

Water Quality and Water Borne Diseases in India: A Review

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Abstract: Climate change is impacting seriously human lives and human health in varied ways. Environmental pollution like air and water pollution are taking heavy toll on human beings. The increasing demand of water lead to its over exploitation and pollution and inefficient water use policies and methods are due to unchecked population growth and expansion of economic activities. Water quality problems are increasing and so are the water borne diseases. Various laws, policies and programmes are started by governments but the quality of water is deteriorating day by day.

Keywords: Water, Diseases, Quality, Policies, Programmes.

I. INTRODUCTION

A healthy population is essential for economic development. The poorest people on the planet suffer most from the health effects from exposures to environmental hazards like air pollution and impure water and consequently these diseases blocks the economic development. Ensuring the supply of safe drinking water in India is a constitutional provision under the Article 47, stating that clean drinking water should be provided to the citizens. The world's water is increasingly becoming degraded in quality, raising the cost of treatment and threatening human and eco-system health (Palaniappan et. al., 2010, [1]). At least 780 million people do not have access to potable water, nearly 2.5 billion people lack access to sanitation system, and 2-5 million people- mainly children die due to water borne diseases every year (Gleick 2002 [2] (UN 2009, [3]) (WHO and UNICEF 2012, [4]).

In developing countries, nearly 80 percent of illnesses are linked to poor water and sanitation conditions. Non-potable water, inadequate sanitation and poor hygiene is a main cause of cholera and many infectious diseases in the African Region (WHO, 2015, [5]). Nearly 1 out of every 5 deaths under the age of 5 worldwide is due to a water-related disease (WHO and UNICEF, 2009 [6]). Estimated 1.8 billion people drink water contaminated with *Escherichia coli*, an indicator of faecal contamination (Bain et. al., 2014 [7]).

There are many studies that observed water quality deterioration during its collection and/or storage in the home (Rajasekaran et. al., 1977 [8]) (Shiffman et. al., 1978 [9]) (El Attar et. al., 1982 [10]) (Kirchhoff et. al., 1985 [11]) (Heinonen et. al., 1988, [12]) (Molbak et. al., 1989 [13]) (Morin et. al., 1990 [14])

(Verweij et. al., 1991 [15]) (Simango et. al., 1992 [16]) (Swerdlow et. al., 1992 [17]) (Shears et. al., 1995 [18]) (Kaltenthaler et. al., 1996 [19]) (Genthe et. al., 1997; [20]).

II. REVIEW OF LITERATURE

Bedi et. al., (2015 [21]) in their paper on, "Health and economic impacts of unsafe drinking water in Ludhiana city of Punjab", highlighted that millions of people in country do not have access to safe potable water. The poor and weaker sections of the society bear the brunt of water related diseases and suffer the loss of income. The incidences of water borne diseases and their economic impact on the households are quite reasonable.

Jalan et. al., (2009 [22]) in their study on, "Awareness and the demand for environmental quality: Survey evidence on drinking water in urban India", highlighted that the demand for environmental quality is often presumed to be low in developing countries due to poverty. Less attention has been paid to the possibility that lack of awareness about adverse health effects of environmental pollution could also keep the demand low.

Raju et. al., (2007 [23]) in their working paper on, "Increasing groundwater dependency and declining water quality in urban water supply", examined that the extent of groundwater dependency and quality status in Hubli, Dharwad, Belgaum and Kolar cities has been increasing. Household survey indicated dependency of 30, 51, 37 and 100 percent while the quality analysis indicated 45, 42, 22 and 97 percent as non-potable in the above cities respectively.

Ramachandriah (2001[24]) in his paper on, "Drinking water as a fundamental right" highlighted the recent landmark judgement by the Supreme Court, placing drinking water in the list of fundamental rights. The study emphasizes that the concern of the judiciary should serve as a stern warning to the politician-bureaucrats nexus that have, in recent years, turned a blind eye to the growing pollution in Indian rivers.

