COMPREHENSIVE APPRAISAL OF WATER QUALITY OF SIRHIND CANAL, MOGA FOR ITS BEST-DESIGNATED USE

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ABSTRACT

A comprehensive assessment on seasonal variations in physico-chemical and biological status of Sirhind Canal along its course in Moga, Punjab, India, in different seasons i.e. summer, monsoon & winter season from 2009-2012, has been discussed in this paper. Ten sampling sites were selected at a distance of approximately 4 Km covering a stretch of 50Km along its course in Moga, Punjab. The investigations were based on physico-chemical, biological factors such as, Temperature, pH, Total Dissolved Solids (TDS), alkalinity, Total Hardness, Nitrate concentration, Phosphate concentration, Dissolved Oxygen, Biological Oxygen Demand and E.coli estimation. Heavy metal analysis was also done to know the impact of heavy metals on human health & environment.

Keywords: Water Assessment, Feacal Contamination, Heavy Metal, Seasonal Variations, Sirhind Canal

I. INTRODUCTION

GEOGRAPHICAL LOCATION AND EXTENT OF AREA

Sirhind canal in Punjab, India, opened in 1882. It consists of an extensive canal system that irrigates more than 2,000 square miles (5,200 square km) of farmland. The system's headworks, where it draws its water, are on the Sutlej River at Ropar, near the border of Himachal Pradesh state. From there the canal runs west-southwest to Doraha, where it splits into three branches. One flows west and then northwest to rejoin the Sutlej near the Pakistan border; One runs southwest past Bhatinda to the border of Rajasthan state; The third flows southeast to Patiala. There are many distributaries, in addition to the three principal branches. It irrigates 728,424 hectares in the districts of Firozepur, Ludhiana and parts of the princely states of Patiala, Nabha, Faridkot, Jind, Malerkotla and Kalsia. The major uses of this of river water, for irrigation (30%) and thermal power plants (50%) while other uses are domestic (7%) and industrial consumption (12%). Due to rapid increase in Industrialization and Urbanization, most of the Indian Rivers and their tributaries are reported to be polluted due to discharge of untreated sewage disposal and Industrial effluents directly in to the rivers. So is the case with Sirhind Canal, passing through Moga, Punjab that is being polluted due to many reasons. As rivers are the most dynamic having as their primary functions the transportation of water[1]; they contribute to the maintenance of the biological or ecological integrity of the system which refers to the capacity to support and maintain a balanced, integrated, and adaptive biological system having the full range of elements and processes expected in a region's natural habitat [2]**.** Water used for irrigation of agricultural lands vary greatly in quality depending upon type and quantity of dissolved salts, which originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals [3]**.** Worldwide, there are about 1.1 billion people who have no access to safe water sources, of which around 84% live in rural areas. Over four million children die from waterborne diseases yearly of which fifteen percent die due to diarrhoea before reaching the age of five, another million die due to malaria each year[4] [5].To deal with the waste problem, investments for a new solid waste management system for recycling & better policies for the river conservation should be implemented [6] [7].

II. MATERIALS & METHODS

2.1 Sampling Sites

These investigations carried on Sirhind Canal, a stretch of 50 miles of Sirhind canal covering 10 stations along its course in Moga, Punjab, to find out whether the water is suitable for drinking, irrigation and other various purposes, are given below:

Sampling Sites: S-1=Raunta; S-2=Mardi Mustafa; S-3=BhagaPurana; S-4=Sivian; S-5=DaateWala; S-6=Langiana; S-7=Bhalour; S-8=PhuleWalan; S-9=Ranian; S-10=Daudhar.

2.2 Purpose of Water Sampling

The purpose of sampling was to handle the water sample very carefully in such a way that no significant changes occur in composition before the tests are made. The bottles were filled and the closed tightly under the surface of the water to avoid the upper air contamination as to get the accurate readings of the dissolved oxygen in the water. The bottles were properly labeled with the sample number and date of sampling and were put in the bag to carry them to the area of testing. Sampling was done from the year 2009-12 in summer, monsoon and winter season. The physical parameter like temperature was taken at the site of collection and samples were brought to the laboratory for detailed physico-chemical and bacteriological analysis.

