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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

HASSAN TALUK,

HASSAN DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

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

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

1.0 SALIENT INFORMATION

Name of the Taluk: HASSAN

District: Hassan; State: Karnataka

Area: 939 sq.km.

Population: 3,96,166

Annual Normal Rainfall: 889 mm

1.1 Aquifer Management study area

Aquifer mapping studies was carried out in Hassan Taluk, Hassan district of Karnataka, covering an area of 939 sq.kms under National Aquifer Mapping Project. Hassan Taluk of Hassan district is located between north latitude 12° 49' 01" and 13° 12' 45 & east longitude 75° 57' 43" and 76° 17' 56" and is covered in parts of Survey of India Topo sheet Nos. 57C/4, 57C/8, 57D/1, 57D/5 & 48 O/16. Hassan Taluk is bounded by Arsikere Taluk on north, Arkalgud Taluk on south, Channarayapatna Taluk on east and Belur, Alur Taluks on the western side. Location map of Hassan Taluk of Hassan district is presented in **Figure-1**.

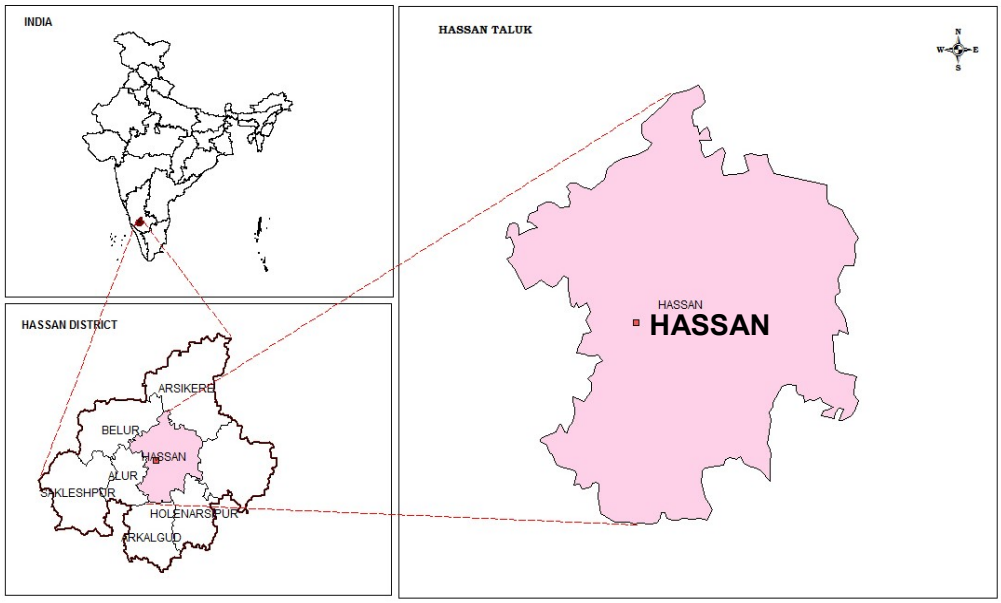

Fig-1: Location Map of Hassan taluk, Hassan district

Taluk administration of Hassan Taluk is divided into 5 Hoblies namely Kasba, Kattaya, Salegama, Shantigrama and Dudda. Hassan town is also the Taluk head quarter for Hassan District. There are 368 inhabited and 26 uninhabited villages in the Taluk.

1.2 Population

According to 2011 census, the population in the Taluk is 3,96,166, in which 2,18,682 constitute the rural population and 1,77,484 urban population, which works out to 55 % (rural) and 45 % (urban) of the total population of Taluk. The study area has an overall population density of 422 persons per sq.km. The decadal variation in population from 2001-2011 is 9.7 % in Hassan Taluk.

1.2 Rainfall

Hassan Taluk enjoys semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Southern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The normal annual rainfall in Hassan Taluk for the period 1981 to 2010 is 889 mm. Seasonal rainfall pattern indicates that, major amount of (490 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 55% of the annual normal rainfall, followed by North-East Monsoon season (221 mm) constituting 25% and remaining (178 mm) 20% in Pre-Monsoon season (**Table-1**).

