Health and Economic Impact of Unsafe Drinking Water

A Study of Ludhiana

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The article is based on a study of the problem of contaminated water supply in Ludhiana. It finds that the incidence of water-related diseases and their economic impact on households is reasonably high. The quality of water was identified as a major problem in all the selected localities of the city. Leaking pipes, water storage and the slow movement of water during transmission and distribution contribute to health problems, especially for the poor.

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Ensuring the supply of safe drinking water is a constitutional provision under Article 47 of the Constitution. Although water is a state subjeact, the union government is responsible for setting drinking water quality standards. Water quality issues have emerged as a major concern over the last four decades, starting with the enactment of the Water (Prevention and Control of Pollution) Act, 1974. In the national development plans, water quality was not emphasised upon till the end of the Sixth Five-Year Plan. The first national initiative for providing safe drinking water was taken up in the Seventh Plan period and the National Drinking Water Mission (NDWM) was launched in 1986. The main aim of NDWM was to improve the performance and cost effectiveness of the ongoing drinking water supply programmes and policies, and to make sure that an adequate quantity of drinking water of an acceptable standard quality is made available to the people at large.

The national water policies (NWPs) of 1987, 2002 and 2012 in India emphasised that both surface water and groundwater should be monitored for quality, and a phased programme should be undertaken for improvements in water quality (GOI 1987, 2002, 2012). While access to drinking water in India has increased over the past decade, the adverse impact of unsafe water on health continues (WHO/UNICEF 2004).

There has been change in water usage, i e, from surface water to groundwater, which has controlled microbiological problems (Shah 2005), but some other problems like fluorosis and arsenic contamination have increased (Rao and Mamatha 2004; Chakraborty and Saha 1987). Excess iron is the main problem in eastern India (Smedley 1991). Around 37.7 million people in India are affected by water-related diseases every year, out of which 1.5 million children die of diarrhoea alone (Divakar and Nagaraj 2002). Thus, it shows that the investment in the water supply and sanitation (WSS) sector has not depicted commensurate health benefits.

There is a dire need to solve the twin problem of sustainability of water resources and water quality. Water quality problems are caused by the pollution of surface water and/or groundwater. Water quality is affected by both point and non-point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields, urban run-offs, and percolation of the chemical substances into the groundwater. Water quality is also affected by floods, droughts, and lack of awareness among users. This article reviews the water quality problems, and incidence of various water-related diseases and their economic impact on households in Ludhiana.

The study is based upon both primary and secondary data. Data regarding the water quality and incidence of diseases was taken from secondary sources. To work out the economic cost of coping mechanisms and disease, cross-sectional data from 360 households was collected for the year 2009-10. The different localities of Ludhiana were categorised into six income clusters as follows:

(1) Very high income group (VHIG) areas with well-planned localities and buildings, and plot sizes more than 400 square yards.

(2) High income group (HIG) areas with well-planned localities and buildings, and plot sizes varying between 250 and 400 square yards.

(3) Middle income group (MIG) areas with well-planned localities and buildings, and plot sizes varying between 125 and 250 square yards.

(4) Low income group (LIG) areas with well-planned localities and buildings, and plot sizes less than 125 square yards.

(5) Mixed areas.

(6) Slum areas.

The number of clusters falling under each income group was identified. Four localities from each income group were selected, and from each locality

15 households were surveyed. The total number of households surveyed from each cluster was 60. Hence, the total sample included 360 households from six income categories.

The water supplied by utilities and consumed by households is well recognised as a vital transmission route for infections and other water-related diseases. When there is a disease outbreak, it makes double the impact on the respondents. On the one hand, they have to pay for the treatment, and on the other, the man-days lost due to illness amount to loss of income for that period.

The calculation for the economic cost of water-related diseases was done as under:

- Total economic cost = Cost of treatment + Income loss.
- Cost of treatment of water-related diseases = Actual expenditure on treatment.
- Income loss = Total days of illness of earning members × Per capita per day income.
- Per capita per day income = Total family income of all households in the category/(number of households × working days × family size).

Water Quality

Potable water of Ludhiana was tested for quality and the testing report was carried out on 21 July 2006 (Table 1). It was found that actual pH level of the water was 7.05, whereas 6.5 to 8.5 was the desirable limit. The presence of total solids, alkalinity levels, total hardness, the presence of chlorides, sulphate, and nitrate, and fluoride concentration per milligram in one litre of water (mg/l) was measured. Faecal coli was found to be absent in the water quality testing report.

