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Original Research Paper

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Over-exploitation of Groundwater, and its Impact on Phreatic Aquifer System, Surface Water Bodies and Rural Water Supply Schemes in Malur Taluk, Kolar District, Karnataka - A Case Study

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ABSTRACT

Water is a precious natural resource which replenishes each year through monsoon rains. Most of the areas in India are facing severe scarcity of water for drinking, irrigation and industrial needs of the society. The crisis of water resources, the development and their management is of great importance because, the required quantity of the water is not available for use due to uneven spatial distribution. In India, groundwater is the main source of irrigation and water supply needs. Excess use of groundwater for irrigation has adversely affected drinking water supply needs in recent years, which has a direct impact on the quality and quantity of groundwater. Better water/groundwater management practices and planning for artificial recharge of groundwater can only improve the sustainability of groundwater resource in coming years. Like in other places of India, in Karnataka, particularly in Malur taluk in Kolar district, is not having any major surface water bodies to cater to the irrigation and domestic water supply needs of the people. The entire area is by and large totally dependent on groundwater for irrigation, domestic and industrial water supply needs. Due to continuous withdrawal of groundwater to meet the demand, dug wells tapping the phreatic aquifers are totally dry since last two decades, which has tremendous impact on phreatic aquifer system, surface water bodies and rural water supply schemes in the area and also on the quality of groundwater. Better groundwater management practices coupled with artificial recharge to groundwater are the options left for sustainability of groundwater resource in the area. Roof top rain water harvesting is also essential to mitigate the drinking water needs of the people in the area. Drip irrigation and sprinkler irrigation in large scale can control the depletion of groundwater level in the area.

INTRODUCTION

Groundwater is a distinguished component of hydrologic cycle. Even though the surface water/groundwater gets renewed through monsoon rains, most of the areas face severe scarcity of water for drinking, irrigation and industrial needs of the society. Accordingly, the importance of water/groundwater has been recognised and greater emphasis is being laid for its judicial use and better management (Anuradha et al. 2010). More than 85% of water supply needs for irrigation and drinking purpose in rural areas in India is met with groundwater. Excess use of groundwater for irrigation has adversely affected drinking water supply needs in recent years, which has direct impact on the quality of groundwater. Both surface as well as the groundwater are becoming scarce due to indiscriminate exploitation to meet the requirements of ever increasing demands of growing population. Better Water/Groundwater management practises and planning for artificial recharge of groundwater can only improve the sustainability of groundwater resource in coming years (Dawoud et al. 2005).

LOCATION OF THE AREA

The study area is located between north latitude 12°48'24" and 13°07'06", and east longitude 77°50'30" and 78°08'15" falling in Survey of India toposheets 57 G/16, 57 H/13, 57 K/4 and 57 L/1 (1:50,000 scale) covering an area of 645 sq kms. The area is bound by Bangarpet taluk of Kolar district in the east, Hosakote taluk of Bangalore district in the west, Kolar taluk of Kolar district in the north, and Tamil Nadu State towards south. The area part of the Ponnaiyyar river basin is covered by two sub-basins namely Kanamanhalli and Devarag-Uttahalli with an area of 439 and 247 sq kms. The location of the Malur taluk is shown in Fig. 1.

LAND USE

Agriculture is the main occupation of the people in the area. Malur taluk is having a total geographical area of 645 sq kms (64500 hectares). Of which 224.54 sq kms i.e., 34.82% of the total area is occupied by agricultural plantations, 40.94 sq kms is occupied by barren rocky/stony waste/sheet

