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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

HARIHAR TALUK,

DAVANAGERE DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

**AQUIFER MANAGEMENT PLAN OF HARIHAR TALUK,
DAVANAGERE DISTRICT, KARNATAKA STATE**

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AQUIFER MANAGEMENT PLAN OF HARIHAR TALUK, DAVANAGERE DISTRICT, KARNATAKA STATE

1.0 Salient information

Taluk name: **HARIHAR**

District: Davanagere; State: Karnataka

Area: 485 sq.km.

Population: 2,54,170

Normal Annual Rainfall: 636 mm

1.1 Aquifer management study area

Aquifer mapping studies were carried out in **Harihar Taluk**, Davanagere district of Karnataka, covering an area of **485 sq.kms** under **National Aquifer Mapping**. Harihar Taluk of Davanagere district is located between north latitude $14^{\circ} 17' 38''$ and $14^{\circ} 38' 13''$ & east longitude $75^{\circ} 37' 26''$ and $75^{\circ} 54' 43''$, and is covered in parts of Survey of India Toposheet Nos. 48N/11, 48N/14 & 48N/15. Taluk is bounded by Harapahalli Taluk in north, Honnali Taluk in south, Davanagere Taluk in east and Ranibennur Taluk of Haveri district on the western side. Location map of Harihar Taluk of Davanagere district is presented in **Fig. 1**.

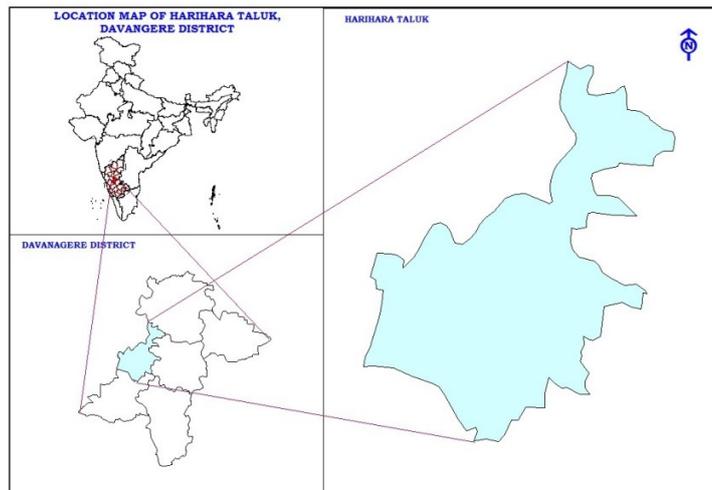


Fig. 1: Location Map of Harihar Taluk, Davanagere district

Harihar city is the Taluk headquarter of Harihar Taluk. There are 79 inhabited and 8 uninhabited villages in Harihar Taluk. Harihara is situated 275 km north of Bangalore. Harihar and Davangere (14 km away) are referred as "twin cities".

Harihar is connected by road and railway, and is located on National Highway 4 (Puna – Bangalore).

1.2 Population

According to 2011 census, the population in Harihar Taluk is 2,54,170. Out of the total population, 1,63,668 constitute the rural population and 90502 is the urban population, which works out to 64 % (rural) and 36 % (urban) of the total population of Taluk. Decadal change in population from 1991-2001 is 3.47% in Harihar Taluk. Decadal change in rural and urban population is 3.65% and 3.14% respectively.

1.3 Rainfall

Harihar Taluk has semi-arid climate. Dry and hot weather prevails in major part of the year. The area falls under Central Dry Agro-climatic Zone of Karnataka state and is categorized as drought prone. Rainy season lasts from June to September due to onset of south-west monsoon.

There is one rain gauge station in Harihar Taluk, the rainfall data in respect of this station from the year 1981 to 2010 is analyzed and presented in **Table 1**. Normal annual rainfall in Harihar Taluk for the period 1981 to 2010 is 636 mm.

Table 1: Statistical Analysis of Rainfall Data of Harihar Taluk, for the Period 1981 to 2010

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
HARIHAR	NRM	1	1	11	28	60	101	75	95	88	110	368	115	45	6	167	636
	STDEV	2	4	23	29	47	61	43	66	38	56	115	82	87	16	111	192
	CV%	324	345	220	103	78	61	57	70	43	51	31	71	192	268	67	30

Seasonal rainfall pattern indicates that, major amount of rainfall(368 mm) was recorded during South - West Monsoon seasons, which contributes to 58% of the annual normal rainfall, followed by North - East Monsoon season (167mm) constituting 26% and remaining (101 mm) 16% in Pre - Monsoon season.

