Trajectory of Urban River Degradation: People’s Initiatives for Conservation and Restoration (A Case of Hanumante River in Bhaktapur, Nepal)

Rajesh Sada
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(A Case of Hanumante River in Bhaktapur, Nepal)

Rajesh Sada
Faculty of Science and Technology, University of Algarve
Email: rajesh_sada@hotmail.com

Present Address: Rua Ataide de Oliveira-31, Faro, Portugal

Abstract

This paper presents the trajectory of Hanumante River degradation and people's initiatives for its conservation and restoration. The study involved laboratory based river water quality analysis, semi-structured interviews with the local people depending upon the river water for religious, cultural, and agricultural purposes and case studies of important events. The water quality analysis revealed progressive degradation in the river water quality as the river passes through the city core. The semi-structured interviews revealed the very poor quality of Hanumante River water at present, which was stated as very good fourty years back. The respondents identified untreated sewage discharge, industrial effluents and solid waste disposal into the river to be the most important causes of river degradation. The study revealed the responsible agencies like municipalities, for river conservation themselves as clear violator of Local Self Governance Act-1999. However, the people of Bhaktapur have organised river cleaning campaigns and resisted attempts to further draining wastewater into the river, either by the municipality or by people in the newly developed residential areas. Although the campaigns and initiatives were spontaneous and unorganised, these do reflect the sentiment of the people and their appreciation of religious, cultural and livelihood importance of Hanumante River.

Key words: Hanumante River, Bhaktapur, Water Quality, Perception, People's Initiatives

1. Introduction

Rapid urbanisation is an on-going and dynamic phenomenon worldwide. In 1920, the urban population made up 14% of the world population. This increased to 25% in 1950 (Weber and Puissant, 2003). It is expected to nearly double by 2050, increasing from 3.3 billion in 2007 to 6.4 billion in 2050 and the growth of urban population is expected to be large in developing countries (UN, 2008). This trend in the urban population growth has also been visible in Nepal, especially after 1980s (Thapa et al., 2008). The size of urban population has increased from 0.4 million to 4.09 million between 1971 to 2008 (Portnov et al., 2007; Thapa et al., 2008). Kathmandu valley has been the most urbanised area in the country. Between 1955 to 2008, the population of Kathmandu valley grew over 499 per cent with the current population size in the valley reaching over 2.51 million (Bhattarai and Conwan, 2010 and CBS, 2012).

The ecological impacts of this growth and population re-distribution are profound (Bernhardt and Palmer, 2007). Booth et al., (2003) shows progressive river degradation with increasing urban development. The conversion of agricultural lands and areas under vegetation to built-up areas influences local climate. As rivers occupy the lowest-lying areas on the landscape, they are integrated in the effects of land-use change hence are very sensitive to urbanisation. Urbanisation increases the loading of water and nutrients, turning the urban river from a functioning ecosystem to an efficient...
gutter (Bernhardt and Palmer, 2007). Some of the studies mention the low diversity of the fish species, invertebrate assemblages and benthic organic matter in urban river (Wang et al., 2000; Freeman and Schorr, 2004; Miltner et al., 2004; Walsh, 2004; Moore and Palmer, 2005; Morgan and Cushman, 2005). Similarly, Kathmandu valley has witnessed serious environmental degradation especially resulting from the decline in river environment (Bajracharya, 2008). Continued degradation of river environment has led to rapid erosion of rich cultural heritage along the river courses along with serious ecological consequences. For example, more than half of the fish species in the Bagmati River have disappeared and some parts of the river is biologically dead (NTNC, 2008). These facts apply suitably to the Hanumante River, one of the major tributaries of Bagmati River which has undergone continued degradation affecting not only the livelihood of the people but also imparting irreversible implication to historical and tourism importance of the city. Despite this, there has been no initiative till date on conservation and restoration of Hanumante River therefore it is important to establish the state of degradation of Hanumante River, the causes and processes thereto. It is in these considerations, this paper tries to explain the state of Hanumante River degradation, one of the urban rivers in Kathmandu valley. It further looks into the causes responsible for its degradation and people's initiatives to improve the existing river health and aquatic ecosystem thereto.

2. Materials and Methods

2.1 Study Area

The Hanumante River is an important tributary of the Bagmati River with a catchment area of 143 km² in Kathmandu valley and its significant portion lies in Bhaktapur district. The major sources of water in Hanumante River are rainfall and natural springs. This has been the major natural waterway in Bhaktapur district which has its origin in Mahadev Pokhari at Nagarkot, Bhaktapur. It flows through the rural and urban areas of Bhaktapur district before joining Manohara River at Jadibuti in Kathmandu. Hanumante River has been important to the people in Bhaktapur and in its neighbourhood for cultural, ecological and economic reasons. Several places of cultural and religious importance including temples with archaeological values are located along the course of Hanumante River. As recently as twenty years ago people living in Bhaktapur and its neighbourhood used to bathe, swim and even drink water from Hanumante which has now turned into a virtual sewerage. The river is getting polluted since entire sewage of Bhaktapur and Thimi municipalities and industrial wastes are drained into river without any treatment. Though religious people still do bathe in the river, others refrain from using the river water.