Table 1: Quality of Potable Water as Per Testing Report Conducted in Ludhiana

Parameter	Actual Value	Desirable Limit	Permissible Limit
pH	7.05	6.5 to 8.5	No relation
Total Solids (mg/l)	380	500	2000
Alkalinity (mg/l)	332	200	600
Total Hardness (mg/l)	210	300	600
Chlorides (mg/l)	30	250	1000
Sulphate (mg/l)	20	200	400
Nitrate (mg/l)	7	50	No relation
Fluoride (mg/l)	0.6	1	1.5
Faecal Coli (MNP/100 ml)	Nil	_	_

Source: City Development Plan (2006), Ludhiana.

Although as per the City Development Report, the quality of drinking water supplied to the residents is free from all types of abnormalities, the sample collected from the end use points depicted a different picture. The water sampling report of the city for the period of January 2011-May 2012, i e, for approximately one and half years, was collected from the civil surgeon office, Ludhiana (Table 2).

Table 2: Water Sampling Report of Ludhiana for the Period January 2011-May 2012

Period	Water Samples Collected	Potable	Failed	Result Awaited
January to December 2011	809 (100.00)	538 (66.50)	268 (33.12)	03 (0.38)
January to May 2012	271 (100.00)	206 (76.01)	65 (23.99)	00 (0.00)
Total	1,080 (100.00)	744 (68.88)	333 (30.84)	03 (0.28)

Source: Civil surgeon office, Ludhiana, Directorate of Health Services, Punjab, 2012.

During January to December 2011, a total of 809 water samples were collected, out of which only 538 were found to be potable and 268 failed the test, while results were awaited for three samples. During January to May 2012, 271 water samples were collected out of which 65 failed the test and 206 were found to be potable. Thus, during this period, a total of 1,080 samples were collected, wherein 333 failed the test and and 744 were potable.

Water-Related Diseases

Mostly diarrhoea, cholera, typhoid, and hepatitis A and E occur due to non-potability of water. These diseases are not exclusively due to contaminated water. But, the information available with Punjab Water Supply and Sewerage Board (PWSSB) revealed that 80% of the diseases such as diarrhoea, cholera, malaria, jaundice, skin infection, etc, are caused by unsafe water. In 2011, around 18,258 diarrhoea, 6,298 typhoid, 607 hepatitis A and E and seven cases of cholera were reported (Table 3). From January 2012 to May 2012, 9,142 diarrhoea, 2,491 typhoid, 336 hepatitis A and E cases were reported. Thus, it made a total of 11,969 cases of water-related diseases in a period of five months. But if we analyse the status of only one summer month, i e, May 2012, then it comes to light that in just one month a total of 2,816 cases were reported, which showed that the outbreak of water-related diseases is high in the summer season.

Table 3: Water-Related Diseases in Ludhiana District for the Period January 2011 to May 2012

Period	Acute Diarrhoea	Cholera	Hepatitis A and E	Typhoid	Total
January to December 2011	18,258	07	607	6,298	25,170
January to May 2012	9,142	00	336	2,491	11,969
May 2012	2,243	00	47	526	2,816
Total	29,643	07	990	9,315	39,955

Source: Personal Interview with Officials of Integrated Disease Surveillance Programme Office, Ludhiana, 2012.

Coping Mechanisms Adopted

Given the tropical climate parasites multiply rapidly. When pipes leak, impurities enter the source, and households have to filter (with reverse osmosis (RO) or otherwise) or boil water to make it fit for consumption. This creates additional monetary burden in the form of electricity and cooking gas. Poor households are unable to have these mechanisms, so they face negative health consequences such as diarrhoea, malaria, skin infections, etc. Majority of the households in the selected localities reported that the initial supply (at the time of opening the tap) of water was contaminated. The coping mechanisms, however, differed among income classes. The income classes that have access to adequate water and financial capabilities install an RO system (as the RO system wastes a lot of water), while others strain and boil the water.

The use of various coping mechanisms by various categories of households is given in Table 4 (p 25). It is quite clear from the table that majority of households in the selected income classes except slums prefer to install an RO or "aquaguard" to purify contaminated water. In VHIG houses, there were some households where both RO and "aquaguard" were used, which may be due to multiple kitchens in the house.

