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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

HUNGUND TALUK,

BAGALKOT DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

AQUIFER MANAGEMENT PLAN OF HUNGUND TALUK, BAGALKOT DISTRICT, KARNATAKA STATE

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AQUIFER MANAGEMENT PLAN OF HUNGUND TALUK, BAGALKOT DISTRICT, KARNATAKA STATE

1. SALIENT FEATURES

1.1 Aquifer management study area

Hungund taluk, located in eastern portion of Bagalkot district, Karnataka State covering an area of 1353.58 sq. km and is a part of Krishna river basin located at longitudes $15^0$51'29.88": 16^0 16'15.96" and east latitude of $75^0$49'56.28": $76^0$20'9.6". It is surrounded by Muddebihal taluk of Bijapur district towards north, Kushtagi taluk of Koppal district towards south, Bagalkot and Badami taluks towards west and in east it is Lingsugur taluk of Raichur district. The Location map of the taluk is in **Figure 1.**

The Hungund taluk is a part of Bagalkot revenue sub-division with Hungund as taluk head quarter. There are four revenue hoblies - Ilakal, Amingad, Hungund and Karadi which covers 162 Inhabitated villages falling in 30 Grama Panchayats. The Hunugund is located at a distance of 40 kms from Bagalkot on NH-13 and the taluk is well connected with good network of roads with State highway and district roads and forming good network of transport facility.

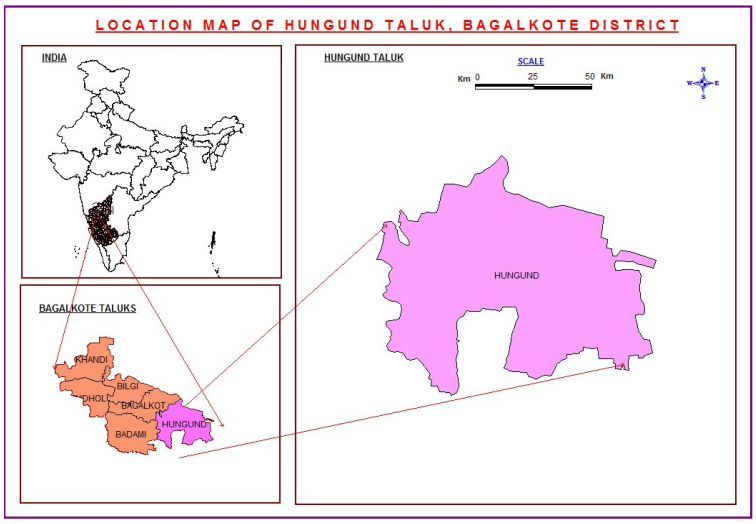

Figure-1: Location Map of Hungund Taluk

1.2 Population:

As per 2011 census, the total population in Hungund taluk is 321338 (161741 males and 159597 Females) of which about 197557 (61.47 %) constitutes the rural population. The taluk has an overall population density of 237.39 persons per sq.km. The decadal change is 11.9 %.

1.3 Rainfall:

Hungund taluk enjoys semi arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Northern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The climate of the taluk is quite agreeable and free from extremes. The temperature in summer is in between 31.7^0C to 36^0C and in winter it is 14.5^0 to 27^0 C. Overall temperature range is in between 26.8^0c to 32.10^0. The rainy season is south-west monsoon is from June to September followed by North-East monsoon and post-monsoon from October to December.

The Annual Normal rainfall (1981 to 2010) in the taluk is 814 mm and the statistical analysis of rainfall data for the above period is presented in the **Table-1**.

Table 1: Statistical Analysis of Rainfall Data of Hungund Taluk, Bagalkot District, Karnataka for the Period 1981 to 2010

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
Hungund	NRM	3	2	8	18	65	96	92	69	99	140	400	126	20	8	154	814
	ST. DEV	9	8	19	22	50	57	69	41	63	93	170	98	34	20	98	362
	CV%	352	330	234	126	77	60	75	60	64	67	42	78	167	230	63	45

Assessment of Drought

Rainfall data has been analysed to assess the drought condition using 103 years Rain Fall data and the results / classification thus obtained are listed in the **Table-2.** It is observed that the Hungund taluk has experienced alternating no drought to severe drought conditions over the years.