On Computations were carried out for the 30 year blocks of 1981-2010, the mean monthly rainfall at Hassan Taluk is ranging between 2 mm during January to 168 mm during October. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 177, 264 & 202 percent respectively. Annual CV at this station works out to be 318 percent (**Table-1**).

Table-1: Statistical Analysis of Rainfall Data of Hassan Taluk, Hassan district, Karnataka (1981 to 2010)

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
HASSAN	NRM	2	3	22	59	92	178	112	128	118	133	490	168	44	8	221	889
	STDEV	4	11	45	49	55	100	67	73	68	84	186	99	55	14	109	280
	CV%	38	29	50	120	168	177	167	175	175	158	264	171	82	55	202	318

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Hassan Taluk. Major Kharif crops are paddy, maize, ragi, tur and vegetables. Main crops of Rabi season are maize, ragi, horse gram, vegetables, groundnut, and sunflower (**Table-2**). Water intensive crops paddy and sugarcane are grown in 4% of total crop area. Maize is grown in 45%, ragi in 14%, vegetables in 29% and pulses in 4% of total crop area of Taluk.

Table-2: Cropping pattern in Hassan Taluk 2014-2015 (Ha)

Year	Paddy	Maize	Ragi	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
2014-2015	1936	23420	7583	20	1943	1253	15460	532	316	2

It is observed that the net sown area accounts 52% and area sown more than once is 17% of total geographical area in Hassan Taluk (**Table-3**). Area not available for cultivation and Forest cover 32% & 4% of total geographical area respectively. 79% of net area irrigated is only from bore wells and 21% from tank irrigation (**Table-4**).

Table-3: Details of land use in Hassan Taluk 2014-2015 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Hassan	91818	3677	29117	91881	48187	15839

Source: District at a glance 2014-15, Govt. of Karnataka

Table-4: Irrigation details in Hassan Taluk (Ha)

Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	11012	50
Tanks	6989	32
Wells	308	1
Bore wells	3597	16
Lift Irrigation	0	
Other Sources	0	
Total	**21906**	

Source: District at a glance 2014-15, Govt. of Karnataka

1.5 Geomorphology, Physiography & Drainage

The general land elevation on the southern side of the Taluk is about 860 m amsl and increases to 1000 m amsl in the north. The general slope is mostly towards NW to SE. Isolated hillock at Sigegudda has an elevation of 1285 m amsl (**Fig.-2**).

The Taluk is drained by 1st to 4th order streams which flow towards south and west wards. The southern boundary of the Taluk is coinciding with the Hemavathi River. The tank system is well developed in the Taluk. The general drainage pattern is dendritic to sub-dendritic in nature and mostly joins Hemavathi River (**Fig.-3**).

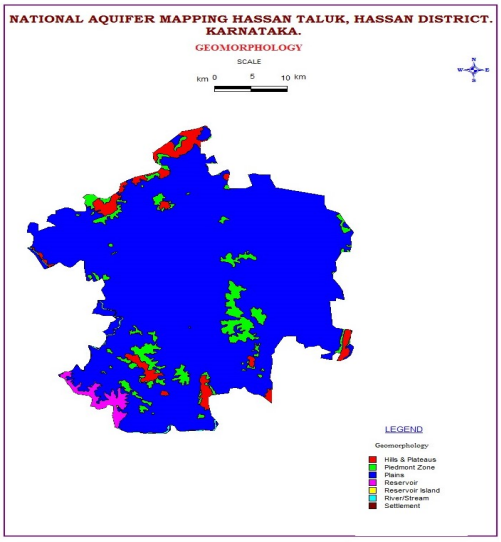

Fig-2: Geomorphology Map

Fig-3: Drainage Map

1.6 Soil

In general, the Taluk is covered by red soil. Patches of black cotton soil are also found at places. The red soil in general derive from granite gneisses. Black cotton soils are derived from schist and alluvial soil found in limited extent and confined to river/nala courses.

