केंद्रीय भूमि जल बोर्ड

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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

KUDLIGI

TALUK, BELLARY DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर
South Western Region, Bengaluru

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

CONTENTS

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

1. SALIENT INFORMATION

- Name of the taluk : Kudligi
- District : Bellary
- Area : 1595 Sq.km.
- Map Co-ordinates:
  North-14° 33' 41.01"& 14° 59' 4.55"
  East-76° 8' 41.96"& 76° 44' 33.41"
- No. of Habitations: 217 nos.
- Population: 308901 (2011 census)
- Literacy rate: 71.45 %
- Annual Normal Rainfall: 607 mm

1.1 Introduction

Kudligi taluk covers an area of 1595 sq km and is bounded by Hagri Bommanahalli and Sandur taluks, Ballary district on the North, South by districts Davanagere and Chitradurga. The taluk Harpanahalli, Ballary district bounded in the west and the eastern side shares border with Andhra Pradesh state **Fig.1.** The major occupation of population is Agriculture and mining. The taluk is divided in to 34 panchayats covering a total of 221 villages.

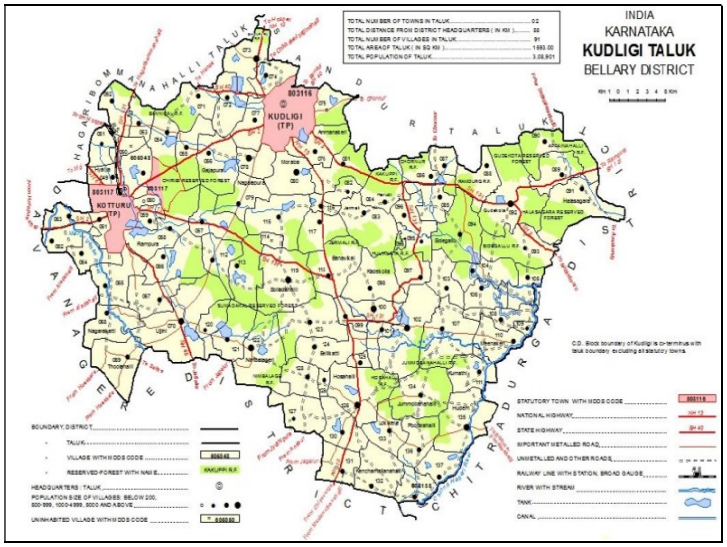

Fig.1: Location map- Kudligi Taluk

1.2 Population

According to 2011 census, the population in Kudligi taluk is 308901, of which 82% people lives in rural areas and 18% lives in urban areas. Decadal growth rate recorded 13.49 %. The major occupation of people is Agriculture and mining activities.

1.3 Rainfall

Kudligi taluk experiences semiarid climate, dryness and hot weather prevail and is free from extremes weather changes. The Normal annual rainfall of 607 mm received from the south-west monsoon with about 41 rain days.

The Co-efficient of Rainfall Variation estimated for pre monsoon, monsoon and post monsoon seasons as 61, 40 & 68 percent respectively. The historical data for the Period of 1981 to 2010 analysed reveal that the taluk experienced various spells of normal drought to severe drought conditions. The detail of Statistical Analysis of Rainfall data is tabulated as in **Table.1.**

Table.1. Analysis of Rainfall Data, Kudligi Taluk

Rain fall	Rain fall Pre-monsoon	Rain fall South West monsoon	Rain fall North East monsoon	Annual Rain fall 'mm'
Normal Rainfall in 'mm'	79	380	147	605
STD deviation	48	150	100	190
Coefficient of Variation %	61	40	68	31

1.4. Geomorphology and Drainage

The taluk is characterized by vast stretches of undulated topography and plains. The Northern border adjoining area of Sandur taluk and the N-NE part covers hills and piedmont zones with regional slope towards S-SE, as depicted in geomorphological map, **Fig-2.** The taluk is drained by tributaries of river Vedavathi/Hagri and minor streams form dendrite pattern of drainage system. It falls within Tungabhadra river sub-basin of major Krishna Basin. The drainage system is a seasonal one and is generally go dry during the summer**.**