Table :2 Classification of drought and its periodicity (IMD, 1971)

% Deviation (Di)		>0	0 to -25	-25 to -50	50 to -75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	
		Years				
Taluk	Hungund	64	18	19	2	Once in 5 years

Out of 103 years of analysis in Hungund taluk, "No Drought" condition is experienced in 64 years, "Mild Drought" condition is 18 years and "Moderate Drought" condition experienced in 19 years. Further it is observed that "Severe Drought" condition is experienced in 2 years ie, during 1923, 1985 and 1923. 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.**

1.4 Agriculture & Irrigation:

Hungund taluk is having 197557 (61.47 %) of rural population wholly dependent on the rainfall for their agricultural activities. The land use pattern of the taluk is presented in the **Table-3**.

Table-3: Land use pattern in Hungund taluk

Geographical area (Ha)	Area under forest (Ha)	Area not available for cultivation (Ha)	Uncultivable land (Ha)	Fallow land (Ha)	Area sown (Ha)		
					Net sown area	Area sown more than once	Total sown/cropped area
135358	9792	11879	1169	1608	13071	7468	138339

District at a glance 2015-2016

1.4.1 Principle crops:

The only principle crop of the taluk is Bengal gram - 73237 ha (52.94% to the total cropped area) followed by Jower crops of 23584 ha (17.04 % to the total cropped area) and Sun flower with an area of 10976 (7.93%) which are normally rain fed crops. Overall food crops are of 81.43% of which pulses with 60.20% and Cereals are of 21.23% are the major crops grown during Rabi season. Vegetables crops are the Kharif crops. The principle crops and area grown are in the below **Table-4**.

Table 4: Principle crops in Hungund taluk

Crops	Cereals (Area in Ha)			Pulses (Area in Ha)				Fruits (Area in Ha)	Vegetables (Area in Ha)	Oil seeds (Area in Ha)		
	Jowar	Maize	Others	Bengal gram	Green gram	Tur	Others			Sun Flower	Ground nuts	others
	23584	2548	3239	73237	7439	2342	268	151	5127	10976	4594	1140
Total	29371			83286				151	5127	16710		
	Total Food Grains -112657 ha							-	-	**Total Oilseeds-16710 ha**		

District at a glance 2015-2016 (ASCR)

1.4.2 Irrigation Practices:

In Hungund taluk, the ground water is being developed from ground water structures like 555 dug wells and 1488 shallow tube wells (Report on 4th census of Minor Irrigation Schemes 2006-2007) is for irrigation purposes. The ground water thus developed from these structures were managed through water distribution irrigation practices by adopting- Open channel, Underground pipe, surface pipe, drip irrigation, sprinklers and others.

1.4.3 Ground water and surface water Irrigation:

In Hungund taluk, Ground water is the main source of irrigation. The details of surface water and ground water irrigation are in the **Table-5**.

Table-5: Details of irrigation in Hungund taluk

Sl. No.	Source		No. / Length	Net area irrigated (ha)	Gross area irrigated (ha)
1	Surface water	Canals	39 kms	520	520
		Tanks	12	140	140
		Lift Irrigation	4	150	150
2	Ground water	Dug Wells	846	265	573
		Bore wells	1662	5116	6651
3	Other sources		-	8379	9038
4	Total		2563	14570	17072

District at a glance 2015-2016 (ASCR)

1.5 Geomorphology, Physiography & Drainage:

Geomorphologically Hungund taluk falls in Northern maidan region. Topographically the region is generally enclosed by a chain of east west running hills and the area between Krishna and Malaprabha presents a sharp change in landscapes. The hills are largely covered with thorn forests. The general slope is from east to west. The area is represented by Badami group of residual hills of red sandstones. The heights generally vary from 600 to 750m amsl. The average elevation of taluk is 531 m above msl **Figure-2**.

Drainage:
Hungund taluk is part of upper Krishna river basin. Malaprabha – tributary of Krishna and Krishan itself are the major rivers which drain the entire taluk. The Malaprabha river a minor counter part of river Krishna enters the taluk in the south western border and drains western and north western portion and joins Krishna at Sangama-Kudalasangama. After confluence of Malaprabha with Krishna which flows north to north eastern border of the taluk. Hungund halla and Ilakal halla are the major streams of Krishna drain central and eastern portion of taluk. The general drainage pattern is of sub-rectangular due to marked influence of geologic structures in the basin **Figure 3**.

