

Influences of artificial snow on the quality of nearby groundwater

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As winter has warmed due to climate change, ski resorts around the world are increasingly relying on artificial snow rather than natural snow. In order to make artificial snow, a huge amount of water resources such as stored rainwater or surface water must be used. Furthermore, chemical species contained in artificial snow can flow into the surrounding water system along with snowmelt, causing environmental pollution. In particular, nitrate, a representative pollutant, causes eutrophication when excessively supplied to the water system, thereby deteriorating the aquatic ecosystem and causing diseases such as cyanosis. This study aimed to investigate the influence of artificial snow on the quality of surrounding groundwater at Ski Resort located in Pyeongchang (South Korea), the venue for the 2018 Winter Olympics. To this end, artificial/natural snow at ski resorts, surface water, and groundwater were sampled from 2018 to 2022, and water quality and stable nitrate isotopes ($\delta^{15}\text{N-NO}_3$ and $\delta^{18}\text{O-NO}_3$) analysis was conducted. As a result, $\text{NO}_3\text{-N}$ concentrations and $\delta^{15}\text{N-NO}_3$ values in groundwater were $4.22\pm 0.66\text{mg/L}$ and $6.95\pm 0.37\text{‰}$, respectively. $\text{NO}_3\text{-N}$ concentrations above 3 mg/L may indicate that the contamination resulted from anthropogenic activities [1]. The $\text{NO}_3\text{-N}$ showed a positive correlation ($r=0.51$) with $\delta^{15}\text{N-NO}_3$ and showed a tendency to increase ($p\text{-value}<0.05$) in January-February. This suggests that there are no agricultural activities or sewage discharge, but artificial snow can be N sources to the top of the mountain. In fact, $\text{NO}_3\text{-N}$ and $\delta^{15}\text{N-NO}_3$ in artificial snow were 5.27mg/L and 10.28‰ , respectively, which was the same source of sewage and manure origin as the surface water ($4.2\pm 1.36\text{mg/L}$ and $10.1\pm 2.01\text{‰}$). This study will be helpful in identifying and monitoring the long-term effects of nitrate in artificial snow on the surrounding water system as the dependence on artificial snow gradually increases.

[1] Madison, R.J., Brunett, J.O., 1985. Overview of the occurrence of nitrate in ground water of the United States. In: National water summary 1984: Hydrologic events, selected water-quality trends, and ground-water resources. In: USGS Water Supply Pap, 2275. U.S. Gov. Print. Office, Washington, DC, pp. 93–105.