UNDER THE AUSPICE OF

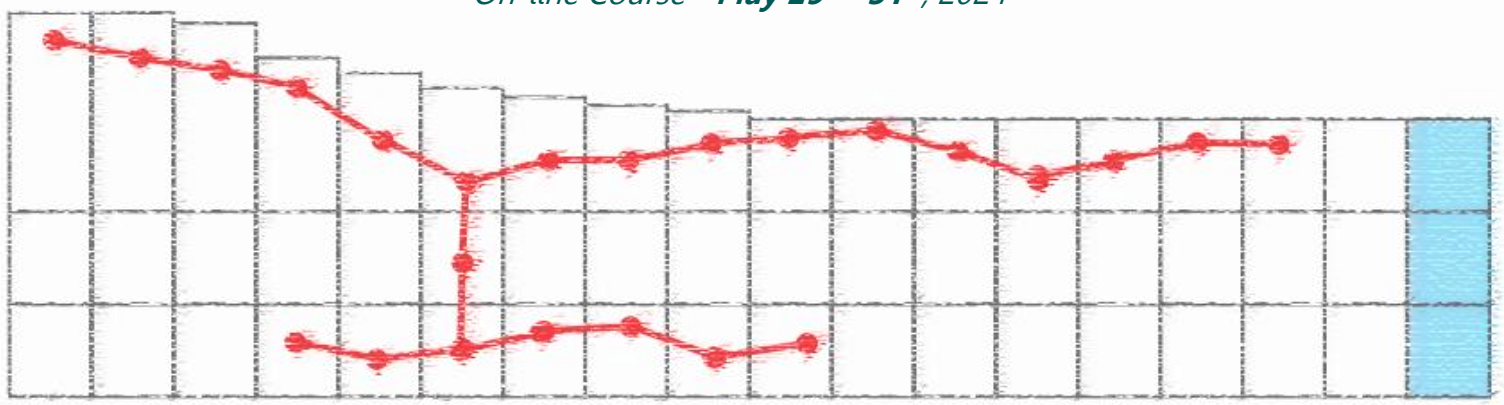
Italian Chapter

School of hydrogeological modelling & Project-related strategies

Ente di Formazione Accreditato

MODFLOW-2005
Conduit Flow Process (CFP)

*On-line Course - **May 29th - 31st**, 2024*



Karst aquifers contribute to a major portion of the groundwater supplies in many parts of the world. Karst aquifers are often characterized by highly permeable solution conduits and a low permeable matrix. Because of the permeability contrast between the conduits and matrix, groundwater flow is often channeled into the conduits, leading to increased flow velocities and much shorter travel times compared to typical porous aquifers. The development and application of mathematical models for karst aquifers face great challenges but are an integral part of sustainable management of groundwater resources.

Main learning objectives

- Understanding concepts of distributed numerical models for karst systems.
- Understanding and applying the coupling approach of MODFLOW-CFP (Darcy-Weisbach with laminar and turbulent flow together with a MODFLOW continuum).
- Application of CFP for idealized karst systems and understanding the settings and parameters.
- Analyzing the results of CFP simulations.

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Programme

DAY 1

May 29 (9-10 am) Lecture 1 – Model concepts and MODFLOW-CFP

- The conceptual model for karst
- Approaches for distributed modeling of karst (single continuum, double continuum, discrete-continuum)
- Overview of typical model applications for distributed numerical models in karst (examples with questions and purpose for model application)
- History and main functionality of MODFLOW-CFP

May 29 (10.15-11.15 am) Workshop 1

- Setting up an idealized model (rectangular shape, recharge boundary, defined head as outlet); basic setup with MODELMUSE;
- running the model with different approaches (Darcy-continuum, smeared conduit approach, discrete-continuum) in steady-state and transient conditions;
- analyzing and discussing the results (head distribution in matrix and conduits, flow velocity).

May 29 (11.30 am-12.30 am) Lecture 2

- Flow equations in MODFLOW-CFP (Darcy-Weisbach with Hagen-Poiseuille for laminar conditions and Colebrook-White for turbulent conditions);
- Coupling mechanism between conduits and matrix and iterative solution of the discrete-continuum model;
- Discussion of specific input parameters for CFP (e.g., roughness height, critical Reynolds numbers, water transfer coefficient)
- Introduction and overview about approaches to generate conduit network structures (Conduit Network Input File Generator CONGEN as stand alone tool, also with a recent Python implementation; MODELMUSE & Groundwater Vistas)

May 29 (12.45 am-2.00 pm) Workshop 2

- Setup of an idealized discrete-continuum model (size and parameters according to a typical karst system);
- Model design with MODELMUSE and text editor (transient and steady-state), implementation of a storm event;
- Model analysis (results, parameter sensitivity).

