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Assessment of Water Pollution of River Tawi in Jammu City: A Case Study

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Abstract

India is a blessed with fresh water resources in the form of numerous rivers and lakes. It is often referred to as the "Land of Rivers". It has 14 major, 55 minor and numerous small rivers. According to the scientists of National Environmental Engineering Research Institute, Nagpur, India, about 70 percent of the available water in India is polluted. Studies showed that domestic and industrial sewage, agricultural wastes, religious beliefs etc. have polluted almost all of Indian rivers. Most of these rivers have turned into sewage carrying drains. India is heading towards a freshwater crisis due to improper management of water resources and environmental degradation, which has led to lack of access to safe water supply to millions of people. This poses a serious health problem as millions of people continue to depend on this polluted water from the rivers. The harmful effects of river pollution are not limited to human population only. Pollution of river has affected all species of animals, sometimes threatening their very existence. It seriously impairs the reproductive ability of animals in general and fish species in particular thus forcing them towards extinction. Looking at the multifarious problems due to water scarcity and water pollution this topic is being chosen to examine the status of River Tawi, in Jammu city of J&K state, India.

Keywords: Freshwater, Water Pollution, River Pollution, Health.

Introduction

Water is one of the most important natural resource without which the existence of life is impossible. It is estimated that by 2025 about 3.5 billion people nearly 50 per cent of the world's population will face water scarcity and 29 of the world's river basin will experience further deterioration. Much of the degradation is due to habitat destruction, construction of dams and canals, introduction of non-native species, pollution and over exploitation. Water borne diseases from faecal pollution of surface waters will peak as a major cause of illness in the Third world. Each year approximately 760,000 children under the age of five year die due to diarrheal diseases a leading cause of which is unsafe drinking water[1] Recent data of GEMS found that sewage, toxic metal and industrial and agricultural chemical are the main water pollutants. Of these the most widespread pollutant is organic matter present in domestic sewage. A 1992 WHO study reported that out of India's 3119 towns and cities, just 209 have potential sewage facilities and only 8 have full wastewater treatment facilities. A 1995 report claimed 114 Indian cities were dumping untreated sewage and partially cremated bodies directluy into the Ganges river[2].The beginning of the new millennium seems to be characterized by a steadily increasing attention being paid to the environment.Sewage discharge for cities, towns and some villages is the predominant cause of water pollution in India[3] (CPCB). Major cities of India produce 38354 million litres per day (MLD) of sewage, but the urban sewage treatment capacity is only 11786 (MLD)[4].

Aquatic ecosystem ordinarily supports a variety of physical, chemical and biological mechanisms by which waste may be assimilated in bio-systems without causing serious changes in abiotic and biotic characteristics of water. Now-a-days, contaminants reach levels in excess of the assimilative capacity of receiving waters. Owing to the large quantity of effluent discharged to the receiving waters, the natural processes of pathogen reduction are inadequate for protection of public health. The extent of discharge of domestic and industrial effluents is such that rivers receiving untreated effluent cannot provide the dilution necessary for their survival as good quality water sources, thereby affecting the organisms directly or indirectly by altering physico-chemical environment.

Moreover, over the past several decades, increase in use of metals in industry has led to serious environmental pollution. The gradual rise in the levels of such metals in aquatic environment has become a problem of primary concern. This is due to their persistence since they are not usually eliminated either by biodegradation or by chemical means, in contrast to most organic pollutants. The deadlier 4 diseases like edema of eyelids, tumor, congestion of nasal mucous membranes and pharynx, stuffiness of the head and gastrointestinal, muscular, reproductive, neurological and genetic malfunctions caused by heavy metals have been documented. Therefore, monitoring these metals is important for safety assessment of the environment in general and human health in particular.

Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards. Although the standards vary from place to place, the objective anywhere is to reduce the possibility of spreading water borne diseases to the bare standard minimum. In reality, the term water pollution refers to any type of aquatic contamination between two extremes: A highly enriched, over productive biotic community, such as a river or lake with nutrients from sewage or fertilizer (cultural eutrophication). A body of water poisoned by toxic chemicals which eliminate living organism or even exclude all form of life.

Rivers and Lakes are prime source of freshwater in the cities. Similarly River Tawi is the lifeline of Jammu city. It is the only river making its course from the heart of the city. Thus is subjected to various forms of contamination. Before we bring into use the water from Tawi we must be aware of its physico-chemical impurities and levels of pollution. And help combating the problem of water pollution, arising due to it. Water could be polluted by biogenic pollutants. But we are determined to identify major physic-chemical pollutants only in the present study.