Rainfall data of Harihar Taluk has been analyzed for 104 years using IMD method to assess the drought condition. The results of classification are listed in the **Table 2**. It is observed that Harihar Taluk has experienced alternating no drought to severe drought conditions over the years.

% 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	Harihar	47	37	19	1	Once in 5 years

On the basis of details of drought assessment, “**Severe Drought**” condition was experienced in 1 year, during 1908 in Harihar Taluk. Also based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought has been studied and it has been observed that the frequency of occurrence of drought is **once in 5 years** at Harihar Taluk.

1.4 Agriculture & Irrigation

Agriculture is the main occupation in Harihar Taluk, since 64% of the total population constitutes the rural population. The amount of rainfall and its distribution throughout the season contributes to the cropping pattern in the area. There are two agricultural seasons namely Kharif (June – October) and Rabi season (Mid October – Mid February). Major Kharif crops are paddy, maize, ragi, jowar, and vegetables. Main crops of Rabi

season are pulses, and oilseeds. Sugarcane, fruits and cotton are other crops grown in the area.

Table 3: Area wise crops grown in Harihar Taluk (Ha)

Year	Paddy	Jowar	Maize	Ragi	Pulses	Sugarcane	Oil seeds	Total fruits	Total vegetables	Cotton
2014 - 15	44005	587	6127	5	143	1385	218	215	343	96

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

Table 4: Land use pattern of Harihar Taluk

Item Taluk	Year	Total Geographical Area (ha)	Area under Forest (ha)	Area not available for cultivation (ha)	Fallow land (ha)	Net sown area (ha)	Area sown more than once (ha)
Harihar	2014-15	49866	2060	5312	3513	37414	19504

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

During the year 2014 - 15 percentage of gross cropped area of total geographical area was 39 % and net cropped area was 75% in Harihar Taluk.

Table 5: Irrigation practice in Harihar Taluk

Source of irrigation	No. of irrigation source	Net area irrigated (ha)	Gross area irrigated (ha)
Canals	19	20321	37288
Tanks	3	0	0
Wells	413	0	0
Bore wells	3178	4460	5174
Lift Irrigation	510	7141	8584
Other Sources	Nil	0	0
Total	4,123	31922	51046

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

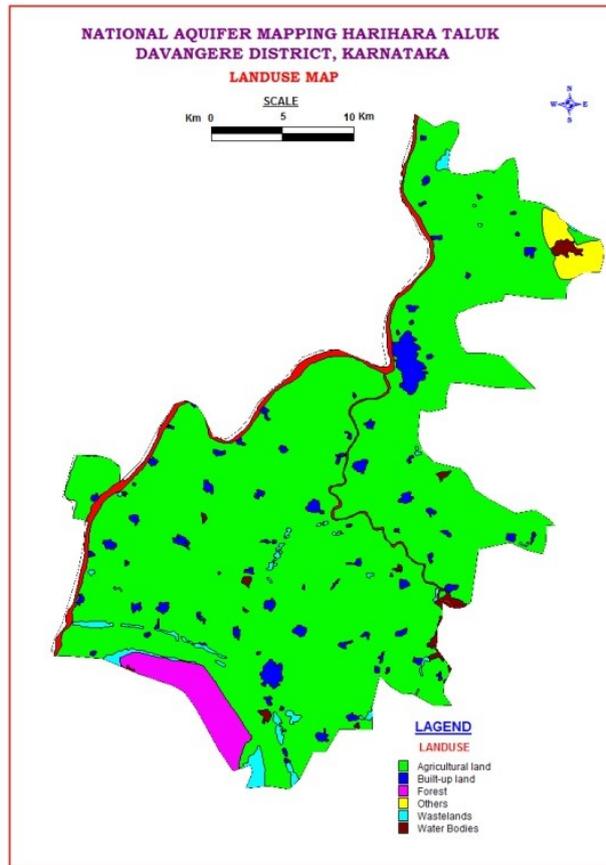


Fig. 2: Land use map

1.5 Geomorphology, Physiography & Drainage

Geomorphology of Harihar Taluk is characterized by vast stretches of undulating plains transforming into low range rocky hills towards north & north eastern part, constituting the adjoining Harpanahalli Taluk and also towards south, south west part of the Taluk (**Fig. 3**).

Davanagere district lies in Krishna river basin and Harihara Taluk is situated on the banks of Tungabhadra River. The major lifeline of this Taluk is Tungabhadra River, **Fig. 4**.

