Master’s thesis (Oct. 2026)

1 – FIELD MEASUREMENTS ON LAKE ISEO

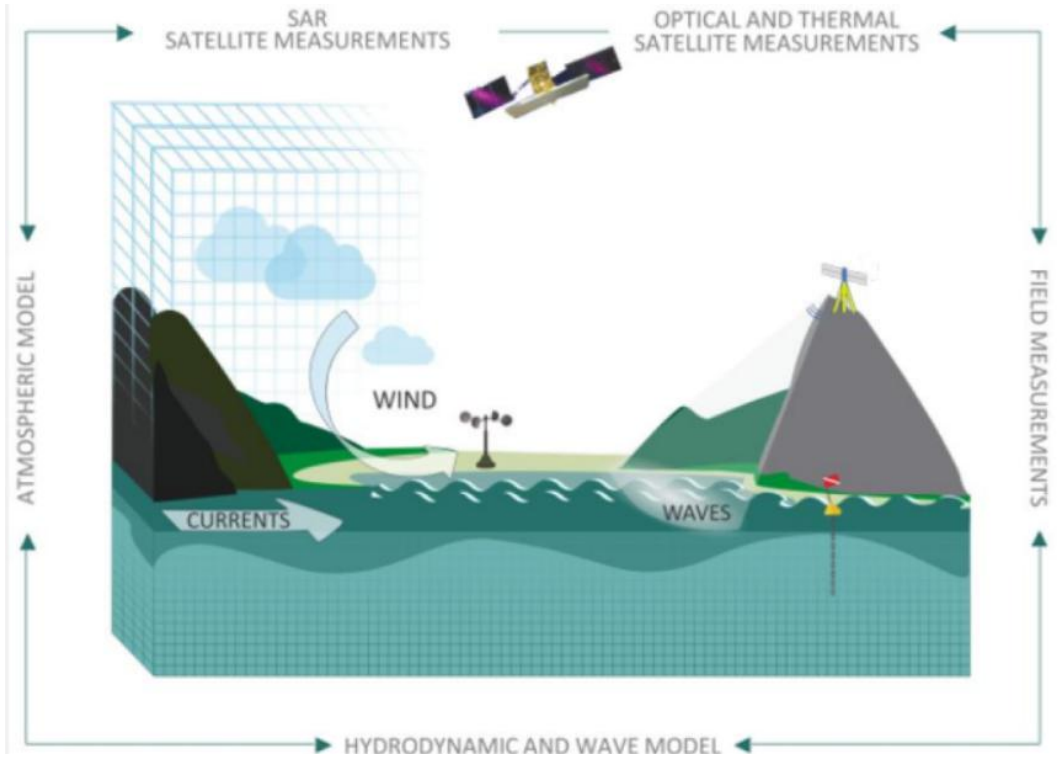
As part of a project with the University of Trento and the Italian National Research Council (CNR), the Hydraulics group will conduct field campaigns in 2027 to test measurement instruments and investigate physical processes in lakes.

Master's thesis projects will be available on selected instruments and datasets. Each project will include fieldwork followed by data analysis. These topics are particularly suitable for students:

– interested in fluid mechanics and lake hydrodynamics

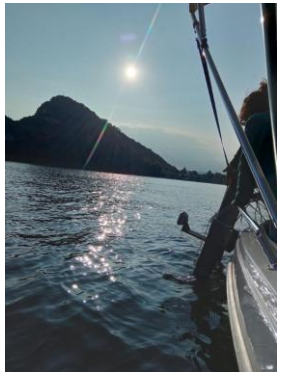
– interested in an applied thesis involving data analysis











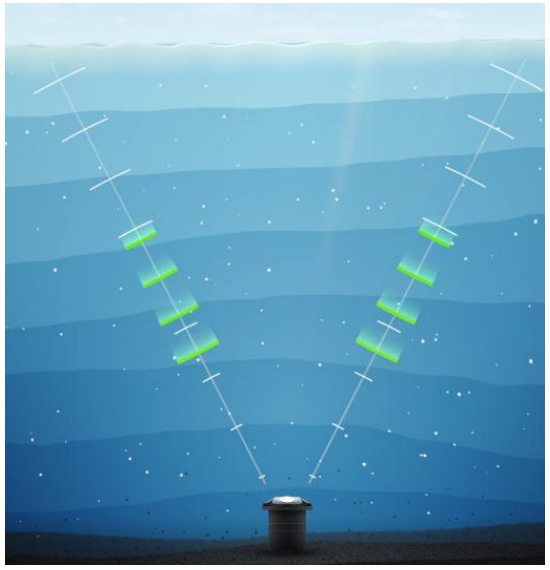


1A – CURRENT MEASUREMENTS

Research question: What is the wind-driven current profile within the upper few tens of metres of the water column? Is it affected by Earth's rotation or by tributaries?

