Saving Earth's water from toxic waste

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Scientists have devised a better way to protect groundwater from acids, heavy metals and toxic chemicals, helping to secure the Earth's main freshwater supply.

The advance is a major step towards shielding groundwater from mining, industrial and domestic waste, all of which can contaminate the water for decades, rendering it unusable and undrinkable.

A team led by Professor Derek Eamus at The National Centre for Groundwater Research and Training (NCGRT) and University of Technology Sydney (UTS) has developed a cheaper and more efficient way to test the optimal design of 'store-release covers' – layers of soil and plants that prevent water from leaking into the waste and contaminating the aquifers underneath.

"Globally, mining produces millions of tons of waste known as tailings that are often stored above ground," says Prof. Eamus. "Industrial and domestic waste are buried as landfill, with Australia alone burying over 21 million tonnes in 2010."

This waste poses a big threat to groundwater, which makes up 97 per cent of the world's fresh water and is thus a major element in global water security, Prof. Eamus explains.

When rain water travels through waste, it leaches toxic chemicals from discarded electronic equipment, batteries, detergents, solvents and pesticides. The contaminated water then drains into the aquifer below,

which may be used for drinking or watering crops. Once polluted, groundwater is expensive and difficult to clean up.

One way to minimise the contamination is to cover the waste with a layer of soil, trees and plants, Prof. Eamus explains. Known as store-release covers, the soil soaks up rain water, allowing the vegetation to use it and release it back into the atmosphere. This siphons off enough water to prevent it from reaching the waste.

However, building store-release covers is expensive, slow and requires a lot of work, Prof. Eamus says. "To build a cover, we have to know what type of soil and plants to use, and how thick the soil layer should be.

"Also, every site has a different climate, vegetation and soil, so a lot of it is guess work, followed by hundreds of experiments. It can take years and years to optimise the design of a store-release cover."

To solve this problem, the researchers ran a soil-plant-atmosphere model with different climate scenarios to test its effectiveness in designing store-release covers. To find out which covers work best, they looked at four factors: the depth of the soil layer, how much water it can hold, how much water a plant will use and the local rainfall.

They then applied the model to three different Australian climates: cool, wet winters with hot, dry summers in Perth; the monsoonal climate in Darwin; and evenly distributed rainfall across the year such as in Sydney.

"We found that an effective store-release cover has to have enough capacity to store any additional rain that falls in wetter years. The trees have to grow leaves that cover the entire ground, and their roots have to reach the bottom of the soil cover," Prof. Eamus says.

"We don't want the lower half of the store-release cover to have no roots,

because water will gather there and seep through the waste. Also, having more leaves that cover the ground means more water will be used and transpired by the plant."

"Now we know what makes an effective store-release cover, we can gather the information for these factors, as well as the rainfall average and extremes for any location, to optimise the design of a store-release cover anywhere in the world," says Prof. Eamus.

"This model removes a lot of guesswork and decreases the number of experiments that we have to carry out. So not only are these covers cheaper to build, they will also be more efficient. This will encourage mining as well as waste management companies to build better covers for their waste."

The model can also be used anywhere in the world to help tackle the global problem of groundwater pollution, Prof. Eamus says.

The study "Design of store-release covers to minimize deep drainage in the mining and waste-disposal industries: results from a modelling analyses based on ecophysiological principles" by Derek Eamus, Isa Yunusa, Daniel Taylor and Rhys Whitley was recently published in the journal *Hydrological Processes*.

More information: onlinelibrary.wiley.com/doi/10 … 02/hyp.9482/abstract

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