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Government of India

# AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

## SHORAPUR TALUK,

## YADGIR DISTRICT, KARNATAKA

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru

# AQUIFER MANAGEMENT PLAN OF SHAHPUR TALUK,YADGIR DISTRICT, KARNATAKA STATE

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# AQUIFER MANAGEMENT PLAN OF SHORAPUR TALUK, YADGIR DISTRICT, KARNATAKA STATE

## 1.SALIENT INFORMATION

Taluk name: SHORAPUR
District: Yadgir; State: Karnataka
Area: 1841 sq.km.
Population: 4,12,291
Normal Annual Rainfall: 642 mm (1981 to 2010)

### 1.1 Aquifer management study area

Aquifer mapping studies was carried out in SHORAPUR taluk, Yadgir district of Karnataka, covering an area of 1841 sq.kms under National Aquifer Mapping. Shorapur taluk of Yadgir district is located between north latitude $16^0$ 11' 27" and $16^0$ 45' 56" & east longitude $76^0$ 17'38" and $76^0$ 52'57", and is covered in parts of Survey of India Toposheet Nos. 48N/11, 48N/14 & 48N/15. Taluk is bounded by Jevargi taluk of Gulbarga district in north, Lingsugur & Deodrug taluks of Raichur district in south, Shapur taluk in east and Muddebihl & Sindgi taluks of Bijapur district on the western side. Location map of Shorapur taluk of Davanagere district is presented in **Fig. 1.**

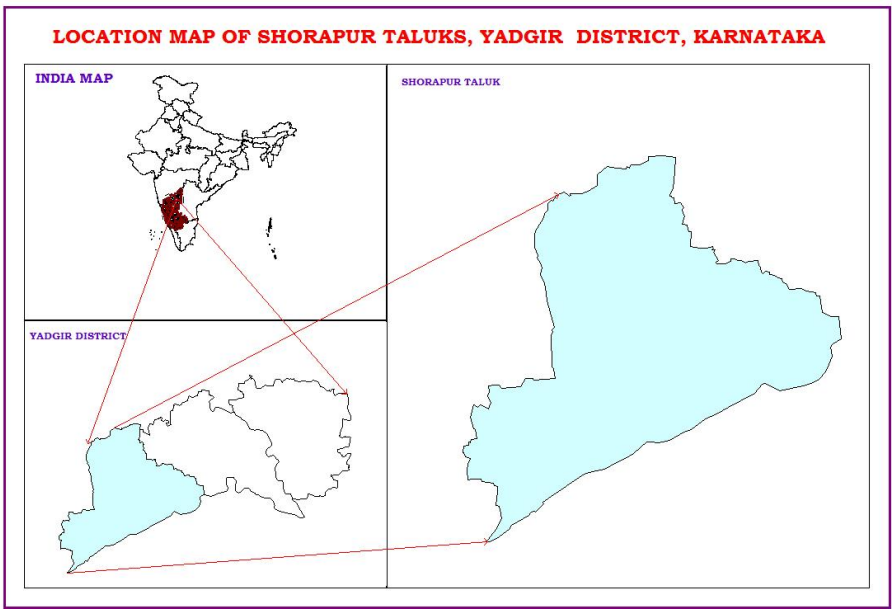


Fig. 1: Location Map of Shorapur taluk, Yadgir district

Shorapur town is the taluk headquarter of Shorapur Taluk. There are 193 villages in Shorapur taluk. Shorapur is situated 508 km north of Bangalore. Shorapur is connected by road and railway.

### 1.2 Population

According to 2011 census, population in Shorapur taluk is 4,12,291. Out of the total population, 3,60,893 constitute rural, and 51,398 urban population, which is 88 % (rural) and 12 % (urban) of the total population of taluk. Percent Decadal change in total

population from 2001 - 2011 is 22 % in Shorapur taluk. Similarly, Percent Decadal change in rural & urban population is 23 % and 18 % respectively.

### 1.3 Rainfall

Shorapur 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 study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post-monsoon season covering the months of October and November and dry or winter Season from December to February.

There is one rain gauge station located in Shorapur taluk (**Table 1**). The data in respect of this station from the year 1981 to 2010 is analyzed and presented in **Table 2**. The data pertaining to this gauge is of long term nature, and are representative of the taluk. Normal annual rainfall in Shorapur taluk for the period 1981 to 2010 is 642 mm.

