Environmental Pressures in Drinking Water Supply - Observations from Karnataka

S. Puttaswamaiah

Abstract:

Drinking water, in adequate quantity and safe quality, is a basic requirement for life and determinant of standard of living of human being. Lack of access to and adequate quantity of safe water supply results in many diseases. Any type of illness, indeed, adversely affects human resource development and productivity, especially poor being worst sufferer. governments attempt to provide for adequate and safe drinking water provision for all households, supply and demand side factors of water supply determine the level of services available to people. Majority of these factors, being environmental in nature, increase with pollution, degradation and depletion of resources such as water and land limiting water supply provision and raising delivery cost. Present paper in this context examines the nature of environmental problems, causes and impacts in drinking water supply sector of Karnataka and concludes with some suggestions for problem rectification.

Key Words: Environmental Pressures, Drinking water supply, Water quality,

1. Introduction:

Drinking water, in adequate quantity and safe quality, is a basic requirement for life and determinant of standard of living of human being. However, around 22 per cent of households in India do not have access to safe drinking water sources, like tap, hand pump and tube well (Census 2001). Lack of access to and adequate quantity of safe water supply results in many diseases such as diarrhoea, trachoma, flourosis, cholera, hepatitis – A, etc. For instance, over 750 persons per lakh population suffered from diarrhoea, attributed to poor water quality drinking water. Any type of illness, indeed, adversely affects human resource development and productivity, especially poor being worst sufferer. Severity of the problem compelled the Central and State Governments to increase efforts for covering more number of households with adequate and safe drinking water supply, along with sanitation services, which coincides with one of the Millennium Development Goals identified by the UN (UNDP 2003). The National Water Policy 2002 reflects the significance attached to drinking water by stating, "adequate safe drinking water facilities should be provided to the entire population both in urban and rural areas. Irrigation and multipurpose projects should invariably include a drinking water component, wherever there is no alternative source of drinking water. Drinking water needs of human beings and animals should be the first charge on any available water" (GoI 2002).

While, governments attempt to provide for adequate and safe drinking water provision for all households, supply and demand side factors of water supply determine the level of services available to

people. From the **supply side**, it all depends upon many factors like availability of water in adequate quantity and quality, sustainability of water resources (e.g., rainfall, surface flows, groundwater availability and recharge, surface run-offs etc.), kinds of institutions and establishments, operation and maintenance of water supply schemes. Likewise, on the **demand side**, several factors such as population pressure, use and discharge of water by industries, inefficient use of land, flow of wastewater and fertilizer into water bodies and soils, inappropriate water pricing mechanisms/market and many others are contributing to the problems of quality deterioration and depletion of water. Majority of these factors, being environmental in nature, increase with pollution, degradation and depletion of resources such as water and land limiting water supply provision and raising delivery cost. Present paper in this context examines the nature of environmental problems, causes and impacts in drinking water supply sector of Karnataka and concludes with some suggestions for problem rectification.

Section II

2. Environmental Pressures in Drinking Water Supply

Drinking water, sourced from both groundwater and surface water, has been encountering resource specific problems such as depletion, deterioration in quality, etc. In Karnataka more than 90 per cent of habitations, especially rural, depend upon groundwater. The pressures exerted by supply and demand side factors have caused several env

The major environmental problems in drinking water supply include: (1) **Inadequate quantity** of drinking water supply, a problem of scarcity and governance; (2) **Scarcity of drinking water in summer months**, a problem of natural factors, seasonality, governance and management; (3) **Depletion of drinking water sources**, a problem of resource management and (4) **Deteriorating quality** of drinking water, a direct environmental problem. The nature and magnitude of these problems in rural and urban areas of Karnataka are discussed in this section.

2.1. Inadequate Quantity of Drinking Water Supply

Inadequacy of safe drinking water supply is the forerunner of several environmental problems. A certain quantity of water is essential for life and maintenance of personal hygiene[1], absence of which leads to health problems like dehydration, skin related diseases etc. Further, maintenance of clean environment becomes increasingly difficult with insufficient use of water, which creates blockages in sewerage system or spread of sanitary waste on surface that can increase pollution of resources like soil, water and even air.

[1] WHO, World Bank propose 40 LPCD of water supply

Karnataka Government, according to the Rural Development and Panchayat Raj Department[2] (RDPR), has created over 2 lakh drinking water supply schemes by the end of 2003 (Borewell with Hand pump - 1,77,879; Mini Water Supply - 19,541; and Piped Water Supply - 15,712), covering 64.7 per cent of the 56682 rural habitations with more than 55 liters per capita per day (LPCD) of water supply (GoK - RDPR 2002-03). The coverage of habitations with adequate drinking water supply increased from 54 per cent in 1999 to 64.7 percent in 2003, at an annual rate of 4.51 per cent. However, over 33 per cent of the rural

habitations are yet to be covered with adequate drinking water supply (Annex 1). The problem of inadequate drinking water supply is more acute in drought prone districts[3], where more than 30 per cent of the rural habitations do not have access to adequate water supply of 55 LPCD.

Apart from lack of coverage of habitations for safe drinking water, it is essential to see whether the stipulated norm of adequacy is actually realized or not and the water supply schemes created are functioning or not. Generally, the claim of having covered the habitations with adequate water supply appears to relate to the pumping and distribution capacity created under various water supply schemes rather than the actual service provided to the villagers (GoK, HPC Report, 2002). A study conducted by the Directorate of Economics and Statistics – Government of Karnataka showed that majority of habitations surveyed had less than 55 LPCD of drinking water supply, which is indicative of lacunae in engineering plan, capacity installation and the satisfaction derived by people (Box 1). According to the RDPR (2001) as many as 21 per cent of drinking water borewell schemes, 7 per cent of mini water schemes and another 7 per cent of piped water supply schemes were found to be defunct.

Box: 1. Actual Level of Drinking Water Supply in Rural Area (Based on sample survey - 2001)

Borewell with Handpumps - 91.7 % of 470 rural habitations had less than 55 LPCD

Mini Water Supply Schemes – Out of 646 schemes surveyed 91.48 % reported less than 55 LPCD

Piped Water Supply Schemes - 86.07 % of 977 rural habitations had inadequate water supply (< 55 LPCD)

Source: GoK, HPC Report, 2002

Access to and adequate quantity of drinking water is a major issue in urban areas also. Karnataka has experienced significant urbanisation (about 34 per cent) as compared to that at all India level (31 percent) (Census 2001), which increases the task of providing water supply services in urban areas. Karnataka Urban Water Supply and Drainage Board (KUWS&DB), the nodal agency for creating water supply and sanitation facilities to urban areas other than Bangalore, has adopted the adequacy norm of drinking water supply

[2] The nodal agency for providing water supply and sanitation services in rural areas

[3] Bellary, Bijapur, Bidar, Baglkot, Dharwad, Gulbarga, Banglaore Urban, Chitraduga, Davanagere, Tumkur, Koppal, Raichur, Gadag and Bangalore Rural

stipulated by the Central Public Health Engineering and Environmental Organisation (CPHEEO), ranging from 70 to 135 LPCD depending upon population.

