sYmple

School of hydrogeological modelling & Project-related strategies

forth edition

Info & Programme

2025 Edition: January 13th – December 31st

Pre-School orientation meeting: December 5th-6th, 2024

On-line (live lessons with recordings available)

Seats are limited to 20 partecipants

Final registration deadline: November 15th, 2024

Rev.0

05/06/2024

Ente di Formazione Consiglio Nazionale Geologi Accreditato

The initiative is under the auspice of the

International Association of Hydrogeologists – Italian Chapter

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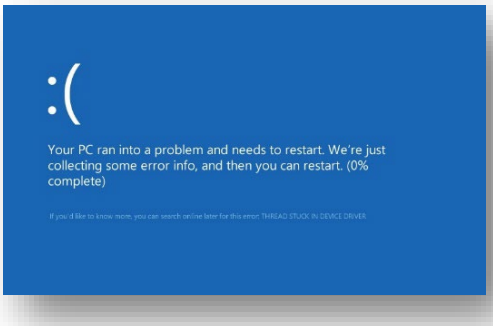
Contents

FOREWORDS

SYMPLE is a school about groundwater modelling that starts from zero. The only prerequisites are the will to learn and a technical-scientific background. The corequisites are those needed to be a numerical modeller: patience, an investigative approach and Information and Communication Technology (ICT) propensity.

If you find yourself getting nervous when your computer crashes... **you might need to work on your digital/computer skills and patience before attending!!**



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 programme associated with the use of strategies to solve specific problems**.

SYMPLE aims to impart an emerging paradigm, supported by the latest ideas and cutting-edge software for data assimilation, of "*starting from the problem and working backwards*". This workflow involves the initial step of identifying the data with the highest potential to minimize the uncertainties associated with decision-critical predictions, and then designing a numerical simulation strategy, based on the open-source MODFLOW family of codes, 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. In many cases, the modelling will be more effective 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.

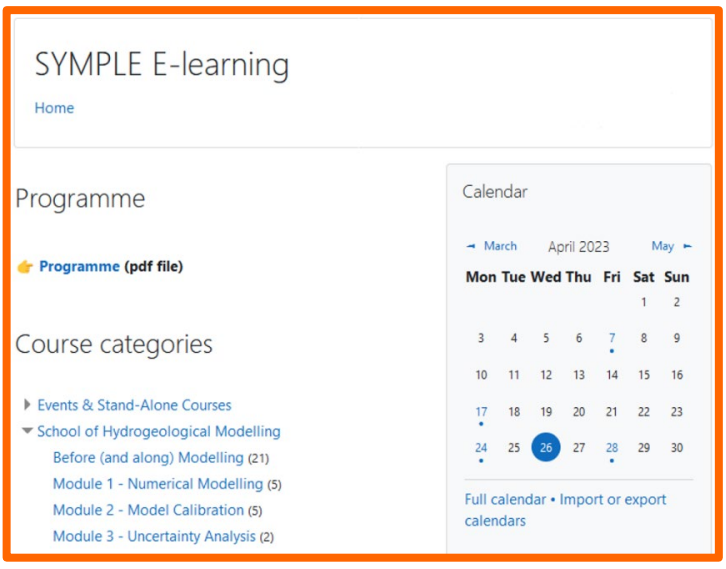
School Outlook

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

Differing from other schools, SYMPLE's mission extends beyond "traditional teaching". We aim to enhance individual learning to transfer as much experience as possible to the participants. In short, we want participants to become "expert hydrogeological modellers". For this reason, we have selected a comprehensive set of tools, explained in a modelling-targeted way, and applied to real-world cases that are much more difficult to "solve" than the step-by-step exercises, where everything works fine.

The trainers look at the school attendees not as "students", but as "colleagues" to work and solve problems with. Participants engage directly with the trainers through dedicated Q&A fora and by asking one-on-one discussions. We wholeheartedly promote interaction, as it is a fundamental knowledge-sharing component.

