

WATER POLLUTION; SOURCES, EFFECTS AND STRATEGIES FOR PREVENTION IN GAMPAHA DISTRICT

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Abstract: Water pollution has become a critical issue with rising population by urbanization and development activities especially in the urban areas of Sri Lanka. Due to industrial effluents, dumping of solid waste, open excretion, seepage of chemicals and pollutants, water in Gampaha district got polluted and cause life- threatening diseases. In order to improve the health status of the people in these areas, there is a vital need to study the sources, effects and to propose strategies for prevention of water pollution in Gampaha District.

Proportionate sampling was done from five Divisional Secretariats in Gampaha district and total of 100 households were studied. Descriptive statistics, Multiple linear regression and Chi-square analysis were used to analyse the data.

The study revealed that all the households had knowledge on water pollution and related impacts. About 47% of households faced problems on contamination of water in Gampaha District and majority of them thought that the pollution may be due to industrial and agricultural activities. Inevitably, almost all households were affected by water related diseases and 93% households were mainly affected by Amoebiasis due to the water pollution. On average, each household spent Rs.1172.70 per year for treating water related diseases. Majority (96%) of households were using water supply for their daily use due to the lack of space to construct well within the premises. About 88% of households disposed their wastes in open places. Majority of the households were boiled the water and used water filters to purify their well water before use. The average cost for purification methods was Rs. 3531.31 per month and the average cost for alternative water source was Rs. 1078.60 per month.

Multiple linear regression analysis results showed that type of water used for drinking purpose significantly influenced the cost for alternative water sources (p<0.01). And major problems with getting good quality water significantly influenced the cost for alternative water source (p<0.05). An increase in total income per month by one rupee will decrease the cost for alternative water sources per month by 3 Cents (p<0.05).

It is recommended that the public and private health sectors must take initiatives to educate the people and the government must take immediate measure to carry out water testing to analyse the quality of water in wells in Gampaha district. And there should be an initiative to have a small scale purification device to reduce the risks of pollution.

Key words: Water Pollution, Purification, Treatment

Introduction

With an expanding population and increasing demand, the need for clean water is a growing issue in the world today. In recent years the awareness and attention to this impending crisis has increased, but it still remains a major crisis in countries across the globe and has yet to be resolved [1]. The quality of water is affected by human activities and is declining due to the rise of urbanization, population growth, industrial production, climate change and other factors. The resulting water pollution is a serious threat to the well-being of both the Earth and its population.



Sri Lanka is acutely facing water pollution problem mostly due to increased human population sedimentation of water bodies is another adverse effect due to the improper agricultural activities in Sri Lanka [2]. Gampaha district is one of the most populated districts in the country[3]. Agriculture-related water pollution is also a serious concern in major agricultural areas in the country [4].

Toxic chemicals then enter the county's water system and are delivered to other parts of the country, for example via the Mahaweli, Kelani, Walawe and Kalu, rivers causing health problems to those who rely on these water sources for their drinking water. The Kelani river is the major drinking water source for the capital Colombo and Gampaha the two most highly-populated districts in the country [5]

In Gampaha District there are industries which cause water pollution direct and indirect; Pugoda textile industries, McCallum beverage factory and other beverage factories, rubber latex factories, milk food industries, steel manufacturing factories, plywood factories, fertilizer manufacturing petroleum factories, refinery-Sapugaskandha, chemical industries (soap, detergents, and pharmaceuticals) and industries within the Biyagama Export Promotion Zone [6].

The response by the government of Sri Lanka concerning the unsafe water and related health problem needs to be urgent and comprehensive. It needs to immediately address the problem at its source by effectively regulating, monitoring and reducing the use of toxic chemicals that enter the water system, rapid urbanization, activities industrial and intensive agricultural practices (Hettige et al., 2014). Water pollution in urban areas of Sri Lanka is increasing due to contaminants, especially human waste. The major water pollutants organic matter, inorganic matter, are infectious agents, toxic organics, sediments and heat [7].

Industrial effluent discharged in open places, wastewater and sewage discharged

into open space, dumping of solid waste into open space, open excretion on canal banks and washing in the canals, surface runoff and flood and seepage of chemicals and other pollutants from upstream were some of the causes for water pollution in Gampaha District [8]

Due to these there are several effects, the polluted water contains bacteria, parasites and viruses. These cause life- threatening cholera diseases like diarrhea, and typhoid.it was also observed a lack of safe drinking water and poor sanitation in Gampaha district [9]. The lakes are polluted and that are unhealthy for swimming, fishing or aquatic life which also reduces bio diversity and aquatic life. In order to improve the health status of the people in these areas, there is a vital need to study the sources, effects and to propose strategies for prevention of water pollution in Gampaha District.

