Investigating hydrogeologic controls on groundwater drought hazard in Sweden and Finland

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Understanding droughts has historically been given low priority in Sweden and Finland, countries of high water abundancy. However, according to the drought monitor of the Joint Research Centre (EDO, http://edo.jrc.ec.europa.eu/), large parts of Scandinavia have since the beginning of 2015 continuously been classified with medium to high risk of being impacted by drought. By summer 2017, groundwater drought was evident in large parts of Sweden according to the Swedish Geological Survey (SGU). Societal impacts included restrictions on water consumption, irrigation bans, and private wells running dry in certain regions. In Finland, the response of groundwater systems differ with the last major groundwater drought occurring in 2003 (based on the Finnish Environmental Institute's (SYKE's) monitoring network). This resulted in cautiousness regarding water usage. The propagation of dry periods, from precipitation deficit to groundwater drought, as well as their severity and persistence, is poorly understood for Swedish and Finnish hydro(geo)logical systems. Therefore, we investigate historical and geographical patterns of periods with low water tables. While geological conditions are similar among the countries, patterns of drought events vary between Sweden and Finland due to differences in regional climate. In a comparative study, we investigate the propagation of drought with the indices SGI (Standardized Groundwater Index) and SPI/SMRI (Standardized Precipitation Index/Standardized Snow Melt and Rain Index) in different Swedish and Finnish hydrogeological settings. Further, we explain propagation based on system characteristics using decision tree learning. By determining significant controls, such as aquifer properties and dimensions, we provide a guideline for the precipitation signal to serve as a proxy for groundwater levels. This proxy can subsequently be used for an improved understanding of impending drought hazards in gauged and ungauged aquifers.