The investment and repair cost per household of these gadgets is an additional burden on the households. The investment cost per household of RO in

VHIG, HIG, MIG, mixed and LIG was Rs 18,400, Rs 14,500, Rs 11,375, Rs 9,667 and Rs 8,500, respectively. Similarly, for "aquaguard" the investment cost was Rs 8,100, Rs 7,167, Rs 6,500, Rs 6,167, and Rs 4,625, respectively. Every year these gadgets need servicing or repairs if there are any problems. On an average, approximately Rs 600 to Rs 1,200 was being borne by various households in different income classes as repair costs.

Table 4: Coping Mechanisms Adopted by Respondents

Sources	VHIG	HIG	MIG	LIG	Mixed	Slum
Reverse Osmosis (RO)						
No of households	42	24	22	12	18	0
Percentage of user households	70	40	36.67	20	30	0
Investment cost per household (Rs)	18,400	14,500	11,375	8,500	9,667	–
Safety level of the mechanism (%)	97	93	93	75	87	–
Repair cost per household (Rs)	1,210	1,000	950	800	933	–
Aquaguard						
No of households	21	24	24	12	18	0
Percentage of user households	35	40	40	20	30	0
Investment cost per household (Rs)	8,100	7,167	6,500	4,625	6,167	–
Safety level of the mechanism (%)	95	91	85	72	81	–
Repair cost per household (Rs)	960	892	1,350	637	707	–
Boiling						
No of households	0	0	0	7	6	9
Percentage of user households	0	0	0	11.67	10	15
Investment cost per household (Rs)	–	–	–	90	100	66
Safety level of the mechanism (%)	–	–	–	65	60	72
Filter through cloth						
No of households	0	0	0	0	0	5
Percentage of user households	0	0	0	0	0	8.33
Investment cost per household (Rs)	–	–	–	–	–	80
Safety level of the mechanism (%)	–	–	–	–	–	55

Source: Bedi (2013).

Table 5: Incidence of Water-Related Diseases

Diseases/Income Class	VHIG	HIG	MIG	LIG	Mixed	Slums
Diarrhoea						
Total no of members	405	399	373	363	387	459
No of members affected	4	3	6	16	5	41
Days of illness per person	7	7	5	4	6	8
Total treatment cost (Rs)	2,600	2,300	1,800	1,600	1,750	1,221
Treatment cost per capita (Rs)	650	766.67	300	100	350	29.78
Malaria						
Total no of members	405	399	373	363	387	459
No of members affected	0	11	17	14	9	11
Days of illness per person	0	5	6	12	7	5
Total treatment cost (Rs)	0	3,000	2,600	2,300	2,425	1,655
Treatment cost per capita (Rs)	0	272.73	152.94	164.29	269.45	150.45
Cholera						
Total no of members	405	399	373	363	387	459
No of members affected	0	0	7	10	4	28
Days of illness per person	0	0	3	3	4	4
Total treatment cost (Rs)	0	0	2,000	1,800	2,300	1,800
Treatment cost per capita (Rs)	0	0	285.71	180	575	64.29
Others*						
Total no of members	405	399	373	363	387	459
No of members affected	6	16	26	28	18	25
Days of illness per person	6	7	5	7	6	6
Total treatment cost (Rs)	2,800	2,362	2,100	1,900	2,050	1,700
Treatment cost per capita (Rs)	466.67	147.63	80.77	67.85	113.89	68
Total						
Total no of members	405	399	373	363	387	459
Total no of members affected	10	30	56	68	36	105
Total days of illness Per person	13	19	19	26	23	23
Total treatment cost (Rs)	5,400	7,662	8,500	7,600	8,525	6,376
Treatment cost per capita (Rs)	540	255.40	151.78	111.76	236.81	60.72

*Others include skin infection, hepatitis, hookworm infection, trachoma, typhoid, etc.
Source: Bedi (2013).

About 11.67%, 10%, and 15% respondents from LIG, mixed, and slums, respectively, use boiling as coping mechanism to purify water. The average safety level percentage through boiling of water as described by residents of LIG, mixed and slums was only 65%, 60%, and 72%, respectively. None of the respondents from VHIG, HIG and MIG houses use boiling as coping mechanism for purifying contaminated water. Water filtration through clothes was not common even in slums, where only 8.33% respondents use it. The safety level percentage of water filtration through clothes was very less, i e, about 55%.

RO and "aquaguard" can be used by only those who have the capacity to buy these appliances and reasonable quantity of water is being available to them. So if purified water is supplied to households, there is no need to install RO or "aquaguard". But the source of water is contaminated and families want purified water for their children so as to protect them from diarrhea, cholera, malaria, etc.