**Table 1: Location of Rain gauge in Shorapur taluk**

| Station | Latitude | Longitude | Altitude |
|---|---|---|---|
| **Shorapur** | 16.53 | 76.77 | 757.3 |

Computations carried out for 30 year block of 1981- 2010 on Mean, Standard deviation and Coefficient of variation, of each month, pre monsoon, monsoon, post monsoon and annual, as shown in **Table 2.**

Mean monthly rainfall at Shorapur taluk ranges between 1mm during February, to 152 mm during September. Coefficient of variation percent for premonsoon, monsoon and post monsoon season is 76, 46 & 66 % respectively. Annual Coefficient of variation percent is 33 %.

**Table 2: Statistical Analysis of Rainfall Data, Shorapur Taluk, Yadgir District, Karnataka (1981 to 2010)**

| STATION | | JAN | FEB | MAR | APR | MAY | PRE MONSOON | JUN | JUL | AUG | SEP | SOUTH WEST MONSOON | OCT | NOV | DEC | NORTH EAST MONSOON | ANNUAL RAINFALL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHORAPUR TALUK | Normal Rainfall (mm) | 5 | 1 | 6 | 18 | 40 | 70 | 77 | 95 | 114 | 152 | 438 | 108 | 21 | 5 | 134 | 642 |
| | STDEV | 12 | 2 | 22 | 22 | 48 | 53 | 55 | 63 | 77 | 111 | 200 | 88 | 31 | 12 | 89 | 214 |
| | CV% | 222 | 277 | 348 | 121 | 120 | 76 | 71 | 67 | 67 | 73 | 46 | 81 | 147 | 231 | 66 | 33 |

### Assessment of Drought

Rainfall data of Shorapur taluk has been analyzed for 46 years using IMD method to assess the drought condition. Results of classification are listed in **Table 3.** It is observed that Shorapur taluk has experienced alternating no drought, to severe drought conditions over the years.

| Table 3: Classification of drought and its periodicity (IMD, 1971) | | | | | | | |
|---|---|---|---|---|---|---|---|
| % Deviation (Di) | | >0 | 0 to -25 | -25 to -50 | 50 to -75 | <-75 | Probability of drought occurrences |
| Category | | No drought | Mild (Normal) | Moderate | Severe | Acute | |
| | | Years | | | | | |
| Taluk | Shorapur | 10 | 22 | 12 | 2 | 0 | **Once in 3 years** |

**Drought assessment:** Out of 46 years of analysis in Shorapur taluk, "No Drought" condition is experienced in 10years, "Mild Drought" condition is experienced in 22 years and "Moderate Drought" condition in 12 years. Further it is observed that "Severe Drought" condition is experienced in 2 years, i.e. during 1972 and 2011. 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 3 years** in Shorapur taluk.

### 1.4 Agriculture & Irrigation

Agriculture is the main occupation in Shorapur taluk, since 88% 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, jowar, and vegetables. Main crops of Rabi season are pulses, and oilseeds, which together constitute 44740 ha of cropped area (**Table 3)**. Among pulses, Tur and Bengal Gram constitute the cropped area of 13394 ha and 12443 ha respectively, which indicate dominance in pulse production in the taluk. Sugarcane, fruits and cotton are other crops grown in the area.

**Table 3: Area wise crops grown in Shorapur taluk**

| Year | Paddy | Jowar | Maize | Ragi | Pulses | Sugarcane | Oil seeds | Total fruits | Total vegetables | Cotton |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area under cultivation (in ha) | | | | | | | |
| 2014 - 15 | 44300 | 10018 | 132 | - | 26048 | 643 | 18692 | 932 | 381 | 27005 |

During the year 2014 – 15, percentage of gross cropped area of total geographical area was 76 % and net cropped area was 57% in Shorapur taluk (**Table 4)** and irrigation details are given in **Table 5**.

**Table 4: Land use pattern of Shorapur taluk**

| 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) |
|---|---|---|---|---|---|---|---|
| Shorapur | 2014-15 | 185523 | 4897 | 25036 | 42435 | 106210 | 35622 |

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

**Table 5: Irrigation practice in Shorapur taluk**

| Source of irrigation | No. / length of irrigation source | Net area irrigated (ha) | Gross area irrigated (ha) |
|---|---|---|---|
| Canals | 98 km length | 71253 | 77754 |
| Tanks | 26 | 470 | 470 |
| Wells | 1147 | 712 | 813 |
| Bore wells | 188 | 1513 | 1700 |
| Lift Irrigation | 1047 | 513 | 737 |
| Other Sources | - | 2711 | 2839 |
| | **Total** | **77172** | **84313** |

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

Inference: Almost entire area of Shorapur taluk falls in Command Area, hence, 77754 ha gross area is irrigated by canal system. Area covered by paddy cultivation is also the maximum among all other crops, this indicates abundance of irrigation water in the taluk.

