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Impact of urbanization on groundwater recharge

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All around the world, as in Switzerland, urban areas are growing. Cities are putting natural resources under enormous stress. Groundwater, as the world's most important reserve of available fresh water, is particularly affected. Managing this resource in a sustainable way is therefore critical. Urbanization significantly affects the entire water cycle and introduces new sources and pathways of groundwater, as well as new sources of contamination. Furthermore, issues related to groundwater overexploitation in urban areas are often recorded, such as land subsidence, groundwater contamination or seawater intrusion.

Urban groundwater recharge remains a poorly understood and under-researched topic. This contribution aims to give an insight into urban groundwater recharge in the concrete case of the municipality of Dübendorf in Switzerland. This study was performed in two parts: first, the influence of climatic conditions on groundwater recharge was investigated; second, the influence of urbanization was assessed.

This study highlights strong positive correlations between both groundwater recharge and precipitation and between groundwater recharge and the extent of an urban area. Two conclusions can be drawn: first, groundwater recharge is highly influenced by climatic conditions and its magnitude can vary strongly from year to year. For example, in Dübendorf recharge was found to be more than two times higher in years with abundant precipitations than in dry years. Second, transformation of natural landscapes into impervious areas leads to a considerable increase in groundwater recharge due to the reduction of evapotranspiration that more than compensates for the increase in runoff and due to the contribution of water main leakages. In Dübendorf, groundwater recharge has increased of 50% between 1880 - where urban areas constituted 6% of the municipality - and 2009 - where these areas represented 44% of Dübendorf territory. Furthermore, water main leakages contributed to 10% of groundwater recharge in 2009.

Our study provides an insight into the response of groundwater recharge to increasing urbanization. It is a helpful basis for sound water management and establishment of adequate institutional frameworks, in order to warrant sustainable groundwater resources and to avoid issues such as groundwater contamination, land subsidence or flooding of underground infrastructure.