Ruet et. al., (2002 [25]) in their paper on, "The water and sanitation scenario in Indian metropolitan cities: Resources and Management in Delhi, Calcutta, Chennai, Mumbai", justified that like other infrastructure in India, the urban water supply and sanitation sector (UWSS) is not on right track. Faced with increasing demand and growing pollution problems, Indian cities are not able to provide services to the people at large. Trevett et. al., (2004 [26]) in their paper on, "Water quality deterioration: A study of household drinking water quality in rural households highlighted that there is growing awareness that drinking-water can become contaminated following its collection from communal sources such as wells and tap-stands, as well as during its storage in the home.

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III. LAWS AND ACTS ON WATER QUALITY MANAGEMENT

On national and state level, several policies and regulations had been formed to restore water quality of aquatic resources and to control the contamination of water resources. Following laws and acts have been passed on water quality management:

- The Water (Prevention & Control of Pollution) Act, 1974
- Water Cess Act, 1977
- Environment (Protection) Act, 1986
- Executive Guidelines for Implementation of Water Quality Testing Laboratories (1990)
- Bureau of Indian Standard (BIS) IS: 10500 Drinking Water Specification (1991)
- National Rural Drinking Water Quality Monitoring and Surveillance Programme (NRDWQMSP) (2006)
- National Rural Drinking Water Programme (NRDWP) (2009)

- Modified National Rural Drinking Water Quality Monitoring and Surveillance Programme (2009)
- The National Green Tribunal Act (2010)

IV. NATIONAL WATER POLICIES ADDRESSING POLLUTION ISSUES

The Government of India drafted national water policies in the years 1987, 2002 and 2012. Each policy was considered as an effort to improve the previous policies to meet the contemporary challenges and to apply the modern technology and management techniques to manage country's water resources. However, there are still many issues on which there is no unanimity among the professionals and few open ended questions still exist. The main elements concerning water pollution of each of the national water policies/drafts, starting from 1987, have been given in Table 1.

Table: 1 Main element concerning water pollution in NWP 1987, 2002 and 2012

Elements	NWP 1987	NWP 2002	NWP 2012
Water Quality	Both surface and groundwater should be regularly monitored for quality. A phased programme should be undertaken for improvement in water quality. Water should be free from contamination. Potable water should be made available by government to all.	In addition, effluents should be treated to acceptable levels and standards before discharging them into rivers. Minimum flow should be ensured in perennial rivers for maintaining ecology and social consideration. Principle of "Polluter Pays" should be followed. With these additions, water quality can be checked from being contaminated, as contaminated water leads to serious health implications.	Sources of water and water bodies should not be allowed to get polluted. System of third-party periodic inspection should be involved and heavy penalty must be imposed on the basis of "Polluter Pays" principle. Quality conservation and improvements are more important as cleaning up of groundwater is a difficult task. Fines in the form of pollution of water will help in increasing the revenue and will further help in strengthening water infrastructure.
Water Conservation	Efficiency of utilization in all diverse uses of water should be improved and awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives. Conservation of water through various alternatives will make water availability in water short regions.	In addition, resources should be conserved and availability be augmented by maximizing retention, eliminating pollution and minimizing losses. For this, selective linings in the conveyance systems and other measures should be promoted. Awareness programme titled 'water as a scarce resource' will help in conserving water and enhancing the drinking water availability in urban areas.	In addition, community should be sensitized and encouraged to adapt to utilization of water as per local availability of water. Community based water management should be institutionalized and strengthened. A system to evolve benchmarks for water uses for different purposes i.e. water footprints and water auditing should be developed to promote and incentivize efficient use of water. An institutional arrangement for promotion, regulation and controlling efficient use of water needs to be established for this purpose at the national level.

Note: The review of National Water Policies of 1987 and 2002 was done by K.S. Murty in 2003 and it was, by and large, reproduced as such while the review of National Water Policy 2012 is done by the author to have a comparative view of various policies.

