Anthropogenic Interpretation on Water Analysis of Northern Western Part of the Indian Subcontinent: Punjab

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ABSTRACT- Numerous physical, chemical, and biological properties, characterize the quality of water. Anthropogenic activities are leading to the worsening of the quality of Punjab's groundwater and surface water. According to the Environmental Protection Agency, agricultural and urban watershed discharge is the major and pervasive cause of contamination. High concentrations of nutrients, metals, pesticides, microbes, and other organic compounds may be present in these waters. People are afflicted with a variety of ailments as a result of drinking contaminated water. Therefore, periodic checking of water quality is imperative. The following variables are taken into account: pH, alkalinity, turbidity, TDS, total hardness, DO, BOD, sulphates, chlorides, and fluorides, as well as the carcinogens arsenic, lead, cadmium, and uranium. The study reveals the water quality in several areas of Punjab and proposes that periodic evaluations of water quality parameters should be carried out.

Keywords: Agrochemicals, Contaminated water, Heavy metals, Quality parameters.

1. INTRODUCTION

The most priceless and important natural resource is water. It is the elixir of life; without it, there would be no life. The three main water sources that are available to people are groundwater, surface water, and rainwater. However, due to geogenic and anthropogenic factors, the quality of groundwater and surface water is currently declining. Rapid industrialization, urbanization, population growth and excessive use of agrochemicals have created a number of environmental issues, the most serious of which is water pollution in Punjab, India, which resulted in deterioration in both the quality and quantity of surface and groundwater.

Nearly half of Punjab's groundwater, according to a CAG assessment, is unfit for human intake because of pollution due to radioactive material, heavy metals, and dangerous compounds that exceed allowable limits. While 10% of it is unfit even for irrigation, 30% of it is just mildly to moderately alkaline and cannot be consumed by people. The CAG noted that excessive amounts of fertilisers and pesticides were being used to boost output, which was resulting in a decline in the quality of both surface and groundwater.

Providing everyone with a safe and adequate water supply is getting more difficult as the population expands and the natural environment deteriorates. The public's health depends on the availability of clean drinking water. The WHO estimates that polluted water is the root cause of 80% of all human diseases.

Therefore, it has become essential to regularly check the quality of the water by measuring various parameters, including pH, conductivity, temperature, total hardness, TDS, alkalinity, turbidity, chloride, fluoride, sulphates, and nitrates, as well as the presence of heavy metals like As, Cd, Pb, and U. The biological magnification that all of these metals induce results in health problems. As a result, it is imperative to preserve water quality for human health as well as for the well-being of the ecosystem.

2. LITERATURE REVIEW

Raperthy Bhargavkumar et al. (2019) investigat ed the physicochemical parameters and groundwate r pollution status in the Jalandhar Phagwara region. In this study, samples were taken from various villages, and the analysis showed that the values for pH, TDS, TSS, alkalinity, hardness, and chloride content were not according to the allowable limits specified by the IS- 10500-2012 standards. The study found that direct land-based wastewater dumping is to blame for the declining groundwater quality in the Jalandhar-Phagwara region.

Kaur Jagdish et.al (2019) carried out a study of groundwater quality parameters in parts of Muktsar district, Punjab. Their research focuses on the decline in the physicochemical analysis of groundwater standards in certain parts of Muktsar in relation to cultivation and human health. The hydrochemistry of the study area reveals that many samples had pH, EC, Na, nitrate and fluoride parameters with values above the permitted limit. This could be because of geological sources, but it was made worse by anthropogenic factors as well as some chemicals and fertilisers leaching from rainwater into the groundwater.

Girish Chopra et al. (2020) investigated the WQI of Kali Bein, a Beas River tributary in Punjab, India. For one year, samples of water were collected from four distinct sites, namely S1, S2, S3, and S4. Temperature, pH, conductivity, total dissolved solids, free CO_2, DO, BOD, total alkalinity, chlorides, hardness, Ca, Mg, PO_4^{3-} and NO^{3-} were all measured. The water quality index of site S3 was found to be very low because it received most of the waste from industries, sewerage water, agricultural runoff water and other solid waste material, indicating that it is unfit for human intake and extremely harmful to aquatic biodiversity.

