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Groundwater management in coastal zones and on islands in crystalline bedrock areas of Sweden

Stefan Banzhaf (1,2), Linda Louise Ekström (1), Andreas Ljungkvist (1), Maria Granberg (1), Johanna Merisalu (1), Sebastian Pokorny (1), and Roland Barthel (1)

(1) University of Gothenburg, Department of Earth Sciences, Gothenborg, Sweden (roland.barthel@gvc.gu.se), (2) Tauw GmbH, Berlin, Germany (stefan.banzhaf@tauw.com)

Groundwater problems in coastal regions are usually not associated with the sparsely populated shores of water-rich Scandinavia. However, the combination of geology and the specific conditions of water usage create challenges even there. Along the Swedish coast, much of the groundwater occurs in fractured bedrock or in relatively small, shallow, and isolated quaternary sedimentary formations. Those aquifers cannot provide water to larger permanent settlements and are thus neither useful for the public water supply nor have previously received much attention from water authorities or researchers. However, of the 450,000 private wells in Sweden, many are located in coastal areas or on islands, creating pressure on groundwater resources in summer months as periods with low or no natural groundwater recharge.

In view of the increasing water demand, as well as the awareness of environmental impacts and climate change, Swedish municipalities now recognize groundwater usage in coastal areas is a major concern. Here, we present the results of an investigation on the “Koster” archipelago which forms a microcosm of coastal zone groundwater problems in Sweden. Koster’s geology is dominated by fractured, crystalline bedrock with occasional shallow quaternary deposits in between. With around 300 permanent residents, and up to 6,000 summer guests in peak holiday season, the existing water supply based on 800 private wells is at its limit. Water availability forms an obstacle to future development and the current mode of operation is unsustainable. Therefore, the municipality must decide how to secure future water supply which involves complex legal problems, as well as social, cultural, economic, hydrogeological, and environmental questions.

As there are no observation wells on the islands, we used approximately 220 of the 800 wells (65% dug and shallow, 35% drilled and up to 120m deep) for our monitoring. Additionally, water samples were collected by property owners on four occasions (spring, summer, fall, and winter). All samples were analyzed for electrical conductivity, major ions, and metals. Groundwater levels, in situ measurements of physicochemical parameters, and borehole logs of electrical conductivity and temperature were conducted for around 80 wells. Hydraulic head, electrical conductivity, and temperature were monitored continuously at 10 locations. Further, an online survey was distributed regarding water quantity, quality, and usage in different periods of the year, before a detailed GIS analysis was carried out to support the water balance calculations and groundwater recharge estimations.

The case is interesting as studies dealing with saltwater intrusion in fractured (bedrock) aquifers are rare, thus offering the possibility to connect state of the art research with practical management questions at the science-society interface. For example, a new method for low cost strontium isotope analysis on an ICP-MS to analyze the origin and contact time of saltwater was used in parallel to interviews with individual well owners. Here, we present monitoring results over an entire hydrological year and how these can better inform the municipalities’ decision-making process.