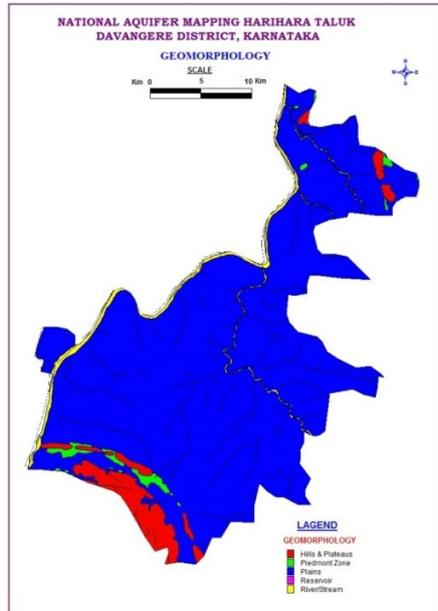


Fig. 3: Geomorphology map

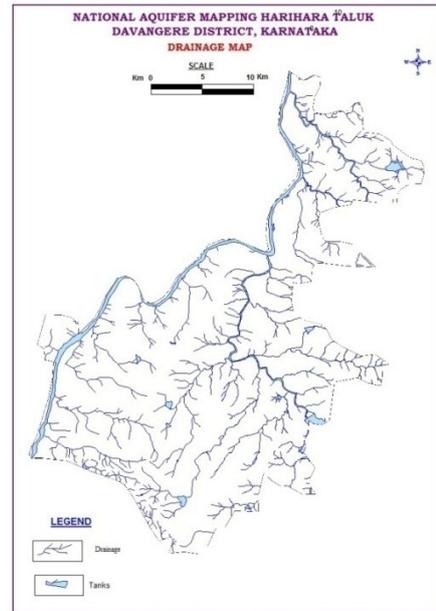


Fig. 4: Drainage map

1.6 Soil

Major part of Taluk is covered by clayey mixed soil, followed by black soil and small patches of clayey soil in western, eastern and north eastern part of the Taluk, **Fig. 5.**

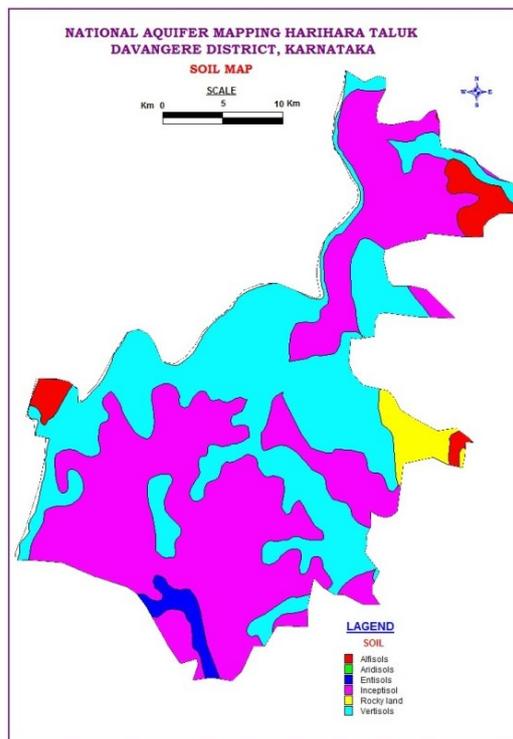


Fig. 5: Soil map

1.7 Ground water resource availability and extraction

(Aquifer wise up to 200 m depth)

**Table 6: Total Ground water Resource available in Aq-I & Aq-II
(March 2017)**

Taluk	Annual replenishable GE resources(in Ham)	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic (in Ham)	Fractured (Down to 200m) (in Ham)	Dynamic + phreatic in-storage + fractured (in Ham)
Harihar	9576	13764	2025	25365

1.8 Existing and future water demands based on ground water resource estimation of March 2017

- Existing demand for ground water (considering all uses) in the Taluk is 6302 Ham. Allocation for future domestic & industrial use is 470 Ham and that for future irrigation development schemes is 3596 Ham. Hence, total allocation for all uses is 4066 Ham.
- Existing stage of ground water development in the Taluk is 66% and categorized as SAFE. Hence, there is ample scope for irrigation from ground water. Prevalent irrigation practice in Harihar Taluk, also indicates that maximum source for irrigation is constituted by bore wells.
- Dependence on ground water for irrigation is recommended, provided measures are taken for sustained recharge of ground water.