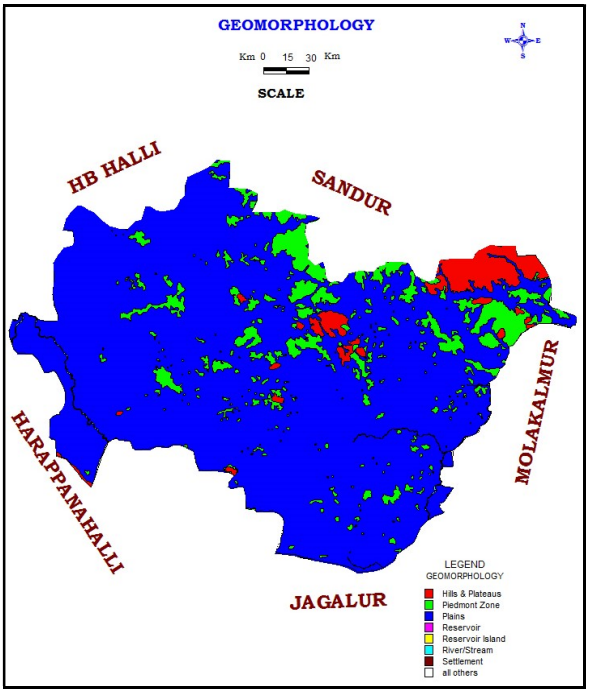

Fig.2: Geomorphology Map

1.5. Soil & Land use

The Red soil are the major type of soil in the taluk, found mainly at elevated places especially along fringes of hills due to decomposition of rocks and surrounding granitic and gneissic hills. 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. These soils are derived from Granites, Gneisses and Schistose rocks, **Fig.3**. The Sandy loam soil mixed with black and grey soils occurs along the stream beds. These are originated from gneisses and granites. They are permeable and mildly alkaline in nature. The thickness of the soil varies from 0.2 to 1.00m.

About 60 % area covers agricultural land and remaining area covers forest and others, including build-up and waste lands, as indicated in the distribution of land, **Fig. 4.**