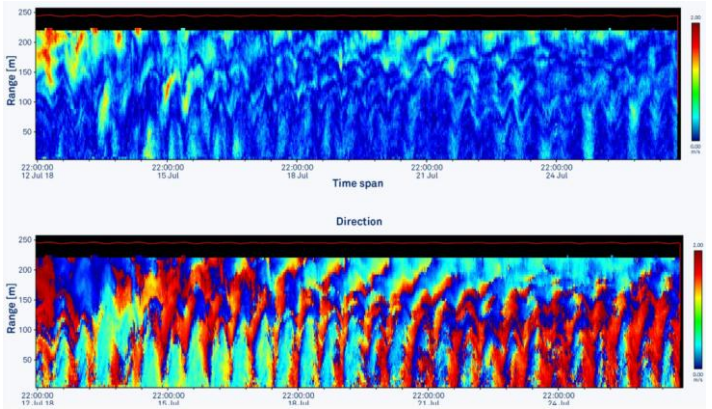
Activities:

- Review of commercially available acoustic Doppler current profilers (ADCPs) and planning their deployment
- Analysis of measured data in relation to the relevant forcing
- Support for field campaigns and collection of data to help interpret the measurements









Example of an ADCP, field deployment configurations, and measured data

1B – WAVE FIELD MEASUREMENTS

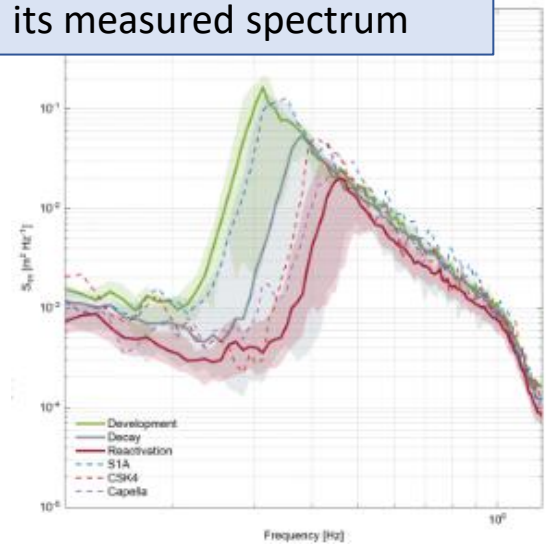
Research question: What wave field occurs on Lake Iseo? Which wind conditions pose a hazard to navigation? Do current forecasts provide enough information to issue a warning?

Activities:

- Review of commercially available wave gauges and planning their installation
- Study of surface-wave theory
- Analysis of measured data in relation to the relevant forcing
- Documentation of historical extreme events
- Assessment of a weather-warning system to improve navigation safety