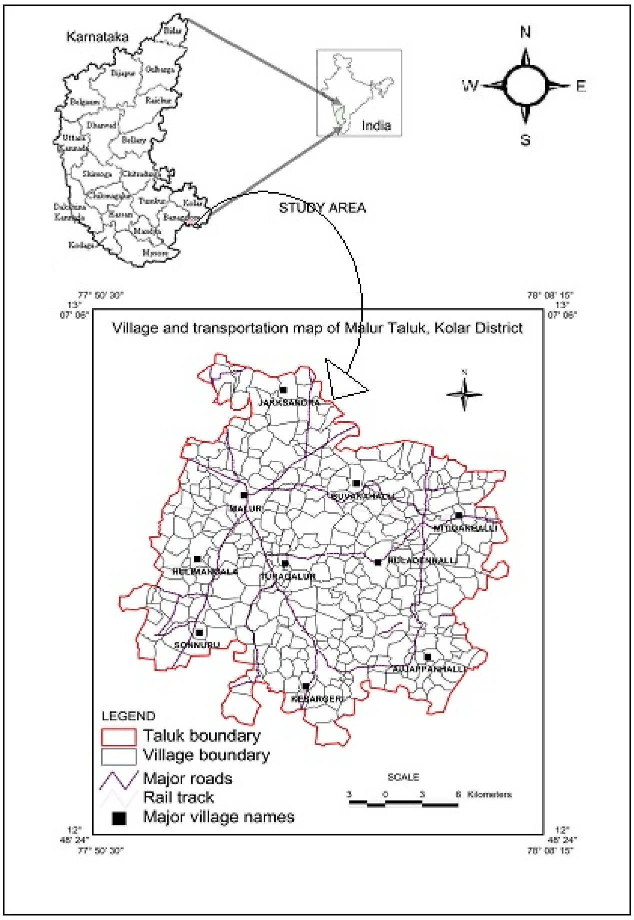

Fig. 1: The location map of Malur taluk, Kolar district, Karnataka.

rocks and about 176.52 sq kms is under kharif and rabi double crops (Sreedhara et al. 1992) (Fig. 2).

RAINFALL AND CLIMATE

The mean annual rainfall for Malur taluk is 751.45 mm. To study the distribution of rainfall and its spatial variation in Malur taluk, rainfall data have been collected for the last 40 years (1971 to 2010) from the rain gauge of Chikkaballapur, Malur, Kolar, Bangarpet, Anekal and Hosakote which are taluk headquarters (Table 1) and spatial distribution of rainfall in Malur taluk is shown in the Fig. 3

GEOLOGY AND STRUCTURE OF THE STUDY AREA

The main rock types in the study area are gneiss and granites of Achaean age (Fig. 4). At places basic dykes, pegmatites and quartz veins intrude these rocks. Recent alluvium is found along the streams and rivers. The various lithological units occurring in the area are as follows.

Recent -	Alluvium
Alagonkian -	Dolerite dykes, pegmatite and quartz veins
Archaean -	Peninsular gneiss, granite, schist & amphilolites, etc.

SUB-SURFACE GEOLOGY

The sub-surface geology data have been obtained from three exploratory bore wells drilled by the Central Groundwater Board, SWR, Bangalore (Groundwater Exploration in Karnataka 2005). The details of the exploratory wells are furnished in Table 2. 2D lithologs of individual exploratory wells are shown in Fig. 5 and 3D multiple litholog of three exploratory wells is shown in Fig. 6.

IMPACT OF OVER-EXPLOITATION OF GROUNDWATER ON SURFACE WATER BODIES

Groundwater development is found in very large scale all over the area of Malur taluk. Earlier groundwater development in the area was only through dug wells. Gradually the farmers switched over to commercial crops, especially vegetables like carrot, cabbage, beetroot, radish, tomato, beans and cash crops like mulberry and flowering plants from traditional crops like paddy, ragi, jowar and maize. This type of change pattern of crops changed the groundwater scenario drastically and almost all the dug wells are dry since last two decades. The groundwater level in the area declined beyond the reach of dug wells in the area (Figs. 7 & 8).

Over-exploitation of groundwater has its own impact not only on groundwater system but also on surface water bodies, especially minor irrigation tanks, which were irrigating 50 to 100 hectares of land, are permanently become dry (Figs. 9 & 10), which has adverse impact on the survival of faunal species like frogs, fishes and birds etc. (Munch et al. 2007).

RURAL WATER SUPPLY SCHEMES

Malur is the only urban town located in the taluk. The population of Malur town is totally dependent on groundwater for water supply as there is no source of surface water supply to this town. The Town Municipal Council, Malur, which is taking care of domestic water supply has drilled 51 bore wells in and around Malur town to meet the water supply. To cater to the demand of water supply for rural region, Zilla Panchayat has drilled nearly 800 bore wells. The depth of these bore wells ranges from 150 to 300 mbgl depth. The details of bore wells drilled in Malur taluk for rural water supply is furnished in the Table 3.

IMPACT OF OVER-EXPLOITATION OF GROUNDWATER ON RURAL AND URBAN WATER SUPPLY SCHEMES IN MALUR TALUK, KOLAR DISTRICT

Table 1: Average annual rainfall data (40 years) of Malur and surrounding areas.

