Study of Ghaggar River Water for Uranium Status through Its Route

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Abstract

Uranium is a naturally occurring radioactive element present throughout the environment, atmosphere, food, soil, rocks and natural waters along with Pb, Cr, As, Zn & Fe. The uranium impacts are primarily from its chemical activities, instead of long-run tomographical toxic effects, which may lead to urinary organ damage and its non functional.

The people living in Ghaggar river basin are facing various waterborne diseases due to polluted water of Ghaggar river. So the purpose of this study was to investigate the uranium concentration levels of Ghaggar river water being used for drinking and irrigating purposes and to determine its health effects, if any, to the local population of river basin. Corresponding radiological and chemical risks have also been calculated for the uranium concentrations in river water samples. In the river water, uranium concentration in 6 water samples collected from different locations has been found to vary between 0.49 ppb and 8.09 ppb with an average of 4.525 ppb. Data analysis revealed that 2 of 6 samples had uranium concentration higher than safe limit of 30 mg/l recommended by WHO, 2011, while 4 samples exceeded the threshold of 60 mg/l recommended by AERB, DAE, India, 2004. The results undoubtedly verify that the quality of Ghaggar river water is not suitable to withstand the aquatic life and not fit for domestic uses.

Keywords:-*Ghaggar River; Uranium Concentration; Radiological Risk; Chemical Risks; Water Pollution; Health Effects.*

Introduction

Recently, Uranium (U) is a specifically studied heavy metal in the fields of environment and health-related issues. Uranium is a natural constituent of the earth's crust and occurs in all of the rocks, soils and fluids and is typically found in the earth's crust up to 0.004 kg/m^3 and may rise up to 0.015 kg/m^3 in farmland soil due to use of phosphate fertilizers [1], while its concentration in sea water is 0.000003 kg/m^3. High concentration of uranium distribution is controlled by geological activities, mainly due to the heavy metal's incompatible behavior in magmatic differentiation which leads to elevated U contents in felsic igneous rocks like granites and pegmatites and associated sediments and finally groundwater [2]. The metal has been found to have good affinity towards organic matter sorption. Inorganic phosphatic fertilizers, mining sites, nuclear industry emissions as well as combustion of fossil fuels represent prospective anthropogenic Uranium sources [3].

Uranium occurs naturally in the hexavalent along with +2, +3, +4, +5 valence states [4]. Naturally, hexavalent uranium is associated with oxygen as the uranyl ion, UO_2^{++}. Uranium (U) occurs naturally as mixture of three radio nuclides (^{234}U, ^{235}U and ^{238}U), all of them decay by both □□and □□emissions [2]. U (VI) being the mobile form (reduced U (IV)) tends to be immobilized as in mineral phase uraninite (UO_2), especially in bicarbonate-containing waters where stable U (VI)-carbonatocomplexes are dominant. ^{238}U isotope is the abundantly occurring along with the ^{235}U and ^{234}U isotopes comprising 0.72% and 0.0054% respectively [5]. It is widespread in nature and occurs in granites and various other mineral deposits [6]. The higher levels of uranium from any drinking water source can raise a person's threat of kidney injury [7]. The metal is excreted speedily from the body via urine and feces; however, a small amount is absorbed in digestive system and carried through the circulatory system to the various body parts. The current recommended guideline value of uranium in drinking water by WHO and USEPA is 0.030 kg/m^3 as maximum contaminant level (MCL) of uranium [8].

Chronic exposure of uranium radionuclide in drinking water is a potential health risk [9]. Although ubiquitous in the environment, uranium has no known metabolic function in animals and is currently regarded as nonessential. Uranium accumulated in human results in chemical and radioactive effects. The principal sites of uranium deposition in the body are the kidneys, the liver and the bones. The toxicity of uranium is a function of the route of exposure, particle solubility, contact time, and route of elimination [10]. The concentrations of radiotoxic elements like uranium in drinking water are hence kept under vigil by different health organizations. The World Health Organization [11] had earlier recommended a reference level 15 mgl1 but now the permissible limit of U in drinking water by WHO is 30 mg/1 [12]. The reference level is derived from epidemiological studies, based on the assumption of a 60 kg adult consuming 2 liters of drinking water per day and 80% allocation of the Tolerable Daily Intake (TDI) to drinking water. Maximum acceptable level of Uranium in drinking water as per guidelines of India's Atomic Energy Regulatory Board, Department of Atomic Energy, is 60 mg/l [13].

