Mountainous Dolomite Karst Site: Zoebelboden (Upper Austria)

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Introduction

The Federal Environmental Agency Vienna runs an UN-ECE-Integrated Monitoring station (Zoebelboden) with slightly karstified dolomite. The Zoebelboden-site is located south of Linz (Upper Austria) in the front range of the Northern Calcareous Alps in form of steep mountain ridges at an altitude of 500-950 m (N 47°50'30", E 14°26'30").
The monitoring site (~5 km2) is divided in plateau and slope areas. At each site, one plot has been selected for intensive measurements of hydrochemical variables. The natural mixed mountain forest (beech, fir) is often displaced by production forest dominated by spruce at the plateau. The mixed forests found on the slopes are composed of beech (Fagus sylvatica) as dominant tree species, Norway spruce (Picea abies), maple (Acer pseudoplatanus) and ash (Fraxinus excelsior). These forests are considered as close to the natural vegetation. In contrast, the plateau forest was changed after a clear-cut in 1910 into a pure Norway spruce (Picea abies) plantation. Since 1992 forest management was restricted to single tree harvest after bark beetle infestation. As the site was not covered with ice during the glaciations a more or less continuous blanket of relictic clayey soil material (Chromic Cambisols and Hydromorphic Stagnosols) remained on the plateau. The slopes are dominated by Lithic and Rendzic Leptosols. Levels of pollution can be considered as background concentrations (geogenic concentrations + ubiquitous inputs) due to the absence of local pollution sources.
Transeuropean air masses coming mainly from NW are washed out by relatively high precipitation rates (1500-1800 mm/year). The long-term average annual temperature is 7.2° C. The coldest monthly temperature at 900 m a.s.l. is -1°C in January. The highest is 15.5°C in August. Monthly precipitation ranges from 75 mm to 182 mm in February and July, respectively. Snowfall occurs between October and May with an average duration of snow cover of about 4 months.

Figure 1: Precipitation collection on the Zoebelboden plateau ("Wildwiese") ©Martin Kralik

On this Zoebelboden-site in the National Park "Nördliche Kalkalpen" a geology, hydrology and hydrogeology research program is running since 1992. Hydrogeological and hydrochemical well studied springs are accessible in winter time. Studies with fluorescence tracers and isotopic studies (18O, 3H, 3H/3He) shows springs with very short (days) and others with very long (up to 20 years) transfer times.

