

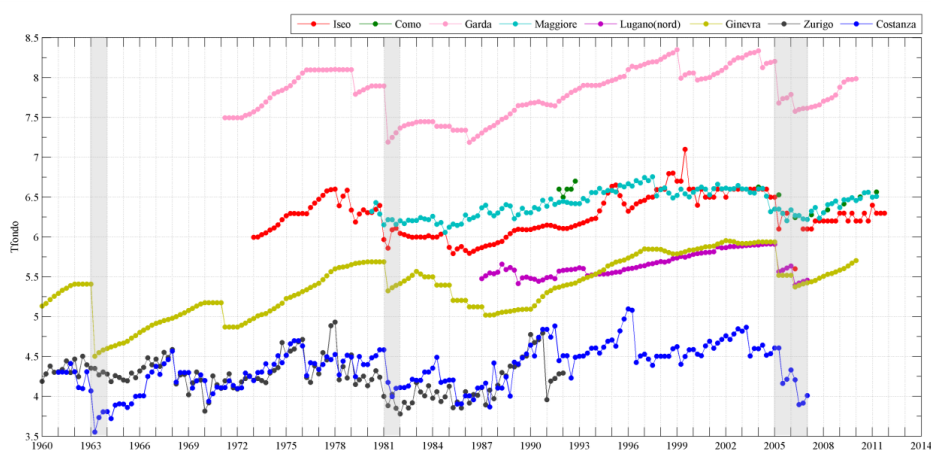
POSSIBLE TOPICS FOR A THESIS IN HYDRAULICS

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L) THESIS IN THE FIELD OF LIMNOLOGY (LAKES-PONDS)

L1) STUDY OF THE LONG-TERM EVOLUTION OF DEEP TEMPERATURE IN ITALIAN LAKES

The time series of deep temperature in deep pre-alpine lakes show a clear warming trend, even though with marked differences from one site to the other. This warming trend, induced by climate change, has been deeply affecting the physics and the chemistry of these lakes. The following activities are aimed at understanding the reasons behind the differential thermal evolution observed in Lake Iseo and Lake Garda.



Temporal evolution of the deep temperature of different lakes.

In the context of this wide topic, we propose the following thesis:

L1-a) CHARACTERIZATION OF THE THERMAL STRUCTURE IN LAKE GARDA AND LAKE ISEO

This thesis is focused on the collection and analysis of all the available temperature data measured in lake Garda and Lake Iseo, including ancient spot measurements, in order to put light on the observed changes in the deep warming / winter cooling in the last century.

The activity will require (i) a deep literature review and data collection and synthesis (ii) a data analysis and interpretation, based on the realization of a long-term thermal budget of these lakes

Suitable both for bachelor (i) and master students (i-ii). Particularly suitable for students living/interested to the area of Garda lake.

In the case of a master thesis, knowledge of Matlab or Phyton is required.

L1-b) MODELING OF THE DEEP TEMPERATURE EVOLUTION IN LAKE GARDA AND IN LAKE ISEO

This thesis is focused on the modelling of the thermal evolution in Lake Garda and Lake Iseo. After the understanding of the physical processes that drive the thermal dynamics of a lake, the student will use the available data in order to develop a 1D model of the lake which is aimed at reproducing the temporal evolution of the deep temperature in the lake in a period where the meteorological forcing are well known. The model will be use to put light on the differential trends in the two lakes and will be finally use in order to see how a reliable modelling could be extended to periods where less data are available.

Suitable for master students, with possible joint activities abroad.

L1-c) MODELING AND FORECASTING THE DEEP TEMPERATURE EVOLUTION IN LAKE GARDA AND IN LAKE ISEO (not currently available)

The results of L1-a and L1-b thesis could drive another thesis aimed at simulating the long-term evolution of the deep temperature in Lake Iseo and Lake Garda and to mark the reasons behind the differential warming of these basins. This modelling could be used as a tool to forecast the temperature evolution in the Lake under different climate change scenario.

Suitable for master students

L2) HYDRODYNAMIC STUDIES OF LAKE GARDA

Since May 2022, a floating station is present in Lake Garda, close to Manerba, measuring all the mechanical and thermal forcing at the lake surface, as well as the thermal response of the water temperature. The following thesis profits from these exceptional data to put light on the hydrodynamics of this lake:

L2-a) INTERNAL WAVES IN LAKE GARDA

This thesis is aimed at analysing the temperature data, measured between 0 and 50 m by the floating station in Manerba gulf. In particular, the activity is aimed at identifying the oscillatory motions induced by the wind and to compare it with previous studies and with the theoretical solutions available for simplified geometries.

Suitable for master students, knowledge of Matlab is required.

L2-b) CHARACTERIZATION OF THE WIND FIELD IN LAKE GARDA (best: since summer 2023)

This thesis is aimed at analysing the measured wind data in order to characterize the wind field in Lake Garda. In particular, the student will identify the differences between the ones measured on the shore of the lake, profiting from the presence of a floating station in the Manerba gulf. At this purpose, the tasks will be (i) a literature review on previous studies on wind on lake Garda, (ii) Statistical analysis of the past time series of the shore stations, (iii) Comparison of shore –lake station data – Cosmo data, (iv) analysis of the hydrodynamic effects of some particular events

Suitable both for bachelor (i-ii) and master students (i-iv). Particularly suitable for students living/interested to the area of Garda lake.