To identify the sources, effects and to propose strategies and remedial measures to prevent water pollution and related issues in Gampaha District. Specific Objectives of the study were to find the possible causes of water pollution in Gampaha district, to find out the effects of water pollution and to propose possible strategies and remedial measures to reduce or prevent water pollution in Gampaha district.

Methodology

This study was conducted in five Divisional Secretariat Divisions in Gampaha District which were Gampaha, Kelaniya, Biyagama, Negambo and Ja Ela. 25 samples were collected from Gampaha and Ja Ela D. S Divisions. 20 samples were collected from Biyagama D. S Division and 15 samples were collected from Negambo and Kelaniya D.S. Divisions. Primary data were taken from personal interviews with household heads using a questionnaire.

Secondary data were obtained mainly on population density, occurrence of water related diseases, quantity of water supplied through National Water Supply, types of water testing done before the study etc.



from the Divisional Secretariat, National Water Supply and Office of the Drainage Board and also from MOH which belongs to selected D.S. Divisions.

Descriptive statistics and frequency analysis were done for questionnaires to explore the socio economic status of households and regression analysis was done to measure the total cost to reduce water pollution and get safe drinking water. In the regression model cost for alternative water source per month (Rs.) was endogenously determined by different independent variables.

Results and discussion

Table 1: Individual level information

Individual Level	Percentage
Information	
Sex	
Male	99
Female	1
Civil Status	
Single	0
Married	99
Divorced	0
Widowed	1
Educational Level	
Primary (Grade 1 to 5)	02
Secondary (Grade 6 to	
A/L)	66
Tertiary (Diploma,	
Degree and etc.)	32
Other (Vocational)	0
No schooling	0
Employment	
Government Employee	30
Private Employee	32
Self-Employed	20
Businessperson	14
Unemployed	0
Student	0
Retired	3
Not working	1

The majority of the household heads in the surveyed area were male (99%) and most of the participants were married (99%). Majority of the household heads (32%) were private employees, 30% of household heads were government employees and 20% of them were self-employees

General knowledge on water pollution

Table 2: Information on water pollution in
study area

Knowledge on water pollution	Percenta
Knowledge on water pollution	ge
Know the sources of water pollution	
in their area	100
Knowledge about industries in the	
area causing water pollution	95
Knowledge on polluted major water	
source	100
Knowledge on their well polluted by	
flooding	17
Knowledge on the use of alternative	
water sources	100
Drinking the water after observation	20

The entire household (100%) heads had the knowledge on the sources of water pollution in their area. About 95% of the household heads stated that industries cause water pollution directly or indirectly in their area.

Table 3: Types of sources of water pollution in study area

Types of source of water pollution	Percentage
Industries (directly or Indirectly)	95
Agricultural activities	97
Household wastes	92
Other sources	5

(Multiple Response)

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The results indicated that 95% of households stated that industries were one of the major sources of water pollution while 97% of households said agricultural activities also contribute on pollution and 92% of households said household waste also cause water pollution.

Table 4: Types of alternative water sources	used
among households	

Alternative water source	Percentage
Water supply	96
Water from neighbours	15
Bottled Water	20
Other	5
(Multiple Response)	

(Multiple Response)

of From the results 96% of survey, household use water supply as an alternative source in Gampaha water District while 20% of households responded that they use water bottles for drinking purpose.

Major problems faced on access and consumption of water among households



Figure 1: Problems faced on consumption of water in Gampaha District

According to the survey results, majority (47%) of households in Gampaha District stated contamination of water was the problem and 31% of them stated that lack of water during drought period was a serious problem

Table 5:	Methods of waste and wastewater
	disposal

Present waste and wastewater disposal methods	Percentage
Open dumping	6
Treatments	0
Sediment tanks	0
Open disposal	88
Collection by local authority	76
Other (Specify)	4
$(\mathbf{M}, 1, 1, \mathbf{D}, \mathbf{N})$	

(Multiple Response)

As shown in Table 5, none of the households used sediment tanks and treatment methods dispose their to wastewater. About 88% of household used disposal open method and 76% of households dispose their waste through local authority.