Year	Station Name					
	Chikkaballapur	Malur	Kolar	Bangarpet	Hosakote	Anekal
1971	717.5	640.6	937.5	546.5	1048.4	962.6
1972	893.6	689	847.9	955	946.8	845.6
1973	899.8	635	747.3	632	1008.5	864.6
1974	1003.2	703.3	869.1	649.4	901.1	863.8
1975	1218.2	769.6	948.1	799.1	1314.8	1175.1
1976	613.4	425.3	566	432.4	760.3	570.7
1977	961.1	664.6	715.7	918.3	856.6	1031.4
1978	1018.7	678.3	869.6	639.3	819.4	890.1
1979	1025.5	960.4	847	1211.1	856.9	1061.5
1980	644	746.2	506.4	464.1	430.8	1090.3
1981	817	992.3	689.7	1169.2	720.4	962.7
1982	576.5	496.9	515.8	577.8	509	556.2
1983	892.7	677.6	724.9	738.4	694.8	945
1984	733.1	692.3	766.2	699	708.9	487.2
1985	658.4	590.8	355.3	547.6	467.7	558.4
1986	702.5	855.5	827.6	826.4	1176.1	1006.1
1987	859.4	672.8	780.2	612.8	1009	1016
1988	959	613	820	673	1056	835
1989	578	517	666	842	709	859
1990	702.5	571	635	581	522	601
1991	1110	1020	1119	1304	1303	1500
1992	602	952	714	621	716	674
1993	825.8	994.2	1238.3	978.6	1157.3	910.2
1994	426.1	387.1	521.2	391.8	555.4	575.8
1995	472	642	616	822	819	745
1996	821	969	981	1071	907	941
1997	710	750	653	787	896	760
1998	562.1	842.4	1207.6	892	867	1240.3
1999	692.6	846.4	883.5	759.4	790.5	1275.6
2000	1005.1	760.9	844.5	915.6	819.6	905.6
2001	793	964	1106	934	1002	743
2002	373	690	540	448	396	628
2003	558	762	550	603	590	522
2004	756	1041	973	725	1165	1081
2005	849	1246	1270	1566	1140	1129
2006	492	412	629	775	342	575
2007	881	840	702	637	767	826
2008	1102	992	1064	687	1116	842
2009	844.2	748	726	866.6	565	1106
2010	1033	608	1006	752	904	786
Total	31382.3	30057.8	31979.2	31050.4	33334.1	34947
Average	784.56	751.45	799.48	776.26	833.35	873.68

Due to continuous withdrawal of groundwater to meet the demand of irrigation and domestic needs of the people in the study area, the groundwater level has declined at an alarming rate. According to estimated groundwater draft, the entire study area is falling under over-exploited category, where the stage groundwater development is 182.19%. This has tremendous impact on the environment of the study area which are as follows.

- More than 90% of bore wells which were fitted with hand pumps for water supply, tapping the aquifers up to 150 m depth, are totally dry.
- At present only the deep bore wells ranging in depth from 200 m to 350 m depth, which are fitted with submersible pumps, are catering the needs of water supply to Malur town and other villages in the area.
- Over-exploitation of groundwater in the area has tremendous impact not only on groundwater system, but also on food production in the area. The agricultural land occupying food crops was gradually replaced by Eucalyptus plantations (Figs. 11 and 12).

Over-exploitation of groundwater in the study also ad-

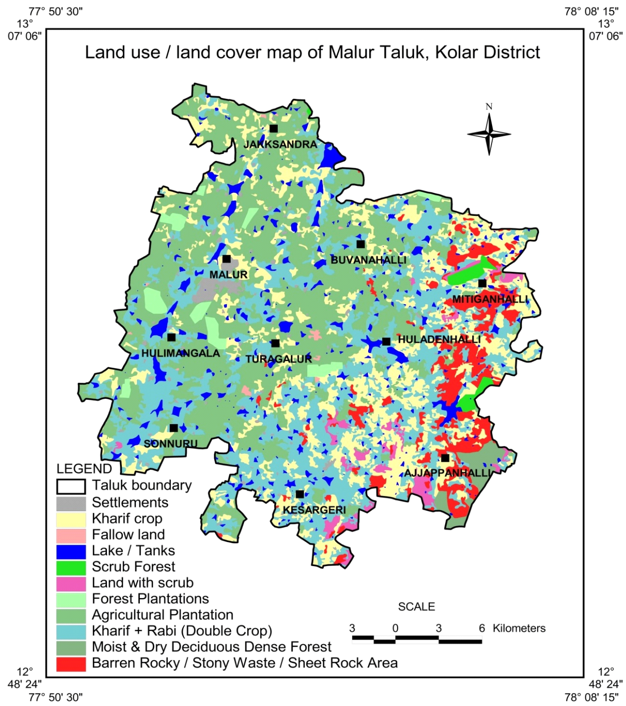

Fig. 2: Land use in Malur taluk, Kolar district, Karnataka.