Karnataka has 226 urban local bodies, and the KUWSDB has taken up drinking water supply works in about 208 ULBs. Among the 208 ULBs for which information is available only about 23 per cent of them have adequate quantity of drinking water supply. All towns in 10 districts (Bangalore Urban, Kolar, Tumkur, Udupi, Chitradurga, Dharwad, Gadag, Haveri, Raichur and Bagalkot) suffer from inadequate quantity of drinking water supply (Annex 2). Out of the five municipal corporations in only two corporations, i.e., Mysore and Mangalore, people are getting adequate drinking water (Table 1). There are about 240 Piped Water Supply Schemes, 127 Urban Water Supply Schemes and 20 Board Water Supply Schemes constructed by the end of October 2003. The progress of the various water supply schemes shows that the number of Piped Water Supply Scheme has increased from 216 in 1999 to 240 by end of October 2003, while that Urban Water Supply Scheme raised from 89 to 127. However, this increase has not been enough to provide adequate drinking water supply to urban people in many ULBs as over 77 per cent of the ULBs suffer from inadequate drinking water supply.

Table 1: Water Supply in Different Municipal Corporation Areas

Name of the Municipal Corporations	Level of Water Supply (in LPCD)	Adequate / Inadequate
1. Hubli-Dharwad	100	Inadequate
2. Gulbarga	86	Inadequate
3. Belgaum	85	Inadequate
4. Mysore	141	Adequate
5. Mangalore	152	Adequate

Source: KUWS&DB

Note: The Norms fixed for Class I towns is 135 LPCD

2.1.1. Problem of Inadequate Drinking Water Supply in Bangalore City

Bangalore, the capital city of Karnataka, is experiencing a rapid increase in population from 4.13 million in 1991 to 6 million in 2001, putting more pressure on the provision of basic amenities of life like adequate drinking water, sanitation facilities, etc. Providing adequate drinking water supply to Bangalore City is one of the important emerging issues at present. The level of drinking water supply in Bangalore city lies in the range of 105 LPCD (Annual Report 2001-2002, BWSSB[4]). But, this level of water supply is far less than the norm of 150 - 200 LPCD recommended for a city of this size by the CPHEEO (BWSSB Website). Apart from low level of water supply, even that rate is on the decline. During 1995, people in Bangalore were receiving about 145 LPCD, but the service declined to 105 in the later years. Hence, inadequate supply of drinking water is an important issue for a large metropolitan city like Bangalore.

[4] BWSSB – Bangalore Water Supply and Sewerage Board- is responsible for providing drinking water supply and sanitation facilities to the Bangalore city.

Apart from inadequate water supply another problem confronted by Bangalore is the more dependency on one drinking water source, i.e., Cauvery River, which provides over 87 per cent of drinking water drawn from river sources. The dependency on Cauvery is growing with the increased number of water supply schemes based on Cauvery water (already three schemes i.e., CWSS I, II and III are completed and CWSS IV is in progress). The increased dependency has its own demerits of high cost, etc., due to the long distance from the source. Arkavathy River is another source contributing about 12 per cent of water to Bangalore, but it is a rain-based river, which dries up during deficient rainfall years. In recent years the frequency of drying up of the T. G. Halli Reservoir on river Arkavathy has increased due to drought situations. Hence, the dependency on Cauvery has increased.

In addition to rivers, ground water is another major source of drinking water in Bangalore. There are over 7000 borewells maintained by the BWSSB, apart from over 80000 borewells maintained by private people. An Estimation by the BWSSB shows that over 103000 million liters of water per year is extracted from groundwater source, which is about 28 per cent of the total drinking water supply during 2001-02. As a result the ground water level is fast declining in Bangalore. Absence of recharging measures of groundwater and conserving rainwater, etc., have added to the problem.

2.2. Scarcity of Drinking Water in Summer Season

Scarcity or inadequate availability of water, particularly during summer months, is a major problem in the provision of drinking water supply, which results in fluctuations and irregularity and reduction in the per capita availability of water. Variations in the supply of drinking water lead to health and environmental problems, and unexpected contamination of water in distributional network attributable to development of rustiness in pipes due to reduced quantity of water supplied. In Karnataka, supply level of rural drinking water scheme goes down by 50 to 75 per cent of the intended level of the scheme during summer months according to the 'Study on Rapid Sector Assessment in Karnataka' (GoK, RDPR, 2001). The High Power Committee reveals that 13 per cent of the 470 villages based on borewell water supply scheme, 15 per cent of the 646 villages based on mini water supply schemes, and 19 per cent of 977 villages based on piped water supply schemes had irregular water supply (Box 2) (GoK, HPC Report, 2002). The problem of water scarcity is high in the drought prone districts indicating that the problem of access to water is more severe in these areas.

Box 2: Functioning of Drinking Water Schemes (Based on sample villages)			
Schemes	**Regular Water Supply**	**Irregular Water Supply**	**Total**
Bore Well with Hand Pump Scheme	409 (87)	61 (13)	470
Mini Water Supply Scheme	599 (93)	47 (7)	646
Piped Water Supply Scheme	793 (81)	184 (19)	977

Source: GoK, HPC Report, (2001)
Note: Figures in parenthesis are percentages to total

2.3. Depletion of Groundwater

Depletion of drinking water sources, be they the ground or surface water adds to further environmental problems, via shortage and deterioration of quality of water. A study by the Department of Mines and Geology (DMG) on fluctuations in ground water tables during 1978 to 1997 (Rajamarthanda, 1998), showed both fluctuations and depletion in the ground water level up to 7 meters in several districts (Annex 3). In the districts such as Bangalore, Chitradurga, Kolar and Tumkur the problems are acute. Another study by the DMG on the ground water level across the watersheds during 1999 depicted 56 watersheds as over exploited and critical, attributed to over extraction of ground water. These 56 watersheds fall in 34 taluks (Table 2), where Kolar, Tumkur, Bangalore Rural, Banglaore Urban, and Chitradurga districts have more number of over exploited and critical taluks. The drastic decline in the ground water has adversely affected over 50 per cent of villages in majority of taluks. This clearly indicates that depletion of groundwater, the major source of drinking water, would affect the availability of drinking water.

