Microplastic pollution in the groundwater under a bedrock island in the South China Sea postprint

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Abstract

Groundwater is the only freshwater resource on islands. Research on microplastic pollution in groundwater on islands is scarce. This study is the first to explore microplastic pollution in the groundwater under a bedrock island (Dawanshan Island) located in the South China Sea. The influence of hydrogeological factors on the distribution, source, and ageing features of microplastics in the groundwater were investigated. Despite the small scale of industrial and agricultural activities on the island, the amount of microplastics in the groundwater ranged from 34 to 64 particles/L, with over 80% of the microplastics being polyester fibres with diameters smaller than 2 mm, which is comparable to those in coastal cities. These microplastics were originated from inland plastic usage, rather than from the surrounding sea, which was confirmed by the lack of seawater intrusion on the island. Owing to the low permeability of granite, microplastics were mainly distributed in the water of the loose layer of porous sediment, and their quantity decreased with depth. In addition, the abundance of microplastics in pore groundwater increased with an increase in the velocity of groundwater flow. The severity of microplastic pollution in the groundwater increased with an increase and decrease in the content of total dissolved solids and dissolved oxygen, respectively. The microplastics originated from plastic waste disposed of on the island, rather than from seawater intrusion. Also, through groundwater infiltration into exposed soil at recharge areas, artificial wells at residential areas, and water exchange with surface water at valley areas. Microplastics buried in the groundwater aged faster along the migration path of the groundwater. These microplastics threaten the safety of people and plants on the island through exposure resulting from the extraction of groundwater for irrigation, while they endanger marine life through submarine groundwater discharge.

Full Text

Preamble

Microplastic Pollution in Groundwater Beneath a Bedrock Island in the South China Sea

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Abstract: Groundwater represents the sole freshwater resource on islands, yet research on microplastic pollution in island groundwater remains scarce. This study marks the first investigation of microplastic contamination in groundwater beneath a bedrock island (Dawanshan Island) in the South China Sea, examining how hydrogeological factors influence the distribution, sources, and aging characteristics of microplastics.

Despite limited industrial and agricultural activity on the island, groundwater microplastic concentrations ranged from 34 to 64 particles/L, with over 80% being polyester fibers smaller than 2 mm in diameter—levels comparable to those in coastal urban areas. These microplastics originated from inland plastic usage rather than marine sources, as confirmed by the absence of seawater intrusion on the island.

Due to the low permeability of granite bedrock, microplastics were primarily concentrated in the porous sediment layer, with abundances decreasing with depth. Microplastic concentrations in pore groundwater increased with groundwater flow velocity. Pollution severity also correlated positively with total dissolved solids content and negatively with dissolved oxygen levels.

Microplastics derived from plastic waste disposed on the island entered groundwater through infiltration in recharge areas, artificial wells in residential zones, and water exchange with surface water in valley regions. Along groundwater flow paths, microplastics exhibited accelerated aging. These contaminants pose risks to island residents and vegetation through irrigation using extracted groundwater, while endangering marine life via submarine groundwater discharge.

Keywords: microplastic pollution, groundwater, bedrock island, hydrogeological conditions

Note: Figure translations are in progress. See original paper for figures.