1.9 Water level behavior

(a) Depth to water level

Aquifer - I

- Pre-monsoon: 1.05 to 6.15 mbgl (Fig 6)
- Post-monsoon: 0.48 to 5.97 mbgl (Fig 7)

Aquifer - II

- Pre-monsoon: 4.7 to 8.3 mbgl (Fig 8)
- Post-monsoon: 2.38 to 7.17 mbgl (Fig 9)

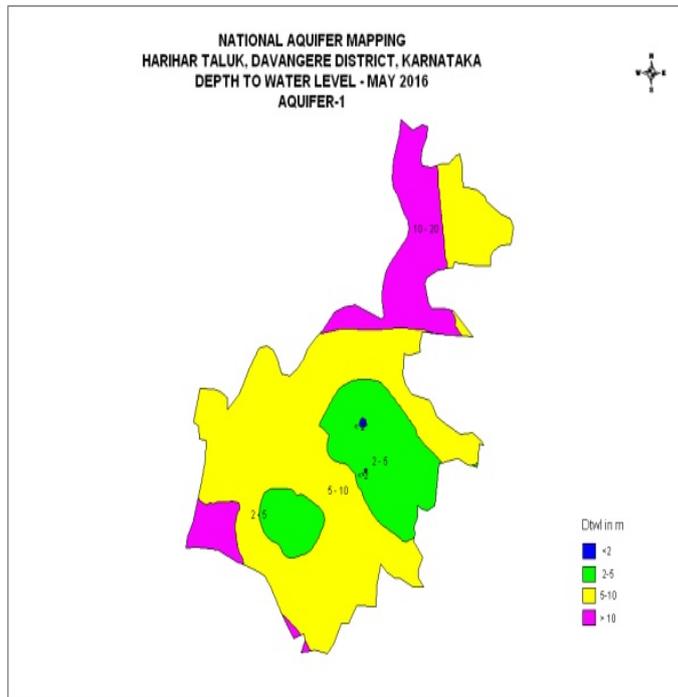


Fig 6: DTW Pre-monsoon (May2016), Aq-I

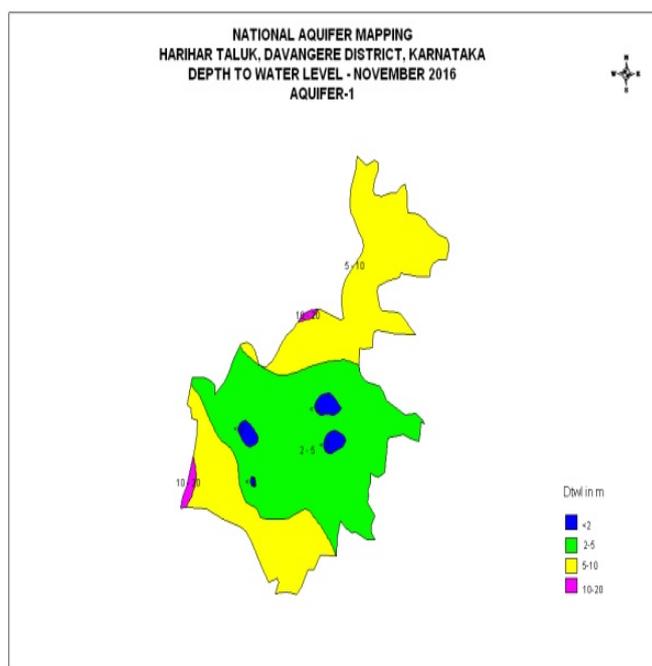


Fig 7: DTW Post-monsoon(Nov,2016), Aq-I

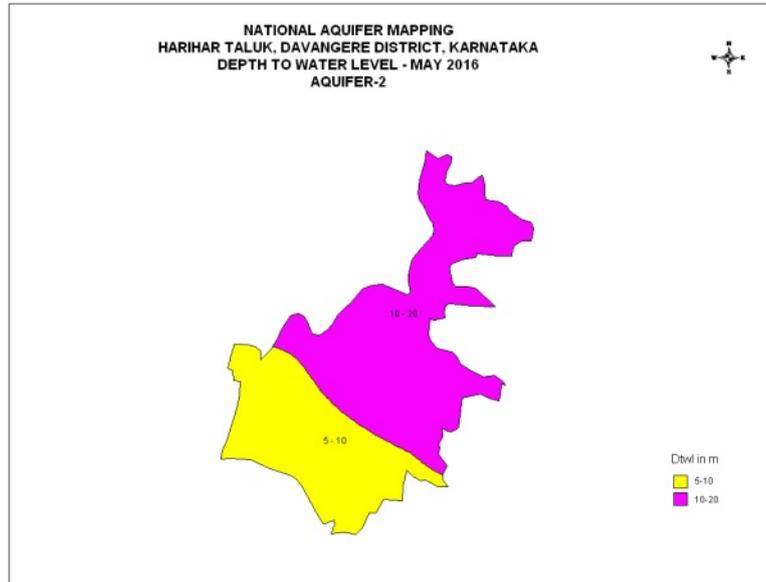


Fig 8: DTW Pre-monsoon (May,2016), Aq-II

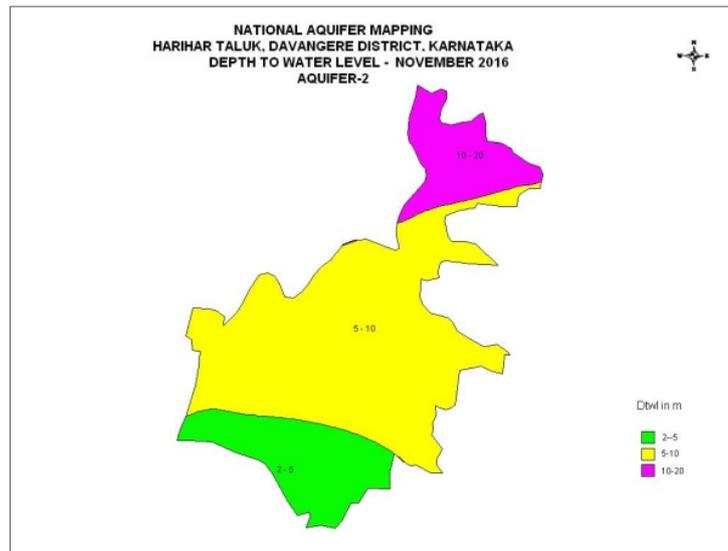


Fig 9: DTW Post-monsoon(Nov,2016), Aq-II

(b) Seasonal water level fluctuation

Seasonal Fluctuation:

Aquifer – I(Fig 10)

- Fall 0.24 mbgl
- Rise ranges between 0.18 to 1.75 mbgl

Aquifer – II(Fig 11)

- No fall in depth to water level observed.
- Rise ranges between 1.13 to 2.32 mbgl

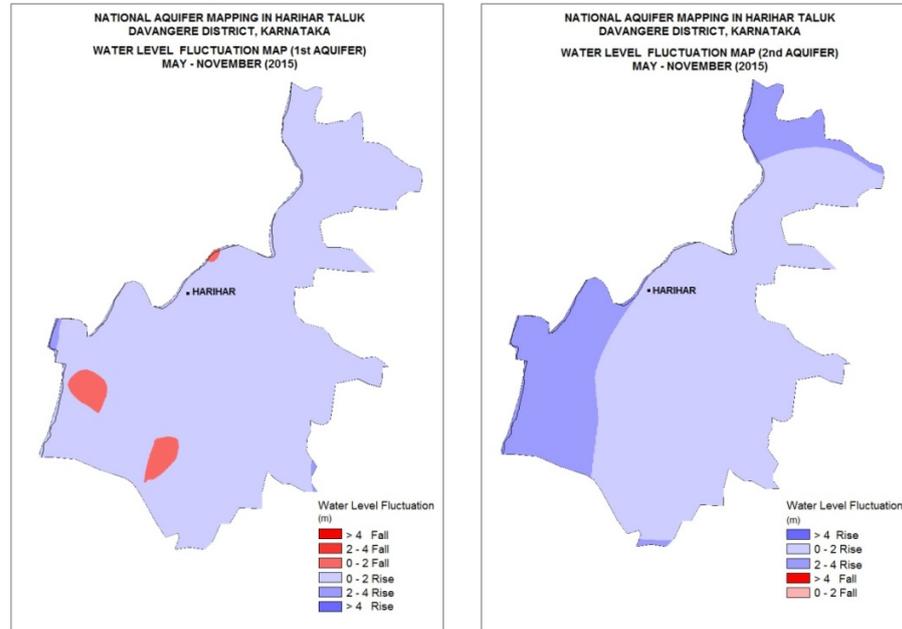


Fig 10: Water level fluctuation (Aq-I) Fig 11: Water level fluctuation (Aq-II)

2.0 Aquifer disposition

In Harihar Taluk, schists are the main water bearing formation occupying nearly the entire Taluk, followed by basalt occurring towards south & south western part, and small area towards north eastern & eastern part where Banded Gneissic Complex formation occurs. Groundwater occurs within the weathered and fractured rocks.

Ground water exploration programme of CGWB reveals that aquifer systems are encountered from a depth of 21 mbgl to 51 mbgl. Bore wells have been drilled from a minimum depth of 86.55 mbgl to a maximum of 200 mbgl. Depth of weathered zone in the Taluk ranges from 23 mbgl to 25 mbgl. Fracture zones are likely to be encountered between depths 30 – 50, 50 – 100, 100 – 200 and > 200 mbgl. Yield ranges from 0.07 to 3.28 lps and Transmissivity from 1.0 to 8.0 m²/day.

