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Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

BELLARY TALUK, BELLARY DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

AQUIFER MANAGEMENT PLAN OF BELLARY TALUK, BELLARY DISTRICT, KARNATAKA STATE

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AQUIFER MANAGEMENT PLAN OF BALLARY TALUK BALLARY DISTRICT, KARNATAKA

1. SALIENT INFORMATION (Source : DAG-2018-19)

- Name of Taluk: Bellary
- Geographical area: 1694 sq.km
- Map Co-ordinates: N15° 00’ 19.7712” &15° 26’ 33.99” , E76° 38’ 18.204”&77° 10’ 11.91”
- Population (Census 2011) : 633046 (Decadal Change 25.71 %)
- No. of Habitations:184
- Annual Normal Rainfall: 519 mm (27 rainy days)
- Self help groups (SHG) : - 487nos
- Literacy rate: 71.45 %

1.1. Introduction

Bellary taluk, Bellary district, Karnataka covers over an area of 1694 sq.km, which includes a small area of forest cover of about 28.77 sq.km, and is depicted in **Fig.1**. The taluk falls under Northern dry agro-climatic zone of Karnataka state and is categorized as drought prone. It enjoys semiarid climate with dry and hot weather. The taluk experiences alternating Normal/No draught to severe drought conditions once in 4 years with a normal annual rainfall of 519 mm. The annual rainfall spread over a period of about 27 days. Though, the area is endowed with rich natural mineral resources, such as Iron and manganese ores etc, people in general mainly engaged in agriculture activities. Also, many industrial units like Steels and Alloys, Vegetable Oil, Cotton yarn, Cement industries etc offer employment to the local work force.

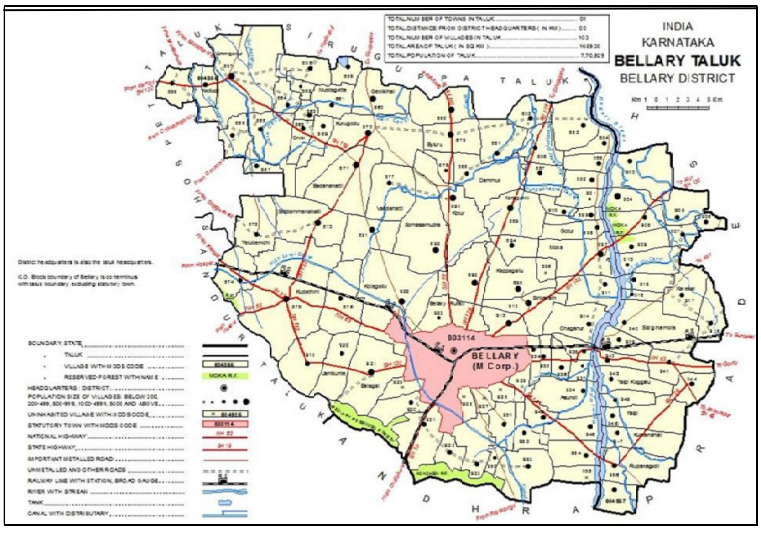

Fig.1: Location map- Bellary Taluk

1.2.Drainage, Soil & Land use

The river Hagri and its tributaries drain the area towards N-NE and fall under Tungabhadra sub basin of Krishna Basin. The drainage pattern is dendritic to sub-dendritic in nature. The taluk covers Sandy loam soil along the stream beds, Red soil in elevated places, black soil in irrigated land and in other parts. The soils are derived from Granites, Gneisses and Schistose rocks, **Fig.2.** They are permeable and mildly alkaline in nature. The thickness of the soil varies from 0.2 to 1.00m. These soils are with high permeability and neutral pH. Black soil with high initial infiltration rate when dry and cracked on getting wet cracks will close and infiltration rate will be very low. The land use record shows out of actual geographical area a net area 89902 Ha sown with various crops and 20864 Ha put under non agricultural uses and forest 2877 Ha and remaining area covers cultivable waste land, barren land etc as indicated in the distribution of land **Fig. 3.**

