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Solid Waste and Cost of River Water Pollution in Nepal: A Case of Bagmati River

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Abstract

Water pollution is one of the burning problems in the cities of Nepal. The present study attempts to discuss about the cost of water pollution in Kathmandu. The study is mainly based on primary information; however, secondary information was also collected to fill the data gap. Direct and indirect costs of water pollution were estimated from the findings of the study. To find direct cost of water pollution health cost i.e. loss of income due to absent working days from the sickness of water borne diseases and the medical cost are considered. Loss of tourist income and willingness to pay of the tourist is also estimated. The survey findings show total direct cost i.e. medical cost and loss of income due to the loss of working days of the residents of Kathmandu metropolis is estimated to be Rs. 1.57 million in a year. The total loss of income due to the loss of tourist inflow is Rs. 530 million and the indirect loss i.e. willingness to pay of the tourists is Rs. 54 million. The total loss due to the pollution of waster is Rs. 585.56 million in a year due to the haphazard disposal of solid waste in Kathmandu.

INTRODUCTION

Like other developing countries, Nepal is also suffering from many environmental problems. Among them, the population problems of rivers in urban areas are growing due to the rapid urbanization. Rural to urban migration continues due to facilities of markets, education, hospitals and others leading to degradation of urban environmental qualities of the country. As most of the towns and industries are situated on the riverbanks, the municipal and industrial effluents find their way into the rivers, making them unfit for drinking and other uses.

Water pollution is the most serious environmental quality issue in Nepal. It is caused by the disposal of solid and liquid wastes on land or into surface waters. The most significant wastes are sewage, industrial effluent and agricultural residuals and chemicals. Sewage originates primarily from domestic premises. Along with industrial effluents it is discharged untreated into streams and rivers, indirectly through runoff and open drains and directly via the public sewerage system. Pesticides, fertilizers, and livestock are the main agricultural sources of ground and surface water pollution.

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Bagmati one of the sacred rivers of Hindus and flowing through the heart of Kathmandu Valley has been degraded rapidly since the last 15 years. Within these years Bagmati River, which was supposed to be pristine and sacred, has become one of the major sewage and solid waste outlets of the city. The gross pollution in the river is due to rapid urbanization, the inadequacy of solid waste, wastewater, and industrial effluents disposal services and the lack of effective institute to execute the legal provisions. The degrading quality of the Bagmati River is becoming a matter of national concern (HMG/World Bank 1994).

Motivation for the study

The problem of river water pollution was not severe before 1950 because the population of Kathmandu was low and the flow of the water in the river was capable of assimilating the pollutants (mainly organic) flowing in the river. The people disposed their garbage in public open areas, scattered throughout the city. The soil of Kathmandu Valley was suitable for vegetable farming and the farmers were also experts in vegetable farming. They fertilized their vegetable crops with compost made from waste materials including human excreta, which they put in a pit known as saga, located in their land. The river became severely polluted after 1980s due to the increase of immigrant population in Kathmandu Metropolitan City. Table 1 shows the increase in population during last 50 years.

Table 1. Population Growth in Kathmandu City

Attribute	1952/54	1961	1971	1981	1991	2001
Population	1,06,579	1,21,019	15,04,02	2,35,160	4,14,264	7,87,101
Population change (%)	-	13.55	24.28	56.35	81.26	90.0
Annual Average Growth (%)	-	1.83	2.2	4.57	5.83	8.7

Source: Sharma (1989 and 1992), CBS, 2002.

The present population growth rate of Kathmandu is about 9 percent, which is the highest in the country. The above table shows that the population of Kathmandu increased over 700 percent during last 50 years. The table also shows that the rate of increase of the population was the highest during last 30 years. Thus, the problem of water pollution in Kathmandu was severe only after 1970s. The demand for the drainage of sewerage increases due to population growth. The Bagmati has different uses. It provides drinking water to the people of Kathmandu. As the population increased the demand for drinking water also increased. To meet the huge increase in demand, water was tapped from the source of the Bagmati in the first half of the 1990s which decreased flow the river. The population increase and the demand for houses intensified sand extraction from the riverbed and riverbanks. All this resulted in low level of the river and problems with assimilation or flushing of pollution.