Source: Bedi (2013 [13]); Murty (2003 [27]).

A. Punjab Water Policy 1987

The State shall endeavor to develop and manage its river systems in accordance with the internationally accepted riparian principles. The needs of riparian/basin states should be the basis for sharing/distribution of river waters. Riparian Water Rights calls for right for water to flow onto your land

in its natural quantity and quality and right to protect property from flooding, and land from erosion.



Riparian Water Duties reminds to pass on the flow of water without obstruction, pollution or diversion affecting the rights of others, to maintain the bed and banks of the watercourse and to clear any debris, whether natural or manmade and to keep any culverts, trash screens, weirs and mill gates clear of debris.

B. Incidence of Water Borne Diseases in States of India

When the networks are empty and unpressurized for prolonged periods of time, it is possible for the contaminants to enter the pipes through leaks in the supply pipes. The situation is particularly serious in cities with unhygienic excreta disposal where sewage flows in open ditches close to water distribution pipes. In Delhi, an intermittent supply and the proximity of water and sewage pipelines were the prime suspects of a paratyphoid fever outbreak in 1996 (Yepes et. al., 2000 [28]). In four Indian town districts between 27 percent and 76 percent of samples tested positive for faecal coliforms under intermittent supply (NEERI, 1994 [29]).

The water borne diseases in India are occurring over the years despite various water quality management plans by the Government of India. Regardless of the initial water quality, unhygienic practices during collection, storage and

consumption led to diarrhea causing germs and other water related diseases (Montgomery A and Elimlech M, 2007 [30]). Incidence of water borne diseases in some selected states of India is presented in table 3. There is a wide range of water borne diseases like diarrhea, cholera, malaria, Japanese encephalitis, hepatitis, dengue, enteric fever etc. But here due to some constraints, comparative data of some water related diseases was not available.

Diarrhea is one of the most occurring diseases in most of the states of India. There were 8,501 thousand diarrhea incidences in various states in 1998, which decreased to 8,414 thousand incidences and again increased to 11,701 thousand in 2012 (Table 3). Main states affected due to diarrhea were Andhra Pradesh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. Malaria had 1661 thousand incidences in 2001 which decreased to 1537 thousand incidents in 2005 and again these decreased in 2013 to 880 thousand. The states affected with malaria were Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and Uttarakhand.

Table 2: States affected by various water quality problems

Parameter	Maximum Permissible limit	Health impact	Affected States
Fluoride	1.5 mg/l	Digestive disorders, skin diseases, dental fluorosis	Andhra Pradesh, Assam, Bihar, Gujarat, Chhattisgarh, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal
Arsenic	0.05 mg/l	Vomiting, abdominal pain and bloody rice water diarrhea	Assam, Bihar, Chhattisgarh, Jharkhand, Tripura, West Bengal, Uttar Pradesh
Iron	1 mg/l	Digestive disorders, skin diseases and dental problems	Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jharkhand, Jammu & Kashmir, Karnataka, Kerala, Manipur, Meghalaya, Mizoram, Madhya Pradesh, Maharashtra, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tripura, Tamil Nadu, Uttar Pradesh, West Bengal, Andaman and Nicobar islands, Pondicherry
Nitrate	100 mg/l	Causes Methanmoglobinemia (Blue body disease) where the skin of infant becomes blue due to decreased efficiency of hemoglobin to combine with oxygen. It may also increase risk of cancer.	Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh
Salinity	2000 mg/l	Objectionable taste to water and it may affect osmotic flow and movement of fluids	Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Pondicherry
Heavy metals	Cadmium-0.01; zinc-15 mg/l; Mercury-0.001 mg/l	Damage of nervous system, kidney and other metabolic disruptions	Gujarat, Andhra Pradesh, Delhi, Haryana, Kerala
Persistent organic pollutants (POPs)	None	High blood pressure, hormonal dysfunction and growth retardation	Delhi, Himachal Pradesh, West Bengal, Jharkhand