2.3 Water analysis was done in three phases

PHASE-1

Physio-chemical parameters include Temperature, pH, Alkalinity, Total dissolved solids, total hardness, Dissolved oxygen, Biological oxygen demand, nitrates, Phosphates. These parameters were analyzed in summer, monsoon & winter.

PHASE-2

Biological parameters include Total coliforms (*E. coli/*Faecal coliforms)/100ml in summer & monsoon.

PHASE-3

Heavy Metal analysis *viz*As, Cr, Cu, Fe, Mn, Ni, Pb, Zn in summer & winter.

III. METHODOLOGY

The standard methods [8]adopted for each parametric analysis of Sirhind Canal, Moga. Various methods for used for physiochemical and Biological analysis are as discussed by[9][10]. Statistical analysis of the data was done at 5% level of significance.

IV. RESULTS & DISCUSSION

During these investigations, it was concluded that pH value was found to be high in summer season in comparison to monsoon & winter season. In summer, pH value ranged between 7-7.4; during monsoon it ranged between 6.5-7; during winter it ranged between 6.2-7. Therefore, water is slightly on the acidic side as is evident from the pH value in monsoon & winter. Temperature ranged between 25-28ºC with maximum temperature at S-1 (28ºC) & minimum at S-4 (25ºC) in summer. In monsoon, temperature ranged between 21-27.5ºC with maximum at S-10 & minimum at S-4 whereas in winter, it ranged between 15.5-17ºC. Temperature has shown significant variations at ($p<0.005$) level in its values among various seasons & different spots. High temperature intensifies the effect of toxic substances and speed up biological degradation process. A temperature of about 35ºC is generally considered as maximum for survival of aquatic life. In present investigations, temperature was found to be within the tolerable limit of aquatic organisms. TDS ranged between 187-215 mg/l with maximum value at S-10 (215 mg/l) followed by S-7 (211 mg/l), S-6 (210 mg/l) & S-9 (207 mg/l) and minimum value at S-3 (187 mg/l) in summer. In Monsoon, value lied between 183-203 mg/l with maximum value at S-7 (203 mg/l) followed by S-10 (200 mg/l), S-9 (197 mg/l) & S-6 (195 mg/l) and minimum value at S-3 (183 mg/l). In winter, TDS lied between 193-217 mg/l with maximum value at S-7 (217 mg/l) followed by S-10 (209 mg/l), S-6 (206 mg/l), S-8 (200 mg/l) and minimum value at S-3 (193 mg/l). Low value of TDS during monsoon might be due dilution effect in rainy season that lowers the concentration of ions in water. The accepted level of the total dissolved solids of any water body is below 500 mg/l. Its level beyond 500 mg/l is usually unaccepted and is the cause of the rejection of the water. Total Dissolved solid (TDS) is within the permissible limits of the pollution and is not harmful for the aquatic life. Alkalinity ranged between 125-142 mg/l with maximum value at S-9 (142 mg/l) followed by S-10 (140 mg/l), S-1 (139 mg/l) & S-7 (137 mg/l). Data does not vary significantly among these sites. In monsoon season, an elevated level of alkalinity was observed ranged between 183-203 mg/l with maximum value at S-7 (203 mg/l) followed by S-10 (200 mg/l) & S-9 (196 mg/l). Alkalinity at these spots is observed to be high because of the fact that these sites are used for agricultural purposes and the all the soil-runoff from these sites get into the river, itself. In winter, alkalinity ranged between 118-134 mg/l with maximum value at S-9 (134 mg/l) followed by S-10 (131 mg/l), S-1 (130 mg/l) & S-7 (129 mg/l). Alkalinity has shown significant variations ($p<0.005$) between summer & winter season. Although alkalinity was found to be within the prescribed limits but elevated alkalinity level in monsoon season does not meet the criteria given by BSI (200 mg/l).

