EO 4 Ecosystem Accounting 2022

Monitoring multidimensional spatial and temporal dynamics of aquatic ecosystems using Earth Observation data

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Intro

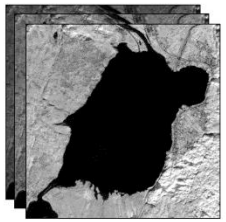
- **Field-based monitoring** of aquatic ecosystems **limited** by logistic constraints and costs (more than in most terrestrial biomes).
- Recent **technical developments** and increasing **operational uptake** (e.g. under Copernicus) boosted the **potential of EO** to map aquatic ecosystem features and conditions quantitatively and efficiently.
- EO can provide **frequent and synoptic** data at **multiple scales** (from local to global) that cover aquatic ecosystem variables, dealing with **physical**, **structural**, **functional** and **landscape features** (UN SEEA EA, 2021), such as:
    - water quality parameters
    - water extent and level
    - phytoplankton blooms
    - aquatic vegetation composition and diversity
    - functioning of primary producers (habitats of community interest).
- We present **quasi-operational examples** showing monitoring spatial and temporal **dynamics** of **freshwater and wetland ecosystems** based on Sentinel-2 satellite data, developed over selected case studies in Italy.

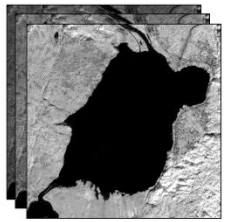
Case study 1 – post-hazard ecosystem assessment

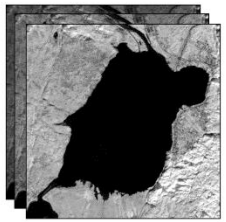
Assessing temporal evolution of key ecosystem variables after an upstream landslide in perialpine Lake Mezzola

P. Cengalo landslide (23 Aug 2017)

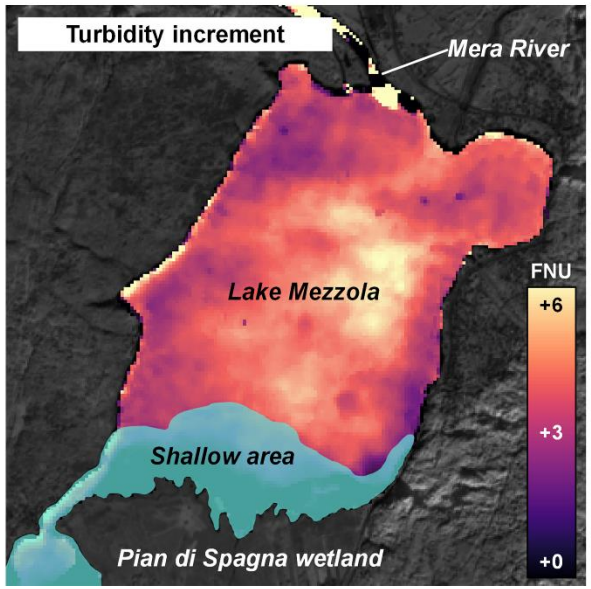
Time series of satellite data (Sentinel-2)

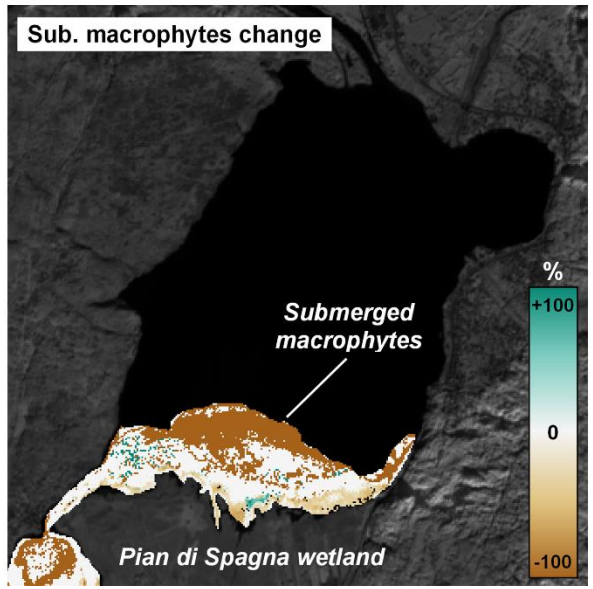

2016 (***pre-event***)