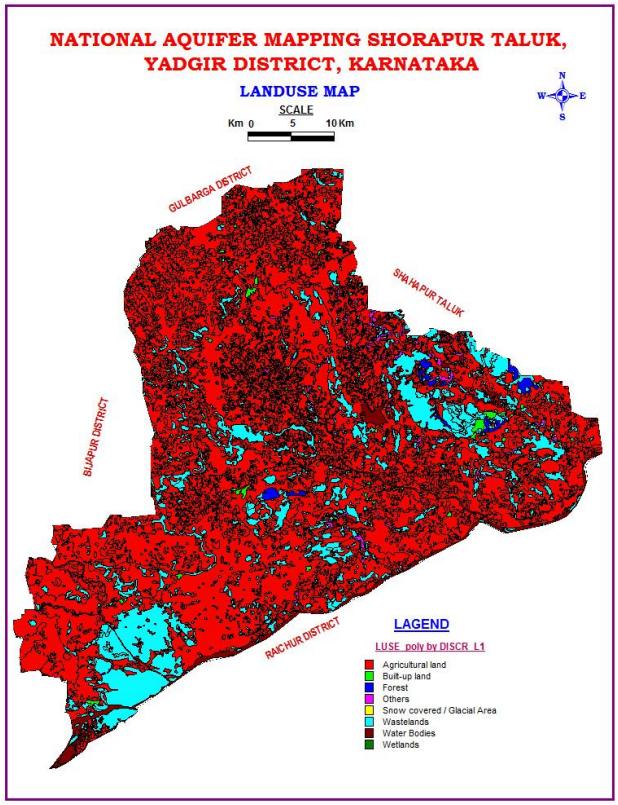


**Fig. 2: Land use map**

## 1.5 Geomorphology, Physiography & Drainage

Geomorphology of Shorapur taluk is characterized by vast stretch of plains towards the north, east, south east, south and south west. The undulating plains transform into plateau and low range rocky hills towards southwest, west and north west. Intermittent piedmont zone occur throughout the taluk area, **Fig. 3**.

Shorapur taluk lies in Krishna River basin. Krishna River flows through the entire southern boundary of the taluk. Apart from it, Devarnala flows from the central part of the taluk and joins Krishna River in the south. Don River flows across the south western part of the taluk and joins Krishna River towards the south. Minor rivers like Hirehalla river flows from south west tip and join Don River. Chinamgeri Nadi also flows through a small

area towards the north of the taluk. The major lifeline of Shorapur taluk is Krishna River, **Fig. 4**.

