Multiscale hydrogeological and hydrogeophysical approach to monitor vadose zone hydrodynamics of a karst system

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GOALS & CHALLENGES
- Karst provides drinking water to 25% of the world population
- Management of karst water resources is crucial in a changing world
- The complex structural heterogeneities and non-linear dynamic are challenging

This multidisciplinary and multiscale study aims at understanding groundwater recharge and storage in karst aquifers

LOCAL SCALE

Caves around Rochefort

- Monitoring & tracing highlight two compartments with different behaviors separated by an impermeable layer (shales). Compartment 1 is flooded when the Lomme river reaches 15 m³/sec and overflows the Pré au Tonneau.
- Compartments 1+2 are flooded when the Lomme river reaches 20-25 m³/sec and overflows the Nou Maulin cave.
- A major fault zone in the Thier des Falizes area enables hydrogeological connection.

Gravimetric Monitoring
- Gravimetric measurements integrate all the Lorette Cave area. Bouguer anomaly links gravity changes to karst water content: \( \Delta g = 2 \times 10^{-3} \text{G.H} \) with G., gravitational constant; p, density of water and H, variation of water level.

Seasonal variations:
- No correlation with saturated zones levels except for flash flood events
- Variation related to water content changes in the vadose zone
- Anti-correlation with gravity monitored in the cave means that most of changes occur above the cave

Flash flood variations:
- Gravimeter is only sensible to floods that occur simultaneously in both compartments 1 and 2:
  - Floods in compartment 1 are much smaller
  - Average porosity of compartment 1 has to be smaller
  - Increase in gravity is lower than what water level sensors suggest: floods overestimated by direct measurements

REGIONAL SCALE

- Identification of 2 underground branches: the underground Wamme and the underground Lomme river that meet in the Thier des Falizes faulted zone
- Surface and groundwater monitoring precise the seasonal and floods dynamics

Saturated Zone Dynamics

- Monitoring & tracing provides valuable data to precise the local dynamic of the epikarst and aquifer recharge
- Combining geophysics (gravimetry & ERT) is applicable to validate and interpret hydrogeological data
- Drip counter & vadose dye tracing provide valuable data to precise the local dynamic of the epikarst and aquifer recharge

CONCLUSIONS

• Hydrogeological monitoring & dye tracing are essential to understand the karst system dynamic at a regional scale.
• Combining geophysics (gravimetry & ERT) is applicable to validate and interpret hydrogeological data.
• Drip counter & vadose dye tracing provide valuable data to precise the local dynamic of the epikarst and aquifer recharge