The Economic Cost

The water-related diseases which mainly affect children and other family members are diarrhoea, malaria, cholera, skin infections, etc. Diarrhoea may be caused by other means, but contaminated water is the main cause for diarrhoea. Malaria is caused by a parasite transmitted by infected mosquitoes. The parasites that often cause malaria need warm temperatures to grow and thrive, so the disease is typically found in tropical and subtropical countries. Cholera is typically caused by contaminated food or water. In areas with poor treatment of sewage and drinking water, the faeces of people with cholera can enter the water supply and spread quickly, resulting in an epidemic. The causes of all these diseases are varied, but these diseases are said to be mainly water-related diseases.

The number of members affected by various water-related diseases was higher in slums (105), followed by LIG (68), MIG

Table 6: Per Capita Economic Cost of Water-Related Diseases for Those Who Fell Ill (Rs)

Cost	VHIG	HIG	MIG	LIG	Mixed	Slums
Per capita cost of treatment	540	255.4	151.78	111.76	236.81	60.72
Per capita income loss	5,187.26	6,266.96	4,200.14	3,274.14	3,077.63	787.29
Per capita economic cost	5,727.26	6,522.36	4,351.92	3,385.90	3,314.44	848.01

Per capita per day income of VHIG, HIG, MIG, LIG, mixed, and slums are Rs 399.02, Rs 329.84, Rs 221.06, Rs 125.93, Rs 133.81, and Rs 34.23, respectively.
Source: Bedi (2013).

Table 7: Economic Cost of Diseases on Proportion of Average Per Capita Income in Various Categories

Categories	Per Capita Annual Income (Rs)	Per Capita Annual Economic Cost (Rs)	Per Capita Economic Cost as Percentage of Per Capita Income
VHIG	1,45,642.30	5,727.26	3.93
HIG	1,20,391.60	6,522.36	5.42
MIG	80,686.9	4,351.92	5.39
LIG	45,964.45	3,385.90	7.37
Mixed	48,840.65	3,314.44	6.78
Slums	12,493.95	848.01	6.79

Source: Bedi (2013).

(56) and mixed areas (36), and very less in the HIG (30) and VHIG (10) classes. The days of illness per member in slums were very high, i e, 23 days (Table 5, p 25). The number of members affected was calculated totally, i e, children and adults were taken together. So if a child suffers, they will miss school due to illness. The recurrent illness makes them susceptible to infections, and thus incapacitates them from attending school regularly and affects their scholastic performance. And, if an adult suffers, it means they will miss work and they lose income for that period.

Diarrhoeal diseases were also there in the selected localities. Diarrhoeal disease also represents an economic burden since patients with diarrhoea are often treated with expensive drugs. This was also justified by study, wherein, the average treatment cost of a patient was approximately Rs 650, Rs 767, Rs 350, Rs 300, Rs 100, and Rs 30 for VHIG, HIG, mixed, MIG, LIG, and slums, respectively.

Similarly the other water-related diseases like malaria, cholera, skin infections, etc, too are an additional burden on the households. The total economic cost of water-related diseases includes cost on treatment and income loss in case of working members (Table 6). It is the poor who bear the heaviest burden as their incomes are so meagre that they cannot afford better health services. This creates an unnecessary monetary as well as physical burden on the people. The rich avail the best possible medical services available. The per capita cost of treatment of the rich was almost nine times that of the slum dwellers, more than double of that of mixed and HIG households, about five times that of the LIG households and 3.5 times that of MIG households (Table 7). However, the per capita economic cost as the proportion of the average per capita income was only 3.93% in VHIG households, which increased to 5.42%, 5.39%, 7.37%, 6.78%, and 6.79% in HIG, MIG, LIG, mixed, and slum households, respectively. This shows that the relative burden of the diseases is higher on the low income category of households.

Conclusions

It can be concluded here that although the quality of water at the source is suitable for human consumption, it gets polluted during its transmission from the source to the end use. A number of government institutions and departments are functioning to monitor the quality of water. But, the investment in water supply and sanitation sector and measures taken by various pollution control boards still have not brought the intended health benefits. Various water purifying mechanisms have been used by households, but the incidence of water-related diseases is still there. Per capita economic cost of water-related diseases led to additional monetary burden on the households. The low income households spent a relatively higher proportion of their income to cope with the water-related diseases. Thus, it further compounded the economic stress on these households.

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