

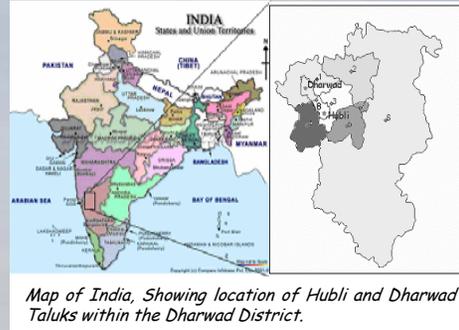
Artificial Groundwater Recharge and Water Quality around Hubli-Dharwad, India.

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Introduction

A water resources assessment of peri urban villages around Hubli - Dharwad, Karnataka, India, was conducted as part of a wider resources and development project. Since 1956 Hubli - Dharwad has relied on piped reservoir sources, while the rural areas have increasingly relied on boreholes. Increasing amounts of water are now being abstracted for irrigation in rural areas and many boreholes are now dry or have water with amounts of dissolved solids which damages some crops.



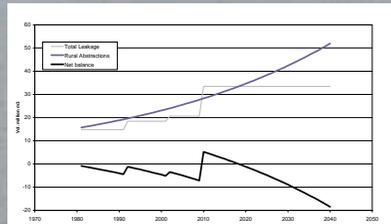
Reservoir	Water supplied ⁽¹⁾		Leakage		
	Contribution	Total (T _w)	Mains (M) = 40% of T _w	Sewage (S) = 30% of (T _w -M)	Total (T _l) = M+S
1956 Neersagar (unenanced)	6.6	6.6	2.6	1.2	3.8
1967 Neersagar (enhanced)	13.1	13.1	5.2	2.4	7.6
1983 Malaprabha stage 1	12.4	25.5	10.2	4.6	14.8
1993 Malaprabha stage 2	6.2	31.7	12.7	5.7	18.4
2002 Malaprabha repaired pipeline	3.7	35.4	14.2	6.4	20.5
2010 Malaprabha stage 3	22.3	57.7	23.1	10.4	33.5

Artificial Water Balance

In urban areas the water supply network has been extended beyond its original design capacity and leakage rates are estimated at around 40% of the water supplied. There are no sewage treatment facilities for Hubli - Dharwad, 30% of sewage goes to cesspits and then seeps into the ground, whilst the remainder enters the sewerage network and drains into local rivers⁽¹⁾.

Water abstractions take place mainly rural areas. Abstractions are assumed to grow at 2%⁽²⁾. The volume of water leakage and sewage seepage was calculated from figures of actual and projected water supply rates⁽³⁾.

The net balance of water abstracted and leaking into the ground is generally negative, however when the third stage of the Malaprabha reservoir scheme is completed the water balance will be briefly positive.



Net water balance between artificial recharge and abstractions

Artificial recharge compared to Natural recharge

Natural recharge from rainfall was compared to water leakage and sewage seepage in the HDMC area, and abstractions across the Hubli and Dharwad Taluks. Water leakage and sewage seepage in 2002 is similar to natural recharge, increasing dramatically when the third stage of the Malaprabha reservoir scheme is completed. Abstractions were found to be a fifth of natural recharge and within limits set by the Indian Dept. of Mines and Geology⁽²⁾.

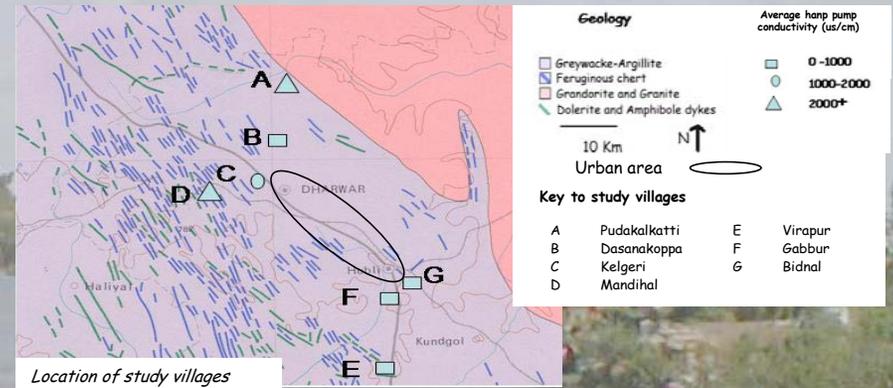
Comparison of depths of water (mm/yr) being abstracted and recharging the Aquifer (figures in brackets millions m³ applied over relevant area)

	Annual average Natural Recharge	Leakage within HDMC suburban area (280 km ²)	Abstractions within H+D Taluks (1657 km ²)
2002	53 - 85	73 (20.5)	14 (23.9)
2010	53 - 85	119 (33.5)	16 (28.0)

Water quality assessment

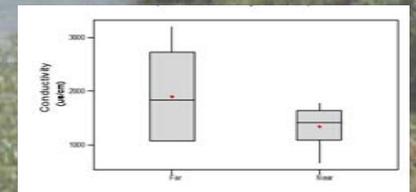
If leakage was occurring in the volumes suggested above then groundwaters within the HDMC area should be significantly more dilute than the surrounding rural area where the only recharge is from rainfall.

Water quality from 27 hand pumps in eight periurban villages was surveyed in May 2001 at the start of the monsoon. The water quality survey looked at four Near villages (2-7 km) and three Far villages (8-15 km) from the urban area located on N, S, E and W transects.



To determine if groundwaters near to the HDMC area were more dilute box plots of villages Near and Far were drawn and a Mann Whitney one sided U test conducted.

The box plots show that although the lower end for the 95% confidence interval was similar for both data sets (1095 and 1073 uS/cm respectively, but the higher end of the 95% confidence interval (1635 uS/cm for Near and 2725 uS/cm for Far) is much greater for the Far villages.



Box plots of water conductivities of hand pumps in Near and Far villages in 2001

A Mann Whitney one sided U test was confirmed that this is significant, Far villages have greater conductivities than Near. In the Near villages close to urban areas, groundwater is generally more dilute compared to Far villages in rural areas. This implies that in urban areas that more recharge than abstraction is occurring relative to the rural areas.

Conclusions

- In 2002 additional recharge from sewage and water supply leakage was equal to natural recharge and was diluting the groundwater near to the cities.
- There will be a dramatic increase in both groundwater levels and dilution of groundwaters within the HDMC and surrounding areas, when the 3rd stage of the Malaprabha starts to provide water around 2010. This will increase recharge of wells close to the urban areas, and water for informal irrigation systems next to rivers.
- Repairing leakage from the water mains would delay the need for further supplies of water from the Malaprabha, however this would reduce flows in rivers draining Hubli-Dharwad which are used for irrigation by some farmers.
- Repairing the sewerage system would reduce pollution of the groundwater under Hubli Dharwad.

References

- (1) Kulkarni S (2001) (KSPCB) Status of Sewage Treatment and Solid Waste Disposal in Hubli Dharwad city. Bhageerath workshop on water and sanitation problems in Hubli Dharwad cities. (30/5/01)
- (2) Department of Mines and Geology (1995b) Groundwater sources of Dharwad District as of 31/12/1994. Department of Mines and Geology, Government of Karnataka, Bangalore
- (3) Polisgowdar S. (2001) Long term perspective planning of water supply and sanitation to Hubli Dharwad Twin Cities. Bhageerath workshop on water and sanitation problems in Hubli Dharwad cities. (30/5/01)