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# Ground water scenario in Hassan district

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## Abstract

*Weathered and fractured gneiss, granite and schist are the major water bearing formations. Alluvial formation of limited thickness and aerial extent is found along the courses of major rivers. Hassan district is situated on old Deccan plateau and south western and interior central part of Karnataka, in terms of latitudinal and longitudinal position of the district; it extends entirely in the southern India. Specific Yield of predominant unconfined aquifers ranges from 1.5 to 2.5% and Transmissivity of aquifers ranges from 2 to 63* $m^2$ */day.*

**Keywords:** Dugwell; Groundwater

## Introduction

Weathered and fractured gneiss, granite and schist are the major water bearing formations. Alluvial formation of limited thickness and aerial extent is found along the courses of major rivers. Groundwater occurs under phreatic (water table) conditions in weathered zones of gneiss, schist and granite and under semi-confined to confined conditions in joints and fractures of these rocks at deeper levels. Weathered and fractured gneiss is the predominant aquifer found in the district followed by schistose and granitic aquifers, which occur as isolated patches in a few taluks.

The depth to water level during pre-monsoon (May-2006) ranges from 1.38 mbgl (Gorur) to 21.67mbgl (Hanumanthapura). During post-monsoon (Nov-2006) it ranges from 0.98 mbgl (Gorur) to 19.42 mbgl (Hanumanthapura). The seasonal fluctuation data reveals that 84% of the wells show rise while 16% of the wells show a fall in water level. The rise in water level ranges from 0.20 m to 9.20m while, the fall ranges from 0.65m to 5.05m.

The trend in water level for pre monsoon as well as post monsoon period are quite significant. The rising trend in pre monsoon generally indicates the reduction of draft, due to increased dependence on surface water supply. While, a falling trend in pre monsoon indicates the reverse. The rising trend in post monsoon indicates effective watershed treatment or high incidence of rainfall, while the falling trend in post monsoon throw light on high level of urbanization by reducing the natural infiltration rates by way of concrete pavements, lined water channels, reduced areas of natural tanks and other water impounding structures etc. Analysis of the long-term water level trend in the last 10 years (1997-2006) reveals that 30% of the wells show a rise in water level ranging from 0.02m to 0.48m, whereas, the remaining wells (70%) show a fall in the range of 0.004m to 0.98 m. This means, more than two-third of the wells indicate a declining water level in the district.

## Objective

To know the ground water scenario in Hassan district.

## Study Area

Hassan district is situated on old Deccan plateau and south western and interior central part of Karnataka, in terms of latitudinal and longitudinal position of the district; it extends entirely in the southern India. Average altitude is 960 meters above MSL (Mean Sea Level). The district lies between 750 331 E to 760 381 E longitude and 120 131 N to 130 331 N latitude. The greatest length of the district, from north to south, is about 80 miles or 129 kilometers, and its greatest breadth, from east to west, is about 72 miles or 116 kilometers, total area of the district has 6826.15 Sq, Km's. It is divided into 3 natural regions like Southern Malnad, Semi Malnad and Southern Maidan. It is divided into 8 taluks 38 hoblis and 2369 villages. The average rain fall is 1031 mms in rainy days (65days), the major rivers in Hassan Cauvery, Hemavathi, Yagachi, Vote hole, Yethinahole, Ganadahole.

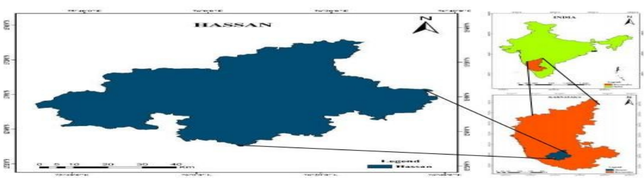


**Fig. 1.** Study Area

## Analysis

Specific Yield of predominant unconfined aquifers ranges from 1.5 to 2.5% and Transmissivity of aquifers ranges from 2 to 63 $m^2$ /day. The taluk wise hydrogeological details are given below:

Alur taluk Groundwater occurs under phreatic condition in weathered zone of gneiss and under semi-confined to confined conditions in joints and fractures at deeper level. The depth of weathered zone (shallow aquifer) ranges from less than 10m to 25 m. The depth to water level varied from 3.53 mbgl to 10.50 mbgl during pre-monsoon (May-06) and from 1.45 mbgl to 7.26 mbgl during post-monsoon season (Nov-06). Average seasonal fluctuation between pre-monsoon and post-monsoon is 3.31m. The long-term water level trend shows a rise of 0.31m/year. Permeability in the shallow zone is less than 10m/day. Specific Capacity of dugwells ranges from10.08 to 154.08 $m^3$ /day/m. Potential deep aquifers occur below 25m to 100m (explored depth 266m) in the form of joints and fractures. The yield of borewells (CGWB exploratory wells) ranges from less than 1 lps to 2 lps.

