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Study of Ghaggar River Water for Physico-Chemical Properties Through its Flow

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Abstract

The objective of the present investigation was to ascertain the physico-chemical attributes of water obtained from eleven discrete sampling sites spanning the whole Ghaggar River. In the month of May 2023, a selection of river water samples were collected and subsequently transported to a laboratory for the purpose of examination. Out of the total of eleven sampling sites, samples were obtained from seven locations, while the remaining four sites had experienced a depletion of water. The collected samples were analysed to assess the impact of various physical and chemical parameters on water quality. These parameters include temperature, pH, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), total hardness (TH), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and dissolved oxygen (DO). The water of the Ghaggar River exhibits an alkaline pH level. The levels of total dissolved solids (TDS) were observed to exceed the permissible limits set by the World Health Organisation (WHO). The Ghaggar River in the selected research area consistently receives wastewater and/or municipal effluents from various domestic, industrial, and municipal origins throughout its entire trajectory.

Keywords: Ghaggar River; Physico-chemical Properties; Waterborne Diseases; Cancer River.

Introduction

The most important and fundamental need for life is water. It is a prerequisite for all activities that sustain life. The surface water found in rivers, lakes, ponds, and dams is typically utilized for power generation, irrigation, and drinking. Typically, untreated streams, rivers, wells, and boreholes serve as the source of drinking water [1]. The element of water that must be present at the ideal level for the proper growth of plants and animals is referred to as the quality of the water. In order to survive and flourish, aquatic species require a nutrient-rich habitat. The physico-chemical properties of the water body determine the productivity. the highest productivity attained at the optimal level of physical and chemical factors [5].

The base flow generated inside the river system serves multiple purposes, encompassing industrial, agricultural, and potable water consumption. Throughout its journey from the upstream to the downstream, water is extracted directly from the Ghaggar River and its tributaries at various points to meet the demands of drinking water and agricultural activities. Several commercial regions, local governments, committees, and corporations are employing diverse methods to release their wastewater and effluents into the water of The Ghaggar River, either through direct or indirect means. Hence, it is imperative to establish consistent time intervals for the purpose of monitoring the water quality. Furthermore, the preservation and conservation of water quality have emerged as significant

global public health objectives. Rivers are natural watercourses that discharge into large bodies of water such as oceans, seas, or other aquatic systems. They are typically nourished along their path by the convergence of tributaries and play a crucial role in transporting water and essential nutrients to various places across the globe [15]. Over the past decade, several studies have been undertaken to assess the physico-chemical condition of the Ghaggar River [2, 6, 7, 8].

The Water Quality Index (WQI) of the Ram-Ganga reservoir located in Kalagarh, Pauri Garhwal district was examined to investigate the seasonal variations in the WQI in relation to the physico-chemical properties of the reservoir. The Water Quality Index (WQI) incorporates nine parameters, namely pH, Total Dissolved Solid, Dissolved Oxygen, Biochemical Oxygen Demand, Total Hardness, Calcium, Magnesium, Total Alkalinity, and Chloride [17]. The pollution of rivers is gradually increasing in the southern part than the northern part flowing downward to be united with the sea. All the civilization and development has been occurred centering the rivers, and as a result, all the big cities stand by the bank of the main rivers of the country [18]. The spatial-temporal variety of water quality of river of Bangladesh, Shitalakkhya, investigated and concluded that some parameters like temperature, TDS, TA, TH, NO2-, and NO3- went beyond highest threshold level. The water quality index (WQI) represented the river water to be inappropriate for drinking and aquatic ecosystem [19].

MATERIAL AND METHODS

Study Area: The study area is situated within the East longitude coordinates of 76°54′36.79″ and 73°13′26.88″, and the North latitude coordinates of 30°45′5.93″ to 29°11′49.29″. This study focuses on various towns and places within the Indian states of Punjab, Rajasthan, Himachal Pradesh, and SAS Nagar (Mohali). The locations encompassed in this study include, but are not exclusive to, Dugshai Village, Panchkula, Patiala, Ambala, Kaithal, Fatehabad, Sirsa, Hanumangarh, and Sri Ganganagar. The climatic conditions in this particular region exhibit significant variability throughout the year, characterised by hot and humid summers, cold winters, and a generally humid to subhumid environment. In the warmest month of the year, temperatures can ascend to a maximum of 47 degrees Celsius, while in the coldest month, they can descend to a minimum of 1 degree Celsius. When comparing the Shivalik hills, it can be observed that the lowest elevations have a very modest annual precipitation of 200 mm, whereas the highest elevations receive a considerably higher amount ranging from 1000 to 1500 mm.