2.4. Deteriorating Quality of Drinking Water

Generally, water, which is sweet and free from odour, colour and organic and inorganic contamination, is considered as safe drinking water. The drinking water quality is determined by the presence of certain organic and inorganic substances in excess of tolerance

Table 2: Overdeveloped (Groundwater) Taluks in Karnataka

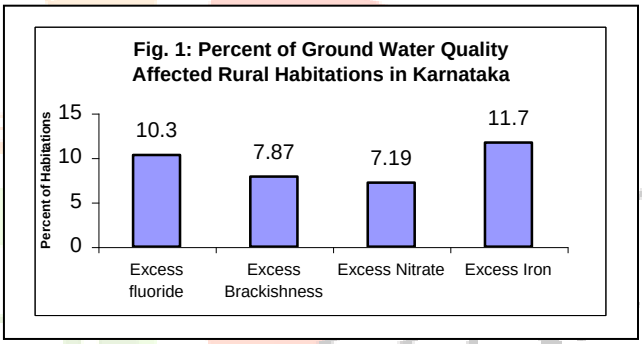
Sl. No	Districts	Taluks	No. of overdeveloped taluks	% of villages affected
1	Bangalore (U)	Anekal, Bangalore (N), Bangalore (S)	3	75
2	Bangalore ®	Devanahalli, Hosakote, Doddaballapur, Ramanagar, Magadi, Nelamangala	6	79
3	Bellary	H B Hally	1	82
4	Chitradurga	Hiriyur, Holalkere, Hosadurga	3	52
5	Kolar	Chikkaballapura, Kolar, Malur, Chintamani, Gouribidanur, Mulbagal, Sidlaghatta, Srinivaspura, Bagepalli, Bangarpet, Gudibande	11	76

6	CR Nagar	Kollegal	1	28
7	Tumkur	Koratagere, Gubbi, Madhugiri, Tiptur, Tumkur, Chikkanayakanahalli	6	70
8	Gulbarga	Afzalpur	1	57
9	Haveri	Ranebennur	1	55
10	Davangere	Channagiri	1	52
	Total		34	63

Source: Department of Mines and Geology

limits shown in Annex 4. Unsafe and poor quality water adversely affects health status of people. For instance, presence of chemicals like Fluoride in excess quantity (more than 1.5 PPM) causes dental and bone hazards, while skin rashes result by consuming water with excess brackishness. Similarly, biological or organic contamination of water may give rise to water borne diseases.

In Karnataka, ground water in more than 37 per cent of rural habitations (Fig. 1 and Annex 5) and surface water in some rivers are contaminated at the points of effluent discharge and also around urban areas. Habitations in Bagalkot, Bangalore Urban, Bijapur, Chamarajnagar, Chitradurga, Haveri, Mandya, Tumkur, Bellary, Davanagere, Kodagu, Kolar, Raichur and Koppal districts have serious ground water quality problems, ranging from 50 to 79 percent. More specifically, excess Fluoride in ground water is a major problem in 14 districts, ranging from 10 to 67 per cent of the total habitations of each district. Similarly, excess Brackishness in 13 districts (in the range of 10 to 27 % of the habitations), excess Nitrate in 8 districts (10 to 51% of habitations) and excess Iron in 12 districts (10 to 63 % of habitations) is adversely affecting drinking water quality.



The drinking water quality problem is not just restricted to rural area as majority of urban areas also are suffering with poor drinking water quality. The quality of drinking water supplied is low due to contamination of ground and surface water and also pollution caused in transmission and distribution system of drinking water. The survey conducted by the High Power Committee (GoK, HPC Report, 2002) reiterates the same. Out of 76 towns surveyed for borewell based water supply scheme, 16 per cent reported of unfitness for drinking purpose; 5 per cent of towns reported saltishness, 5 per cent hardness and 3 per cent contamination. Among the districts surveyed by the HPC, saltishness is a major problem in 33 per cent of towns in Raichur, 20 per cent in Bangalore Rural, 15 per cent of towns in Kolar, while hardness in water was reported in 50 per cent of towns in Shimoga, 40 per cent in Bangalore Rural and 17 per cent in Haveri districts. In Davanagere and Tumkur water was contaminated, respectively in 33 and 12 per cent of towns.

Similarly the water quality test for tank based drinking water schemes showed that in 8 per cent of 28 towns surveyed, the quality of water was low with high salt and hardness in water.

The surface water contamination is yet another environmental problem in Karnataka as water at certain pockets of some rivers and other water bodies is polluted. For instance, water in river Bhadra at the point of effluents discharge by the Mysore Paper Mills and Vishweshvaraiah Iron and Steel Limited, is turbid and contaminated with effluents; in rivers Kabini and Cauvery water is polluted around the townships situated on the banks of these rivers (reported in Deccan Herald, 24 February 2001). NEERI (2002) reported that in intensive mining areas of Bellary district surface water quality is characterized by neutral pH, high turbidity and suspended solids. All these evidences indicate that the quality of surface water is also depleting fast in the state.

As observed above, there is an increasing pressure on drinking water sources both ground and surface water in terms of quantity and quality in the state. The problems of depletion and deterioration of water quality can result in either sub-optimal or non-functioning of drinking water supply systems, which ultimately aggravate the problem of meeting adequate safe drinking water requirements.

3. Causes for Environmental Problems in Drinking Water Supply

While environmental problems associated with drinking water supply are many, the root causes can be fewer. The following section examines some of the causes for environmental problems in drinking water supply sector in Karnataka.

3.1. Causes for Inadequate Coverage and Depletion of Groundwater

Problem in drinking water supply are caused by both supply and demand side factors. Two major supply factors are depletion and deterioration in the quantity and quality of water. The major environmental factors causing inadequate supply of drinking water are non-availability of perennial water sources, high dependency on ground water, depletion of ground water, etc. Ground water is experiencing wide fluctuations and cyclically declining in many districts. The major causes are seasonality, geographical and geological conditions, rainfall fluctuations, low recharging rate, etc. It is important to note that as much as depletion of ground water (a supply factor), over extraction (a demand factor) is also a factor causing this depletion. The rapid and accelerated drawal of ground water to meet competing demands from various sectors like agriculture, industry, etc., are leading to decline in ground water table.