Arkalgud taluk Groundwater occurs under phreatic condition in weathered zone of gneiss and under semi-confined to confined conditions in joints and fractures at deeper level. The depth of weathered zone (shallow aquifer) ranges from 10m to more than 20 m. The depth to water level ranges from 1.81 mbgl to 10.56 mbgl during pre-monsoon (May-06) and from 1.38 mbgl to 5.75 mbgl during post-monsoon season (Nov-06). Average seasonal fluctuation between premonsoon and post-monsoon is 4 m. The long-term water level trend shows a rise of 0.54m/year. Permeability in the shallow zone is less than 10m/day. Specific Capacity of dugwells ranges from 3.92 to 102.24 m 3 /day/m. Potential deep aquifers occur between 25m and 100m (explored depth 196m) in the form of joints, fissures and fractures. The average yield of borewells (CGWB exploratory wells) is 2.0lps. Transmissivity ranges from 16 to 22 $m^2$ /day.

Arsikere taluk Groundwater occurs under phreatic condition in weathered zone of gneiss, granite and schist and under semi-confined to confined conditions in joints and fractures of these formations at deeper level. Of these, gneiss is the most predominant aquifer covering major part of the taluk. The depth of weathered zone (shallow aquifer) ranges from less than 10m to 20 m. The depth to water level ranges from 5.0 mbgl to 6.0 mbgl during pre-monsoon (May-06) and from 2.55 mbgl to 10.95 mbgl during post-monsoon season (Nov-06). Average seasonal fluctuation between pre-monsoon and post-monsoon is 2.45 m. However, in some areas, fall in water level during post-monsoon season is also observed. The long-term water level trend shows a rise of 0.17m/year to 0.55m/year at some places and a fall of 0.08m/year in higher ground water development areas. Specific Capacity of dugwells ranges from 11 to 117 m3 /day/m. Permeability in the shallow zone varies from less than 10m/day to 20 m/day. Potential deep aquifers occur below 25m to 90m (explored depth 90 m) in the form of joints, fissures and fractures. The yield of borewells (CGWB exploratory wells) varies from 2 lps to 10.5 lps Transmissivity ranges from 17 to 50 $m^2$ /day.

Belur taluk Groundwater occurs under phreatic condition in weathered zone of gneiss, and under semi-confined to confined conditions in joints and fractures of the formation at deeper level. The depth of weathered zone (shallow aquifer) ranges from less than 10m to 42 m. The depth to water level ranges from 5.36 mbgl to 12.34 mbgl during pre-monsoon (May-06) and from 2.37 mbgl to 7.04 mbgl during post-monsoon season (Nov-06). Average seasonal fluctuation between pre-monsoon and post-monsoon is 2.48 m. The long-term water level trend shows a rise of 0.14m/year to 0.31m/year. Permeability in the shallow zone varies from, is less than 10m/day to 20 m/day. Specific Capacity of dugwells ranges from 4.6 to 123 m3 /day/m. Potential deep aquifers occur below 25m to 180m (explored depth 235 m) in the form of joints, fissures and fractures. The yield of borewells (CGWB exploratory wells) varies from 1 lps to 4 lps. Transmissivity ranges from 3 to 21 $m^2$ /day.

Channarayapatna taluk Groundwater occurs under phreatic condition in weathered zone of gneiss and schist and under semi-confined to confined conditions in joints and fractures of these formations at deeper level. Of these, gneiss is the predominant one covering major part of the taluk. The depth of weathered zone (shallow aquifer) ranges from less than 10m to 15 m. The depth to water level ranges from 3.58 mbgl to 6.25 mbgl during pre-monsoon (May-06) and from 4.56 mbgl to 6.41 mbgl during post-monsoon season (Nov-06). Average seasonal fluctuation between pre-monsoon and post-monsoon is 0.95 m. However, in some areas, fall in water level during post-monsoon season is also observed. The long-term water level trend shows a fall of 0.11m/year to 0.15m/year. Permeability in the shallow zone varies from is less than 10m/day to more than 20 m/day. Specific Capacity of dugwells ranges from 15 to 164 m3 /day/m. Potential deep aquifers occur below 25m to 90m (explored depth 90 m) in the form of joints, fissures and fractures. The yield of borewells (CGWB exploratory wells) varies from less than 1 lps to 8 lps. Transmissivity ranges from 27 to 63 $m^2$ /day.