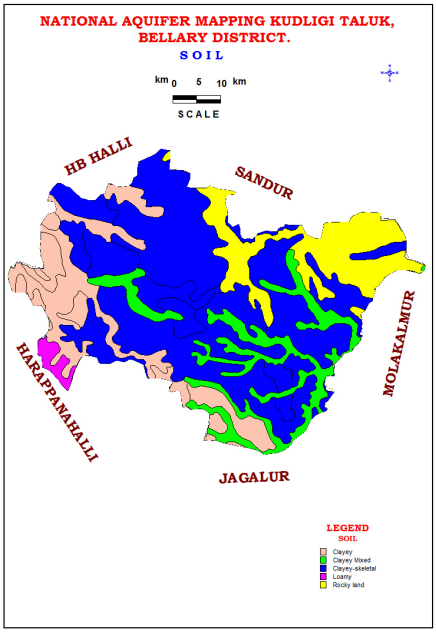

Fig.3: Soil Map

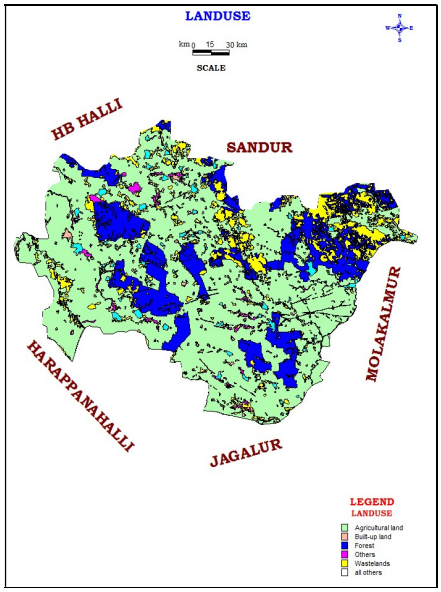

Fig.4: Land use Map

1.6. Agriculture & irrigation

In general a major part of the taluk area covers under cultivation. As, there is no perennial river flow in the area ground water is the main source of irrigation. The statistical records of the taluk indicate a net sown area as 48023 Ha and the total area as 92392 Ha. The principal crops grown are, Maize, Jowar, Bajra, Ragi, Paddy, Wheat, Tur, Horse gram, and Black gram. Out of the total sown area, the Cereal & minor millets account for 32396 Ha, Food grains grown in 13899 Ha, Oil seeds covers about 41399 Ha besides other minor crops like pulses, fruits and vegetables.

The ground water is main source of irrigation and is carried out both by Bore wells & dug wells in the taluk. It is recorded/reported about 23161 nos. BW are used for the purpose. Source: Dept.of Minor Irrigation, KA. Besides dug wells, minor surface water tanks and shallow bore wells irrigate an area of 22629 Ha. The ground water covers about 69% of area ie 15724 Ha as detailed in Table 2. Over all the ground water irrigation covers a total/ cross area of 23161 Ha. Source: District at a Glance 2015-16, Karnataka.

Table 2: Source of Irrigation

Sl.No	Source of Irrigation	Nos.	Net Area in 'Ha'
1	Tanks	52	NA
2	Wells	2106	82
3	Bore wells	3603	15642
Total			**15724**

2. AQUIFER DISPOSITION

2.1. Hydrogeology

The major water bearing formations in the taluk are hard rocks, comprising granitic gneiss, granites and schists belonging to Achaean age. The principal aquifers in the taluk are granites, gneisses, and schists. The weathered, semi weathered and fractured zones in them occur to a maximum thickness up to 25 m.bgl and Schistose formation in the hilly tracts in the northern flank observed with less granular and fractures zones forming poor aquifer. The Alluvial formation occurs locally along the river courses and yield meagerly.

The deep-seated fracture is common along major lineaments and the bore wells piercing them yield moderately. The **Fig.5** depicts the aquifer disposition in the study area along A-A' section and a fence diagram shows the extent of aquifer material across the taluk. In general the Ground water occurs under phreatic to semi-confined condition.

The average apparent resistivity of the rock formations observed (ρ) > 70 ohm m , as deciphered through geophysical investigations and exploratory bore well drilling and is depicted in **Table.3** . The granitic gneiss and granites form major aquifers and the weathered and semi weathered zone extends up to 25m. Schistose formation has weathered zones with less frequent and tight fractures (most frequent up to 60mbgl). The ground water exploratory drilling carried out, data plot **Fig.6** Bannavikallu EW, reveals the occurrence of potential fractures below 45 to 180 mbgl, Normally occurrence of fractures recorded between 100 to 150 mbgl. The transmissivity of aquifer tested ranged from 2 to 98 m/day with the yield of 0.50 to 7.00 lps.

Table 3: Salient features of subsurface geophysical characteristics rock formations/Aquifer material in Kudligi taluk as deciphered through VES

VES Location/ name of village	**Resistivity in ohm m**			**Thickness in m**			Depth to Massive formation H in m	Fractures Inferred Range(m)
	ρ1	ρ2	ρ3	h1	h2	h3		
Kudligi	25	70	V.H	1.0	24.0	-	25	45 to 150
Banvi Kallu	45	130	V.H	2.2	12.8	-	15	
Gude Kota	36	72	38	1.1	7.1	16.8	25	
Mahadevapura	14	35	V.H	2.5	9.5	-	12.0	

