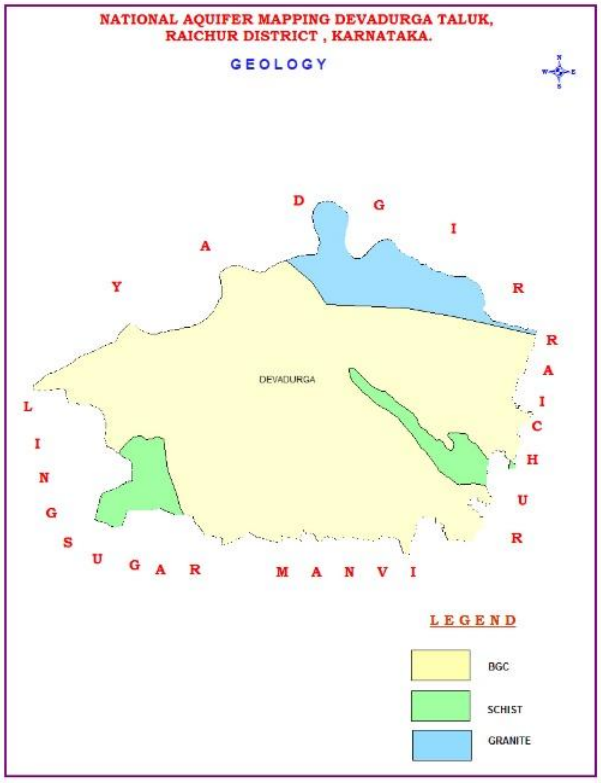
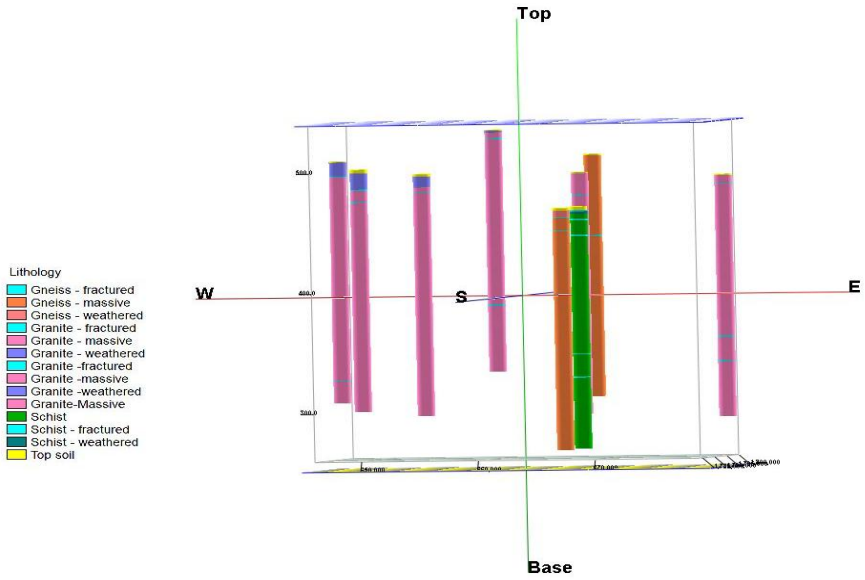
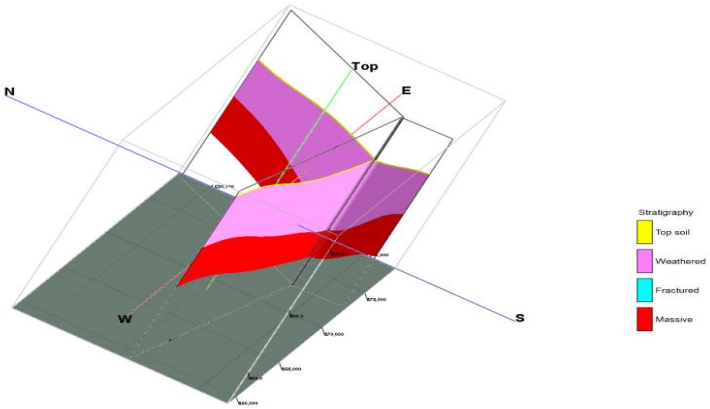