Example of a wave gauge on Lake Garda and its measured spectrum





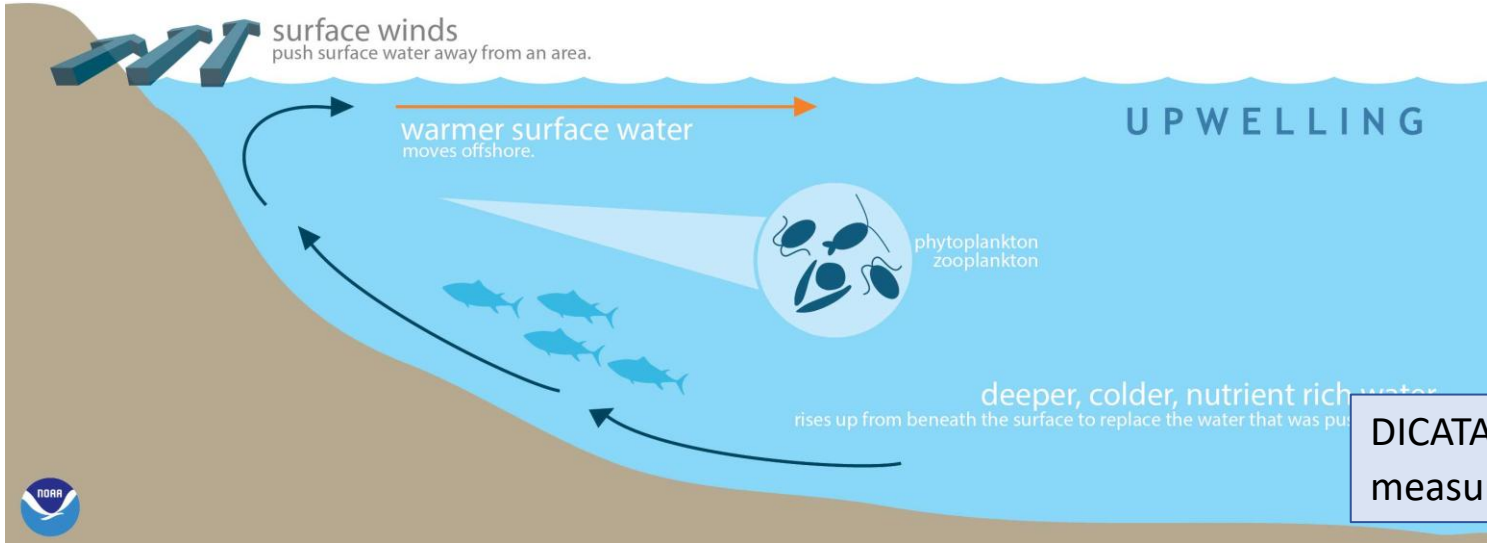


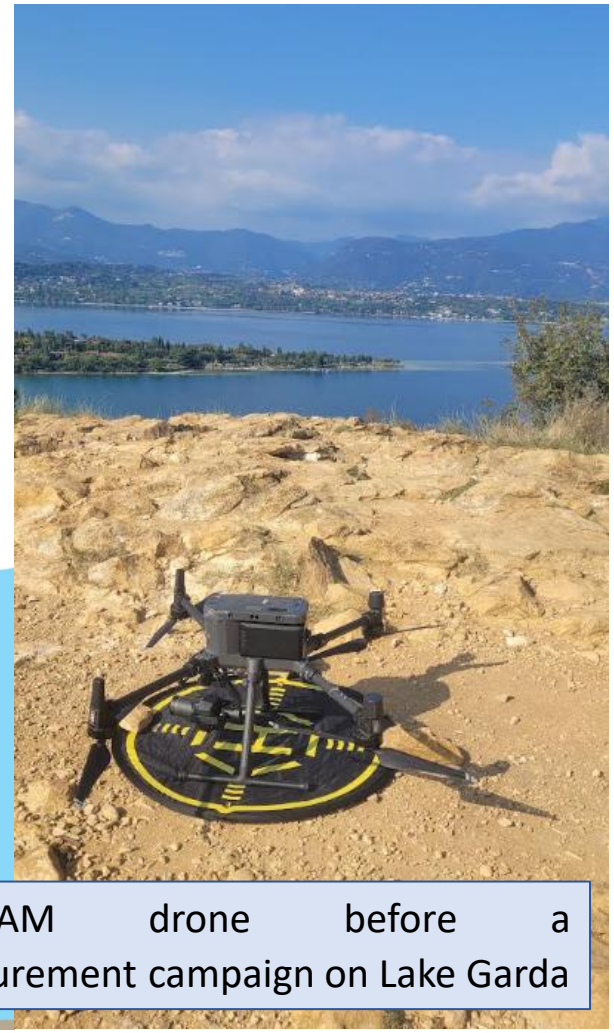
1C – SURFACE TEMPERATURE MEASUREMENTS

Research question: Can thermal cameras mounted on drones be used to map surface temperature? Can internal circulation explain the observed temperature differences? Are there areas where wind-driven upwelling brings cold water to the surface?

Activities:

- Study of how thermal sensors work
- Planning drone and boat-based measurement campaigns, including water-temperature measurements at several points on the lake
- Study of upwelling, the wind-driven rise of cold water toward the surface
- Analysis and interpretation of the collected data





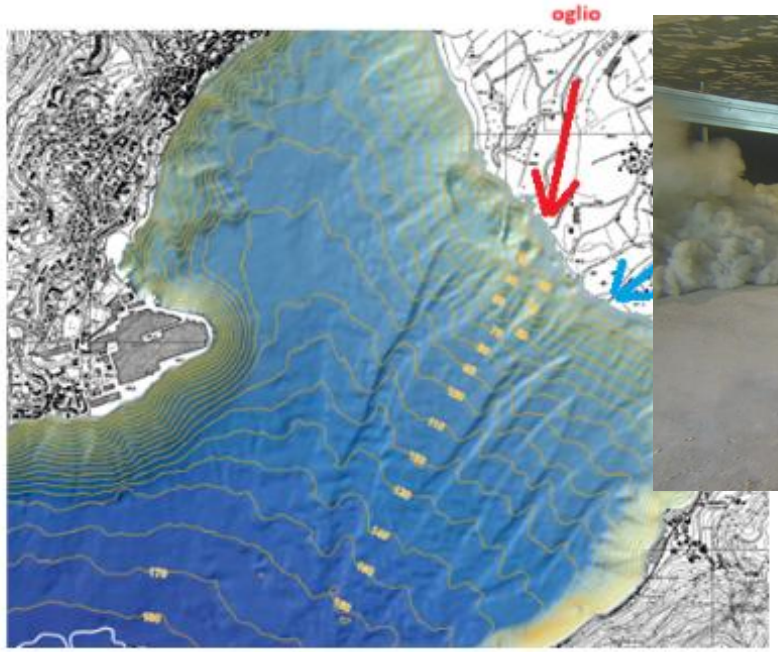
DICATAM drone before a measurement campaign on Lake Garda

