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Current Water Quality Status of Rivers in the Kathmandu Valley

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ABSTRACT

The condition of the rivers in the Kathmandu Valley has been rapidly degrading. Several governmental and non-governmental institutions, civil society organisations and other stakeholders are working to improve the environmental conditions of these rivers. This study analyses the current water quality status of the Kathmandu Valley river system. For this purpose, water samples were collected three times from different locations in January and February 2015 to establish quality indicator parameters. River water on the outskirts of the valley was found to be suitable for aquatic life, bathing and irrigation; some treatment is, however, necessary if it is to be used as drinking water. However, the water quality in the core urban area was found to be extremely poor and unsuitable for sustaining a healthy water ecosystem.

Keywords: water quality; Kathmandu Valley; aquatic life; freshwater ecosystem

INTRODUCTION

The world population is growing rapidly over the last few The Bagmati River is the principal river in the Kathmandu Valley river system. It drains the entire valley with its six major tributaries, the Bishnumati, Manohara, Dhobikhola, Nakhhu, Balkhu and Tukucha. The river basin covers an area of 595.4 km2 with an altitude varying from 1,178-2,723 m above sea level. The average annual rainfall is 1,900 mm of which about 80% occurs only during the monsoon (July-Sept). The river basin currently faces a number of serious environmental and ecological challenges. Urbanization and industrialization of the basin headwaters in Kathmandu contribute to a deterioration in water quality, with regional consequences for the aquatic ecosystem and the health of downstream sub-basin user groups.

Solid wastes like kitchen waste, dead animals, hospital waste, and industrial waste have been dumped by the riverside. In addition, sewer lines for domestic and industrial wastewater have been connected to the river (UN-HABITAT, 2008). These activities have caused serious pollution and the production of foul odours near the riverside. River system water entering the core urban area is visibly black with filth, stinks badly, and no tests are really needed to verify its quality.

Several governmental and non-governmental institutions, civil society organizations and other stakeholders are working to improve the environmental conditions of rivers in the Kathmandu Valley. The number of parties becoming involved is growing, but the status of the rivers is further deteriorating every day. As part of the river restoration activities, work is in progress to construct sewage diversion structures, concretize river banks for bank stabilization, divert and modify river flows, and construct sewage lines. The aim of this paper is to summarize the current water quality status of the Kathmandu Valley river system and describe areas in which further research is needed.

MATERIAL AND METHODS

Environmental Services Nepal P. Ltd. was commissioned to collect water quality data of the Kathmandu valley river system. A grab sampling method was used and analysis was carried out as recommended by American Public Health Association (APHA, 1998). Samples were collected three times in January and February 2015 to establish quality indicator parameters from twenty-two different locations, as shown in Figure1. Table 1 summarizes the collected water quality parameters and the test methods.

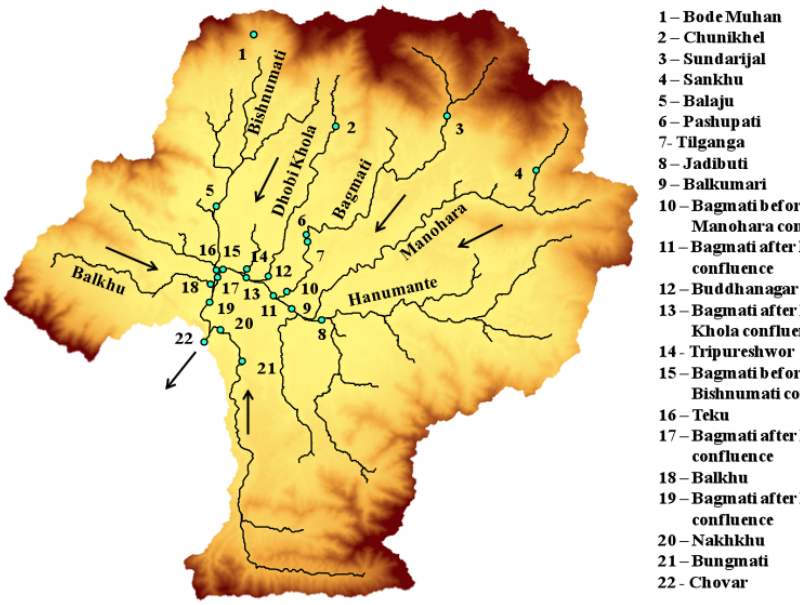

Figure 1 *Water quality sampling locations in the Kathmandu Valley river system.*