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

- i. **Aquifer-I (Phreatic aquifer; weathered zone)** comprising of Schist, which is the dominant water bearing formation in Harihar Taluk.
- ii. **Aquifer-II, (Fractured multi-aquifer system)** comprising of Fractured Schist.

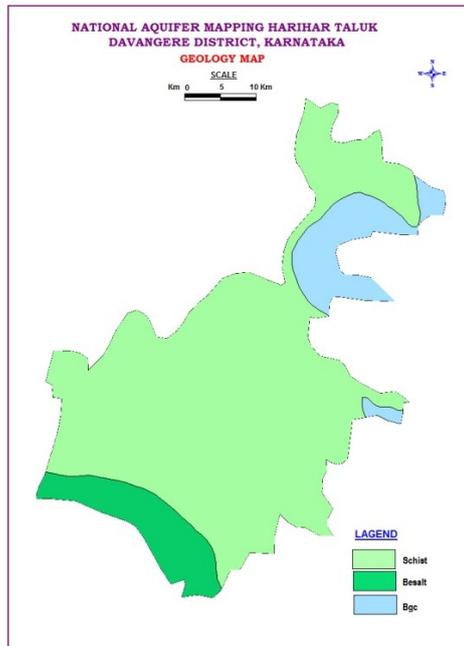


Fig 12: Geology map

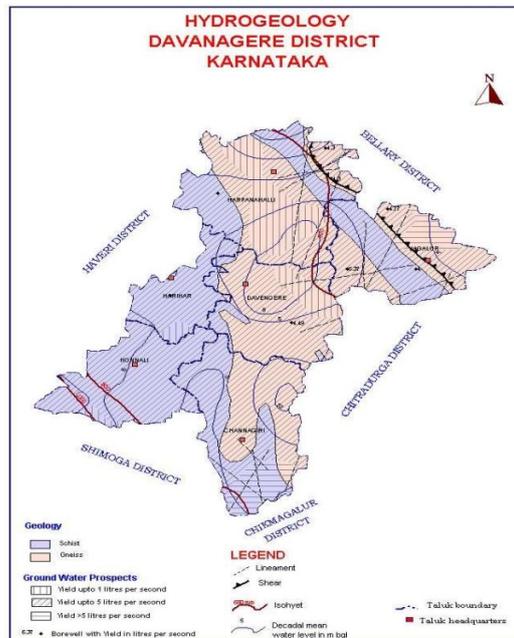


Fig 13: Hydrogeology Map

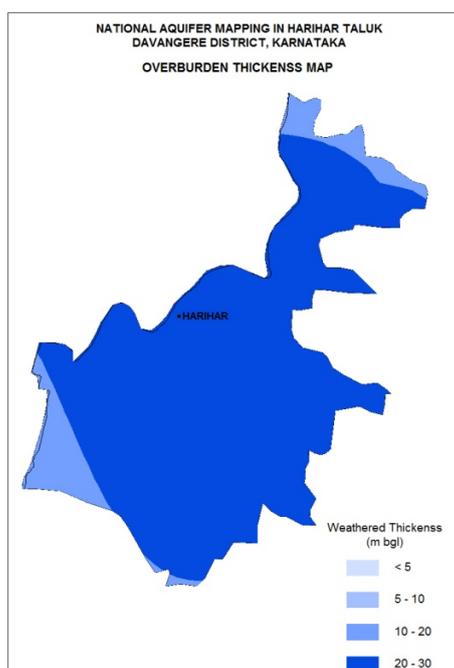


Fig 14: Overburden thickness map

3.0 Ground water resource, extraction, contamination and other issues

3.1 Aquifer wise resource availability and extraction

Table 7: Present Dynamic Ground Water Resource
(as on March 2017)

Taluk	Net annual GW availability (in Ham)	Total draft for all uses (in Ham)	Stage of GW development (%)	Category
Harihar	9576	6302	66	SAFE

Table 8: Present total Ground Water Resource
(Dynamic+phreatic-in-storage+fractured-in-storage)

Taluk	Annual replenishable GW resources (in Ham)	Fresh In-storage GW resources (in Ham)		Total availability of GW resource (in Ham)
		Phreatic Aq-I	Fractured Aq-II	Dynamic + phreatic in-storage + fractured in-storage
Harihar	9576	13764	2025	25365

Table 9: Present ground water availability and draft scenario (2017) in Harihar Taluk of Davanagere district and expected improvement in Stage of Ground Water Development in future on implementation of artificial recharge & irrigation development schemes.

