Assessment of Physico-Chemical Parameters of Bagmati River, Kathmandu, Nepal

Narayan Kunwar[1], Manoj KC[2], Rashika Shrestha[3], Sushil Chaudhary[4], Anima Shrestha[5], and Bibek Rana Chhetri[6]

[1,2,3,4,6]Tribhuvan University, St. Xavier's College, Kathmandu, Nepal

[5]Tribhuvan University, Tri-Chandra Multiple Campus, Kathmandu, Nepal

***Abstract*—** The discharge of sewage into the Bagmati River and open dumping of waste along the banks is clearly visible and has become a serious problem because polluted water is responsible for mortalities of organisms when it becomes a vehicle for transmission of diseases. The present study was carried out for the assessment of physico-chemical parameters of Bagmati river water. Total number of 6 sites were selected (B1-B6) from Chovar to Baghdwar. From each site 10 samples were taken for analysis except for B6 from where 5 samples were taken. The major work of study was physico-chemical analysis i.e., pH, temperature, total dissolved solid, chloride, dissolved oxygen, and biochemical oxygen demand. Most of the physico-chemical parameters at all sites except B5 and B6 were found to be beyond natural limit. Maximum average value of total dissolved solid, chloride, dissolved oxygen and biochemical oxygen demand was 684.1 ppm, 89.9 mg/l, 10.38mg/l, and 160.7 mg/l respectively. This study highlights the scenario of Bagmati River from Baghdwar to Chovar which showed that the river is extremely polluted when it enters into the urban area i.e., mainly from Thapathali to Sundarighat.

***Keywords*—** Bagmati River, pH, temperature, total dissolved solid, chloride, dissolved oxygen, biochemical oxygen demand.

I. INTRODUCTION

Water pollution is becoming one of the most important worldwide environmental challenges, as well as a health concern because it is one of the mechanisms of disease transmission (Wild, 2012) [1]. Bagmati River, one of Nepal's most contaminated water sources, flows from Baghdwar over the southern edge of Shivapuri Hill, roughly 15 kilometers north-east of Kathmandu. It has a catchment area of 3710 square kilometers in Nepal and is supplied by natural springs and monsoon rains (NTNC, 2009) [2]. As it passes the center of Kathmandu, it reaches the edge of the Kathmandu Valley and enters Chovar Gorge near the Dakshinkali temple complex (Davis, 2007) [3]. The discharge of sewage into the Bagmati river and open dumping of waste along the banks is clearly visible. The amount of waste entering the river is greater than other areas due to much higher population density (Revenga, 2000) [4]. Water sample form Bagmati, Dhobi khola and Tukucha was polluted by toxic metallic ions whose sources were industrial effluents that are discharged into river without treatment. (Sharma and Upadhyaya, 1995) [5]. The chemical parameters of Bagmati river were beyond the natural level (Paudel, 2005) [6]. The physico-chemical parameters of Bagmati River, revealed that pollution in Bagmati River is mostly by organic wastes rather than industrial waste (Ghimire, 1998) [7]. Most of the physioco-chemical parameters increased consistently from upstream to downstream sites of river and level of pollution was more severe in pre-monsoon than monsoon season. (Raut, 1994; Barakoti, 2014) [8,9]. The ground water parameters were found to be in decreased value from within 50 m to 50-100 m, and 100-150 m distance from the riverbank (Gautam et. al., 2013) [10]. In order to assess the health risk associated with a contaminated water supply, it is critical to monitor the physiochemical properties of the river water. Therefore, this study was carried out to evaluate the physico-chemical parameters such as temperature, pH, TDS, Chloride, DO, BOD.

II. MATERIALS AND METHODS

A. Study Area

To perform this study, 6 different sites (B1-B6) of Bagmati River was specified. And 10 samples were taken (approximately at 600 m distance) except for site S6 where total 5 samples were taken.