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth is given in **Table-5** below.

Table-5: Total Ground Water Resources (2017) (Ham)

Taluk	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
Hassan	13032	15762	1863	30657

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

- Net ground water availability for future irrigation development: 66.49 MCM
- Domestic (Industrial sector) demand for next 25 years : 6.98 MCM

1.9 Water level behavior

(a) Depth to water level

Aquifer - I

- Pre-monsoon: 1.60 – 17.16 mbgl (**Fig.-4**)
- Post-monsoon: 1.88 – 11.45 mbgl (**Fig.-5**)

Aquifer - II

- Pre-monsoon: 5.96 – 21.81 mbgl (**Fig.-6)**
- Post-monsoon: 4.40 – 21.56 mbgl (**Fig.-7**)

(b) Water level fluctuation

Aquifer-I (**Fig.-8**)

- Seasonal Fluctuation: Rise ranges 0.28 – 3.25 m;
  Fall ranges 0.89 – 12.82 m

Aquifer-II (**Fig.-9**)

- Seasonal Fluctuation: Rise shows 1.18 m

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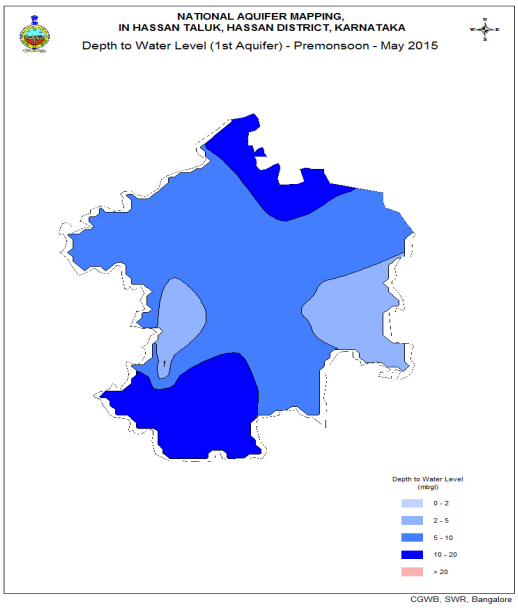

Fig-4: Pre-monsoon Depth to Water Level (Aq-I)

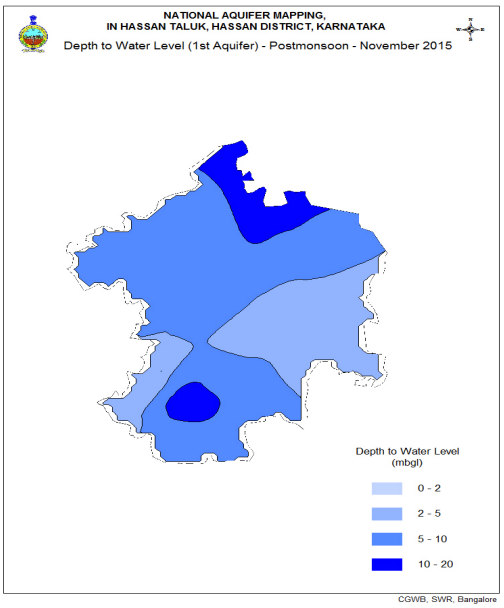

Fig-5: Post-monsoon Depth to Water Level (Aq-I)

