Lack of oxygen in the groundwater

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Airports use de-icing agents during the winter. These chemicals have a negative impact on groundwater quality, according to a new study of geoscientists from the Friedrich Schiller University Jena. Credit: Jan-Peter Kasper/FSU

Spring has arrived in Europe with mild temperatures and sunshine. Where just a few weeks ago the ground was frozen and partly covered in snow and ice, it is now thawing. This doesn't only have an impact on the flora and fauna. Thawing results in soil and the groundwater at airports

being impacted by chemicals, which are contained in melt water. The reason: Airports have to use de-icing agents during the winter, which end up on unpaved areas and infiltrate into the soils during snowmelt.

"Admittedly, airport operators in EU-countries are compelled to sustain a good condition of the groundwater or at least to avoid detrimental concentrations of pollutants in the groundwater," says PD Dr. Markus Wehrer from the Friedrich Schiller University Jena (Germany). "However, it is common practice that along the runways huge amounts of de-icing fluids infiltrate into the ground," the Hydrogeologist adds. It does indeed make sense to use the natural self cleaning capacities of the soil. However, the de-icing chemicals have a negative impact on groundwater quality and the functions of the soil. This was shown in a new study of a team of researchers around Prof. Dr. Kai Uwe Totsche at the Jena Chair of Hydrogeology.

In the science magazine *Environmental Science and Pollution Research*, the scientists of the University Jena wrote that chemicals like propylene glycol und potassium formate are being degraded by micro-organisms living in the soil and therefore don't get into the groundwater – at least not straight away. "On the other hand, heavy pollution through these substances leads to a dramatic decrease of oxygen content in soils and groundwater," Heidi Lissner, the first author of the study explains: This is because the microbes use oxygen to degrade the pollutants. "The more of these substances they have to metabolize, the more oxygen they use for this," says the geoscientist, who developed the results – which are now published in the study – within the framework of her PhD thesis. As a consequence iron and manganese oxides, which stabilize the intergranular cement of the structure of the soil, dissolve.

For their study the Jena team of researchers analyzed the soil around the airport of the Norwegian capital Oslo. There, every winter about 1,000-1,500 tons of de-icing agents are used. "At the same time, the

airport is situated directly next to the largest superficial aquifer in Norway, the Romerike-Aquifer," explains Dr. Wehrer, who supervised Heidi Lissner's work together with Prof. Dr. Totsche. The geoscientists took soil core samples close to the runway of the airport and examined them. "We wanted to find out, how the de-icing agents affect the condition of the soil and the percolating water," Heidi Lissner explains. In order to do so, the young scientist loaded soil cores with water that contained de-icing chemicals and thus simulated a "thawing event". She collected the seepage water after it passed through the soil cores, followed by an examination for de-icing chemicals as well as the oxygen content and additional parameters.

According to the Jena scientists, their exemplary results can be transferred to the situation at other airports. "Chemicals for de-icing aircrafts as well as runways are used wherever there is snow and ice in winter," Dr. Wehrer says. He stresses that, additionally, measures to reduce the oxygen content in the soil around airports could be deducted from the new scientific results. Apart from installing specific areas, which allow the thawing water to seep away in a controlled manner, a controlled use of bacteria in the soil, which are specialized in the degradation of these chemicals, is conceivable. This requires an additionally improved oxygen supply in the soil. Also, alternative substances, which can be used for the degradation of pollutants similar to the way in which oxygen works, may be supplied. Moreover, the texture of the soil could be shaped in a way that delays the seepage of the polluted soil water. Through a longer interval, which is then available for the degradation of the substances, a lack of oxygen could be avoided, because atmospheric oxygen is transferred slowly but continuously into the soil.

More information: "Constraints of propylene glycol degradation at low temperatures and saturated flow conditions." *Environ Sci Pollut Res* (2015) 22:3158–3174, DOI: 10.1007/s11356-014-3506-3

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