sYmple

School of hydrogeological modelling & Project-related strategies

3rd edition

Info & Programme

2024 Edition: January 12 – December 31

On-line (live and recorded lessons)

Seats are limited to 30 participants & 30 scholarship places

Professional credits (50 APC) for Italian Geologists

(schedules are subject to changes)

Rev.0

26/04/2023

Ente di Formazione Consiglio Nazionale Geologi Accreditato

The initiative is under the auspice of the

International Association of Hydrogeologists – Italian Chapter

iah aih Italian Chapter

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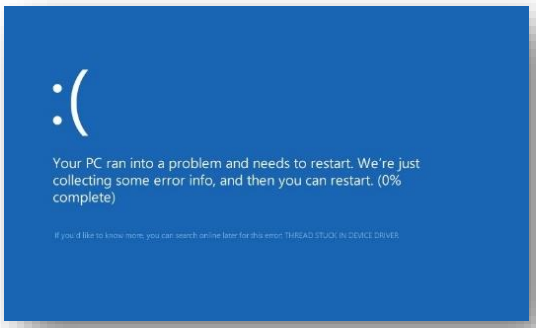
Contents

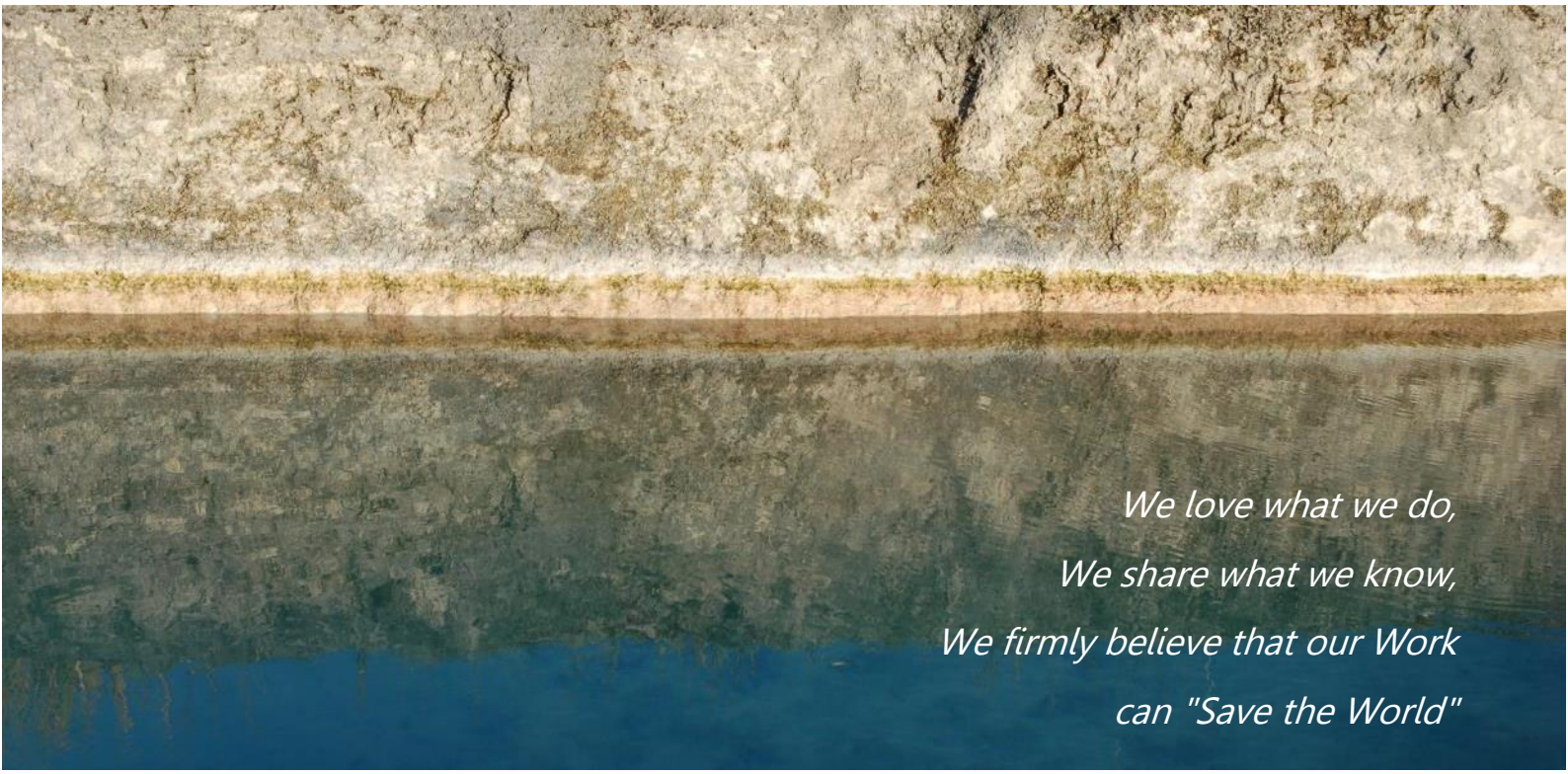
FOREWORDS

SYMPLE is a school about numerical modelling that starts from zero. The only pre-requisite is the will to learn and a technical-scientific background. The co-requisites are those needed to be a numerical modeller: patience, investigative approach and ICT propension.

If it happens to you to get nervous when your computer crashes… **you are NOT eligible to attend!!**



School Outlook



OUR MISSION

SYMPLE is an Innovative Start-up that intends to **promote and facilitate the understanding, use and evaluation of hydrogeological numerical models through a multidisciplinary program associated with the use of strategies aimed at solving specific problems**.