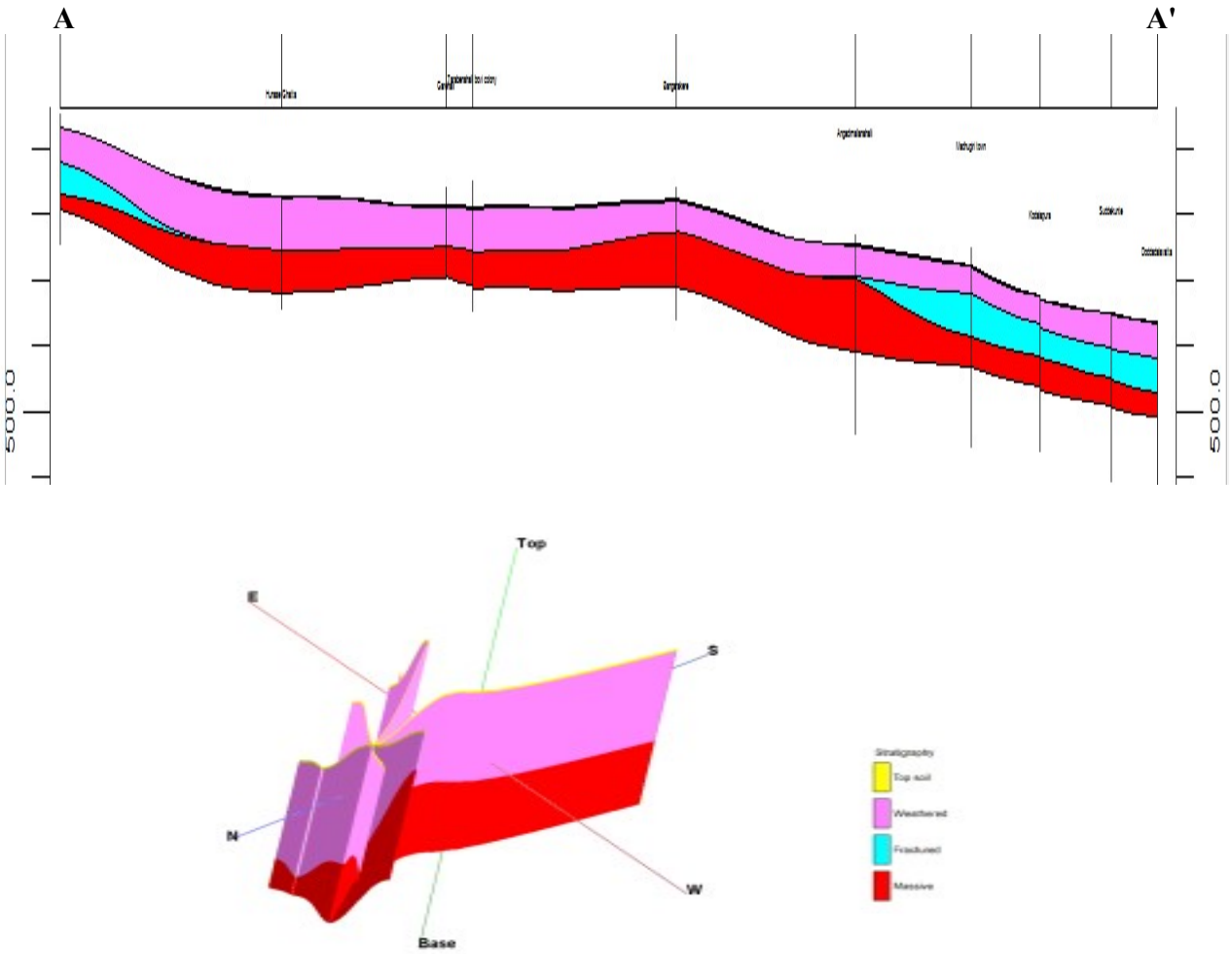

Fig.5. Aquifer geometry in the Study area

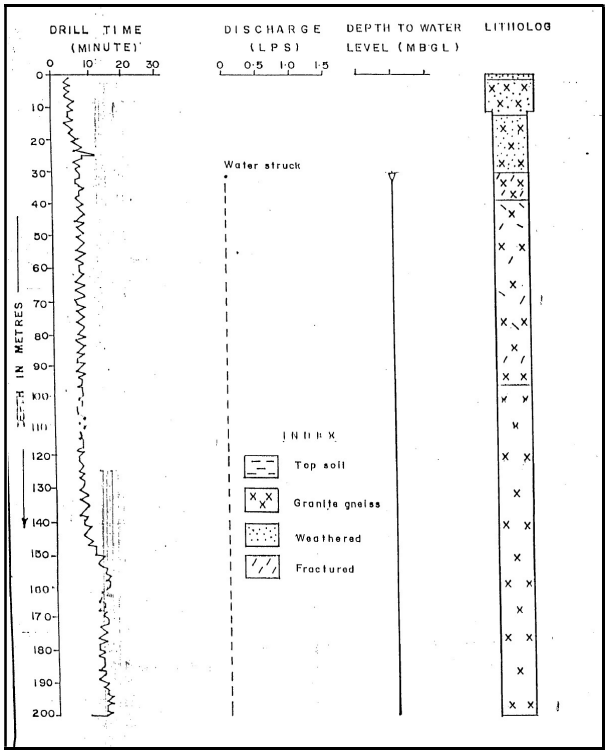

Fig.6: Exploratory bore well records of Bannavikallu

2.2. Occurrence of ground water

The fractures and joints as secondary porosity occur in them act as aquifers. Groundwater exploration work carried out down to 200 metres reveals that the presence of ground water saturated zones in the top weathered (up to 35 m) and fractured zones beneath up to 150 m. The fractured portions encountered at various levels and it occurs more frequently between 20 m to 80 m depth. Ground water occurs in them under phreatic and semi confined conditions. The saturated weathered and fractured aquifers yield 4 to 7 lps.

Occurrence and movement of ground water are controlled by the degree of weathering and fractures possessed in the formation and regional topography. Due to compactness and clay filled fracture zones in the Schistose formations the ground potential zones are less in them. The ground water development is being carried out by shallow bore wells within the depth range of 30 to 60 m bgl. The dug wells constructed in these areas tap highly weathered granitic aquifers and sustain water during post-monsoon periods.