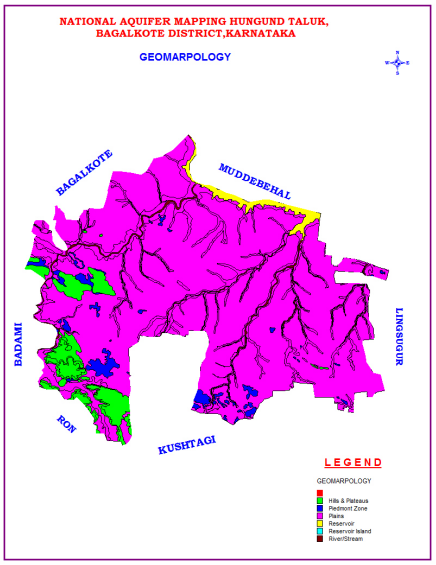

Figure2: Geomorphology map

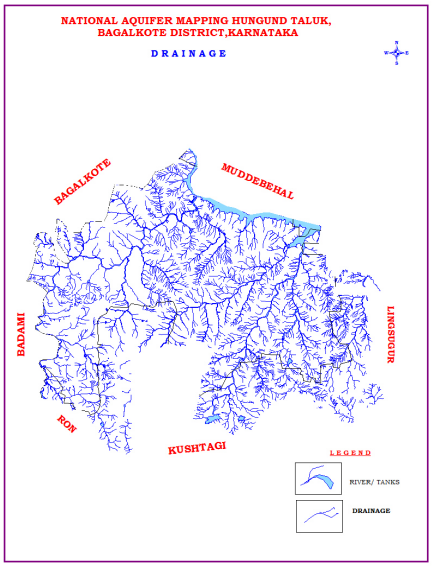

Figure 3: Drainage map

1.6 Geology:
Major portion of Hungund taluk is occupied by Banded Gneisses referred as peninsular Gneiss and granites in north western portion Lime stones and basalts as major rock formation **Figure-4**.

1.7 Soil :
The soils of the taluk are derived from Gneiss / Granites and sand stones. The soils are hard and poor in general. Clayey, loam, black soil are the soil types **Figure-5**.

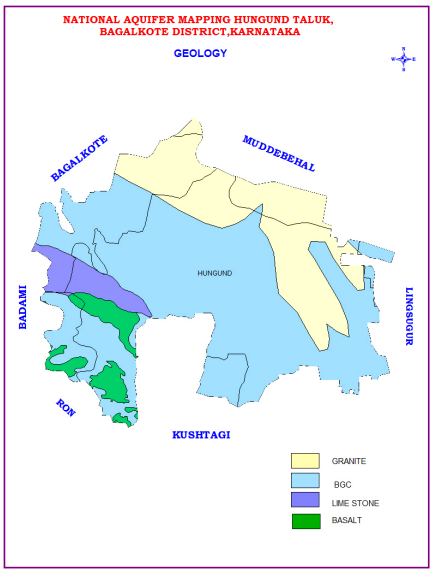

Figure 4: Geology map

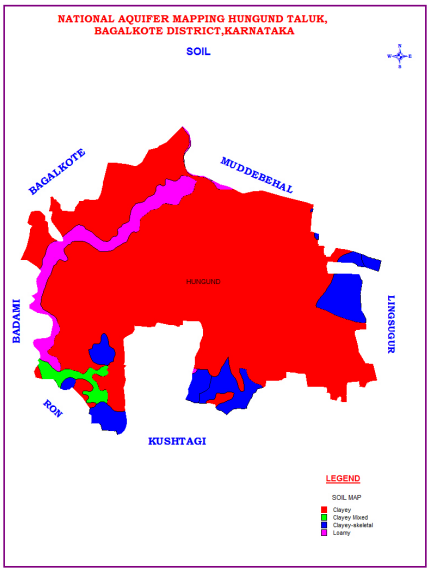

Figure 5: Soil map

1.8 Ground water resource availability and extraction:

The Ground water availability as per Resource Estimation 2009, 2013 & 2017 is as in the **Table-6**.

Table-6

Year	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	Dynamic +phreatic in-storage + fractured
2009	7065 HAM	8010 HAM	2547 HAM	17623 HAM
2013	6987 HAM	10008 HAM	2547 HAM	19542 HAM
2017	9601 HAM	9992 HAM	2547 HAM	22140 HAM

As per the estimation **(GEC 2017**) the ground water draft (extraction) for irrigation worked out to be **6489 ham** with stage of ground water development of **69%**.

1.9 Existing and future water demands

As per GEC (2017) existing ground water draft for irrigation, industrial & domestic (all use) is **6596 ham** and availability for future demands with judicious utilization as the stage of ground water development is **69 %** having scope of **3734 ham** of which **115 ham** is for domestic and industrial use and **3619 ham** is for future irrigation purposes.

