ISSN PRINT 2319 1775 Online 2320 7876

Research paper **Volume 12, Iss 4, 2023**

Investigating the Water Quality of Ghaggar River in Terms of Heavy Metal Content Along Its Flow.

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Abstract:

The present study briefly deals with the presence of trace heavy metals in the waters of River Ghaggar throughout its route. The study was carried out in May 2023 on 11 selected sampling sites of River Ghaggar. Concentrations of heavy metals viz., Zn, Cu, Fe, Cr, Cd, and Pb were studied throughout the route of river Ghaggar. In the selected research area, the Ghaggar River is receiving the domestic, industrial and municipal waste waters/effluents all along its course. All in all, the dominancy of the analyzed heavy metals in the surface water of Ghaggar followed the sequence: Fe > Pb > Cd > Cr > Cu > Zn.

Keywords: Ghaggar River; Heavy Metals; Harmful Effects; Poisonous Effects; Water Pollution; Cancer River.

Introduction:

Water pollution may be defined as the "alternation of physical and biological properties of water or any addition of foreign material and the natural water which may have harmful effect on living beings, human agricultural system and other biological aspects, either directly or indirectly or immediately or after sometimes or after a very long period" [13]. Rivers are natural steam of water emptying into an ocean, sea, or other bodies of water and usually fed along its course by joining tributaries. Rivers are very important carriers of water and nutrients to regions all around the earth [18]. Generally, heavy metals are present in trace amounts in water. Some of the heavy metals or trace elements are essential for physiological functions of living tissue and regulate many biochemical processes. The deficiency of heavy metals is harmful. The deficiencies of heavy metals in human beings and animals have been identified [5]. The same metals, however, at increased level may have severe toxicological effects on human beings [3]. During the last decade some studies have been conducted to evaluate the physico-chemical status of the Ghaggar River [1, 9, 10, 12]. Therefore, monitoring these heavy metals is important for safety assessment of the aquatic environment and human health in particular.

In the present study, the Ghaggar River was selected to evaluate the heavy metal characteristics of its surface water in upper reaches. The Ghaggar River originates from the Siwalik Hills of Himachal Pradesh and Haryana. It runs along the foot of the Siwaliks and flows through Haryana and Punjab to Rajasthan and then disappear itself in the sands

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of the Thar Desert. The selected study area falls within the boundaries of several states and covering parts of different districts of Himachal Pradesh, Haryana, Punjab and Rajasthan. At downstream sites various point sources *viz.*, Medkhali Nallah, Sukhna Choe, Jharmal Choe, Dhabi Nallah, Dhakansu Nallah, Patiala Nadi, Markanda River, and Shaabaad Nallah are joining the Ghaggar River and discharging their untreated effluents into it.

Study Area:

The study area is located between North latitudes 30°45′5.93″ to 29°11′49.29″ and East longitudes 76°54′36.79″ to 73°13′26.88″. The inquiry is concentrating its efforts on a number of cities and regions in the Indian states of Himachal Pradesh, Haryana, Punjab, and Rajasthan, including but not limited to Dugshai Village, Panchkula, SAS Nagar (Mohali), Patiala, Ambala, Kaithal, Fatehabad, Sirsa, Hanumangarh, and Sri Ganganagar. This region has a climate that ranges from humid to subhumid, with hot summers and frigid winters, as well as large temperature and precipitation variations throughout the course of the year. Temperatures can reach an all-time high of 47 degrees Celsius in the hottest month, and they can drop below 1 degree Celsius in the coldest month of the year. In comparison, the lower parts of the Shivalik hills receive a meagre 200 mm of precipitation, while the highest parts receive 1000-1500 mm.

Research Objective:

The current investigation is focused on the Ghaggar River to know the extant of heavy metals and also to assess the risk involved to the people residing in the study area thereby to get an idea about and to know the need for any protection from radio-logical hazards over its entire route by adopting the various steps:

To know about the current status of heavy metals in water of Ghaggar River of the research area, primary data were collected before sampling.

Water samples have been collected from various sites of the Ghaggar River and was examined in the laboratory for further investigation.

Sample Collection:

For the present research, 11 sites were selected in order to qualitative analysis of surface waters samples throughout the stretch of Ghaggar River. Out of 11 sites at 4 sites, sampling is not possible due to dry bed of river. For heavy metal analysis the primary sampling sites was in the surface water layer (0-6 cm from the surface) at main flow. Surface water was collected using acid-leached polythene bottles and chilled immediately to 4º to 5ºC.

