

Alessio Barbagli

Alessio Barbagli (Senior Hydrogeologist) is graduated in geoscience (MSc at the University of Siena) with expertise in Hydrogeochemical groundwater characterization, GIS, Applied Hydrogeology, Environmental Monitoring. In 2017 he got a PhD at the Sant'Anna School for Advanced Studies of Pisa with a thesis on "Analysis of groundwater interaction in drainage water phyto-treatment and in aquifer recharge schemes". During his PhD, he participated and contributed to several international projects (H2020 FREEWAT, FP7 MARSOL, Italo-Israeli join project PHARM-SWAP MED, EU-MED E2STORMED) improving his knowledge in: hydro-geochemistry, emerging pollutants, managed aquifer recharge, groundwater numerical modeling and ecosystem services. While following research activity at the University of Ferrara (Department of Physics and Earth Science) and being consultant for Geoexplorer Impresa Sociale S.r.l. (Italy), he is involved, thanks to a joined collaboration network, as collaborator in the Geophysics & Hydrogeology group at CGT Center for GeoTechnologies of University of Siena (Italy) and as collaborator, within the framework of the REWAT project, together with the Institute of Life Sciences, Sant'Anna School of Advanced Studies (Pisa).

Iacopo Borsi

Iacopo Borsi has more than 18 years of experience in modelling industrial and environmental processes. His specific skills include: (A) scientific programming for environmental data processing, even GIS-embedded (he is author of QGIS plugins for data analysis and numerical modelling). (B) modelling hydrological/hydrogeological processes (hydrological modelling, climate data analysis, groundwater flow and solute transport); (C) modelling impact and risk probability of hazard accidents in industrial plants. He is skilled on using software tools: modelling and numerical software (MODFLOW, MT3DMS, HEC-RAS, HEC-HSM, MATLAB, SciLab, COMSOL, GIS software, relational databases, etc.) and programming languages (Python, Fortran, C++). Teaching experience at national and international level. Project Manager of international and national projects in research and development, technological transfer and industrial innovation. He is author of one monograph, more than 25 papers in international journals and is reviewer for international journals on applied and industrial mathematics, environmental and chemical engineering. Since 2012, he is Co-Editor in Chief of Acque Sotteranee – Italian Journal of Groundwater. Presently he is Senior Environmental Modeler at TEA SISTEMI S.p.A., where he oversees environmental data analysis, modelling, and Project Management of R&D projects (national and international). He is developing ICT, GIS-integrated, environmental modelling tools (water resources estimation, wastewater treatment, air pollution, risk assessment, etc.) even connected to real-time sensing technologies and relational databases.

Giovanna De Filippis

In 2012 she got an MSc degree in Physics at Università del Salento (Lecce, Italy) and in 2016 a Ph.D. in Earth Sciences at Università degli Studi di Milano (Milan, Italy). Since April 2020, she works at AECOM URS Italia S.p.A., a large company established as a leader in environmental consultancy services, where she is part of the "Water & Risk" group. Main tasks include participation in civil and environmental engineering projects through the development of environmental, geological, hydrogeological and geotechnical characterizations, in order to acquire data needed for the design, installation and management of remediation systems.

Between October 2015 and March 2020, she was part of the Water Nexus Group of the Institute of Life Sciences at Scuola Superiore Sant'Anna (Pisa, Italy), being involved in relevant EU-funded and National projects dealing with water management, especially focusing on issues related to quality and quantity of groundwater resources. The main objectives included: (i) management and protection of water-related ecosystems; (ii) analysis of the resilience of groundwater resources, due to impacts of climate change and human pressure; (iii) producing tools to support decision-making, in view of making the use of ground- and surface-water resources more sustainable. The wide range of experiences allowed her to develop technical skills related to the knowledge and ability to use: (i) tools for the analysis, storage and visualization of hydrological, hydrogeological and climate data; (ii) modelling tools for the simulation of processes related to the hydrologic cycle; (iii) GIS and programming languages for development of software tools aimed at integrated water management.

Enrico Guastaldi

Head of Geophysics & Hydrogeology sector at CGT – Center for GeoTechnologies of University of Siena (Italy), Project Manager and Member at Geoexplorer Impresa Sociale S.r.l. (Italy); he is also President of CGT SpinOff S.r.l. (Italy) and Member of Société Marocaine de GéoTechnologies (Marrakech, Morocco). He coordinates consulting and research activities mainly concerning hydrogeology, environmental geology, applied geophysics. He has got a degree in Geology Sciences in November 1999 (University of Siena) and MSc in Mining and Environmental Geostatistics (University of Leeds, UK). In November 2005 he has got a PhD at the University of Siena, School of Earth Science (Italy). During his 19 years of experience, he gained skills in several fields as geologist and hydrogeologist, as specialist in Environmental Hydrology, Statistics and Geostatistics, Spatial Analysis, Remote Sensing, GIS, Natural Radioactivity, Environmental Pollution and Remediation. Since 2005, he is lecturer at the University of Siena at the CGT of University of Siena.