Another important reason for the pollution of the river was the carpet industry. There

was a tremendous increase in the carpet industry in Kathmandu valley after the mid-eighties. Most of the carpet factories were located on the riverbanks of the Bagmati. The factories discharged chemicals used for washing and dying carpets directly into the river thereby acutely increasing the pollution of the river. Thus the Bagmati was polluted severely after the 1980 mainly due to rapid increase in population and carpet factories.

The river is providing a common land for the disposal of solid waste. In Kathmandu there is not any practice of door-to-door collection of waste. Thus, people residing near by the river are practicing to through the waste into the river. The Bagmati Rives flows crossing many villages. The density of some of these villages is almost equal to the density of municipalities. The villages don't have the provision of collection and management of such household and industrial waste. They normally through the waste into the near by river. Thus, one of the services that the Bagmati River is providing is the dumping ground of household and municipal solid waste.

With all these uses and misuses of the Bagmati River, it may have costs to the country and even to the rest of the world. Some of the past studies presented in section two have focussed about the water pollution, however, none of the studies have discussed about the costs of water pollution to the society. It is necessary to estimate the cost of pollution for the intervention to improve the situation. Estimation of cost (direct and indirect) of river water pollution may give justification to the policy maker for the investment for purification of the river. Thus, the paper attempts to estimate the cost of river water pollution.

Objectives of the study

The paper mainly aims to find out the existing situation of Bagmati River, its uses/ misuses, and cost of river water pollution due to solid waste disposal.

POLLUTION OF THE BAGMATI ACCORDING TO PAST STUDIES

There are several studies on the pollution of the Bagmati (Shrestha and Sharma, 1996; Poudel and Upadhyaya, 1995; RONAST, 1988; Karmacharya, 1990; and HMG/World Bank, 1994). According to these studies the main reasons for the pollution of the Bagmati are the practices of the local inhabitants as well as the lack of functioning sewerage treatment plants as a result, the quality of water is far below WHO parameters for clean water.

The inhabitants of Kathmandu dispose and discharge their domestic, municipal, and industrial wastes, including animal waste produced during animal slaughtering on the river banks, dead dogs, cats, cattle and rats directly into the river. Factories also dispose their wastes and effluents into the municipal disposal system, or directly into nearby water bodies often with little or no efficient pre-treatment. The effluents from some selected industries in the Kathmandu Valley show a high level of organic pollution as well as some toxic chemicals; for example, chromium was found up to the level of 1,600 mg/I (Dhamala, 1990). The increasing number of squatters along the river is also contributing to the degradation of water quality. The squatters generally defecate and urinate on riverbanks and dispose all their wastes directly into the rivers. The practice of unsustainable sand extraction from

riverbeds has a very damaging impact on the river. This practice has resulted in the lowering of riverbeds, alteration of the downstream sediment carrying capacity and destruction of the ecosystem of river. The assimilative capacity of the Bagmati is greatly reduced due to the decrease in the volume of water in the river. The capacity of these rivers to sustain aquatic life has already approached zero at the point adjacent to and downstream of urban Kathmandu (NPC/IUCN 1991).

Though there are sewage treatment plants in Kathmandu and Patan, they are not functioning properly at the moment and can hardly treat the wastes of the valley. Many sewerage systems are broken or clogged in different areas of the city and discharge sewage directly into the rivers. During storms there is a continuous discharge of untreated sewage and washing of accumulated gutter contents into the river. Due to these factors, The Bagmati is characterized by high turbidity, eutrophication and large contents of pathogens (Shrestha and Sharma, 1996).

It is not only the river that is polluted. The riverbanks are also polluted because they are used as dumping sites for all types of wastes (HMG/World Bank, 1994).

All these practices have contributed to the degradation of the quality of river water and created problems for the various uses of the river such as for source of municipal and rural water supply, washing vegetables, clothes and utensils, recreation and ritual uses (HMG/ World Bank, 1994). In most of the urban areas, the Bagmati has become a complete sewerage without flow in dry season. The water is black colour and it stinks. The river is a lake of floating saprophytes within the vicinity of Kathmandu city, thus reducing the recreational value of the river and being potential health hazard. The river is highly degraded virtually, culturally and ecologically (HMG/World Bank, 1994).