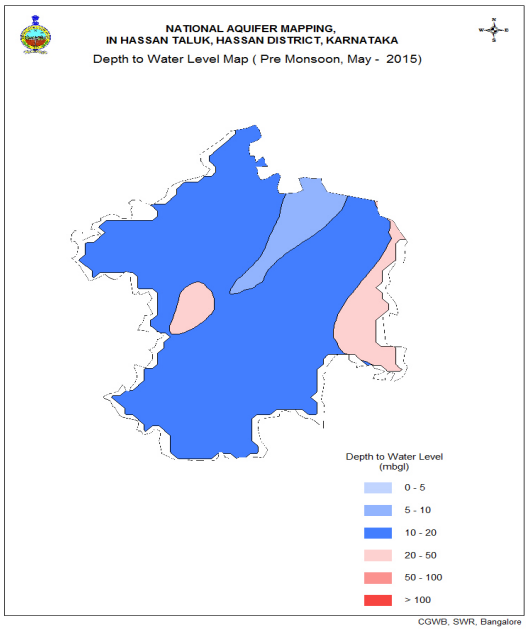

Fig-6: Pre-monsoon Depth to Water Level (Aq-II)

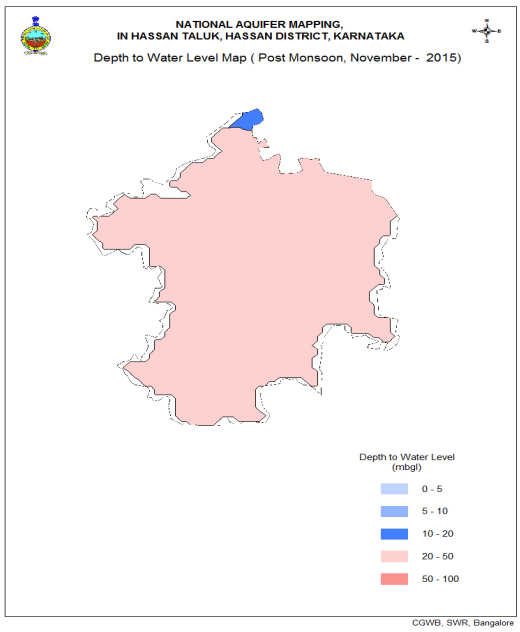

Fig-7: Post-monsoon Depth to Water Level (Aq-II)

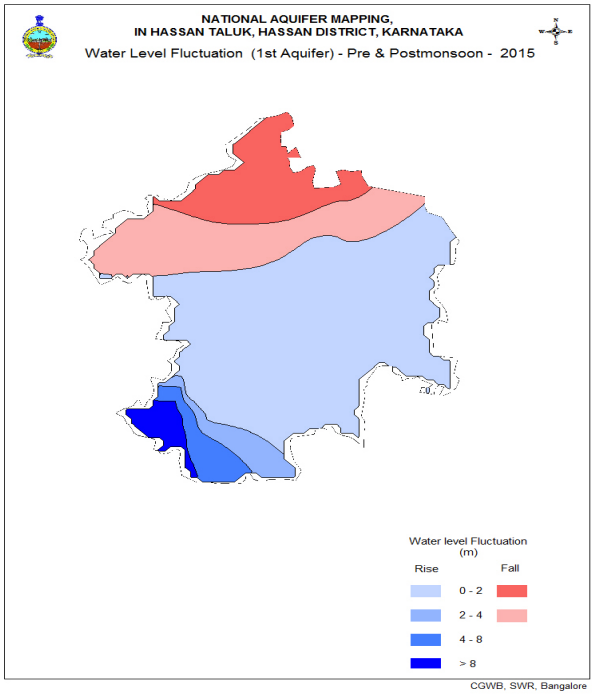

Fig-8: Water Level Fluctuation (Aq-I)