SYMPLE intends to teach an emerging paradigm, supported by latest available ideas and software for data assimilation, of "*starting from the problem and working backwards*". This workflow consists of firstly identifying the data that has the greatest capacity to reduce the uncertainties associated with decision-critical predictions, and then designing a numerical simulation strategy that serves the decision-support imperative of actually quantifying and reducing those uncertainties.

Development of better strategies to address pressing problems requires the same data and software mostly already available (PEST and PEST++ suites), but a new mindset. And in many cases the modelling will be quicker and less expensive because it is:

- management targeted;
- no more complex than it needs to be to serve the decision-support demands;
- supported by project-related strategies with associated specific software.

That is, modelling will be complex enough to assimilate data and reduce uncertainty, but strategically simple because it is decision-focused.

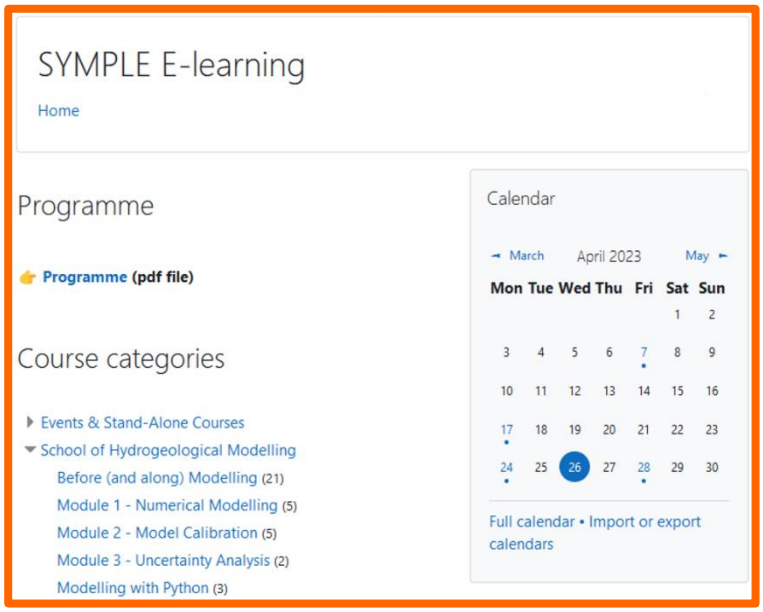
School Outlook

SYMPLE proposes a comprehensive, applied, internet-based School of Hydrogeological Modelling. Through undertaking the courses, participants will acquire practical knowledge of effective model deployment in different decision-making contexts.

Differently from other schools, the attempt of SYMPLE is not only to "teach", but to transfer as much experience as possible to the participants. We would like to make you an "expert hydrogeological modeller". For this reason, we selected all the tools a modeller needs, explained in a modelling-targeted way, and applied to real-world cases, much more difficult to "solve" than step-by-step exercises where everything works fine.