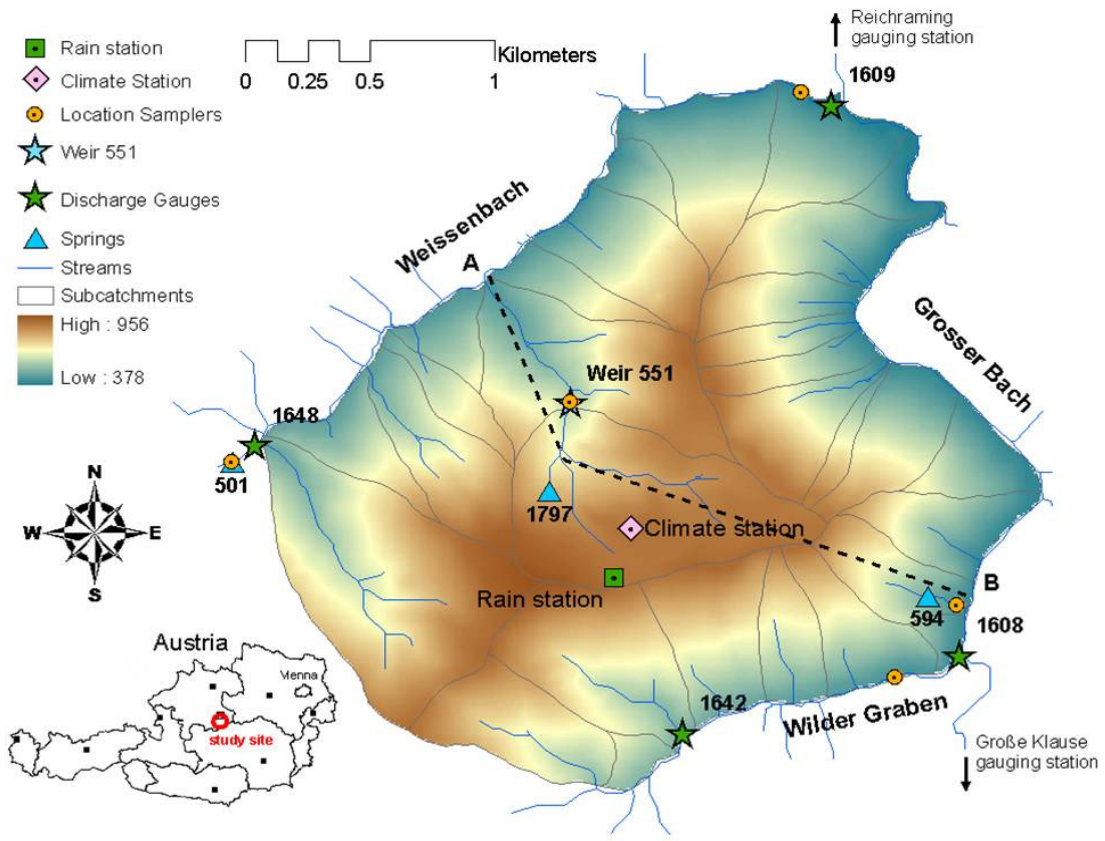

Figure 2: Map of the study site Zoebelboden (Reichraminger Hintergebirge, Austria); the dashed line indicates the cross section in Fig. 3 (HARTMANN et al. 2012)

These variable transfer times and the lack of anthropogenic impacts are an ideal site to assess hydrochemical and isotopic trends in the drinking water quality due to climate change or other reasons. Continuous data records are available of climatic data, of major ions, nitrogen, sulphur and heavy metals of precipitation, surface water outflow and springs.

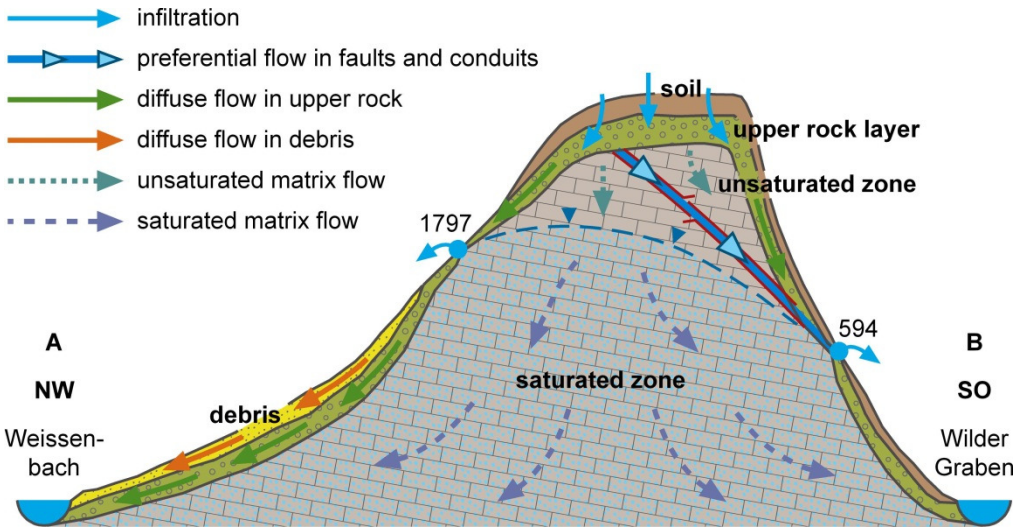

Figure 3: Schematic cross section of the study site from northwest to southeast intersecting the weir and springs 1797 and 594 (indicated in Fig. 2; HARTMANN et al. 2012).

Based on a perceptual model the model structure presented in Figure 4 was selected. It consists of a snow reservoir on top of an overflow reservoir, which is connected to three parallel linear reservoirs. In order to capture the fast preferential flow processes, a sub daily model time scale of 6 h was selected.
The results of a simultaneous calibration show that it is possible to identify system intrinsic parameters and to provide acceptable simulations at different five locations within the system. But sensitivity analysis revealed that some of them remain almost insensitive, which means that they are hardly identifiable. Consequently, transferring only the best parameters to the system scale results in rather moderate than good predictions. However, considering the parameter uncertainty the simulations' 95% confidence limits cover more than 90% of the observations.
Adding isotopic information results in decrease of discharge simulation performance and from and an increase for the δ18O simulations. Accordingly, the optimized intrinsic parameters shift towards values favoring better solute transport. Indeed, the isotopic information increases the sensitivity of some intrinsic parameters, but unfortunately this goes along with a sensitivity decrease for other parameters. Since no significant deterioration in the system scale simulations occurs when the isotopic data is added, at least the credibility in the model structure increases (Hartmann et al. 2010).