Mara Meggiorin

In 2016 she concluded a Double Degree Program and graduated in Environmental Engineering at the University of Trento and at the Instituto Superior Técnico de Lisboa. In 2020 she completed an executive PhD in Environmental Engineering at the University of Padua, in collaboration with Sinergeo (discussion in March 2021). The PhD project investigated the groundwater system of the Bacchiglione basin by applying statistical analyzes to a large timeseries dataset of groundwater levels and the implementation of a flow model in FEFLOW. Over her studies and with the master and doctoral theses, she focused on hydrology, modeling, statistics and geostatistics. This knowledge was applied in three different internships: the first, in a company that designs industrial wastewater treatment plants (2016); the second in the Dutch research center Deltares (2017) and the third in the U.S. Geological Survey (2019). Both abroad internships focused on the implementation of 3D models describing the interconnected dynamics of groundwater and salt water in coastal areas: Mekong Delta (Vietnam) and Long Island (NY). Since October 2020, she works for Sinergeo s.r.l., an environmental consultancy company, specialized in the hydrogeological sector. The main activities consist in geological and hydrogeological characterization, management and optimization of monitoring networks and statistical analysis of the available chemical and hydrological data. Several technical skills have been developed in these work experiences: the use of different groundwater modeling software and the organization, management and analysis of datasets with GIS tools and different programming languages.

Session programme

Statistics (E. Guastaldi) (8 + 20 hrs)

Univariate statistics

- Variables and statistical inference
- Frequency distribution
 - Simple graphs: the histogram
- Quantify the characteristics of the data
 - Measures of central tendency: mean, median and mode
 - Measures of dispersion: variance and standard deviation
 - Deduction of the histograms for the population
 - Other charts: Box and whiskers plot, Quantile plot, Normal Probability plot (normal q-q plot)
- Continuous Probability distribution
 - Moments
 - Normal distribution
 - Lognormal distribution

Multivariate Statistics

- Descriptive statistics for multiple variables
 - Covariance and correlation
 - Regression analysis (Ordinary Least Squares)
 - Variances and covariances (Variance-covariance matrix and correlation matrix)

Exercise

- Let's calculate some statistics!

Geostatistics (E. Guastaldi) (8 + 30 hrs)

Introduction to geostatistics

- Generalization, description, interpretation and control of data
- Estimates from a simple random sampling

Spatial interpolation

- Voronoi polygons
- Triangulation
- Natural Neighbor interpolation
- Inverse functions of distance
- Basic Radial Functions (Splines)

Characterization of spatial processes: covariance and the variogram

- Regionalized variables
- Spatial covariance and covariance function
 - Stochastic hypotheses: stationarity
 - Strict stationarity
 - Second order stationarity
 - Intrinsic stationarity (or Intrinsic stationarity)
 - Covariance function
 - The scatter plots (h-scatterplots)
- Variogram
 - Equivalence of the semi-variogram with the covariance
 - Correlogram
 - Structural properties
 - Calculation of the experimental variogram
 - Quantification of the variogram: the variogram model

Local estimate or prediction: the kriging

- Main aspects of an estimate
 - Global estimate and local estimate
 - Full means and distributions
 - Estimates of points and estimates of blocks
- General characteristics of kriging
 - Estimation criteria
- Ordinary Kriging
 - Weights
 - Research around
 - Example of Cr estimation using Ordinary Kriging
- Cross validation of the variogram model
- Other types of kriging
 - Simple kriging
 - Universal kriging

Multivariate geostatistical models

- Coregionalization
- Linear model of co-regionalization
 - Experimental cross-variogram
- Cokriging
 - Isotopy and heterotopy
 - Ordinary Cokriging
 - Simple Cokriging

Notes on geostatistical simulation

- General aspects

- Estimates of reality
- Conditional and non-conditioned simulations
- Estimates and simulations
- Conditional simulations
 - Conditioning a simulation
 - Sequential Gaussian Simulation
 - Data transformation
 - SGS simulation procedure
 - Example of CD simulation using SGS

GIS (G. De Filippis) (6 + 20 hrs)

- Introduction to Geographic Information Systems (GIS)
- Data structure
- The QGIS interface
- Data visualization and style management
- Dealing with coordinate systems
- Spatial data management
- Generation of vector data (points, lines and polygons)
- Geoprocessing tools
- Preparation of maps
- Raster processing with QGIS
- Spatial interpolation
- Use raster calculator
- Georeferencing images in QGIS
- Import delimited text as a point layer

Relational databases (A. Barbagli) (4 + 8 hrs)

- What is a relational database
 - Non spatial DB
 - Geo DB
- Example of relational database and use
- Database design and conceptualization
 - Designs Steps
 - Conceptual, logical and physical design
- SQL basics
- SQLite and SpatialLite as open source Spatial DBMS
- Geo DB validation
- DB data normalization
- Build and use a relational DB: step by step example and exercise

Time series analysis (I. Borsi) (2 hrs)

- Intro on Time Series
- Statistical Characteristics of Hydrologic Time Series, and exploratory analysis
- Methods for Time Series Analysis:
 - Stationarity
 - Detecting trend
 - Periodicity
- An Example
- Suggested reading & software tools

Application of statistical methods (M. Meggiorin) (3 + 5 hrs)

- Examples of descriptive statistics application
- Examples of time series analysis application
- Examples of time series clustering analysis