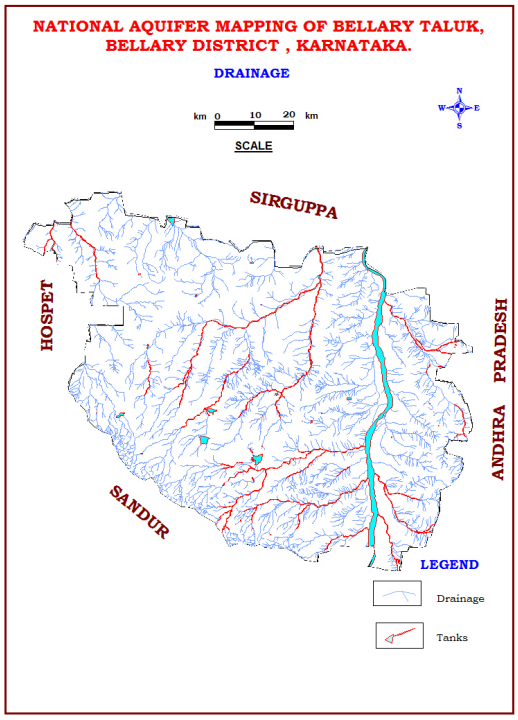

Fig.2 : Drainage map

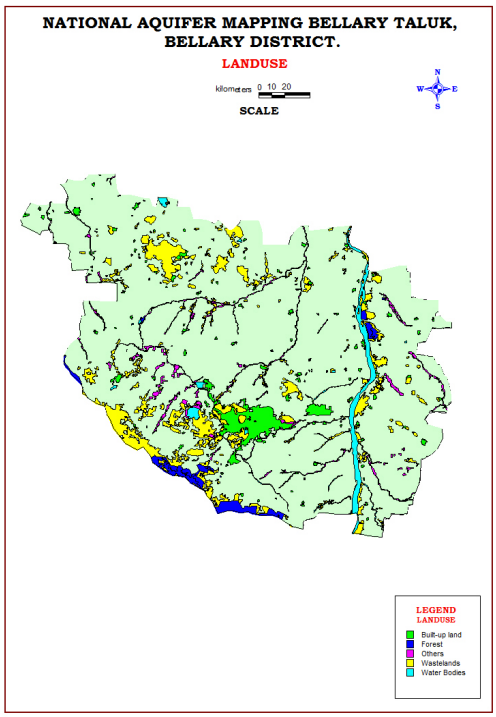

Fig.3 : Landuse map

1.3. Agriculture & Irrigation

The main economical activity is the agriculture. The principal crops like Paddy, Maize, Jowar and Bajra are grown in the taluk. Total cereal &minor millets accounted for 53465 Ha and pulses grown in 14984 ha (source: DAG). The Commercial crops, cotton grown in 20250 Ha and sugarcane, fruits, Oil seeds etc grown in the taluk. The irrigation through surface water from river Tunga Bhadra canal (TB

canal) and ground water from Bore Wells together accounted for a net area of 77702 Ha (Gross area 86826 Ha.), which accounts for 86.43% area of net sown area of 89902 Hac. as indicated in **Table 1**.

Table 1. Source of Irrigation

Sl.No	Source of Irrigation	Nos.	Irrigated Area (Net area Ha)
1	Canals (Tunga Bhadra)	78	55650
2	Tanks/others	N.A	0
3	Wells	574	1332
4	Bore wells	2484	12148
5	Lift Irrigation	754	8572
Total Area			**77702**

2. AQUIFER DISPOSITION

2-1.Ground water exploration & Aquifer geometry

The entire taluk covered by Hard rocks, comprising such Granites, Granitic gneisses and Schists etc. The weathered and fractured portion present in the above rocks forms aquifers. As deciphered from the studies, a highly weathered portion in the hard rock occurs down to 30 m, which helps in holding and recharging the aquifer underneath. The geophysical investigations by vertical electrical sounding/resistivity studies carried out in the taluk indicate the occurrence of four sets of geoelectric layers in the sub-surface with a thickness ranging from < 1 m to 113 m and measures an apparent resistivity 'ρ' in the order of 2.00 to >250 ohm.m (VH=very high value of 'ρ'). The fractured zones in the above hard rocks occur at various depth levels with occasional ground water saturation recorded in the depth range of 20.00 to 185.00 m.bgl. The high resistive massive hard formation inferred at a depth of 06.00 to 145.00 m.bgl, as depicted in Table .3. and the distribution shown in **Fig.4.**

