**Milestone 1.1 Identification of the study areas**

Lake Erken and lake Mälaren are two of the very few lakes in Northern Europe that have a long history of monitoring, including both manual and high-frequency automatic measurements of lake and stream stations. The monitoring programme includes measurements of physical and chemical parameters as well as plankton composition.

Lake Erken is a moderately eutrophic lake located in east-central Sweden near the Baltic coast (59.8 N 18.6 E). The lake has a surface area of 24 $km^2$, an average depth of 9 m, a maximum depth of 21 m and a water residence time of approximately 7 years. The Lake has been the site of Uppsala University's limnological field station for nearly 80 years, where a large variety of research covering all aspects of limnology have been carried out. The field station was first established in 1944, and later followed by the addition of a research Laboratory on the lake shore, and a small meteorological station on an island offshore (Fig. 1).


Figure 1 - Lake Erken and its watershed. The bottom shows the location of the automated monitoring systems that are operational on the lake.

This meteorological station on Malma Island, completed in 1958, was one of the first developed to support limnological studies. In addition to standard meteorological measurements of wind solar radiation and air temperature, a stilling well was installed to allow continuous monitoring of lake level, and underwater thermistors were installed to automatically monitor water temperature. Originally, all data were collected on paper charts and these were transcribed to produce daily summary statistics. Between 1987 - 1988 the meteorological station measurements were converted to record data digitally, and measurements made at 1 min frequency were summarized and saved at hourly and daily time intervals. During this time a water temperature monitoring system was also established at the eastern end of the main basin of the lake at a depth of 15 m. Measurements at 0.5 m intervals made at this station allow detailed analysis of the lake thermal structure and supplementary measurements of wind speed close to the water surface. Water discharge is measured entering the lake from the largest input at Kristineholm, and the lake outflow discharge is measured at Stensta. At Kristineholm the inflow concentrations of dissolved organic carbon (DOC) are estimated by monitoring the fluorescence associated with DOC in the inflowing stream water. In 2014 the Erken laboratory joined the SITES (https://www.fieldsites.se/en-GB) research network and as result of increased funding and support was able to further increase the automated monitoring program to include a YSI profiling system that collects hourly profiles of dissolved oxygen, turbidity, pH and fluorescence measurements of phytoplankton, chlorophyll, cyanobacteria phycocyanin and DOC . Automated lake monitoring from

Malma Island and other sites (Fig. 1) continues to this day (http://130.238.87.115:8080/Erken4/index.html). Lake Erken joined the GLEON lake monitoring network (http://www.gleon.org/) in 2007 and has one of the longest data records of the GLEON sites.

