Retrieval and analysis of remotely sensed water quality parameters published on a collaborative web platform for SIMILE project

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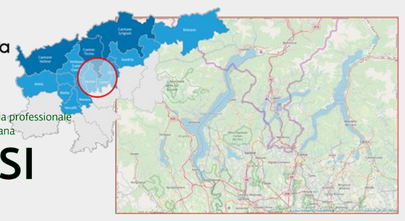
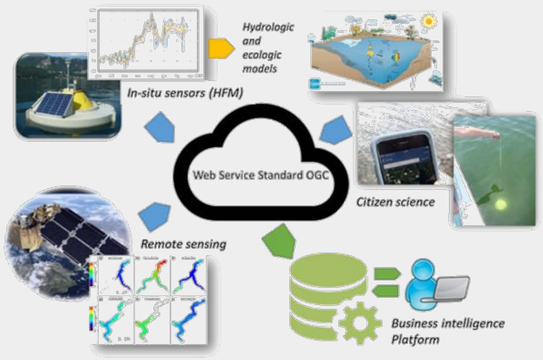
ABOUT THE PROJECT

SIMILE (Integrated monitoring system for knowledge, protection and valorisation of the subalpine lakes and their ecosystems), is an **INTERREG Italy-Switzerland** project, started in 2019, that **aims at preserving the water quality** of the subalpine lakes **Lugano**, **Como** and **Maggiore** by **integrating new monitoring techniques to the existing ones**.



SIMILE involved partners and study area



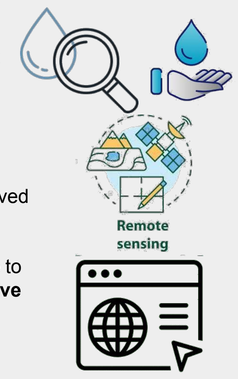
SIMILE integrated monitoring system

AIM

SIMILE aims to **catch lake water quality behavior** through the use of different monitoring techniques .By understanding better the lakes, it is possible also to **manage and protect** them in a more effective way.

In SIMILE project, **Remote sensing** has the aim to freely, frequently and synoptically **collect water quality parameters over the whole lakes areas**. Satellite imagery **processing workflow should be feasible** to all SIMILE involved partners to establish a long term monitoring capacity.

All SIMILE water quality maps derived from satellite imagery will be **accessible** to citizens and public administrations thanks to the **development of a collaborative web platform** for sharing monitoring products.