1.10 Water level behavior:

The depth to water levels during pre and post monsoon and the rate of fluctuation of water level are in the **Table-7 and Figures 6 to 11.**

Table-7: Water level behavior

Item	Depth to Water levels in Hungund taluk					
	Pre monsoon		Post monsoon		Water level fluctuation	
	Aquifer I	Aquifer II	Aquifer I	Aquifer II	Aquifer I	Aquifer II
Range	2.88 to 11.80	-	2.60 to 11.50	-	0.00 to 2.64	-
Average	6.24	-	5.81	-	0.46	-

A.Depth to water level Aquifer I

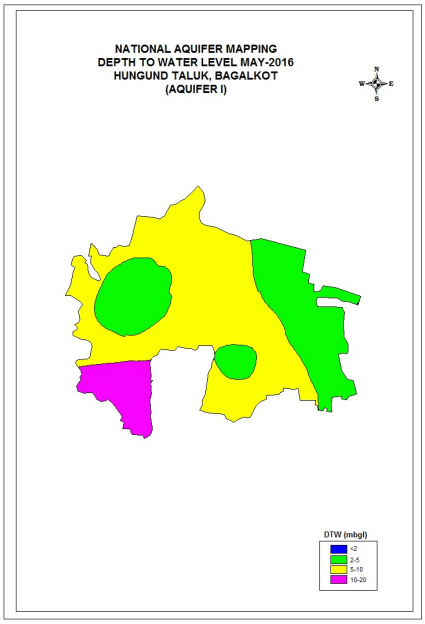

Fig-6 Pre monsoon DTW Map Aquifer I

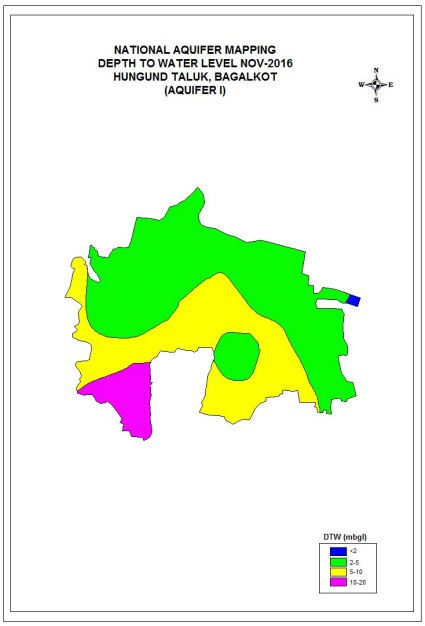

Fig-7 Post monsoon DTW map Aquifer-I

B.Depth to water level Aquifer II

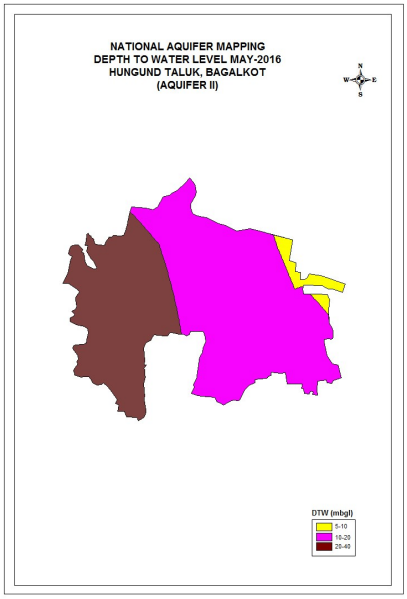

Figure-8 Pre monsoon DTW in Aquifer II

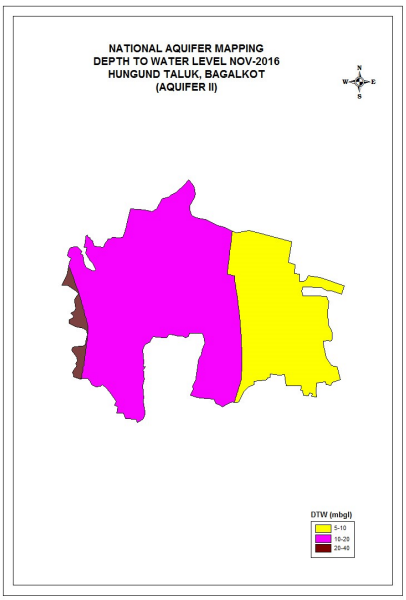

Figure-9. Post monsoon DTW in Aquifer II

C.Water level fluctuation :