The river water quality varies with seasonal variation. Pollution load is highest in summer, while it decreased in winter and during the rainy season. Estimates of water availability within the valley during the dry season together with the amounts consumed and the volume of effluent generated shows that (1) 70 % of the river flow below Teku may be untreated effluent in the dry season, and thus highly polluted; (2) groundwater levels are declining; and (3) there is severe shortage of water resources in the valley (in dry season 33 % water is used for agriculture, 57 % is used for domestic purpose and remaining 10 % is used for industrial purpose (HMG/ World Bank 1994).

All the above studies have focused mainly technical aspects of water pollution. There are some questions, which are yet to be focused. One of the questions that normally policy maker want to know is the actual cost to the society to justify the investment for the clean environment. This part of the study attempts to calculate some cost to the society due to the water pollution by solid waste.

METHOD OF STUDY

Information Collection Strategy

The study was conducted mainly with primary information. Some secondary information were also collected to fill the data gap. Secondary information was collected mainly from

the review of past studies. Primary information was collected from field study. About 100 households were selected for interview randomly. Households were selected from among the households residing along the riverbanks. It was estimated that about 1000 households reside along the Bagmati riverbanks and 10 % of the households were selected randomly for the purpose of the study. Due to the non-reporting of three households only information from 97 households is analyzed in this paper. Detailed field study was conducted with a semi- structured, open ended and structured questionnaire. Transit walk was also made to understand the situation of the river area from Sundarijal to Chobhar. Information like causes of water pollution of Bagmati River and major pollutants were collected during the interview.

Information was also collected form about 25 tourists visiting Pashupatinath temple. Pashupatinath Temple is located in Bagmati riverbank. Though the non Hindu people are not permitted to inter into Pashupatinath Temple, some non-Hindu tourists also visit to Pashupatinath temple area and the Bagmati River side. Thus, their perception regarding the present situation of Bagmati River may indicate the view of rest of the world regarding pollution of Bagmati River. Attempt was made to capture the direct cost due to the loss of tourist inflow because of River water pollution. Information from tourists was collected regarding their decision about the coming next time and the reason. Similarly, their willingness to pay (WTP) for any improvement of the river was also captured from the structured questionnaire. The WTP of the tourists is considered as the indirect cost due to water pollution since it shows how the people weigh their loss of aesthetic value on the river. It shows the total loss and which can be recovered by cleaning it. Thus, it may also be considered as the benefit from the improvement in the polluted river.

Capturing the WTP is very difficult task and it may need a large sample with more time and resources. This study being a pilot research may not be able to represent a clear picture. However, it may show the trend of the situation.

Study Area

Only the Bagmati River within Kathmandu Valley was taken for the present study. Thus the study area was considered in between Sundarijal (the original point of the river) and Chobhar (the exit point).

The Kathmandu Valley is roughly elliptical in outline, 25 kms along its east-west axis with a maximum width of 19 kms. It lies at an altitude of about 1,340 m. from which mountains rise, rather steeply on all sides. The Kathmandu valley has three municipalities i.e. Kathmandu, Lalitpur and Bhaktapur with several other village development committees.

Bagmati is main water body flowing through the heart of Kathmandu valley. It is a perennial river, originating in the Mahabharat hills below the snow line, i.e. from Bagdwar which is situated in the north of Shivapuri watershed area at an altitude of 2650 m. Starting from Mahabharat range in the north the river flows along the slope of Kathmandu Valley of 662 sq. km. and comes down to plains of Nepal and enters in India to merge to the holy Ganga. It runs more than 30 Km within the Kathmandu Valley. The river flows southeast from the valley. There are 24 main tributaries, which originate from Mahabharat and Siwalik from Bagdwar to the boarder, feeding the river Bagmati. But within the Kathmandu

valley it receives only 5 main tributaries such as Manohara, Dhobikhola, Vishnumati, Balkhu and Nakhu.

Cost Estimation

Mainly direct cost is estimated with the findings of the study. While estimating the direct cost, loss of income due to absent working days because of sickness of water borne diseases, health cost for the treatment of water borne diseases and loss of tourist income due to the disgust or aesthetic loss due to river water pollution were considered. In the same way the WTP of the tourists is also considered as a proxy of an indirect loss due to the river water pollution.

