

## **KARSYS, KarstALEA and KarstMOD: applied and innovative methods for the management of karst environment**

**Date:** 23<sup>rd</sup>- 24<sup>th</sup> September 2017

**Schedules:** 9:00 – 17:00

**Minimum and maximum number of participants:** 10/20

**Price:** 250 EUR/ students 150 EUR (includes lunches and refreshments during breaks)

**Instructors:** Prof. Nico Goldscheider (Inst. Tech. of Karlsruhe), N. Doerfliger (BRGM, Orléans), Dr. Pierre-Yves Jeannin (ISSKA, CH), Dr. Arnaud Malard (ISSKA, CH).

***All attendees should bring their own laptop computer***

This 2-days workshop is dedicated to the learning of the KARSYS approach. KARSYS is developed for hydrogeologists working in karst regions, in order to address hydrogeological questions in a very pragmatic and concrete way. KARSYS makes it possible to build an explicit conceptual model (3D image) of the karst aquifers and of the associated flow systems. The approach is based on a 3D model of the carbonate aquifer synthesizing all standard geological and hydrological data, and coupled to a series of simple fundamental hydraulic principles. This provides, within a limited effort, a consistent hydrogeological conceptual model of karst flow systems within any investigation area. The course is designed for hydrogeologists with basic knowledge on karst, hydrogeology and 3D modelling. Any professional interested in groundwater management, engineering, renewable energies in karst environments will gain a good understanding of karst hydrogeology and a pragmatic way to assess karst hydrogeological systems. Participants will apply KARSYS by themselves on a case study. For that, they will be initiated to the functioning of the Visual KARSYS tool, which is still under development, but already support users to apply KARSYS.

The course will be extended further with an introduction to KarstALEA method, which has been developed for predicting the position and characteristics of karst occurrences within a massif. KarstALEA was initially designed for tunneling, but can be applied to any kind of underground construction in karst areas. At last, an outlook to KarstMOD (flows simulation procedures based on KARSYS) will be presented.

KarstALEA and KarstMOD are both extensions of the KARSYS approach, providing de facto a consistent and continuous workflow in karst hydrogeology.

**Key-words:** Karst hydrogeology, Conceptual model, 3D, Water management, KARSYS, KarstALEA, Visual KARSYS, KarstMOD

### **Workshop agenda**

*Day 1 Saturday morning (09:00 – 13:00)*

*15 minutes break*

#### **Reminders on karst and hydrological processes in karst aquifers**

- a. General introduction (P.-Y. Jeannin)
- b. Issues in karst water management (N. Doerfliger)
- c. Overview of applied methods in karst (N. Goldscheider)....

#### **APPLICATION & INFORMATION**

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**44<sup>th</sup> ANNUAL CONGRESS OF THE INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS**  
Dubrovnik, Croatia, 25<sup>th</sup>-29<sup>th</sup> September 2017

**Introduction to the KARSYS approach (A. Malard & P.-Y. Jeannin)**

- a. Basics and application principles

Lunch break (13:00 – 14:00)

*Day 1 Saturday afternoon (14:00 – 17:00)*

*15 minutes break*

- b. Practical application of KARSYS on a case study
- c. Catchment delineation and KARSYS outputs

*Day 2 Sunday morning (09:00 – 13:00)*

*15 minutes break*

**Introduction to Visual KARSYS, a web-tool dedicated to the application of KARSYS (A. Malard & P.-Y. Jeannin)**

- a. Presentation of the platform
- b. Online demonstration
- c. Exercise: guided application of KARSYS on a case study

Lunch break (13:00 – 14:00)

*Day 2 Sunday afternoon (14:00 – 17:00)*

*15 minutes break*

**Introduction to KarstALEA (A. Malard & P.-Y. Jeannin)**

- a. Principles of the method
- b. Applicability
- c. Presentation of a case study from KARSYS to KarstALEA
- d. Other possible applications (natural hazards, geothermics, etc.)

**Further extensions to KARSYS (A. Malard & P.-Y. Jeannin)**

- a. The generation of karst conduit networks
- b. KarstMOD (flow simulation)

**Conclusion and outlooks** on other development (hydrogeological mapping, vulnerability, climate change)

**About Instructors:**

**Pierre-Yves Jeannin**, Ph.D., is hydrogeologist, Director of the Swiss Institute for Speleology and Karst-Studies (SISKA) and Invited lecturer and researcher at Centre d'hydrogéologie (Univ. Neuchâtel). He is a researcher on karst hydrogeology since 1988 and closely supervised several PhD-theses related to the understanding and modelling of flow and mass transport in solution in karst systems. He also took part to the development of methods for the evaluation of the vulnerability of karst groundwater (EPIK and VULK). Pierre-Yves supervised several research projects on the infiltration of water in karst regions, showing the very important role of the soils and the epikarst (weathered zone at the top of limestone) for absorption, temporary storage and the self-purification of water. In 2009, he successfully submitted the Swisskarst project to the Swiss National Science Foundation on the sustainable management of water (PNR61). The KARSYS approach developed in this project induces a high degree of interest among the water community because it provides an explicit 3D conceptual model of karst hydrogeological systems.

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**Arnauld Malard** is scientific collaborator at SSKA since 2011 and specialist for 3D modelling and flow simulation. He works as hydrogeologist for ten years in different public offices and private companies in France and overseas department. He is member of the French geological society and responsible for several publications in karst and volcanic aquifers. Arnauld Malard was the main actor for the development of KARSYS in the frame of the Swisskarst project (2011-2013). He is now developing extensions for KARSYS, mainly regarding hydrogeological mapping principles and flow simulation modules.

**Prof. Nico Goldscheider** is a professor of hydrogeology at the Karlsruhe Institute of Technology (Germany). His research is focused on karst hydrogeology, alpine hydrogeology and groundwater quality issues. He is chairman of the IAH Karst-Commission and author of various papers and books, mainly dedicated to karst hydrogeology. His book on “Methods in Karst Hydrogeology”, as well as his leading participation to the “World Karst Aquifer Mapping (WOKAM)” project make him the right person to introduce to the proposed short course and to present an overview of existing investigation methods in karst.

**BRGM (Nathalie Doerfliger)** is active in a broad range of disciplines related to resources management. The brgm is the French geological survey organization and France’s public reference institution in Earth Science application for the management of surface and subsurface resources and risks. Its activities are geared to scientific research, support to public policy development and international cooperation. As karst aquifers are widely developed in France, brgm carries out scientific research activities as well as methodological activities in the field of public policy development, setting namely methodology guidelines to study, characterize, manage and protect this type of aquifer. The speaker, Nathalie Dörfliger, specialist in Karst hydrogeology, head of the Water, Environment & Ecotechnology Division at the brgm, will be in charge of giving an outlook of practical issues in karst aquifers, for which KARSYS can be useful. She has carried out several projects concerning karst aquifers in France, from Jura to South France during the last 20 years, co-supervised PhD Thesis and sit on several jury committees of PhD thesis concerning karst aquifers. She also contributed to set up guidelines addressed to stakeholders, engineers companies concerning karst hydrogeology, karst vulnerability mapping in the framework of capture work protection zones.

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