Household health information

Table 6: Information about diseases

Information on water related diseases	Percentage
At least one family member	
suffered from water related	
disease	100
Got treatment for water related	
disease in hospital	85
Felt that diseases might be caused	
due to drinking of contaminated	
water	91
Doctor advised that diseases	
might have caused due to	
drinking of contaminated water	73

All of respondents stated any one of their family members was suffered from water related diseases. About 85% of them got treatment from hospital for water related diseases and 73% of them stated that doctors also advised them that the disease bv drinking might be caused of contaminated water. Now the households started to use good quality water from various sources.

Table 6: Diseases or Problems caused by	y
drinking contaminated water	

Diseases or Problems	Percentage	
Diarrhoea	25	
Cholera	9	
Amoebiasis	93	
Enteric fever	7	
Dysentery	6	
Malaria	6	
Fluorosis	1	
Skin rashes	81	
Kidney problem	2	
Other	15	
(Multiple Response)		

According to the medical records the households had, it was revealed that none of the household were affected by Typhoid, Lead poisoning, Schistosomiasis, Arsenicosis, Polio, Hepatitis A, Trachoma, Polyomavirus infection, Cancers and Reproductive problems. Majority of the household were affected by amoebiasis and skin rashes (93% and 81% respectively). (1% few percentage and Verv 2% respectively) of households were affected by Fluorosis and Kidney problem.

It was clearly observed that considerable amounts of households did not have clear ideas on the types of water borne diseases they had in the past unless they had been advised by the doctors. In China, 21 million people were affected by endemic dental fluorosis in 2003, whereas 1.3 million drinking-water-related suffered from



skeletal fluorosis. The annual incidence of typhoid worldwide at present is estimated to be about 283 cases per 100,000 The incidence rate of cholera has been low in China in recent years 0.02 cases per 100,000 were reported in 2003[10]. Therefore, the results suggested that these types of problems are very low and limited in the study area which implies the degree of pollution and its severity

Table 7: Cost for treatment of diseases

	Mean	Std. Deviation
Annual cost for treatments of disease per household	6953	1595.98
Annual cost for treatment of water related diseases	1172.7	539.49
by households		

The result of this study showed that the average annual cost for treating the diseases was Rs.6953 per household and out of this amount household were spending average of Rs.1172.70 for water related diseases only This annually. clearly showed that household were spending considerably high amount of money to treat water related diseases

Methods of Water Purification

Table 7: Information about purification methods

Purification methods use by	
household	Percentage
Chlorination	0
Boil the water	97
Using water filters	99
Local techniques	3
Other	4
Information about filters	
Commercially available filters	92
Filter by a cloth/sponge	93
Other(specify)	3
(Multiple Response)	

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According to survey results, almost all of the households knew about the purification methods. Majority of them (99% and 97% respectively) used filters and boiling the water as major purification methods. About 99% of respondent stated that they used filters and among 92% of them used commercially available filters and 93% of them filtered water by a cloth/sponge as it was easy and low cost method.

None of the household used chlorination method because of they didn't know the actual proportion of chlorine to be added to the water which clearly implies that the lack of coordination between public health sectors and the households. It is also notable that the percentage of people filtered their water significantly higher than the other studied area. In a study in North Central Dry Zone, Thirappane D. S. Division about 40% of people used water for drinking after boiling and 20% of people use water after filtering and about 40% of people use water for drinking without any treatment to the water it means they direct consume getting water from well [11]

Table 6. Cost for purification of water

	Mean	Std. Deviation
Cost for purification methods per household (per month)	3531.31	1481.36
Cost for maintenance the filter per	915.4	622.7
household (per month)		

Results of the data analysis showed that household were spending on average of Rs.3531.31 per month for purification methods and they stated that they had to spend Rs.915.40 for the maintenance of their commercial filters mainly for cleaning the filter elements monthly.

Chi-square analysis

Table 8: Chi-Square analysis between Educational level of Head of household and the selected variables

Variables	X^2	df	Р	Decision
			value	
Use of	6.572	2	P <	Significant
Boiling			0.05	
water				
Using	49.495	2	P <	Highly
filters			0.01	significant

There was a significant association observed between the educational level of household head and use of boiling water (X2=6.572, p < 0.05). Similarly, there was also a high significant association observed between the household educational level and usage of filters (X2=49.495, p < 0.01).