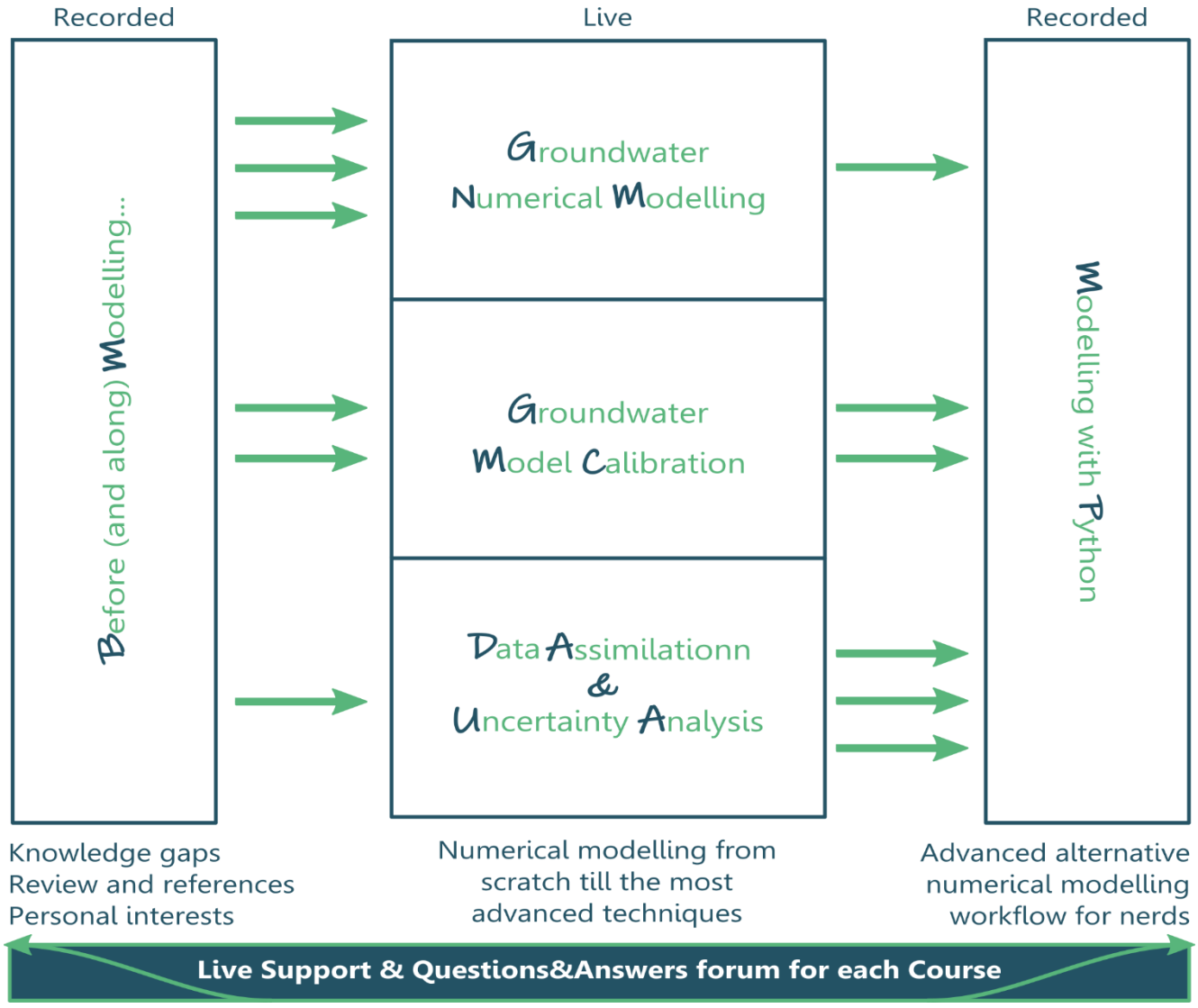
Trainers consider the school attendees not as "students", but as "colleagues" to work and solve problems with. It is always possible to directly interact with the trainers in the dedicated Q&A fora and/or asking for individual discussions. We absolutely encourage interaction, being a fundamental component of knowledge sharing.

All the lessons are organized in the SYMPLE e-learning platform, based on the open-source Moodle environment.



School Contents

The programme is organized into a *Before Modelling* section, 3 *Modelling Modules*, plus a stand-alone *Python Module* that covers the whole modelling process. The interconnections among the three parts are visualized in the scheme below.



Recorded courses and webinars are provided in a dedicated section to address knowledge gaps and/or to refresh the most important concepts. Live lessons are mostly held by Francesca Lotti and John Doherty, with the participation of other trainers according to the subject. All live lessons are held in English, recorded and then uploaded on the e-learning platform. Q&A fora and support are available for all courses, no matter if live or recorded.