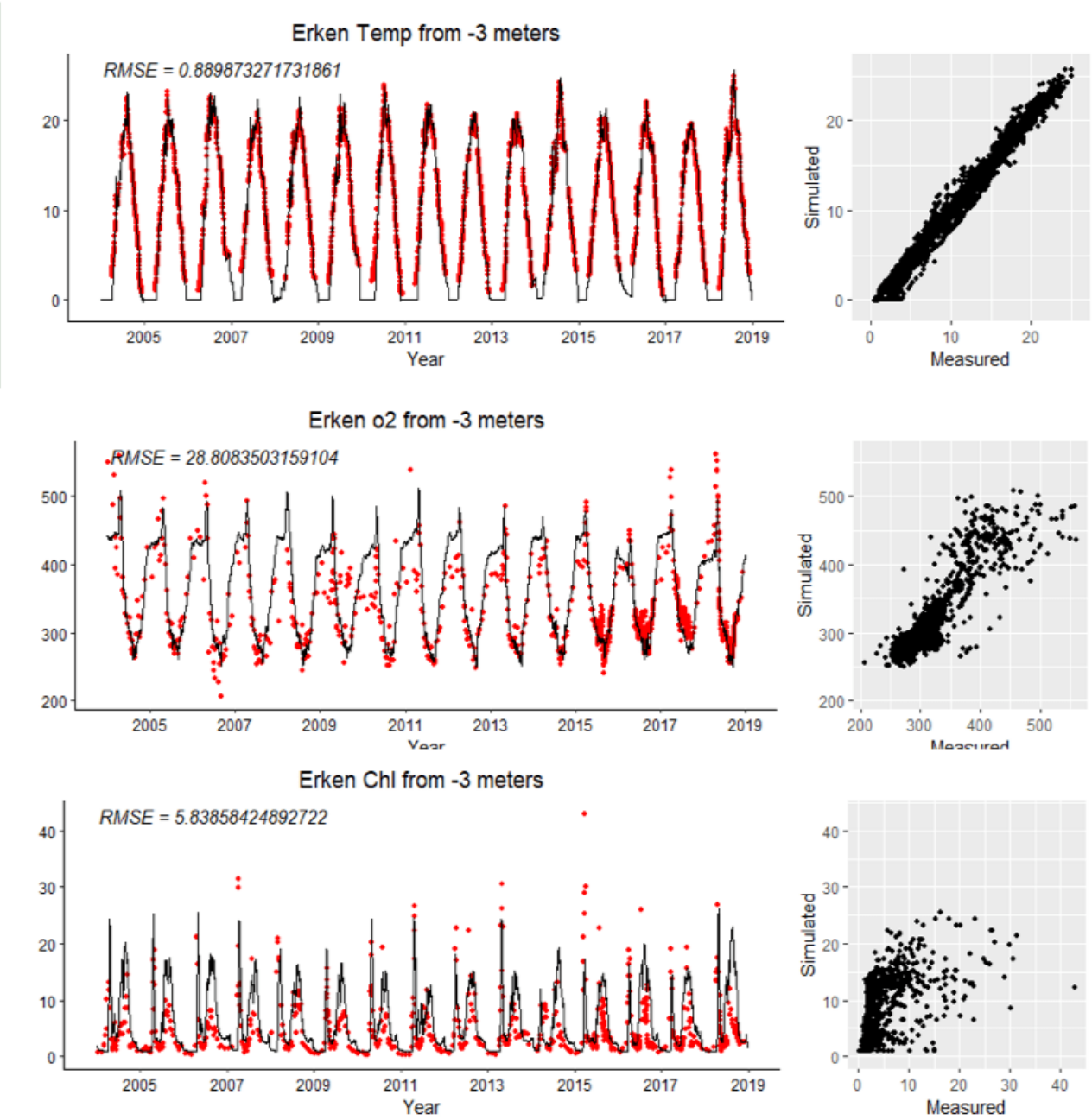
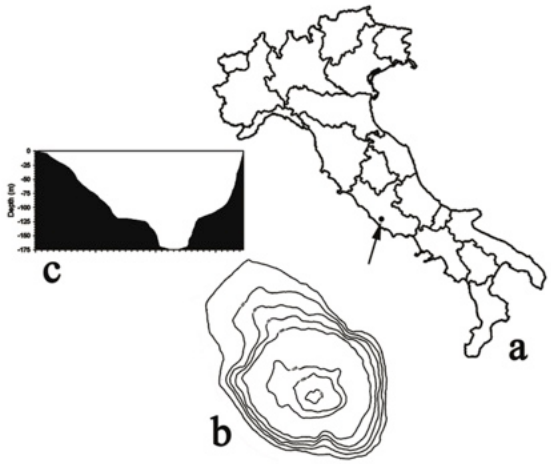



Figure 2. Model simulations of Lake Erken water temperature (top) dissolved oxygen (middle) and chlorophyll concentration (bottom). Red points are data from Erken's monitoring programs. Black line is the simulated values.

Lake Albano is a closed crater basin located on the west side of the Colli Albani volcano in Latium (central Italy), nestled between small hills and a few municipalities of the area

known as Castelli Romani, 25 km south-east of the city of Rome. On its coasts there are important prehistoric and Roman archaeological remains, such as the Village of Macine, the artificial emissary and the Doric and Bergantino nymphaeums, along with a part of the complex of the Villa Albana of Domitian.




Geographical position of Lake Albano within the Italian peninsular (a), bathymetric map (b) and a cross sectional profile of the lake from NW to SE of the lake (c). (source Ellwood et al., 2009)

The lake is located at 293 m above sea level and has an area of 5.2 km2, a perimeter of 10 km and a depth of ~ 175 m. Unlike most volcanic lakes, Albano is elliptical in shape, stretched in the NW-SE direction, filling two craters that represent the last known eruptive products of the volcano. For the frequent seismic activity in the volcanic system, the local uplift, the gaseous emissions (mostly CO2, H2S, HF) and the hydrothermal activity the area is still deemed geologically hazardous.