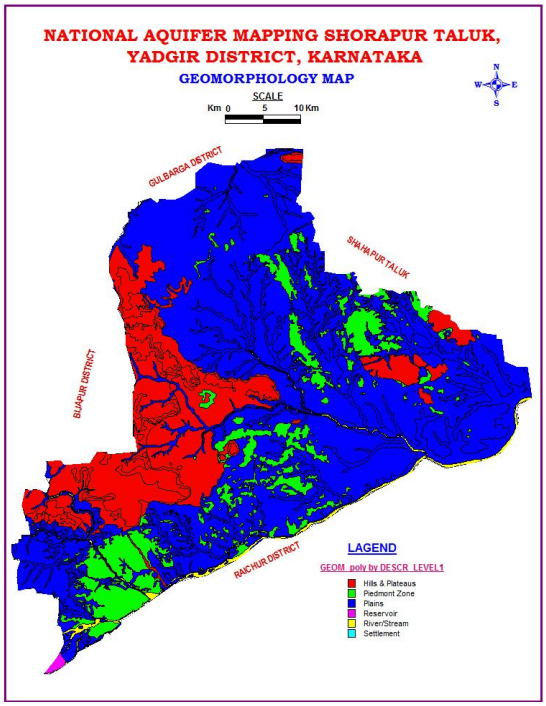


**Fig. 3: Geomorphology map**

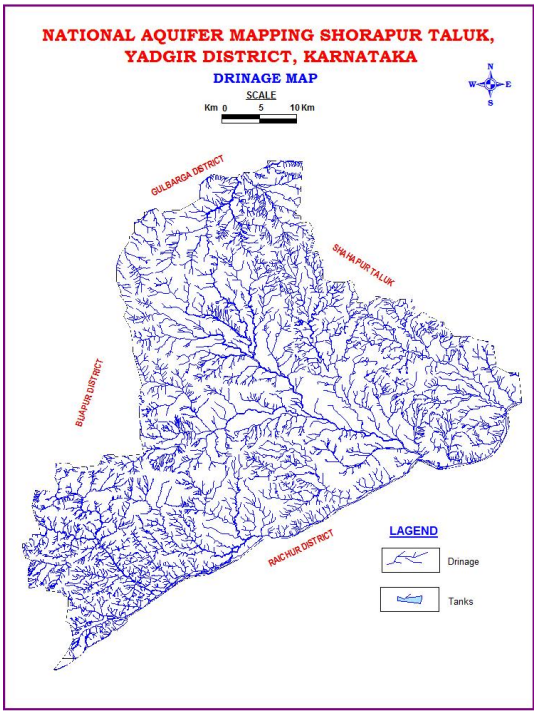


**Fig. 4: Drainage map**

## 1.6 Soil

Major part of taluk is covered by clayey soil, followed by clayey skeletal soil and small patches of loamy soil in southern and northern tip of the taluk, **Fig. 5**.

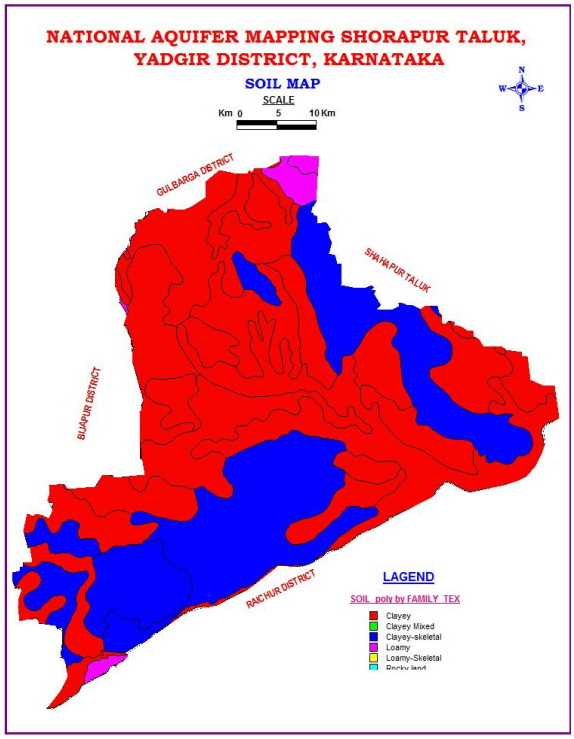


**Fig. 5: Soil map**

## 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 2013)**

| Taluk | Annual replenishable GE resources (in ham) | Fresh In-storage GW resources | | Total availability of fresh GW resources |
|---|---|---|---|---|
| Shorapur | 11987.96 | Phreatic (in ham) | Fractured (Down to 200m) (in ham) | Dynamic + phreatic in-storage + fractured (in ham) |
| | | 4650 | 3596 | 20144 |

## 1.8 Existing and future water demands based on ground water resource estimation of March 2013

- Existing demand for ground water (considering all uses) in the taluk is 3270.3 ham. Allocation for future domestic & industrial use is 1756.90 ham and that for future irrigation development schemes is 7616.94 ham.
- Existing stage of ground water development in the taluk is 27% and categorized as SAFE.
- 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: 2.78 – 12.57 mbgl **Fig. 6**.
- Post-monsoon: 0.65 – 12.23 mbgl **Fig.7**.

**Aquifer - II**

- Pre-monsoon: 6.63 mbgl **Fig.8**.
- Post-monsoon: 1.55 mbgl **Fig.9**.