Hassan taluk Groundwater occurs under phreatic condition in weathered zone of gneiss and schist and under semi-confined to confined conditions in joints and fractures of these formations at deeper level. Of these, gneiss is the predominant one covering major part of the taluk. The depth of weathered zone (shallow aquifer) ranges from 10m to 20 m. The depth to water level ranges from 1.55 mbgl to 21.67 mbgl during pre-monsoon (May-06) and from 0.98 mbgl to 19.42 mbgl during post-monsoon season (Nov-05). Average seasonal fluctuation between pre-monsoon and post-monsoon is 2.35 m. The long-term water level trend shows a rise in the range of 0.10 m/year to 0.33 m/year at some places and a fall of 0.14m/year in higher ground water development areas. Permeability in the shallow zone varies from less than 10m/day to more than 20 m/day. Specific Capacity of dugwells ranges from 3 to 417 $m^3$ /day/m. Potential deep aquifers occur below 25m to 85m (explored depth 85 m) in the form of joints, fissures and fractures. The yield of borewells (CGWB exploratory wells) varies from less than 1lps to 2.4 lps. Transmissivity ranges from 5 to 10 $m^2$ /day.

Holenarsipur taluk Groundwater occurs under phreatic conditions in weathered zone of gneiss and schist and under semi-confined to confined conditions in joints and fractures of these formations at deeper level. The depth of weathered zone (shallow aquifer) ranges from less than 10m to 20 m. The depth to water level ranges from 1.38mbgl to 5.75 mbgl during pre-monsoon (May-06) and from 1.18 mbgl to 3.54 mbgl during post-monsoon season (Nov- 06). Average seasonal fluctuation between pre-monsoon and post-monsoon is 1.20 m. The long-term water level trend shows a rise of 0.018m/year at some parts and a fall of 0.071m/year in higher ground water development areas. Specific Capacity of dugwells ranges from 10 to 268 $m^3$ /day/m. Permeability in the shallow zone varies from, is less than 10m/day to more than 20 m/day. Potential deep aquifers occur between 25m and 53m (explored depth 53 m) in the form of joints, fissures and fractures. The average yield of borewells (CGWB exploratory wells) is 2.4 lps. Transmissivity ranges from 10 to 46 $m^2$ /day. Sakleshpur taluk Groundwater occurs under phreatic condition in weathered zone of gneiss and under semi-confined to confined conditions in joints and fractures at deeper level. The depth of weathered zone (shallow aquifer) ranges from less than 10m to more than 20 m. The depth to water level ranges from 8.64 mbgl to 13.00 mbgl during pre-monsoon (May-06) and from 3.60 mbgl to 5.36 mbgl during post-monsoon season (Nov-06). Average annual fluctuation is 4.6m.The long-term water level trend shows a rise of 0.31m/year. Permeability in the shallow zone is less than 10m/day. Potential deep aquifers occur below 25m to 100m (explored depth 196m) in the form of joints and fractures. The average yield of borewells (CGWB exploratory wells) is 2.0 lps.

## Groundwater quality (Irrigation and drinking point of view.)

Quality of groundwater in the district, in general is good and potable. It is suitable for domestic and irrigation purposes. Water samples from NH Stations were analysed to decipher the shallow aquifer water quality and samples from exploratory borewells represent water quality of deeper aquifers in the district. All the important parameters like EC, pH, TDS and fluoride levels, both in the shallow and the deep aquifers are, in general, within the permissible limits prescribed for drinking water standards. Only nitrate and chloride are found in higher concentrations at a few places.

The shallow zone groundwater is Calcium-Magnesium Bicarbonate type and suitable for all purposes. At the following places the nitrate and chloride concentrations are in excess of permissible limits. Nilavagilu (Alur taluk), Harnahalli, Javagallu and Kanakatte (Arsikere taluk), Halebeedu (Belur taluk),Bragur, Hiresave and Jambur (Channarayapatna taluk),Kattaya and Shantigrama (Hassan taluk).The combination of these two ions in excess of permissible limits indicates the pollution from point source in these villages. Only nitrate is in above permissible concentration at Ballupet (Sakleshpur taluk), Bychanahalli and Vadrahalli (Arkalgud taluk), and Gorur (Hassan taluk), which indicates the non-point source of pollution and is due to the use of nitrogenous fertilizers in the surrounding area. The Sodium Adsorption Ratio (SAR) ranges between 0.02 and 6.63, which is in 'Excellent' class (being less than 10).