Table 9: Chi-Square analysis between usage of purification methods and the selected variables

Variables	X^2	df	P	Decision
			value	
Employment	32.660	5	P <	High
			0.01	significant
Water	19.192	1	P <	Highly
quality tested			0.01	significant

There was a high significant association observed between the household employment and use of purification methods (X2=32.660, p < 0.01). Similarly, there was also a high significant association observed between the usage of purification methods and testing of water quality by household (X2=19.192, p < 0.01).



Correlation analysis

Table 10: Correlation between regression variable

	Age	Education	Employ ment	Family size	Income	Type of water	Water qualit y	Major proble ms	Medica 1 expens es	Cost for alternati ve water source
Age	1									
Education	-0.002	1								
Employment	-0.221**	-0.348*	1	1						
Family size	0.661*	-0.069	0.034	0.567^{*}						
Income	0.364*	0.083	-0.005	0.051	1					
Type of water	0.022	-0.167	0.143	-0.021	-0.01	1				
Water quality	0.017	-0.075	0.037		-0.093	-0.058	1			
Major problems with getting quality water	0.039	0.19	0.038	-0.06	-0.058	-0.101	0.056	1		
Medical expenses for water related diseases	0.281*	0.122	0.059	-0.164	0.022	0.003	-0.147	-0.002	1	
Cost for alternative water source	-0.195	0.173	-0.179	-0.300*	-0.271*	-0.543*	-0.03	0.240**	0.136	1

*. Correlation is significant at the 0.01 level (2-tailed)

**. Correlation is significant at the 0.05 level (2-tailed) (Source: Survey Data, 2016)

Results of correlation analysis revealed that the cost for alternative water source was positively correlated with household's major problems for getting quality water (r = 0.24, p<0.05) while the cost for alternative water sources was negatively correlated with household total income per month significantly (r = -0.27, p<0.01). Results revealed that the cost for alternative water source was negatively correlated with type of water used by the household for drinking purpose (r = -0.55, p < 0.01) and negatively correlated with family size (r = -0.3, p < 0.01) significantly.

Table 11: Regression Analysis

	Coefficients		
	В	Std.	Sig.
		Error	
Age	6.23	818.60	0.62
Educational status	-10.34	191.62	0.96
Employment of	-96 61	67 95	0.16
household	-70.01	07.95	
Family size	-193.47	145.40	0.19
Household total income			
per month	-0.02	0.11	0.04**
Water quality	-100.26	114.87	0.38
Type of water use for			
drinking	-248.81	39.25	0.00*
Major problems with			
getting good quality water	150.08	69.20	0.03**
Medical expenses for			
Water related diseases	0.26	0.17	0.13
annually	0.20	0.17	
Constant	3788.63	818.61	0.00

*Significance at 1% level (No = 100, $R^2 = 0.452$)

**Significance at 5% level (Source: Survey Data, 2016)



Multiple regression results revealed that the R2 was 0.452 which implied that about 45.2% of the cost for alternative water source was explained by the factors such as household heads education, age, employment, family size, total income per month, water quality, type of water used for drinking, major problems to getting quality water and medical expenses on water related diseases annually. But, the cost for alternative water source was significantly affected only by household total income per month, type of water used for drinking and major problems with getting good quality water.

The results showed, type of water used for drinking purpose was significantly and negatively influenced the cost for alternative water sources (p<0.01) and also major problems with getting good quality water were significantly influenced the cost for alternative water source(p<0.05). It is interestingly noted that an increase in total income per month by one rupee will decrease the cost for alternative water sources per month by 2 Cents (p<0.05).

Conclusion

Households spent Rs.1172.70 per month for treating water related diseases in the study area. Majority of the households were used boiled water and water filters to purify their drinking water. The average cost for purification methods was Rs. 3531.31 per month. The study results revealed that majority (85%) of households expressed their unhappy on public health sector especially the visit of their PHI. It was noted that they were unhappy about PHI that they could not normally get proper scientific advice from PHI as they are more concerned on dengue related issues and not paid attention for the water related problems when they visit in the study area.

Among the Participants, almost all households used alternative water sources. The mean expenditure for alternative water source was Rs.1078.60 per month. Multiple regression results revealed that the cost for alternative water sources was significantly affected by, employment status of the household, type of water that use by household for drinking purpose and the and household's major problems for getting quality water.

It is recommended that the public and private health sectors must take initiatives to educate the people and the government must take immediate measure to carry out water testing to analyse the quality of water in wells in Gampaha district. And there should be an initiative to have a small scale purification device to reduce the risks of pollution.

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