Table 1 *Water quality parameters and test methods.*

S.N.	Parameter	Test Method
1	Dissolved oxygen, DO (mg/l)	Electrometric, HANA Probe
2	Temperature, Temp. (°C)	Electrometric, HANA Probe
3	pH at 14°C	Electrometric, 4500-H+B, APHA
4	Total Suspended Solids, TSS (mg/l)	Oven Drying Method, 180°C, 2540D APHA
5	Total Dissolved Solids, TDS (mg/l)	Oven Drying Method, 180°C, 2540C APHA
6	Biochemical Oxygen Demand, BOD (mg/l)	Winkler Azide Modification (Dilution and Seeding), 5210 B, APHA, ISO5815-1989
7	Chemical Oxygen Demand, COD (mg/l)	Potassium Dichromate Reflux, 5220B, APHA
8	Total Kjeldal Nitrogen, TKN (mg/l)	Macro Kjeldahl Digestion, 4500-NorgB: APHA
9	Total Phosphorous, TP (mg/l)	Ascorbic Acid, 4500-PE APHA
10	Fecal Coliform, F. Coli. (MPN/100ml)	Multiple tube Fermentation, 9221 E, APHA

RESULTS AND DISCUSSION

Table 2 shows the observed water quality values at different sampling locations on the Kathmandu Valley river system. The limiting values for water quality parameters for different water uses are presented in Table 3. Figure 2 compares Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) at different locations along the Bagmati River (the major river of the system). Variations in water quality values were observed throughout the entire study. This study shows the deterioration of the river system at various locations in the urban center.

The quality of water deteriorates as the rivers flow towards the densely populated urban center. In most of the sampling locations aside from Bode Muhan, Chunikhel, Sundarijal, Sankhu, and Pashupati, the quality of river water was extremely poor and not appropriate even for agricultural purposes (Table 2, Table 3 and Figure 2). The river water at Pashupati was also not suitable for drinking or aquatic life. However, the water at Bode Muhan, Chunikhel, Sundarijal and Sankhu (outskirts of the Kathmandu valley) was suitable for aquatic life, bathing and irrigation; some treatment is however necessary if it is to be used as drinking water (Table 2, Table 3 and Figure 2).

Effluents from the Guheshori wastewater treatment plant are discharged downstream from Pashupati, leading to an abrupt change in water quality observed at Tilganga (Figure 2). The treatment plant receives its influent from an area of 537 hectares. Similarly, there are reports in the region of illegal sewerage input drains discharging into the river (UN-HABITAT, 2008).

Table 2 *Water quality values at different sampling locations.*

River	Sampling Locations	Temp. (°C)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	TDS (mg/l)	TKN (mg/l)	TP (mg/l)	F. Coli (MPN/100ml)
Bishnumati	Bode Muhan	12.1	7.6	8.8	<1.0	1.8	<1	62	1.99	0.10	172
Dhobi Khola	Chunikhel	12.8	7.4	9.4	2.8	9.6	15	115	4.72	0.34	3107
Bagmati	Sundarijal	10.0	7.7	10.7	1.5	4.3	<1	50	6.72	0.19	99
Manohara	Sankhu	11.9	7.7	10.0	<1.0	1.6	1	56	2.50	0.22	1968
Bishnumati	Balaju	16.3	7.0	1.2	473.3	1420.0	367	419	108.24	8.58	88333
Bagmati	Pasupati	16.4	6.7	7.5	5.5	18.3	92	89	5.27	0.58	12650
Bagmati	Tilganga	17.4	6.9	1.8	226.0	496.6	253	248	53.65	9.53	18970
Hanumante	Jadibuti	15.5	7.1	0.5	283.6	563.0	315	371	80.00	8.00	150000
Manohara	Balkumari	14.1	7.1	0.9	121.0	279.0	111	287	53.90	6.15	810000
Bagmati	Before Manohara confluence	17.4	7.0	0.6	356.3	773.3	525	359	57.11	15.44	184453
Bagmati	After Manohara confluence	16.7	7.1	0.5	186.0	413.3	548	361	52.13	12.22	220350
Dhobi Khola	Buddhanagar	15.0	7.1	1.8	190.0	450.0	427	480	98.48	8.45	227000
Bagmati	After Dhobi Khola confluence	16.7	7.1	0.5	266.3	526.6	300	376	76.87	12.35	31167
Tukucha	Tripureshwor	15.9	6.9	1.4	583.0	1190.0	480	660	134.00	13.40	83666
Bagmati	Before Bishnumati confluence	16.0	7.1	0.6	272.7	500.0	444	461	105.70	10.21	185097
Bishnumati	Teku	16.8	7.0	0.4	409.0	793.3	513	516	121.74	11.21	53717
Bagmati	After Bishnumati confluence	15.8	7.1	0.5	384.3	740.0	457	414	108.20	10.77	220350
Balkhu	Balkhu	16.9	7.0	1.3	475.0	996.0	366	631	133.00	12.60	227000
Bagmati	After Balkhu confluence	16.6	6.9	0.4	208.6	420.0	443	334	113.87	9.83	220093
Nakhkhu	Nakhkhu	16.7	7.6	7.7	63.3	134.0	166	289	17.27	2.69	16067
Nakhkhu	Bungmati	13.5	7.5	3.8	95.7	198.0	120	323	69.99	4.41	43717
Bagmati	Chovar	16.5	7.1	0.4	356.0	760.0	343	437	128.83	11.44	256667

