UNDER THE AUSPICE OF iah aih Italian Chapter

On-site/Online Course 2025

the PEST course
Application & Theory

Ente di Formazione Consiglio Nazionale Geologi Accreditato

Online: September 10th **Onsite: September 15th -19th, Italy**

Course overview

This five-day course is led by John Doherty, author of PEST. He will be assisted in practical sessions by Francesca Lotti. The course covers the theory behind modern-day inversion and uncertainty analysis as these are applied to groundwater modelling. Just as importantly, practical sessions demonstrate how theory can be turned into workflows using a graphical user interface such as ModelMuse in conjunction with utility software from the PEST suite. This utility software allows a modeler to undertake calibration and uncertainty analysis in innovative ways that are not supported by off-the-shelf modelling interfaces.

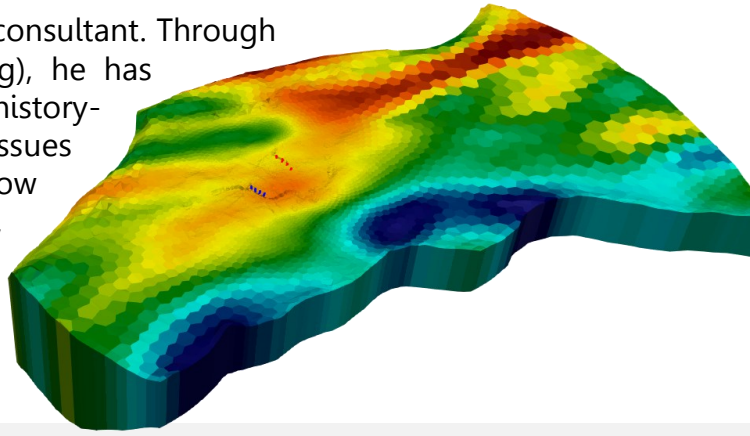
Assignment of site-specific parameters to models that must be used to support expensive decisions provides important insights into issues such as appropriate structural and parameterization complexity. A particularly exciting topic is that of non-stationary geostatistics, and how these can be used to parameterize models that possess both structured and unstructured grids.

Data space inversion is another exciting new technology. It enables data assimilation and predictive uncertainty analysis to proceed without the need to actually adjust model parameters. This has profound implications for the speed with which sophisticated numerical models can be built and deployed to support operational and regulatory decision-making.

John Doherty is the author of PEST and PEST-support utility software. Until recently, he also contributed heavily to GMDSI, an industry-sponsored initiative to boost awareness and education on the principles and practice of decision-support groundwater modelling; see https://www.gmdsi.org

Over his career of nearly 50 years, John has worked in the private, public and Tertiary sectors. He has also undertaken extensive research and development in topics related to decision-support modeling.

However John has spent most of his career as a consultant. Through his company (Watermark Numerical Computing), he has assisted colleagues worldwide in building, history-matching and deploying models that address issues such as extraction sustainability, high and low enthalpy geothermal, contaminant remediation, and environmental impacts of mining and coal seam gas extraction.



UNDER THE AUSPICE OF iah aih Italian Chapter

On-site/Online Course 2025

the PEST course

Application & Theory

Ente di Formazione Consiglio Nazionale Geologi Accreditato

Online: September 10th **Onsite: September 15th -19th, Italy**

Course Programme

September 8 (10 am–1 pm CET)
Optional on-line preliminary session

- Introduction to the course
- Instructions for installing the software and accessing the e-learning platform
- A test model is provided to check that everything runs fine
- What to read to get a "foretaste" of issues related to model parameterisation

Workshop 1: videos and tutorials are provided to build a simple model using ModelMuse

September 15 (2-6 pm)

- Metrics for decision-support modelling
- Brief review of linear algebra and geostatistics
- What does "calibration" really mean?
- Bayes theorem, and how it is applied in groundwater modelling
- Predictive uncertainty and predictive error
- Old style calibration based on parameter parsimony: why it doesn't really work

Workshop 2: MODFLOW 6 and PEST settings in ModelMuse. Preparing for calibration.

September 16 (9 am-1 pm; 2-6 pm)

- The costs and benefits of parameter uniqueness
- Highly parameterized inversion and regularization
- Subspace methods including singular value decomposition
- Tikhonov regularization
- Pilot points as a parameterization device
- Construction of covariance matrices for parameter regularization and uncertainty analysis

Workshop 3: model calibration with pilot points.