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	ADDITIONAL POTENTIAL FROM PROPOSED IRRIGATION DEVELOPMENT SCHEMES THROUGH INTERBASIN TRANSFER	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	%	%
Harihar	9576	6302	66	0	5886	15462	40.75	25.25

Table 10: Comparison of ground water availability and draft (in HAM) scenario in Harihar Taluk (2009 to 2017)

Taluk	2009			2011			2013			2017		
	GW Availability	GW Draft	Stage of GW withdrawal	GW Availability	GW Draft	Stage of GW withdrawal	GW Availability	GW Draft	Stage of GW withdrawal	GW Availability	GW Draft	Stage of GW withdrawal
Harihar	5354	3684	69%	5388	3889	72%	5318	3909	74%	9576	6302	66%

3.2 Chemical quality of ground water and contamination

Representative water samples have been collected from National Hydrograph Stations (NHS) during pre-monsoon and analyzed at Chemical Laboratory, C.G.W.B, S.W.R, Bangalore. Interpretation from Chemical Analysis result is mentioned as under:

ELECTRICAL CONDUCTIVITY:(a) Aquifer – I: 11 samples were collected from NHS dug wells representing Aq – I in Harihar Taluk and chemical analysis result indicate ground water from Aq - I has EC value within the permissible limit. EC ranges between 560 to 1530 m/mhos/cm at 25°C, Fig.15.Thus, EC ranges between permissible range in ground water in Aq-I.

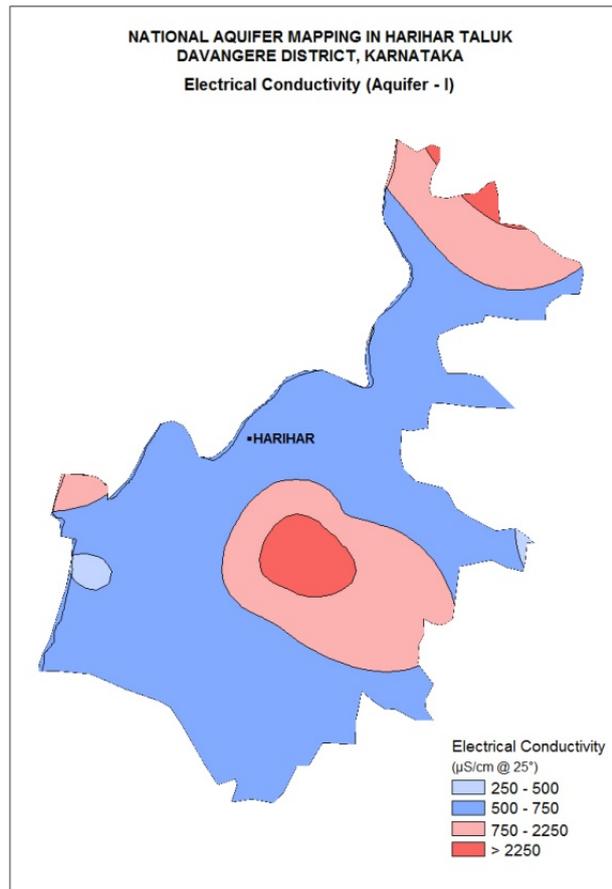


Fig. 15: Electrical Conductivity map (Aq-I)

FLUORIDE: Fluoride concentration in ground water is of geogenic origin in areas underlain by younger granites/ gneisses containing minerals like fluorspar & fluoroapatite. Out of 11 samples collected from NHS dug wells representing Aq – I, 7 samples indicate fluoride greater than permissible limit of 1.5 mg/l, **Fig. 16** illustrates fluoride concentration and its spatial occurrence in water samples of Aq- I. Ground water in central, western

and south western part of the Taluk has areas where fluoride is greater than permissible limit. F ranges between 1 to 2.5 mg/l. However, fluoride contamination has sporadic occurrence and is not extensively prevalent.

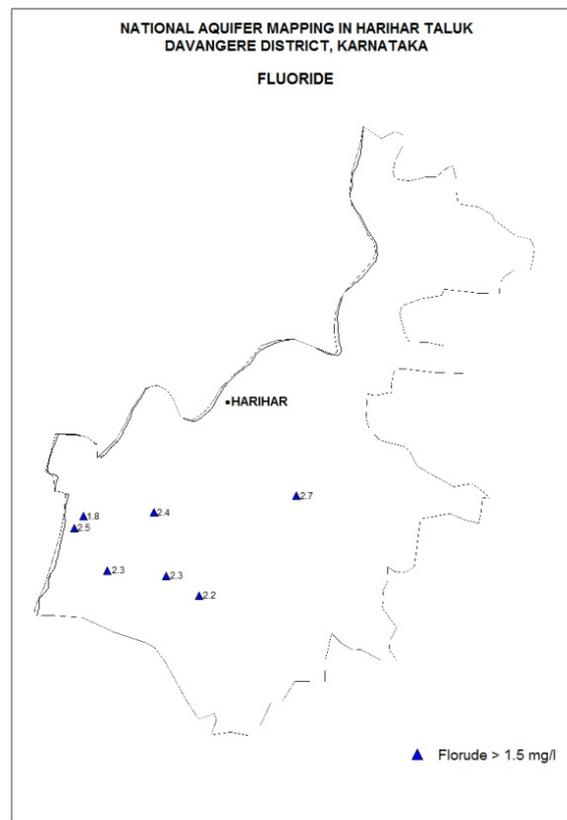


Fig. 16: Fluoride map (Aq-I)