Table 1: *Sampling sites of Bagmati River and the total number of sample collection*

Sampling sites (Bagmati River)	Area covered	Number of samples
B1	Chovar to Teku	10 (S1-S10)
B2	Teku to Pingalasthan	10 (S11-S20)
B3	Pingalasthan to Jorpati	10 (S21-S30)

B4	Jorpati to Gokarna	10 (S31-S40)
B5	Gokarna to Sundarijal	10 (S41-S50)
B6	Sundarijal to Baghdwar	5 (S51-S55)

B. Sample collection

Physical parameters such as temperature, pH, TDS, were determined in the site itself. BOD bottles were used for the determination of DO and BOD. In feasible sampling sites, Chloride and DO were also determined on the spot otherwise samples were carried and processed in the laboratory within 4 hours. Dilutions were also made to those samples whish were highly polluted and turbid.

C. Physico-chemical analysis

Temperature was determined by mercury thermometer. The bulb of thermometer was dipped in the water surface and the reading was noted. Hydrogen ion concentration (pH) of sample water at the spot was measured using pH paper. TDS was measured using TDS metre (HANNA Instruments). Chloride and DO were determined using standard procedure and Winkler's Iodometric method (Trivedy and Goel, 1986) [11]. Similarly, Biochemical Oxygen Demand (BOD) was determined as described in standard procedure (APHA, 2000) [12].

III. RESULTS AND DISCUSSION

3.1. Physico-chemical analysis

The physico-chemical parameters such as temperature, pH, TDS, chloride, BOD and DO are beyond the natural level from B1-B4 which may be because of increasing pollution of the river in these sites. This result is supported by the work done by Paudel (2005) [6]. Barkhoti (2014) [9] also found that the chemical parameters were beyond the natural level in almost allthe stations except Sundarijal.

3.1.1 pH: The maximum and minimum average pH recorded was 7.3 and 6.6 at site B5 and B2 respectively. This indicates pH was nearly neutral throughout the sampling sites. The pH of the Bagmati River was found to be in the range of 7.23 to 8.36 which indicates pH is not in critical in terms of pH (Shrestha, 2004) [13]. The average pH of B6 was found to be neutral may be due to the absence of human intervention whereas the pH of other sites was slightly higher and lower than neutral pH may be because of variation in human intervention.

Figure 1: *On-site analysis of Chloride and Dissolved Oxygen*

Figure 2: *Graph showing average range of pH from each sampling site*

3.1.2 Temperature: The maximum and minimum temperature recorded was 27 and 15 at site B4 and B6 respectively. Site B6 was the origin of Bagmati River i.e., Baghdwar which runs along the Shivapuri Hill which may be due to factors such as the season, time and place of sample collection.

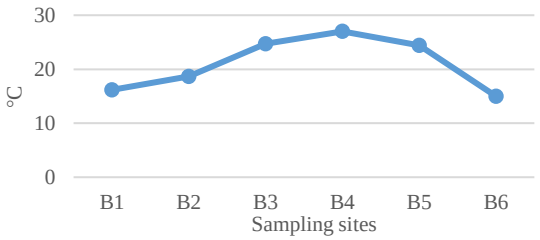

Figure 3: *Graph showing average range of Temperature (°C) from each sampling site*

3.1.3 Total Dissolved Solid (TDS): The maximum and minimum average TDS recorded was 684.1 ppm and 9.4 ppm at site B1 and B6 respectively. Besides this, maximum and minimum value was found in Sundarighat i.e., 880 ppm and Baghdwar i.e., 8 respectively. At Sundarighat, the river is highly polluted because of higher human settlement, discharge from industries, hospitals as well as mixing of more polluted tributary i.e., Bishnumati at Balkhu whereas the river

water was least polluted in Baghdwar as there isn't any sign of human settlement.

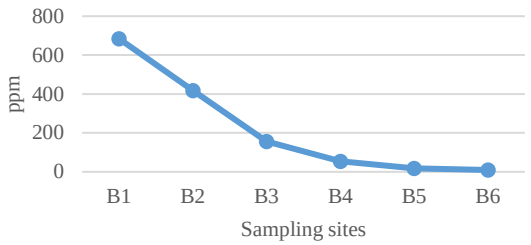

Figure 4: *Graph showing average range of TDS (ppm) from each sampling site*

3.1.4 Chloride: The maximum average chloride recorded was 89.9 mg/l at site B1 and minimum average chloride recorded was 1.42 mg/l at site B5 as well as B6. Besides this, the maximum value was found in Thapathali Bridge i.e., 109.34 mg/l which may be due to high sewage discharge and release of industrial effluents into the river.