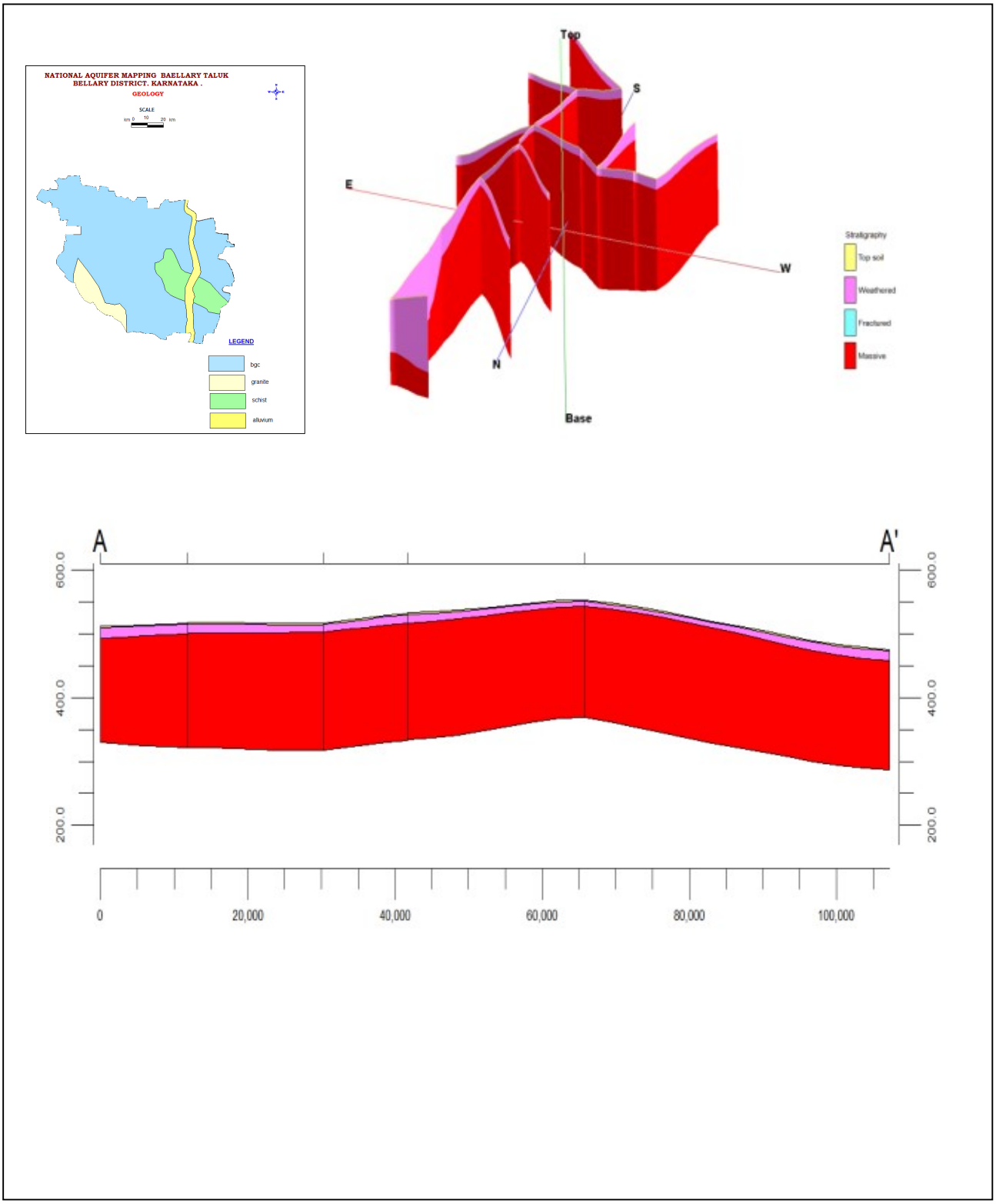

Fig.4: Geological Section through Ground Water Exploration (2D&3D images)

The ground water investigations carried out under various programmes including drilling exploratory Bore wells down to 200 mbgl reveal, the occurrence of weathered zone **(Fig.5)** and highly fractured rock formation extends down to 30.00 mbgl and more. The alluvium formation confined to Hagri/Vedavathi river course and which acts as an aquifer having a high groundwater productive patches. These alluvial aquifers attain a maximum of 25 m thick. In general, potential or granular zones occur of about 5.00 to 6.00 m thick. Also, at places the wells yield copious water measuring about 146 m^3/day, (P.D.Halli village). Transmissivity of aquifer varies from 2861 to 14842 m^2/day.