Most of the exercises makes use of public domain software, such as QGIS and ModelMuse. Anyway the commercial MODFLOW GUI Groundwater Vistas is also applied, since it is the one which better supports PEST(++) at present. Participants can purchase the licences with 20% discount, as agreed with the software developers.

Before Modelling...

The first part of the School is a kind of "modeller's toolbox" that, in association with textbooks and papers, can provide some of the basics needed before engaging in numerical modelling. Even if extremely rich, the contents are not exhaustive – other specific topics can be added on request. All the courses are recorded and immediately available on the platform. The importance of getting back to the pillars of geology, hydrogeology and maths is surely clear, but it will be even clearer during the practical modelling exercises. Even if placed "before modelling", this section is thought to be a companion along the whole School. Attendance of the courses is up to the individual, according to his/her own interests and personal background.

Recorded Courses, Webinars and Insights		Hours	Trainer	Lang.
Basics	Environmental Economics and EU Regulation	3:00	*Leggio, Sapiano*	*IT/ENG*
	Linear algebra	2:30	*De Filippis*	*IT/ENG*
	Hydrogeochemistry	5:30	*Barbagli*	*IT/ENG*
	Geophysics	3:30	*Menghini*	*IT*
	Structural Geology	2:00	*Guastaldi*	*IT/ENG*
Data analysis	Statistics and Geostatistics	16:00	*Guastaldi*	*IT/ENG*
	GIS	6:00	*De Filippis*	*IT/ENG*
	Relational databases	6:00	*Barbagli*	*IT/ENG*
	Time series analysis and examples of statistical application	3:00	*Borsi, Meggiorin*	*ENG*
Hydrogeology	Introduction to Hydrogeology	2:30	*Dragoni, Ducci*	*ENG/IT*
	Solute transport	3:00	*Borsi*	*IT/ENG*
	Types of Aquifers, Springs and Rivers	11:00	*Petitta, Bonomi, Piscopo*	*IT*
	Properties of soil. Geotechnical Investigations	3:30	*Di Matteo*	*IT*
	Hydrogeological investigations and Isotopes	2:30	*Mastrorillo, Petitta*	*IT*
	Wells construction and Aquifer tests	4:30	*Piscopo*	*IT*
Contamination	Regulatory context in Italy	3:00	*Di Gennaro*	*IT*
	Contaminants origin and properties (fate and transport). Sustainable aquifer and groundwater remediation	5:30	*Petrangeli Papini*	*IT*
	Groundwater Monitoring	3:30	*Preziosi*	*IT/ENG*
Coastal hydrogeology **Detailed Programme**	Coastal groundwater systems Groundwater flow in coastal aquifers Groundwater exploration in coastal regions Hydrochemistry, Modelling and Management issues	6:00	*Post*	*ENG*
Engineering	Groundwater control for construction	1:00	*Preene*	*ENG*
	Roads, Tunnels and Dams	2:30	*Francani*	*IT*
Groundwater resources management	Groundwater use in river basin management	1:00	*Rossetto*	*ENG*
	Rural water management	1:00	*Rossetto*	*ENG*
	Measures for adapting to climate change: MAR	4:00	*Rossetto*	*ENG*
	Potable water supply	1:30	*Vettorello*	*ENG*
	Italian regulation on mineral waters production. The case of a mineralized aquifer	2:00	*Viaroli*	*IT*
	Low-enthalpy geothermal plants (open loop)	1:30	*Vettorello*	*ENG*
	Socio-Hydrogeology	3:00	*Re*	*ENG*

Module 1
Groundwater Numerical Modelling

The first module deals with data processing, geostatistics and the basics of numerical modelling with MODFLOW starting from scratch. It is intended to provide the necessary "bricks" needed to approach hydrogeological problems. It includes a review of hydrogeology and ICT basics, fundamental components of any modelling process. A specific session is devoted to the extraction of information from with the maximum efficiency. The module ends up with a first introduction to model calibration and introduces the two software suites of PEST and PEST++.