Ground water level

The water level in the groundwater regime monitored at the NHS/OW spread over the taluk reveal the depth to water level (DTW) in pre-monsoon period range from 06.00 to 9.50 mbgl in shallower zones **(Fig.7 & 8).** Whereas, it occurs between 16.00 to 32.00 m.bgl in deep wells/fractured aquifers **(Fig.9& 10).** The Post monsoon water level varied from 3.00 to 11.00 m and 18.00 to 38.00 mbgl respectively in shallower and deeper zones. The seasonal water level fluctuation observed greater in fractured/deeper aquifer than in shallower phreatic aquifers. The seasonal variation (+/-ve) in the water level at different depth level in different geomorphic set up can be attributed to the poor rate of recharge and withdrawal during the process of recharge and the time lag in stabilization of ground water regime, as depicted in **Table.4 & 5** and **Fig.11.**

Table.4.Ground water level in Kudligi Taluk (CGWB&GWD)

Sl. No	Monitoring station/Village	DTW in mbgl May-2016	DTW in mbgl Nov-2016
1	Jogi Kallu	5.85	N.A
2	Shivapur	7.05	8.75
3	Nagara Hunse	8.58	11.4
4	Kakkuppi	9.17	8.9
5	Kottur_DMG	16.3	18.7
6	Gundumunugu	17.1	23.65
7	Kottur	17.9	NA
8	Lokikere	22.4	28.2
9	Hosahalli	30.5	37.5
10	Ujjini	32.35	38