Total Direct cost = Loss due to absent days (Absent days[1] * Normal wage rate) + Medicinal costs + Loss of tourist income (Percent of tourist not coming again due to river water pollution * total number of tourist inflow within the country during that year * per tourist income).

Indirect cost = (% of tourists ready to pay* Total tourist inflow* Average WTP)

COST OF RIVER WATER POLLUTION

Attempt was made to find the direct cost by finding water pollution and its effect. To find the direct cost of river water pollution absent working days due to the water borne diseases were captured from the household survey and attempt is made to find the loss of income of the family due to the water pollution. In the same way medicinal costs for the treatment of water borne diseases are also collected and added to the direct of cost of water pollution. It is found that the ground water near the Bagmati River was not suitable for drinking (Appendix). It is also found that the people who are using the ground water have instances of diarrhea, discentry and skin diseases (Table 2).

Table 2. Landless People Residing Bagmati Riverbank and Health Problems

Location	No of HH	Population	Disease	Absent days in a year	Medical cost in a year
Tripureshwor	42	300	diarrhea, skin, discentry	25	1000
Sankhamul	13	80	skin, Discentry	10	500
Thapathali	33	250	Diarrhea, skin, discentry	22	1500
Venus School	35	275	diarrhea , skin	35	3000
Tinkune-Tilganga	80	600	skin, discentry, diarrhea	60	5000
Total	203	1505		152	11000

Source: Field Study, 2002.

[1] Absent days are calculated with the percentage of non-working days of the survey households due to the sickness of household members multiplied by the total households within the Metropolis.

Table 4 shows that the people residing in riverbank could not participate in the work by about 152 working days due to the problem of water borne diseases. It comes to be 0.19 percent of the total working days of the survey household with the assumption at least two economically active people in a house and 200 working days in a year[2]. In the lowest estimate (@110 per day i.e. wage rate of unskilled workers) the direct cost to the people residing in the riverbanks is about NRs. 16,720 in a year (Table 3). However, it is found that the pollutants of the river water are sewer drainage, industrial waste and solid waste. Thus, the ground water pollution may have cumulative effect of all these pollutants. It is extremely difficult to distinguish the cost of water pollution due to the disposal of solid waste only and it may have cumulative effect. For simplicity one third of the total cost could be considered as the cost due to the solid waste. Thus, the loss of income due to water pollution by solid waste disposal is Rs. 5573 in a year. In the same way the medical cost is also Rs. 3667 in a year due the water pollution caused by solid waste only.

Total Health cost

With the above findings of the field survey attempt is made to find the total health cost of Kathmandu. Here also total loss of working days and medical cost is also estimated with the base of survey findings. Following assumptions are made to estimate the total health cost.

Assumptions:

1. Drinking Water Corporation provided water for nearly 60 percent of the total population of Kathmandu (KMC)[2].
2. About 20 percent households get the water from the natural sources i.e stone spout, wells and other sources (Bhattarai, 2003).
3. At least 20 percent household use ground water for the drinking and other household uses.
4. It is estimated that at least two people are economically active in a household (Bhattarai, 2003).
5. Fifteen percent of the total population is unemployed in an average considering the disguised unemployed (NPC, 2002).
6. Total working days in a year are estimated at least 200 days (Working days of government employees).
7. It is assumed that one third of the pollutant of ground water come from the solid waste only[3].

[2] Total working days in a year will be 200 working days in a year *203 Households *2 working member in the house = 81200 days in a year. Total absent days found by the survey is 152 days in a year within the sample households. Thus, the number of absent days is (152/ 81200) only 0.19 percent of the total working days.

[3] Though the pollution of river water is a cumulative function of sewerage, solid waste and industrial pollutants, for simplicity to estimate the cost of solid waste it is assumed here that one third of the pollution is due to the solid waste.

With all these assumptions total loss of working days and medical cost is calculated as per the survey findings. The survey findings show that in an average the people are absent in work about 0.19 percent of the total working days. In the same way the average medical cost of the household is Rs. 54 in a year (Table 4). Table 5 shows the detail of the total health cost in Kathmandu due to haphazard disposal of solid waste.