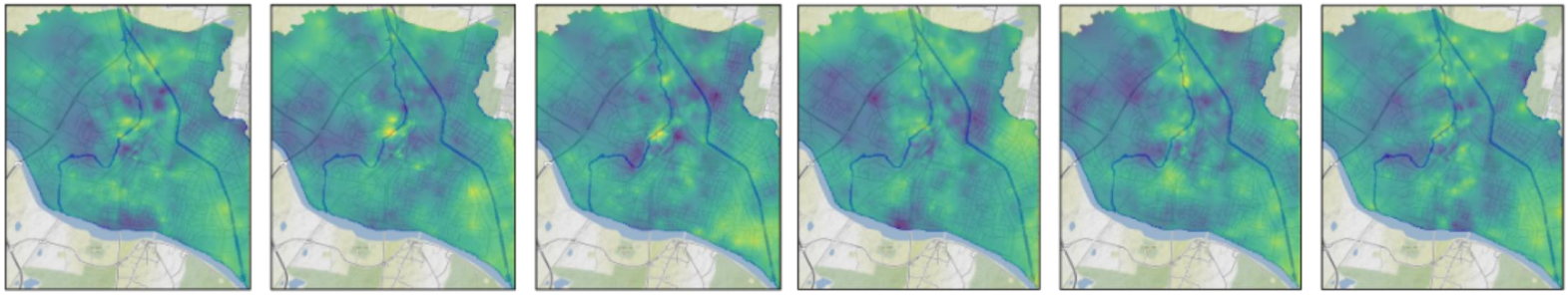
Session	Contents	CET	Days
M1-A Review of key topics *F. Lotti*	Fundamental concepts of groundwater flow: flow equations, aquifer properties, water balance (I), transport equations. ICT basics and tips. Execution of general tasks (exercise to check the proper settings of computers).	3-6pm 3-6pm 3-6pm	2024-01-12 2024-01-19 2024-01-26
M1-B Data processing *F. Lotti*	Introduction to applied statistics and geostatistics. Analysis and processing of hydrogeological datasets, semivariogram modelling, field data regionalization, uncertainty of spatial distributions. Interpretation of pumping tests. Water balance (II).	3-6pm 3-6pm 3-6pm 3-6pm	2024-02-02 2024-02-09 2024-02-16 2024-02-23
M1-C Numerical Modelling Introduction *T. Bonomi* *G. Bernagozzi* *R. Hunt* *F. Lotti*	From the conceptual model to the numerical model (in Italian). From analytical to numerical solutions (in Italian). Getting started in applied groundwater flow modelling. Numerical methods in groundwater: solution of flow equation through finite differences and finite elements, numerical methods, grid and mesh construction, boundary conditions, model assumptions.	*2 hrs* *5 hrs* *1 hr* 3-6pm 3-6pm	*Recorded* *Recorded* *Recorded* 2024-03-01 2024-03-08
M1-D Advanced Flow Modelling with GW Vistas *D. Feinstein*	MODFLOW history Introduction to GW Vistas MODFLOW-NWT Multi-Node Well (MNW) package Exchanges between surface water and groundwater MODPATH-5 and MODPATH-7 MODFLOW-6: new strategies		2024-03-15 2024-03-22 2024-03-29
M1-E MODFLOW Conduit Flow Process (CFP) *T. Reimann* *S. Birk*	The conceptual and numerical model for karst Theory and application of MODFLOW-CFP, set up with ModelMuse and text editor Advanced features in CFPv2 Primer and outlook of CFPy (Scripting CFP with Python) Primer and outlook to transport computation	10am-1pm 2-6pm	2024-04-05 2024-04-05
M1-F Transport Modelling with GW Vistas *D. Feinstein*	Contaminant transport with MT3DMS and MT3D-USGS SEAWAT: introduction to modelling of saltwater intrusion SEAWAT2005: Heat transport		2024-04-12 2024-04-19

Module 2
Groundwater Model Calibration

The focus of the second module is advanced model building and calibration. The MODFLOW GUIs used in the exercises are Groundwater Vistas and ModelMuse, free interface from the USGS, in association with PEST(++). The GW Vistas course is held by Daniel Feinstein who provides important insights about MODFLOW, as well as many other related codes, explaining in detail the nuances and settings of several packages. The theory behind history matching ("calibration") is introduced by John Doherty, the author of PEST. The ModelMuse and GW Vistas courses will start from a real-world problem to be discussed, conceptualized and developed through the numerical model process.