September 17 (9 am-1 pm; 2-6 pm)

- Principles of uncertainty analysis
- Nonstationary geostatistics
- Generating random hydraulic property fields for structured and unstructured grids
- Linear uncertainty analysis
- Ensemble smoothers: theory and practice
- Direct predictive hypothesis-testing

Workshop 4 - Post-calibration linear analysis.

September 18 (9 am-1 pm; 2-6 pm)

- Uncertainty in uncertainty: parameterizing the prior
- Data space inversion
- Ensemble space inversion
- Hierarchical inversion
- How history-matching can do more harm than good

Workshop 4: nonlinear analysis of predictive uncertainty.

September 19 (9 am-1 pm)

- Optimization under uncertainty
- Data worth analysis
- Some considerations for contaminant transport modelling
- Some considerations for low enthalpy geothermal modelling
- "Group therapy": participants discuss their own problems

Assignment

An optional exercise will be proposed as homework. This will test assimilation of the course contents, and how to overcome the most common obstacles for beginners. Assistance is provided in case you get stuck.

On request
On-line session

Q&A session

Optionally, an additional on-line session can be organized to discuss questions and issues that you may have after you have thought about the course for a while.

UNDER THE AUSPICE OF

Italian Chapter

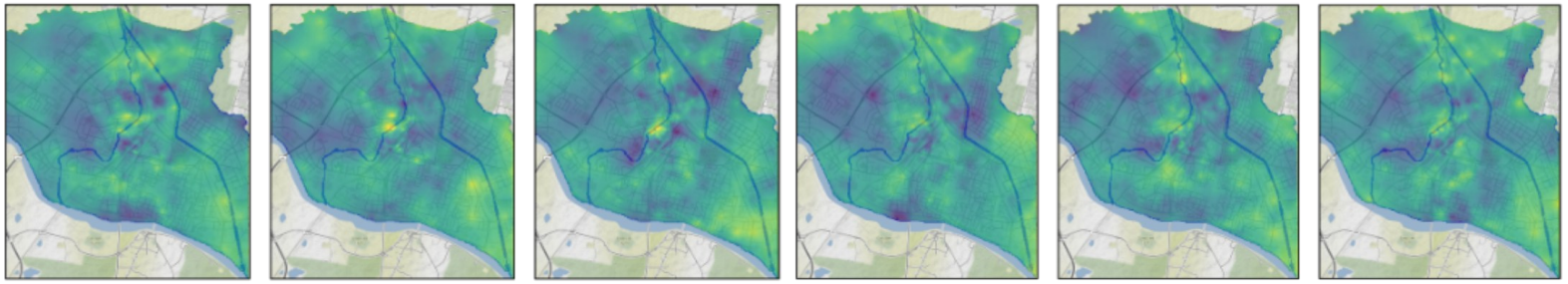
On-site/Online Course 2025

the PEST course

Application & Theory

Ente di Formazione Consiglio Nazionale Geologi Accreditato

Online: September 10th **Onsite: September 15th -19th, Italy**



What is included

- Access to live lessons (both in the on-site classroom and remotely)
- Software and installation instructions provided before the course
- Material to carry out the exercises
- Access to our e-learning platform to watch again the recorded lessons with no limit of time
- *APC credits* for Italian Geologists
- Coffee breaks and light lunches.

Remote/Live Attendance

The course can be attended blended (online and onsite sessions) or completely by remote viewing. Lessons are recorded. The venue is located in Vetralla (VT), Italy (60 km from Rome).

Costs

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

- Regular: 1000 €
- IAH/SGI: 800 €
- Students/ECHN: 500 €
- Scholarships available for the attendees of the current edition of the SYMPLE School
- Installments available

We live in a wonderful place, surrounded by wild woods and near the volcanic Lake Vico... For accommodation suggestions and "how to get there" advice, just ask us!

Other opportunities to "meet" PEST

- See roadmaps, videos, webinars, tutorials and frequently asked questions that are accessible for free through the PEST web pages.
- Further training material is available on the GMDSI web pages.

Registration link

Register preferably before July 26, 2025

OUR MISSION

SYMPLE is an Innovative Start-up founded by Francesca Lotti in 2021 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**.

website info@hydrosymple.com telegram +39.0761.481622 LinkedIn