DAY 2

May 31 (2-2.45 pm) Lecture 3

- Advanced features in CFPv2 (Conduit Associated Drainable Storage - CADS, various boundary conditions like pumping wells, switch boundary conditions);
- Consideration of partially filled pipes;
- Discussion of assumptions and limitations of CFPv2
- Application example of CFPv2
- Examples of further use of CFPv2 (mining, horizontal wells)

May 31 (3.00-3.45 pm) Workshop 3

- Extending the model from Workshop 2 by CADS and advanced boundary conditions (water infiltration, pumping well);
- Analysis of the extended model (results like discharge and heads, parameter sensitivity).

May 31 (4.00-5.00 pm) Lecture 4

- Primer and outlook of CFPy (Scripting CFP with Python; in combination with FloPy and other open-source tools like stochastic karst conduit network generators).
- Primer and outlook to transport computation (heat and solutes) with a view towards applications like tracer test evaluation

May 31 (5.15-6.00 pm) Workshop 4

- Extending the model from Workshop 2 by solute- and heat transport (tracer test).
- Model analysis (results like temperature and solute concentrations, parameter sensitivity)

There will be a 2 hour follow-up session at the 2024 Eurokast conference in Rome, taking place on June 10th 2024. The follow-up session will introduce the most recent developments regarding solute- and heat transport implementation, coupling to Python through CFPy and use of advanced methods like stochastic network generation with pyKasso.

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Trainers

Thomas Reimann is a researcher and lecturer at the Institute for Groundwater Management at TU Dresden, Germany. With more than 20 years of experience, Thomas' work focuses on groundwater engineering, often combined with distributed numerical models in different environments, e.g., karst systems or open-pit mining for soft coal. He received a diploma in water management with a focus on groundwater engineering from TU Dresden in 2003. In 2012, he was promoted to Dr.-Ing. (Ph.D.) in groundwater management for research in karst systems by TU Dresden. Thomas is a specialist in applying and adapting distributed numerical models for use in research and industry. He enhanced the distributed numerical discrete-continuum model MODFLOW Conduit Flow Process (CFP) by various boundary conditions, flow- and transport processes as CFPv2. Current research projects comprise Karst system characterization with inverse groundwater modeling, groundwater management in open-pit mining environments, and Managed Aquifer Recharge. Besides research, he has been actively teaching groundwater management and groundwater modeling since 2003 at TU Dresden and as a guest lecturer for Hydrogeology since 2017 at the University of Gothenburg (Sweden). The ongoing teaching activities use various innovative digital methods to improve the learning process, which was honored by the TU Dresden Teaching Award in 2017. Innovative and digital learning and teaching materials are currently enhanced and transferred to various European partners by the EU cooperation project iNUX.

Steffen Birk holds a Ph.D. from the University of Tübingen, Germany, and is a Full Professor of Hydrogeology at the University Graz, Austria, where he teaches hydrogeology within the Bachelor's and Master's programs in Geosciences. His research focuses on developing and applying quantitative approaches for the simulation and analysis of groundwater systems. He has been particularly interested in the characterization of karst aquifers and the simulation of flow and reactive transport processes in these settings. For this purpose, he has developed and employed various research codes and cooperated with the USGS in the release of the Conduit Flow Process (CFP) for MODFLOW. He has authored around 60 peer-reviewed papers addressing various topics such as karst hydrogeology and modeling, impacts of climate change on water resources, evapotranspiration, and groundwater recharge. He is a member of the International Association of Hydrogeologists, of the hydrogeological associations of Germany and Austria, and an Associate Editor of the journal Groundwater since 2004.

What is included

- Access to live lessons
- Software and installation instructions provided 1 month before the course
- Material to carry out the exercises
- Access to our e-learning platform to watch again the recorded lessons until December 31st, 2024
- Follow-up session during Eurokarst
- *APC credits* for Italian Geologists

Costs

SYMPLE is an Accredited Training Organization, VAT is not due (art. 10 DPR 633/72).

- Regular: 350 €
- IAH/SGI: 300 €
- Students/Eurokarst*: 150 €

  **Eurokarst participants can benefit of the student fee*
- Included for the attendees of the 3rd ed. of the SYMPLE School

Registration form

Register preferably before May 17th, 2024