Another related cause is decline in the availability of surface water particularly during summer season, which results in inadequate drinking water supply. The supply capacity of surface sources like

rivers, lakes, reservoir and tanks also has come down due to another set of causes. The notable ones are: forest degradation and siltation, uncertainty and fluctuations in rainfall (GoK 2004). The general neglect in conserving rainwater has resulted in waste of rainfall by way of run-off and evaporation. Finally, manmade factors like discharging untreated waste, sewage flow, etc., to water bodies also lead to depletion and deterioration of water resources.

Increasing demand and hence over-exploitation are the other demand based causal factors leading to inadequate drinking water availability. There is an increasing population pressure on ground water extraction, since it is not only used for drinking purpose but also for irrigation. This can be noticed from the increased number of wells in the state from 78503 in 1987-88 to 885814 during 1999, which is the major source of drafting ground water. All these factors have reduced the quantum of ground water availability in aquifers, particularly during summer season, which results in fluctuations in the supply of drinking water.

Apart from the above (supply and demand driven) factors, lack of operation and maintenance of water supply schemes (a matter of management and governance) is another major cause for inadequate drinking water supply as rightly pointed out by the Strategy Paper of RDPR (GoK, RDPR 2000). Other management related causes, which can be attributed to variations in supply of water are leakage in distribution network, and power fluctuations, making water supply schemes sub-optimal (GoK, HPC, 2002). Leakage and unaccounted use of water cause disparity in the distribution network, all of which lead to reduction in the actual quantity of drinking water supplied. In urban areas loss of water through leakage is a major cause reducing the quantity of water supplied, but precise information on the quantity of water lost in the distribution network[5] in the state is not available. However, the enormity of the leakage problem can be visualized from the data on leakage in Bangalore City, which is around 35 per cent of the flow of water according to BWSSB engineers. The leakage is caused mainly due to corroded pipes in the distribution network, damages caused during road widening and repair works and use of inadequate quality pipes in majority of household connections.

Out of 161 ULBs with inadequate water supply, 40 ULBs have adequate supply at bulk level, but faulty distribution system has caused leakage and thus reduction in the quantity supplied at consumer end.
Source: KUWS&DB

3.2. Causes for Deterioration in Drinking Water Quality

Various factors, such as natural, man-made (or demand driven) and institutional (like lack of monitoring system), are responsible for deterioration in drinking water quality either at source or in the distribution system. Quality of ground and surface drinking water is affected by factors like (1) Natural factors such as geological and geographical characteristics leading to inorganic contamination of water

[5] A nationwide study conducted by National Environmental Engineering Research Institute (NEERI) showed that about 17 to 44 per cent of the total flow in the distribution system is lost through leakages in main, communication and service pipes and leaking valves (quoted in Suresh Website).

resulting in excess Fluoride, Iron, Nitrate, etc. and (2) Manmade factors like over extraction of ground water, discharging pollutants to surface and ground water bodies, inadequate and improper drainage and sewerage systems, etc. The common practice of using open places for defecation, activities like washing, bathing around water bodies, inadequate and improperly designed sanitation facilities pollute the water bodies. Discharging of industrial effluents is one of the major causes for decline in the water quality. Studies conducted by the DMG on the quality of water in the vicinity of major industrial locations[6] revealed that in 93 per cent of the stations the ground water quality had exceeded the IS:10500-1991 (drinking water standards) permissible limits for Total Dissolved Solids (500 mg/l). A study conducted team from Bangalore University – Civil Engineering Department, showed that in urban areas of Chikkaballapur and Mandya ground water was contaminated with Nitrates and Chlorides above the permissible limits, because of inadequate and improper design of sanitation facilities (reported in Indian Express, Dec. 22, 1998). Another study by the Central Ground Water Board showed the Nitrate level between 147 mg/liter to 550 mg/liter in some rural habitations of Bangalore Rural district. The experts state that improper sanitation system is one of the causes for high level of Nitrate in ground water (reported in Deccan Herald, 14th March 2003). Surface water quality is also adversely affected at several places due to discharge of industrial effluents, urban wastes, etc., in the State.

Apart from the source level pollution, drinking water is also likely to get contaminated in the distribution network when the sewage or other waste materials get mixed with drinking water at the broken or leaking pipes. There is a major cause for contamination of water in urban areas due to inadequate sanitation system. Improper siting of water points particularly in low lying areas, unhygienic practice of collecting water by households from pits dug in the ground due to inadequate residual pressure in the distribution pipe, etc., also adversely affect the water quality.

Referring to institutional factors, lack of drinking water quality monitoring system is another major cause for quality deterioration. In the State even now there is no agency with a well-defined mandate for routine water quality monitoring, particularly in rural areas. Various institutions like Department of Health and Family Welfare, Department of Mines and

Geology, District Level Laboratories of Zilla Panchayat (ZP), Pollution Control Board, etc.,

are all involved in testing water quality. But, many of these institutions lack either adequate equipment for testing of chemical and bacteriological contamination of water, trained staff, etc., or there are serious coordination problem among all these facilities. It should be noted that out of 18 District Level Laboratories of ZP 11 are not functioning (GoK, RDPR 2001). All these factors add problems to water quality monitoring.

[6] Attibele and Jigani (Bangalore Urban) Devanahalli and Bidadi (Bangalore Rural), Malur (Kolar), Nanjanagud (Mysore), Aurad

4. Impacts of Environmental Problems in Drinking Water Supply

The environmental problems in drinking water supply lead to different types of impacts both environmental and others. Two major impacts that are discernible are on the status of health (see Box 3) and the other impacting the water bodies and other resources.

Box 3: Diseases Transmitted through Water
1. Water Washed Diseases – scabies, trachoma, with inadequate water for personal hygiene causing spread to occur through water used for bathing **2. Water Based Diseases** – infections transmitted through aquatic invertebrate animals e.g., Leptosopirosis and guinea worm **3. Water Related Vector Borne Diseases** – infections spread by insects that depend on water through vector breeding in water – malaria, filariasis, dengue fever, Japanese encephalitis. **4. Water Borne Diseases** – through faecal contamination – gastroenteritis, cholera, typhoid, Hepatitis A, etc.

Source: Adopted from Gleik (1998)

4.1. Impacts of Inadequate Water Supply

Consumption water less than required quantity causes 'water washed diseases' like scabies, fungal infections, trachoma, etc. In many rural habitations of Karnataka health problems due to inadequate water use are observed. Further, inadequate water use creates blocks in sewage flow, which contaminates water sources. Irregular water supply contaminates water in distributional network due to rusting of pipes, etc., and insufficient water flow creates back syphonage of water due to low pressure in the distribution system leading to contamination of water and health problems. In some villages (Jagalur Taluk in Davanagere district) skin diseases were reported as people stopped bathing due to shortage of water (reported in Deccan Herald, March 12, 2003).