Table 2: Salient features of Geophysical (VES) investigation

Name of village/VES Location	Resistivity of layers 'ohm m'					Thickness of geoelectric layers 'm'				Depth to Massive formation 'm'bgl
	ρ1	ρ2	ρ3	ρ4	P5	h1	h2	h3	h4	
Kudathini	55	13	60	330	V. H	0.8	2.4	6.3	71.5	80.0
Bellary Site 1	3.2	V.H	-	-	-	1.4	-	-	-	1.4
Bellary Site 2	78	19	58	V. H	-	1.1	4.4	16.5	-	22.0
Sanjeevarayakota	195	47	250	V. H	-	2.4	15.1	127.5	-	145.0
Rupanagudi	2.5	4	V.H	-	-	1.7	5.0	-		6.7
Hagari	5.6	3.8	V.H	-	-	1.4	7	-	-	8.4
Moka	1.3	12.5	V.H	-	-	2.0	17.0	-	-	19.0
Banapura	1.7	3.8	V.H	-	-	1.8	5.2	-		7.0
Kolur	47	250	52	560	V. H	1.0	1.0	10.0	113	125.0
Kurugodu	47	16	40	V. H	-	1.2	8.3	9.1	-	18.6

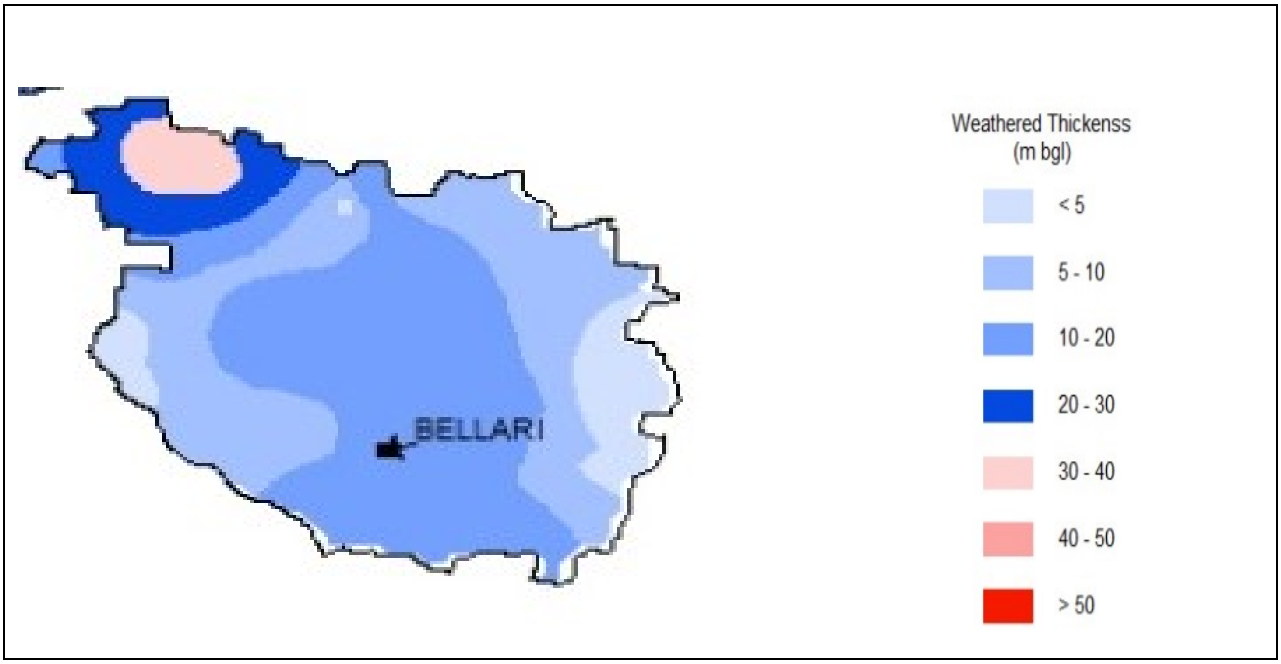

Fig. 5: Depth to weathered zone (inferred by VES & Exploratory Drilling data) in Ballary Taluk

2.2. Ground Water regime

During the pre-monsoon period of May 2016, the ground water regime monitored in the shallower zones, indicate the depth to Water level (DTW) in the range of 03.00 to 06.00 m.bgl, where as it observed with a slight variation in the deeper aquifers **(Fig. 6 & 7)**. The shallowest water level observed in Tunga Bhadra irrigation canal command areas. During the Post-monsoon periods the water level recorded between 3.5 to 6.50 m.bgl, as depicted in **(Fig. 8 & 9)**. It is clear from the above scenario, the annual seasonal water level fluctuation established as in negative (–ve) trend, especially in fractured aquifers, as shown in **Table 3**. The shallower aquifers maintain its water resources due to recharge form the canals & irrigation fields with a slight rise in isolated areas, as about 0.50 m, excepting central region, **Fig.10.** The water level compared with preceding corresponding periods, reveals a –ve fluctuation at few stations/isolated pockets, i.e. fall in the water level up to 1.0 m. As, there is regular water flow in TB canal and irrigation activities continue throughout the year, the recharge to ground water maintain a near stability in the region indicating a very minimum or no any remarkable change in the ground water regime of the region.