2.2 Methods

Water Sample Collection

Purposive water sampling was carried out to establish the state of water quality at different reaches of the river which was used as one of the indicator of river degradation. The water samples were collected from seven different locations along the river course- Sudal (S1), Hanumanghat (S2), Sallaghari (S3), Srijananagar (S4), Dadhikot (S5), Kaushaltar (S6) and Lokanthali (S7), referred herein after as, S1 to S7 (figure 1). One sample was collected from each of these sites. The first sample was collected from the upstream river stretch before the river enters into urban areas of Bhaktapur, which was considered to be unpolluted section. Rest of the samples were collected from different spots after river reached the urbanized area, on the basis of their religious, social, cultural and economic importance and uses of river
water. The locations of industries along the river course and the municipal effluent discharge points were also considered for selecting sampling sites. The reason behind choosing Srijananagar (S4) which is close to S3 were due to the fact that industrial effluents were being discharged directly into the river after station S3. Further, the river water was being used for irrigation after station S4. The water samples were collected during April, 2009 starting from 11:30 at Sudal and ending at 14:15 in Lokanthali. The month of April is considered to be the last month of dry season in this area. During the dry season, the river flow is very limited and almost no water flow in river as it reached the city core or station S2. The flow in the river is mainly the contribution of domestic sewage discharged directly into the river from Bhaktapur and Madhyapur Thimi municipality, hence increasing the pollutants load. However, it is to be noted that there were rainfall events a week before the day on which the sampling was carried out.

GPS coordinates of each of the seven sites were recorded using portable Garmin Etrex GPS receiver. The locations of the water sampling sites are illustrated in figure 1.

![Figure 1: GPS location of water sample collection sites in Hanumante basin](image_url)

**Laboratory Test for water quality analysis**

Water samples were analysed in the water testing laboratory of Environment and Public Health Organisation (ENPHO). Physico-chemical and bacteriological analysis of 20 different parameters of water samples collected from seven different sites were evaluated. The tested parameters, their unit of measurement and methods used in the analysis are given in table 1.

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Table 1: Methods for the evaluation of water quality parameters

<table>
<thead>
<tr>
<th>S.N</th>
<th>Parameters</th>
<th>Unit</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>-</td>
<td>pH meter</td>
</tr>
<tr>
<td>2</td>
<td>E.C.</td>
<td>uS/cm</td>
<td>Conductivity meter</td>
</tr>
<tr>
<td>3</td>
<td>DO</td>
<td>mg/L</td>
<td>Alkali Iodide Azide Modification</td>
</tr>
<tr>
<td>4</td>
<td>Calcium</td>
<td>mg/L</td>
<td>EDTA Titration</td>
</tr>
<tr>
<td>5</td>
<td>Magnesium</td>
<td>mg/L</td>
<td>EDTA Titration</td>
</tr>
<tr>
<td>6</td>
<td>Chloride</td>
<td>mg/L</td>
<td>Argentometric</td>
</tr>
<tr>
<td>7</td>
<td>TSS</td>
<td>mg/L</td>
<td>Gravimetric (filtration, weighing of residue)</td>
</tr>
<tr>
<td>8</td>
<td>VSS</td>
<td>mg/L</td>
<td>Gravimetric heated at 550(^\circ) c</td>
</tr>
<tr>
<td>9</td>
<td>Total Solids</td>
<td>mg/L</td>
<td>Gravimetric (filtration, evaporation &amp; weighing)</td>
</tr>
<tr>
<td>10</td>
<td>BOD</td>
<td>mg/L</td>
<td>5 days incubation at 20(^\circ) c and titrating of initial and final dissolved oxygen</td>
</tr>
<tr>
<td>11</td>
<td>COD</td>
<td>mg/L</td>
<td>Dicromate oxidation and titration with ferrous ammonium sulphate</td>
</tr>
<tr>
<td>12</td>
<td>Ammonia</td>
<td>mg/L</td>
<td>UV Spectrophotometric method</td>
</tr>
<tr>
<td>13</td>
<td>Nitrate</td>
<td>mg/L</td>
<td>Spectrophotometric method</td>
</tr>
<tr>
<td>14</td>
<td>Total Phosphorus</td>
<td>mg/L</td>
<td>Ammonium molybdate ascorbic acid reduction</td>
</tr>
<tr>
<td>15</td>
<td>Sodium</td>
<td>mg/L</td>
<td>Flame emission</td>
</tr>
<tr>
<td>16</td>
<td>Potassium</td>
<td>mg/L</td>
<td>Flame emission</td>
</tr>
<tr>
<td>17</td>
<td>Chromium</td>
<td>mg/L</td>
<td>Atomic absorption Spectrometer (AAS)</td>
</tr>
<tr>
<td>18</td>
<td>Lead</td>
<td>mg/L</td>
<td>Atomic absorption Spectrometer (AAS)</td>
</tr>
<tr>
<td>19</td>
<td>Zinc</td>
<td>mg/L</td>
<td>Atomic absorption Spectrometer (AAS)</td>
</tr>
<tr>
<td>20</td>
<td>Faecal Coliform</td>
<td>CFU/100 ml</td>
<td>Membrane Filtration</td>
</tr>
</tbody>
</table>

**Note:** E.C.- Electrical Conductivity, DO- Dissolved Oxygen, TSS- Total Suspended Solid, VSS- Volatile Suspended Solid, BOD- Biological Oxygen Demand, COD- Chemical Oxygen Demand, EDTA- Ethylenediaminetetraacetic Acid, UV- Ultra Voilet, CFU- Colony Forming Unit
A total of 55 respondents were interviewed from different locations within the study area. The semi-structured interviews were primarily focused to assessing the trend of river degradation, factors and processes leading to river degradation. The state of degradation of the river with time, as perceived by different people, was assessed using a scale from very poor to very good as: 1 = very poor, 2- poor, 3- moderate, 4- good, and 5- very good.