Apart from health effects, inadequate water supply increases the hardship on women and children, as they have to spend more time and energy in collection of water. Loss of water in distribution system adversely affects the poor and vulnerable people and those who live in outlying areas, as they will be compelled to buy water from private people or go to distant place for collecting drinking water.

4.2. Impacts of Depleting Drinking Water Sources

Depleting water resources, i.e., unsustainable drinking water sources results in shortage of water availability. This is already being witnessed in many parts of the state with the continued spell of drought

(Bidar), Chennagiri (Davanagere) and Machenahalli and Bhadravathi (Shimoga).

during the last four years. For instance, in many villages of Raichur, Dharwad, Belgaum and some other districts drinking water sources are dried up, causing serious drinking water problems to people. The decline in the ground water table causes geo-chemical changes resulting in wide spread chemical contamination of ground water (e.g. excess of Fluoride, Brackishness, Iron, Nitrate) which has its adverse effects on health of population.

4.3. Impacts of Poor Water Quality

Poor quality water has serious implications on health and environment. For instance, contaminated water has adverse impacts on health like disorder of teeth, bones, skin allergies, birth defects and premature infant death, water borne diseases, etc. Ground water with excess fluoride has caused Fluorosis to 1.29 lakh people in Gulgarga and Tumkur (reported in The Hindu, 5 April 2002) and to more than 25000 people in Kolar (reported in Vijaya Karnataka, Kannada Daily, 2 October 2000). Polluted ground water around Bangalore peri-urban areas is causing health problems like skin irritation, throat infection, vomiting, jaundice for children, etc., and this has resulted in an increased health expenditure of about Rs. 3000 per year per family (Diwakar and Nagaraj, 2002). Contamination of river water has led to no aquatic life like fish up to 2 Kms. range in river Bhadra from the point of effluents discharge by Mysore Paper Mills. This indicates that in general river and tank aquatic life is severely affected due to low quality water.

4.4. Health Impacts of Unsafe Drinking Water Supply

The major diseases occurring due to unsafe drinking water are gastroenteritis, cholera, typhoid and others. Table 3 presents the incidence of these diseases in the State. Gastroenteritis is the major disease with nearly 24 thousands of incidences and claiming about 200 lives during 2001. It should be noted that Viral Hepatitis is increasing rapidly in the state from 1714 cases in 1997 to 5438 cases in 2001. Malaria also has its sway as more than 93 thousand cases were proved positive during 1999. Even these are gross underestimates as the data on incidence of water borne diseases is from the Department of Health and Family Welfare, which does not include the incidence reported in private health centers.

Table 3 : Incidence of Water-Borne Diseases and Deaths

Year	Gastroenteritis		Cholera		Malaria		Viral Hepatitis		Typhoid	
	Cases	Deaths	Cases	Deaths	A	B	Cases	Deaths	Cases	Deaths
1997	23665	307	741	10	7726512	181450	1714	4	2880	5
1998	26832	501	434	2	7568155	26776	3824	2	8242	4
1999	17743	126	134	3	7405711	93651	4792	2	23946	2
2000	31132	265	354	3	131	NA	3077	10	8	NA
2001	23893	198	342	1	NA	NA	5438	28	33346	6

Source: Department of Health and family Welfare, GoK

A: Total Blood smear collected and examined B: total positive cases

5. Institutional Arrangement in Drinking Water Supply

In the provision of drinking water supply different institutions are involved, in both rural and urban areas, in activities ranging from creation of infrastructure to operation and maintenance; water quality testing and monitoring, etc. It may be useful to take a close look at the institution involved, their functions and limitations in the existing system in dealing with the environmental problems in the provision of drinking water supply.

5.1. Institutions in Rural Drinking Water Supply

5.1.1. State Level Institutions

The **Rural Development and Panchayat Raj Department** (RDPR), the nodal agency in planning, implementing, monitoring and evaluating all the rural development activities in the State, is responsible for providing drinking water in rural areas. The RDPR has different wings to carry out its programmes, shown in Table 4.

Table 4: State Level Institutions

RDPR Wings	Matters Related to Drinking Water & Sanitation
1. Area Development Programme Wing	Implementation and monitoring several programmes among which Integrated Watershed Development Programme is included.
2. Rural Water Supply Wing	This wing has two sub wings – one for External Aided Projects of Rural Water Supply and Sanitation and the other for the regular Rural Water Supply and Sanitation. The Rural Development Engineering Department (RDED) implements and monitors all programmes related to rural water supply and sanitation.
3. Karnataka Rural Water Supply and Sanitation Agency	Established by the GoK as a society under Karnataka Societies Registration Act. Implementing the World Bank aided Jal Nirmal Project
4. Panchayat Raj Wing	This wing deals with all the matters including implementation of the Zilla Panchayat, Taluk Panchayat, and Grama Panchayat.
5. a) Special Economic Programme Wing b) Finance Wing c) Plan Monitoring and Evaluation Cell d) Administrative Wing	Implement and monitors the Swarna Jayanthi Rozgar Yojana, Swavalambana, etc. Over-viewing all activities including drinking water and Sanitation.

5.1.2. Institutions at District and Lower Levels

At the district level there are three Panchayat Raj Institutions responsible in implementing the programmes, including those on drinking water supply.

Zilla Panchayat: ZP, the first tier in Panchayat Raj institutions, is responsible for planning, implementing and monitoring all the developmental programmes in the district which are being carried out by the departments such as PWD.

District Project Monitoring Unit is formed at district level under Project Planning and Monitoring Unit of ZP and responsible to oversee the activities at district level. It has technical, administrative personnel and also a social scientist.

Taluk Panchayat: Taluk Panchayat liaisons between ZP and Grama Panchayat, and responsible for implementing and monitoring developmental works at taluk level.

Grama Panchayat: As the lowest tier of Panchayat Raj institution it prepares its own plan and implements after getting approval from Taluk Panchayat. It is also responsible for collecting water charges, operations and maintenance of water supply schemes.

Village Water and Sanitation Committee (VWSC): VWSCs are developed to involve the local community participation in the project villages of the World Bank assisted Integrated Rural Water Supply and Sanitation. VWSCs play a crucial role in planning, implementation and operation and maintenance of the assets created.