Analysis of the water samples for heavy metals analysis was carried out in the National Facility for Bio-pharmaceuticals Laboratory (A project sponsored by department of

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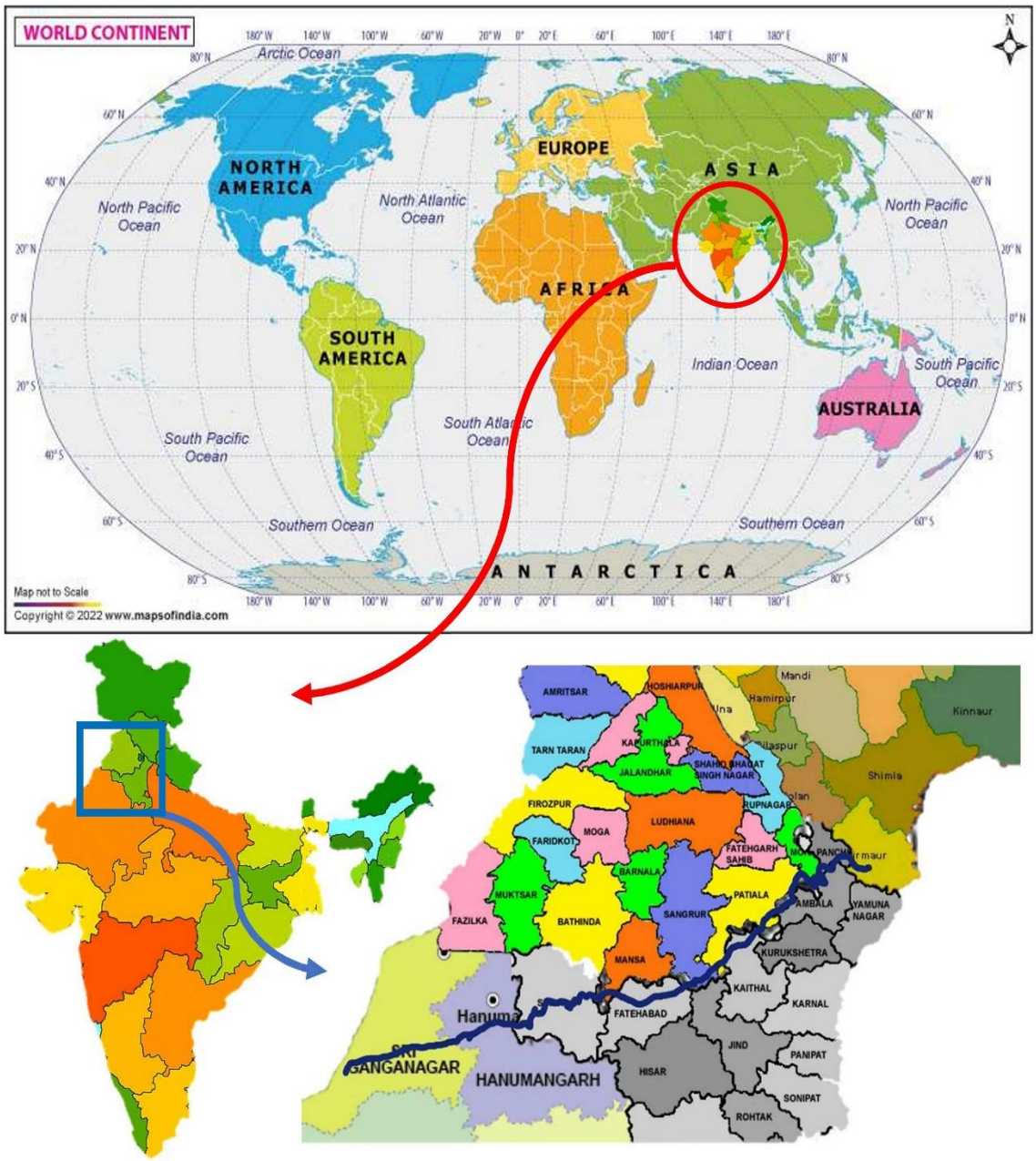
science and technology, Government of India) Matunga, Mumbai-19, Maharashtra, (India) with the help of ICP-OES.



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Results And Discussion:

Table 1 is showing distributional pattern of trace elements in Ghaggar River water at different seven monitoring sites and impact of point sources waste waters/effluents on the river.