The case study approach was also adopted in order to assess the in-depth understanding of some important events pertaining to the Hanumante River. Among the three case studies conducted, one was about river conservation and restoration. The second one was regarding the resistance and opposition by religious groups against direct domestic sewage disposal to river and last one was on conflict between groups of people due to river pollution.

Beside these, interviews with key-personnel from municipality, local conservation groups, religious and cultural groups were also conducted to get deep insight about the cases and also to understand the trajectory of Hanumante River degradation.

3. Result and Discussions

3.1 Hanumante River Water: The Present Scenario

The Bagmati Basin Water Management Strategy and Investment Programme stated that Bagmati River and its tributaries within the Kathmandu valley including Hanumante River is not suitable for drinking, recreation or irrigation (Stanley/Mott MacDonald/East, 1994). Similarly, the water quality studies by Sharma et al. (2005) and KAPRIMO (2007) also reported that the water quality of the Hanumante River is excessively polluted and has deteriorated physically, chemically and bacteriologically, and is unsuitable for any freshwater fauna and flora especially during the dry season.

According to the water quality analysis done in this study, the dissolved oxygen (DO) level was found to be the highest (7 mg/l) at S1 (first sampling site) and the lowest (0 mg/l) at S3 and S4. Contrarily, the BOD was the lowest (3.5 mg/l) at S1 while the highest value of BOD (79.9 mg/l) was noted at S3. Similarly, the COD level was found to be lower at the first two sampling sites, S1 and S2, whereas the highest value of COD (128 mg/l) was noted at S3.

According to Nepal Water Quality Standard (NWQS), the DO value for the existence and growth of aquatic life, bathing and irrigation use is 6, 3 and 3 mg/l, respectively (GoN, 2008). If this is used as the basis in evaluating the suitability of different sites for specific uses, S1 would be the only suitable site for the growth of the aquatic life, while the rest of the sites are grossly unsuitable. Similarly, none of the other sites are suitable for bathing and irrigation purpose except S1 and S2.

The maximum tolerance limit of BOD for different industrial effluents is 60-100 mg/l (CBS, 2008 as cited as Nepal Gazette, 2001) whereas the standard value of BOD for aquatic ecosystem, bathing and
irrigation is 4, 6 and 10 mg/l, respectively (GoN, 2008). Comparing the observed value with these standards, S1 would be the only site suitable for aquatic ecosystem, recreation and irrigation purposes and S2 for later two purposes only. While rest of the sites are far beyond the standard value and hence cannot be considered suitable for any of the stated three uses.

The primary reason behind zero DO and high BOD and COD observed at S3 and S4 is discharge of untreated domestic wastewater from whole Bhaktapur Municipality, into the river course at several points such as Hanumanghat, Ram Mandir and Barahi. The organic waste disposed into the river from the surrounding agricultural lands also affects these parameters. The gradual increase in DO and decrease in the BOD and COD beyond this point is the combined implication of fresh water contribution from tributaries such as Ghatte River at Dadhikot, Godawari River at Balkot, comparatively lower amount of domestic wastewater discharge into the river and also the natural purification capacity of the river.

The next parameter which exceeds the tolerance limit at all the sampling sites is ammonia. The proposed standard value for ammonia by Sharma et al., 2005 for aquatic life, bathing and for irrigation uses are 0.02, 0.2 and 0.2 mg/l, respectively and same is the tolerance limit for industrial effluents to be discharged in the inland surface water sources (GoN, 2008). But the observed values ranged from 0.4 to 25.1 mg/l. Ammonia, the most reduced form of nitrogen is found in water where dissolved oxygen is lacking which is also supported by this result. Runoff from the fertilizers applied agricultural land, human and animal wastes including dead animals thrown into the river and industrial effluents are the main sources of ammonia in this river. According to OATA (2010), increase in temperature also changes ammonium into ammonia.

The observed value of total phosphorus was increasing gradually from 0.092 mg/l at S1 to 1.71 mg/l at S5 which was then noted to decrease to the rest of the sites progressively. These observed values were slightly higher than the NWQS for aquatic ecosystem, and irrigation. The major sources of phosphorous are partially treated or untreated septage, runoff from the agricultural fields, weathering of rocks, fertilizers and phosphate release from the sediments under anoxic conditions. Phosphorus clings tightly to soil particles and is used by plants, so its concentration in clean water is generally very low. The higher concentration of phosphorous has negative impacts on the growth of phytoplankton and aquatic plants and also accelerates the aging process of water bodies. When phosphorus exceeds 20 mg/l, it is likely to reduce the availability of copper, iron and zinc in alkaline soils (WHO, 2006).