5.1.3. Other Institutions

Department of Mines and Geology

The Groundwater Division of the Department conducts the activities of: (1) assessment of ground water resources in all the taluks; (2) periodic monitoring of groundwater levels; (3) monitoring of the ground water quality for various purposes; (4) determination of aquifer characteristics; (5) selection of sites and construction of artificial recharge structures; (6) selection of suitable sites for drilling borewells; (7) issue of feasibility reports/certificates; and (8) regulate development of groundwater resources in a systematic and scientific manner.

Directorate of Health and Family Welfare: This department apart from implementing various health programmes, conducts water quality testing for bacteriological contamination with its District Surveillance Unit. A district level coordination committee headed by the Deputy Commissioner of the district coordinates with all departments and reviews the surveillance of the communicable diseases including water borne diseases.

Directorate of Watershed Development: This department is concerned with carrying out activities like recharging ground water, along with several other activities like soil conservation, etc.

Irrigation Department: The irrigation department is the nodal agency for major and minor irrigation projects. Although major portion of water is used for agriculture purpose, it is also used for drinking purpose hence the irrigation department is also involved in the provision of drinking water supply.

NGOs and Community Based Organisations (CBOs): NGOs and CBOs play a crucial role in creating awareness among the communities to involve in planning, implementation and monitoring activities of drinking water projects.

5.1.4. Institutions in Operation and Maintenance of Rural Water Supply

In Karnataka, with the introduction of Panchayat Raj institutions, the responsibility of operation and maintenance of drinking water supply schemes is entrusted to Grama Panchayats. The GPs appoint pump operator and other personnel for the operation of the systems from the local villages. The maintenance of the schemes is carried out by fixing some amount of tariff for the users on adhoc basis. Taking into account the inadequate attention given by the ZPs in maintenance activities of drinking water supply schemes, and to create a sense of ownership among the GPs and users, the Government has transferred the operation and maintenance of all Piped Water Schemes and Mini Water Schemes to the GPs. Although the government is partially meeting the operation and maintenance expenditure, it is proposing to transfer the full responsibility to GPs in the coming years.

5.1.5. Institutions in Water Quality Monitoring

At present there is no well defined and conceived agency with a mandate for water quality monitoring in rural areas. The water quality in rural areas is supposed to be tested by the RDED. The RDED tests the quality of water in the newly dug borewells and if the standard (BIS) is met then the water will be supplied for use. But, after the initial testing, no regular monitoring of water quality is done.

Apart from RDED, few other institutions have the facility of testing water quality. They are:

Public Health Institute and District level Public Health Laboratories of the Health and Family Welfare Department has 28 laboratories

Public Health Institute at Bangalore, conducts test for chemical and bacteriological contamination

Three Divisional Laboratories at Gulbarga, Mysore and Belgaum: Five Regional Laboratories at Mangalore, Chikkamaglur, Chitradurga, Raichur, and Dharwad – these laboratories mainly conduct food testing and cannot be used water quality testing.

Nineteen District Health Laboratories (before formation of new districts), one at each district – 19 laboratories do not have necessary equipment and trained staff for chemical examination of water, 6 do not have the facility for bacteriological testing of water.

Department of Mines and Geology has district or regional laboratories for collection and testing of ground water samples twice a year from its observation wells. But it does not contain facility of testing for bacteriological contents.

Zilla Panchayats - District level water quality monitoring laboratories have been set up under ZP in each district. But these labs have inadequate staff to conduct tests. According to RDED out of 18 District Level Laboratories 11 are not functioning.

State Pollution Control Board has laboratories at Mysore, Davanagere and Dharwad, and Bangalore; these laboratories collect and test ambient water quality.

5.2. Institutions in Urban Drinking Water Supply

The responsibility of providing drinking water and sanitation services in urban local bodies, except Bangalore City and 8 City Municipal Councils situated around Bangalore, lies with the Karnataka Urban Water Supply and Drainage Board (KUWS&DB). The Board executes water supply and drainage schemes, and transfers it to local bodies for operation and maintenance by providing technical guidance. While it adopts population base as a norm in selecting different water supply schemes for urban local bodies, for implementing under ground drainage services all urban local bodies irrespective of population size are covered.

The Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC) is also involved in implementing urban water supply and sanitation projects through KUWS&DB.

5.2.1. Operation and Maintenance

The urban local bodies are responsible for operation and maintenance activities of water supply and sanitation schemes created by KUWS&DB. As per the Government order (G. O. No. UDD 204 UMS 95 dated 15-11-1996) the Board has to hand over the completed projects to ULBs for operation and maintenance activities (KUWS&DB, 1999-2000).

5.2.2. Water Quality Monitoring

The KUWS&DB has the facility of testing for water quality at four places viz., Mysore, Belgaum, Hubli-Dharwad and Mangalore and also two laboratories in Bangalore.

5.2.3. The Slum Clearance Board

The Slum Clearance Board, established in 1973, has the responsibility of enabling the slum dwellers to live in hygienic condition by providing basic amenities like drinking water, roads, drains, community bathrooms, storm water drains, street lights, etc. At present the Board is implementing its programmes in 21 Class – I cities of the State.

5.3. Institutional Arrangement of BWSSB

The Bangalore Water Supply and Sewerage Board is responsible for providing water supply, sewerage system and sewage disposal services to the Bangalore Metropolitan area.

Operation and Maintenance: A separate engineering section headed by a Chief Engineer is responsible for maintenance of water supply and sewerage system.

5.4. Problems or Gaps in the Institutional Structure of Drinking Water

Although different institutions are involved in the provision of drinking water supply, the institutional system has certain limitations, which are briefly discussed here with reference to the problems. There is an overlapping between state government programmes and those implemented by the externally aided agencies in the provision of drinking water services (as shown by a project of the World Bank 'Roles of Rural Local Organizations' at Institute for Social and Economic Change, Bangalore). Local organisations have not given adequate importance for operation and maintenance activities of drinking water supply schemes in both rural and urban areas, due to paucity of resources – financial and manpower (Puttaswamaiah and Shashanka Bhide 2004). The urban local bodies are responsible for operation and maintenance of water supply schemes, but, some local bodies have not taken up this responsibility from the Board, which shows lack of coordination in responsibility sharing among the organizations. There is lack of an integrated system of water quality testing and monitoring, since multiple institutions are involved in this activity, and utilisation of these different institutions is limited due to various reasons like lack of coordination, high cost, non-functionality, etc.