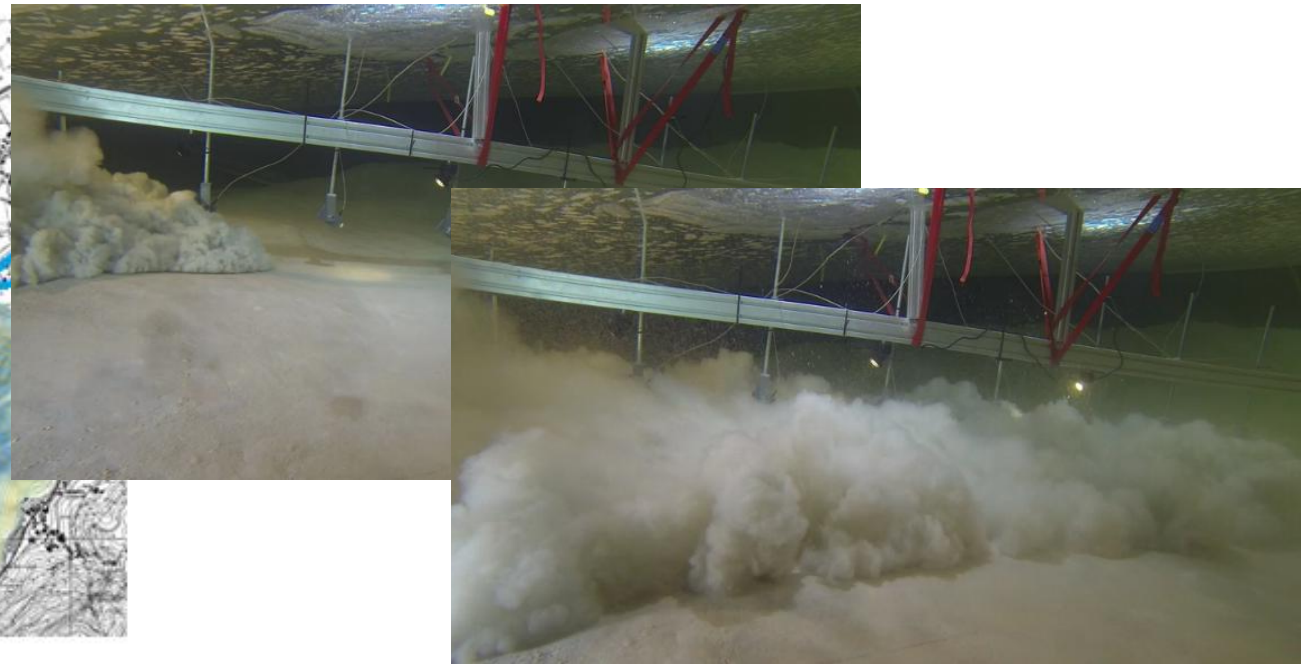
1D – MEASUREMENTS NEAR THE OGLIO RIVER MOUTH

Research question: What happens to Oglio River water as it enters Lake Iseo? Which conditions trigger the transport of oxygen to depth? How does a gravity current change as it descends into the lake?

Activities:

- Study of gravity currents
- Planning field campaigns to identify gravity currents in the northern part of the lake
- Analysis and interpretation of the data





Bathymetry of northern Lake Iseo, showing submarine canyons carved by turbidity currents. Example of a turbidity current simulated in the laboratory

THIS PROJECT MAY ALSO INCLUDE LABORATORY WORK AT RESEARCH CENTRES ABROAD

2 – MODELLING LAKE HYDRODYNAMICS

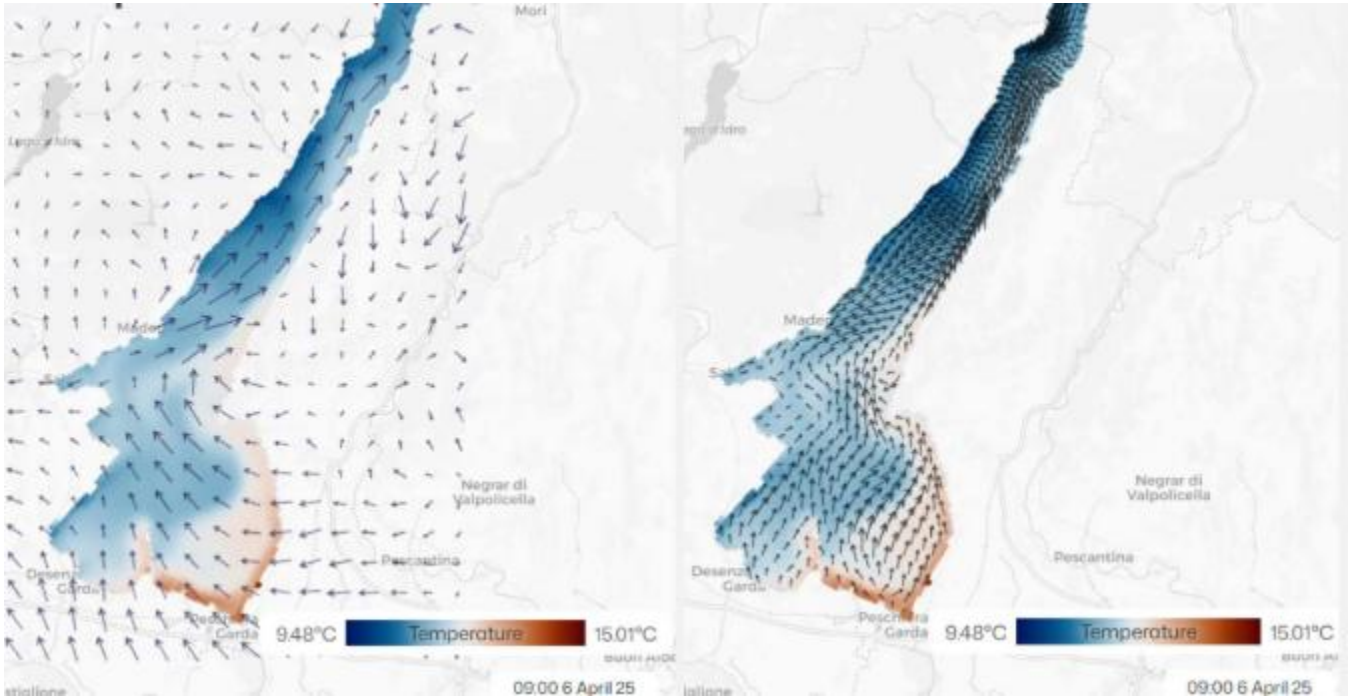
The Hydraulics research group uses software and develops mathematical models to understand the mechanisms that govern water motion in lakes and the resulting transport of dissolved and suspended substances.