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



Module 1
Groundwater Numerical Modelling

The hydrogeology basics are applied to synthetic and real-world cases to extract salient information from data, to be transferred to the modelling process. The basics of numerical flow and transport modelling is introduced through the GUIs ModelMuse and Groundwater Vistas. Model building is also approached through Python scripting with FloPy.

Live Sessions	Contents	CET	Days
M1-A Review of key topics and assessment of users knowledge *T. Reimann, F. Lotti*	Fundamental concepts of groundwater flow: flow equations, aquifer properties, water balance, and transport equations.	2-7pm 9am-2pm	2025-01-13 2025-01-17
	Introduction to Python.	2-7pm	2025-01-24
M1-B Data processing *F. Lotti, T. Reimann*	Introduction to applied statistics and geostatistics. Case Study introduction. Analysis and processing of hydrogeological datasets, semivariogram modelling, field data regionalization, uncertainty of spatial distributions. Aquifers and Wells. Flow to wells, capture zone, aquifer investigation and pumping tests evaluation.	9am-2pm 2-7pm 9am-2pm 2-7pm 9am-2pm	2025-01-31 2025-02-07 2025-02-14 2025-02-21 2025-02-28
M1-C Numerical Modelling of flow with MODFLOW *T. Reimann, F. Lotti*	Analytical and numerical methods in groundwater: solution of flow equation through finite differences and finite elements, numerical methods, grid and mesh construction, boundary conditions, model assumptions.	2-7pm 9am-2pm 2-7pm 9am-2pm	2025-03-07 2025-03-14 2025-03-21 2025-03-28
M1-D Numerical Modelling of basic transport *T. Reimann, F. Lotti*	Euler / Lagrange approaches, Numerical schemes (FD, TVD, MOC, MMOC, HMOC) and different applications. Uncertainty due to solution method and parameters. Exercise/tutorials with MODELMUSE.	2-7pm 9am-2pm	2025-04-04 2025-04-11
M1-E Model building of the Case Study *F. Lotti, T. Reimann*	Demonstration of model design. Exercise/tutorials with MODELMUSE. Case Study model building, evaluation of aquifer geometry, properties and boundary conditions from previously processed data (M1-B).	2-7pm 9am-2pm	2025-04-16 2025-04-25
M1-F 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.	9am-2pm 2-7pm	2025-05 2025-05

