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Assessment of Environmental Pollution in Mahadev Khola, Tarakeshwor Municipality

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Abstract
One of the Small tributaries of the Bishnumati River is Mahadev Khola. It originates from Ale Danda, and downstream, it gets mixed with the Bishnumati River flowing from Tokha. It is 8.9 km in length and its elevation is 2000. The river's physio-chemical and biological characteristics were analyzed to know the river's pollution status. Primary data were collected from field observation and water sample analysis tests, and the secondary data were collected from the Tarkeshwor Municipality. Data analysis was done through MS-Excel. pH, ammonia, phosphate, chloride, hardness, iron, BOD5, and conductivity increase from upstream to downstream, whereas DO decreases. Temperature, turbidity, TS, TSS, and TDS were higher at the middle point than the other two, and coliform was found in the middle and exit points. Among the three segments of the river, the quality of the source point was good in terms of standards for drinking water. The middle and exit points were in medium and lousy condition, respectively.The principal causes of deteriorating water quality in Mahadev Khola are mainly the free and direct discharges of household and industrial wastes into the river and excessive mining of sand from the river bed. Since the quality of the river is deteriorating day by day, it's the responsibility of the local government and the people to take immediate action for its conservation.
Keywords: Physiochemical, biological, coliform

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Introduction

Bishnumati River is one of the major tributaries of Bagmati River, originating from Bishnudwar (elevation 2300 m) at Shivapuri and flowing towards the south. The length of the Bishnumati River is about 17.3 km. The total catchment of the Bishnumati River is about 109.30 sq. km (Map. 5). The Bishnumati River is one of the primary water sources in Kathmandu city for domestic and agricultural uses. But the quality of the river environment has seriously degraded in the last few years. The major tributaries are Chharchhare Khola, Ludi Khola, Sangla Khola, Mahadev Khola, Samakhushi, Bhacha Kushi and the Manamati (Bagmati Action Plan 2015)

One of the Small tributaries of the Bishnumati River is Mahadev Khola. Mahadev Khola originates from the place called Ale Danda, and downstream at its end, it gets mixed with the Bishnumati River flowing from Tokha. It is 8.9 km, and its elevation is 2000 (KAPRIMO, 2007). Anthropogenic activities along the bank of the river have brought changes in the river's natural state. Activities like polluting water, dumping wastes, and sand and stone quarrying are the most common in the rivers of Nepal. The rapid growth of urban population and mass rural to urban migration are also causes of degradation of the quality of the rivers.

The rich cultural heritage along the river and the tributaries, such as traditional monuments, ghats, and temples, is slowly eroding. The river has been widely used for everything from sand extraction to land encroachment. Urban water quality in Kathmandu Valley needs to be better to sustain a healthy water ecosystem. Originality of the river has been completely lost because of the degraded environment. Recent studies on river quality indicate that most of the rivers in the Kathmandu Valley are highly degraded (UNEP, 2002; Basnet, 2005; Baidya, 2005). The deteriorating quality of river water has caused frequent cases of waterborne diseases such as diarrhea, dysentery, cholera, and skin diseases among people living in riverside areas. It has also reduced rivers' religious, recreational, and aesthetic value (Shrestha et al., 2015).

The study of Mahadev Khola was done by KAPRIMO in 2007. The river was highly polluted then, with a BOD value of 36.23 mg/l. From then on, no data related to pollution status was

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recorded; hence, information regarding the pollution status needed to be included. Thus, this study is carried out to get more information about the pollution status of the river. This study will help determine the river's usability for various purposes and the Water Quality Index. It is beneficial to Tarkeshwor Municipality to design the development activities associated with Mahadev Khola and help future researchers carry out the research activities.

Materials and Methods

2.1 Location of the Study

This study was conducted in the 8.9 km long Mahadev River, which started from Alle Danda and followed the river to the Tarakeshwor Mahadev Mandir. The first site's GPS location was 27^{0} 47 “45’ N 85^{0} 17” 58’ E 1570 m elevation. GPS location of the second site was found to be 27^{0} 46” 50’ N 85^{0} 18” 28’ E, 1340 m elevation, and the third site was found to be 27^{0} 44” 21’ N 85^{0} 18” 38’ E

2.2 Sample collection

Surface water samples of the river were collected from three different river points on October 8, 2017. Various water quality parameters were monitored, and a detailed field survey was conducted within the study area. A proper sampling procedure was followed while collecting the samples. In this study, the sampling depth was 15- 20 cm.

Laboratory Testing and Standards

The experiment on a selected river segment was carried out in October, just after the completion of the wet season. Though the wet season was completed, occasional rainfall was still there. To assess the water quality, test on fifteen water quality parameters (DO, BOD, pH, turbidity, total solid, total dissolved solids, total suspended solids, total hardness, chloride, temperature, conductivity, phosphate, ammonia, iron, coliform) was conducted. These parameters were used to compare them with the different guidelines for it usability in different purposes (drinking, irrigation, aquatic ecosystem and aquaculture) and determine the Water Quality Index.