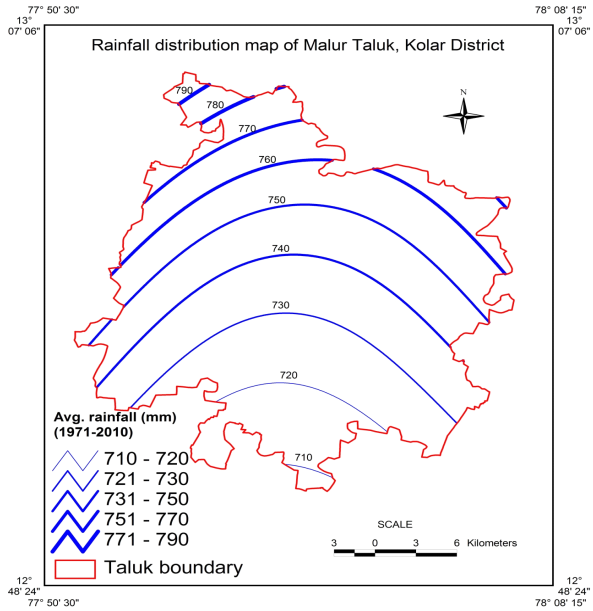

Fig. 3: Spatial distribution of rainfall in Malur taluk.

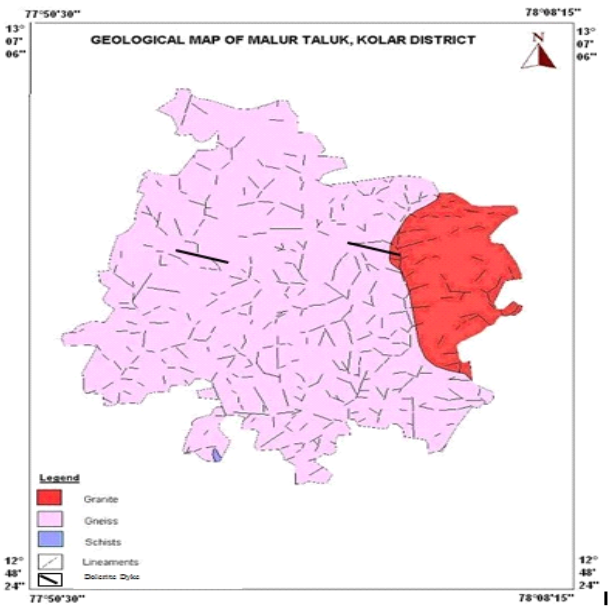

Fig. 4: Geological map of Malur Taluk, Kolar district, Karnataka.

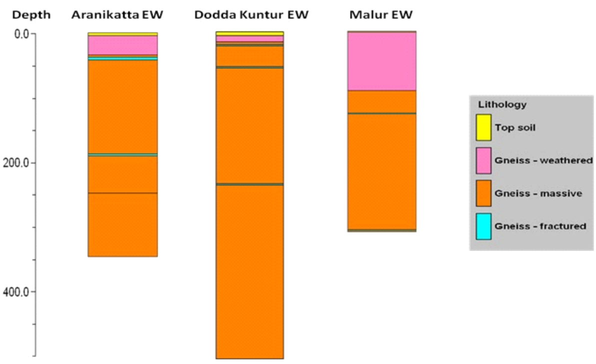

Fig. 5: The 2D lithologs of individual exploratory wells in Malur Taluk.

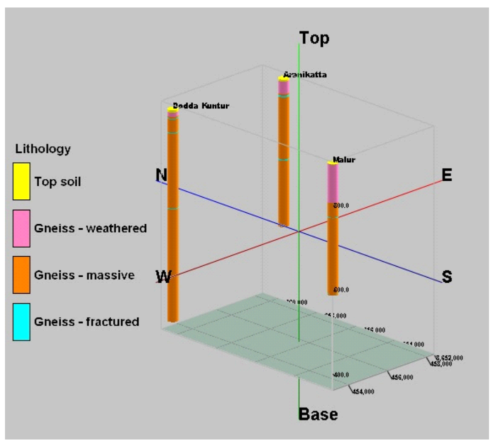

Fig. 6: The 3D multiple litholog of three exploratory wells in Malur Taluk.