Objectives of the Study

1. To study the quality of water of river Tawi.
2. To assess the sources and levels of pollution in river Tawi.
3. To analyze the socio economic conditions persisting along the Tawi river in Jammu city.

Database and Methodology

The present study is based on both primary as well as secondary sources of data. Primary data were collected with the help of

1. Field visits
2. Field observations
3. Questionnaire/ Interviews

Secondary data were collected from different sources i.e. Government Offices, Published bulletins, Census of India, Central Ground Water Board, Office of the State Ground Water Board, Municipality Office Jammu, Bureau of Indian Standards, Internet Sites.

For the collection of primary data multistage random sampling method is used. In the first stage, sampling of the area was done only among the number of wards falling across the river Tawi. Five wards were selected for the study. The wards were selected on the basis of the points which cover the Jammu from initial to end points. Another criteria for the selection of wards where number of effluents is mixing in the river tawi. Only those wards were selected which are located along the river.

Table 1. Name of the Five Wards are following

Ward No.	Ward Name
6	GUJJAR NAGAR
12	KRISHAN COLONY
14	BHAGWATI NAGAR
19	BIKRAM CHOWK
47	OLD BAHU FORT

To assess the quality of water in River Tawi five samples were collected in plastic bottles of capacity one litre each. They were further treated with 2ml HCL. After acid treatment they were sent to central ground water laboratory for the testing of the following physico chemical parameters.

Table.2:Tawi River-Water Sampling Sites

Location	Date of Sample Collection
Sitli lift Canal	2-08-16
Bagh e Bahu	2-08-16
Gujjar Nagar	3-08-16
Vikram Chowk	4-08-16
Bhagwati Nagar	5-08-16

The following parameters are to be tested from the obtained samples.

1. HCO_3 (Bicarbonate)
2. CO_3 (Carbonate)
3. Cl (Chloride)
4. Ca (Calcium)
5. Mg (Magnesium)
6. Na (Sodium)
7. K (Potassium)
8. TH (Total Hardness)
9. Sp Cond.(Specific Conductivity)

After obtaining the results of the samples it was compared with the Bureau of Indian Standards values.

For getting the people's perception regarding the quality of water detailed questionnaire/interviews was conducted. A total of hundred respondents were interviews randomly from all the selected location along both the banks of River Tawi.

For the assessment of data simple statistical techniques were used. Microsoft Excel and Microsoft Word were used for preparing the reports and figures. QGIS techniques is been used for the preparation of map.

Study Area

Jammu, the city of temples and the winter capital of Jammu & Kashmir, is located on both the banks of the River Tawi. The old city is confined to the right bank and the later expansions of the city (new Jammu) have largely taken place on the left bank of the river but a number of new colonies such as Roopnagar, Janipura, Barnai, Bantalab, Anand Vihar, Tathar etc. have come up on the right bank also. Large scale urbanisation and industrialisation has given rise to what is called now Greater Jammu,

the name given to old, new and the suburbs of Jammu.

Jammu is located 32^0.27N to 33^0 50N Longitude and 75^0.19E to $75^0$20E Latitude. It has an average elevation of 327 m (1073ft.). Jammu city lies at uneven ridge of low height at the Shiwalik hills. It is surrounded by Shiwalik range to the north east and southeast while the trikuta range surrounds it in the north-west. It is approximately 600 kilometers from the national capital New Delhi.