Results and Discussion

Table 1: Test for Usability

Parameter Exceeding	Site KM from Source (Alle Dada)		
	Source	Middle point	End point
Drinking Water Guidelines	None	Turbidity	Turbidity
Irrigation Water Guidelines	None	TSS	TSS
Target for Aquatic Ecosystem	None	NH3	NH3
			DO
Aquaculture		NH3	NH3
	Fe	Fe	Fe
Number of Different Parameters	1	4	5

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The table 1 shows that the river water between 4km and 8.9 km is unsuitable for drinking, aquatic ecosystem, aquaculture and irrigation. Source is suitable for all purposes except for the aquaculture

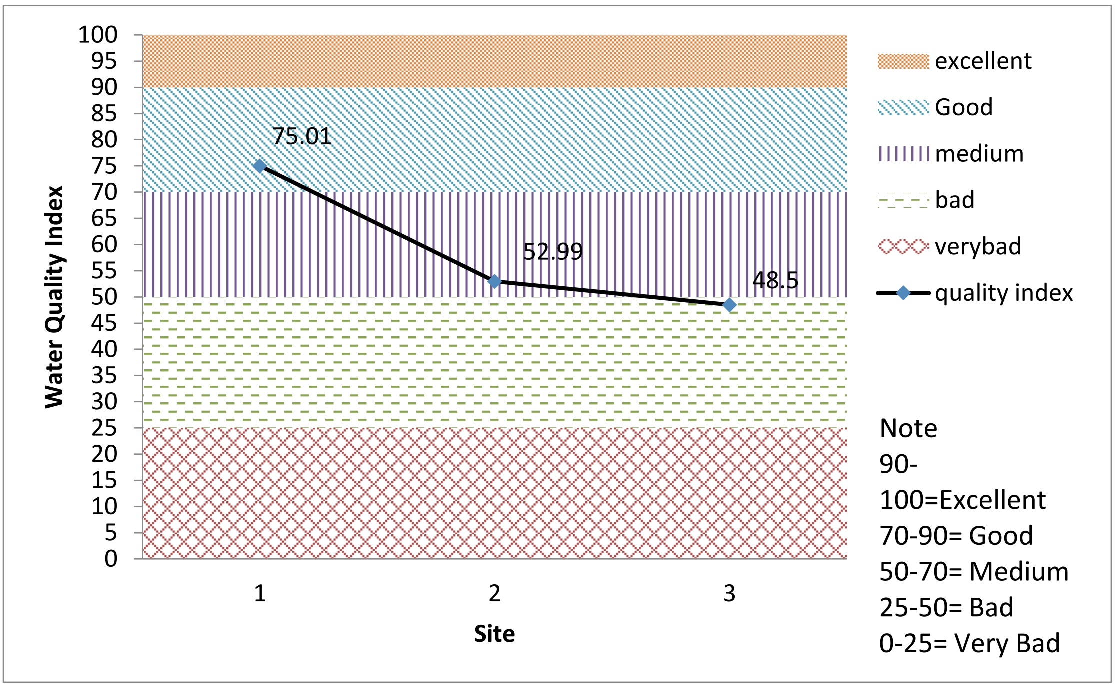

Figure 1: Water Quality Index based on parameters

The following parameters were used: DO%, BOD, pH, total coliform, TS, turbidity, nitrate, Phosphorus, and temperature. The results of the water quality index calculations are plotted in the figure. At 0 km, the river water was of “Good” standard, and a decline can be seen in 4km and subsequently at 8.9 km with a medium standard and bad standard, respectively. The very bad quality was not observed at any point. The water quality index in the Babai River (Sharma et al., 2005) and the Bagmati River was found to be excellent to very bad, depending on the sites (Bagmati River Expedition 2015). The National Sanitation Foundation water quality index (WQI) was used to indicate the effect of multiple parameters along the river. This WQI, as described by Tyagi et al. (2013), was chosen to represent differences along the river easily.

The Water Quality Index is also directly related to the number of houses. Households were counted at a distance of 100m from the bank of the river. As the number of houses increases, quality decreases. In this study, there were no houses at the source, and from the source to the midpoint, there were 76 households; from the midpoint to the exit point, there were 142 houses.

This chart represents the overall shape of water quality deterioration and improvement along the Mahadev Khola in Balaju. It is highly recommended to develop a WQI, specifically for Nepalese standards and guidelines for rivers in Nepal, for future studies.