Fig. 7: Dried up and abandoned dug well at Malur village.

Fig. 8: Dried up abandoned irrigation dug well at Rajena Halli village.

Fig. 9: Dried-up tank at Nallanda Halli.

Fig. 10: Dried-up tank at Rajena Halli.

Fig. 11: Agricultural land replaced by eucalyptus plantation near Malur town.

Fig. 12: Ruined coconut plantation replaced by eucalyptus plantation at Kudenur.

Fig. 13: Drip irrigation adopted by farmer Shankarappa at Yesvantpur.

Fig. 14: Drip irrigation at K.G Halli village.

Fig. 15: Check dam.

versely affected the drinking water needs of the people in the area. Two decades back, open wells catering to the irrigation needs as well as drinking water needs of the people, were gradually replaced by shallow bore wells ranging in depth from 90 m to 200 m. At present, these shallow bore wells are replaced by deep bore wells ranging in depth varying from 200 to more than 300 m. Even many of these bore wells are dry or sustain pumping with intermittent discharge. As per the CGWB data available, there is a declining trend

Table 2: Details of exploratory wells drilled by CGWB in Malur taluk, Kolar district, Karnataka.

Sl.No.	Location	Depth Drilled (m bgl)	Casing Lowered (m)	Zones encountered (m bgl)	Discharge (lps)	SWL (m bgl)	Formation
1	Malur EW	311.25	94.00	126-128,163-165,308-309	7.90	193.85	Granitic gneiss
2	Malur OW	310.50	64.35	85-96,301-302	2.9	196.51	-do-
3	Doddakuntur	500.70	15.22	19-21,53-55,232-234	2.00	83.77	Gneiss
4	Aranikatta	349.20	34.25	38-42,189-192	0.50	34.24	Gneiss

Table 3: Details of bore wells fitted with hand pumps and with submersible pumps for rural water supply schemes in Malur taluk.

Sl No.	No. of bore wells drilled for water supply	No. of bore wells fitted with hand pumps	No. of bore wells fitted with submercible pumps for piped water supply	No. of bore well fitted with sub-mercible pumps for mini water supply
1	796	636	45	115

water level at 0.6 m/annum. A total of 5677 irrigation wells has dried up in the taluk. Areas once covered by groundwater irrigation, have to depend upon uncertain rainfall at present. Farmers are losing their livelihood and many are forced to migrate to urban city for their livelihood.

GROUNDWATER MANAGEMENT

Planning for the development of natural resource, especially the groundwater, it is essential to have information about the magnitude and extent of its availability for exploitation to ensure a continuous supply and to avoid danger of over-exploitation and other harmful effects (Jacob et al. 1999) During the survey in Malur taluk, it is noticed that a large number of bore wells were drilled in such a way that the spacing between the wells is not at all taken into consideration. This adversely affects the groundwater body and the natural groundwater system. Advanced groundwater irrigation systems like sprinkler irrigation and drip irrigation help in managing this valuable resource (Srinivasa Rao et al. 2000). Presently a small number of farmers are adopting drip irrigation in few villages (Figs. 13 and 14). This type of irrigation system is to be adopted by each and every individual farmer in all over the area to minimize the groundwater withdrawal.

It is necessary to manage the water resources in scientific way, by adopting water conservation, efficient use of water in irrigation, crop management, social forestry, etc., has become important for the area with an integrated approach (Jacob et al. 1999) The following integrated approaches have to be initiated.

- The area receives very scanty rainfall during southwest monsoon season. However, sometimes during the northeast monsoon season the area receives heavy rains. During such time of torrential rains, surface runoff available in streams, which can be utilized for artificial recharge of groundwater.
- The suitable artificial recharge structures like check dams (Fig. 15), sub-surface dykes and nalabunds can be constructed at selected places.
- There are a large number of dug wells, which are dry since last two decades. Farmers can make use of these dug wells for recharge of groundwater by diverting the surface run off available during monsoon period to these dug wells.
- Bunds in agricultural lands, contour bunds in the area having rolling topography and trenches will also help for recharging of groundwater.
- Roof top rain water harvesting is also the best option.
- It is the right time to create the awareness among the public, especially farming community, for conservation of groundwater and how the farmers are responsible for groundwater level decline by exploitation of groundwater for their irrigation needs.
- Conducting mass awareness programmes at taluk/village levels is also essential to conserve and protect this precious resource for future generation.

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