L2-b) INTEGRATION OF FIELD AND SATELLITE DATA FOR THE CHARACTERIZATION OF THE SURFACE WATERS IN LAKE GARDA (*assigned*)

This thesis is aimed at identifying the satellite data useful to integrate the measurements accomplished at the floating stations. Through an integrated analysis of these data, the student will develop the analysis to get insights on the hydrodynamics of Lake Garda. In particular, the analysis will focus on the role of the bathymetry in the cooling processes in the lake at the end of the limnological winter.

Suitable both for master students.

L3) HYDRODYNAMIC STUDIES OF LAKE ISEO

Since 2010, the hydraulic group has been studying the hydrodynamics of lake Iseo (see related publications at <https://hydraulics.unibs.it/hydraulics/contacts/>), where the group manages a network of limnological stations. In this framework, we propose the following experimental and numerical activities:

L3-a) INSIGHTS OF LAKES HYDRODYNAMICS FROM IMAGES OF THE LAKE SURFACE

Since 2016, a webcam is providing pictures of the surface of the northern part of Lake Iseo every half an hour (examples at <https://hydraulics.unibs.it/hydraulics/il-monitoraggio-del-lago-diseo/webcam/>). The most interesting pictures were already selected in a previous bachelor thesis. In this thesis the student will study some aspects of the hydrodynamics of the large water bodies and their manifestation at the surface of lakes and ocean, in order to provide an interpretation to some of the selected images.

Suitable for bachelor students

L3-b) THREE DIMENSIONAL MODEL OF THE SURFACE CURRENTS INDUCED BY WIND IN LAKE ISEO

Numerical thesis that makes use of a 3D commercial software to simulate the surface currents in Lake Iseo under the action of the wind. The aim is to focus on some particular events in the lake where it is possible to verify the capability of the model in modelling the surface movements derived by a set of images taken by webcams and satellites (examples at <https://hydraulics.unibs.it/hydraulics/il-monitoraggio-del-lago-diseo/webcam/>).

Suitable for master students

L3-c) EXTREME EVENTS

The undergoing climate change will likely be characterized by more frequent and intense extreme events. Extreme winds in particular have a major impact on lakes hydrodynamics, especially at the end of the winter when the water column is weakly stratified and prone to deep mixing. This thesis is aimed at analysing the effects of extreme wind events in Lake Iseo, by analysing the data measured on lake Iseo (i) and by developing some numerical investigations (ii) at the light of the available literature in this field. Suitable both for bachelor (i) and master students (i-ii), with possible joint activities abroad. In the case of a master thesis, knowledge of Matlab is required.

L4) A SMALL-SCALE LABORATORY FOR LIMNOLOGY: THE URBAN LAKE IN PARCO DELL'ACQUA

In the scientific park "Ambienteparco" (Brescia), a 2m-deep pond was created with didactic and recreational purposes, allowing in particular the view of the aquatic system from an underground tunnel (<https://ambienteparco.it/biolaghetto-e-tunnel-subacqueo/>). The system is eutrophic and this creates some challenges for the correct functionality of the system. The thesis is firstly aimed to characterize the hydraulics and thermodynamics of the system, making use of both measurements of the main chemical and physical variables (to be carried out in the pond by means of a probe) as well as to an hydraulic model of the system. Depending on the specific interests of the student, the thesis could also include a modelling part of some ecological components of the system.

Particularly suitable for students living in Brescia, potentially compatible with a stage on a similar topic.

L5-a) ORGANIZATION OF A MONITORING PROJECT OF TORBIERE D'ISEO

The thesis aims to create a monitoring program for waters of the Sebino Torbiere Nature Reserve, located to the south of Lake Iseo. The work will be carried out in collaboration with the Institution Reserve and will consist in organizing the type of monitoring, instructing those who are going to carry it out, organize the arrangements data collection and their subsequent publication and dissemination. Suitable for bachelor students living in the area surrounding Torbiere d'Iseo.

I) THESIS IN THE FIELD OF MANAGEMENT OF IRRIGATIONAL CHANNELS

I1) DISCHARGE MEASUREMENTS IN IRRIGATION CHANNELS (*assigned*)

This Thesis will investigate the potential of the different velocity measurements in irrigational channels. The work will consist in (i) a literature review and in (ii) an experimental activity in some monitored sites managed by Consorzio di Irrigazioni Cremonesi.

Particularly suitable for students living nearby Cremona, potentially compatible with a stage on a similar topic.

C) THESIS IN THE FIELD OF CFD

C1) 3D MODEL OF THE HYDRAULICS OF A WASTEWATER TREATMENT PLANT.

The exponential growth in computer power over the last few decades has made possible the application of sophisticated Computational Fluid Dynamics (CFD) models for the solution of complex 3D water motions. In particular, it has been used for the design of different parts of wastewater treatment plants. This Thesis two-phase simulations (water – air) of the hydraulics of a free-surface compartment of a wastewater treatment plant, where local conditions determine the formation of three dimensional flow structures.

Suitable for master students.

M) MISCELLANEOUS/INTERDISCIPLINARY TOPICS

M1) MACHINE LEARNING MODELS APPLIED TO LIMNOLOGY.

Artificial intelligence and Machine learning applications in water management and hydro-environment engineering and research have been increasing rapidly during the last few years. In particular, these models could be complementary to physical-based model for the solution of problems characterized by an intrinsic complexity of the processes or the unavailability of the information needed for their mathematical description. In this Thesis, the student will develop a ML model for the simulation of the overflows from the sewer systems to a lake, which have a major consequences to the bacterial pollution of the waters used for recreational purposes.

Suitable for master students. Knowledge of Matlab or Phyton is required.