Another problem in the present institutional system is involvement of various institutions for undertaking groundwater recharging measures, because of the absence of an integrated agency to plan and implement programmes for rejuvenating groundwater and tanks. It seems there is no coordination between water users - public, private (for drinking water provision, agriculture, industry, etc) and agencies involved in undertaking groundwater recharging activities. Lack of an institution to promote rainwater harvesting particularly in urban areas as most of the agencies are concentrating on rural areas is another limitation.

Although different institutions are involved in providing drinking water supply there is inadequate information/data base on problems related to quantity of water supplied, water quality at source, distribution network, and consumer point, and information on health and environmental impacts.

6. Remedies/Suggestions

Considering the status of and problems in the water supply the following points might be considered to resolve the problems and augment the services. Partially covered habitations, in both rural and urban areas, should be brought under full coverage of water supply. Drought prone districts should be given high priority to resolve the problem of inadequate water supply. Drinking water quality affected habitations should be taken on first priority basis to provide safe drinking water, through alternative sources or by treating water. Operation and maintenance is a major problem in water supply system. Hence importance needs to be given to operation and maintenance activities for efficient working of the system. Waterman should be a trained /qualified personnel also for maintenance of water supply system (both quantity/quality). ULBs can consider privatisation of operation and maintenance of water supply schemes, but by protecting poor and vulnerable groups. In villages, Village Water Supply and Sanitation Committees (VWSCs) can be established, based on the World Bank project experiences in Karnataka, to supervise the operation and maintenance activities of water supply schemes. Maintenance of water quality is an important issue. A single water quality-testing agency should be promoted for both rural and urban areas, and should be informed to people on a transparent basis. A vigilance group might be created to report on quantity and quality of water supplied functioning of the system, etc., for regular and efficient functioning of the system. Water quality awareness camps should be promoted, particularly in rural areas, where groundwater quality is a serious problem. Measures need to be initiated and implemented against water polluting industries and ULBs for treating wastewater before discharging.

An integrated institutional system for groundwater conservation and recharging measures needs to be promoted as ground water is the major source of drinking water. Institutional initiatives need to be promoted for rainwater harvesting in both urban and rural areas. Attention may be given towards dual water supply system in water quality affected areas (i) one for drinking (ii) another for washing, bathing and

cleaning purposes. Utilisation of treated waste water needs to be promoted for purposes like industrial and gardening activities, for which incentives in terms of subsidized price may be considered.

Annex Tables

Annex 1: Status of Rural Water Supply in Karnataka State – 2002

Sl.	District	No. of Habitations with LPCD								
							< 55 LPCD		55 LPCD and above	Total
		0-10	10-20	20-30	30-40	40-55	No.	% to Total		
1	Bangalore ®	54	9	128	134	631	956	30.09	2221	3177
2	Belgaum	5	100	376	242	272	995	64.44	549	1544
3	Bellary	3	58	134	112	283	590	57.28	440	1030
4	Bidar	19	14	80	56	42	211	23.29	695	906
5	Bijapur	0	125	156	78	165	524	52.04	483	1007
6	Bagalkot	17	35	69	87	125	333	46.77	379	712
7	Chikkamagalore	234	22	194	121	134	705	19.79	2857	3562
8	Chitradurga	0	70	191	111	132	504	33.14	1017	1521
9	Davangere	0	24	101	121	145	391	31.94	833	1224
10	Dakshina Kannada	0	696	318	221	235	1470	47.88	1600	3070
11	Udupi	57	364	285	350	346	1402	41.38	1986	3388
12	Dharwad	15	46	70	65	49	245	54.69	203	448
13	Haveri	0	8	70	85	176	339	48.85	355	694
14	Gadag	27	10	23	30	38	128	34.04	248	376
15	Gulbarga	0	220	355	259	374	1208	62.59	722	1930
16	Hassan	0	92	597	702	532	1923	44.53	2395	4318
17	Kodagu	142	98	80	72	60	452	82.94	93	545
18	Kolar	35	59	218	176	217	705	18.29	3149	3854
19	Mandya	0	27	195	160	204	586	29.43	1405	1991
20	Mysore	3	0	97	137	303	540	26.77	1477	2017
21	Chamarajanagara	0	84	120	140	165	509	75.18	168	677
22	Raichur	48	154	113	83	131	529	37.7	874	1403
23	Koppal	0	14	46	72	133	265	33.42	528	793
24	Shimoga	4	301	297	288	178	1068	23.39	3498	4566
25	Tumkur	30	614	467	408	399	1918	37.33	3220	5138
26	Uttara Kannada	18	192	154	340	594	1298	22.74	4411	5709
27	Bangalore (U)	0	330	120	101	150	701	64.79	381	1082
Total		711	3766	5054	4751	6213	20495		36187	56682
Per cent to total no. of Villages		1.25	6.64	8.92	8.38	10.96	36.16		63.84	100.00

Source: Department of Rural Development and Panchayat Raj

Annex 2: Distribution of Towns by Level of Water Supply during 2001					
Sl. No	District	No. of Towns with Adequate Water Supply	No. of Towns with Inadequate Water Supply	Percent of Towns with Inadequate Water Supply	Total No. of Towns
1	Bangalore (U)	0	1	100	1
2	Bangalore ®	2	7	78	9
3	Kolar	0	12	100	12
4	Tumkur	0	10	100	10
5	C R Nagar	1	3	75	4
6	Mysore	2	6	75	8
7	Mandya	1	6	86	7
8	Hassan	1	7	88	8
9	Chikkamagalur	2	6	75	8
10	Kodagu	2	2	50	4
11	D Kannada	4	4	50	8
12	Udupi	0	4	100	4
13	Shimoga	6	2	25	8
14	Davanagere	2	4	67	6
15	Chitradurga	0	6	100	6
16	Dharwad	0	6	100	6
17	Gadag	0	9	100	9
18	Haveri	0	7	100	7
19	U Kannada	5	6	55	11
20	Belgaum	6	10	63	16
21	Bijapur	2	4	67	6
22	Bagalkot	1	11	92	12
23	Gulbarga	4	8	67	12
24	Bidar	2	4	67	6
25	Bellary	3	7	70	10
26	Raichur	0	6	100	6
27	Koppal	1	3	75	4
	Total	47	161	77	208