Sample Collection: A total of eleven sites were selected for the present investigation with the aim of conducting a qualitative analysis of surface water samples across the whole length of the Ghaggar River. Sampling is unfeasible at four out of the total of eleven sites due to the absence of water in the riverbed. The collected samples were analysed to assess the impact of various physical and chemical parameters on water quality. These parameters include temperature, pH, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), total hardness (TH), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and dissolved oxygen (DO).

Results And Discussion

Table 1 displays the results of the physico-chemical parameters for the water samples in Ghaggar River water at different seven monitoring sites and impact of point sources waste waters/effluents on the river.

Table 1: Physico- Chemical Parameters in May 2023

Sample Site	Location	Temp.	EC	TH	pH	TSS	TDS	BOD	COD	DO
SP-1	Dugshai Village, Himachal Pardesh	28.2	0.462	116	6.8	11	118	3	47	7.1
SP-2	Panchkula, Haryana	27.8	0.351	135	7.9	35	330	7	60	7.8
SP-3	Devigarh Village, Punjab	29.1	0.972	172	8.1	140	370	15	93	6.5
SP-4	Mandvi Village, Punjab	29.6	0.991	160	7.8	198	471	18	125	5.9
SP-5	Sardulgarh, Punjab	31.6	1.115	266	9.8	211	906	23	175	4.5
SP-6	Sirsa, Haryana	31.2	1.215	238	8.3	170	952	25	191	5.2
SP-7	Ottu Barrage, Haryana	30.7	0.992	175	8.1	155	792	21	215	5.4
	Minimum	27.8	0.351	116	6.8	11	118	3	47	5.4
	Maximum	31.6	1.215	266	9.8	211	952	25	215	7.8
	Average	29.7	0.783	241	8.3	111	535	14	131	6.6

Temperature

Temperature exerts the most significant influence among all the components. The behavior of organisms, as well as the solubility of gases and salts, is influenced by the temperature of the water [14]. According to the provided data, the Ghaggar River exhibits a temperature variation ranging from 27.8°C to 31.6°C. The findings of the study indicate that the temperature of river water is influenced by point sources, which refer to locations where hot waste waters and effluents mix with the Ghaggar water.

Electrical Conductivity (EC)

The measurement of conductivity is used to assess the capacity of a material or solution to facilitate the flow of electrical current in an aqueous medium. The observed range of electrical conductivity (EC) values was within the range of 0.351 to 1.215. High electrical conductivity (EC) readings indicate a notable presence of ionised dissolved inorganic substances.

Total Hardness (TH)

The primary factors contributing to elevated levels of bicarbonate, chloride, and dissolved sulphate in water are the presence of these three chemical constituents. The total hardness measurements were found to fall within the permissible limit set by the World Health Organisation (WHO), with values ranging

from 270 mg/l to 414 mg/l [16]. According to established classifications, water with a hardness level of up to 75 mg/l is categorised as mild, while water with a hardness level ranging from 76 to 150 mg/l is classified as moderately soft. Water with a hardness level between 151 and 300 mg/l is regarded hard, and water with a hardness level over 300 mg/l is deemed very hard [11]. Based on its classification, the water of the Ghaggar River is classified as being of high hardness, with an average value of 241 mg/l.

Potential of Hydrogen (pH)

pH is a scale that quantifies the concentration of hydrogen ions in water and indicates how acidic or alkaline it is. Samples of water had pH values ranging from 6.8 to 9.8. Water samples were found to have a pH that is slightly alkaline and within the World Health Organization's recommended range [16].

Total Suspended Solids (TSS)

These particles have the ability to sink and create silt buildup, or they can float and create unattractive scum layers. Liquids that are immiscible, organic, and inorganic may make up the suspended solids. Surface waters frequently contain inorganic particles like clay silt and other soil components. Surface water frequently contains organic items like plant fibers and biological solids from bacteria and algae. Regarding aesthetics, the entire suspended solids are always inappropriate [13]. The Ghaggar River's total suspended solids range from 11 mg/l to 211 mg/l.

Total Dissolved Solids (TDS)

The palatability of the drinking water was evaluated by panels of tasters in proportion to its total dissolved solids (TDS) level, and the scores were recorded. The categorization of results into levels of acceptability is as follows: very poor, with a range of 900 to 1200 mg/1; fair, with a range of 600 to 900 mg/1; good, with a range of 300 to 600 mg/1; and excellent, with a value less than 300 mg/1 [10,16]. These categories serve as indicators to determine if a result is deemed acceptable or not. Additionally, it has been proposed that taste-related issues may arise due to the presence of total dissolved solids (TDS) above 1000 mg/1. Total Dissolved Solids (TDS) provides an indication of the collective concentration of dissolved substances in water, hence reflecting its total saltiness. Water with high total dissolved solids (TDS) tends to form deposits of scale on boilers and kitchen appliances. The TDS concentrations ranged from 118 mg/l to 952 mg/l. The presence of multiple point and non-point sources is resulting in variations in the Total Dissolved Solids (TDS) levels seen in the Ghaggar River.