Bishnu Kant Shukla et al. (2020) conducted res earch on the physicochemical analysis of some surf ace water bodies of Punjab. In this study, they evaluated samples from several sources in northern Punjab and examined them for pH, TDS, TSS, turbidity, DO, chloride concentration, Fe content, and hardness of water. The collected data was compared to the permitted parameters specified by IS: 10500-2012 standards. The results showed a higher amount of contamination, and it is advised that water from these areas be properly treated before being consumed by humans.

Raj Setia et al (2020) examined the concentration of metal in the water of the river Sutlej. Health risks associated with humans also included an analysis of the likelihood of cancer. During the year's pre- and post-rainy seasons, water samples from the Sutlej River were taken. An atomic absorption spectrometer was used to examine the samples for 10 metals (Zinc, Copper, Iron, Manganese, Nickel, Cadmium, Lead, Cobalt, Chromium and Arsenic). In comparison to the post-rainy season, the pre-rainy season had a higher metal concentration in the water. Cd > Ni > Cr > As was found to be the most likely metal to cause cancer when ingested through water.

Harpreet Kaur and Dr Gursharan Singh Kainth (2020) conducted research on the physiochemical evaluation of effluent from the Ludhiana textile industry near Buddha Nullah. For research, waste from several industrial sources was gathered. The results showed that the WHO's recommended values for pH, water temperature, TDS, TSS, BOD, and COD were significantly exceeded, making them unsafe for human consumption and even for irrigation and industrial cooling.

Nitish Sharma et al. (2021) collected 30 water samples from Dera Bassi for evaluating the groundwater quality for human intake and agricultural purposes. To determine whether the groundwater samples were suitable for drinking, the analysis of the physicochemical parameters was compared to IS 10500:2012 and WHO (2006) standards. It was discovered that all parameters, with the exception of alkalinity, were within the allowable range. The observed trend of ionic dominance was $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$ for cations and $Cl^{-} > NO_3^{-} > SO_4^{2-} > F^{-}$ for anions.

Kaptan Singh et al. (2021) discovered oncogenic microelements in the groundwater of Bathinda. The study examined the types and concentrations of several metallic ions known to cause cancer that was found in the groundwater of Punjab's Southwestern Bathinda area. Hg, Cd, As, Cr, Se, Be, Co, and Ni are some of the carcinogenic metals found in groundwater. The pH was in the permitted range for drinking groundwater, which was 6.5 to 7.4. Cr and Hg are over the allowable range as per WHO and BIS standards.

Gopal Krishan et al. (2021) conducted research on the presence of harmful microelements in Punjab’s groundwater. A total of 275 typical water samples were gathered and examined. These samples were examined for the presence of As, Al, Fe, Mn, Zn, Cu, Cr, Cd, Ni, and Pb. The main sources of microelements are anthropogenic and natural. The analysis revealed that As concentrations were above the tolerable limit in 3.8% of the groundwater samples and 0.38 % of the samples were above the 50 g/L acceptable limit. 14.83% of groundwater samples had iron concentrations that were higher than the 0.3 mg/L allowable limit for drinking water.

Ashutosh Khajuria et.al conducted a groundwater analysis in Doaba,Punjab. The goal of the research was to identify the type and number of components present in the groundwater samples taken from these districts. Samples were taken from Jalandhar, Hoshiarpur, Nawanshehar, and Kapurthala districts. Electrical conductivity, pH total hardness, BOD, and COD were the parameters that were determined. The biggest deviation was found in Jalandhar, which indicates that the city is approaching abnormality in comparison to WHO norms, which were established and maintained. As a result of inorganic agriculture and industry, the water quality in the Jalandhar region has been impacted.

Yadvinder Singh et.al (2021) examined water quality in a few different wetlands in Punjab, India. The condition of water quality of 7 chosen wetlands was accessed using various statistical methods and WQI. pH, TDS, electrical conductivity, COD, total alkalinity, bicarbonate and ammonium contents, DO, BOD, and phosphate content were the parameters analysed. The outcomes showed that during the study seasons, the WQI in the chosen wetlands ranged from good to bad (summer, monsoon, and winter).

Prafulla Kumar Sahoo et al. (2021) examined conditions,risks to health and hydrogeochemical processes associated with Uranium concentration Punjab’s groundwater. TDS, salinity, sodium, potassium, hydrogen carbonate, nitrate of nitrogen, phosphorus, and fluoride were all shown to be closely associated with Uranium concentrations, while TDS and salinity remained highly associated. This association leads to the conclusion that the primary source of Uranium mobilisation is the salt impact brought on by intense ion competition. Uranium and Fluoride have a strong positive correlation indicating that geology is their principal cause and man-made activities like canal irrigation, groundwater table drop, and usage of chemicals in agriculture (mostly nitrate fertilisers) also results in uranium enrichment.

