

Hydrogeology education in Sweden: are our curricula designed to meet society's demands?

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Society is facing many groundwater related challenges, some specific for Sweden and Nordic countries, some concerning many countries around the globe. The latter are foremost related to groundwater overuse and contamination, but increasingly more frequently also to hydrological extremes such as flood and drought. Hydrological extremes are predicted to increase even more because of climate change and even the water-rich Nordic countries have recently been affected by water scarcity and low groundwater levels (Nygren et al., 2021).

The more specific hydrogeological challenges in Sweden are often related to the construction of roads, railways, tunnels, big buildings, etc. Land-subsidence, as a result of groundwater abstraction, is a common problem that has created huge damage in the past and must be avoided in the future. Sweden is also facing problems of groundwater pollution, PFAS being just one popular example (Banzhaf et al., 2017). Another new and hot topic is the restoration of wetlands to reduce greenhouse gas emissions and to secure water supply. All these are challenging questions that require an integrated hydrological and geological perspective.

Against this background, we as university teachers and responsible for curricula, need to ask the question if we are educating enough groundwater professionals and if those future groundwater professionals have the required skills and knowledge to tackle the challenges.

To investigate this, three surveys were carried out: One, among group, team and section leaders in hydrogeology at all major Swedish consultants and agencies, to determine how easy it is for them to recruit new staff, how new staff meets the requirements and expectations, and how they see the future of the job market. A second survey was sent to professionals working in hydrogeology. They were asked about the contents of their education and how well they felt prepared for their work as professionals. A third survey was sent to teachers teaching hydrogeology or related subjects at Swedish universities.

The surveys were complemented with a compilation of all groundwater related courses taught at Swedish Universities using the University webpages as a data source. LinkedIn profiles containing groundwater or hydrogeology in keywords of 300 Swedish groundwater professionals were used to determine where groundwater professionals work and what kind of education they had.

Altogether a very detailed and complete picture of hydrogeology education in Sweden could be compiled. Results show positive and negative developments. On the negative side, it is not possible to obtain a complete education in hydrogeology at any University in Sweden. Each university offers only relative few specialized courses. At the same time, employers have difficulties to recruit staff which is worrying against the background of an increasing demand. On the positive side, many groundwater professionals feel that their education prepared them well for the demands of the job market. There is a common agreement though, that there is a growing demand for both broader and deeper education in hydrogeology. There is also a need for standardization and certification of hydrogeological education.

Banzhaf, S., Filipovic, M., Lewis, J., Sparrenbom, C.J., Barthel, R., 2017. A review of contamination of surface-, ground-, and drinking water in Sweden by perfluoroalkyl and polyfluoroalkyl substances (PFASs). *Ambio*, 46(3): 335-346.

Nygren, M., Giese, M., Barthel, R., 2021. Recent trends in hydroclimate and groundwater levels in a region with seasonal frost cover. *J. Hydrol.*, 602.