The following slides show examples of this type of modelling work.

These topics are particularly suitable for students:

– interested in fluid mechanics and lake hydrodynamics

– interested in a modelling thesis involving the use or development of mathematical tools to solve the equations governing a physical process



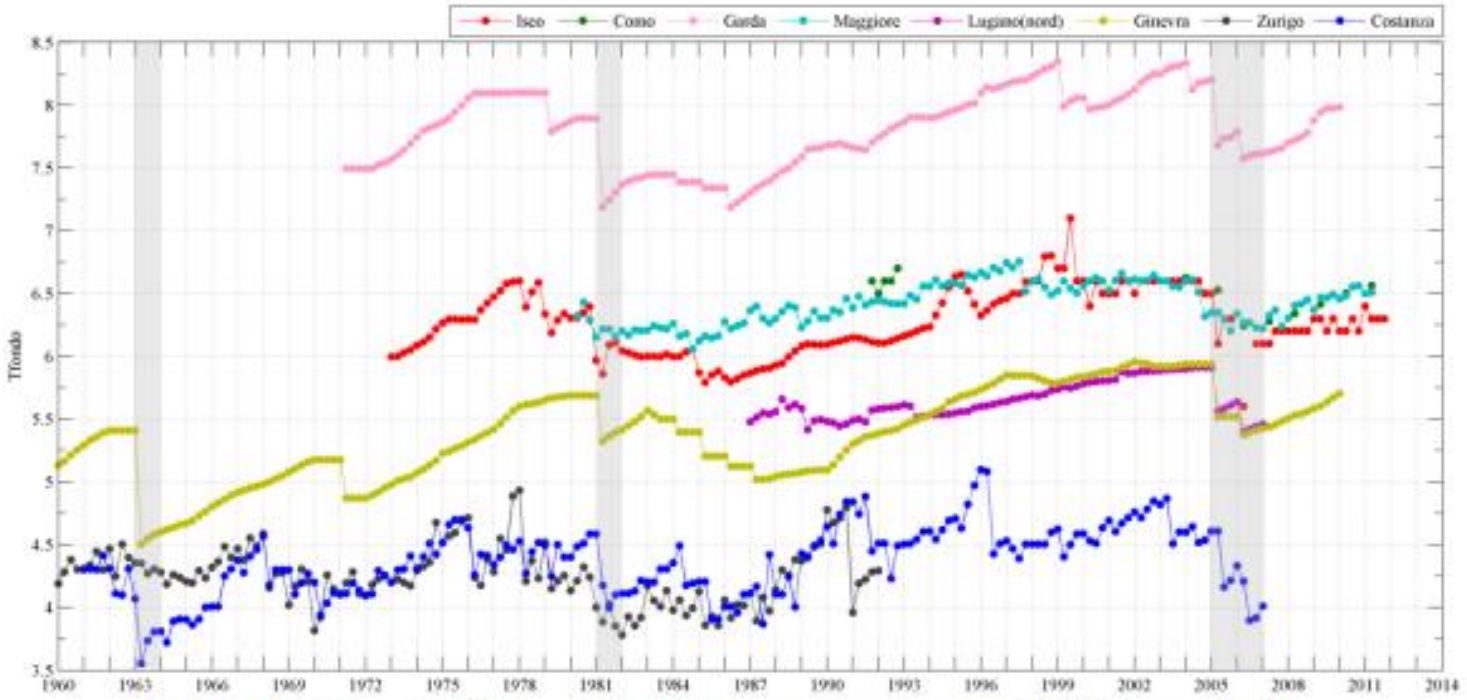
Example of a simulated surface-flow field on Lake Garda in April 2025. The forcing (wind) is shown on the left; the lake's response, in terms of temperature and surface currents, is shown on the right

2A – MODEL OF DEEP-WATER TEMPERATURE

Research question: What explains the marked differences in deep-water temperature time series across pre-Alpine lakes?