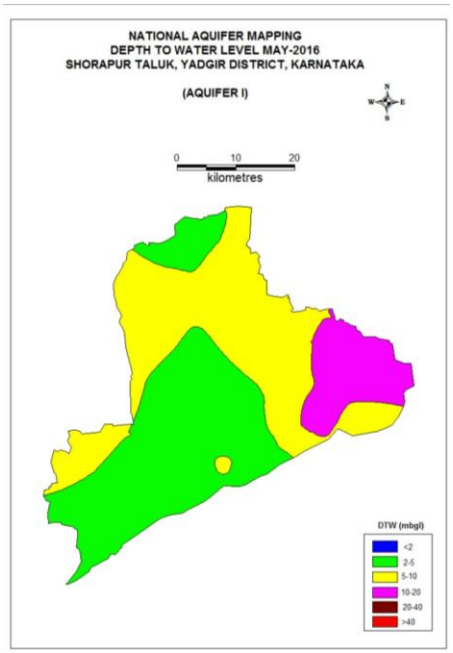


**Fig 6: Pre-monsoon (May 2016), Aq - I**

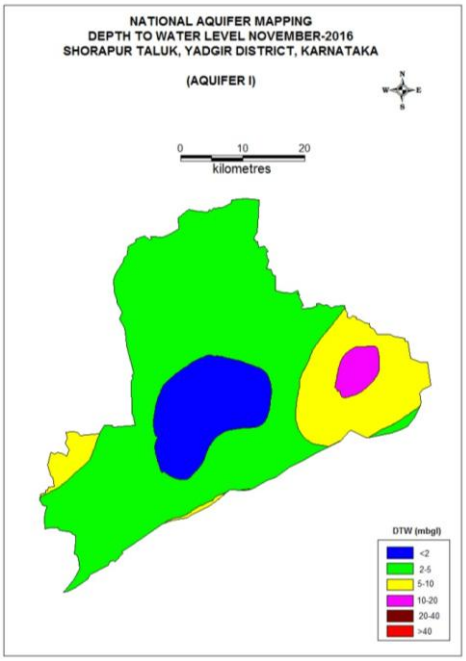


**Fig 7: Post – monsoon (Nov2016), Aq - I**

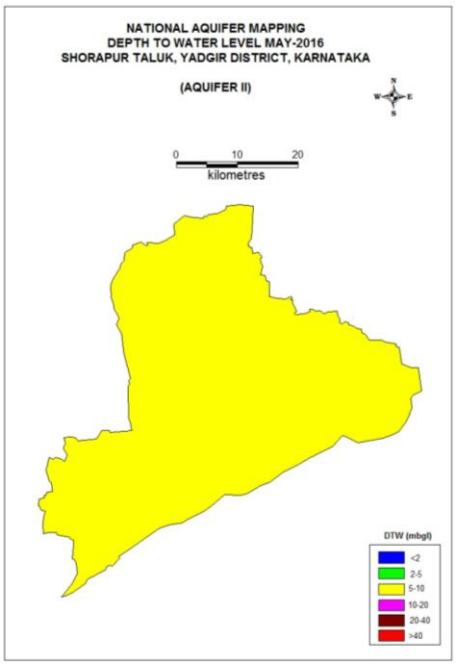


**Fig 8: Pre-monsoon (May 2016), Aq - II**

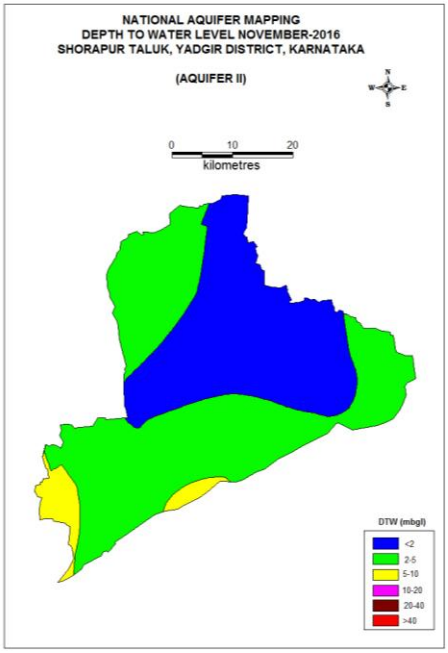


**Fig 9: Post-monsoon (Nov 2016), Aq - II**

***(b) Seasonal water level fluctuation***

Seasonal Fluctuation:

**Aquifer - I**

- Fall 0.24 mbgl
- Rise ranges between 0.18 to 1.75 mbgl **Fig.10**

**Aquifer - II**

- No fall in depth to water level observed.
- Rise ranges between 1.13 to 2.32 mbgl **Fig.11**