Total Hardness (TH) ranged between 60.6-71.5 mg/l with maximum concentration at S-6 (71.5 mg/l) followed by S-4 (68.9 mg/l), S-5 (66.8 mg/l) & S-1 (64.7 mg/l) and minimum concentration at S-10 (61 mg/l) in summer. In monsoon, TH lied between 54.7-62.2 mg/l with maximum concentration at S-4 (54.7 mg/l) followed by S-1 (61.5 mg/l), S-6 (60.6 mg/l) & S-5 (59.3 mg/l) and minimum at S-10 (54.7 mg/l). In winter, TH ranged between 56.8-64.3 mg/l with maximum concentration at S-4 (64.3 mg/l) followed by S-6 (63.8 mg/l), S-1 (62.6 mg/l) & S-5 (62.3 mg/l). Total hardness has shown low concentration in monsoon in comparison to summer & winter.

Data has shown significant variations ($p<0.005$) in TH concentration among various seasons. Hardness in water is also derived from the solution of carbon dioxide released from the bacterial action in soil in percolating water [11][3]. Nitrate concentration ranged between 0.57-0.8 mg/l with maximum concentration S-1 (0.8 mg/l) followed by S-2 (0.77 mg/l) & S-6 (0.75 mg/l) and minimum concentration at S-8 (0.57 mg/l) in summer. In monsoon, it varied from 0.68-0.84 mg/l with maximum concentration at S-1 (0.84 mg/l) followed by S-6 (0.82 mg/l) & S-7 (0.79 mg/l) and minimum at S-8 (0.68 mg/l). Nitrate concentration does not vary significantly ($p>0.005$) between summer and monsoon but it varies significantly between summer and winter. Increased concentration of nitrate in monsoon might be the result of agricultural run-off that gets in to the River during rainy season. The concentration of nitrate in drinking water should be less than 0.01 mg/l as per WHO guideline. In present investigations, nitrate concentration was not within the permissible limits, therefore, water is not fit for drinking. Also in future, it may accelerate the process of eutrophication. Phosphate concentration ranged between 1.9-2.9 mg/l with maximum value at S-1 (2.9 mg/l) followed by S-7 (2.5 mg/l) & S-8 (2.4 mg/l) in summer. In monsoon, phosphate concentration lied between 2.1-3 mg/l with maximum at S-1 (3 mg/l) and minimum at S-8 (2.1 mg/l). Phosphate concentration was found to be same at S-3 (2.8 mg/l), S-6 (2.8 mg/l) & S-7 (2.8 mg/l) in monsoon. In winter, it varied between 1.64-2.32 mg/l with maximum concentration at S-1 (2.32 mg/l) followed by S-3 (2 mg/l) & S-4 (1.9 mg/l) and minimum at S-5 (1.64 mg/l). Phosphate has shown significant variations ($p<0.005$) between summer & monsoon season. Phosphate being a good nutrient for whole aquatic life (flora as well as fauna) is accepted up to a level of 5 mg/l as its high concentration leads to damage to aquatic life by devastating the oxygen from water. The prescribed limit for phosphate for irrigation is 0-2 mg/L [12]. Phosphate level in Sirhind Canal has been increasing at fast rate and in future it may lead to the problem of eutrophication. DO ranged between 12.4-15 mg/l with maximum value at S-4 (15 mg/l) followed by S-2 (14.8 mg/l), S-1 (14.6 mg/l) & S-3 (14.4 mg/l) and minimum value at S-9 (12.4 mg/l) in summer. In monsoon, DO varied between 13.5-15.8 mg/l showing maximum value at S-4 (15.8 mg/l) followed by S-2 (15.5 mg/l) & S-5 (15.3 mg/l) and minimum value at S-9 (13.5 mg/l). In winter, DO varied between 12.8-15.3 mg/l with maximum value at S-4 (15.3 mg/l) followed by S-2 (15.2 mg/l) & S-1 (14.9 mg/l) and minimum value at S-9 (12.8 mg/l). DO was found to be in permissible limits at all the study sites among various seasons, therefore water is of good quality for aquatic life. Significant variations ($p<0.005$) were observed among various seasons. BOD ranged from 17-21 mg/l with maximum at S-4 (21 mg/l) followed by S-2 (20 mg/l), S-1 (19.7 mg/l) & S-3 (19.3) and minimum at S-3 (19.5 mg/l) in summer. In monsoon, BOD varied from 16.1-19.5 mg/l with maximum at S-4 (20.1 mg/l) followed by S-3 (18.5 mg/l), S-2 (17.8 mg/l), S-5 (17.5 mg/l) and minimum at S-9 (16.3 mg/l). In winter, maximum, BOD varied from 17-20.1 mg/l with maximum at S-4 (20.1 mg/l) followed by S-3 (19 mg/l), S-1 (18.5 mg/l), S-2 (18.3) and minimum at S-8 (16.6 mg/l). Significant variations ($p<0.005$) occur between summer & monsoon and summer & winter. Elevated level of BOD at some study sites shows the presence of organic matter in the water. All the selected spots have shown microbial presence in terms of the total coliform count and *E.coli* count during summer & monsoon season. Bacterial growth was high during summer in comparison to monsoon. Higher bacterial levels observed during the summer might be due to factor existed which promote bacterial growth and re-growth in streams. The positive relationship between temperature and bacterial levels suggest that heat induced growth may be a contributing factor to seasonally high bacterial levels. On the onset of monsoon season, total and faecal growth was observed to be less due to flushing out by heavy rain. High bacterial growth was observed at S-4 in both the seasons followed by S-3.