Activities:

- Compile historical measurements from selected pre-Alpine lakes and the meteorological time series required as model inputs
- Set up and calibrate 1D models to reproduce long-term deep-water temperature trends
- Compare results to identify differences in the lakes' thermal responses



Temporal evolution of the deep temperature of different lakes.

Time series of temperatures measured at depth in pre-Alpine lakes show a clear warming trend, with marked differences between sites. Climate change is altering the physical and chemical properties of these lakes. The proposed work aims to understand why deep-water temperatures have evolved differently in Lakes Iseo and Garda.

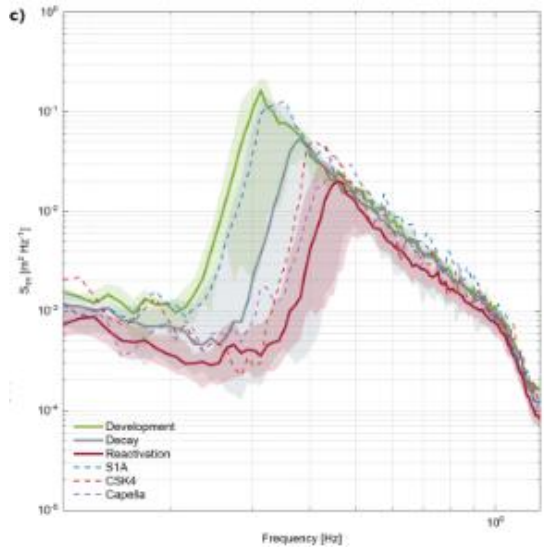
2B – MODEL OF THE LAKE WAVE FIELD

Research question: What wave field occurs on Lake Iseo? Which areas pose the greatest risk to navigation? Could a model coupled with weather forecasts provide a navigation-warning tool?

Activities:

- Set up and calibrate a numerical model using inputs from the hydrodynamic model and measurements from a wave gauge
- Analyse results to identify areas of greatest risk