NWQS guidelines for irrigation water set target range of less than 1 count per 100 ml for faecal coliforms. However, it is also mentioned that 1-1000 count/100 ml could be used for irrigating crops where edible parts are not wetted. But the count of faecal coliform was found to be tremendously higher than the standard guideline, i.e. exceeding 8000 count per 100 ml at all the seven sampling sites. More faecal coliforms in irrigation water is likely to have more impacts in the human health due to consumption of food.

Besides these, almost all others parameters were within the limit of NWQS for aquatic ecosystem and irrigation. The detail values obtained from the water quality analysis comparing with the national standards are given in table 2.
3.2 Trajectory of Hanumante River Degradation

Hanumante River has been facing the “Tragedy of Commons” (Hardin, 1968), the dilemma similar to other common pool resources. The 'principle of non-exclusion' seem to apply in the context of Hanumante, as people know that they themselves have been responsible for polluting the river. However, they are left with no option but to continue polluting the river. They think pollution of Hanumante is a huge problem which is beyond their control, thus shrugging off their woes with 'what to do?' They now face to Bhaktapur Municipality and District Development Committee and other related government organisations with the hope that these agencies would intervene into the matter and do something about it - which has not happened till date.

As mentioned in section 5.1 of Local Self Governance Act 1999, it empowers the local government - Municipalities and Village Development Committees (VDCs) as custodian of natural resources at local level, and hence they are expected to ensure conservation and restoration of natural resources, including water bodies, within their jurisdiction. In Contrary to this expected role, Municipalities and VDCs seem to be clear violator of the provisions of this act at least for now. The municipalities have been dumping untreated sewage in Hanumante River at different locations such as Brahmayeni, Liwali, Hanumanghat, Ram Mandir, Barahisthan, Sallaghari, Byasi, and other different points at Madhyapur Thimi. Not only this, the solid waste of the entire area of Bhaktapur and Thimi Municipalities is dumped along Hanumante River.

Degradation of Hanumante River can be traced back to the implementation of Bhaktapur Development Project during mid-1970s. As a part of urban development plan of the city of Bhaktapur, the then Government of Nepal in Collaboration with the Government of Federal Republic of Germany launched the Bhaktapur Development Project (BDP) through technical support of German Technical Cooperation (GTZ). The BDP was established in 1974, initially covering an area of about 10 per cent of the old town. The underlying concept at the start of the project was to initiate simultaneously various measures aimed at the comprehensive renewal and development of the city in order to establish and enhance the value of the city as important tourism destination. The first phase of the project, from 1974-76, witnessed the restoration of monuments - public, semi-public and private, which were in the state of poor physical condition. Parallel to the architectural restoration, renovation and construction of new public infrastructure e.g. wells, ponds, paving of streets and lanes, laying of new sewer lines were also carried out.

During the second phase of the Project, which lasted for four years, from 1976 to 1980, preservation and restoration remained the guiding focus of the project. Alongside this, investments were made in the construction of infrastructure, such as water supply, drains, roads and pavements. Economic development activities were initiated with the setting up of the industrial estate in the northern part of town, where new technology and production systems were introduced to old traits (Shah, 2003).

After phasing out of BDP, Bhaktapur Municipality continued with the development of new infrastructure and services alongside of heritage conservation and restoration of old cultural artifacts. One of the significant initiatives of the municipality has been land pooling for urban planning since 1990. Though BDP and Bhaktapur Municipality had been successful in other infrastructure program, that contributed significantly in enhancing the tourism and tourism based economy of the city in the
Table 2: Water quality of Hanumante River in different river sections and Nepal Water Quality Standards (NWQS)

<table>
<thead>
<tr>
<th>S. N</th>
<th>Parameters</th>
<th>Unit</th>
<th>Sample ID</th>
<th>NWQS for Irrigation</th>
<th>NWQS for Aquatic Eco.</th>
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<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>pH</td>
<td>-</td>
<td>7.68</td>
<td>7.37</td>
<td>6.97</td>
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<tr>
<td>2</td>
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<td>µS/cm</td>
<td>126</td>
<td>148</td>
<td>42.3</td>
</tr>
<tr>
<td>3</td>
<td>DO</td>
<td>mg/l</td>
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<td>5.3</td>
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<td>75</td>
<td>65</td>
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<td>VSS</td>
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<td>18</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>Total Solid</td>
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<td>206</td>
<td>234</td>
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<tr>
<td>10</td>
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<td>4.7</td>
<td>79.9</td>
</tr>
<tr>
<td>11</td>
<td>COD</td>
<td>mg/l</td>
<td>18.9</td>
<td>17.9</td>
<td>128</td>
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<td>12</td>
<td>Ammonia</td>
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<td>13</td>
<td>Nitrate</td>
<td>mg/l</td>
<td>3.39</td>
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<td>14</td>
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<td>15</td>
<td>Sodium</td>
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<td>16</td>
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<td>Chromium</td>
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<td>&lt;0.02</td>
<td>0.02</td>
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<td>Lead</td>
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<tr>
<td>20</td>
<td>Faecal Coliform</td>
<td>CFU/100ml</td>
<td>TNTC</td>
<td>TNTC</td>
<td>TNTC</td>
</tr>
</tbody>
</table>