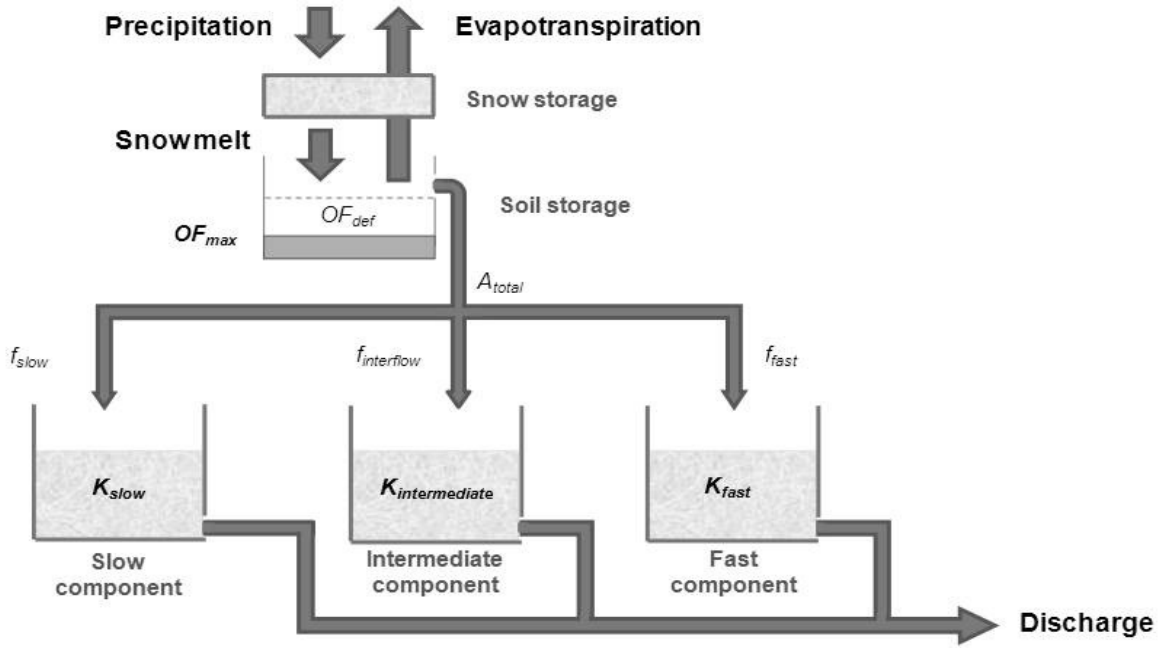

Figure 4 Hydrogeological model structure and its parameters of the Zoebelboden dolomite Karst system (HARTMANN et al. 2012).

Table 1. Umweltbundesamt-Environment Agency Austria, M. Kralik and F. Humer (http://www.umweltbundesamt.at/leistungen/netzwerke/oekosystem_monitoring/)

Kenndaten des LTER Standortes Zöbelboden		
Lage	Breite: 47° 50' 30" / Länge 14° 26' 30"	
Land, Bezirk	Oberösterreich, Steyr	
Größe	ca. 90 Hektar (900.000 m²)	
Temperatur	+ 6,7° C Jahresmittel	
Niederschlag	1.650 mm/Jahr im Durchschnitt	
Gestein	Hauptdolomit, z. T. geringmächtige Plattenkalkauflagen	
Vegetationszeit	ca. 190 Tage/Jahr	
Schutzstatus	Nationalpark Kalkalpen	
	Plateau mit dem Intensivplot 1	**Hänge mit dem Intensivplot 2**
Seehöhe	850-956 m ü.A.	550-850 m ü. A.
Boden	Braunlehme	Rendzina
Hangneigung	0-10 Grad	30-60 Grad, z. T. Felswände
Hangausrichtung	alle Richtungen	Ost-Nordost-Nord-Nordwest-West
potentielle Vegetation	Buchen-Tannen-Mischwald mit Schneerose	Buchen-(Tannen)-Mischwald, Föhre (Felsrippen), Ahorn (Schluchten)
aktuelle Vegetation	Vor allem Fichten	weitgehend natürlich (s. o.)

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