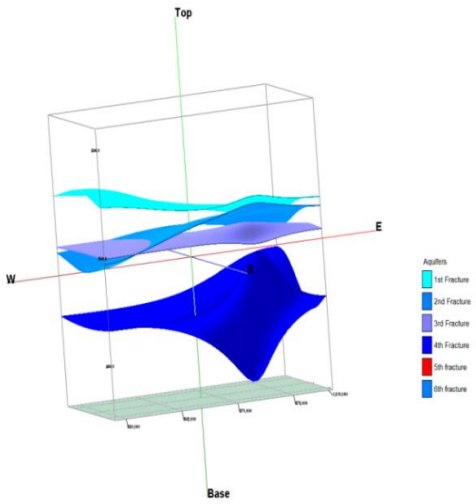
Fig.11: Geology Map

The ground water occurs under water-table conditions in the weathered parts of at shallow depth up to 20 m and generally under semi-confined to confined conditions in the jointed and fractured portions of the above rocks up to about 200 m depth. 30 exploratory wells were drilled by CGWB under exploratory drilling programme in the depth range of 110-200 m bgl. Yield of the bore wells range from 1to 6 lps. Aquifer disposition, litholog and cross-sections are presented in **Fig.12**.





Different Stratigraphic layers



3D Disposition of fractured aquifers

Fig.12: Aquifer Disposition, Cross - sections and Litholog

Report: Studies carried out by CGWB 2012-2013

3.0 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

a.Aquifer wise resource availability and extraction

Table 9 (a) Present Dynamic Ground Water Resource (GEC 2017) in ha m

Devadurga Taluk	NetAnnualGroundWater Availability (Ha m)	ExistingGrossGround WaterDraftfor Irrigation (Ha m)	ExistingGrossGround WaterDraft ForDomestic andIndustrial Water Supply (Ha m)	ExistingGrossGround Water DraftforallUses (Ha m)	AllocationForDomestic andIndustrialUsefor Next25Years (Ha m)	NetGroundWater AvailabilityforFuture IrrigationDevelopment (Ha m)	ExistingStageOfGround WaterDevelopment (%)	Category
GEC 2017	6604	3088	626	3714	793	2723	59	SAFE
GEC 2013	6933	2224	479	2702	573	4136	39	SAFE

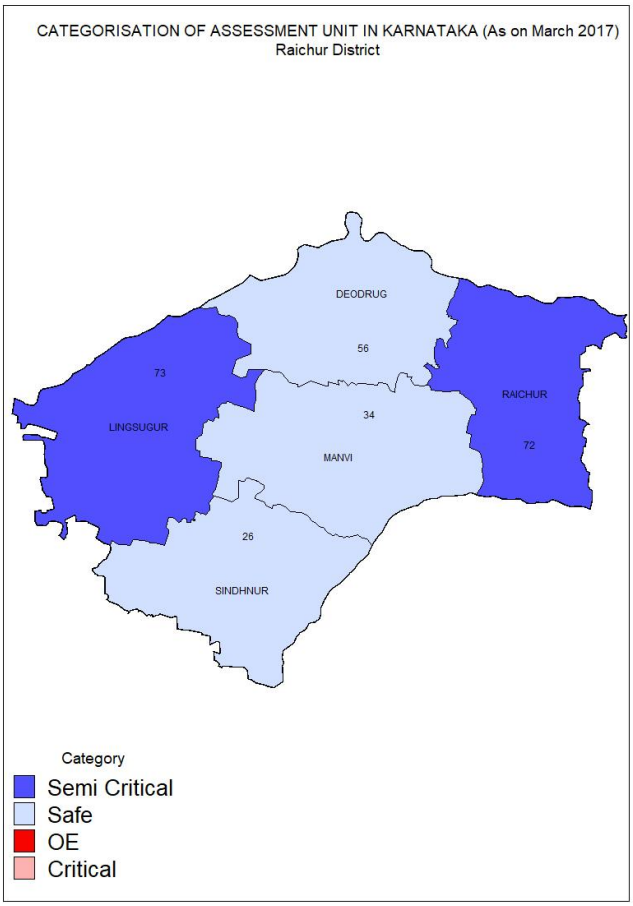


Fig:13 Categorization of Devadurga taluk as per GEC 2017

Table 9 (b) Present total Ground Water Resource (GEC-2017) in ha m

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of GW resource
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Devadurga	6933	9256	898	14884