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Table 2: Water quality parameters test at different points

Parameters		Sites		
		Source	**Mid-point**	**End point**
Temperature	Atmospheric	20.5°c	29.9 °c	27.6 °c
	Water	24.5 °c	31 °c	28.2 °c
pH		6.1	6.5	6.9
DO		91.66%	83.33%	75.06%
Turbidity		4NTU	97NTU	54NTU
TS		100 mg/l	700 mg/l	400 mg/l
TSS		100 mg/l	400 mg/l	200 mg/l
TDS		0 mg/l	300 mg/l	200 mg/l
Ammonia		0.0004 mg/l	0.029 mg/l	0.066 mg/l
Nitrate		0 mg/l	0 mg/l	0.17 mg/l
Phosphate		0 mg/l	0.1562 mg/l	0.327 mg/l
Chloride		18.46 mg/l	31.24 mg/l	49.7 mg/l
Total hardness		0	20	60
Iron		0.2477 mg/l	0.2487 mg/l	0.2595 mg/l

In the table 2., time of day, weather and incoming tributaries all influence the water temperature naturally, but pollution and the subsequent chemical reactions can also affect it. The highest temperature was found at mid-point with 31 ^{0}C atmospheric temperature and 29.9^{0}c water temperature. Increased in temperature was due to the pollution that can be easily visualized and the weather condition. Similar result was obtained in Bagmati expedition 2015 (Milner et al, 2015). As stated in Nepal water guidelines (2008), the pH value should be in between 6.5 to 8.5 for drinking water, irrigation, livestock and recreation and all values from each sample are within the point.

In the given sample DO saturation was found to be 91.66 % at the source which indicates the excellent DO level but decreases as moving downward (Dhital, 2017) DO saturation was found to be even higher i.e. 103.8 % at Gokarna (Dahal et al., 2011). DO saturation was good at the midpoint and exit points, 83.33 % and 75.06 %, respectively. Water turbulence, photosynthesis, and diffusion can increase the DO saturation in water (UNEP GEMS/Water Programme 2008). The levels of DO change with depth. For example, if there is little mixing of the water close to the substrate, which may be where the dead organic matter collects after sinking, there may be a much lower DO saturation than at the surface. The decrease of turbidity at the source (4 NTU) may be due to the absence of waste input and, subsequently, high turbidity (97NTU) at the midpoint. An increase in turbidity at this point may be due to the deposition of solids along the river, increased discharge, and sand extraction (Malla, 2009). TS, TSS, and TDS were higher at the midpoint due to industrial and municipal effluent and sand extraction activities (Singh et al., 2010).

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Ammonia levels in groundwater and surface water are usually below 0.2 mg/liter. Anaerobic groundwater may contain up to 3 mg/liter" (WHO 2011). High ammonia concentration may be found as an indication of municipal waste and sewage. All three samples meet the Nepalese drinking water guidelines of 1.5 mg/l. Though many visible sources of municipal waste and sewage enter the river downstream, the high concentration of ammonia in the river wasn't observed as occasional rain occurred. Methemoglobinemia (blue baby syndrome) is the main concern of high nitrate concentrations in drinking water (WHO 2011). The sample from the exit point contains nitrate. It is not suitable for the aquatic ecosystem as it promotes algal growth and causes eutrophication, as mentioned in the study by Koh (2019). Phosphate is an essential nutrient for plants and algae to grow but, in excess, causes eutrophication, leading to hypoxia. All three samples meet Nepal's target for aquaculture for phosphate, which is 0.6 mg/l.

The World Health Organization gives no health-based guideline for chloride in drinking water but states that it is detectable by taste at 250mg/l (WHO 2011). For irrigation purposes, it should be below 100mg/l (Schreuder & Brewer,2001), and all three samples are within the range. Total Hardness (TH) measures calcium and magnesium salts as the most significant minerals causing hardness. The concentration of total hardness in the tested samples is within the range. Therefore, it is suitable for drinking, irrigation, aquatic ecosystems, livestock, and recreation. There is no significant difference in the concentration of iron in all three points.

BOD at the midpoint and the exit point was found to be 24.8 mg/l and 54.8 mg/l, which indicates severe pollution. In 2007 study done by KAPRIMO, the BOD value was found to be 36.23 mg/l. In the study of Dhital (2017), the BOD of Bishnumati at different points other than the source was higher than 100mg/l, indicating extensive pollution compared to the Mahadev Khola.

Conductivity increases as the total dissolved solid increases, so polluted water generally has high conductivity. In the given water sample, the conductivity of the sample from all three points was less than 1 ms, which is less than the WHO guideline, which is 5-50 ms. It should be noted that the conductivity measurement done to determine the purity of water will not respond to non-conductive contaminants such as organic compounds, so an additional purity test must be carried out.

In the Mahadev Khola basin, coliform bacteria directly enter the river from animal and human waste, diffuse runoff from land, and untreated sewage that the municipalities drain into the river due to lack of sewage treatment plants. Coliform was not detected in the source as there were no houses, but in the study of Milner et al. (2015), coliform was found even in the source. Coliform was found to be a 100/100ml sample at the midpoint, and at the exit point, it was found numerous to count.

Conclusion

Anthropogenic actions like open defecation, wastewater discharge, cattle washing, and funeral rituals near Mahadev Khola's vicinity are the leading causes of river pollution. River

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water pollution is a severe economic and public health problem and sustains aquatic life. So, regular monitoring of the water quality is required to assess the condition of river water. WQI helps save the river from further degradation and maintains the standard of sustaining aquatic life.

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