Session	Contents	CET	Day
M2-A Introduction to history matching *J. Doherty* *F. Lotti* *G. Formentin*	An overview of decision-support modelling and its relationship to the scientific method The null space and nonuniqueness History-matching: Calibration The role of data assimilation software such as PEST and PEST++ *Exercise - Model building in ModelMuse*	10am-1pm 2-6pm	2024-05-10 2024-05-10
M2-B Manual regularization *J. Doherty* *F. Lotti* *G. Formentin*	Traditional parameter estimation: the quest for uniqueness Manual regularization: theory and practice Problems with manual regularisation *Exercise - Traditional parameter estimation and critical evaluation of results*	10am-1pm 2-6pm 10am-1pm 2-6pm	2024-05-15 2024-05-15 2024-05-17 2024-05-17
M2-C Highly parametrized approach *J. Doherty* *F. Lotti* *G. Formentin*	Highly parametrized approach: the need for many parameters Subspace regularization – singular value decomposition Tikhonov regularization Pilot points as a spatial parameterization device *Exercise - Pilot point calibration of parameters and critical evaluation of results*	10am-1pm 2-6pm 10am-1pm 2-6pm	2024-05-20 2024-05-20 2024-05-22 2024-05-22

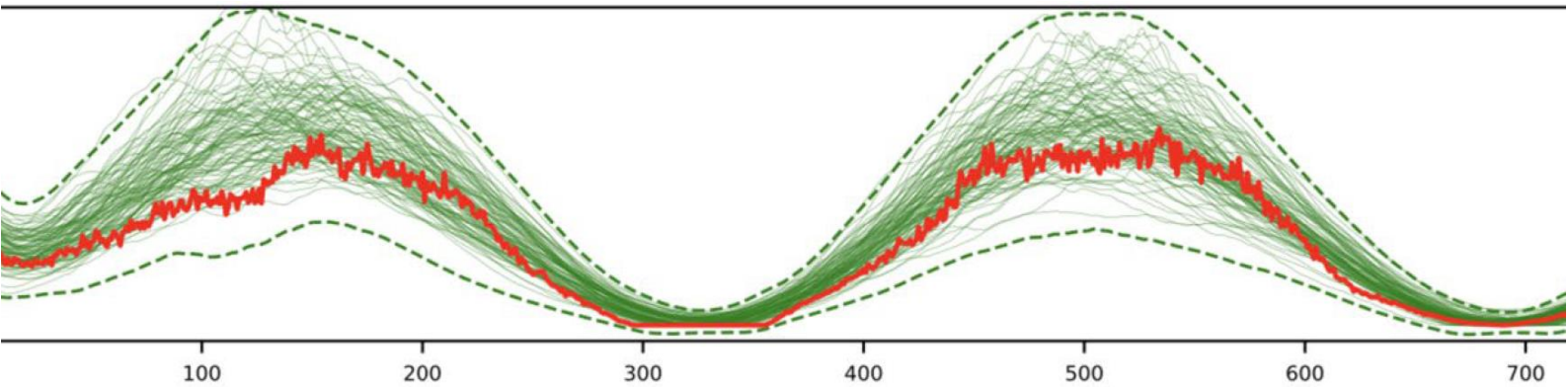
Module 3
Data Assimilationn & Uncertainty Analysis



The module is fully dedicated to model calibration and uncertainty analysis through the use of the PEST suite, explained by the author of the code, John Doherty. A wide set of exercises helps the understanding of sometimes complex concepts, making use of both GUIs and command line input. A real-world case is analysed to demonstrate data assimilation, uncertainty analysis and its application to decision-support modelling.

Session	Contents	CET	Day
M3-A Uncertainty Analysis *J. Doherty*	Bayes equation Short discussion on geostatistics Linear uncertainty analysis • Parameter contributions to predictive uncertainty • Optimisation of data acquisition • Other uses of linear analysis Pertinent PEST Utilities Principles of nonlinear uncertainty analysis Rejection sampling Null space Monte Carlo Ensemble methods (PESTPP-IES) Data space inversion *Exercises from the command line*	10am-1pm 10am-1pm 10am-1pm	2024-05-27 2024-05-29 2024-06-03
Practicalities and examples	The effect of model defects Formulation of an appropriate objective function Direct predictive hypothesis testing When to be simple and when to be complex When to calibrate and when not to calibrate Examples Getting the most out of PEST and PEST++	10am-1pm 10am-1pm	2024-06-05 2024-06-12
M3-B Exercises *F. Lotti* *G. Formentin*	*Exercises about the application of Uncertainty Analysis to real case studies (ModelMuse/GW Vistas + command line)* Assignment of a real project to develop and deliver.	10-1pm 2-6pm 2-6pm	2024-06-21 2024-06-21 2024-06-28