Table 3. Estimation of Loss of Income and Total Health Cost in Kathmandu

Total HH	HH using ground water (25%)	Total working population (at least 2 in a household)	Uneplpoyed Population (15%)	Net working pop.	Total working days in a year (200 days)	Absent working days (0.19%)	Total loss of income in Rs Million #	Medical cost (in million Rs)
152155	38038	76077	11412	64665	12933000	24573	2.7	2
Total cost due to solid waste only (one third of the total)						8191	0.9	0.67

Loss is calculated with the wage rate of unskilled worker, i.e. Rs. 110 per day.

Source: Field survey estimation by the researcher.

Table 3 shows that total loss of working days is 8191 days and loss of income is 0.9 million due to the water pollution caused by solid waste disposal. In the same way total medical cost to the people of Kathmandu is Rs. 0.67 million for the treatment of water borne disease due to the unmanaged disposal of solid waste.

Loss of Tourist Inflow

Loss of tourist inflow is collected indirectly. Questions were asked to the tourists regarding the situation of water pollution, their interest to come back again. Tourists who are not coming back again were asked about the cause. Those who are not coming due to the disgust and unmanaged waste were considered as the loss of tourist inflow due to the unmanaged waste.

Attempt was made to collect the information regarding the loss of tourist inflow due to the river water pollution by the disposal of solid waste. Mainly tourists come due to the religious purpose to see the goddess Pashupati and to take a bath from the Bagmati River. During the study period a high level committee was formed and it developed a sewer treatment plant near the Guheshwari. The plant started its work and the Bagmati river water near the Pashupati was clean and bath able. Because of this changed scenario, it became difficult to find the loss of religious tourist inflow due to the water pollution by solid waste. The major religious tourists are Indian. These people are also facing the same type of problem within their country. In some places their problem is much more sever than ours. As such they could not give the due weight for the pollution of river water.

Among the surveyed tourists about 12 percent of the surveyed tourists are not coming back again since they found the city as dirty (Table 4).

Table 4. Total Surveyed Tourists and Reasons for not Coming again

Total surveyed tourists	Not coming again	Reason of not coming	Not coming due to Solid waste
25	3	Water pollution and disgust in the city	1
100 %	12 %		4 %

Source: Field Survey.

Table 4 shows that about 12 percent of the total tourists are not coming again due to the pollution in the city. Among them about 4 percent are not coming due to the disgust of waste in the city. Attempt is made to estimate the total loss of tourist inflow due to the unmanaged solid waste in Kathmandu. Though the number of observation is very small and it may be difficult to generalize with this data for the country as a whole, however it may give the trend since Kathmandu is the only one entry point of tourists coming from air. The data show that about 80 percent tourists come via air (HMG/N, 2000). Table 5 shows that there will be loss of about US $ 6.8 million in a year by the loss of tourist inflow due to the unmanaged solid waste in Kathmandu.

Table 5. Total Loss due to the Loss of Tourist Inflow

Description	
Total tourists coming in Nepal by air in 2000	376,914
Average income from the tourists in 2000 in US $	453.7
Number of tourists not coming due to the solid waste (four percent of the total tourist coming by air)	15077
Loss of tourist income in NRs	530 million
Loss of tourist income (US $)	6.8 million

Source: Nepal Tourism Statistics, 2000 and field survey.

Indirect Loss

Attempt is made to estimate the indirect loss due to the solid waste. Willingness to pay of the tourists to clean the Bagmati River was collected to find the indirect loss of water pollution. It was found that about 76 percent of the surveyed tourists are ready to pay to clean the water of Bagmati River. The average WTP is Rs. 567 (Table 6).

Table 6. Number of Tourists Who are Ready to Pay and WTP

	Total tourists	Ready to pay	Average WTP in Rs.	Total WTP in '000 Rs. in a year	Total WTP in '000 Rs. due to solid waste
Surveyed tourists	25	19 (76%)	567	11	3.66
Total tourists inflow and WTP in a year	376914	286455	567	162420	54140

Source: Field Survey.

Total tourist inflow within the country by air is 376914 in the year 2000. Majority of the people who come from the air stay in Kathmandu for at least two days and travel around the city (Nepal Tourism Statistics, 2000). The survey shows that about 76 percent of the tourists are willing to pay. In terms of the WTP of the tourists the total amount comes to be Rs. 162 million in a year (Table 6). However, as discussed the pollutants are many. It is assumed that one-third effect in water pollution is by the solid waste. As such the indirect cost of solid waste is Rs. 54 million in a year.