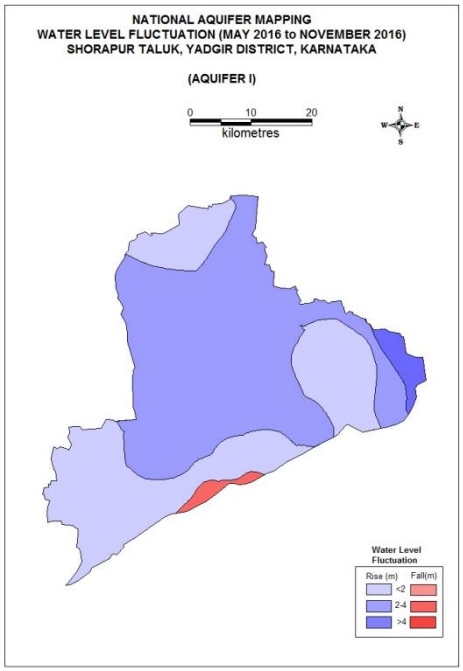


**Fig 10: Seasonal water level fluctuation (May 2016 – November 2016) in Aq-I**

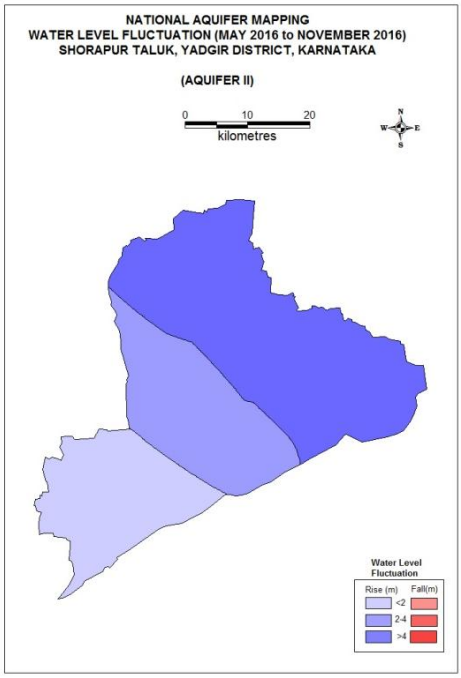


**Fig 11:Seasonal water level fluctuation (May 2016 – November 2016) in Aq-II**

## 2.0 AQUIFER DISPOSITION

In Shorapur taluk granites are the main water bearing formation occupying about 70 % of the taluk, followed by limestone, sandstone and basalt occurring towards western part, and small area towards centre part of taluk where schist formation occurs. Ground water occurs within the weathered and fractured rocks. Ground water exploration programme of CGWB reveals that aquifer systems are encountered from a depth of 7 mbgl to 90 mbgl. Bore wells have been drilled from a minimum depth of 30 mbgl to a maximum of 90 mbgl. Depth of weathered zone in the taluk ranges from 2 mbgl to 18 mbgl. Fracture zones are likely to be encountered between depths 7 – 50mbgl. Yield ranges from 0.01 to 4.2 lps and Transmissivity from 0.56 to 250 $m^2$/day.

**2.1 Number of aquifers:** In Shorapur taluk, there are mainly two types of aquifer systems;

i. **Aquifer-I (Phreatic aquifer; weathered zone) comprising of** Granites, which is the dominant water bearing formation in Shorapur taluk.
ii. **Aquifer-II, (Fractured multi-aquifer system) comprising** Fr**actured Granites.**

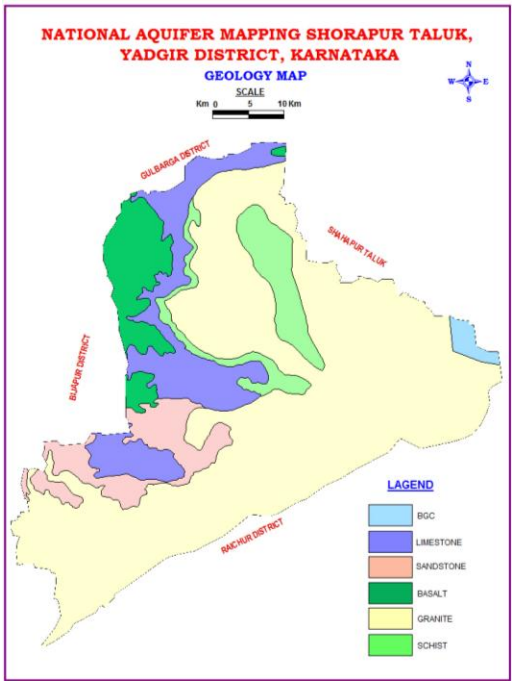


**Fig 12: Geology map**

## 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 2013)

| Taluk | Net annual GW availability (in ham) | Total draft for all uses (in ham) | Stage of GW development, % | Category |
|---|---|---|---|---|
| Shorapur | 11988 | 3270 | 27 | **SAFE** |

**Table 8: Present total Ground Water Resource**

| 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 |
| **Shorapur** | **11987.96** | **4650** | **3596** | **20144** |

**Table 9:** Present ground water availability and draft scenario (2013) in Shorapur taluk of Yadgir 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 | % | % |
| Shorapur | 11988 | 3270 | 27 | 3000 | 0 | 14988 | 22% | 5% |

