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Current Status of Water Environment in Kathmandu Valley, Nepal

Niranjan Shrestha Environmental Services Nepal Pvt. Ltd., Lalitpur, Nepal

Alaka Lamsal Environmental Services Nepal Pvt. Ltd., Lalitpur, Nepal

Ram Krishna Regmi United Nations University Institute for the Advanced Study of Sustainability, Tokyo, Japan

Binaya Kumar Mishra United Nations University Institute for the Advanced Study of Sustainability, Tokyo, Japan

Water and Urban Initiative

This working paper series shares findings produced as part of the research activities under the Water and Urban Initiative (WUI), a research project of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS). The WUI aims to contribute to sustainable development, focusing on developing countries in Asia, by providing policy tools and an information platform to assist planning and implementing policies for sustainable urban and water environment.

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ABSTRACT

This research has reviewed existing water quality management frameworks and spatial relationships between land uses and urban water quality in Kathmandu Valley. Primary data on water quality has been collected through sampling of river water from various locations within the valley. Similarly, review of secondary data and related literature from various sources, field observation, interaction and discussion with concerned stakeholders of various governments and non-governmental line agencies were carried out to perceive the existing water environment situation of the valley. All these data and study indicates that urban water quality in Kathmandu valley is not good enough to sustain healthy water ecosystem. Deteriorating quality of river water has caused frequent cases of water borne diseases such as diarrhea, dysentery, cholera, and skin diseases among people living in riverside areas. It has also reduced the religious, recreational and aesthetic value of rivers.

Keywords: urban water environment; urbanization; wastewater; water ecosystem; sampling of river water; water quality modeling; river restoration activities; land use planning

1. Introduction

Kathmandu, the Capital City of Nepal, is selected as one of the study area for case study of low carbon urban water environment project under research program titled 'Water and Urban Initiative (WUI)' of UNU-IAS (United Nations University - Institute for the Advanced Study of Sustainability), Japan. Increase in transient and migrant population in Kathmandu leads to haphazard urbanization of Kathmandu valley resulting in heavy pressure on existing natural resources. Water quality of rivers within Kathmandu, is deteriorating due to over population and its consequent stress on the environment. Water resources are being increasingly polluted by domestic, agricultural and industrial wastes.

Kathmandu valley was at pristine condition before some decades ago. People cultivated for their livelihoods. Most of the valley floor was used for agriculture and farming. After the onset of democracy in 2007, the valley witnessed rapid immigration in past few decades. People who were engaged in farming have shifted to urban life now. Large sewerage pipes were added to the rivers as river tributaries to the river. The population of the 899-square kilometer valley has increased fivefold in the last 60 years, from 197,000 people in 1952 to 997,000 by the time of the 2001 census. Meanwhile, the built-up area has increased by 134%, from 24.54 square kilometers in 1989 to 57.32 square kilometers in 2006. Not only is the surface water the groundwater depletion also very high.

2. Method and Materials

This case study tries to assess the existing urban water environment of the Kathmandu Valley through urban water quality modeling for the sustainable urban water environment of the valley in future. This research has reviewed existing water quality management frameworks and spatial relationships between land uses and urban water quality measured with biological, water chemistry and habitat indicators in some representative urban watersheds. Primary data on water quality has been collected through sampling of river water from various locations to assess the urban water quality within the valley. Similarly, review of secondary data and related literature from various sources, field observation, interaction and discussion with concerned stakeholders of various governments and non-governmental line agencies were carried out to perceive the existing water environment situation of the valley.

3. Water Quality Management Frameworks

There are several legislative arrangements aimed at improving urban water quality in Katmandu Valley. The Water Resources Act, 2049(B.S) focuses on the utilization of natural resources without causing any considerable damage to the resource. The Aquatic Animal Protection Act, 2017(B.S.) prohibits use of explosives and poisonous substances in any water bodies. Similarly, Environment Protection Act, 1996 (A.D.) focuses on environmental protection with proper use and management of natural resources. Likewise, the Kathmandu Valley Development Authority Act, 2045 (B.S) empowers the authorities to regulate the environmental situation of the Valley in a more holistic manner. The Industrial Enterprise Act, 2049(B.S) gives due consideration to environmental pollution problems and Waste Water Management Policy (2006 A.D.) recognizes the need to improve compliance with standards and to improve coordination among various stakeholder agencies to foster public-private partnership and proposes separate sewerage for storm and sanitary sewage.