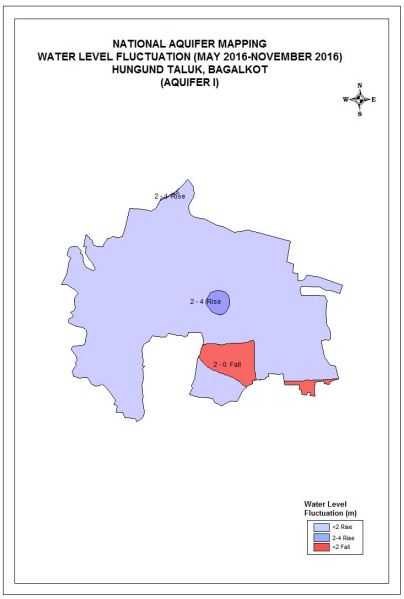

Figure-10: WL Fluctuation in Aquifer I

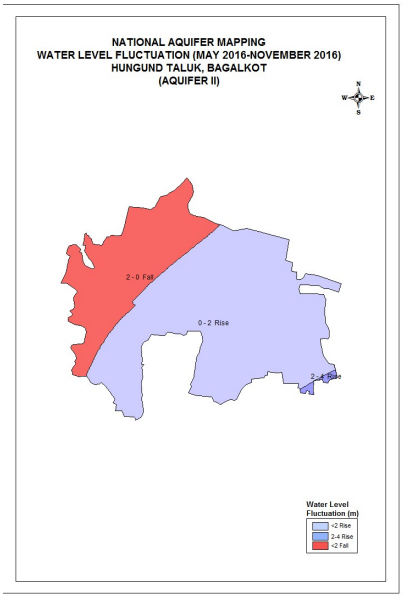

Figure-11: WL Fluctuation in Aquifer II

The analysis of **long term water level trend** in Aquifer-1 indicates that in pre monsoon there is rising trend in between 0.0136 to 0.4127 m/y with an average of 0.13182m/y and falling trend in the range of 0.0339 to 0.6034 m/y with an average fall of 0.2682m/y. Similarly during post monsoon showed rising trend in the range of 0.0683 to 0.1519m/y with an average of 0.1038m/y. Falling trend during post monsoon observed in the range of 0.0209 to 0.8893m/y with an average of 0.3625m/y. Overall trend indicates that rising trend to the tune of 0.0328 to 0.1192m/y with an average of 0.0830 m/y and falling trend is in the range of 0.0376 to 0.7049m/y with an average of 0.3239m/y.

2.0 AQUIFER DISPOSITION

The data collected during Geophysical investigation, Ground water exploration were used to delineate the aquifer system, Geometry and the extension of aquifer in terms of both lateral and vertical extent. No deep drilling beyond 100m in the taluk. However exploratory drilling up to the depth of 95.00 was carried out during 1988 to 1990 and the details of ground water exploration are in **Table-8**.

Table 8: Details of Ground water Exploration in Hungund taluk

Sl.No.	Details	No/Range	Average
1	No of wells drilled	6	-
2	Depth range in 'm'	60.45 to 95.30	80.20
3	Depth of Casing in 'm'	6.00 to 19.50	13.11
4	Discharge in LPS	0.32 to 5.55	2.596
5	S.W.L. in m	3.30 to 13.36	7.916
6	Transmissivity m^2/day	2.62 to 106.00	45.26

2.1 Number of aquifers: Based on the Ground water exploration data In Hungund taluk, there are mainly two types of aquifer systems;

i. Aquifer-I- (Phreatic aquifer) comprising Weathered Gneiss / Granite / Lime stone / Sand stone.

ii. Aquifer-II- (Fractured multi-aquifer system) comprising Fractured **Gneiss / Granite / Lime stone/San dstone.**

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION

3.1 Aquifer wise resource availability and extraction:

Aquifer wise ground water resource (2009) has already been discussed in above chapter (1.8 & 1.9). However overall Groundwater resource estimation in Hungund taluk as on 2011, 2013 & 2017 indicating present and future scenario (2025), Stage of ground water development and categorization is presented in the below **Table-9**.