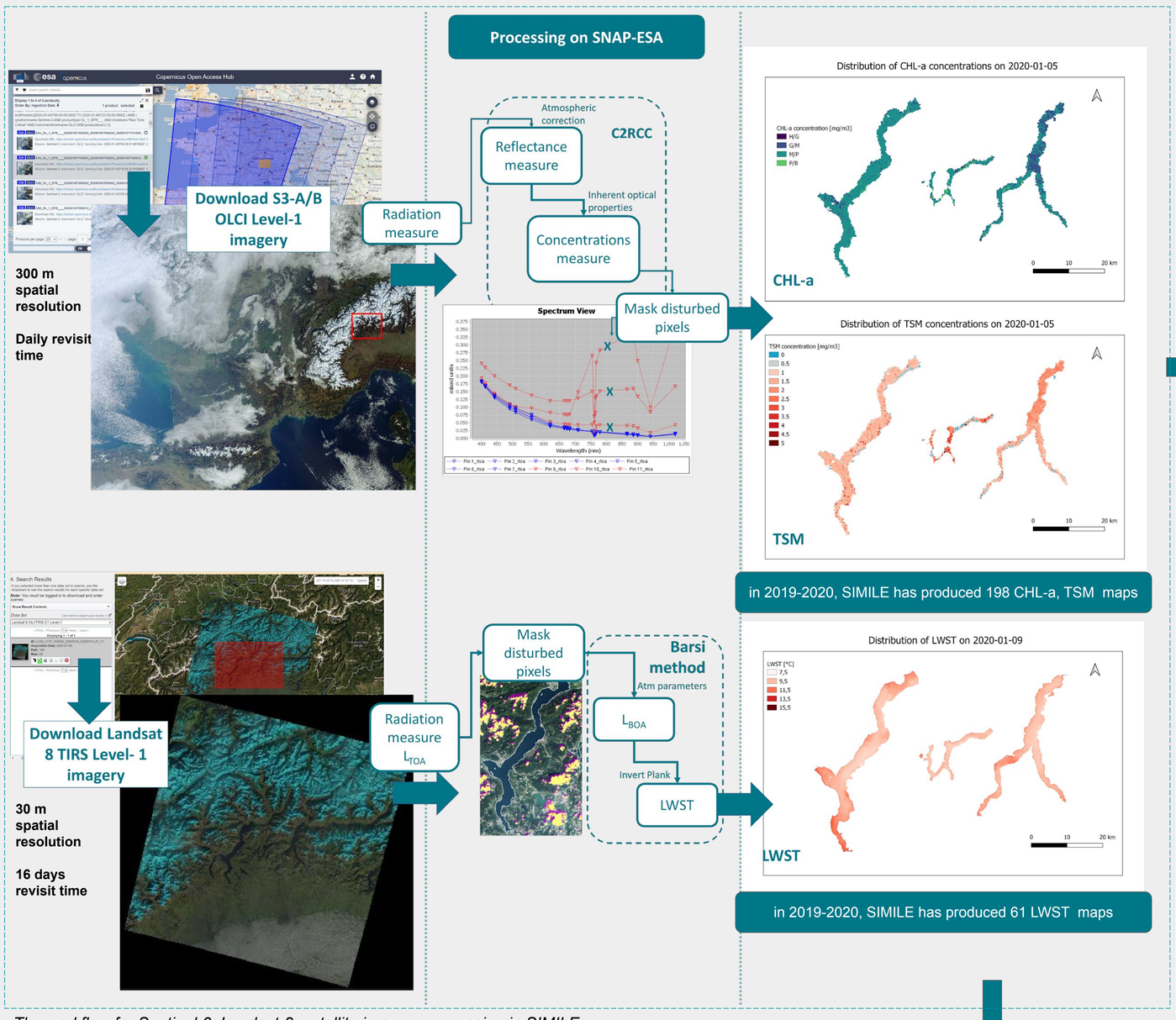


SATELLITE IMAGERY PROCESSING

Under the scope of the SIMILE project, the study exploits different sources of remotely sensed data:

- **ESA Sentinel-3 A/B OLCI** for mapping chlorophyll_a (**CHL-a**) and Total Suspended Solids (**TSM**) concentrations;
- **NASA Landsat 8 TIRS** for mapping the Lake Surface Water Temperature (**LSWT**);
- **ESA Sentinel-2 A/B MSI**, 10-20 m resolution images, for occasionally investigating anomalies in the detected CHL-a and TSM concentrations.

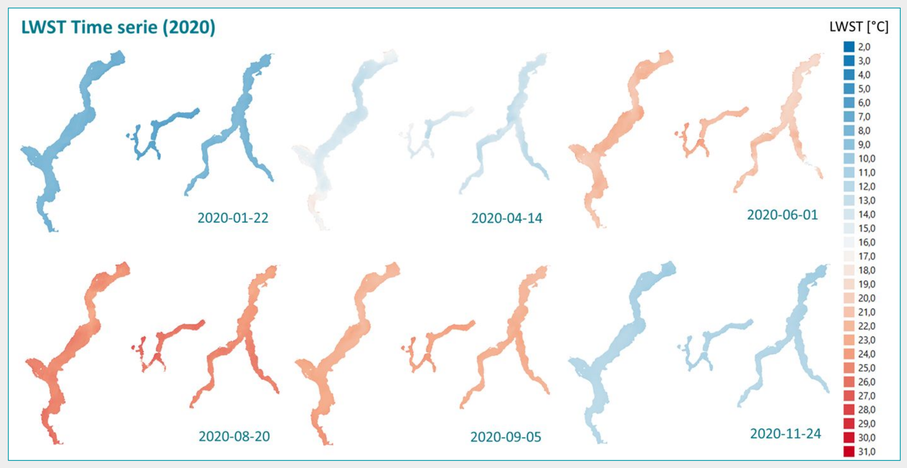
Sentinel-3 and Landsat 8 images are processed on the free and open source software **SNAP**, distributed by ESA. In particular, Sentinel-3 imagery is processed through the Case 2 Regional Coast Colour **C2RCC** open source algorithm that automatically performs radiometric and atmospheric correction and retrieves CHL-a and TSM concentrations, by having in input some site-specific coefficients for the inherent optical properties of the lakes. LWST is instead computed with the **Barsi method**, by inverting Plank law, after atmospheric correction (transforming sensor detected radiances, Ltoa, to bottom of atmosphere ones, Lboa). For both Sentinel-3 and Landsat-8 imagery processing includes **mask application** on pixels disturbed (e.g. for clouds presence).