Table 3: Depth to Water level (mbgl)

Sl.No	Village/Monitoring station	Depth in M.bmp	Pre-monsoon WL /May-2016	Post- monsoon WL /Nov-2016	Fluctuation m
1	Emmiganur	9.00	2.68	3.5	-0.82
2	Karachedu	61.40	2.7	4.2	-1.5
3	Korlagundi	55.00	4.8	5	-0.2
4	Burranayak	36.00	6	6.5	-0.5
5	Karekallu	48.00	11	11.15	-0.15
6	Joladarashi	42.00	13.6	13.6	0
7	Kuduthini	35.00	19.1	22.95	-3.85
8	Bellary	50.00		3.4	
9	Bailuru		4.4	3.3	1.1

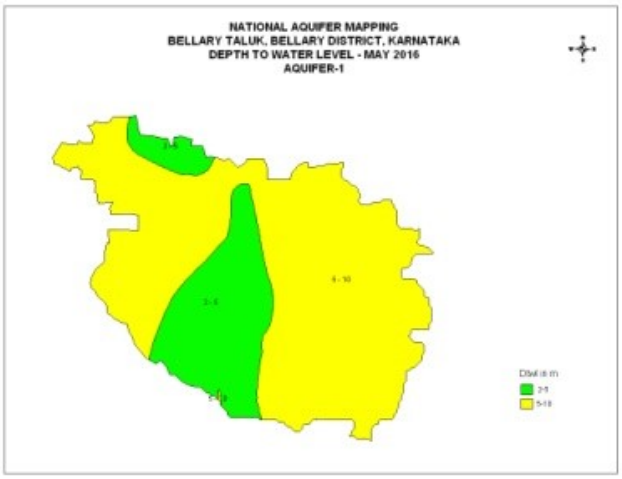

Fig. 6: DTWL Pre-Monsoon (Shallow)

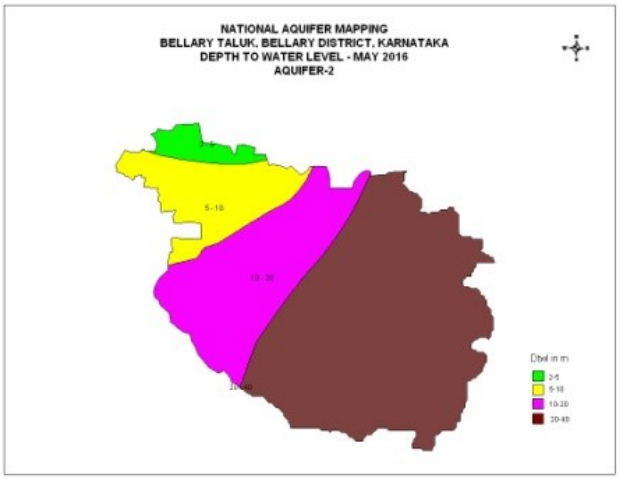

Fig. 7: DTWL Pre-Monsoon (Deep)

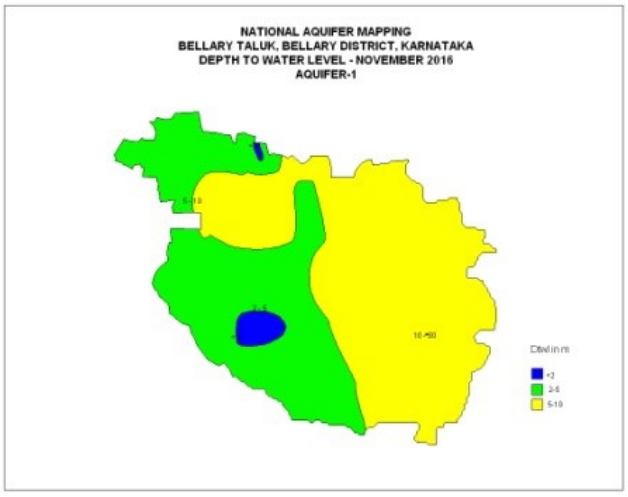

Fig. 8: DTWL Post-Monsoon (Shallow)

Fig. 9: DTWL Post-Monsoon (Deep)

