Severe uranium contamination in India's groundwater: Study

Groundwater depletion and nitrate pollution may be aggravating the already present natural uranium contamination to dangerous levels. | Photo Credit: K.GOPINATHAN

Scientists have found widespread uranium contamination in groundwater from aquifers across 16 states in India, much above the WHO provisional standard for the country. The findings published in the journal *Environmental Science & Technology Letters* are the first to demonstrate the predominant prevalence of uranium in India's groundwater.

The researchers from Duke University in the US unveiled new data showing that the occurrence in uranium in Indian groundwater — a primary source of drinking water and irrigation — is an emerging and widespread phenomenon.

They compiled data on groundwater uranium from 16 Indian states and new data from 324 wells in Rajasthan and Gujarat that shows a high prevalence of uranium concentrations above the WHO provisional guideline value across India.

The WHO has set a provisional safe drinking water standard of 30 micrograms of uranium per litre for India, a level that is consistent with US Environmental Protection Agency standards. Despite this, uranium is not yet included in the list of contaminants monitored under the Bureau of Indian Standards' Drinking Water Specifications, researchers said.

The study suggests that contribution of human factors such as groundwater depletion and nitrate pollution may be aggravating the already present natural uranium contamination to dangerous levels. Several studies have linked exposure to uranium in drinking water to chronic kidney disease.

"Nearly a third of all water wells we tested in one state, Rajasthan, contained uranium levels that exceed the World Health Organization and US Environmental Protection Agency's safe drinking water standards," said Avner Vengosh, a professor of geochemistry and water quality at Duke's Nicholas School of the Environment. "By analysing previous water quality studies, we also identified aquifers contaminated with similarly high levels of uranium in 26 other districts in northwestern India and nine districts in southern or southeastern India."

Many of India's aquifers are composed of clay, silt and gravel carried down from Himalayan weathering by streams or uranium-rich granitic rocks. When over-pumping of these aquifers' groundwater occurs and their water levels decline, it induces oxidation conditions that, in turn, enhance uranium enrichment in the shallow groundwater that remains.

While the primary source of uranium is geogenic (naturally occurring), anthropogenic (human caused) factors such as groundwater table decline and nitrate pollution may further enhance uranium mobilisation. Using geochemical and uranium isotope data, it suggests factors that may drive high uranium concentrations in groundwater, including uranium content in aquifer rocks, oxidation state, and groundwater chemistry that promotes the formation of soluble uranyl carbonate complexes.

"Our analysis showed that the occurrence of uranium in these groundwater sources depends on several factors," said Rachel M Coyte, a PhD student in Vengosh's lab.

These factors include the amount of uranium contained in an aquifer's rocks; water-rock interactions that cause the uranium to be extracted from those rocks; oxidation conditions that

enhance the extracted uranium's solubility in water; and the interaction of the extracted uranium with other chemicals in the groundwater, such as bicarbonate, which can further enhance its solubility.

"In many parts of India, these factors co-occur and result in high uranium concentrations in the groundwater," Coyte said. "Geochemistry and isotopic tools help us to better understand the process and conditions that control uranium occurrence in groundwater."

Human activities, especially the over-exploitation of groundwater for agricultural irrigation, may contribute to the problem, said Coyte. "One of the takeaways of this study is that human activities can make a bad situation worse, but we could also make it better," Vengosh said.

The study strongly suggests the need for revision of the current water quality monitoring program in India, evaluation of human health risks in areas of high uranium prevalence, development of adequate remediation technologies, and, above all, implementation of preventive management practices to address this problem, said Vengosh.

"Including a uranium standard in the Bureau of Indian Standards' Drinking Water Specification based on uranium's kidney-harming effects, establishing monitoring systems to identify at-risk areas, and exploring new ways to prevent or treat uranium contamination will help ensure access to safe drinking water for tens of millions in India," he said.

It includes samples of a bug isolated from Alexander Fleming's nose in 1915

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