Table-9: Ground water resources in HAM

Sl.No	Resource details	As per 2011 Estimation	As per 2013 Estimation	As per 2017 Estimation
1	Net Ground Water Availability	6973	6987	9601
2	Existing Gross Ground Water Draft for Irrigation	5507.53	5618	6489
3	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply	794.70	576	107
4	Existing Gross Ground Water Draft for all use	6302.23	6194	6596
5	Allocation for Domestic And Industrial Use for next 25 years	1110.34	876	115
6	Net Ground Water Availability for future Irrigation Development	1365.27	1333	3619
7	Existing Stage Of Ground Water Development in percentage	90	89	69
8	Categorization	Semi critical	Semi critical	Safe

3.2 Chemical quality of ground water and contamination

The chemical quality of ground water in Hungund taluk is assessed from the analysis results of 6 ground water samples from dug wells (Aquifer-I). The variation range and average of the different chemical constituents are presented in the **Table-10** and the distribution of chloride, EC, Nitrate and Fluoride is presented in the **Figure-17 to 20.**

Table-10: Variation range and average of chemical constituents in Ground water

→ Chemical constituents in PPM	P^H	EC in m/mhos /cm at 25^0 C	Total hardness as $CaCo_3$	Ca^{++}	Mg^{++}	Na^{++}	K^+	Hco_3	Cl	So_3	No_3	F
Range	8.5 to 8.8	493 to 3967	150 to 740	12 to 44	22 to 153	49 to 778	0 to 6	183 to 415	21 to 652	5 to 196	9 to 221	0.08 to 2.26
Average	8.6	2021	333.3	25.33	65.83	322.7	2.5	284.8	264.5	57.50	69.83	1.057

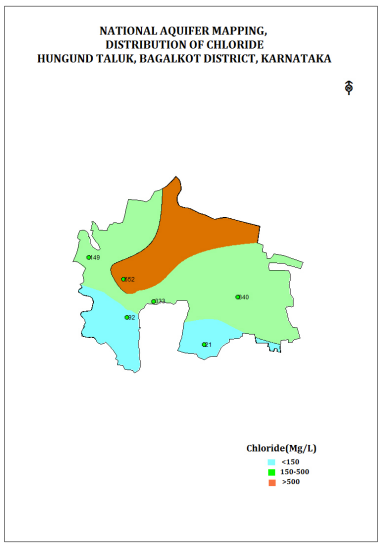

Figure 17: Distribution of Chloride

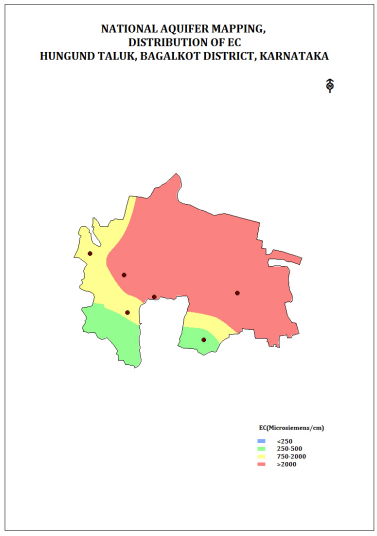

Figure 18: Distribution of EC

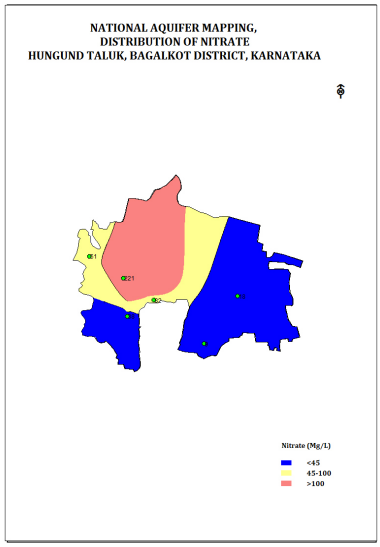

Figure-19: Distribution of Nitrate

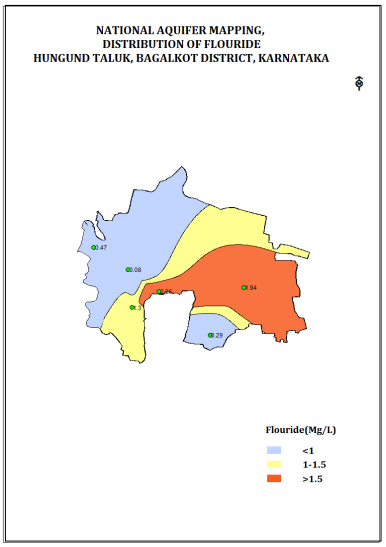

Figure-20: Distribution of Fluoride

3.2.1. Suitability of ground water for **drinking purposes** is assessed as per Indian Standard Drinking water specification (IS 10500: 1991)which indicates that water is potable and all the required chemical constituents is within the desirable/permissible **limits**. The range of chemical constituents (under NAQUIM) in ground water of the taluk is plotted in Piper diagram **Fig. 21**.

