Groundwater is a key source of drinking water in many parts of India and meeting water requirement of a large community. About 50% of the total irrigated area is dependent on groundwater and about 60% of the irrigated food production depends on irrigation from groundwater wells. As we know the importance of groundwater and also know that human beings are totally dependent upon groundwater. Rural and urban households and public water supplies depend on wells and groundwater; farmers too use groundwater for irrigating crops and for their animals. Industries and commercial business also depend on groundwater for their processes and operations. Other industries rely on groundwater for the production of electric power, food, beverages, paper, and material production. Due to increase in population density the consumption of water from the ground is increased, pressure on it also increases, and this leads to decrease in groundwater level.

MATERIALS AND METHODS

a) Study area: Haridwar is regarded as one of the seven holiest places to Hindus and gateway to God. The district has a total area of 2360 sq.km and divided into three tehsils and six development blocks. It is now growing as the industrial hub of the Uttarakhand State. A number of medium and large scale industrial units are already operating within and in the fringe areas of the town and many others are in the offing. An Integrated Industrial Estate is also operational in the area. Water quality of Haridwar is deteriorating mainly due to commencement of various industries after the development of industrial Estate of State Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIDCUL) established by the State Government. Samples collected from ten different locations in Haridwar district shown in Fig-1.

b) Metal Analysis: The study was carried out by collection of ground water samples from different selected location in and around SIDCUL industrial area in Haridwar. Samples were analyzed for chromium (VI), iron, manganese, copper, lead, cadmium and nickel. Standard methods were used for collection and analysis of ground water. Samples were analyzed for metal concentrations by atomic absorption spectrophotometer, as per requirements.

c) ARC VIEW GIS: Using ARC GIS software the spatial interpolation was done on the basis of attribute values like cadmium, copper, iron, lead, nickel, and zinc etc. For each metallic parameter the spatial analysis was done and maps were created except for nickel. Five thematic maps have been prepared by using ArcGIS software.

RESULTS AND DISCUSSION

Results of metallic parameters for the year 2013-14 are given in the Fig-1. Ground water contained cadmium was reported between 0.002 mg/l in Hetampur to 0.09 mg/l in Roshanabad. Higher cadmium concentration was reported at Roshanabad, Railway Colony, BHEL and Shivalik Nagar. Due to higher

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cadmium concentration water becomes toxic but there are a few recorded instances of Cd poisoning in human beings following consumption of contaminated fishes. While, cadmium was reported 0.29 ppm in ground water samples of Panipat that was also higher than the standard limits of ISI. The study revealed that the copper concentration was ranged between 0.002 mg/l at Sultanpur Mazri to 0.200 mg/l at Roshanabad. It was noted that all the sites have copper concentration within standard limits except Roshanabad. Higher concentration of 0.75 mg/l was also reported in the ground water samples collected from the neighboring area of textile units at Sanganer, Jaipur. If present in higher amount (above 0.05 mg/l) it gives astringent taste to water and causes discoloration and corrosion of pipes, fitting and utensils. Prescribed limit for copper is between 1.0-1.5 mg/l. In the present study, iron (Fe) was observed during 2013-14, ranging between 0.143 mg/l at Railway Colony to 0.963 mg/l at Nanheda Anantpur. It is little within the set limit of 0.3 -1.0 mg/l for iron. Beyond this limits taste and appearance are affected, has adverse effect on domestic uses and water supply structures.
and promotes iron bacteria. During the present study, lead was found during 2013-14 that values for lead were minimum (0.08 mg/l) at Hetampur and maximum (1.07 mg/l) at Roshanabad. Desirable limit for lead is 0.05 mg/l, beyond this limit water becomes toxic\(^9\). Whereas, 0.24 - 0.45 mg/l of lead was reported in ground water samples at Panipat, Haryana\(^5\).

In the present study, nickel was absent in the entire sample. IS limits for nickel is 0.02 mg/l. According to Agency for Toxic Substances & Disease Registry, nickel is an essential trace element in animals. Its deficiency is manifested primarily in the liver; effects include abnormal cellular morphology, oxidative metabolism, and increases and decreases in lipid levels. The essentiality of nickel in humans has not been established, and nickel dietary recommendations have not been established for humans\(^10\). During the present study, Zinc was noted ranging between 0.002 mg/l at Hetampur to 3.88 mg/l at Roshanabad. It was found within the prescribed limit of Indian standard i.e. 5.0 mg/l. Desirable limit for zinc is 0.5 mg/l, beyond this limit affects stomach lining, kidney and liver. It may lead stomach cramps, diarrhea, nausea and vomiting.

**CONCLUSION**

It has been shown that various human activities generate pollutants which have high organic and inorganic contents which are directly or indirectly disposed on land without any pretreatment, thereby affecting the groundwater quality. The pollutants tend to spread more laterally and at a slow flow rate because of the flat terrain of the area. This gives a greater possibility of infiltration of polluted water into the underground surface or groundwater. The study has shown that Geographic Information System (GIS) software is very useful in the analysis of groundwater table variation, in the distribution of groundwater pollution. Considering the concentration of metals in the water samples almost all the samples need treatment before use as they are found to have metals values more than the prescribed standards.

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**REFERENCES**

10. IS 10500:2012