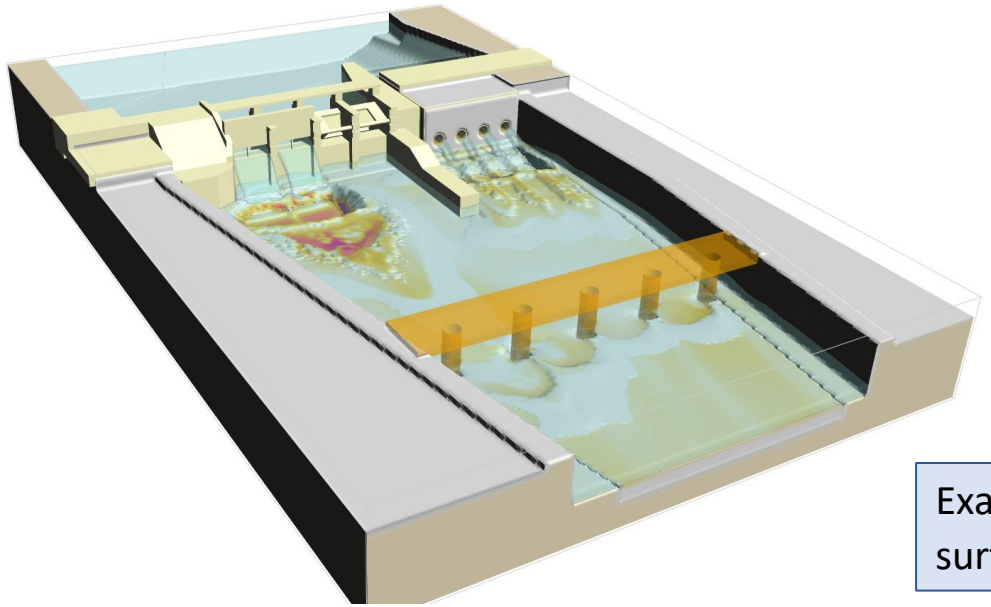


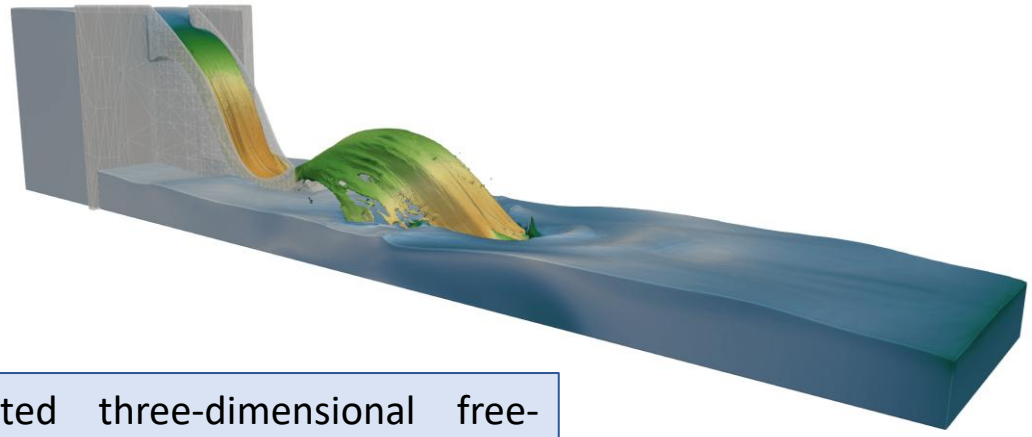
2C – CFD MODELLING

Environmental hydraulics describes and quantifies fluid motion in natural systems, identifying the dominant mechanisms and their role in transport and mixing. Alongside experiments and theory, Computational Fluid Dynamics (CFD) makes it possible to study configurations whose geometric complexity, fluid properties, and three-dimensional flows make purely analytical approaches, simplified numerical models, or extensive field campaigns impractical. CFD numerically solves the three-dimensional conservation equations for mass and momentum, here using the finite-volume method.

These topics are particularly suitable for students:

- interested in computational fluid dynamics, which has applications well beyond environmental hydraulics
- interested in modelling fluid–structure interaction and using three-dimensional software





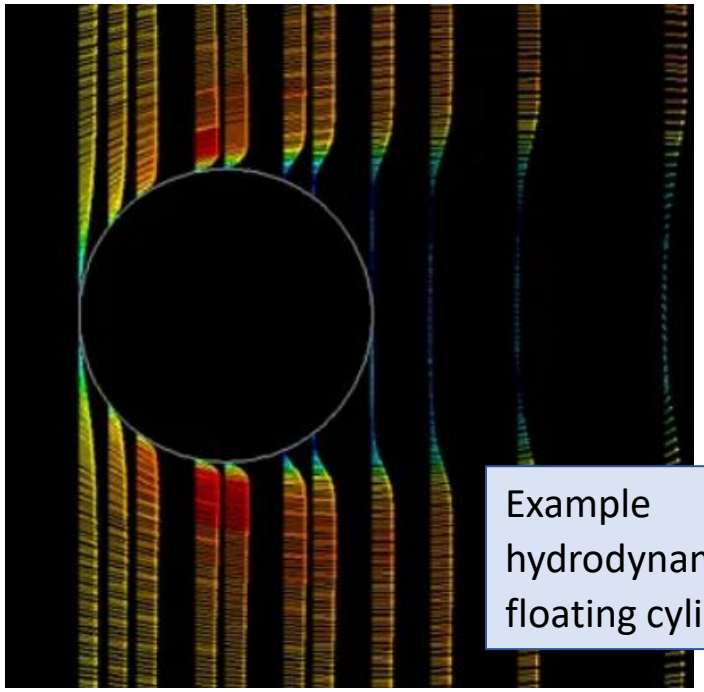
Example of simulated three-dimensional free-surface flow fields using FLOW-3D HYDRO

3A – MODEL OF FLOATING-DEBRIS TRANSPORT

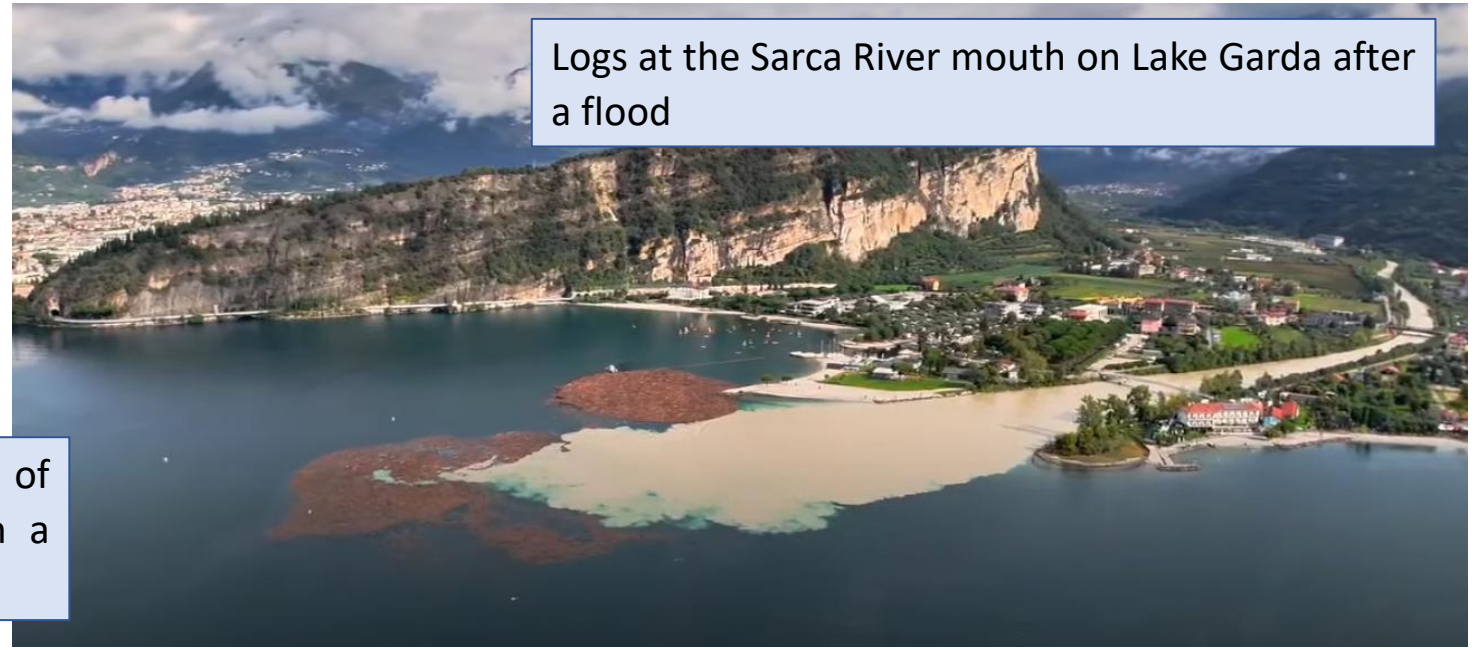
Research question: What forces act on floating materials, such as logs in a lake, when they are exposed to wind and currents?