Source: (BIS Standards: IS 10500: 1991 [31])

(<http://www.ddws.nic.in/popups/submissionfunds-200607-195.pd> [32])

(www.cseindia.org/programme/health/pdf/conf2006/a69industrydelhi.pdf. [33])

(Khurana and Sen, Water aid, 2005 [34])

Hepatitis is also one of the water related disease. It was reported that there were 140 thousand incidences in 2000-01 which fell to 129 thousand incidences of hepatitis in 2006, which further fell to 118 thousand in 2012. The states affected by this particular disease were Andhra Pradesh, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

Water Quality and Water Borne Diseases in India: A Review

Governments of various states were successful enough in bringing down hepatitis incidences as there was a fall of 8.52 percent in hepatitis incidences in the country collectively. Table 3 is a collective presentation of incidences of various diseases in different years in different states and Table 4 presents incidence of water borne diseases in particular states in different years.

Table 3: Trends in the incidence of water borne diseases in selected states of India

Disease	Incidence (in thousands)			States affected
Diarrhea	8501 (1998)	8414 (2006)	11701 (2012)	Andhra Pradesh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal
Malaria	1668 (2001)	1537 (2005)	880 (2013)	Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal
Hepatitis	140 (2000-01)	129 (2006)	118 (2012)	Andhra Pradesh, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal

Note: Figures in brackets shows the years of study.

Source: 1. MoHFW, GOI, 2006, 2013 [35].

2. National Health Profile 2006, CBHI, DGHS – MoHFW [36]

Table 4 highlighted that Andhra Pradesh had 18, 52, 642 incidences of diarrhea in 1998 which fell to 12, 15,659 in 2006. Malaria cases were 57,735 in 2001 which dropped to 39,099 in 2005 and hepatitis cases too bowl down to 17,846 in 2006 from 27,595 in 2000-01. This shows that although there were a large number of various water related diseases in Andhra Pradesh, but the government had been successful enough in bringing down the incidences over the years.

Diarrhea cases had fallen in 2006 in comparison to 1998 in Andhra Pradesh, Delhi, Haryana, Kerala, MP, Maharashtra, Orissa, Punjab and Uttar Pradesh while the incidences had increased in Gujarat, Karnataka, Rajasthan, Tamil Nadu and West Bengal. West Bengal had a different case as there were 7, 20,352 diarrhea incidences in 1998 which increased to an astonishing figure of 26, 22,968 incidences in 2006. Malaria incidences too had increased in West Bengal. Other states in which malaria incidences had increased from 2001 to 2005 were Gujarat, Haryana, Jharkhand, Kerala, Punjab, Tamil Nadu, Uttar Pradesh, and Uttarakhand. While the states of Andhra Pradesh, Assam, Bihar, Delhi, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Rajasthan had reportedly less incidences of Malaria in 2005 as compared to 2001.