Table 9 (c) Comparison of ground water availability and draft scenario

Taluk	GW Availability (Ha m)	GW Draft (H am)	Stage of GW Development	GW Availability (Ha m)	GW Draft (Ha m)	Stage of GW Development	GW Availability (Ha m)	GW Draft (Ha m)	Stage of GW Development
	2011			**2013**			**2017**		
Devadurga	Command 2797	373	**13%**	6933	2702	**39%**	6604	3714	**59%**
	Non command 4125.71	2327	**56%**						

b. Chemical Quality of Ground water (May 2018):

Ground water quality in the taluk is good and potable in general. It is suitable for domestic and irrigation purposes in major parts of the area. All the important parameters analysed from the water samples collected from monitoring stations are within permissible limits. However fluoride above desirable limit has been reported from isolated patches in the taluk. Nitrate above permissible limit (97-200mg/l) is also reported. Chloride values are above desirable limits. No in-land salinity is reported in the taluk. Distribution of Fluoride, nitrate, EC and Chloride is presented below in **Figs.14 to 16**.

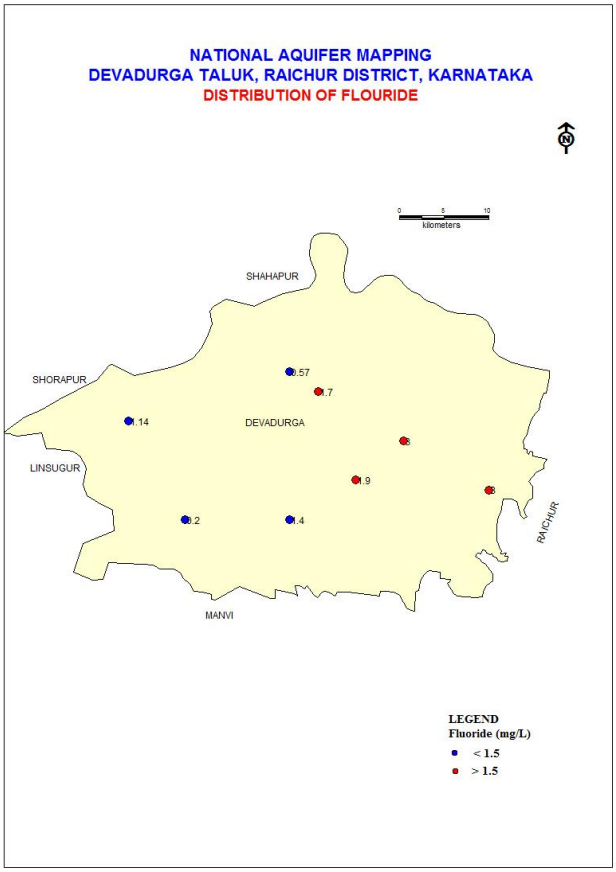


Fig. 14: Fluoride Distribution

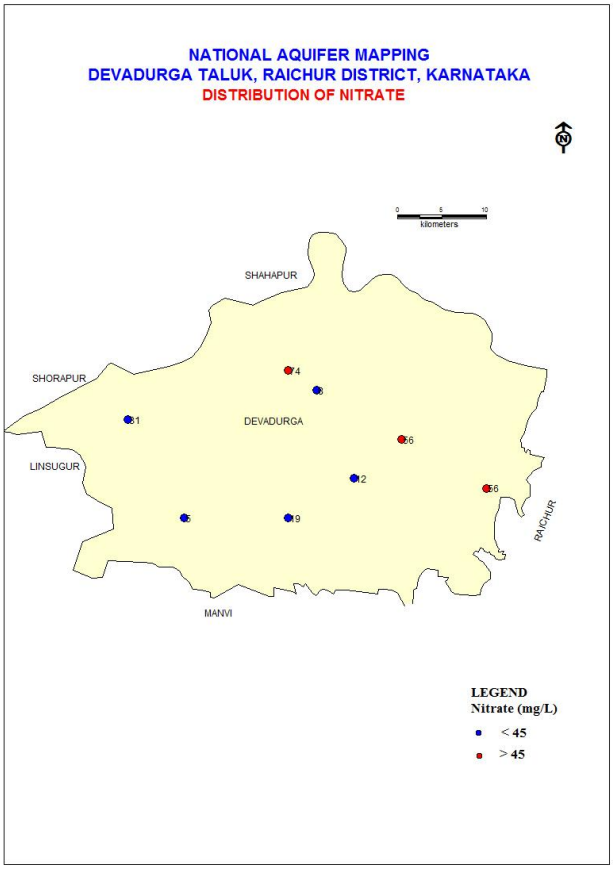


Fig.15: Nitrate Distribution

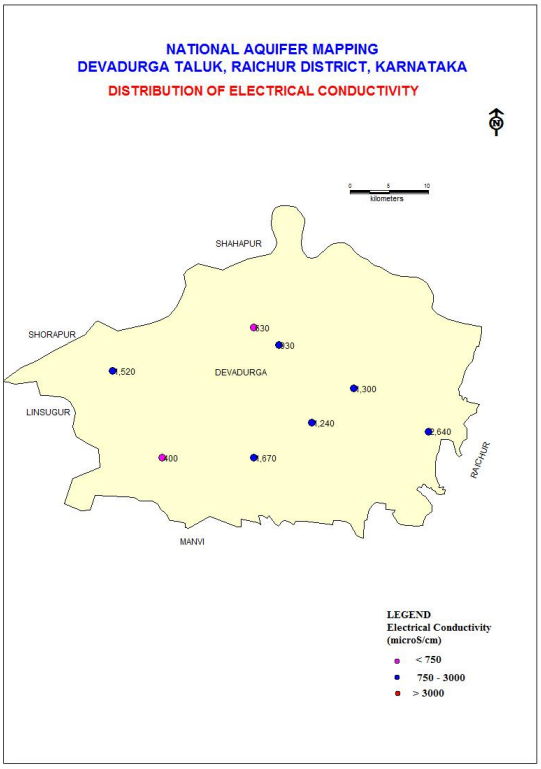


Fig.16: EC Distribution

c. Sustainability