Vikas Duggal and Samriti Sharma (2022) determined fluoride contamination in potable water and risks to health associated with it, in the Malwa Belt of Punjab. This study focused on the fluoride levels, the non-carcinogenic risk for different age groups and physicochemical properties in 745 groundwater samples from 7 districts of Punjab. The tolerable limit of 1.5 mg L^{-1} specified by the BIS and WHO was exceeded by 49.7% of samples, with fluoride concentration ranging from 0.1 to 17.5 mg L-1.

The analysed age group's noncarcinogenic risk was distributed as follows:

children > adolescents > adults > elderly people > new-borns.

Surabhi Bharti et.al (2022) studied the assessment of groundwater quality in several zones of Punjab's northern western regions. Pre- and postmonsoon periods were used to collect 150 water samples from the primary water sources, which included privately owned submersible pumps and government-run rural water supply taps, 50 samples from each village in each of the three districts of Shri Muktsar Sahib, Ludhiana, and Moga. To determine the quality of the water, the sample's physical and chemical characteristics were examined. During both monsoon seasons, water samples from Killianwali village showed considerably higher EC, TDS, TS, nitrate, hardness, and DO concentrations than those from Rode village, which had the lowest concentrations. The study found that factors like TDS, nitrate, temperature, and water hardness had an impact on water quality.

Ritu Bala et al. (2022) identified the occurrence, behaviour, and risk to health associated with uranium in the groundwater of Punjab's semi-arid region. Investigating the vertical range of pollution and the geochemical parameters influencing U mobilisation in Punjab's semi-arid groundwater were the goals of the study. The analysis of 140 samples revealed that 76% of the samples had uranium concentrations over the WHO chemical toxicity limit of 30 $\mu g.L^{-1}$. and that 34% of the samples had concentrations above the AERB's 60 $\mu g.L^{-1}$ limit for radiological toxicity.

3. ANALYSIS OF WATER QUALITY PARAMETERS

pH: The acidity and alkalinity of a water solution are measured using the pH scale. It is a crucial sign of chemically altering water. "Logarithmic units" are used to express pH. The pH scale ranges from 0 to 14, with 7 being neutral. A pH of 7 or above implies alkalinity, whereas a pH of 7 or less suggests acidity.

Conductivity: The tendency of water to conduct electrical current is measured. It is directly impacted by the quantity of conductive ions in the water. Inorganic substances like chloride, carbonate, alkali, and sulphide compounds as well as dissolved salts are the sources of conductive ions. The desired limit for drinking water conductivity, as per WHO regulations, is 400 μS/cm.

Alkalinity: Alkalinity refers to a measurement of the water's ability to neutralise acids. It measures the amount of carbonate, bicarbonate, hy droxide ions, and carbon dioxide that are naturally present in the water. The BIS states that 2 00 mg/l of alkalinity is the maximum allowed in drinking water.

Turbidity: The amount of suspended particles in water that ca uses it to become less transparent is known as turbidity. The turbidity of drinking water should be less than 1 NTU and should not overpass 5 NTU as per WHO standards.

TDS: Total Dissolved Solids (TDS) in water refers to a variety of organic and inorganic substances, such as minerals and ions, that have been dissolved in a specific volume of water. With the aid of a TDS metre, the TDS content of water can be determined. TDS levels in water cannot exceed 500 ppm, according to the BIS. But 300 ppm is the TDS level that the WHO suggests.

Total hardness: Total hardness is calculated as the sum of calcium and magnesium values, both of which are given as calcium carbonate (mg/L). Water that has a ppm level of less than 60 can be described as soft, water that has a ppm level of 60 to 120 as moderately hard, and water that has a ppm level of more than 120 as hard.

BOD: Biochemical oxygen demand is a measure of the amount of oxygen consumed by bacteria and other microorganisms during the aerobic decomposition of organic matter at a certain temperature. Water having a BOD level of 1-2 ppm is seen as being clean; water that has a BOD level of 3-9 is regarded as being mildly contaminated; and water that has a BOD level of more than 100 ppm is regarded as being seriously polluted. The CPCB has set a limit of 10 ppm for the discharge of municipal and industrial waste in order to control water pollution and ensure effective water treatment.