Activities

- Analyse the hydrodynamic forces on a single log under varying conditions (waves, wind, currents, shape, submergence, orientation, etc.) to identify a suitable simplified model.
- Reproduce selected laboratory studies numerically or, alternatively, collect field measurements to test the model, or analyse results from a three-dimensional CFD model



Example study of hydrodynamic forces on a floating cylinder



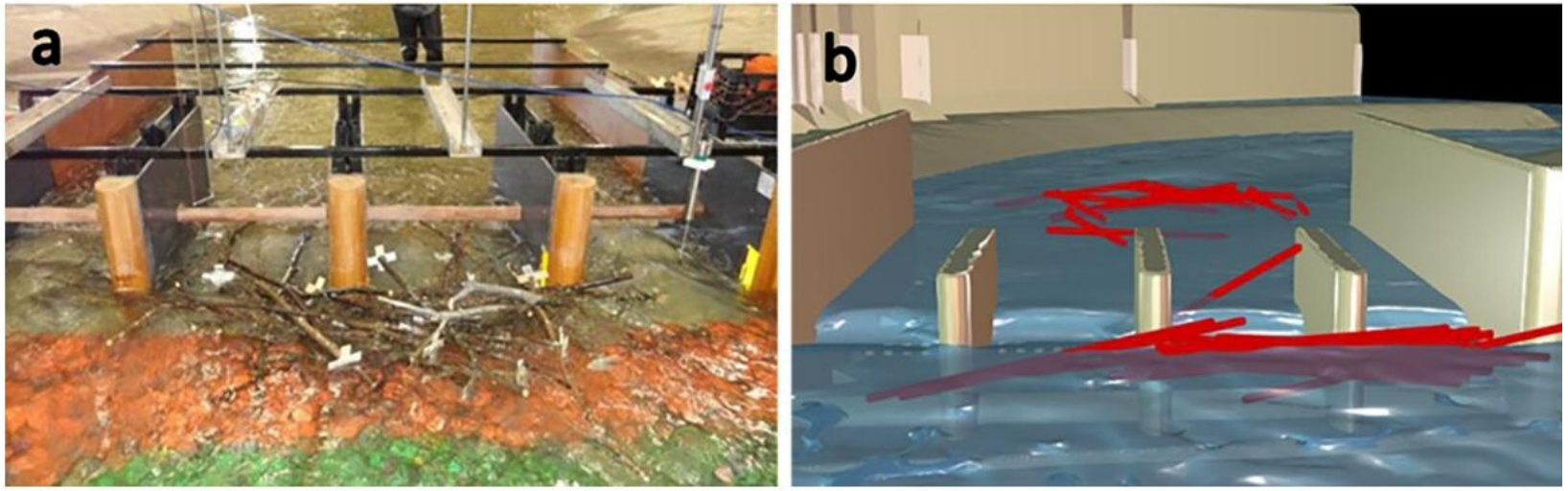
Logs at the Sarca River mouth on Lake Garda after a flood

3B – MODEL OF LOG TRANSPORT

Research question: Which mechanisms govern the equilibrium and transport of floating materials, such as logs in a lake, when they are exposed to wind and currents?

Activities

- Model the transport of groups of logs under specified hydrodynamic conditions and study their movement, including interactions with containment structures



Comparison of log transport around a hydraulic structure in a physical model (left) and a numerical simulation (right). https://www.tandfonline.com/doi/full/10.1080/19942060.2026.2682105#d1e193