Table 1: Status of Heavy Metals Analysis of Ghaggar River System Surface Water (May 2023).

Sample Site	Location	Zn (mg/L)	Cu (mg/L)	Cr (mg/L)	Cd (mg/L)	Pb (mg/L)	Fe (mg/L)
SP-1	Dugshai Village, Himachal Pardesh	0.024	0.026	0.037	0.231	0.941	3.41
SP-2	Panchkula, Haryana	0.036	0.032	0.024	0.245	0.854	3.426
SP-3	Devigarh Village, Punjab	0.029	0.039	0.029	0.143	0.767	6.416
SP-4	Mandvi Village, Punjab	0.024	0.031	0.038	0.157	1.123	5.42
SP-5	Sardulgarh, Punjab	0.032	0.028	0.037	0.249	1.159	5.94
SP-6	Sirsa, Haryana	0.038	0.034	0.038	0.316	1.054	6.16
SP-7	Ottu Barrage, Haryana	0.043	0.031	0.031	0.371	1.184	5.84

Zinc is a very important micro-nutrient for the human body, but at high concentrations it can cause toxic effects [11]. Copper and cadmium increase zinc toxicity, while increasing hardness reduces it. Zinc concentrations in surface water range from a minimum concentration of 0.024 mg/litre in Dugshai village, Himachal Pradesh to a maximum concentration of 0.043 mg/litre in Ottu dam, Haryana. Zinc toxicity also increases with increasing temperature and decreasing oxygen. When water hardness is low and temperature is high, zinc is very and long-term toxic to aquatic organisms, especially fish [15]. The zinc content in Ghaggar remains within optimal drinking limits.

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Copper is an important element of the organism for the human body. Copper levels range d from a minimum of 0.026 mg/litre in Himachal Pradesh's Dugshai village to a maximu m of 0.039 mg/litre in Punjab's Devegarh village. Copper concentrations were below the 100% limit in the analyzed points. Copper is also widely used in agriculture in the form o f fertilizer, fungicide, and insecticide. Studies have also confirmed that copper deficiency is associated with neonatal anemia, diarrhea, and bone demineralization. Copper concentr ations in treated water often increase during supply as a result of copper input for soil or waste processing, fertilization and atmospheric precipitation, especially in systems with a cidic pH or highly carbonated brine systems with alkaline pH [2].

Iron is an important part of human nutrition. Iron concentration ranged from a minimum of 3.41 mg/litre in Dugshai village of Himachal Pradesh to a maximum of 6.416 mg/litre in Devegarh village of Punjab. The water quality of Panchkula, Devigarh and Sirsa distric ts is affected by various sources such as Dhabi Nallah, Jharmal Choe and Patiala drains. At the Devigarh site, the amount of iron was found to be almost double that at the previou s site due to the mixture of impurities. Iron concentration gradually decreases in Devigarh district till Sadurgarh, Punjab and then increases slightly due to lack of space. Iron levels are above the limit in two districts, Devigarh and Sirsa. High iron concentrations often ca use an inky, bitter and astringent taste [7]. He can also take off clothes, pipes and make la rge pipes. The red color in the water body is caused by the precipitation of ferric iron hyd rate oxides, which cause poor water quality, pipe clogging, pipe corrosion and odor due t o the iron content in the sediments and water [6].

Cromium concentration observed in the water of river surface ranged from a minimum of0.024 mg/ litre in Panchkula Haryana from a minimum of 0.038 mg/litre in Mandvi village, Punjab and in
Sirsa, Haryana. The chromium content in Ghaggar remains within optimal drinking limits . Health problems associated with chromium exposure depend on its oxidation state. The metallic form of Cr has low toxicity. The hexavalent form is toxic. Adverse skin effects o f the hexavalent form include ulcers, dermatitis, and skin allergies. Inhalation of hexavale nt chromium compounds may cause ulceration and perforation of the nasal septal mucosa , pharyngeal and laryngeal irritation, asthmatic bronchitis, bronchospasm and edema. Res piratory symptoms may include cough, wheezing, wheezing, and nasal congestion. Hexav alent chromium is toxic to plants and animals. It causes yellowing of leaves
wheat and paddy [4].