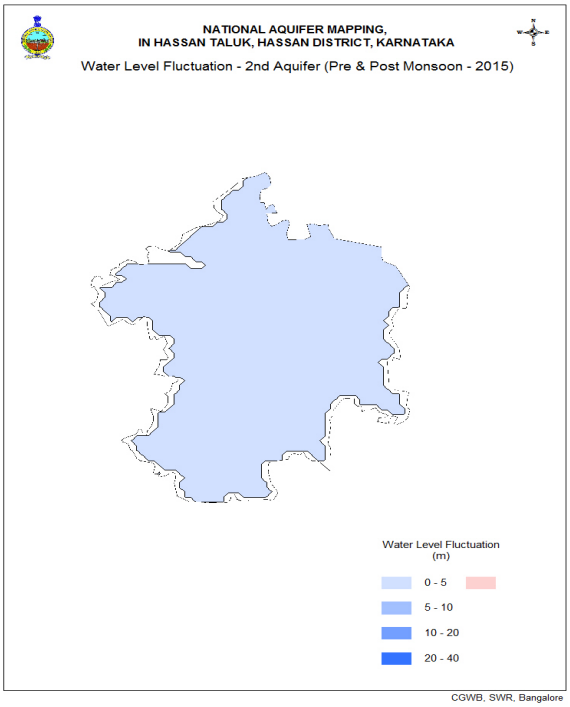

Fig-9: Water Level Fluctuation (Aq-II)

2.0 AQUIFER DISPOSITION

2.1 Number of aquifers: In Hassan Taluk, there are mainly two types of aquifer systems;

i. **Aquifer-I (Phreatic aquifer)** comprising Weathered Grainte Gneiss / Schist
ii. **Aquifer-II (Fractured aquifer)** comprising Fractured Grainte Gneiss / Schist

In Hassan Taluk, granitic-gneisses & schist are the main water bearing formations (**Figure-10**). Ground water occurs within the weathered and fractured granitic-gneisses & schist under water table condition and semi-confined condition. In the Taluk, bore wells were drilled from a minimum depth of 124 mbgl to a maximum of 200 mbgl (**Table-6**). Depth of weathered zone (Aquifer-I) ranges from 22.5 mbgl to 49.5 mbgl (**Figure-11**). Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 30 to 200 mbgl. Yield ranges from 0.08 to 16.0 lps. Transmissivity ranges from 11 to 577 m^2/day.

The basic characteristics of each aquifer are summarized in **Table-7**

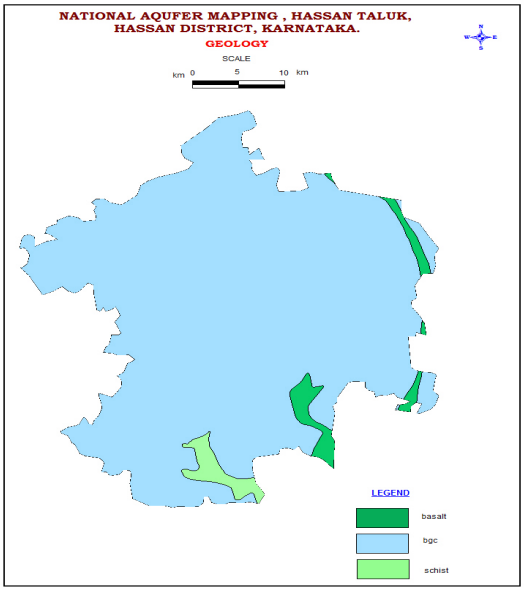

Fig-10: Geology Map

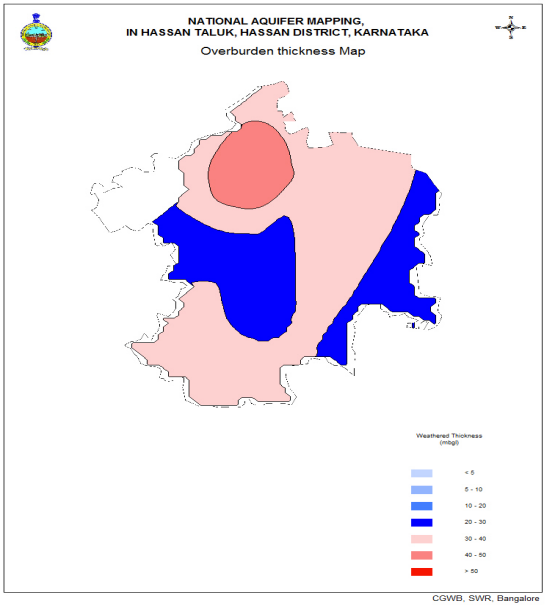

Figure-11: Weathered thickness map (Aq-I disposition)