Fig.1: Location of Study Area

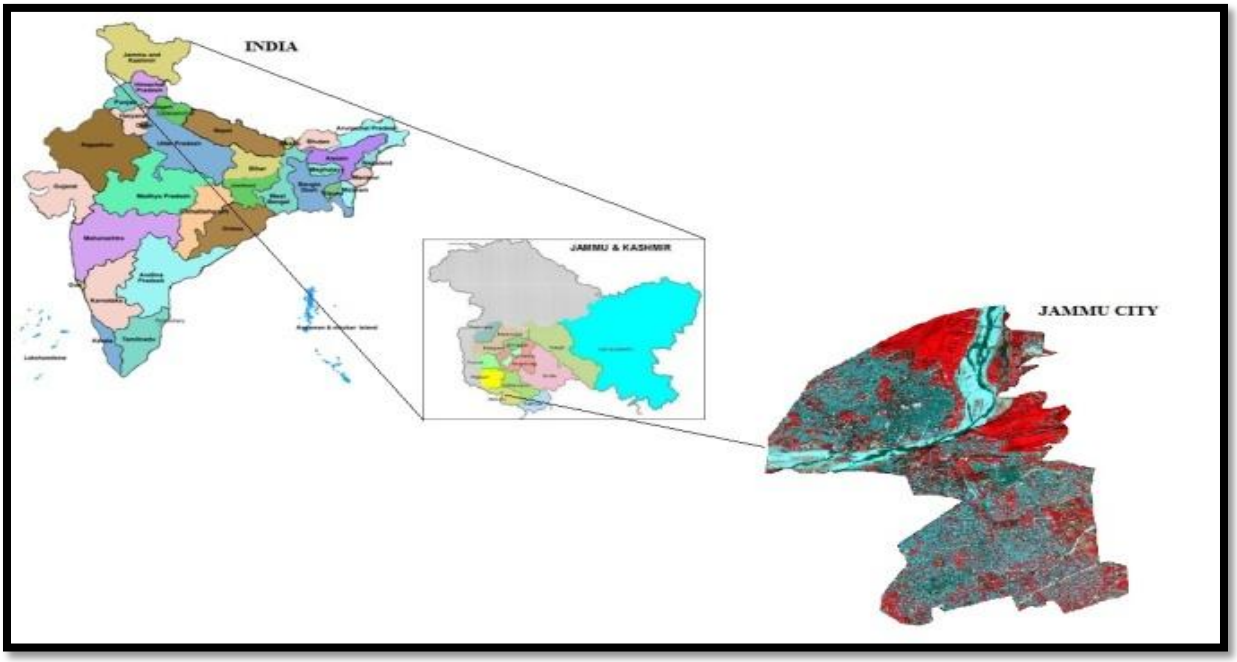
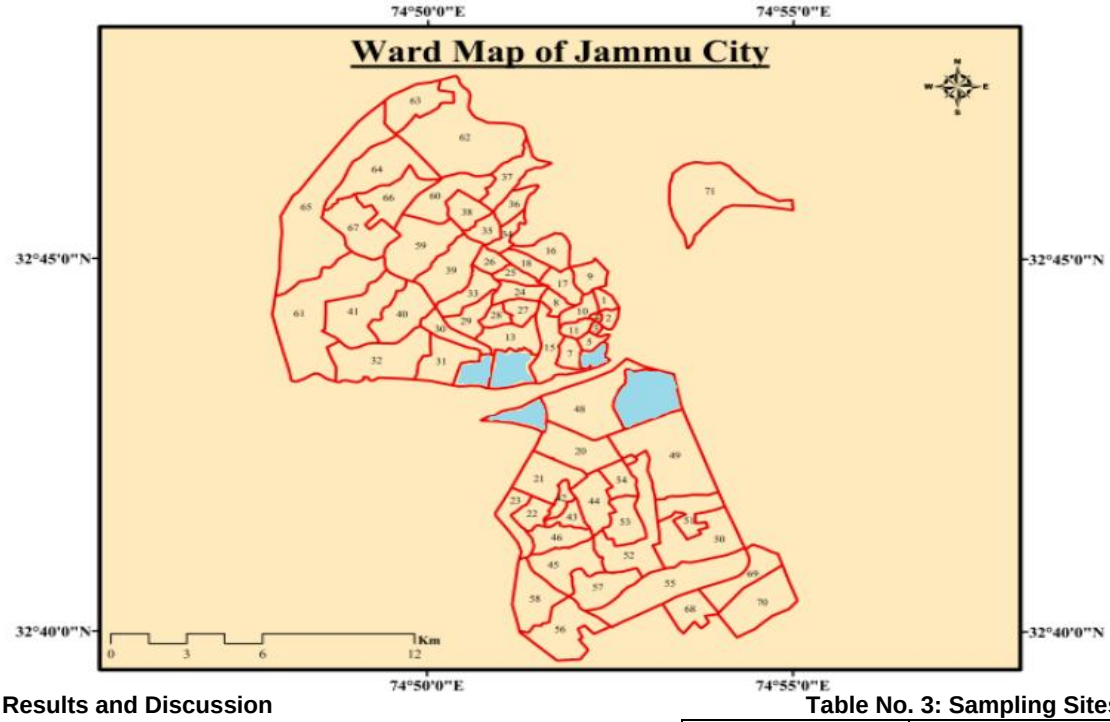


Fig.2: Jammu City: Sampled Ward along River Tawi



Results and Discussion

Status of Water Quality in River Tawi

Status of water quality in river tawi was determined by obtaining samples from five consecutive sites across the river tawi namely.