The chloride concentration increased consistently from upstream to downstream sites of the Bagmati Rover (Raut, 1994) [8] which supports our findings.

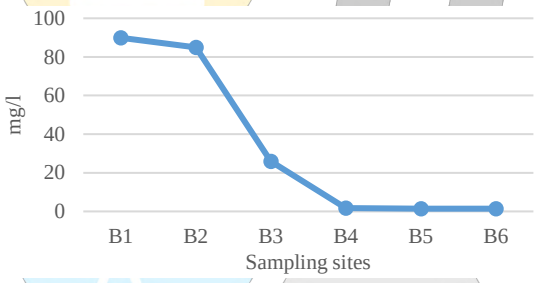

Figure 5: *Graph showing average range of Chloride (mg/l) from each sampling site*

3.1.5 Dissolved Oxygen (DO): The maximum and minimum average DO record was 10.38 mg/l and 0 mg/l at site B6 and B2 respectively. From this study, it can be concluded that site B2, is the most polluted site among all the other sites.

The value of DO at Thapathali, Sundarighat and Khokana was measured 0 mg/l (Barakoti, 2014) [9].

The maximum DO value was found at Baghdwar i.e., 10.8 mg/l which illustrates that this area is not polluted and free of human interference.

In the urban areas, the DO was below 4 mg/l and in the rural areas, DO was above 6.2 mg/l (Kannel et. al., 2007) [14].

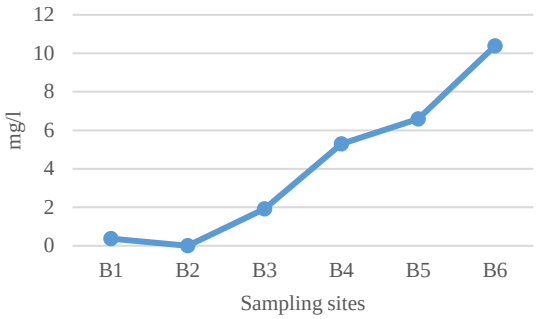

Figure 6: *Graph showing average range of DO (mg/l) from each sampling site*

Figure 7: *Dissolved Oxygen*

3.1.6 Biochemical Oxygen Demand (BOD): The maximum and minimum average BOD recorded was 160.7 mg/l and 0.3 mg/l at site B1 and B6 respectively. The lower value of BOD at site B6 (minimum at S53 i.e., Baghdwar) may be due to absence of water pollution at that area whereas the BOD was high at site B1 (maximum at S7 i.e., Sundarighat) which may be because of the more polluted condition of the river in that area. The reason for this may be direct discharge of sewage, unmanaged settlement of slum dwellers, mixing of more polluted tributaries such as Bishnumati, Tukucha etc. This fact was also supported by UNEP (2001) [15]. Moreover, KAPRIMO (2007) [16] also found that the BOD value at site such as Sundarijal, Gaurighat, and Thapathali was 2 mg/l, 5.5 mg/l and 117.5 mg/l respectively.

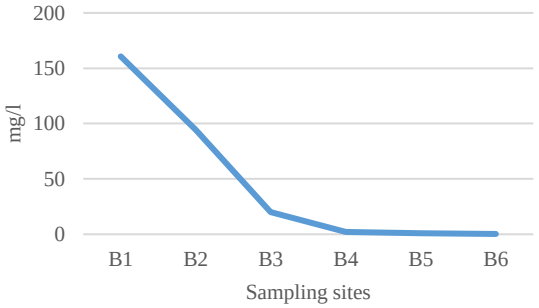

Figure 8: *Graph showing average range of BOD (mg/l) from each sampling site*

IV.CONCLUSION

Mostly in urban areas, none of the physico-chemical parameters (TDS, chloride, BOD, and DO) were within the natural level. This confers that in these regions, the river water is extremely polluted. It can also be concluded that the present condition of the river is due to various factors such as open sewage, dumping of waste, discharge of industrial, hospital effluents etc. These activities are increasing rapidly due to unplanned and uncontrolled urbanization and industrialization. Moreover, mixing of more polluted tributaries like Bishnumati, Tukucha, Dhobi khola etc. has worsen the situation.

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