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Table-6: Details of Ground Water Exploration

S. No	Location	Latitude	Longitude	Depth Drilled (mbgl)	Casing Depth (m)	Fracture Zones	SWL (mbgl)	Q (lps)	DD (m)	T (m2/ day)
1	Anugavalli	13°6'40''	76°11'40''	124	33.5	53 - 54, 62 - 63, 70 - 71, 85 - 86	5.96	16	2.54	262.0
2	Anugavalli OW	13°6'40''	76°11'41''	124	30	32 - 33, 68 - 69, 104 - 105, 122 - 123	7.87	13.8	2.28	154.0
3	Bailahalli	13°3'4''	75°59'20''	166	25.8	90 - 91, 114 - 115, 136 - 137, 145 - 146	14.78	2.73	15.18	29.0
4	Bailahalli OW	13°3'4''	75°59'21''	126	22.5	37 - 38, 107 - 108, 120 - 121	8.47	8.82	17.55	19.0
5	Hassan	13°0'45''	76°7'20''	162	26	27 - 28, 59 - 60, 68 - 69	10.08	13.8	1.13	577.0
6	Hassan OW	13°0'46''	76°7'21''	200	31.5	93 - 94	8.81	0.08	-	14.0
7	Sommanahalli	13°5'23''	76°7'22''	178	49.5	72 - 73, 99 - 100, 106 - 107, 125 - 126	18.91	9.9	9.14	21.1
8	Sommanahalli OW	13°5'24''	76°7'22''	200	44.76	83 - 84, 87 - 88, 100 - 101, 137 - 138, 199 - 200	19.52	3.28	7.32	44.2
9	Duddanayakana halli	12°54'45''	76°2'50''	200.2	31.5	80 - 81, 160 - 161, 199 - 200	4.4	0.21	-	11.0
10	Karakere EW	12°58'25''	76°15'35''	200		66, 158, 160	16.7			
11	Karakere OW	12°58'25''	76°15'35''	200		23, 27, 47, 120, 129, 180	15.82			

Table-7: Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Gneiss / Schist	Fractured / Jointed Gneiss / Schist
Thickness range (mbgl)	30	Fractures up to 200 mbgl
Depth range of occurrence of fractures (mbgl)	-	32 - 200 80% between 50 - 200
Range of yield potential (lps)	Poor yield	1 - 10
Specific Yield	2%	0.2%
T (m^2/day)	-	11 – 262
Quality Suitability for Irrigation	Suitable	Suitable
Suitability for Domestic purposes	Suitable	Suitable
Remarks	Safe	Ground water potential fractures, 1 to 3 sets likely up to the depth of 200 m bgl.

3.0 Ground water resource, extraction, contamination and other issues

3.1 Aquifer wise resource availability and extraction

(a) Present Dynamic Ground Water Resource (2017)

Taluk	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
	Ham	Ham	Ham	Ham	Ham	Ham	%	
Hassan	13032	5926	609	6536	698	6649	50	SAFE

(b) Present total Ground Water Resource (Ham)

Taluk	Annual replenishable GW resources (Ham)	Fresh In-storage GW resources (Ham)		Total availability of GW resource (Ham)
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
Hassan	13032	15762	1863	30657

(c) Comparison of ground water availability and draft scenario in Hassan Taluk

Taluk	GW availability (Ham)	GW draft (Ham)	Stage of GW development	GW availability (Ham)	GW draft (Ham)	Stage of GW development	GW availability (Ham)	GW draft (Ham)	Stage of GW development	GW availability (Ham)	GW draft (Ham)	Stage of GW development
	2009			2011			2013			2017		
Hassan	25035	7080	28	16808	6730	40	16372	6862	42	13032	6536	50

3.2 Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Hassan Taluk is mentioned as under:

ELECTRICAL CONDUCTIVITY: In general, EC values in Aq-I range from 330 to 1700 µ/mhos/cm at 25^{o}C which are within the permissible limit in both the aquifers. In Aquifer-II, EC value ranges from 580 to 730 µ/mhos/cm at 25^{o}C.

