

Natural contaminant threat to drinking water from groundwater

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More than half of the world's population faces a looming threat to the quality and availability of their drinking water because climate change and urbanisation are expected to cause an increase in groundwater

organic carbon, a new UNSW study has found.

The research, published in *Nature Communications*, examined the largest global dataset of 9404 published and unpublished groundwater dissolved [organic carbon](#) (DOC) concentrations from aquifers in 32 countries across six continents.

DOC is a naturally occurring component of groundwater, but the higher its concentration, the more difficult and expensive it is to make groundwater drinkable. In Australia, groundwater is widely used as the main source of drinking water for many cities and towns.

Lead author Dr. Liza McDonough, of the Connected Waters Initiative Research Centre at UNSW, said the study forecasted elevated DOC concentrations because of projected changes in temperature and rainfall due to [climate change](#), as well as increased urbanisation.

"We identified groundwater DOC concentration increases of up to 45 per cent, largely because of increased temperatures in the wettest quarter of the year—for example, in a number of south-eastern states in the United States. We predict increases in DOC in these locations could increase water costs for a family of four by US\$134 per year," Dr. McDonough said.

"Other areas such as eastern China, India and parts of Africa already experience severe groundwater contamination issues. These may be further compounded, particularly in south-eastern China, by groundwater DOC increases associated with large predicted increases in temperature in the wettest quarter of the year by 2050.

"Generally, we expect urbanisation to increase groundwater DOC concentrations by up to 19 per cent, compared to agricultural or natural land use, likely as the result of contamination—for example, through

leaking septic and sewer systems."

The research, a collaboration between UNSW, the Australian Nuclear Science and Technology Organisation (ANSTO), Southern Cross University, British Geological Survey, and the University of Bradford, found four major contributing factors to groundwater DOC levels: climate, land use, inorganic chemistry and aquifer age.

Health threat

Dr. McDonough said increased groundwater DOC, whether naturally occurring or due to contamination, also posed a threat to human health.

"Groundwater is Earth's largest source of freshwater and provides essential drinking water for more than 50 per cent of the world's population," she said.

"But, because most health impacts caused by DOC are related to the formation of by-products of [water treatment](#) chlorination and depend on concentrations of other water chemical parameters, the World Health Organization and many countries—including Australia—do not regulate DOC concentrations in drinking water directly."

Dr. McDonough said that while DOC is a naturally occurring, key element of groundwater it could combine with, and transport, potentially dangerous heavy metals otherwise bound to rocks and sediment where groundwater occurs.

"This is a concern when, for example, more than 100,000 lifetime cancer cases in the United States alone can be attributed to drinking water contaminants," she said.

Water treatment costs to rise

Dr. McDonough said it was important to understand what caused high DOC concentrations in groundwater.

"An increase in groundwater DOC concentration impacts the ability and therefore cost to make groundwater drinkable," she said.

"For example, we projected a 16 per cent increase in annual household [water costs](#) in some parts of the United States because of rising water treatment costs—due to the need to implement additional water treatment measures to remove increased DOC concentrations.

"The decrease in groundwater quality and substantial increase in water treatment costs will also compound existing constraints on groundwater resources, including availability."

Wet vs arid climates

Dr. McDonough said the impacts on groundwater DOC levels from climate change and urbanisation, while likely to occur globally, differed by geography and climate.

"Our research found that in arid climates, groundwater DOC concentrations increased with higher rainfall because microbes can better break down organic matter, such as leaves, under warm and increasingly wet conditions," she said.

"Increased temperatures in arid environments, however, reduced groundwater DOC concentrations because when conditions are too hot and dry, vegetation and organic matter sources are limited.

"By contrast, increased rain in warm and wet environments decreased groundwater DOC concentrations because heavy rainfall dilutes the DOC in groundwater."

Water treatment solutions

Dr. McDonough said she looked forward to conducting further research to determine the best water treatment options for areas where [groundwater](#) DOC concentrations are anticipated to increase.

"Our next step is to investigate how the character of DOC changes when you have different aquifer minerals, because some types of organic matter can stick to certain mineral surfaces and ultimately reduce this type of [organic matter](#) remaining in the water," she said.

"This will help provide guidance on the most suitable water treatment options in areas where DOC concentrations are expected to increase."

More information: Liza K. McDonough et al, Changes in global groundwater organic carbon driven by climate change and urbanization, *Nature Communications* (2020). [DOI: 10.1038/s41467-020-14946-1](https://doi.org/10.1038/s41467-020-14946-1)

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