DO: Total oxygen already dissolved in a water sample is referred to as DO (dissolved oxygen). The water quality is likely to deteriorate and aquatic life may be affected if DO levels are too low or high. According to BIS recommendations, there should be at least 5 mg/l of dissolved oxygen in most rivers, lakes, and streams in order for most aquatic creatures to survive. DO values between 4 and 6 mg/L should be present in drinkable water.

WQI: A single value that indicates the entire water quality is provided by the Water Quality Index (WQI). The procedure has three steps –

1. Parameter selection.
2. Choosing a quality function for each parameter
3. Using a mathematical equation to aggregate.

It is ranged on a scale from 0 to 100. The following are the specified WQI ranges:

- 90-100: Excellent
- 70-89: Good
- 50-69: Moderate
- 25-49: Poor
- 0–24: Very Poor

Chloride: A surplus of chloride in the water is problematic because it leaves a residue. When this remaining amount is ingested, the stomach reacts and some organ cells are damaged. Chloride levels in drinking water must not exceed 250 mg/l, according to BIS and ICMR.

Fluoride: Fluoride is both a naturally occurring substance and a product of human activity. Fluoride levels in water must not exceed 1.0 mg/l, according to the WHO. Dental caries are prevented at concentrations below 1.0 mg/l, but dental fluorosis, thyroid, liver, and other organ damage are caused at concentrations above 1.0 mg/l.

Nitrates: Human waste, livestock manure, fertilisers, and erosion of natural deposits are the main sources of nitrates in groundwater. Nitrate levels must not exceed 45 mg/l.

Sulphate: Sulphate is produced in large quantities by mines, smelters, paper mills, textile mills, and tanneries. It ends up in industrial waste and enters streams and groundwater. Due to their great solubility, sodium, potassium, and magnesium sulphates are the principal sulphates that are present in our water. The acceptable maximum, according to BIS is 200 mg/l.

Uranium: Uranium poses serious health risks to people. Drinking water with low concentrations of uranium is harmless, but drinking water with high levels of uranium can have serious health consequences, like kidney damage. WHO set the uranium concentration at 30 μg/L for drinking water. The allowable limit of uranium as per the Atomic Energy Regulatory Board of India (ppb) is 60 μg/L for drinking water.

Arsenic: Groundwater naturally contains arsenic, a poisonous metal. Skin blemishes and cancer are the results of ongoing exposure. 10 μg/L is the permissible limit for arsenic in drinking water.

Lead: Leaching from plumbing and distribution system components typically results in the occurrence of lead in potable water. BIS recommends 0.01 mg/L as the allowable limit. Anaemia, paralysis, kidney, and brain damage can occur due to exposure to higher levels of lead.

Cadmium: The BIS-recommended tolerable limit for cadmium is 0.01 mg/l. Renal, arterial hypertension, Itai Itai illness, and other conditions may be linked to acute toxicity. Cramps, nausea, vomiting, and diarrhoea are side effects of cadmium salt.

4. CONCLUSION

Punjab's surface and groundwater quality has been significantly impacted by rapid population increase, urbanization, industrialization, and agricultural activities. Large quantities of fertilizers and pesticides are being used because of the intense agricultural activities in order to increase crop yield. All of the State's major rivers are severely polluted as a result of industrial and municipal wastes being dumped in nalas, sewers, etc. This has caused pollution of both surface and groundwater over a long period of time. In the Malwa region, Bathinda district, and groundwater of Sutlej River, drinking water samples showed the presence of carcinogenic metals such as As, Hg, Cd, Cr, Se, Pb, and even uranium. In comparison to the post-rainy season, the pre-rainy season had a greater concentration of metals in the water. The presence of these cancer-causing metals is extremely dangerous to humans since it can impair the kidneys and lead to cancer, anaemia, and other diseases. It is clear from the study that several physicochemical parameters, including pH, conductivity, turbidity, alkalinity, DO, BOD, fluoride concentration, etc., are above the acceptable ranges suggested by WHO and BIS. It is advised that an intense monitoring network be set up for ongoing surveillance in locations where numerous constituents are posing health-related issues. Water resource management should be planned, designed, and actively coordinated by all water-using organisations, both public and private. There is a need to undertake thorough investigations to determine location-specific strategies based on drainage, integrated agricultural systems, micro-irrigation systems, and agronomic interventions.

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