Table 4: Incidence of water borne diseases in major states of India

States	Diarrhea			Malaria			Hepatitis		
	1998	2008	Percentage change	2001	2005	Percentage change	2000-01	2006	Percentage change
Andhra Pradesh	18,52,642	12,15,659	-34.38	57,735	39,099	-32.27	27,595	17,846	-35.32
Assam	5,96,176	-	-	95,142	67,885	-28.64	-	-	-
Bihar	N.R.	-	-	4,108	2,733	-33.47	-	-	-
Delhi	1,33,089	94,398	-29.07	1,484	1,133	-23.65	4,007	4,080	1.82
Gujarat	2,07,027	3,82,056	84.54	81,347	1,79,023	120.07	3,982	9,396	135.96
Haryana	3,75,113	2,85,342	-23.93	1,202	33,262	2667.22	1,086	3,983	266.76
Jharkhand	-	14,752	-	1,30,784	1,93,144	47.68	-	51	-
Karnataka	6,74,805	9,39,221	39.18	1,97,625	83,181	-57.90	24,571	14,980	-39.03
Kerala	5,50,768	4,75,510	-13.67	2,289	2,554	11.57	5,521	7,018	27.11
Madhya Pradesh	4,79,073	3,18,935	-33.42	1,83,118	1,04,317	-43.03	6,620	2,499	-62.25
Maharashtra	10,98,750	6,95,723	-36.67	56,043	47,608	-15.05	40,962	43,215	5.5
Orissa	7,93,442	3,73,748	-52.89	4,54,541	3,96,573	-12.75	14,011	2,687	-80.82
Punjab	1,96,398	1,82,451	-7.10	604	1,883	211.75	1,796	3,829	113.19
Rajasthan	2,11,710	3,18,169	50.28	1,29,233	52,286	-59.54	1,601	3,869	141.66
Tamil Nadu	47,367	1,16,062	145.02	31,551	39,678	25.75	1,740	4,523	159.94
Uttar Pradesh	5,64,587	2,84,709	-49.57	94,524	1,05,303	11.4	988	3,716	276.11
Uttarakhand	-	94,746	-	1,196	1,242	3.84	-	3,381	-
West Bengal	7,20,352	26,22,968	264.12	1,45,053	1,85,964	28.2	5,831	7,433	27.47

NR: Not reported.

Source: 1. Ministry of Health and Family Welfare, GOI, 2006.[37]

National Health Profile 2006, CBHI, DGHS-MoHFW.[38]

MoHFW, GOI, Annual Report 2002-03.[39]

Hepatitis cases too had a downfall from 2000-01 to 2006 in the states of Andhra Pradesh, Karnataka, Madhya Pradesh and Orissa, while in most of the states the incidence of hepatitis had increased in 2006 as compared to 2000-01.

Apart from these diseases, the incidences of cancer deaths in Punjab are much higher than the accepted national and international averages. World Health Organization (WHO) reference regarding incidences of cancer was 80 affected persons from the population of one lakh while Punjab's survey revealed this figure as 90 affected persons from the population of one lakh (The Indian Express, Chandigarh, Tuesday, Jan. 29, 2013, 2:03 hrs [40]). A survey was conducted by Punjab Government in 2012 wherein it was revealed that 33,318 cancer deaths have occurred during last 5 years, out of which 14,682 were in Malwa region alone. As many as 4,000 of these deaths happened in Ludhiana.

Table 5: Water borne diseases in Ludhiana district

Period	Acute Diarrhea	Enteric fever	Hepatitis A and E	Cholera
2008	4948	2474	335	17
2009	9498	3633	356	13
2010	9527	4710	200	01
2011	18258	4545	420	07
2012	23738	3415	261	03
2013	18861	2844	05	04
2014 till September	7691	1282	00	02

Source: Integrated Disease Surveillance Programme Office, Ludhiana, 2012, CGWB (2014).[41]

V. CONCLUSION

In brief, water quality problems are due to pollution of surface or groundwater. The over- exploitation of groundwater leads to contamination of water and serious health problems crop up. The unsafe water causes various water borne diseases like diarrhea, malaria, cholera, skin infection, tuberculosis, etc. These incidences have been increasing year by year thus putting great stress on the health of the masses. Still many states suffer from the supply of contaminated water and this has led to spread of water borne diseases. So to provide safe drinking water to people various government institutions and departments are functioning so as to monitor the quality of water. But still the investment in water supply and sanitation sector and various pollution control boards does not coextensive with the health benefits. So there is a need to pump in more resources in the supply of the drinking water in the urban areas with special emphasis on the weaker sections of the society.

Despite the number of policies and programmes initiated by the government, the supply of safe drinking water in the urban areas is far from satisfactory. Therefore, the supply of safe drinking water and waste water disposal should remain as a priority area under the five year plans.

A special programme to provide the safe drinking water in the low income localities and slums should be initiated and strongly monitored for the achievement of 100 percent target.

DECLARATION

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Water Quality and Water Borne Diseases in India: A Review

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