- In Devadurga taluk, canal water supply caters to major part of irrigated agriculture. 45 % of total taluk is covered under irrigated agriculture (67595 ha) including kharif, Rabi and summer crops and 43% of taluk area is rainfed. Dependence on groundwater in command area is less and in non-command area irrigated agriculture is more relied on ground water, mostly through from borewells**.**
- The taluk is being drained by the Krishna river and its tributaries. One of the major irrigation projects of Karnataka - the Upper Krishna project is covering the taluk. The right bank canal is the major source of surface water which provides water for agricultural and other activities in the area. Hence ground water as such is not under stress in the taluk.
- The rainfall is mainly from June to October with the heavy intensity, and it spread over 41 to 50 days. Nearly 75% to 80% of annual rainfall is during the period of southwest monsoon, which results in water drains out from fields to nala and then to river.A few showers are also received during the North East Monsoon, generally in the month of November and December. Hence the watershed activities need to be taken up for integrated soil and water management which will aid to reduce the soil losses and also increase the insitu moisture, by which the crop yield can be increased.
- Entire drinking water demand of the taluk is met from ground water alone .By assuming the domestic water demand as 135 lpcd, gross water demand for whole taluk is 0.01382 BCM/ annum for 2011 population. The projected gross water demand in 2021 will be 0.01572 BCM for per annum.