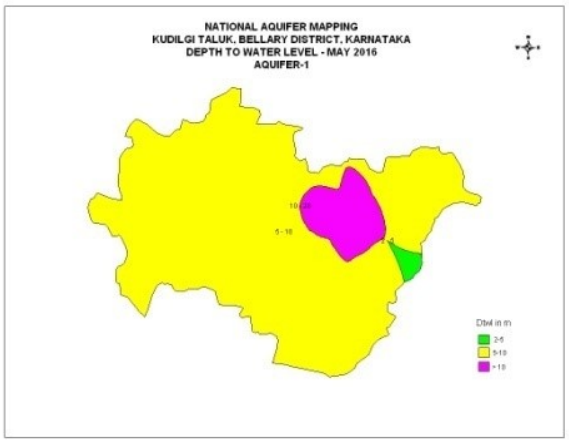

Fig. 7: DTWL Pre-Monsoon (NHS)

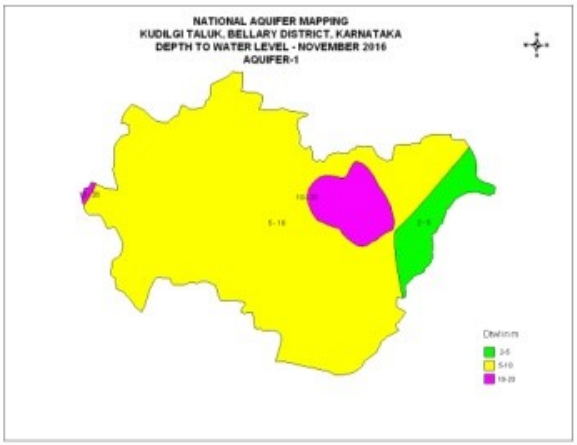

Fig. 8: DTWL Post-Monsoon (NHS)

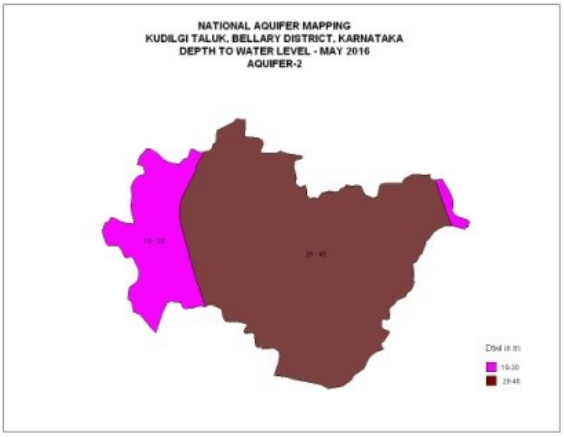

Fig. 9: DTWL Pre-Monsoon (PZ)

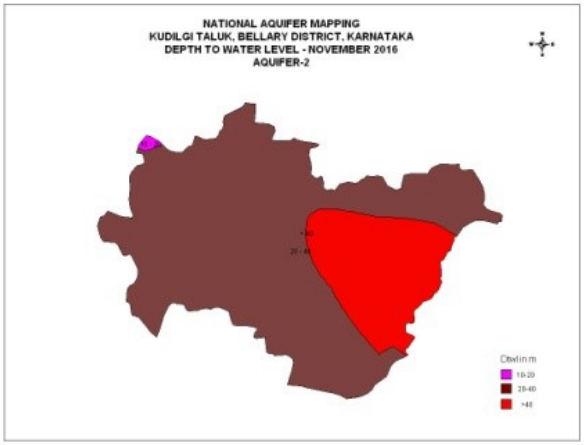

Fig. 10: DTWL Post-Monsoon (PZ)

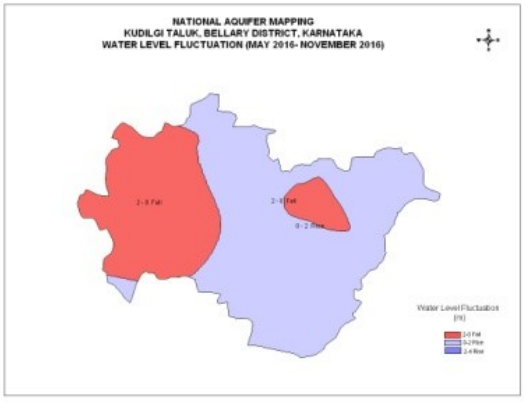

Fig. 11: Seasonal Fluctuation (CGWB,NHS)