High number of bacterial growth at S-4 is a clear indication that the site has been used for lot of anthropogenic activities. Considerable variations were observed in the concentration of all heavy metals (As, Cr, Cu, Fe, Mn, Ni, Pb, Zn) at all the ten sampling sites with less accumulation during winter season and high during summers. As, Pb and Zn have shown little variations in their concentrations during summer and winters. Considerable variations were observed in the concentration of Fe, Cu & Cr during both seasons but the seasonal pattern for all the heavy metals was same i.e. high values during summer and low values during winter season. Fe has shown the highest concentration in both the seasons among all the heavy metals studied varied from 0.040-0.093 ppb followed by Cr (0.019-0.058 ppb), Cu (0.005-0.015 ppb), Mn (.005-.015 ppb), Zn (.0035-.0080 ppb), Pb (.0046-.007 ppb), As (.004-.0065 ppb) & Ni (.001-.0031 ppb). Increased concentration of Fe, Cr & Cu is a matter of concern. Increase in the concentration of heavy metals during summer seasons could be due to drought and decrease in water level. Increase in temperature also increases toxicity due to depletion in dissolved oxygen, increase in energy demand causing rise in respiration rate in the organism, which leads to rapid assimilation of waste. Similar kinds of studies have already carried out by several workers all over the world[13][14][15][16]

All the heavy metals have shown significant variations ($p<0.05$) in its concentration at some points between summer & winter season. Also significant variations ($p<0.05$) have been observed among some study sites within the same season.

V. CONCLUSION

It is inferred from the investigations that though most of the parameters are seem to be with in the permissible limits or have shown marginal values; still the water could not be used for drinking/domestic activities without any prior treatment. Elevated levels of nitrate & phosphate at some study spots could be worrisome to accelerate the eutrophication. Increased alkalinity in monsoon can be attributed to the fact that all the agricultural run-off gets in to water during rainy season. Also increased concentration of Fe, Cr & Cu is a matter of concern. Fe has shown the highest concentration in both the seasons among all the heavy metals studied. Increased concentration of these heavy metal may be threat to aquatic life, vegetation &man-kind because these heavy metals in water further contaminate the agricultural, enters into food chain & leads to the process of biomagnification. There is urgent need for making the policy for the conservation of the small rivers and tributaries and monitoring of the river water quality. Therefore, complete assessment of water quality shows that curative measures should be taken to treat the effluent before discharging it in to river water.

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