Modelling with Python



An advanced stand-alone section is dedicated to the state-of-the-art Python scripting with FloPy and PyEMU explained by a team of experts among which the developers Jeremy White (INTERA) and Mike Fienen (USGS). The section covers the whole process from data processing and model building to calibration and uncertainty analysis applied to a real contaminated site. Codes involved are MODFLOW, MODPATH, PEST and PEST++ suites. Students are provided with a GitHub repository with necessary data files and executables. These also include a template Jupyter Notebook with instructions to follow along with the videos. Completed notebooks are also provided with the results.

Session	Contents	Hours	Day
Language basics *I. Borsi*	Intro on Python as programming language Fundamentals and advanced features Analysis of a pumping test and of evapotranspiration Using Python/Pandas to manage hydrological timeseries	4:30	*Recorded*
Model building with FloPy *R. Hugman*	Before getting started A first simple steady state and transient model Flow and transport model building and predictive use	5:30	*Recorded*
Advanced model building and PESTPP-IES application *M. Fienen* *J. White*	Overview of the *modflow-setup* tool Pre-processing of data and building the model from YML notebook Introduction pf PEST++ and PyEMU Set up and run of PESTPP-IES	4:00	*Recorded*

Trainers

The Teaching Staff includes about 40 prestigious experts from Universities, Companies, Professional Orders, Public Agencies from different countries.

	Alessio Barbagli *GEOexplorer S.r.l.*	**Gabriele Bernagozzi** *Geologist*	**Steffen Birk** *University of Graz, Austria*	**Tullia Bonomi** *University Milano Bicocca*
	Iacopo Borsi *TEA Sistemi SPA*	**Giovanna De Filippis** *AECOM URS Italia S.p.A.*	**Antonio Di Gennaro** *Engineer - Ministry of the Environment*	**Lucio Di Matteo** *University of Perugia*
John Doherty *Watermark Numerical Computing, Australia*	**Walter Dragoni** *University of Perugia*	**Daniela Ducci** *University of Naples Federico II*	**Marco Falconi** *ISPRA*	**Daniel Feinstein** *Wisconsin University Milwaukee, USA*
Michael Fienen *USGS, USA*	**Giovanni Formentin** *HPC Italy srl* *SYMPLE*	**Vincenzo Francani** *Politecnico di Milano*	**Enrico Guastaldi** *GEOexplorer S.r.l.*	**Rui Hugman** *INTERA, USA*
Randall Hunt *USGS, USA*	**Luigi Lana** *Kataclima S.r.l., SYMPLE*	**Sara Leggio** *Economist, SYMPLE*	**Francesca Lotti** *SYMPLE*	**Lucia Mastrorillo** *University of Roma Tre*
Mara Meggiorin *Ramboll Italy Srl*	**Antonio Menghini** *Emergo*	**Marco Petitta** *University Sapienza*	**Marco Petrangeli Papini** *University Sapienza*	**Vincenzo Piscopo** *University of Tuscia*
Vincent Post *EDINSI Groundwater*	**Martin Preene** *Preene Groundwater Consulting, UK*	**Elisabetta Preziosi** *CNR-IRSA*	**Viviana Re** *University of Pisa*	**Rudy Rossetto** *Scuola Superiore S. Anna*
Thomas Reimann *Technische Universität Dresden, Germany*	**Manuel Sapiano** *EWA, Malta*	**Luca Vettorello** *Sinergeo S.r.l.*	**Stefano Viaroli** *University of Roma Tre*	**Jeremy White** *INTERA, USA*

Registration

Ente di Formazione Accreditato

Professional credits (**50 APC**) for Italian Geologists

Prices		
Students - ECHN **1500 €**	SGI – IAH members **2400 €**	Regular **2600 €**
Fill the **Registration form**	**Payment information**	**Contact us**

Siamo presenti sul MEPA acquistinretepa

CARTA del DOCENTE SPENDI QUI IL TUO BUONO

Seats are limited to **30 Participants & 30 Scholarship places**

To be eligible for a **Scholarship place**, applicants must:

- be resident in and national of low- and middle-income countries (see the list in the application form);
- be preferably 35 years old or younger.

To apply, **fill this FORM** with required information.

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