Biochemical Oxygen Demand (BOD)

The BOD in the Ghaggar River ranges from 3 mg/l to 25 mg/l. It should be noted that any biodegradable organic matter found in drinking water is prohibited. In order to classify inland surface waters, the CPCB and ISI have established limits of 2.00 mg/l for Class A waters and 3.00 mg/l for Class B and Class C waters, respectively [3].

The data indicates that the Ghaggar River exhibits consistently elevated levels of biochemical oxygen demand (BOD) throughout the monitoring period. An elevated biochemical oxygen demand (BOD) value exerts an influence on the process of eutrophication within a river system, resulting in a reduction in the concentration of dissolved oxygen. Consequently, this depletion renders the river environment inhospitable for the sustenance of aquatic organisms.

Chemical Oxygen Demand (COD)

The oxygen equivalent of organic materials that can be oxidized by a powerful oxidizing agent is displayed by the chemical oxygen demand, or COD. The COD is frequently used to gauge how susceptible organic and inorganic elements in water bodies are to oxidation. Surface water's COD can range from less than 20.00 mg/l in clean water to more than 200.00 mg/l in water that receives waste water or effluents [4].

Many researchers observed a significant amount of chemically oxidizable organic matter present when COD values are high [9, 12]. Because the Ghaggar River receives waste items, it has been observed that the COD value in the water is high. The Ghaggar River's COD ranges from 47 mg/l to 215 mg/l.

Dissolved Oxygen (DO)

Aquatic organisms and the entities responsible for the natural cleansing processes in water ecosystems rely on the presence of dissolved oxygen. The assessment of water quality commonly involves the examination of various characteristics, with the quantity of dissolved oxygen being a particularly critical factor. Dissolved oxygen levels are influenced by various factors, including temperature, salinity, turbulence, photosynthetic activity of algae and other aquatic plants, and air pressure. Throughout the designated period of investigation, the Ghaggar River exhibited variations in dissolved oxygen levels within the range of 2.00–8.00 mg/l. When the concentration of dissolved oxygen in the source of the Ghaggar River exceeds 6.00, it indicates a higher level of water quality. Dissolved oxygen level drops gradually from Panchkula,Haryana to downstream in both the season. The outcome of this experiment yields a dissolved oxygen (DO) level of only 2 mg/l. The dissolved oxygen levels in this stretch of the river routinely fall below the threshold of 6.00 mg/l, which is necessary for maintaining a healthy river system. The Central Pollution Control Board (CPCB) and the Indian Standards Institution (ISI) have established specific maximum levels of dissolved oxygen for different water classifications. Class A water has a maximum dissolved oxygen level of roughly 6.00 mg/l, Class B water has a maximum level of 5.00 mg/l, and Class C and D water have maximum levels of 4.00 mg/l [3].

Conclusion and Findings

The present study aimed to assess the physico-chemical attributes of water samples collected from eleven discrete locations along the Ghaggar River. In the present analysis, it was seen that the majority of parameters reached the contamination level, with the exception of pH, total hardness, and chloride. The water quality results are presented in Table 1. The inadequacy of utilising river water for domestic use becomes readily apparent. The observed ranges of key water quality indicators, including dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solids (TDS), exceeded the acceptable norms for inland water bodies by several factors.

The findings indicate a progressive deterioration in the water quality of the Ghaggar River. Additionally, it was discovered that there were a higher number of recorded occurrences of waterborne diseases in the geographical region situated downstream of the Ghaggar River. Research has demonstrated an increase in waterborne diseases among communities residing along or within the catchment basin of the Ghaggar River. The observed phenomenon can be attributed to the discharge of industrial effluents and untreated sewage into the river. The data also indicates that, on average, the indigenous populace encounters annual epidemics, predominantly attributed to the availability of water. In contrast to the challenges encountered in the middle and upstream segments of the river, the issues faced by the downstream basin

were significantly more severe. Despite reaching its lowest level of pollution towards the conclusion of the wet season, the summer period witnessed a significant increase in the occurrence of sickness outbreaks. The research domain has witnessed instances of outbreaks mostly attributed to the inadequate drainage of sewage and effluent into rivers, leading to the contamination of water bodies. There has been a discernible increase in the frequency of pandemics that have occurred in recent years. The river has been occasionally labelled as "Cancer River," hence necessitating further investigation.

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