4. Wastewater Treatment Plants in Kathmandu Valley

Wastewater treatment plants have very important roles in keeping city clean. Although government of Nepal has recognized the problem and established various treatment plants at well designed locations of the river reach, the treatment are unable to function and the sewage mixes directly into the rivers. The wastewater treatment plants and their operational status are summarized in the Table 1 below:

Table 1: Wastewater Treatment Plants, their capacity and operation status in KTM valley
Key: mld = million litres per day; Source: Timilsina 2004; Nippon Koie et al. 1999; Metcalf and Eddy 2000; ENPHO leaflet

Plant	Capacity (mld) and type	Status
Dhobighat: receives wastewater from the main urban area of KMC. Constructed in 1978 with IDA funding	15.4 mld. Oxidation Pond consisting of two primary anaerobic ponds, one secondary facultative pond, and a tertiary aerobic pond. Wastewater requires pumping from Sundarighat pump station.	Not operational, out of operation almost since construction. Problem began with pumping wastewater and conveying through under-river sewer.
Kodku: receives wastewater by gravity from eastern core areas of Lalitpur. Constructed in 1978 with IDA funding	1.1 mld. Oxidation Pond: consists of two primary/anaerobic ponds, one secondary facultative pond, and one tertiary/maturation pond	Partially operational but inefficient Poor O&M: Sludge accumulation and non-functioning flow-control valve, resulting flow short-circuiting (less detention time). Farmers tap raw sewage flowing through sewers for irrigation
Sallaghari: receives wastewater from some parts of Bhaktapur urban area. constructed in 1983 with GTZ support	2.0 mld. Originally designed as an aerated lagoon system using diffused aeration equipment. The plant is now converted to a non-aerated lagoon.	Partially operational Difficulties related to pumping and operation of mechanical aerators. Farmers tap raw sewage flowing through the sewers for irrigation.
Hanumanghat: serves only a small part of the core area of Bhaktapur. Constructed in 1977 with GTZ support	0.5 mld. Originally developed as an aerated lagoon	Partially operating as an oxidation pond/non aerated lagoon with low efficiency
Guheshwori: constructed by High Powered Committee in 1999	17.3 mld. Activated sludge oxidation ditch	In operation. High operating costs: in 2005, it was over 10 million (about 65% of this was for electricity). Foaming in aeration tank is the major technical difficulty. There is also a sludge rise/floatation problem in the secondary clarifier (Sah 2006)
Teku: constructed by Kathmandu Municipal Corporation	Constructed wetland – vertical flow bed	For treating septage (from septic tanks). Not in operation
Madhyapur Thimi: constructed with technical support from ENPHO as a pilot demonstration activity of ADB, UN-Hbitat, and Water Aid Nepal	Reed Bed Treatment System – horizontal/vertical flow bed	In operation. Serves around 200 households, and receives about 30 m3/day of sewage. The municipality looks after the O&M.

Water quality sampling stations for water quality data
Whole drainage basin of Bagmati river territory was considered for the study. 21 sampling locations were fixed at Bagmati River and its tributaries. The stations were monitored for two times for indicator parameters like Temperature, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Total Kjeldal Nitrogen, Total Phosphorous, Mercury, Lead, Chromium, and Fecal Coliform.