Table 5: Ground water regime of Kudligi Taluk

Type of Abstraction structure (CGWB	Ground water Monitoring season/Month	Static water level 'm' bgl	Seasonal water level Fluctuation "metre"
Dug well (Shallow zone)	Pre-monsoon (May. 2016)	6.00 -9.50	>1.50 m
	Post-monsoon (Nov. 2016)	3.00- 11.00	
Bore well (Deeper Aquifer zone)	Pre-monsoon/Post monsoon (May. 2016/Nov.2016)	16.00-32.00/ 18.00 to 38.00	> - 4.00 m (-ve fluctuation)

3. GROUNDWATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER RELATED ISSUES

3.1. Ground water resources

The principal source of ground water is the direct recharge from the annual precipitation and by percolation from surface water bodies/tanks. Irrigation channels and return flow from applied irrigation water form an additional recharges. In respect of ground water development the taluk has been categorized as Semi-Critical with 81% of extraction from the annual replenishable resources (GEC 2017), as depicted in **Table 6**. 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 reveal the availability as 4956 Ham as on March2017.

Table 6 : Ground Water Resources (Ha) in Kudligi Taluk (GEC-2017)

Net annual ground water availability	Existing gross ground water draft for irrigation	Existing gross ground water draft for domestic and industrial water supply	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
4956	3759	258	4017	293	904	81	Semicritical

3.2. Ground water extraction

In general the ground water extraction has been taking place within the depth range of 50 to 200 mbgl, through bore wells. The dug wells constructed in shallow and alluvial aquifers made with perforated cement rings. Also, cavity wells were noticed near Kottur area. The dug wells are generally fitted centrifugal pumps.

The developments restricted to replenishable resources available in the zone of fluctuation within the shallower aquifer. Also, owing to the Poor annual rain fall, less recharge potential of hard rock aquifers and high demand the withdrawal of ground water resources observed to be erratic and unplanned.

It is estimated a gross extraction of ground water accounted to tune of 4967Ham annually GEC 2017. It is observed that the irrigation sector consume a major portion of the water resources, as it stood around 3759 Ham annually. The records states about 9189 IP sets, operated by electicity-9069 & 120 diesel pumps operated for extraction of ground water in irrigation sector, (Source: DAC-2018-19). Almost 100% of drinking water supply met with ground water (Census 2011) in the taluk.

As such, it has been observed that a remarkable increase in the development of ground water resources with the quantum jump of 87% during 2013 from a mere 34% recorded in the year 1992, as detailed in **Table.7.** It is observed an overall decline in the resources as the annual draft attains about 87% of net resources in GEC- 2013 and 81% in GEC 2017 may be due to the slight decrease in existing gross ground water draft for all uses.

Table.7. Ground water resources development in the taluk from 1992 to 2013

Resource description	Year of ground water estimation					
	1992	**2004**	**2009**	**2011**	**2013**	**2017**
Ground Water Availability “Ham”	8300	9634	4914	4957	4967	4956
Ground Water Draft “Ham”	2800	6389	3694	4006	4302	4017
Stage of Ground Water withdrawal in %	34	66	75	81	87	81

3.2. Chemical Quality & Groundwater Contamination

The ground water quality monitored reveals that the ground water in general is good and potable, excepting few isolated localities where, a higher concentration of 'Nitrate-NO_3 and Flouride (F) observed,**Table. 8.** The electrical conductivity (EC) of the ground water analysed found in the range of 420 to 1782 µS/cm at 25°C and is suitable for all the purposes. The localities like Ujjini, Ganda bommanahalli etc recorded high value of Nitrate, where necessary precautions should be observed while using the ground water for domestic consumption. At places higher concentration of Fluoride observed to be remarkable and to the maximum of 1.12 mg/l , at Kakkuppi village. A perusal of historical records of water quality in terms of Flouride concentration, there has been a remarkable variation in the quality parameters recorded over the years. Therefore, it is suggested to take suitable precautionary measures by checking the quality periodically.