Table No. 3: Sampling Sites

Location	Date of Collection
Sitli lift Canal	2-08-16
Bagh e Bahu	2-08-16
Gujjar Nagar	3-08-16
Vikram Chowk	4-08-16
Bhagwati Nagar	5-08-16

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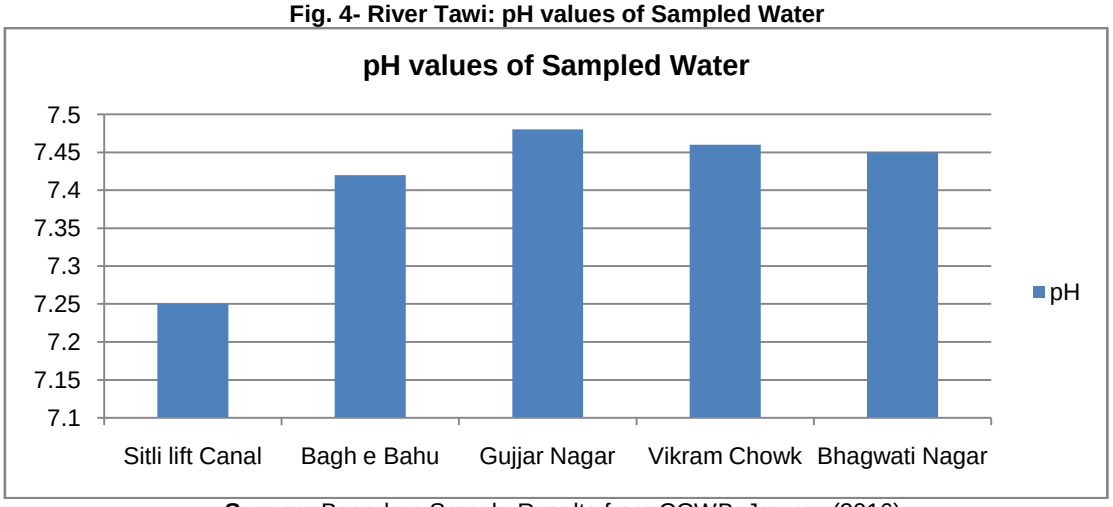
Table No. 4: Sample Results

Location	pH	HCO3	Chloride	Ca	Mg	Na	K	TH	Sp Cond ms/cm
Sitli lift Canal	7.25	128	42	40	6	6.05	2.37	160	260
Bagh e Bahu	7.42	128	42	40	2	5.5	2.44	110	230
Gujjar Nagar	7.48	122	42	34	9	5.5	2.29	115	220
Vikram Chowk	7.46	220	42	34	7	4.9	2.45	115	210
Bhagwati Nagar	7.45	180	42	36	7	6.7	2.7	120	180

Source: Based on Sample Results from CGWB, Jammu (2016)

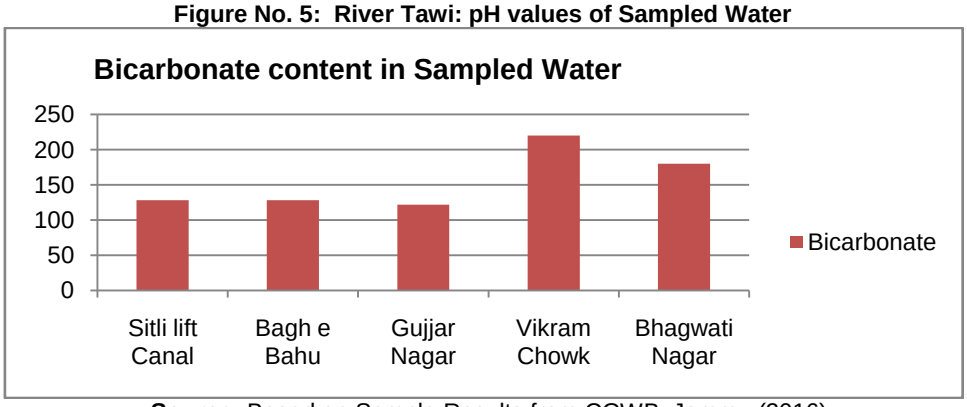
Fig. 4- River Tawi: pH values of Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the research work, the pH values depict an increasing trend. The lowest pH values of water have been found in Sitli Lift Canal which is 7.25, Bagh -e-Bahu is 7.42. The higher values of pH were found in Vikram Chowk and Gujjar Nagar- 7.48. outlaying an increasing waste disposal at the two junctions.