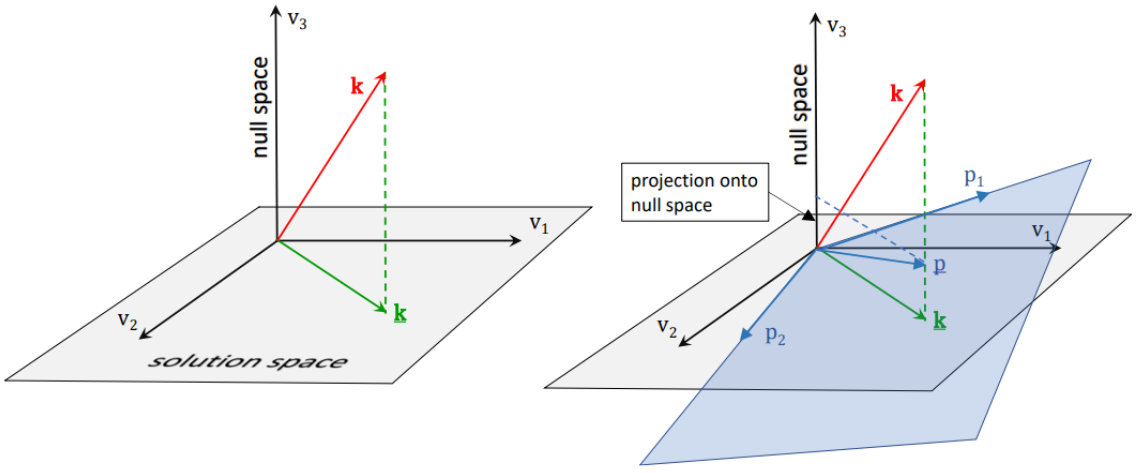
Module 1 total: 90 hours

Module 2
Groundwater Model Calibration

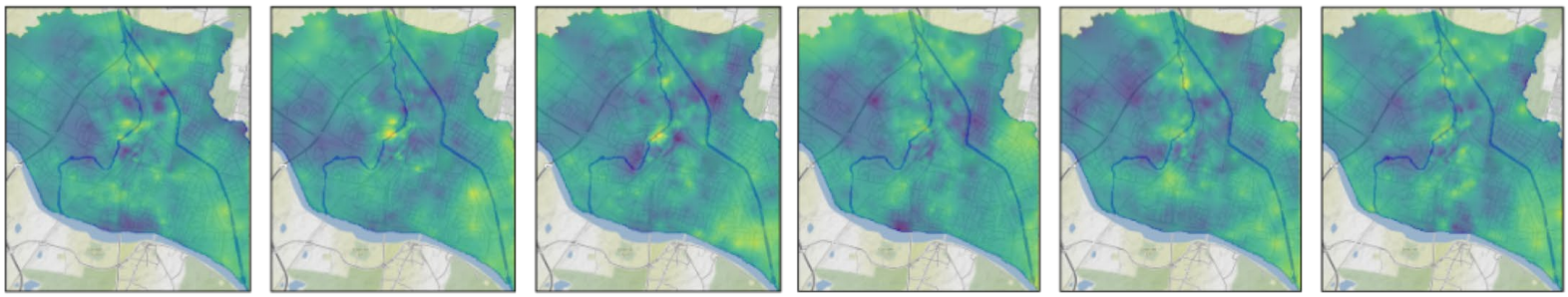
The focus of the second module is model calibration. The MODFLOW GUI used in the exercises is ModelMuse in association with PEST(++). John Doherty, the author of PEST, introduces the theory behind history matching ("calibration").

Live Session	Contents	CET	Day
M2-A Introduction to history matching *J. Doherty* *F. Lotti*	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 - PEST settings in ModelMuse for a synthetic model and the Case Study.	2-7pm 9am-2pm 2-7pm	2025-04-30 2025-05-07 2025-05-14
M2-B Manual regularization *J. Doherty* *F. Lotti*	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, for a synthetic model and the Case Study.	9am-2pm 2-7pm	2025-05-21 2025-05-28
M2-C Highly parametrized approach *J. Doherty* *F. Lotti*	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. Continuation of the Case Study analysis.	9am-2pm 2-7pm	2025-06-04 2025-06-18

Module 2 total: 35 hours



Module 3
Uncertainty Analysis



The module is fully dedicated to uncertainty analysis through the use of the PEST suite, explained by the author of the code, John Doherty. A wide set of exercises helps understand complex concepts, using both GUIs and command line inputs. Examples are analyzed to demonstrate data assimilation, uncertainty analysis and its application to decision-support modelling.

Live Sessions	Contents	CET	Day
M3-A Uncertainty Analysis *J. Doherty*	Bayes equation Short discussion on geostatistics Linear uncertainty analysis • Parameter contributions to predictive uncertainty • Optimization of data acquisition • Other uses of linear analysis Principles of nonlinear uncertainty analysis Rejection sampling Null space Monte Carlo Ensemble methods (PESTPP-IES) Data space inversion *Exercises from the command line*	9am-2pm 9am-2pm	2025-06-25 2025-07-02
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 Getting the most out of PEST and PEST++	9am-2pm	2025-07-09
M3-B Exercises *F. Lotti* *G. Formentin*	Exercises about the application of Uncertainty Analysis to the Case Study. Assignment of a real project to develop starting from raw field data, deliver and discuss along the last School section (Project-related Strategies).	2-7pm 9am-2pm	2025-07-11 2025-07-18

Module 3 Total: 25 hours

Registration

Ente di Formazione Accreditato

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

Prices	Siamo presenti sul MEPA acquistinretepa	CARTA del DOCENTE SPENDI QUI IL TUO BUONO
Students - ECHN **1600 €**	SGI – IAH members **2500 €**	Regular **2700 €**
Registration form	**Payment information**	**Contact us**

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.