Note: TNTC- Too Numerous to Count
(Source: Laboratory Analysis, 2009, **GoN, 2008 and *Sharma et al., 2005)
subsequent years, the development of new sewer lines and underground drainage system failed to produce the expected outputs. Covered pipe drains and sewers were installed as part of the BDP project. Two treatment plants were also installed along the river on the southern and western parts of the city. Individual toilets in houses were encouraged for a healthy and clean living in urban environment. The underground drains started getting clogged with time and there was no any effort to maintain these drains; as a result, new outlets were developed to discharge the sewer directly into the river. Also, untreated sewage from new town planned areas, such as those in Liwali and Jagati, were discharged into the river directly. As a result of this, the river started functioning as a trunk sewer line. Hanumante River, which has been life line of Bhaktapur for centuries for its religious, cultural and livelihood importance, has thus been losing its sacred value over time. The seed of this problem lies in the so called 'modernization' that completely disregarded the environmental, cultural and religious significance of the river.

When the officials at the Bhaktapur Municipality were asked about the programs for conservation and restoration of Hanumante River, the response from most officials was that the municipality is very sensitive to initiate conservation and restoration program. The Municipality is planning to take over the responsibilities of maintenance and operation of sewerage system of Bhaktapur city, which is currently under the Department of Water Supply and Sewerage. For this, Bhaktapur Municipality in support of GTZ has already prepared a plan for developing a new network of sewerage systems which will function as a gravity sewer for north bank of Hanumante and has been named as Hanumante North Bank Collector (HNBC). This plan of improvement of the sewerage system in Bhaktapur has not yet been released and its contribution to lowering down to sewage load in Hanumante River is yet to be seen. Beside this, Bhaktapur Municipality has been cleaning Hanumante River occasionally by dredging sediments deposited in the river with the help of excavator in every two to three years.

3.3 Religious, Cultural and Livelihood Significance of Hanumante River

Rivers and riverine resources have been attracting people for the reasons of availability of fertile soil and water, for food production and to meet domestic needs. Rivers also serve as the means for natural waterways for effluent discharge. The rivers are also linked strongly to the social, cultural and religious value system. In the religious realm, rivers are intricately linked to rites and rituals among the Hindus. Rivers are considered "pure" and "sacred" and treated as "mother" and "goddess". A holy dip in the river is essential before performing many religious rites. The last rites after the death are generally performed on the banks of holy rivers. Usually there are designated places for cremation of deceased along the river banks and cremation is also not allowed at all locations. Hanumanghat has been one among the nine important Ghats in Kathmandu Valley in terms of religious importance for cremation of deceased. Hanumanghat, locally called 'Khorhen' by the people is located at the confluence of two rivers, namely, Brahmayeni Khol River flowing from the north-east side and Tabyakhusi Khol River flowing from the south-east side. The river carries the name Hanumante only in the downstream of the confluence of these two rivers. There is a belief with regards to religious importance of Hanumanghat, Hanumanghat is considered to be located at tribeni (confluence of three rivers) of Bira, Bhadra and Tamasa. To them, Bira is Brahmayeni Khol River and Bhadra is Tabyakhusi Khol River and that the river Tamasa is coming out from the ground.

Considering the religious importance of the place, people use water from the river for rituals in temples and at home, they also pay homage to ancestors by cupping the river water in their hands and holding it
in the air. Beside these daily rituals, there are occasional rituals and functions performed at Hanumanghat. These include Bratabandha, Chhat puja, Ghasthashapana (the first day of dashain) and doing shrada or last rituals of ancestors. On specific days bathing in the rivers is considered sacred. During Dashain, Navaratri (nine days festival) is celebrated by taking holy bath in different sections of Hanumante River for nine consecutive days. Likewise, in every first day of new month locally called as Sankranti, there is a tradition of taking holy dip and offer donations. These activities are also performed at other religiously and culturally important sites such as Bageshworighat, Brahmayenighat, Maheshworighat, Pasikhyoghat, Chupinghat, Ketamarughat, Ramghat, Mangaltirtha and Bhaillahueghat along Hanumante River. Some of the major events performed in Hanumante River are listed in table 3.