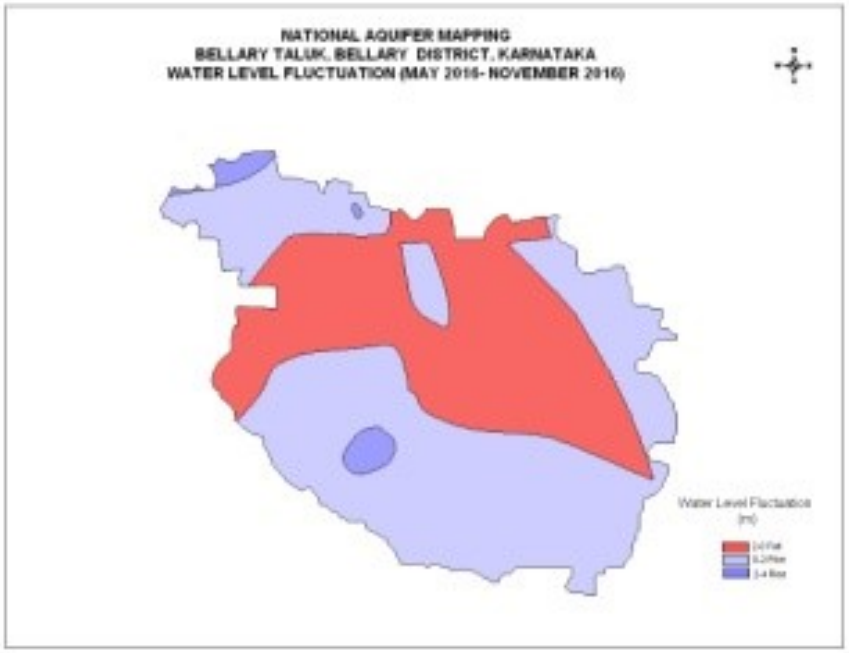

Fig.10: Map showing seasonal water level fluctuation (Shallow)

3. GROUNDWATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1. Groundwater Resources

The main sources of ground water resources in the taluk is Rain fall, seepage from Tunga bhadra irrigation canal network and recharge from applied canal water irrigation. In respect of ground water development the taluk has been categorized as Safe with 39 % of extraction from the annual replenisable resources (GEC 2017), as depicted in **Table 4**. Though there is a remarkable quantum of ground water available as in-storage in the lower part of unconfined and deeper aquifers, the ground water development mainly occurs within the zone of fluctuation. The ground water resources estimated (GEC2017) reveal the availability as 8477 Ham as on March 2017.

Table 4 : Ground Water Resources (Ha) in BellaryTaluk (GEC-2017)

Net annual ground water availability	Existing gross ground water draft for irrigation	Existing gross ground water draft for domestic and industrial water	Existing gross ground water draft for all uses	Allocation for domestic and industrial use for next 25 years	Net ground water availability for future irrigation development	Existing stage of ground water development %	Category
14156	5094	391	5486	604	8477	39	safe

3.2. Groundwater extraction

In general the ground water extracted through shallow bore wells, which are developed in the depth range of 35-60 m and dug wells constructed within the depth range of 10 to 15 m. The development carried out by dug wells estimated to be around 150 to 200 cum/day and is primarily used for domestic purposes. The Bore wells in the TB canal command area and in the Chikka hagri river sub-basin yields 1 to 8 lps as depicted in the representative **Fig.11**, which is used for both irrigation and domestic purposes. The record indicate about 7904 IP sets have been operated in irrigation activities, including 118 nos. by diesel pumps (DAG:2018-19).