According to a hydrogeological study (Capelli et al. 2000), the lake is fed mainly by groundwater as it intercepts water from two aquifer systems, a regional one and a perched one.

Since 1960s the lake water level has dramatically lowered by more than 4 meters, mainly due to ongoing anthropogenic processes such as urbanization and over-exploitation of lake water and groundwater, that is not balanced by the meteoric intake, which has also decreased.

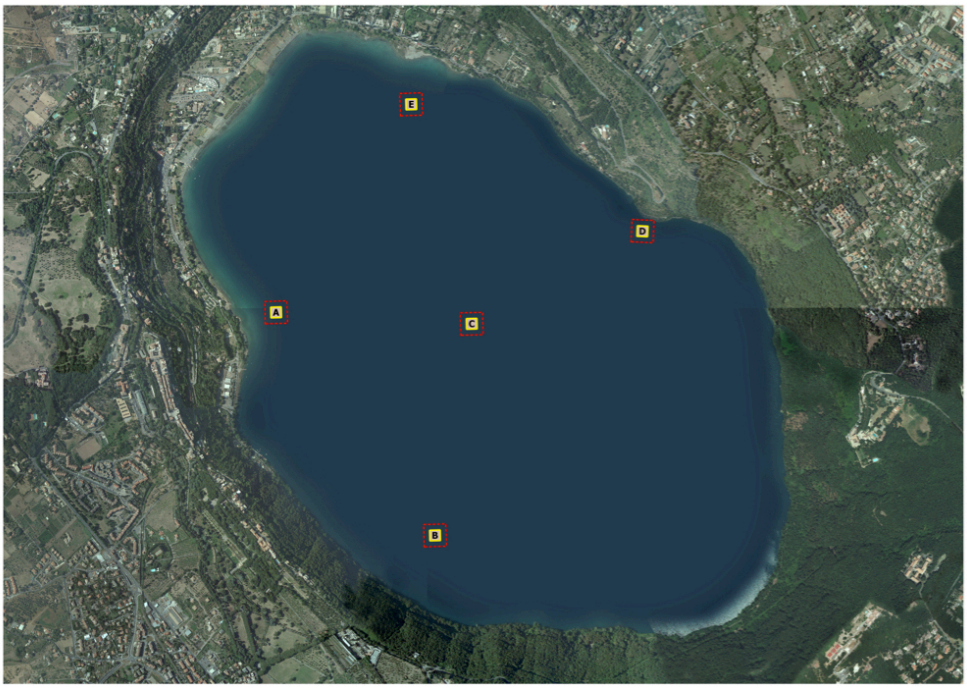
In addition, a 47 years-water renewal time combined with increase pollutants, mainly from sewage effluents and to a lesser extent from surface run-off, results in elevated levels of nitrogen and phosphorus that affect the water quality and increase the anthropogenic lake eutrophication.

Massive algal blooms are a well-known consequence of the excess of nutrient loading and storage to water bodies with low hydro dynamism, and lake Albano is also affected by algal blooms.

Following the large toxic algal bloom detected in February 2001, indeed, a study carried out by Istituto Superiore di Sanità (2001-2003) showed the presence of two steady populations of the toxic Cyanophycea *Planktothrix rubescens*. The toxins from these cyanobacteria, when produced in sufficient quantities can cause death of animals and pose risk to human health.

The high Nitrogenous/Phosporous ratio presents in Lake Albano is particularly favourable to algal bloom of the toxic *P. rubescens.*

For these reasons, bathing and lake fruition are in general forbidden to the population during the period of algal blooms (winter-early spring).




Bloowater-Flight areas and water sampling points

**Sources**

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Lake Castreccioni is a lake created in the 1980s when a dam was placed across the Musone River near Monte San Vicino, at about 70 km far from the coast. The biggest artificial lagoon in the Marche region (Central Italy), Lake Castreccioni covers about 2.4 $km^2$ and reaches depths of 55 feet. The dam (67 m high and 280 m long) is situated on a homogeneous calcareous-majolica formation (Upper Jurassic-Lower Cretaceous) belonging to the prevalently limestone unit of the Umbro-Marche sequence. The volume of the lake at the maximum altitude is approximately 50 million cubic meters.