Table 3 *Water quality standards for different uses of the Bagmati River and its tributaries*

Parameter	Drinking	Aquatic life	Bathing	Agriculture
pH	6.5-9.2	6.5-8.5	6.5-9	6.5-9
TDS (mg/l)	1500	1000	1500	500-3000
SS (mg/l)	-	25	50	-
DO as O_2 (mg/l)	-	6	3	3
Cl as Cl (mg/l)	600	500	1000	100-1000
SO_4 as SO_4 (mg/l)	400	500	1000	1000
NO3-N as N (mg/l)	-	20	20	25
NO2-N as N (mg/l)	-	0.15	1	1
NH3-N as N (mg/l)	-	0.02	0.2	0.2
Total PO4 as PO4 (mg/l)	0.1	0.1	0.2	0.2
BOD as O2 (mg/l)	4	4	6	10
F as F (mg/l)	3	1	1.5	1.5
Total Hg	-	0.0001	0.001	0.001
Total Cd	-	0.005	0.005	0.01
Total Pb	0.05	0.05	0.05	0.1
Cr	-	0.05	0.05	0.1
Phenol	0.002	0.005	0.1	0.2
Total Cynide	-	0.005	0.2	0.2
Total Coliform (MPN/100ml)	-	-	1000	1000

Source: BBWMSIP (1994)

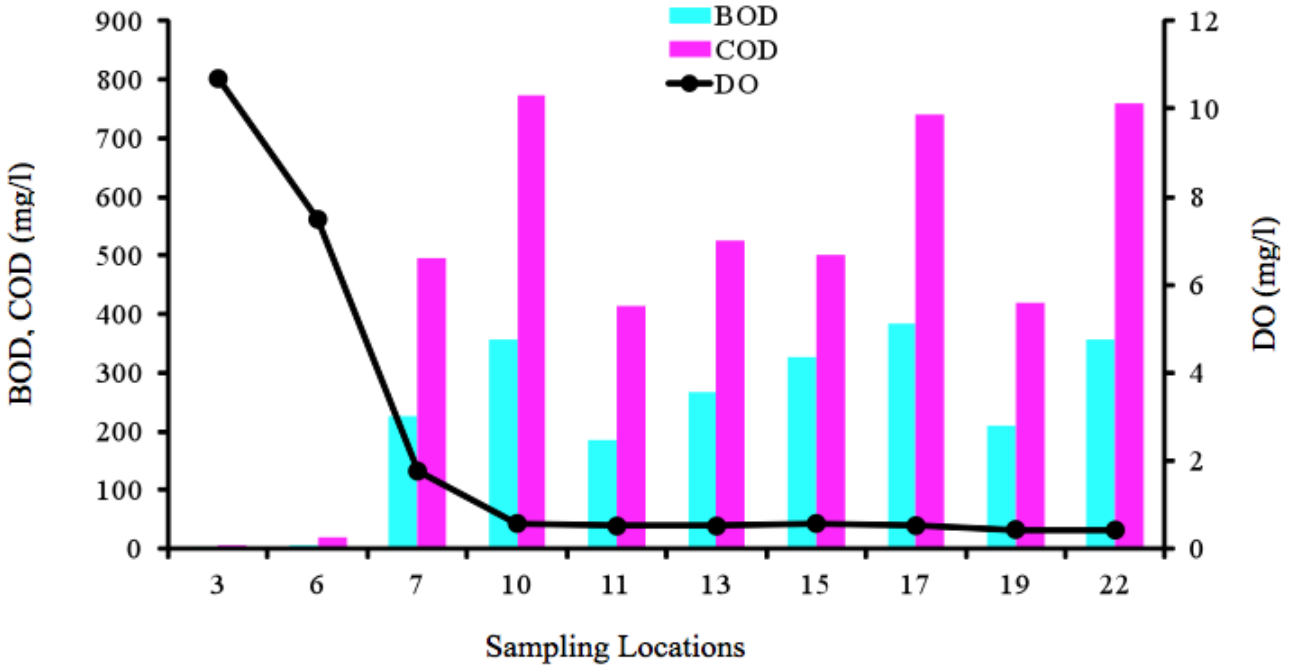

Figure 2 *Variation in DO, BOD and COD along different sections of the Bagmati River.*

CONCLUSIONS

Water quality was analyzed at different locations in the Kathmandu Valley river system. Water samples were collected three times in January and February 2015 for some quality indicator parameters. River water at locations on the outskirts of the valley was found to be suitable for aquatic life, bathing and irrigation; some treatment is however necessary if it is to be used as drinking water. However, in most of the sampling locations in the core urban area, the quality of river water was extremely poor and not appropriate even for agricultural purposes. Further studies based on numerical analysis, considering the possible impacts of existing river restoration activities, and future land use and population, are necessary to promote healthy ecosystems and environments in the Kathmandu Valley.

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