<table>
<thead>
<tr>
<th>S.N</th>
<th>Religious and Cultural Activities</th>
<th>Month and Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bathing and washing face with religious sentiments and bringing water for rituals in the temples.</td>
<td>Whole month of Baisakh (April/ May); Every Solar and Lunar eclipse days; Every full moon day (Purnima); Every Aaunsi; Every Ekadasi; Baisakh Sankranti (Mid of April or Nepalese New Year Day); Shrawan Sankranti (Mid July); Maghe Sankranti (Mid February); Dashain during Ashwin (September/October); Radha Damodar Puja during Kartik (October/ November); Laxmi Puja during Mangsir (November/ December) and Ram Nawami during Chaitra (March/ April)</td>
</tr>
<tr>
<td>2</td>
<td>Radha Krishna Jhula</td>
<td>Shrawan (July/ August)</td>
</tr>
<tr>
<td>3</td>
<td>Bathing and washing face with religious sentiments; bringing water for rituals in the temples and taking soil from river to make Jamara</td>
<td>Ghasthashapana (1st day of Dashami) during Ashwin (September/October)</td>
</tr>
<tr>
<td>4</td>
<td>Fasting and telling Sri Swosthani Bratha Katha; Bathing with religious sentiments and bringing water for rituals in the temples.</td>
<td>Madhav Narayan Festival and Sri-Swosthani Brata during whole month of Magh (January/ February)</td>
</tr>
<tr>
<td>5</td>
<td>Sorha Sraddha (Last rituals of ancestors)</td>
<td>Whole Year</td>
</tr>
</tbody>
</table>

Table 3: List of major religious and cultural activities performed in Hanumante River
Beside these religious and cultural significances of Hanumante River, it is also equally important for irrigating agricultural land, washing clothes, swimming and also for brick production by brick entrepreneurs. According to Sada (2012), there are 138 drinking water supply schemes and 127 irrigation schemes in Bhaktapur district which are operated by the water tapped from the springs and tributaries contributing to Hanumante River. It was estimated that the total water consumption by these drinking water supply systems is around 65 million litres per day. Sada (2012) also estimated the cumulative command area of all the irrigation schemes and found that 5173.7 hectare of agricultural land is irrigated by the tributaries of Hanumante River during monsoon though the irrigation coverage during dry season is estimated to be 2241 ha. Besides diverting river water for irrigation at different locations by building temporary brushwood diversion structures, people also pump river water using low lift centrifugal pumps to irrigate land along the river courses. Pump users are generally those farmers who are involved in commercial vegetable cultivation in the fringe area of the city of Bhaktapur district. It is though difficult to ascertain the exact number of pumps used by the farmers at different locations, however more than 100 pumps are estimated to be used by the farmers in pumping water from Hanumante River at different locations.

Similarly, Sada (2012) also calculated the amount of water consumed by the brick industries from the tributaries of Hanumante River. Among 63 brick industries in Bhaktapur, 42 are using water directly from the Hanumante River and its tributaries and estimated that total annual water consumption by these industries is 142 million litres. Almost all of these industries are located in the upstream areas of Hanumante and its tributaries. Not only consumption of water from the river, but the Hanumante and tributaries have also been used as an effluents drainage channel by the several water polluting industries. According to the Department of Small Scale and Cottage Industries- Bhaktapur, there are 232 different kinds of water polluting industries, most of which are carpet production industries, metal industries, cloth production, thread colouring, garment factory and dairy. All these industries are disposing their liquid waste directly into the river without treating them (Sada, 2012).

3.4 Perceived Degradation in Water Quality

Alongside of water quality analysis in the laboratory, the changes in the water quality of Hanumante River as perceived by the people in the area were also evaluated. The study required information on the river about forty years ago, so, among the 55 respondents involved in semi-structured interview, 42 of them who were above 46 years old were only considered in this part of study. They were asked to rank the decadal change in the water quality, over past 40 years, as perceived by them, on a five point scale as: very poor, poor, moderate, good and very good. All of them stated the water quality of Hanumante to be very poor at present which they ranked as very good 40 years back (figure 2). Most of the people related the beginning of degradation of Hanumante River with the commencement of a project that intended improvement of sewerage lines in the city of Bhaktapur, implemented under the technical and financial support of German Government in 1978, popularly known as German Project in the area. The project supported construction of two wastewater treatment plants at Hanumanghat in 1975 and at Sallaghari in 1983 A.D where wastewater collected through underground sewer lines from the households was expected to be treated. However, the treatment plants started getting defunct since early 1990s (Nyachhyon, 2006) that resulted in direct drainage of wastewater into Hanumante River. Prior to this Project, only small number of households in Bhaktapur had toilets and water tap connection in the homestead. People either used public toilets or used river banks for the faecal disposal. Most
households had also a small waste disposal site within the homestead, locally called "Saga" where they collected the waste, including the faecal matters, which were then transferred to the farm lands. This existed as decentralised and sustainable system of waste and wastewater collection and management at the household level.

After the construction of sewerage system under German Project, people started constructing toilets and getting water tap connection in the homestead. During this period, Bhaktapur municipality provided an incentive of NRs. 700 for the construction of toilets to those who did not have toilet in the homestead. This further accelerated the toilet construction by the households that increased the dependence and load on centralised system for wastewater collection and treatment. Failure of the treatment plant resulted to disposal of untreated and concentrated sewage in the river that has been continuing till the date. With the increasing urbanisation in the city of Bhaktapur, that took place in the subsequent years, the wastewater disposal in Hanumante River further intensified with the increasing industrial establishment, solid waste dumping along the river course, and river encroachment.