**Table 10: Comparison of ground water availability and draft scenario in Shorapur taluk (2009 to 2013)**

| 2009 | | | 2011 | | | 2013 | | |
|---|---|---|---|---|---|---|---|---|
| GW Availability (Ham) | GW Draft (Ham) | Stage of GW withdrawal (Ham) | GW Availability (Ham) | GW Draft (Ham) | Stage of GW withdrawal (Ham) | GW Availability (Ham) | GW Draft (Ham) | Stage of GW withdrawal (Ham) |
| 11898 | 2662 | 22 | 11967 | 3087 | 26 | 11988 | 3270 | 27 |

Considering ground water resource estimation of 2009, 2011 & 2013, there is marginal increase in annual gross annual ground water draft for all uses and similarly stage of ground water withdrawal in the taluk renders in SAFE category.

### 3.2 Chemical quality of ground water and contamination

Representative water samples collected from National Hydrograph Stations (NHS) during pre-monsoon, and analyzed at Chemical Laboratory, CGWB, SWR, Bangalore. Interpretation from Chemical Analysis result is mentioned as under:

**Electrical Conductivity: (a) Aquifer – I -** 7 samples were collected from NHS dug wells representing Aq – I in Shorapur taluk, and chemical analysis result indicate ground water from Aq - I has EC value within the permissible limit in one station and four stations have recorded EC values within desirable limit **Fig. 13**. Two samples have recorded EC values above 3000 m/mhos/cm at 25$^{o}$C**.**

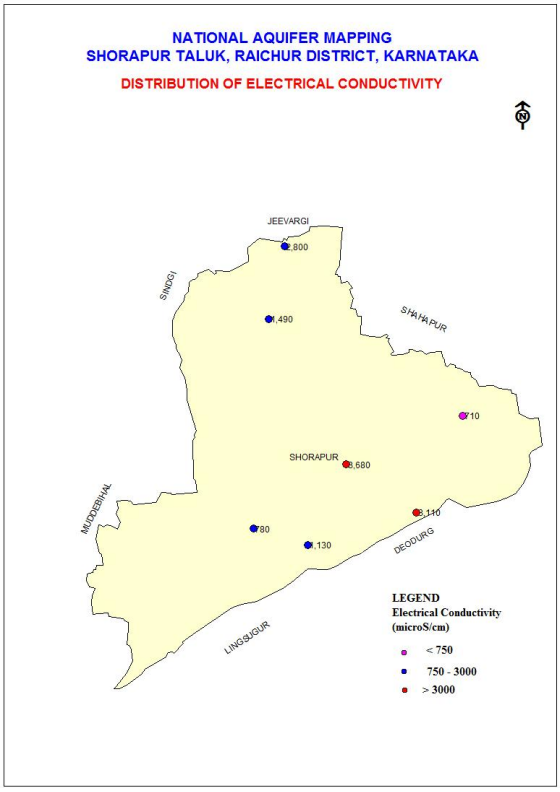


**Fig. 13: Electrical Conductivity map (Aq-I)**

**Fluoride:** Fluoride concentration in ground water is of geogenic origin in areas underlain by younger granites/ gneisses containing minerals like fluorspar & fluroapatite. Out of 5 samples collected from NHS dug wells representing Aq – I, one sample indicate fluoride greater than permissible limit of 1.5 mg/l, **Fig. 14** 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 within permissible limit.

*<u>Inference:</u> Fluoride contamination is observed in ground water samples of Aq – I collected from areas in south western part of Shorapur taluk. Fluoride contamination has sporadic occurrence and is not extensively prevalent.*

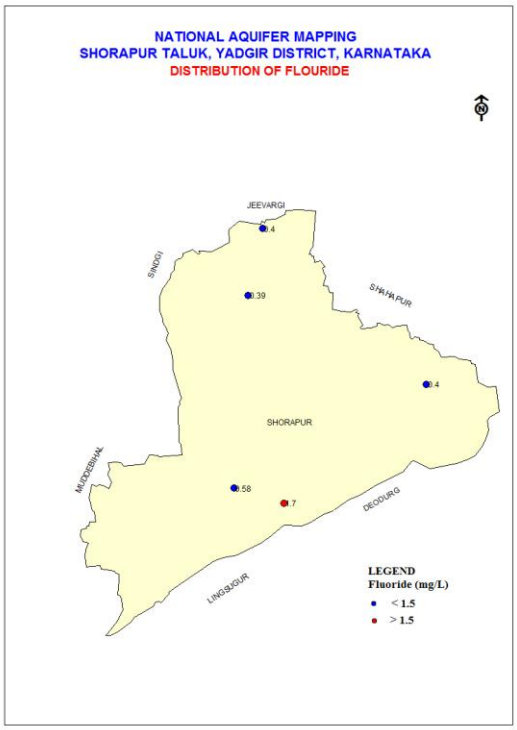


**Fig. 14: Fluoride map (Aq-I)**

**Nitrate: Aquifer – I -** Out of 7 samples collected from NHS dug wells representing Aq – I, three samples indicate nitrate concentration greater than the permissible limit of 45 mg/l.In general ground water quality in Shorapur 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.