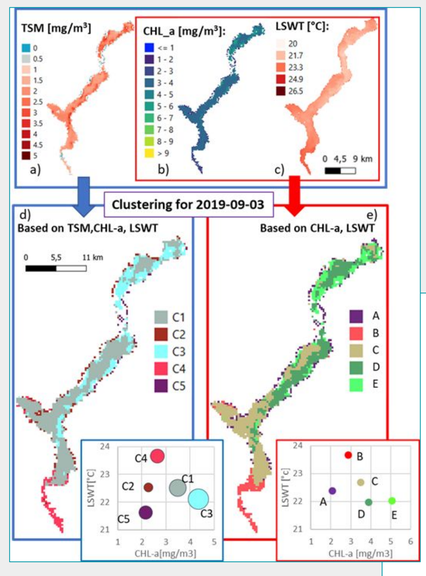
The workflow for Sentinel-3, Landsat-8, satellite imagery processing in SIMILE.

THE ANALYSIS OF RESULTING WATER QUALITY PARAMETERS MAPS

CHL-a, TSM and LWST maps produced for SIMILE project can be **analysed and combined** to better understand the lakes behavior **over time and space**.

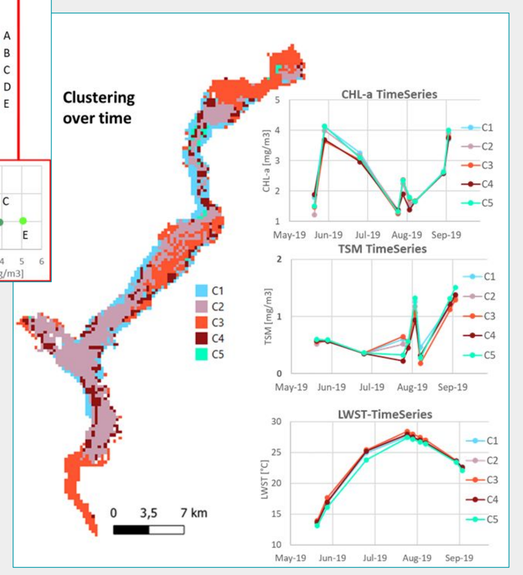


Lake Water Surface Temperature distributions through 2020.



From combination of CHL-a, TSM and LWST, it is possible to better understand the spatio-temporal variability of lake water quality.

Particularly, by clustering the three detected parameters through time and space it has been possible to zone the lakes for the different behaviors of their areas.



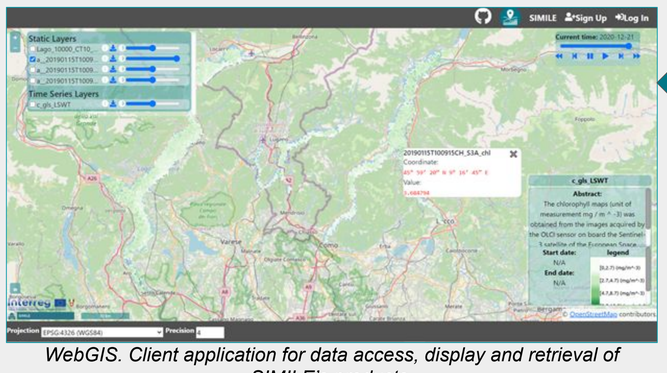
Example of clustering on a combination of TSM, CHL-a, LWST maps (a, b, c) for 2019-09-03. Zoom on Lake Maggiore.

Example of clustering with respect to CHL-a, LSWT and TSM values over time. Zoom on Lake Maggiore. Time series for each cluster are shown here from May to September 2019.

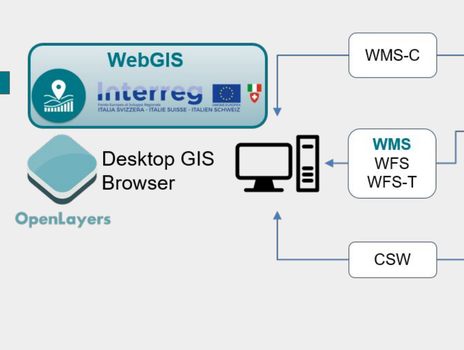
COLLABORATIVE WEB PLATFORM

The **collaborative web platform** is composed by **two parts**. First, there is the **Web data sharing platform** built on top of a Docker composition of GeoNode. The platform incorporates a collection of robust frameworks and software aimed at easing the data-sharing of geospatial data. Besides, the platform grants the possibility to make the stored data available through OGC web services. A second step to the collaborative platform is the development of a **WebGIS** using node.js and OpenLayers (JavaScript web mapping library). The WebGIS provides a user-friendly environment for the visualization of SIMILE's products. The WebGIS focuses on simplifying the **access**, **display** and **retrieval** of **time series of data**.