3.2.2. Suitbility of ground water for **irrigation purposes** was assessed and the chemical analysis of the taluk is plotted in United States Regional Salinity Labaratory (1954) classification and presented in the diagram-**Figure 22.**

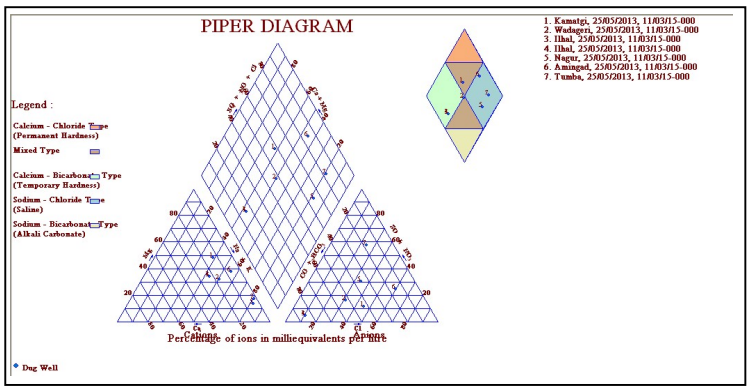

Figure 21: Chmeical anlysis Plot on Piper Diagram

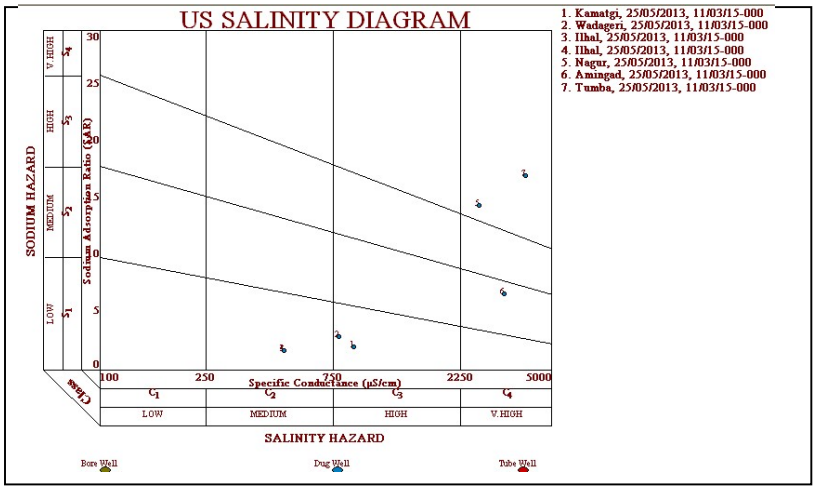

Figure 22: U.S. Salinity diagram

3.3.Ground water contamination :

Perusal of the above analysis/interpretations of chemical data it indicates that there is no major ground water contamination except point contmination of different chemical constituents were noticed here and there in the taluk.

4.0 GROUND WATER RESOURCE ENHANCEMENT:

Continuous drought, increase in agricultural activity, subjected to excessive ground water withdrawal leading to depletion of ground water table, reduction in yield and deterioration of ground water quality etc., suggests a need for proper ground water management and enhancement of storage capacity of aquifers, protection of ground water quality and proper utilization of ground water.

To enhance the storage capacity of aquifers, the dewatered aquifers are to be recharged, for which the artificial recharge structures like Check dams, percolation tanks, point recharge structures etc have to be constructed **(Table 11).**

4.1 Aquifer wise space available for recharge and proposed interventions

Quantity of water available through non-committed surface run off:
The surplus non-committed monsoon run off is calculated to be 94.524 MCM this can be used to recharge the aquifer through suitable recharge structures which augment the net ground water availability in the taluk. The details of types of structure/number for recharge are presented in the **Table 11**.