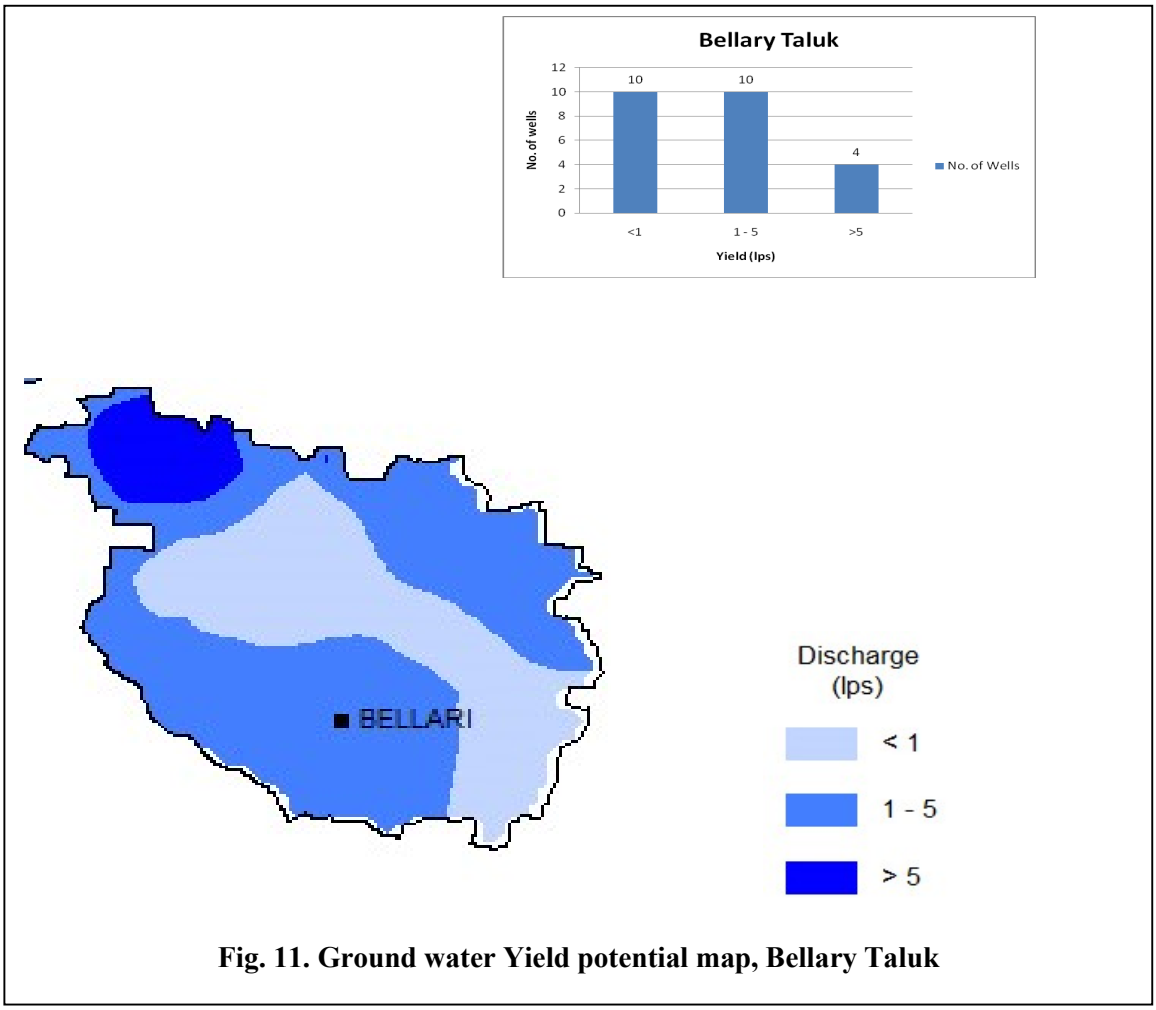

Fig. 11. Ground water Yield potential map, Bellary Taluk

3.3. Groundwater Quality & Contamination

In general the quality of ground water in the area is alkaline in nature and potable in the non-command areas. Ground water sampled from select localities analysis indicate the presence of Fluoride 'F^-' in higher concentration as recorded around Allipuram & Bailuru areas and at places the Nitrate 'No_3' occur in higher concentration, exceeding the permissible limit, as depicted in **Table 5**. The Nitrate, NO_3 contamination in the ground water is attributed to the poor drainage disposal system exists in the canal command and in the habitations. The Fluoride, F^- said to be derived from the decomposing rock forming minerals present in the host aquifer material. It is reported that the incidence of health hazards in the taluk due to the consumption of fluoride rich groundwater. The electrical conductivity (EC) of the water ranges from 270 to more than 4000 µS/cm at 25°C as depicted in **Fig.12**. Higher EC value recorded in the canal command, which can be attributed to poor drainage system and external application of fertilizers in the agricultural fields.

Table 5. Ground water quality in Bellary Taluk

Sl.No	Name of Station	Specifc Conduct. in µS/cm at 25°C (EC)	Nitrate (NO_3)	Fluoride (F^-)	Total Hardness (TH)
1	Sridara gadde	270	0	0.2	70
2	Thoranagallu	510	0	0.5	105
3	Genikihal	670	13	1.2	160
4	Sirigere	840	109	0.1	250
5	Gadiganur	1300	14	0.4	250
6	Bailur	1640	116	2.1	310
7	Emmiganur	1980	19	1.3	200
8	Allipuram1	4528	500	3	160
9	Sirivara	1916	13	0.66	260
10	Hosa dorji	570	8	0.42	100