The deep zone ground water is Calcium-Magnesium Bicarbonate and Chloride type and suitable for all uses. Excess nitrate and chloride are noticed at Javagallu and D.M.Kurki (Arsikere taluk), which is due to point source pollution and reached the deep aquifer from shallow zone due to pumping. Only nitrate is in above permissible concentration at A.M.G.Halli (Arkalgud taluk), Shanegere, Mudodi and Banavara (Arsikere taluk), Y.Cross (Channarayapatna taluk) and Kandli (Hassan taluk), which is due to the excess use of nitrogenous fertilizers in the surrounding area. Excess fluoride of 1.63 mg/litre is observed at Banavara (Arsikere taluk) alone. The Sodium Adsorption Ratio (SAR) ranges between 0.66 and 3.13, which is in 'Excellent' class (being less than 10).

Status of Groundwater development There is development of groundwater in Hassan district. As per the Resource Estimation (GEC-1997) as on March 2004, the net groundwater availability for future irrigation development is 157.32 mcm. The stage of groundwater development varies from 39.5% in Arkalgud taluk to 87.71% in Arsikere taluk. The average value of development of the district as a whole is 71%. Little more than half of the district area (54%) falls under 'safe' category, 16% area under 'semi-critical' category and the remaining 30% is 'over-exploited'. When considered taluk wise, the entire Sakleshpura and Alur taluk and major parts of Arkalgud, Belur taluks and small parts of Arsikere and Hassan taluks are in 'safe' category. Major parts of C.R.Patna, Holenarsipura and Hassan taluks fall under 'over-exploited' category. Major part of the Arsikere taluk and almost one-third area of Belur taluk fall under 'semi-critical' category. From the above discussion it is observed that, the western higher rainfall area has a lower groundwater development than the eastern plain, lesser rainfall area.

## Groundwater management strategy

Hassan is basically agriculture-dominated district, where it is the main occupation of the rural population, which constitutes 82.3% of the total population (2001 census). As per the data available (Hassan District at a glance-2014-15), total irrigated area constitutes 20.5% of the net sown area. The contributions of surface water, groundwater and other sources in irrigated agriculture in the district are 48%, 45% and 7% respectively. It is apparent that groundwater is playing equally vital role in agriculture sector apart from being the main source of drinking water in major part of the district. Hence, its judicious use and sustainable management is all the more important. Water economy irrigation practices like adoption of drip and sprinkler irrigation methods should be popularized. Efforts should be oriented towards conservation and augmentation of groundwater. In canal command areas, conjunctive use approach can be adopted. In deeper ground water areas of maidan area, artificial recharge measures like percolation tanks and check dams are to be implemented to augment the groundwater resource. In the hilly areas (Malnad region) watershed treatment techniques can help in augmenting the groundwater resources. Point recharge structures would help in recharging deeper depleted fractures and fissures so as to have a sustainable yield from borewells. Technical management of groundwater should be kept in mind while extending institutional finance to farmers and awareness should be created in different user communities.

## Groundwater development

Groundwater development has reached 71% for the district as a whole. Further development in the over-exploited areas of Hassan, Holenarsipur, Channarayapatna and Arsikere taluks should be restricted. In semi-critical areas of Arsikere and Belur taluks further development of groundwater should be done with all cautions. As groundwater level in general is declining, deepening of dug wells, conversion of dugwells into dug-cum-borewells is needed. The shallow zone ground water can be developed for irrigation through dug wells in topographic low areas and dug-cum-borewells in valley slope areas having comparatively deeper water levels. Optimum depth of dug well is 10-12 m having a diameter of 6-7m.The optimum depth of dug-cum borewell is 15-20 m having a diameter of 6-7 m in dug part and 100mm in lower borewell part to a depth of100m. A minimum spacing of 75 to 100m between dugwells is recommended. The recommended optimum discharge of dugwells is 4lps for the prevailing cropping pattern for a pumping of 4 to 5 hrs and 3 H.P. pump is needed. The recommended command of each well is 1.2 hectare. Borewells are possible in all topographic conditions and pinpointing of site, depth, yield prospects etc, should be ascertained by suitable investigations. The minimum distance of 150 m between two borewells is necessary to avoid mutual interference.

