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Influence of high Alpine Karst Morphology on Vulnerability - a Case Study from the Viennese Water Catchment

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The karst massifs Hochschwab, Schneealm, Rax, and Schneeberg comprise the catchment areas of springs, which are used to supply the city of Vienna with high quality fresh water via two long-distance pipelines. The Vienna Waterworks initiated several research projects in order to assure quality and reliance of long-term water supply. The project particularly addresses vulnerability evaluations of the karst aquifers. Research on karst morphology has been carried out within the frame of the KATER I and II projects and resulted in a detailed GIS-based karst map of the plateaus covering an area of 146 km^2 until now. Work includes systematic field mapping in the scale of 1:5000. Maps show the following data. (1) Karst features: dolines, poljes, polygenetic cirque-depressions, dry valleys, caves, karren, and palaeokarst outcrops; (2) hydrological items: springs, surfaces runnels, ponors and karst ponds; (3) geologic items relevant as protective covers: tertiary clay soil and glacial till; (4) anthropogenic structures as possible inputs for pollution: mountain huts, hiking trails, gravel roads, and meadows. Results show that the vulnerability of the karst plateaus is very inhomogeneous due to locally highly variable infiltration rates and subsurface water transport conditions. Locations of highest vulnerability are related to karst structures (poljes with active ponors, dolines, karren fields, and caves) causing rapid and very concentrated input of surface water directly into the aquifer. Karst structures with extremely high permeability act as sinks and enable the rapid transport of both organic and inorganic pollutants into the karst water body without interim storage and filtration in covering soils or the epikarst. Subsurface observation in caves and data on speleogenesis proof that water, which directly infiltrates into wide-open karst conduits, is not stored, filtered, and purified. For these high alpine karst setting karst morphology is the most

important factor determining vulnerability as rocks and soil with high retention potential (low permeability - high porosity) are bypassed. The vulnerabilities of such karst sinks are compared and quantified using analyses of digital models (DEM). Analyses identify local minima of the depressions, the area of the morphological catchment for each sink, and the potential surface runoff drained into the sinks (analytical software by Wingeol-Terramath). Karst morphology and DEM-derived data are used for a vulnerability ranking and for the straight-forward qualitative discrimination of highly vulnerable sites within the karst plateau. Accordingly, the most vulnerable areas are karst structural poljes, which formed on top of aquicludes (Lower Triassic Werfen Formation), and are confined by major tectonic faults. The largest polje (Bodenwiesen / Gahns) covers an area of about 2.2 km^2. Other poljes (Sonnschienplateau, Filzmoos, Sackwiesensee, Sachwiesenalm on Hochschwab) are about a magnitude smaller, but show permanent infiltration of surface water into ponors at their borders. Other highly vulnerable features are huge polygenetic cirque depressions with dolomitic catchment areas that also lead to surface water infiltration. Huge dolines draining big areas into well-developed karst shafts are found on the glacially not overprinted nunataks topping the plateaus. The biggest karst depressions reach up to 700 m diameter and 70 m depth. Combination of the vulnerability ranking derived from karst analysis with assessments of areas with potential anthropogenic pollution by pasture, tourism and forestry highlights several critical areas. For some of these areas regular monitoring and protective measures against contamination by the cattle would be beneficial.