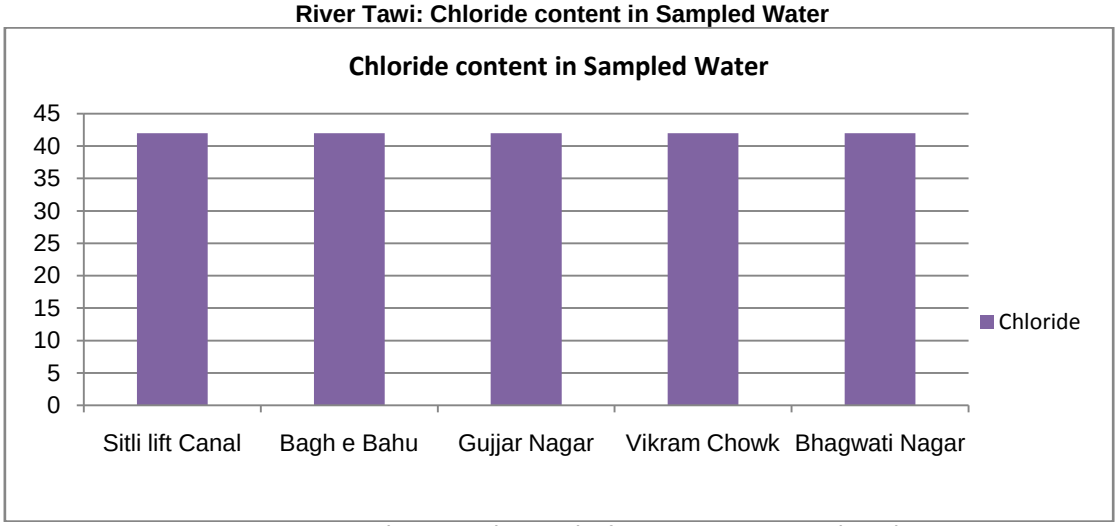
Figure No. 5: River Tawi: pH values of Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the study, bicarbonate content has been found maximum at Vikram Chowk which is 220 units and Bhagwati Nagar records the second highest levels of bicarbonate in the water. Sampling stations at Sitli lift Canal, Bagh e Bahu, and Gujjar Nagar recorded lower values of bicarbonate in the water.

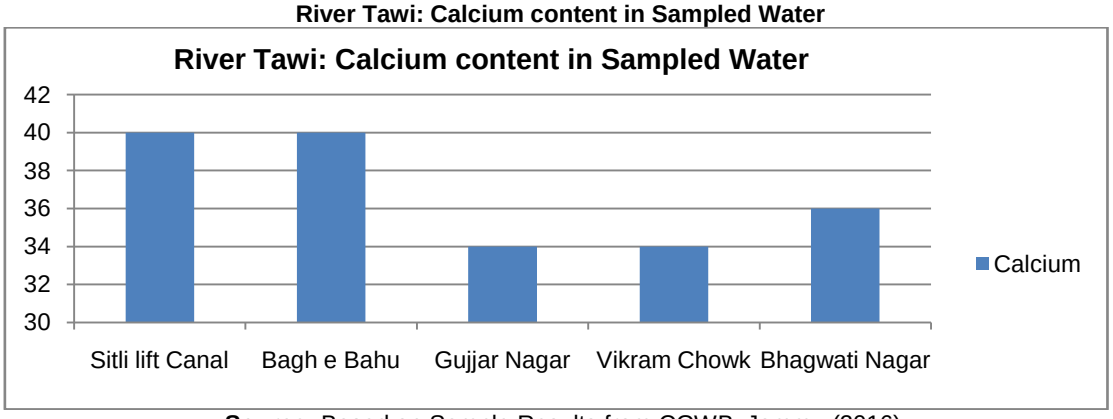
Figure No.6
River Tawi: Chloride content in Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the study, Chloride levels have been found to be same at all the sampling stations of the River Tawi.Thereby, showing no significant discrepancy in the amount of chloride in the water.

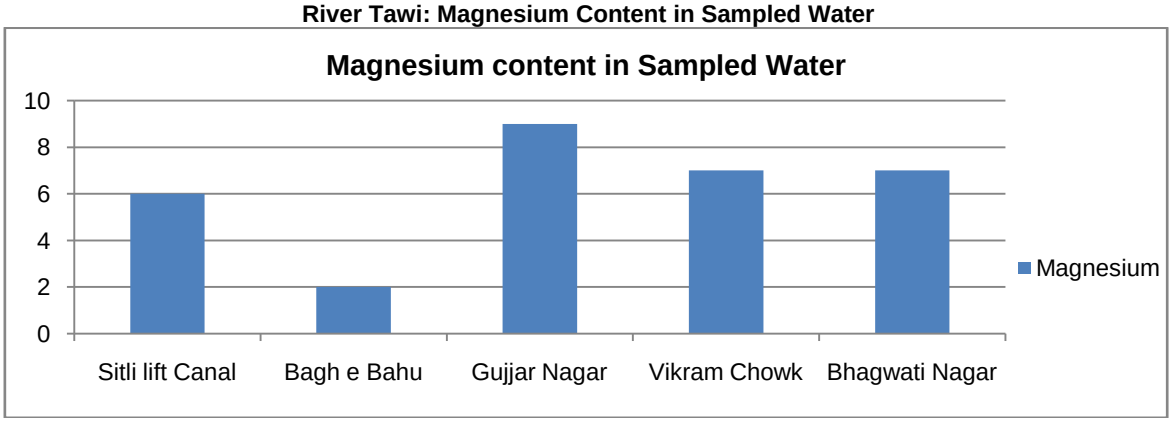
Figure No.7
River Tawi: Calcium content in Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the research work, water samples of Sitli Lift Canal and Bagh e Bahu hint at high amount of calcium content which is 40 units. Sampling stations of Gujjar Nagar and Vikram Chowk recorded lower most levels of calcium content with 34 units. Whereas Bhagwati Nagar occupied the middle values at 36 units.