These figures indicate that Nepal has a lot of cost of haphazard disposal of waste. The following table shows the total loss due to unmanaged solid waste.

Table 7. Total Direct and Indirect Loss of Pollution due to Waste

Headings	Types of loss		Loss Amount (Rs. In a year)	Loss due to solid waste
	Loss	Loss quantity		
Sickness	Working days	24573	2.7 million	0.9 million
Sickness	Medicine cost	2 million	2 million	0.67million
Tourist Inflow	Tourist not willing to come due to dirty city		1560 million	530 million
WTP of tourist for clean water of Bagmati and cleanliness of the city	Average WTP is Rs. 567 and 76 % of the tourists are willing to pay		162 million	54 million
Total				585.56 million

Source: Field Survey, calculation by the researcher.

Table 7 shows the total cost due to the unmanaged solid waste is 585.56 million in a year. The direct medical cost and loss of income due to sickness is Rs.1.57 million. The indirect cost is Rs. 54 million. The loss due to the loss of tourist inflow is Rs. 530 million.

Summary and Conclusion

Water pollution is one of the burning problems in Nepal. The present study shows that the river water is highly polluted by solid waste, sewer and industrial waste of the city.

Bagmati River is used for many purposes. One of the uses of the river is the dumping of solid waste formally and informally. Formally solid waste is dumped in the riverbank and informally it is dumped along the river in different locations within the city area. The out look of the river is very ugly and disgusting due to the haphazard disposal of waste into the river.

An attempt is made here to estimate the cost of water pollution due to the unmanaged waste disposal in the city. The study shows that ground water quality is below WHO standards and it is not fit for drinking. Surface water is dangerous even to touch.

Many people in the city are suffering from water borne diseases by drinking the ground water in and around the Bagmati riverbank. The survey findings show that the medical cost for the treatment of water borne diseases is Rs. 54 per household and the absent working day is 0.19 percent. With these survey findings total direct cost i.e. medical cost and loss of income due to the loss of working days of the residents of Kathmandu metropolis is estimated to be Rs. 1.57 million in a year.

The loss of tourist inflow due to the ugliness and disgust by the haphazard disposal of waste was also estimated with the help of survey data and secondary data. The total loss of income due to the loss of tourist inflow is Rs. 530 million and the indirect loss is Rs. 54 million. Thus, the total loss is Rs. 585.56 million in a year due to the haphazard disposal of solid waste in Kathmandu.

Ground water pollution is a sever problem in case of Kathmandu. It shows a tremendous cost to the society if not considered seriously may harm to the society and the social cost will be much higher in the future. Thus, the policy makers should be cautious to provide the potable drinking water to all the households within the Metropolitan city and adjacent VDCs.

The findings show that the loss due to the unmanaged dumping and haphazard disposal of solid waste along the riverbank is tremendous to the society. Thus, the government should give due priority and make investment for the proper management of waste of Kathmandu metropolis. Government may prohibit using the ground water in riverbank area and should provide suitable drinking water supply to the residents of such area. Stringent regulation and dedicated monitoring authority may reduce the cost of river pollution.

The findings of the study show that if there is strong commitment form the policy maker resources may not be the problem. We may charge voluntary tax to the tourists for the cleaning of the river, since tourists are ready to pay for to see the clean river water.

Present research is a pilot study and could not cover the indirect costs. The findings are based on a relatively small sample size due to the time and resource constraint. Thus, it would be desirable to conduct further study regarding the indirect cost of river water pollution with large sample coverage.