In attempt to establishing the causes and their relative contribution to river degradation, the perception of the people were assessed using semi-structured interviews with the local people depending upon river water for religious, cultural, and agricultural purposes. The people were asked to enlist the causes of river degradation and rank them by the order of importance in terms of contribution to river degradation. The identified causes were untreated sewage, industrial effluent, solid waste disposal, upstream water extraction, encroachment, and illegal settlements along the river course (figure 3).
3.5 People’s Initiative to Hanumante Conservation and Restoration

While the role of Bhaktapur Municipality to conservation and restoration of Hanumante River has been limited to occasional dredging of sediments and cleaning of garbage dumped into the river, the people of Bhaktapur seem to be sensitive to river degradation and ever increasing pollution in the river and the consequences resulting there from. They have organised river cleaning campaigns in the past and also resisted attempts to further draining waste water and untreated effluents into the river, either by the municipality or by people in newly developed residential areas along the stretches of the Hanumante River (figure 4). Although these campaigns and initiatives have been spontaneous and unorganised, they do reflect upon the sentiment of the people and their appreciation toward religious, cultural and livelihood importance of Hanumante River. This section presents analysis of three cases in the recent past, which demonstrate the people’s concern for river conservation and restoration. These cases provide insights to social dynamics of the people and their sensitivity to the acts of river degradation.
Case 1: Hanumante River Restoration Campaign at Barahisthan

The people of Bhaktapur organised a campaign for cleaning of Hanumante river at Mangal Tirtha that continued for two weeks beginning 4 September 2009, which has been exemplary to people's initiative and their collective action to river conservation and restoration. The initiative has been though unorganised and spontaneous in the beginning, started by small number of people, but once started it succeeded to mobilize support from large number of people. This initiative forced the local government and other government institution to join the campaign when it gained wide coverage by media.

The river course at Mangal Tirtha had started shifting gradually to the northern bank as a result of continued encroachment by the people, resulting to serious erosion along the northern bank. This was a threat to temples, ghat, bridge and settlements nearby the river. There was a spur (called tunga in Newari) constructed to check the river shifting however due to continued erosion even this structure was damaged and not serving the intended function. There was a 10-12 feet deep scour hole at the side of tunga that would result to collapse of the structure any time rendering the land along the river vulnerable to the erosion and damage. When a group of youth saw this, they started talking among them to do something about this. On 4 September 2009, these youth gathered to the point and started voluntary work to repair the damaged spur. On the first day of work, only 12 youths had gathered to the voluntary work. The same number of people also contributed their labour the next day. Though their initiative resulted to some repair of the spur site, there was still huge work left for the conservation of the religious site of Mangal Tirtha. Same evening, the youth decided to invite others to join the initiative. They started beating the Dhimaya Baja (a traditional large drum like musical instrument), to inform people for social gathering. This elicited an amazing response from local people with more than 400 people gathered to work with them shovels, spades and hoes, the very next day (figure 5), though the event was unplanned and small initiative taken by some youths.

People started cutting the trees in the land encroached by Barahi Bridge to Ram Mandir Bridge. The target of the people was to make 6 m wide road along the river course in between these two bridges. On 8 September 2009, around 200 people went on a delegation to Bhaktapur Municipality for support, and conservation and restoration of area, while others continued the work at the site. The participation of the people was honoured by the municipality officers and Bhaktapur Municipality sent a bull dozer to work at the site in widening of the river. The municipality also sent a number of trucks to transport the soil and other debris from the site. The campaign started facing resistance of others who had encroached upon the river course and whose land was being acquired by the people in the clean-up and restoration campaign. The organisers of the campaign felt the need of a committee which could lead the campaign in an organised way. On 12 September 2009, a general assembly of the people was called which was attended by more than 500 people. This led to formation of a 17 member committee for the campaign. The river cleaning and conservation works continued for more than 30 days with large of peoples participation for 11 days. Alongside of Bhaktapur Municipality, other government agencies including Department of Survey (DoS) and District Administration Office (DAO) also supported the campaign. DoS and Municipality deputed 4 surveyors to measure out the land and assess the right of way of the river and encroachment made by the people at different locations. DAO ensured security of the people by sending the police force. The participants were provided free lunch out of the money raised from among themselves and also from the funds collected from the vehicles passing through Barahi Bridge.

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The 30 days long river cleaning campaign resulted to accomplishing following tasks of conservation and restoration:

- Clearing of the river bank between Barahi and Ram Mandir bridges which was encroached by the people and covered with trees and shrubs.
- Widening of river cross section.
- Opening of track for 6 m wide earthen road from Barahi Bridge to Ram Mandir bridge.
- The spur at the site was repaired and land along the northern bank was restored by putting vegetative revetment.

The work accomplished through this campaign was worth of around NRs. 2 million if the nominal monetary value of labour contribution alone by 400 people for 11 days is accounted at the prevailing wage rate of unskilled labour at Rs. 450 per person per day. The actual value of conservation and restoration works accomplished by this campaign was much higher than this and if the environmental and social benefits are also accounted it would be turn out to be much higher. This kind of initiative should be continued in long run and replicated in other sections of the river as well so that importance of Hanumante River could be remained intact and also it could forced the responsible organizations to act on river conservation and restoration. However, this is not happening and it was the first and last of its kind of people’s initiatives on river conservation and restoration in Bhaktapur till date.