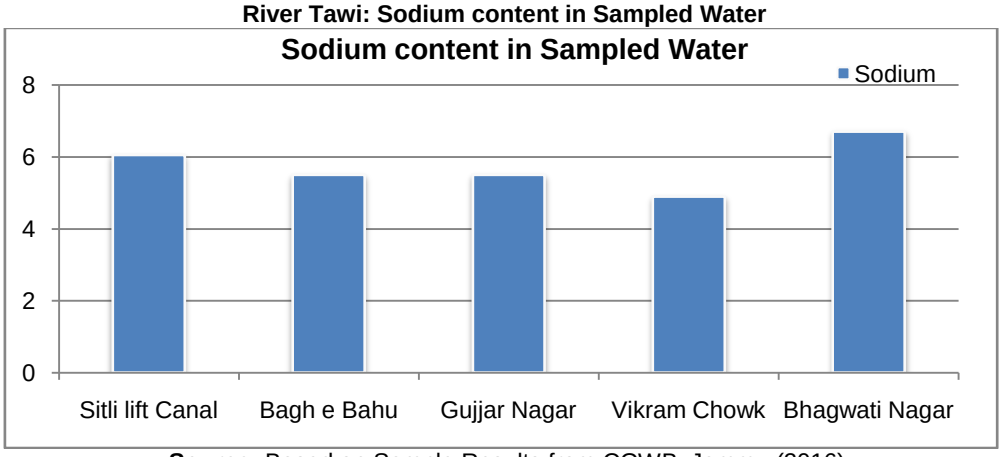
Figure No.8
River Tawi: Magnesium Content in Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the research, the magnesium levels have been found maximum in Gujjar Nagar which is 9 units. While the areas of Sitli Lift Canal, Vikram Chowk and Bhagwati Nagar denote mediocre amount of magnesium ranging from 6-7 units. The Bagh e Bahu sampling station recorded the lowest value of magnesium i.e. 2 units.

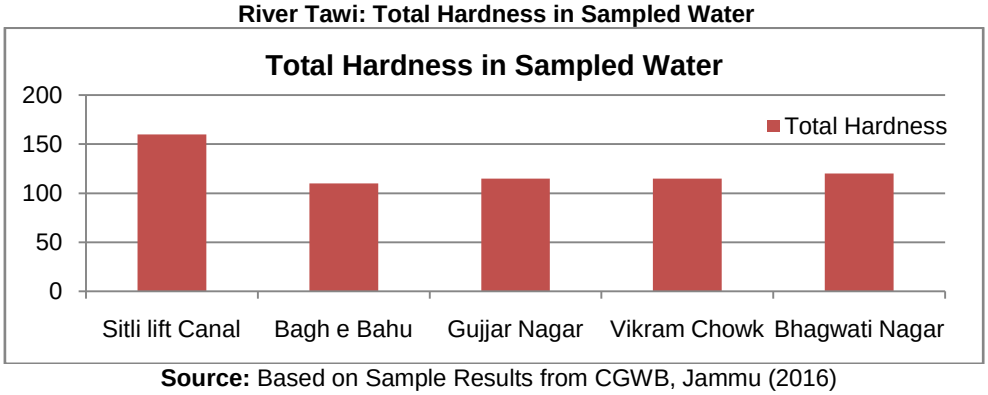
Figure No.9
River Tawi: Sodium content in Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the study, Bhagwati Nagar recorded the highest amount of Sodium content in the water. Whereas the sodium levels of the other samples scattered around it, ranging from 4.9-6.0 units.