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Cadmium is an element that occurs naturally in the earth's crust. It is uniformly distributed in the Earth's crust, where it is generally estimated to be present at an average concentration of between 0.10 and 0.50 µg/g. Cadmium is produced during extraction of zinc and is used in plating industry, pigments, in manufacture of plastic material, batteries and alloys. The water is contaminated with cadmium by industrial discharge, leaches from land filled area. Cadmium is released to environment in wastewater, and disperse pollution is caused by contamination from fertilizers [19]. Cadmium precipitates from solution at high pH and toxicity of it depends on pH and hardness of water [14]. Cadmium is biologically non-essential and non- beneficial constituent. Cadmium concentration observed in river surface water ranged from a minimum of 0.143 mg/L at Devigarh Village, Punjab to a maximum of 0.371 mg/L at Ottu Barrage, Haryana. The possible sources of cadmium in river water system are contributed by domestic wastewater released from residential area, impetuously use of pesticides, fertilizers used in palm oil estates along the rivers bank and local air pollution caused by open burning [17]. Cadmium ranks next to mercury in its toxicity. Exposure at low levels usually does not produce immediate health effects, but may cause severe health problems over long periods. The gastrointestinal tract is the major route of Cd uptake in both humans and animals. Cadmium is toxic to humans, animals, micro- organisms and plants, however only a small amount of Cadmium intake is absorbed by the body and will be stored mainly in bones, liver and, in case of chronic exposure, in kidneys. In the last few years there have been some evidences that relatively low Cadmium exposure may give rise to skeletal damage due to low bone mineral density and fractures. The toxicity of the metal lies in that, after absorption, it accumulates in soft tissues. Animal tests have shown that Cadmium may be a risk factor for cardiovascular disease [8]

Lead is the most common of the heavy elements. Several stable isotopes exist in nature, ^{208}Pb being the most abundant. Lead is used principally in the production of lead-acid batteries, solder and alloys. Lead is a soft metal such that has been known many applications of it over the years. During present investigation, Lead concentration observed in river surface water ranged from a minimum of 0.767 mg/L at Devigarh Village, Punjab to a maximum of 1.184 mg/L at Ottu Barrage, Haryana.

Lead concentration was found above the desirable limit of BIS. It is not known to be essential for the functioning of biological systems and the exposure to this metal should be kept as low as possible. Lead exposure in children and adults can cause a wide spectrum of health problems, ranging from small effects on metabolism and intelligence to convulsions, coma, renal failure, and death [16].

Conclusion and Findings:

The concentration of above heavy metals in the river water exhibiting the following order: Fe > Pb > Cd > Cr > Cu > Zn. In the present study the concentration of trace elements far exceeded the maximum permissible limits of drinking at many sites. The study revealed that the Ghaggar River water contained high concentration of Fe, Pb, Cd, Cr, Cu, and Zn and crossed the desirable as well as maximum permissible limit. River

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water at almost sites even crossed the maximum permissible limit prescribed for iron concentration and water was not suitable for drinking. The observed high concentration of heavy metals particularly in downstream stations indicating substantial inputs coming from industrial, agricultural and municipal effluents through point and non-point sources all along the river route. In terms of Fe, Pb, Cd, Cr, Cu, and Zn concentration river water was least contaminated. Kundu [12] detect the heavy metals in upper regions of Ghaggar. The occurrence of heavy metals in the river Ghaggar water more than that of recommended maximum permissible limit all along its route in Haryana was reported by Kaushik *et al.* [10]. They were also found that industrial, municipal and agricultural wastes from Punjab region were main sources of heavy metals pollution in the river water at downstream stations.

According to the findings, the quality of the water in the Ghaggar River has been steadily deteriorating. Also, it was discovered that the area downstream of the Ghaggar River had a greater number of cases of documented waterborne infections. It has been discovered that there is an increase in waterborne diseases in communities that are located close to or within the catchment area of the Ghaggar River. This is because untreated sewage and industrial effluents are thrown into the river. The data also demonstrated that epidemics strike the local population on average once per year, and that the presence of water in the primary contributor to the majority of these outbreaks. The problem in the downstreame basin were significantly more severe than the problems found in the river's upstream and middle regions. The summer saw the highest number of outbreaks of sickness, although the river's contamination was at its lowest point towards the conclusion of the wet season. The contamination of water bodies and the improper drainage of sewage and effluent into rivers were significant factors that contributed to epidemics in the area under study. In recent years, there has been a discernible increase in the number of pandemics that have occurred. Further investigation is required as a result of the river's frequent nick moniker, "Cancer River." It is critical to collect crop samples and carry out comprehensive assessment of the relevant heavy metals. As people called it Cancer River, further investigation is required. Crop sampling and critical heavy metal analysis should be done.

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