## Water Conservation and Artificial Recharge

Fast, unchecked and indiscriminate withdrawal of groundwater through different abstraction structures has resulted in the decline of ground water level. Further, deforestation and conversion of grass-covered land for other activities has reduced the natural groundwater recharge area. Hence, most part of the rain leaves the area as run-off causing floods and heavy soil erosion. By constructing suitable structures the contact time of this flowing water with the land can be increased and some part of which, will percolate down to recharge the groundwater. Rain Water Harvesting would be a remedy in areas where there is ground water quality problem due to high nitrate, chloride and fluoride concentrations. By studying the nature of geological formations, slope of the land, depth of weathering, depth to water level and availability of land and water source for these artificial recharge structures, different types of artificial structures are recommended and shown in the map. The plain lands in eastern parts of the district covering Arsikere, Channarayapatna, Holenarsipur, Hassan, Arkalgud and parts of Alur and Belur are suitable for construction of Percolation tanks, Nalla bunds and point recharge structures like recharging through existing borewells/dugwells and recharge pits. The moderate to high sloping, undulating terrain on the western parts of the district covering Sakleshpur taluk and the parts of Alur and Belur taluks are suitable for artificial recharge structures like gully plugs, gabian structures, cement plugs, nala bunds, contour bunds and contour trenches. The selection of a suitable artificial recharge structure is site specific. So, scientific studies should be conducted while selecting the site for a specific type of structure. The year 2005 has received the highest rainfall in the last 10 years and hence; water levels in dugwells for the period are shallow even in high ground water development areas. However, artificial recharge structures are recommended in such areas considering the long-term water level trends. Feasibility of Artificial Recharge Structures.

## Groundwater related issues and problems

Decrease in the yield of borewells and depletion of ground water is the main cause of concern in the over-exploited taluks. Over development is witnessed in major parts of the taluks of C.R.Patna, Hassan and Holenarsipur followed by a lesser extent in Arsikere and

Arkalgud. The average stage of development is 71% and about one-third (30%) of the district, as elaborated above, is falling under 'Over-exploited' category, where, feasibility of further ground water development is very much restricted or nil. Excess nitrate and chloride due to point source on a localized pattern is found in different parts of the district. Excess nitrate over restricted area in canal command area is noticed.

## Conclusion

After analyzing the present groundwater scenario in Hassan district, the following recommendations are made to develop ground water on sustainable basis in different parts of the district.

1. Dugwells, which are currently in use, may be further deepened to tap more saturated part of the phreatic aquifer and increase the yield. Wherever dugwells are more than 15 meter in depth, borewells of 100 to 150mm diameter to a depth of 50 m may be tried at the bottom to enhance the yield. Such measures will help in mitigating the irrigation water scarcity.
2. Pinpointing of sites for wells and borewells in feasible areas should be tried after taking technical guidance and scientific investigations. Otherwise, farmers have to suffer heavy financial burden in case of failures of wells.
3. In canal command areas of Arkalgud, Holenarsipur, Channarayapatna, Hassan, Belur taluks, conjunctive use of surface and groundwater should be practiced. Withdrawing more groundwater through dugwells and shallow borewells and transferring it to upland and tail end areas will solve water scarcity in such areas and reduces the waterlogging problem in the command area.
4. Water-economy methods like drip irrigation and sprinkler irrigation can be practiced in irrigated agriculture to save water.
5. In situ rainwater harvesting in the villages, where ground water carries excess nitrate and fluoride contents, will offer a solution for drinking water problems.
6. Artificial recharge measures like check dams, percolation tanks, point recharge structures should be implemented on extensive scale, especially in over-exploited areas like Arsikere, Hassan, Channarayapatna and Holenarsipur taluks. Suitable artificial recharge structures should be constructed in different terrains, which will arrest and store the run-off in rainy season, which will otherwise, go waste. This stored water will recharge groundwater and will help in arresting soil erosion and also flood control.
7. Rejuvenation of existing MI tanks by de-silting would enhance their storage and percolation capacities.
8. Institutional financial assistance should be provided to poor farmers for deepening of dugwells and for new borewells. Incentives should be given for those who are interested in implementing Rain Water Harvesting schemes. Construction of different Artificial Recharge Structures, which is generally not affordable to individuals, should be taken up by the government.

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