FLUORIDE: Fluoride concentration in ground water is of geogenic origin in areas underlain by younger granites/ gneisses containing minerals like Flurospar & fluroapatite. F value ranges between 0.23 - 1.011mg/l which are within the permissible limit of 1.5 mg/l.

NITRATE: Nitrate value ranges between 29 to 85 mg/l. Out of 11 samples, 4 samples indicate nitrate greater than the permissible limit of 45 mg/l

In general, ground water quality in Hassan Taluk is good for drinking purpose except in some areas, where nitrate & fluoride is found to be greater than the permissible limit as per “Indian Standard Drinking Water Specification 2009”. Ground water samples have also been tested and found suitable for agriculture & irrigation purposes.

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-8**). The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge.

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Table-8: Quantity of non-committed surface runoff & expected recharge through AR structures (As per Master Plan on Artificial Recharge in Karnataka & Goa, 2020)

Artificial Recharge Structures Proposed	Hassan Taluk
Non committed monsoon runoff available (MCM)	64.113
Number of Check Dams	324
Number of Percolation Tanks	58
Number of Subsurface dykes	02
Tentative total cost of the project (Rs. in lakhs)	4427.596
Expected recharge (MCM)	48.085
Additional irrigation potential (in lakh hectares)	0.058
Cost Benefit Ratio (Rupees/ cu.m. of water harvested)	9.2

4.2 Improvement in GW availability due to Recharge, Hassan Taluk

Taluk	Net annual ground water availability	Existing gross ground water draft for all uses	Existing stage of ground water development	Expected recharge from proposed Artificial Recharge structures	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		%
Hassan	13032	6536	50	4808.5	17840.5	36.64	13.36

5.0 Demand side interventions

5.1 Advanced irrigation practices

It is observed that ground water through wells & bore wells contribute only 18% of the source for irrigation in Hassan Taluk. Balance 82% irrigation is from surface water from canals & tanks. Also, water intensive crops paddy and sugarcane are grown in less than 5% of total crop area from surface water source. Present stage of ground water development is 50% (GEC 2017). Thus, efficient irrigation practices are not suggested in the Taluk.

Further, change in cropping pattern is also not recommended.

5.2 Water Logging and additional area of irrigation

Area prone for water logging (2-5 m pre-monsoon water level contour) is estimated (Table-9). In these areas, quantum of withdrawal of ground water is calculated considering specific yield of 2% and water column to be reduced to 5 mbgl. The volume of ground water withdrawn in Hassan Taluk is 756 ham (0.267 TMC). Additional area of crop can be irrigated using 75% of irrigation efficiency is calculated on the basis of recommendation of University of Agriculture Science, Bangalore. Accordingly, since maize and vegetables are grown in 73% of total crop area of Taluk, it is suggested that additional area of 1134 ha can be irrigated for Maize or Vegetables or 1890 ha for Jowar crops (Table-9).

Table-9: Withdrawal of Ground Water and Increase in area of Irrigation in Hassan Taluk

Water Level Range (mbgl)	Water Level to be reduced to (mbgl)	Water Column (m)	Area (Ha)	Specific Yield	Volume of Ground Water to be withdrawn		Area of crop can be irrigated using 75% of Irrigation Efficiency (Ha)		
					(Ham)	(TMC)	Maize	Jowar	Vegetables
0 - 2	5	4	0	0.02	0	0.000	0	0	0
2 - 5	5	3	12600	0.02	756	0.267	1134	1890	1134
Total					**756**	**0.267**	**1134**	**1890**	**1134**

5.3 Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate & fluoride concentration is found in ground water samples require remedial measures viz.
    - Dilution of nitrate rich ground water through artificial recharge & water conservation.
    - Roof top rain water harvesting.
    - Micro irrigation.