Annex 3: District-wise Water Level Fluctuations (Meters) in Karnataka

Districts	Years											
	1978	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Bangalore	9.47	10.2	10.3	9.84	10.6	11.9	10.3	12.6	12.5	14	14.9	15.4
Belgaum	10	9.3	9.8	9.07	10.1	11.9	10.5	11	9.85	17.2	12.3	11.6
Bellary	7.37	7.4	7.97	7.19	8.12	9.42	10.4	11	10.1	12.1	13.3	10.9
Bidar	10.9	12.9	11.3	10.8	9.63	10	12.7	12.4	12.6	13.6	11.4	10.7
Bijapur	7.97	9.07	8.15	7.57	7.14	9.69	8.62	9.35	9.93	11.1	11	10.5
Chikkamagalur	8.95	9.22	8.54	8.69	8.48	9.7	9.01	8.16	8.82	9.87	10.4	9.95
Chitradurga	8.06	10.4	8.85	9.25	10.7	13	13.1	12.4	12.5	16.5	16.5	13.3
D.Kannada	8.72	8.84	8.4	9.01	8.8	9	9.01	8.7	8.78	8.87	8.95	9.06
Dharwad	12.2	13.5	11.2	14	15.8	12.7	15.9	13.4	14.2	16.7	17.6	13.9
Gulbarga	7.26	8.1	6.98	7.74	6.81	6.35	8.04	8.57	8.59	9.39	7.4	7.13
Hassan	9.26	9.46	7.77	9.64	10.1	11	9.68	8.85	8.5	8.84	10.7	9.86
Kodagu	9.8	9.19	8.34	9.92	9.86	9.8	9.28	7.35	9.29	8.5	9.14	7.88
Kolar	8.68	9.48	9.52	10.4	11.6	13.4	10.4	13.5	13	13.5	14.3	13.4
Mandya	9.14	8.72	7.55	8.03	8.15	9.49	7.89	8.11	7.85	8.59	9.66	9.46
Mysore	10.2	10.4	9.72	11.1	12	13	11	10.4	10.5	10.1	11.8	11.3
Raichur	5.96	7.03	6.21	6.1	6.42	6.99	8.1	7.81	7.39	7.99	8.04	6.58
Shimoga	9.23	9.03	8.9	9.31	9.19	8.62	8.97	8.23	8.49	8.56	9.8	9.76
Tumkur	8.04	9.53	8.5	8.21	9.17	10.9	9.65	11.1	11.3	13.2	14	14.7
U.Kannada	7.83	8.7	8.79	8.59	8.76	8.27	8.35	7.98	7.8	8.02	8.24	8.12

Source: Behaviuor of Depth to Water level between 1978-97 in Karnataka State, D.Rajamarthanda, Department of Mines and Geology, GOK, 1998.

Annex 4: Standards Prescribed for Drinking Water in India

Sl. No.	Substance / Characteristics	Desirable/ Essential	Highest desirable Limit (ppm)	Maximum Permissible limit in Absence of Alternative source (ppm)
1	Calcium	Desirable	75	200
2	Magnesium	Desirable	30	100
3	Iron	Essential	0.3	1
4	Chloride	Essential	250	1000
5	Sulphate	Desirable	200	400
6	Nitrate	Desirable	45	100
7	Fluoride	Desirable	1	1.5
8	Total Dissolved Solids	Desirable	500	2000
9	PH	Essential	6.5-8.5	No relaxation
10	Total Hardness	Essential	300	600

Source: Bureau of Indian Standards: IS 10500:1991

Annex 5: Status of Water Quality by Habitations in Karnataka State – 2002

Sl No	District	No. of habitations affected by								Total No. of habitations affected	% of Affected habitations	Total No. of Habitations
		Excess fluoride	Percent	Brackishness	Percent	Excess Nitrate	Percent	Excess Iron	Percent			
1	BAGALKOTE	135	21.29	158	24.92	33	5.21	88	13.88	414	65.30	624
2	BANGALORE (U)	262	20.39	224	17.43	0	0.00	318	24.75	804	62.57	1285
3	BANGALORE (R)	406	11.96	148	4.36	411	12.1	189	5.57	1154	34.00	3394
4	BELGAUM	134	8.9	159	10.56	1	0.07	419	27.82	713	47.34	1506
5	BELLARY	489	41.87	91	7.79	38	3.25	26	2.23	644	55.14	1168
6	BIDAR	37	4.56	56	6.90	123	15.2	1	0.12	217	26.72	812
7	BIJAPUR	200	21.55	241	25.97	19	2.05	113	12.18	573	61.75	928
8	C.R.NAGAR	34	4.10	27	3.25	425	51.20	173	20.84	659	79.40	830
9	CHIKKMAGALORE	51	1.52	77	2.29	136	4.04	524	15.57	788	23.41	3366
10	CHITRADURGA	519	37.91	345	25.20	126	9.20	87	6.36	1077	78.67	1369
11	D.KANNADA	2	0.06	4	0.13	0	0.00	294	9.37	300	9.56	3137
12	DAVANGERE	358	33.03	156	14.39	288	26.57	1	0.09	803	74.08	1084
13	DHARWAD	49	9.92	115	23.28	1	0.20	74	14.98	239	48.38	494
14	GADAG	127	36.29	42	12.00	0	0.00	0	0.00	169	48.29	350
15	GULBARGA	443	19.29	59	2.57	3	0.13	148	6.45	653	28.44	2296
16	HASSAN	159	4.08	181	4.64	39	1.00	323	8.28	702	18.00	3900
17	HAVERI	77	12.22	113	17.94	130	20.63	198	31.43	518	82.22	630
18	KODAGU	3	0.52	0	0.00	6	1.05	306	53.40	315	54.97	573
19	KOLAR	509	13.60	319	8.52	1005	26.86	109	2.91	1942	51.90	3742
20	KOPPAL	477	67.28	50	7.05	0	0.00	4	0.56	531	74.89	709
21	MANDYA	158	8.44	518	27.66	51	2.72	684	36.52	1411	75.33	1873
22	MYSORE	105	5.43	434	22.44	121	6.26	288	14.89	948	49.02	1934
23	RAICHUR	322	26.42	195	16.00	129	10.58	51	4.18	697	57.18	1219
24	SHIMOGA	89	2.01	87	1.97	2	0.05	362	8.18	540	12.21	4424
25	TUMKUR	658	12.00	585	10.67	976	17.80	1490	27.17	3709	67.63	5484
26	UDUPI	11	0.20	2	0.04	1	0.02	218	3.87	232	4.11	5640
27	UTTAR KANNADA	24	0.62	74	1.90	13	0.33	145	3.72	256	6.56	3901
	TOTAL	**5838**	**10.30**	**4460**	**7.87**	**4077**	**7.19**	**6633**	**11.70**	**21008**	**37.06**	**56682**

Note: Percent is to Total Number of Habitations

Source: Rural Development and Engineering Department

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