4.0 GROUND WATER RESOURCE ENHANCEMENT

4.1 Aquifer wise space available for recharge and proposed interventions

Recharge dry **phreatic aquifer (Aq-I)** in the taluk, through construction of artificial recharge structures, viz; check dams, percolation tanks & point recharge structures **(Table 10).** The choice of recharge structures should be site specific and such structure need to be constructed in areas already identified as feasible for artificial recharge. Artificial recharge is recommended in Non-command areas of Devadurga taluk where ground water levels are deeper and pumping for irrigation de saturates deeper aquifers

Table 10: Quantity of non-committed surface runoff & expected recharge through AR structures

Number of Artificial Recharge Structures to be constructed in parts of Devadurga Taluk						
Structures	No.	Unit Cost (Lakhs)	Estimated Cost (Lakhs)	Annual Storage Capacity (MCM)	Volume of water likely to recharged (MCM)	Additional Irrigation Potential Likely to be created (Hectares)
Check Dam	1	3.0	33.0	1.342	0.67	124
Percolation Tank	1	7.5	7.5	0.453	0.34	
Point Recharge Structure	1	2.0	2.0	0.018	0.02	
TOTAL	1		42.5	1.813	1.17	

4.2 Improvement in GW availability due to Recharge, Devadurga taluk

Taluk	Net annual groundwater availability	Existing gross groundwater draft for all uses	Existing stage of groundwater development	Expected recharge from proposed artificial recharge structures	Additional potential Fromproposed irrigation development schemes through inter-basintransfer	Cumulative annual ground water availability	Expected improvement in stage of ground water development after the implementation of the project	Expected improvement in overall stage of ground water development
	HAM	HAM	%	HAM	HAM	HAM	%	%
Devadurga	6604	3714	59	117	0	6725	9	50

After implementation of Artificial Recharge structures the annual ground water availability will increase from 6604 to 6725 ha m and the expected improvement in stage of development is 9% i.e., from 59% to 50%.

5.0 DEMANDSIDEINTERVENTIONS

5.1 Advanced irrigation practices

- Efficient irrigation practices like drip irrigation and sprinkler irrigation need to be adopted by the farmers even while using ground water source.
- Since drip irrigation and sprinkler irrigation aims to moisturize only the root zone of the proposed crops, wastage of water, return flow and recharge component from any applied irrigation is considered to be negligible. Recharge component of sprinkler irrigation is considered as 5% and for drip irrigation, it is considered as nil.
- Command area canal irrigation facility extended to the taluk under surface water supply

scheme, Irrigation efficiency is to be ensured to avoid water logging conditions where depth to water level is < 3 mbgl. In these areas proper drainage facility is to be created to avoid deterioration of soil quality**.**

- Conjunctive use of surface water and ground water is recommended in command areas where stage ground water extraction is less than 15 % to avoid water logging and the soil salinity problems.
- In convergence with other water conservation schemes, activities such as water harvesting, creation of irrigation canals & drains, providing infrastructure for irrigation, land development, renovation of water bodies including desilting, renovation & maintenance of irrigation canals & drains, Institution & Capacity Building need to be taken up under the umbrella of Participatory water management-the key component of demand side management.

5.2 Change in cropping pattern:

- Cultivation of water intensive Paddy (15830 ha) is recommended in command areas where surface water supply is ubiquitous. Farmers may be encouraged to opt for more water efficient Pulses for agricultural production. Cotton cultivation can be extended to more areas.
- Crops which are suitable for the soil type and traditional cultivation practice of farmers may be adopted in consultation with agricultural department. Crop water requirement has to be considered before adopting the cropping pattern and preference should be given to light water requirement crops. Water use efficiency should be ensured water productivity in all demand sectors and improved irrigation efficiency.

5.3 Alternative water sources: Nil

5.4 Regulation and Control:

Taluk is categorized as **"Safe "** from ground water development point of view. Stage of Ground water Extraction is 59% (GEC 2017). As per the Guidelines of Karnataka Ground Water Authority, the ground water regulation agency in the state, regulations have been imposed on any proposed ground water abstraction by Industrial /Infrastructure / Packaged drinking water agency. Rainwater harvesting and artificial recharge is made mandatory for any ground water withdrawal to maintain the sustainability of the ground water resources. The guidelines of KGWA stipulates on obtaining NOCs from the regulatory body prior to any sort of ground water abstraction for commercial/ industrial purposes.

Stage of ground water development in the taluk increased from 36 % as per GEC 2013 estimations to 59% (GEC 2017). It indicates the need for judicious use of ground water in Non-Command areas where as in command areas extraction of ground water can be enhanced to avoid water logging conditions.