NITRATE: Aquifer – I : Out of 11 samples collected from NHS dug wells representing Aq – I, no sample indicate nitrate concentration greater than the permissible limit of 45 mg/l, which indicates use of fertilizers in agriculture has not exceeded in order to contaminate ground water in Aq-I. Nitrate ranges between 12 to 25 mg/l.

In general ground water quality in Harihar Taluk is good for drinking purpose except in some areas as depicted in above illustrated maps, where fluoride is found to be greater than permissible limit. Ground water samples have been found suitable for agriculture & irrigation purposes.

4.0 Ground water resource enhancement

As per Master Plan on Artificial Recharge in Karnataka and Goa,2020, the area feasible for artificial recharge is 70sq.km, already 06 Check dams, 02 percolation tanks and 24 point recharge structures have been completed by various agencies, hence new recharge structures have not been proposed.

4.0 Demand side interventions

Advanced irrigation practices

Bore well is the prevalent source for irrigation in the Taluk. Thus, by adopting below mentioned techniques will contribute in ground water resource enhancement in the long run.

- Efficient irrigation techniques will contribute in saving ground water and thus will reduce the irrigation draft.
- Existing stage of ground water development in the Taluk is 66% and categorized as SAFE. Prevalent irrigation practice in Harihar Taluk, also indicates that maximum source for irrigation is constituted by bore wells.
- Dependence on ground water for irrigation is recommended, provided measures are taken for sustained recharge of ground water through construction of ground water recharge structures as recommended.

4.3 Change in cropping pattern

The change in cropping pattern is not necessary since cultivation of water intensive crops is not widely prevalent in the Taluk, although area under paddy cultivation is considerable. This practice may be replaced owing to consistent increase in stage of ground water development in the Taluk.

4.4 Alternate water sources

- **Proposed GW Recharge and Assured Supply of Drinking Water Schemes (Inter basin Transfer):** Inter-basin transfer from Tunga Basin under Project-2 service canal is proposed in the “Integrated Irrigation Development Schemes” by Shri.G.S.Paramashivaiah, Retd. CE, Irrigation Department and submitted to the Govt. of Karnataka. Under this project, it is proposed to fill Minor Irrigation tanks with 79 TMC of water to 19 Taluks of Bellary, Davanagere, Tumkur and Kolar districts. 50% recharge is considered from the surface water proposed to fill the tanks for irrigation, which includes recharge from tanks, canal seepage and return flow from irrigation. For Harihar Taluk, it is calculated that about 5886 Ham can be considered as recharge from above project, if commenced.

After implementation of proposal of GW recharge scheme (inter-basin transfer), the annual ground water availability will increase from 9576 to 15462 Ham, and the expected improvement in stage of development is 25.25% from 66% to 40.75%.

4.5 Regulation and Control

- Harihar Taluk is categorized as **SAFE**, since the stage of ground water development has reached **66%** (GEC March 2017). There is ample scope for irrigation from ground water. Prevalent irrigation practice in Harihar Taluk, also indicates that maximum source for irrigation is constituted by bore wells.
- Dependence on ground water for irrigation is recommended, provided measures are taken for sustained recharge of ground water.
- Efficient irrigation techniques will contribute in saving ground water and thus will reduce the irrigation draft.

- Ground water recharge component needs to be made mandatory in State Govt. Project, concerned with further development of ground water, viz; Irrigation Projects or Public Water Supply Projects.

4.6 Other interventions proposed:

- **Phreatic aquifer (Aq-I):** Pre monsoon depth to water level in Harihar Taluk, ranges between 1.05 – 6.15 mbgl; and post monsoon 0.48 – 5.97 mbgl.
Aq-II:Pre monsoon depth to water level in Harihar Taluk, ranges between 4.7 –8.3 mbgl; and post monsoon 2.38 – 7.17 mbgl. This indicates that water levels are considerably shallow and can be replenished through construction of artificial recharge structures. 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.
- Periodical maintenance of artificial recharge structures should be incorporated in the Recharge Plan.