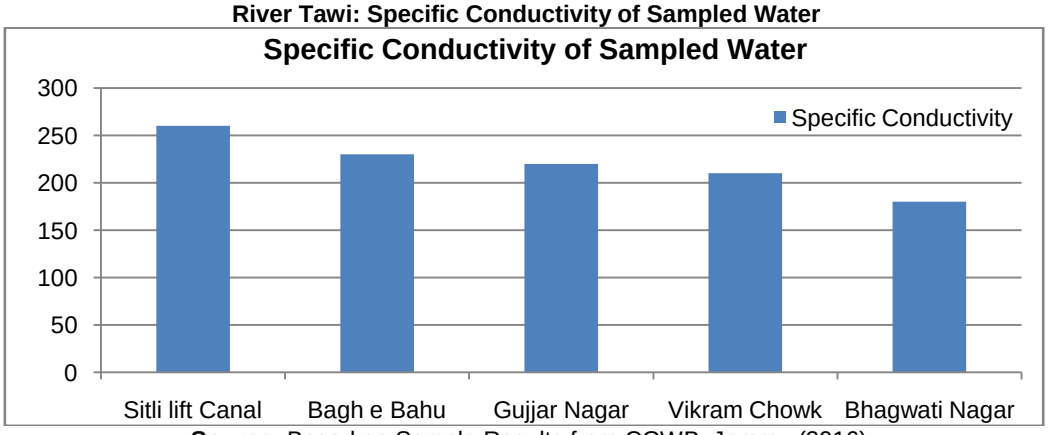
Figure No.10
River Tawi: Total Hardness in Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the research work, Samples procured from the Sitli Lift Canal recorded the maximum hardness of water which is 160 units. On the other hand, other stations such as Bagh e Bahu, Gujjar Nagar, Vikram Chowk and Bhagwati Nagar recorded hardness ranging from 110-124 units approximately.

Figure No. 11
River Tawi: Specific Conductivity of Sampled Water



Source: Based on Sample Results from CGWB, Jammu (2016)

Out of the five samples of waters of River Tawi obtained during the research work, Samples reveal a decreasing trend in the Specific Conductivity from Sitli Lift Canal to Bhagwati Nagar.

Over the distance the specific conductivity of water reduced considerably which is evident in the results. The Sitli Lift Canal denoted 260 units, Bagh e Bahu-230 units, Gujjar Nagar -220, Vikram Chowk -210 and Bhagwati Nagar 180 units respectively

Water Quality of River Tawi Compared With Bureau of Indian Standards

Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Drinking Water Sectional Committee had been approved by the Food and Agriculture Division Council.

Table No. 5- Sampling Results compared with BIS

Location	***pH***	***HCO3***	***Chloride***	***Ca***	***Mg***	***Na***	***K***	***TH***	***Sp Cond ms/cm***
Sitli lift Canal	7.25	128	42	40	6	6.05	2.37	160	260
Bagh e Bahu	7.42	128	42	40	2	5.5	2.44	110	230
Gujjar Nagar	7.48	122	42	34	9	5.5	2.29	115	220
Vikram Chowk	7.46	220	42	34	7	4.9	2.45	115	210
Bhagwati Nagar	7.45	180	42	36	7	6.7	2.7	120	180
Mean Values	7.412	155.6	42	36.8	6.2	5.73	2.45	124	220
BIS ideal values	6.5-8.5	300	250	75	30	30	20	200	400
BIS critical limits	>=8.5	1000	1000	200	100	100	100	600	1000

Source: Based on Sample Results from CGWB, Jammu (2016)

This standard prescribes the requirements and the methods of sampling and test for drinking water. According to BIS, the pH of the drinking water should range between 6.5 - 8.5 if we compare the results of the study with the standard values it is seen that the average pH values of the river water i.e. 7.412 lies between the permissible limits of the BIS and hence can be regarded fit for consumption for humans.

The bureau of Indian standards has also provided idea values of the bicarbonate content, according to which HCO3 content in water should be 300 units. If we compare the results of th e study with the standard values it is seen that the average HCO3 content of the river water is 155.6 units which lies within the permissible limits of the BIS.

The BIS has also given delineated standard values of chloride content for drinking water which should be 250 units and if we compare the results of the study it can be clearly indicated that the obtained results of chloride content 42 units is within the permissible limits of BIS.

The BIS has set standard values of specific conductivity of drinking water which is 400 units and when we compare this with the results obtained in our study, it can be said that the obtained results of specific conductivity is 220 units which is within the permissible limits of BIS.

The standard for hardness of water is 200 units where as our sample has reported hardness of 124 units; which proves that it is potable water.