Table 8 : Chemical quality of Ground water

Village/Ground water monitoring Station	Electric Coductivity µS/cm at 25°C	NO_3 (mg/l)	F^- (mg/l)
Ujjini	1720	87	0.2
Gandabommanahalli	1204	48	0.78
Kakkuppi	1782	12	1.12
Gudekote	420	12	0.4

4. GROUNDWATER RESOURCE ENHANCEMENT

Rain water harvesting and Artificial Recharge: It has been estimated about 19.10 MCM of a surplus of surface water available as runoff in the taluk. Also, there is aquifer storage potential of 251 MCM exists in the region, which can be used for developing the above non committed surface runoff water available. The conservation structures like Check Dams (CD), Percolation Tanks (PT), Point Recharge structures (PRS) and smaller structures like trench, bunds, boulder checks, gully plugs, trench cum bund etc can be developed at appropriate places for enhancing the aquifer potential. About 137 no. of structures could be developed in the non-arable lands, such as dry land, rocky, forestry land etc. and semi-arable (horticultural land) with the above surplus runoff.

The development of above structures is anticipated a recharge of 10.633 MCM to the aquifer in the taluk, as detailed in **Table 9.** The structures thus built expected to enhance the groundwater resources by 16% and its sustainability with a remarkable rise in the water table too. Also, the additional resources added to the aquifer would bring up the annual resource development rate to a comfortable 71%.

Table 9: Artificial recharge structure proposed and estimated changes in the Ground water regime

Sl. No	Type of Artificial recharge structure	Artificial recharge structure feasible in Nos.	Recharge from recharge structure (MCM)
1	Check Dams (CD resource/0.03MCM*4 fillings)	116	6.945
2	Percolation Tanks (PT resource/0.4MCM*1.5 fillings)	8	3.519
3	Point Recharge Structures (PRS resource/0.015 MCM)	13	0.169
Total		**137**	**10.633**

5. DEMAND SIDE INTERVENTIONS

Regulatory measures: The state ground water regulatory authorities is active in providing rural drinking water supply by various schemes for fluoride affected area (123 localities) and other water scarcity region through bore wells (725 wells), the water use efficiency practices promoted in agriculture sector. It has been found in the process of aquifer mapping activities-NAQUIM, there is a need to train the farming community and other stake holders to manage the water resources efficiently and judiciously through a set of regulation measures like restrict the development of additional wells and pricing for the quantum of water utilised for irrigation. Also, the cultivation of water-intensive and commercial crops should be banned.

As the water balance studies on micro watershed level brought out valuable information elsewhere in the country in the recent years, appropriate regulations implemented at village Panchayat level could be useful in understanding the water resource situation. The understanding would take up required conservation measures and devising appropriate ground water

development and management strategies including the operation and maintenance, and community management.

Changing Crop Pattern: Though there is about less than 10% of net area is under ground water irrigation, keeping in view of the erratic rain fall and the poor ground water potential available in the taluk, second crop can avoided. Also, it has been proposed to consider about 60% of the irrigated land to put under micro irrigation practices. Developing less water-intensive crops in the other lands may be developed with due consideration of soil suitability, thereby increase the ground water substantially.

Recycling of waste water & Water sharing/inter basin surface water transfer: Since, the entire drinking water demand and almost the whole taluk's irrigation demand have been met with ground water, it is suggested to make arrangements for sharing surface waters from the adjoining taluks- HB Halli & Hospet, thereby, reduce the dependency on ground water and stress on the aquifer system. The villages with higher population can adopt measures to treat the grey water/waste water generated both in domestic and business houses there by to reduce the ground water extraction marginally.