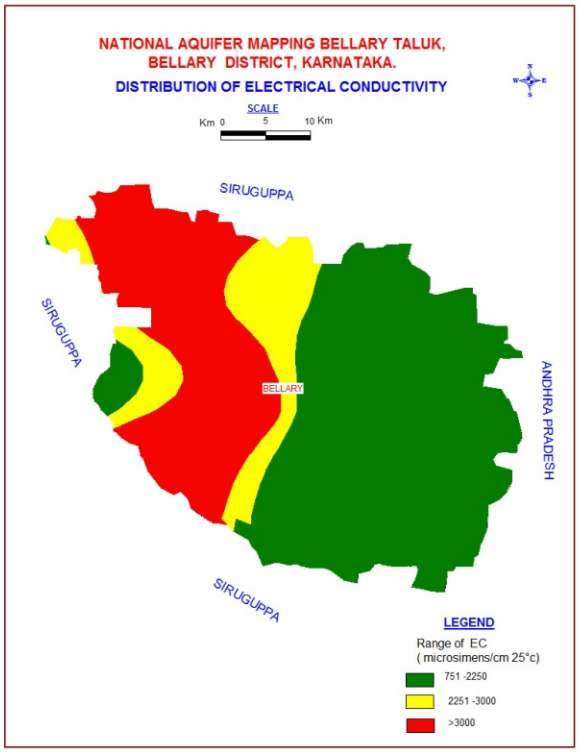

Fig.12: Distribution of Electrical conductivity (EC) in Bellary taluk

4. GROUNDWATER RESOURCE ENHANCEMENT

4.1. Conservation of water resources

It is estimated that a surplus resources of 10.4 MCM rain water available during monsoon period as rain fall run-off with no commitment for its utilisation in the taluk. Also, there is an adequate storage potential available in the aquifer system within the 200 m depth, which is accounted for about 23688 MCM (below the zone of fluctuation), could be considered for recharging it with the surplus run-off and enhance the resource availability for future.

Considering the non availability of land for construction of surface storage facilities and advantages of aquifer storage over any other surface conservation facilities in terms of cost and safeguarding its quality and quantity for a longer period, the above said sources could be used to augment the ground water regime in the non-command and deeper water level areas identified in the taluk by constructing 591 no. of artificial recharge structures (ARS). It is thus estimated to improve the net ground water resources by an additional quantum of 5.913 MCM. Necessary precautionary measure is suggested to avoid the water logged and area susceptible/prone to water logging of about 709 sq.km while implementing the above ARS structures.

As, there are good numbers of Govt and Business establishments exist with the considerable roof top areas, it is suggested to implement the roof top rain water harvesting facilities RTRWH, at all the Govt.buildings and to increase the fresh water availability in the taluk.

5. DEMAND SIDE INTERVENTION

The taluk as a whole is endowed with Tunga Bhadra river/surface water system with well knitted canal network facilitate the recharge of aquifers. It is observed that the drinking water supply has not been adequately supplied to the entire populations, as the record indicates about 4.1% of Households receives Surface water supply and the rests through ground water sources (census 2011). Appropriate measures taken could reduce the shortage of supply by improving storage facilities to get from the TB canal/surface water available in the taluk. The existing 29.35 % of habitations coverage of water supply, ie.villages supplied at the rate of 50 LPHD or more (DAG-2018-19) can be improved remarkably through the additional storage facilities.

Considering the taluk Head Quarter as the district Head Quartes, with presence of good transport, communication network infrastructures, the active major economical activities, the erratic monsoon pattern, the demand for the water for various sectors expected to increase many folds in the years to

come. Therefore, there is a need for conserving the water resources by adopting water use efficient measures (WUE), like recycling the waste/grey water for reusing them. It is also suggested to change of irrigation practices to reclaim the water logged and quality affected areas. Also, installation of suitable WUE gadget and RTRWH facilities in the government and residential buildings would bring down the water demand to a reasonable extent for making the resources sustainable. By adopting WUE measures, the availability of the precious water resources can be improved. Adopting a comprehensive conjunctive use plan in the water logged and shallow water table area in the canal command can enhance the availability of water resources. The using both the water in conjunction would enhance supply to the water shortage areas, non-Command areas or tail end areas of the command.

Keeping in view of the taluk population of 625494 (Census:2011, 31% of District's population) with average growth rate of 25.71%, demand for water intensive crops in the flourishing agriculture sector, ever increasing medium and large scale industrial units the demand for water resources in the taluk expected to increase many folds in due course of time. Therefore, for the overall maintenance of water resources and its sustainability in the taluk it is required to implement ground water regulatory measures.