Surface Run Off

Rainy season contribute the surface run off of old city Gujjar nagar, Jewel, Bhagwati nagar Krishna nagar and Gorkha nagar, bawe etc. other adjoining catchment area the common observation during the present study clearly shows the load of waste material in tawi water increased rapidly from nagrota on ward and its due to urbanized life style. The sewage water or clogged drain is common scenario during monsoon. The waste water and solid waste carried with rain water to Tawi River.

Washing and Bathing Activities

The nomadic people settled along the Tawi River include Gujjar and Bakerwaals. Bathing and washing activities by these people and locals is another cause of water pollution in river Tawi. The Tawi bed is exploited for sand gravel and stone which effects the ecology of the Tawi bed .The washing of vehicles is also observed which cause the oil and grease particles to the water of Tawi river.

Festival of Navratras

Festival such as Ganesh Visrejan and Navratra celebrated by the people these religious festivals increase the load of non biodegradable waste material by several fold plastic, polythene remain scattered and choke the water flow.

Table 6-Jammu City: People's Perception Regarding the Quality of Water in Selected Wards

Quality of Water		Bahu Fort Area	Bikram Chowk	Bhagwati Nagar	Krishan Colony	Gujjar Nagar
Households surveyed		20	20	20	20	20
Color	a) Clear	100%	75%	85%	100%	80%
	b) Turbid	0%	25%	15%	0%	20%
Taste						
	a)Tasteless	90%	100%	100%	100%	75%
	b) Bitter	10%	0%	0%	0%	25%
Saltiness						
	a) Yes	0%	0%	0%	0%	0%
	b) No	100%	100%	100%	100%	100%
Hardness						
	a) Yes	0%	25%	0%	0%	35%
	b) No	100%	75%	100%	100%	65%

Source: Based on Field Survey-2016

The above table reveals the status of drinking water in the surveyed wards on the basis of parameters such as color, taste, saltiness, hardness. No households in any of the wards have reported saltiness in the water. Similarly very few proportion of households in the Vikram Chowk and Gujjar Nagar have reported hardness of water i.e. 25% and 35% respectively. Apart from these wards no wards have associated their supply of water to hardness. Only 10% houses in Bahu Fort Area and 25% Households in Gujjar Nagar have reported bitterness in water. Rest all the households have account to tasteless water. The color of the water is also unobjectionable in wards of Bahu fort area, Krishan Colony. But 25% households in Vikram Chowk, 15% in Bhagwati Nagar, and 20% in Gujjar Nagar have described their water supply as turbid in color, relating to mixing of gravel and other impurities.

Conclusion

The present research work is aimed to assess the sources and levels of pollution in River Tawi and to examine the quality of water of River Tawi. For detail analysis the water samples obtained along the Banks of River Tawi and were tested for various physico-chemical parameters at the Central Ground Water Laboratory, Jammu.

The study has helped to assess about the quality of water and also been proven beneficial in assessing the levels of water pollutions in river tawi. It can be inferred from the study that the water of river is physico- chemically fit for Human usage. As it shows that the averages of Chloride 42 units, ph 7.41, total hardness 124 units, sodium 5.73 units, magnesium 6.2 units, and calcium content 36.8 units respectively. Average results are far below the range of Bureau of Indian Standard's Ideal values of drinking water. But this water can further be tested for biogenic impurities present in it.

Suggestions for Control of Water Pollution in River Tawi

Implementation of Water Act 1974

Proper implementation of water act 1974: there are several laws pertaining to the maintenance of water quality. Water act 1974 needs to be implemented strictly to ensure its portability.

Proper Treatment of Sewage Water

The treatment of sewage water needs to be adopted at concerned authority's levels. Jammu city is expanding due to urbanization but there is no sewage water treatment plant.The waste water discharge directly or indirectly into river tawi is the major cause of its pollution and which needs to be checked.

Building of Embankment around Tawi

Within city there is need to construct embankment along the tawi so that entry of pollutant can be checked and which may also help to restrict over spillage it helps in over spillage of water to the surrounding area during Rainy season. Plantation in upper catchment area also helps in reducing the load of sediments.

Appropriate Methods of Solid Waste Management

Waste material can be used as resource by adopting recycling, composting, reuse etc. The modern techniques such as incineration, sanitary land fill needs to be initiated for effective Solid waste management (SWM).

To protect this water ecosystem, there should be proper management and planning of deposition of municipal sewage and domestic wastage for health hygiene and sustainable environment. The sanctity of river tawi needs to be restored by both public and concerned authorities. Although several work has been done on this issue but practically it has not been taken yet. Tawi River is a major source of drinking water for the old city. Untreated sewage in Jammu pollutes Tawi River as it passes through the city.

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