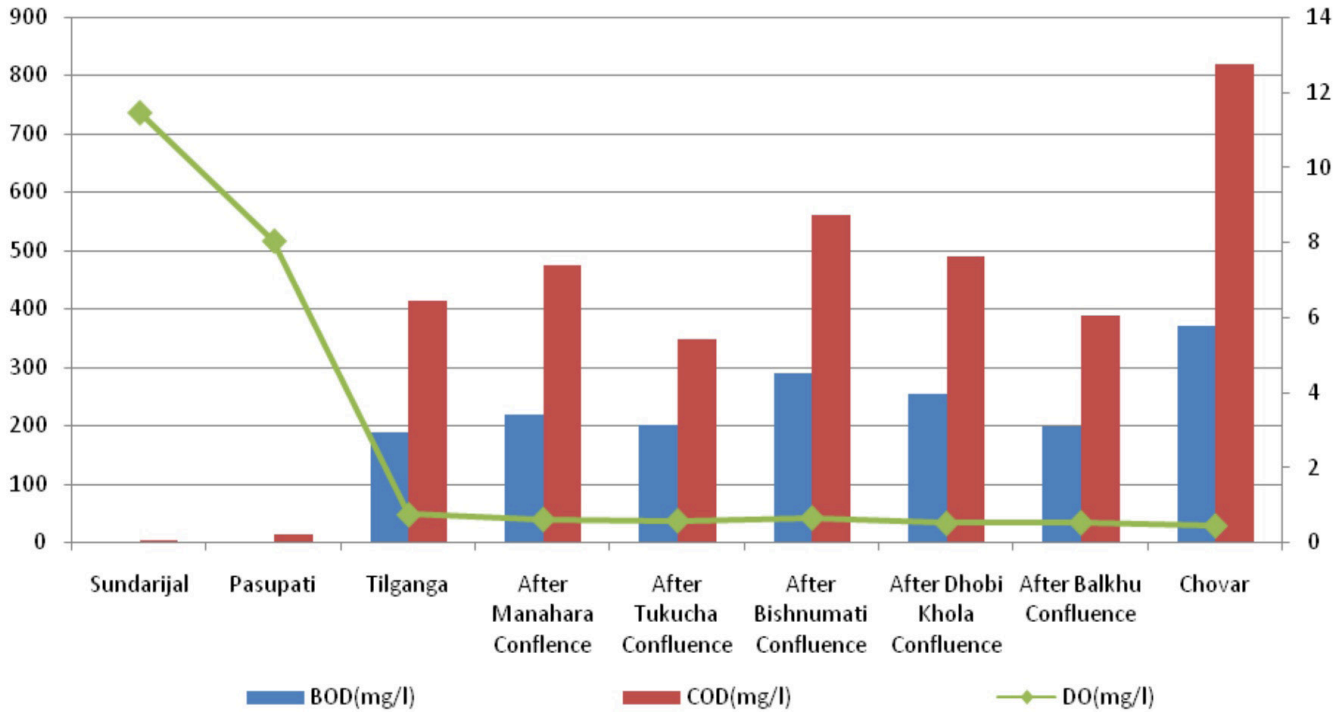

Figure 1: Water quality characteristics at various location Bagmati River

5. Results and Discussion

Bagmati River was found to be good at the source. As recommended by BBWMSIP (1994), the desirable BOD level for drinking and aquatic life is 4mg/l and bathing and agriculture is 10mg/l. At Sundarijal, the BOD and COD values were found to be within the BBWMSIP guideline indicating good water quality. It can be observed from Figure 1 that with the increase in Organic load (BOD and COD) in river water, the dissolved oxygen decreases. BOD and COD are pollution indicator parameters mainly derived from Organic wastes. The decrease in dissolved oxygen with the increase in BOD and COD can be credited to the use up of oxygen in the oxidation of the wastes.

At core city areas, the dissolved oxygen concentrations is below 1mg/l which shows that the water is anoxic and such water is poisonous for aquatic lives (Chapman, 1992). As the river flows downstream the river gets more polluted and by the time the river reaches Chovar the river water quality is analogous to grey water based on the greywater characteristics as described by Metcalf & Eddy, (2003). Similar observations were made by Lamsal, (2014),Tachmaho & Shah, (2013) in Bagmati river.

6. Nutrients

It is observed that Bagmati river water consists of excessive nutrients. The concentration of Nitrates and Phosphates is very high. The probable cause of this is the mixing of household greywater rich in nutrients.

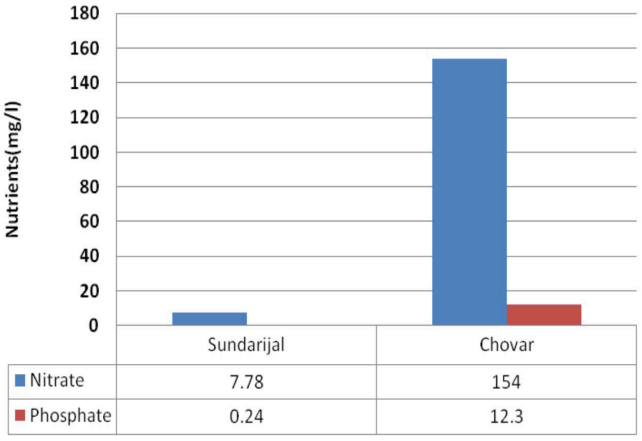

Figure 2: Nitrate and phosphate value at two location of Bagmati River

7. Conclusion and Recommendation

All these data and study indicates that urban water quality in Kathmandu valley is not good enough to sustain healthy water ecosystem. Instead of sustaining life, they have become the carrier of diseases and pollution. Deteriorating quality of river water has even caused frequent cases of water borne diseases such as diarrhea, dysentery, cholera, and skin diseases among people living in riverside areas. It has also reduced the religious, recreational and aesthetic value of rivers.

Although there are strict legislations regarding protection of Bagmati river basin, the rapid deterioration of the basin is due to problems in institutional arrangements, crosscutting issues in governmental agencies and lack of holistic mechanism for the protection of the resource.

Besides various ongoing river restoration activities like construction of sewage diversion structures, concretizing river bank for bank stabilization, altering river flow, flow modification, sewerage line construction work and river cleaning campaigning, Effective management plan with appropriate land use planning and various water quality improvement measures is necessary for the sustainable urban water environment in Kathmandu Valley.