Table 11: Details of Artificial structures (As per Master Plan for artificial recharge in Karnataka and Goa, 2020)

Artificial Recharge Structures available/Proposed	Hungund taluk	Resource available in MCM
Non committed monsoon run off available (MCM)	94.524	
Number of Check Dams	263	23.631
Number of Percolation Tanks	85	47.262
Number of Subsurface dyke	3	14.179
Tentative total cost of the project (Rs. in lakhs)	4383.135	-
Expected recharge (MCM)	70.893	-
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	4.26	-

Thus considering above source water for ground water recharge the volume of water expected to be conserved or in the ground water resource enhancement is as detailed in the below **Table-12**.

Table 12: Details of resource enhancement after proposed artificial recharge

Sl.No	Resource details	As per 2017 Estimation
1	Net Ground Water Availability in HAM	9601
2	Existing Gross Ground Water Draft for All use HAM	6596
3	Existing Stage Of Ground Water Development in percentage	69
4	Expected recharge from Artificial Recharge Projects HAM	7089.3
5	Cumulative ground water Availability HAM	16690.3
6	Expected improvement in stage of ground water Development after implementation of the project in percentage	39.52
7	Expected improvement in overall Stage of Ground water development in percentage	29.48
8	Expected additional irrigational potential in lakh hectares	0.085

5. DEMAND SIDE INTERVENTIONS:

5.1 Advanced irrigation practices:

Major crops of Hungund taluk is Bengal gram and Jowar which are rain fed crops. Remaining crops like some of the other pulses, Vegetables and fruits are depending upon the ground water source.

The ground water for irrigation is being developed through **555** irrigation dug wells and **1488** irrigation bore wells. The existing **advanced irrigation practices** and the irrigation potential created over the taluk is as detailed in the below **Table 13**.

Table 13: Details of Irrigation practices

Sl.No	Advanced Irrigation practices	No. of Irrigation Dug wells and potential utilized area in hectares		No. of Irrigation Bore wells and potential utilized area in hectares		Total	
		No. Dug wells	potential utilized (area in hectares)	No. of Bore wells	potential utilized (area in hectares)	Total no of structures	Total potential Utilized(area in hectares)
1	Open water channel	351	910	275	732	626	1642
2	Underground pipe	136	302	520	1471	656	1773
3	Surface pipe	66	152	630	1592	696	1744
4	Drip irrigation	0	0	1	1	1	1
5	Sprinklers	1	3	61	253	62	256
6	Others	1	1	1	2	2	3
	Total	**555**	**1368**	**1488**	**4051**	**2043**	**5419**

Source: *4th Census of Minor Irrigation schemes, Department of Minor irrigation, Bangalore, March 2011*

Perusal of the above **Table-13**, the irrigation practices like Drip irrigation & sprinklers, as water distribution system is comparatively negligible with negligible irrigation potential utilized when compared to other distribution systems resulting in difficulty in economy of water conservation. If these methods of drip and sprinkler irrigation systems increased, maximum available ground water can be conserved judiciously. This ultimately enhances the area under irrigation potential.

5.2 Change in cropping pattern

Farmers are facing inadequacy of groundwater for agriculture so farmers have to change in their cropping pattern and water economy irrigation practices like drip irrigation and sprinkler irrigation which are negligible number. If they also adopt the water use efficient irrigation practices like mulching-plastic sheeting, spread on the ground around plants to prevent excessive evaporation or erosion, enrich the soil, etc., and there will be additional saving in water. Therefore, encouragement from government is essential for achieving full target of water use efficiency in the taluk.

5.3. Alternate water sources:

As per the resource estimation – 2017, Hungund taluk falls under Safe category. since 2011 resource estimation with the stage of ground water development of 89 % leading towards water scarcity problem. So there is need to formulate management strategy to tackle the water source scarcity in the taluk.

If the artificial recharge projects as proposed is implemented the Surplus non committed monsoon runoff water available-through artificial recharge structures about 70.893 MCM of water can be conserved. This alternate water sources will cope up additional irrigational potential of 0.085 lakh ha of agricultural land **(Table-11&12**).

5.4. Regulation and control:

Considering the current existing ground water draft for all use – 6596 ham with the stage of ground water development up to 69%, it is necessary to plan to augment the ground water through artificial recharge besides use of ground water judiciously. Apart from this it is also necessary to adopt advanced irrigation practices like drip irrigation, sprinklers and other practices which are reported to be in no/negligible number and management of ground water for irrigation with water use efficiency methods.

5.5 Other Interventions proposed:

The major issue in the taluk is water scarcity for drinking and irrigation. To mitigate this critical issue of scarcity for safe drinking water, construction of rain water harvesting units at the family level are must implementation of artificial structures as proposed to recharge the ground water.