The natural environmental radioactivity is wide spread in the earth environment including soil, rock, water and air. People are exposed to ionizing radiation from naturally occurring radionuclides such as ^{238}U, ^{232}Th and their decay series and the radioactive 40K is found in almost all types of rocks, soil and sand [14]. The activity concentrations of these radionuclides are related to the types of rocks. Igneous rocks such as granite have high level of radiation and sedimentary rocks have low level of radiation [15]. High natural background radiation areas that are present in several areas of the world are Kerala coast of India, Yangjiang in China, Ramsar in Iran etc., [16–18]. High natural background radiation level is due to local geology, location, altitude and geochemical effects [19–21]. Exposure to radiation may cause somatic and genetic disorders. Somatic effects include the production of cancer cells and damaging tissues. Genetic effects are due to the damage caused to parent germ cells [22, 23]. In the control of radiation hazards, knowledge about the distribution of natural radionuclides in soil and rock is very essential. Many researchers across the nation are actively involving in environmental radioactivity and radiation levels. In Indian scenario; activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K were found to be higher than that of Indian and world average values at Shivalik foot hills of Haryana, Jaduguda uranium mineralization zone of Jharkhand and costal environment of Kalpakkam [24–26].

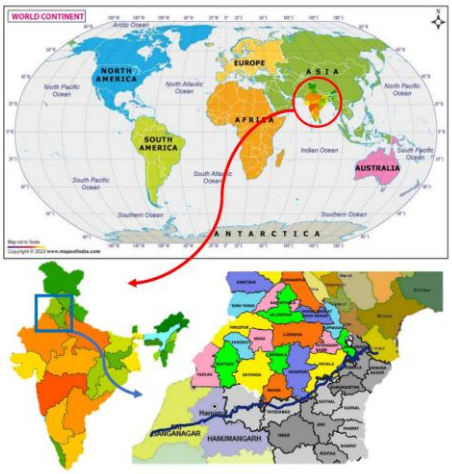
Ghaggar River

The Himalayas and the Indian state of Haryana are the places where the watershed of Ghaggar River begins. The After Ghaggar River begins its journey in the base of the Shivalik Hills and continues on through the states of Haryana and Punjab before entering the state of Rajasthan. After that, it flows into the Thar Desert where it is eventually swallowed up by the sand dunes. The chosen research area extended beyond state lines, encompassing parts of Punjab, Haryana, and Rajasthan respectively. A variety of smaller rivers and streams come together to form the Ghaggar River further downstream. They include the Patiala Nadi, the Markanda River, the Shaabaad Nallah, the Dhabi Nallah, the Sukhna Choe, the Jharmal Choe, the Dhabi Nallah, and the Dhakansu Nallah.

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 Haryana, Punjab, and Rajasthan, including but not limited to 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.

Sample Collection: The samples were collected from the surface water of the Ghaggar River in pre-cleaned olyethylene bottles and were



Research Objective

The current investigation is focused on the Ghaggar River to know the extent of radionuclides activity 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 length by adopting the various steps as follows:

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

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

3. Pollution loads and water quality were investigated to detect the present condition of water quality and water pollution tendency. Besides studying the various reports, journals and thesis, opinions from experts as well as from local bodies were also collected.

Result and Discussion

The examination of the collected samples shows that there is great variation in concentration of Uranium ^{238}U range as the river flow downward there are mixing of sewage and industrial effluents. The observed concentration value of Uranium ^{238}U ranged from 0.49 to 8.09. The concentration value of Uranium ^{238}U was observed minimum 0.49 ppb. at origin i.e. at Dugshai village of Shiwalik Range, Northwestern Himachal Pardesh and maximum 8.09 ppb. at Ottu Barrage of Sirsa Southwestern Haryana.

Table 1: Uranium 238U Analysis of Ghaggar River in January 2023

Sr. No.	Sample Code	Location	Average Concentration of Uranium ^{238}U in (ppb)
1	S1	Dugshai Village, Himachal Pardesh	0.49
2	S2	Panchkula, Haryana	1.48
3	S3	Devigarh Village, Punjab	4.99
4	S4	Mandvi Village, Punjab	5.94
5	S5	Sardulgarh, Punjab	6.16
6	S6	Ottu Barrage, Haryana	8.09

Conclusion

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 is the primary contributor to the majority of these outbreaks. The problems in the downstream 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 assessments of the relevant heavy metals. As people is called it Cancer River, further investigation is required. Crop sampling and critical heavy metal analysis should be done.

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