Appendix I

Ground Water Quality at Different Locations along the Bagmati Riverbank

#	Parameters	Observed Values					WHO Limits for Drinking Water
		S-1	S-2	S-3	S-4	S-5	
1	pH	6.6	6.63	6.8	6.64	6.8	6.5-8.5
2	Conductivity (mmhos/Cm)	966	742	764	801	821	-
3	Turbidity, (NTU)	34	1	130	38	95	5.00
4	Total Hardness as CaCO3, (mg/l)	367	278	314	298	313	-
5	Total Alkalinity as CaCO3, (mg/l)	202.5	255	360	360	372.5	-
6	Chloride, (mg/l)	99	67	55.5	68.5	65	250
7	Ammonia, (mg/l)	18.7	2.23	13.36	14.33	3.21	1.5
8	Nitrate, (mg/l)	4.43	25.56	3.2	4.8	6.68	50.0
9	Nitrite, (mg/l)	0.18	0.02	0.01	0.13	0.04	3.0
10	Calcium, (mg/l)	83.2	81.6	70	68.8	86.4	-
11	Magnesium, (mg/l)	38.64	18.0	33.78	30.62	23.58	-
12	Iron, (mg/l)	3.72	0.22	11.03	11.73	12.17	0.3
13	Manganese, (mg/l)	1.70	0.27	1.19	1.17	5.44	0.5
14	E. Coli, (MPN Index/100ml)	Nil	Nil	Nil	7	>1100	Nil

Remarks: Compared to the WHO standard for drinking water, the observed values of the given samples indicate:

Sample-1: (Teku-Tripureshwor) Turbidity, ammonia, iron and manganese are beyond the acceptable limits

Sample-2: (Thapathali) Ammonia level is beyond the acceptable limit.

Sample-3: (Sankhamul) Turbidity, ammonia, iron and manganese are beyond the acceptable limits.

Sample-4: (Gairigaun) Turbidity, ammonia, iron, manganese and E. coli are beyond the acceptable limits.

Sample-5: (Venus School) Turbidity, ammonia, iron, manganese and E. coli are beyond the acceptable limits.

Source: Nepal Environmental and Scientific Services (NESS) (P.) Ltd.

Date of water analysis: 03-05-2002.

REFERENCES

Bhattarai, Ram Chandra. (2003). "River Water Pollution and Environmental Law in Nepal, The case of Bagmati," in Rajendra Pradhan (ed.) *Law, History and Culture of Water in Nepal*, Legal Research and Development Forum (FREEDEAL) 2003.

CBS (2002). *Statistical Pocket Book*. Kathmandu: HMG/N National Planning Commission, Central Bureau of Statistics.

Dhamala, Jeetnath (1990). "The problems of Water and Environmental Pollution: A study in the Pashupatinath Temple Area," Unpublished M.A. Thesis (Sociology and Anthropology), Tribhuvan University, Kathmandu Nepal.

Gautam, Dilli Raj (1995). Study of the Environmental Degradation and its Impact on Human (With Special Reference to Kathmandu Valley). Kathmandu: Research Division, Tribhuvan University.

HMG/N (2000). *Nepal Tourism Statistics 2000*. Kathmandu: Ministry of Culture, Tourism and Civil Aviation, HMG/N.

HMG/World Bank (1994). *Bagmati Basin Water Management Strategy and Investment Program, Issues Framework Knowledge Attitudes and Practices*. A Report by the World Bank.

Karmacharya, A. (1990). "Water Pollution Assessment in the Bagmati River and its tributaries in Kathmandu Town Section," unpublished M.Sc. thesis submitted to the Central Department of Botany, Tribhuvan University, Kathmandu, Nepal.

NPC/IUCN (1991). *Environmental Pollution in Nepal: A Review of Studies*. Kathmandu: NPC/IUCN NCS Implementation Program, IUCN, Kathmandu, Nepal.

Poudel, A. and N.P. Upadhyaya (1995). "River Water Quality in Kathmandu and Its Environmental Implications," in *Research in Environmental Pollution and Management Series*. A publication of NESS (P) Ltd. Kathmandu, Nepal.

RONAST (1988). *Pollution Monitoring of Bagmati River*. Kathmandu: Royal Nepal Academy of Science and Technology.

Sharma, P. (1989). *Urbanization in Nepal*. Honolulu: East-West Publication Institute.

Sharma, P. (1992). "A Note on Recent Trends in Nepal's Urbanization," *The Himalayan Review*, xx-xxiii: 1-10.

Shrestha, R. and Sapana Sharma (1996). *Trend of Degrading Water Quality of the Bagmati River (1988-1995)*. Kathmandu: Environment and Public Health Organization (ENPHO).