The potabilization plant (Acquambiente Marche) is located near the district of Castreccioni in the municipality of Cingoli and is responsible for drinking water for the member municipalities: Cingoli, Filottrano, Numana and Sirolo. Furthermore, through the Castreccioni pipeline, the treated water also supplies the Municipalities of Osimo and Castelfidardo.

Acquambiente Marche has the purpose of treating and drinking water from the reservoir of the Castreccioni dam from which it is fed by gravity through the intake present in the dam body. The plant represents the center of the activities of Acquambiente Marche both for its strategic importance, supplies water for a total of about 65,000 inhabitants in the winter and about 95,000 in the summer, using technologically advanced and equipped of an advanced ozone disinfection system.

The drinking water plant was started in 2000 and over the years has treated about 140 million cubic meters of water. The maximum capacity is 500 l/sec divided on two equal lines of 250 l/sec. The flow of treated water is a function of the needs of the distribution network and is accounted for both influent and effluent. The process steps are: Pre-disinfection with ozone (pre-ozonation), clariflocculation, sand filtration, disinfection, ozonation, activated carbon filtration, accumulation tanks and final disinfection with chlorine dioxide. There is also accessory equipment thanks to which the chemical and physical parameters such as temperature, turbidity, pH, conductivity, dissolved oxygen for raw water or pH, nitrite conductivity and active free chlorine for the treated water and aluminium and ozone in intermediate samples are continuously determined. The variability of the organoleptic and chemical characteristics of the water coming from the Castreccioni reservoir obliges the Company to continuously and dynamically manage to promptly intervene in all cases in which

unfavourable interventions occur under the conditions of the drinking water process also in case of cyanobacteria concentrations in the influent.

Based on the monitoring campaign by ARPAM conducted since 2014, it is concluded that:

- Lake Castreccioni is characterized by relatively low nutrient values (oligo-mesotrophic lake); also identified as "phosphorus as the limiting element for algal productivity" (typical for most Italian lakes).
- The genus *Planktothrix* constitutes the prevalent part of the phytoplankton (except for the summer period, in which there are more algal species). The same is typical of the initial stages of cyanobacterial contamination, so that once they reach the oligotrophic reservoir, they proliferate in the absence, or scarce co-presence of other algal species. Over the years, as a rule, there should be an increasingly articulated structure of the phytoplanktonic populations, a structure that should guarantee "a greater ecological balance between the species, also determining containment of the intensity of the algal blooms".

*P. rubescens* can produce numerous types of toxins (microcystins) with a hepatotoxic, gastroenteric and carcinogenic value. Since one of the possible means of the migration of these toxins is drinking water, Acquambiente monitor the concentrations of these substances in the distributed water through periodic analyses.

Fig. 1 - Lake Castreccioni, Cingoli (Marche Region, Italy)

Fig. 2 - Basin of the municipalities through the Castreccioni pipeline.

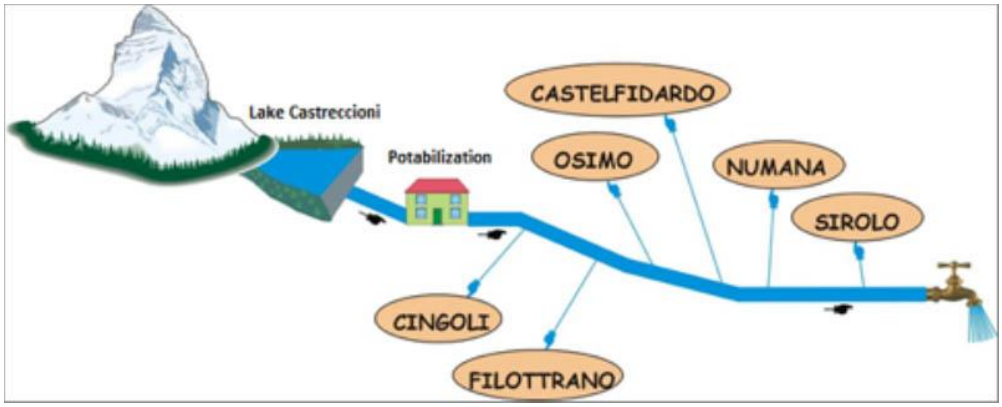

Fig. 3 - Potable water supply of Lake Castreccioni (obtained and modified from the Acquambiente website)