Characterization of the linkage between soil moisture dynamics and discharge at a karst region in Southwest Germany (preliminary results)

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Motivation

- The most typical approach to characterize a karst system: the disintegration of its output signal measured at the karst spring which includes discharge observations, the hydrochemical signal or tracer information.
- In this ongoing study, elaboration on the value of soil moisture observations to characterize the karstic groundwater recharge dynamics.
- Storage-discharge relationship in catchment can be hysteretic and can reveal different hydrological processes.
- Hysteresis analysis can help developing more realistic models for karst systems.

Study area, Experimental setup & Data

- **Location**: Swabian Alb - Baden-Württemberg - Southwest Germany
- **Geology**: Upper Jurassic carbonate rocks - Karstified
- **Soil**: Rendzina soil
- **Data**: Soil moisture data: 50 soil moisture profiles measurement in grassland, 49 soil moisture profiles measurement in woodland. Soil moisture probe at 10 and 20 cm depth. Measurements from 2009 to 2017 - 1 h resolution
- **Discharge data**: Grosser Lauf river - 1 h resolution
- **Rainfall data**: 1 h resolution

Hypotheses & approach

1. The discharge does not react immediately to the rainfall event - the soil moisture increases
2. The discharge increases while the soil saturation is reached
3. The soil moisture decreases but the discharge continue to increases because of infiltration
4. The discharge decreases

First qualitative analysis:
- Selection of 1 profile in the grassland, 1 profile in the woodland equipped with soil moisture probes at 10 cm and 20 cm depth
- Selection of 1 soil moisture - discharge event during summer (dry conditions) and 1 soil moisture - discharge event during winter (wet conditions)

Selected events

- Woodyland soil moisture -10cm
- Woodyland soil moisture -30cm
- Grassland soil moisture -10cm
- Grassland soil moisture -20cm

Winter event - duration ~ 13 days
Summer event - duration ~ 6 days

Clockwise reaction observed: it seems that the soil storage has first to be refilled before the water is infiltrated to the saturated zone.

The woodland soil moisture increases faster than in the grassland: it can be interpreted as the presence of preferential flow

Conclusions

- Hysteresis reaction observed, with only the clockwise direction in this study
- New possibility to identify karst hydrological processes in a qualitative way
- Different behaviors observed between land uses and antecedent hydrological conditions

Perspectives

This approach has been conducted on 2 profiles and 2 events. It will be applied to a larger number of profiles and events in a systematic way. Other measurements and analyses will be included to improve processes characterization. For instance, independent estimates of evapotranspiration will help to separate unsaturated percolation in the soil from the reduction of soil moisture due to vaporization.

Acknowledgments

This research work was funded by the Emmy Noether-Program of the German Research Foundation (DFG; grant number WA 83/1-3); project Global Assessment of Water Stress in Harz Regions in a Changing World). Soil moisture and climate data was provided by the Biodiversity Exploratory research project (DFG Priority Programme 1376 - Co2- Project Instrumentation. Streamflow data were provided by the Environment Agency of the German state of Baden-Württemberg (LUBW).