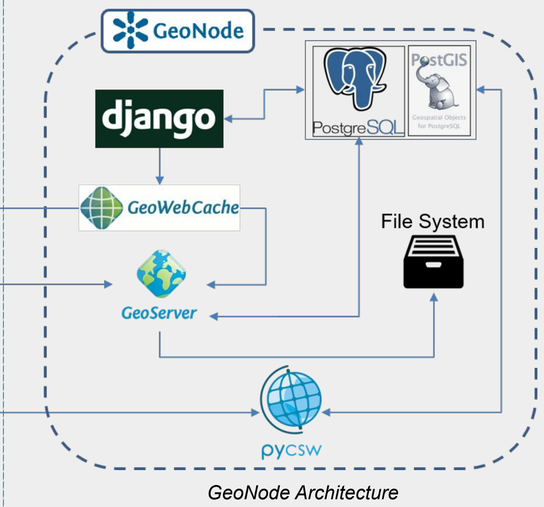
WebGIS



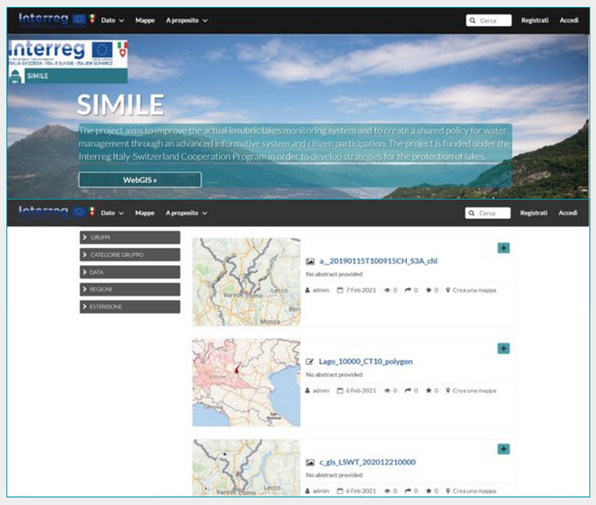
WebGIS. Client application for data access, display and retrieval of SIMILE's products.



Web data sharing platform

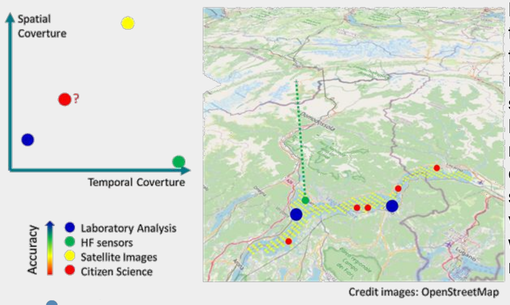


GeoNode Architecture



GeoNode web interface. Web data sharing platform for water quality data. Upload, edit and management of data.

OPPORTUNITIES



Differently from *in situ* traditional measurements, through Remote Sensing it is possible to **simultaneously monitor large areas**, with a **relevant temporal coverage**, catching the spatial and temporal variability of optically active water quality parameters at relatively low costs.

It has been possible to teach the Sentinel-3 and Landsat-8 imagery processing to SIMILE partners through a 10h course.

CHALLENGES

- The **effective temporal resolution** of these optical remote sensing products depend also by meteorological issues: **clouds** and other phenomena can cause disturbed pixels that are masked due to their false values
- In the smaller lakes as Lugano, the medium spatial resolution of Sentinel-3 makes it more difficult to detect the spatial variability of water quality parameters due to higher occurrence of **mixed pixels** that need to be masked.
- While GeoNode provides a powerful tool for data-sharing, there are some limitations regarding the management of multidimensional raster datasets (such as rasters time series). The web platform does not support to upload of raster data with a temporal attribute. The WebGIS had to benefit from a standardized naming convention for the datasets to recreate the time series.

ACKNOWLEDGMENTS

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