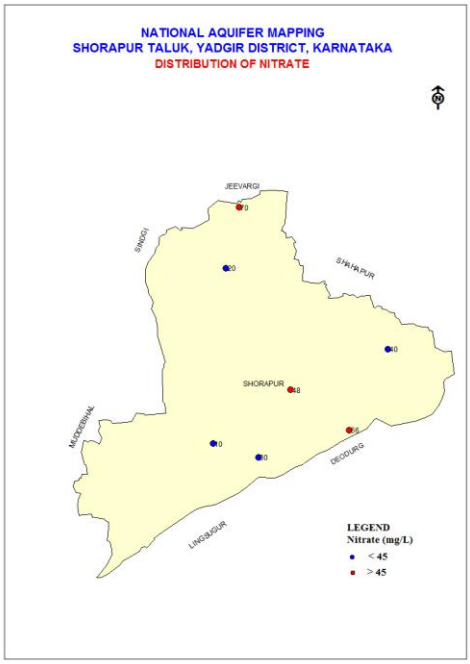


**Fig. 15: Nitrate map (Aq-I)**

## 4.0 GROUND WATER RESOURCE ENHANCEMENT

Continuous drought, increase in agricultural activity, subjected to excessive ground water withdrawal, thus leading to depletion of ground water table, reduction in yield and deterioration of ground water quality etc. Shorapur taluk is drought prone, since rainfall analysis result indicate drought like situation every 5 years. Thus, there is need for ground water management, enhancement of storage capacity of aquifers, protection of ground water quality and proper utilization of ground water.

### 4.1 Aquifer wise space available for recharge and proposed interventions

**Table 11: Quantity of water proposed to be made available through non-committed surface runoff**

| Artificial Recharge Structures Proposed | **Shorapur Taluk** |
|---|---|
| Non committed monsoon runoff available (MCM) | 52.98 |
| Number of Check Dams feasible | 327 |
| Number of Percolation Tanks feasible | 22 |
| Number of Point Recharge structures feasible | 35 |
| Tentative total cost of the project (Rs. in lakhs) | 1277 |
| Excepted recharge (MCM) | 30 |
| Expected rise in water level (m) | 3.526 |
| Cost Benefit Ratio (Rupees/ cu.m. of water harvested) | 4.26 |

**Table 12: Improvement in GW availability due to Recharge, Shorapur taluk**

| GW availability (ham) | Stage of GW dev % | Expected Additional Recharge from non committed monsoon runoff (Ham) | Expected Increase in GW Availability (Ham) | Expected Stage of GW Development after recharge (%) |
|---|---|---|---|---|
| 11988 | 27 | 2400 | 4016 | 16 |

## 5.0 DEMAND SIDE INTERVENTIONS

### 5.1 Advanced irrigation practices

Bore well is the prevalent source for irrigation in 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 27% and categorized as Safe. Hence, there is ample scope for irrigation from ground water. Prevalent irrigation practice in Shorapur 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.

### 5.2 Change in cropping pattern

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.

### 5.3 Regulation and Control

- Shorapur taluk is categorized asSafe, since the stage of ground water development has reached **27%** (GE March 2013). There is ample scope for irrigation from ground water. Prevalent irrigation practice in Shorapur 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. Expected recharge is 4.01 MCM through artificial recharge structures.

- 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.

### 5.4 Other interventions proposed:

- **Phreatic aquifer (Aq-I):** Pre monsoon depth to water level in Shorapur taluk, ranges between 2.78-12.57 mbgl; and post monsoon 0.65 – 12.23 mbgl.
  **Aq-II:** Pre monsoon depth to water level in Shorapur taluk is 6.63mbgl; and post monsoon 1.55 mbgl. This indicates that water levels are considerably shallow and can be replenished through construction of artificial recharge structures, viz; sub – surface dams, check dams, step bunds & percolation tanks.

- 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.

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