Figure 5: Peoples’ involvement in river cleaning campaign
Case-2: Resistance against Untreated Effluent Discharge by Inhabitants of Liwali Town Planning at Hanumanghat

As a part of city extension project and development of new township, Bhaktapur Municipality implemented the Liwali Land Pooling Project during 1996-1999 covering an area of 33.45 ha (Karki, 2007). Currently, there are around 500 households residing in this township in addition to two engineering colleges and three schools that are located in the project area. The project had installed the sewerage system which has direct outlet to Brahmayeni River (a tributary of Hanumante), 200m upstream of Hanumanghat. This was the first shock to the people performing daily and occasional religious rituals at Hanumanghat. There were series of debates between people coming to perform religious rituals at Hanumanghat and those living in the Liwali area. The people had been raising voice against the act of disposal of effluent upstream of Hanumanghat and had also sent delegations to Bhaktapur Municipality several times in order to change the sewerage discharge point from Liwali Town Planning. The municipality however did not take any action despite repeated efforts. Alternatively, the people devised an innovative way which has since become a regular feature.. In the month of Magh (Jan/Feb) every year, the people performing daily religious rites at Hanumanghat block the river just downstream to the sewerage discharge point so that polluted effluents do not enter Hanumanghat where thousands of people come to perform religious activities during Magh, on the occasion of Makar Sankranti. The task of blocking of the river at this time has become regular act of the people and has been working to some extent in controlling the water pollution at Hanumanghat during the period when large numbers of people gather at this site for religious rituals. Bhaktapur Municipality has not taken any action on this issue, which, shows insensitivity of the municipality to the conservation and restoration of the religious sites in its development initiatives.

Case-3: Non Action of Bhaktapur Municipality on Construction of New Sewer Line by the People of Jagati

Brahmayeni River and Tabya Khusi River merge to form Hanumante River at Hanumanghat. With the blocking of Brahmayeni River as stated in case 2, the river water from Tabya Khusi river became the only source of water for performance of religious bathing and other activities at Hanumanghat.

The dwellers of Jagati area, which is located at the southern flange of Tabya Khusi River, have been demanding permission for the disposal of sewer from this area into Tabya Khusi River. The dwellers of Jagati have been putting this demand to Bhaktapur Municipality for several years in the past without resulting to any action from the municipality. Due to the delayed action from Bhaktapur municipality, local people have laid down underground pipelines with the outlet of sewer into the river without permission from local government which was highly opposed by others who perform their daily rituals in the river especially at Hanumanghat. After the huge arguments, the opposition group petitioned the Bhaktapur Municipality. In January 2010, officers from municipality came for an inspection of the sewer line construction by residents of Jagati and removed the underlined pipelines and requested to not to proceed further. The people from Jagati then asked the municipal officials to first remove the sewerage system from Liwali area and stop direct disposal of sewage into the river, to stop the construction of the sewer line in their area. But as the sewerage system in Liwali area was installed by municipality itself, the officials were speechless and returned back without any further argument. When there was no action by the municipality staff in the matter, the very next day, people from Jagati completed the construction of the pipeline with outlet into Tabya Khusi River. This has further worsened the situation of water pollution at Hanumanghat. This has been still another act of insensitivity of Bhaktapur Municipality to
degradation of sites of religious importance due to uncontrolled effluent discharge.

4. Conclusion and Recommendation

Urban rivers display common characteristics such as; high concentrations of pollutants, flashy hydrograph, altered channel morphology and loss of aquatic biodiversity. Hanumante River- the life line of Bhaktapur city, Nepal is facing the same situation. Several studies have already proved that the Hanumante River is biologically dead and cannot be used for drinking, recreation and irrigation purposes. This study aimed to establish the state and causes of degradation of Hanumante River and the institutional dynamics and people’s initiatives for the conservation of the Hanumante River.

Analysis of river water quality at seven different locations along the river course revealed progressive degradation in the river water quality as the river passes through the city core. If DO and BOD alone are used as indicator of water quality in evaluating the suitability of water for different uses, none of the study sites, except that at S1 (Sudal), is considered suitable for aquatic ecosystem, recreation and irrigation uses. Also, concentration of faecal coliform in water was found to be very high exceeding 8000 count/100ml at all the sampling sites. This concentration of faecal coliform in the river water clearly shows potential health risk resulting from river water use. Besides these, the people in the area also stated the water quality of Hanumante to be very poor at present, which was stated to be very good 40 years ago. The study found direct discharge of untreated sewage, industrial effluents, and solid disposal to be the most important causes of river degradation.

Hanumante River though having significant religious, cultural and livelihood importance, has been facing the “Tragedy of Commons”, however, the concerned agencies have not started any initiatives of river conservation and restoration. But the people of Bhaktapur seem to be sensitive to river degradation and have organised river cleaning campaigns and resisted attempts to further draining wastewater and untreated effluents into the river.

Public participation for river conservation and restoration initiated in Bhaktapur is good example which should be promoted and motivated by the concerned organisations. Some of the approaches that can be implemented for the conservation and restoration of Hanumante River would be establishment of sufficient number of wastewater treatment plants and constructed wetlands, assurance of environmental flow, in-stream water pollution control, integrated watershed management, and consideration of river environment in urban planning and development.

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