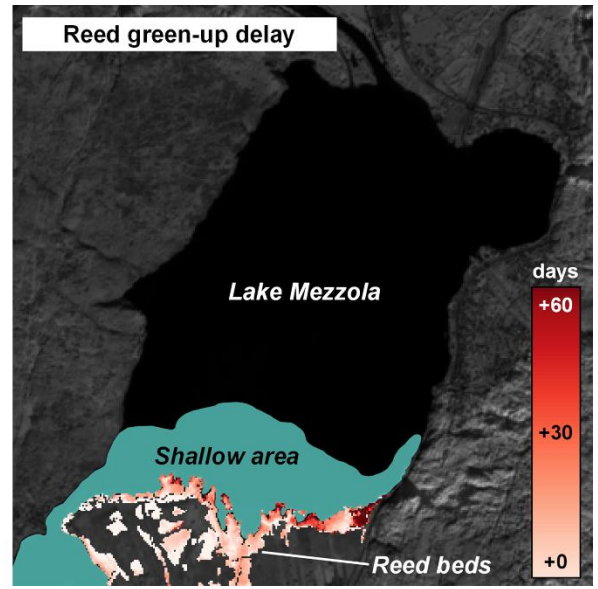

2017


2018 (***post-event***)

Mapping of landslide aftermath impacts on Lake Mezzola ecosystem



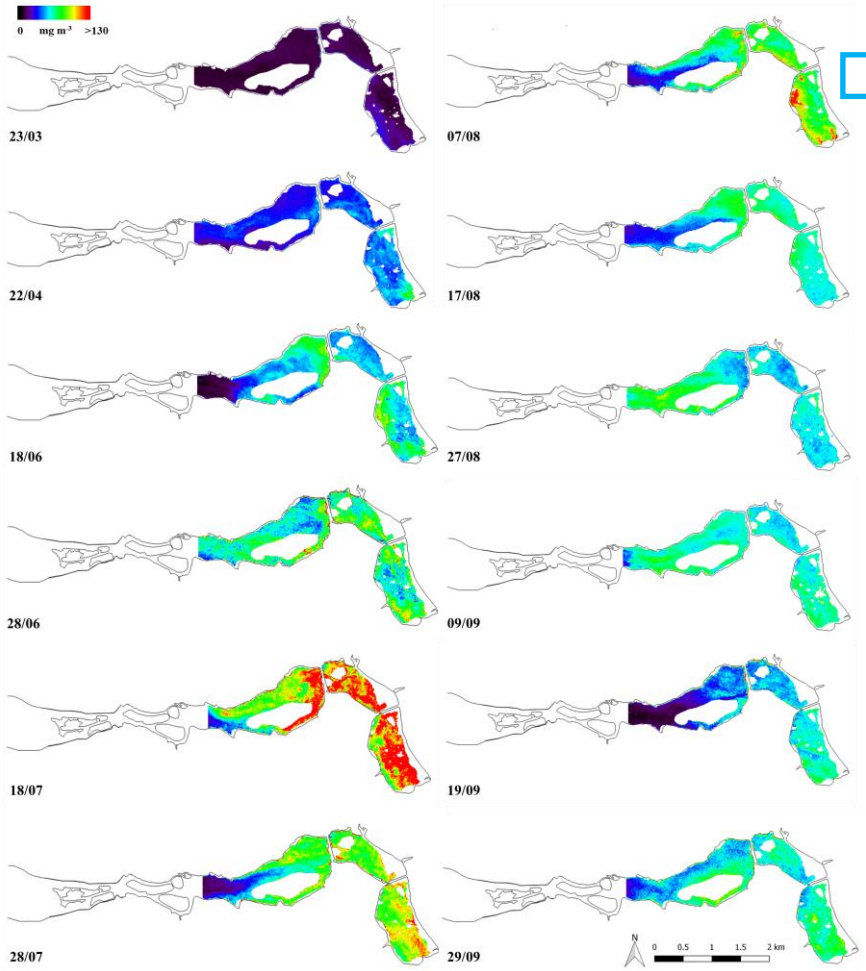




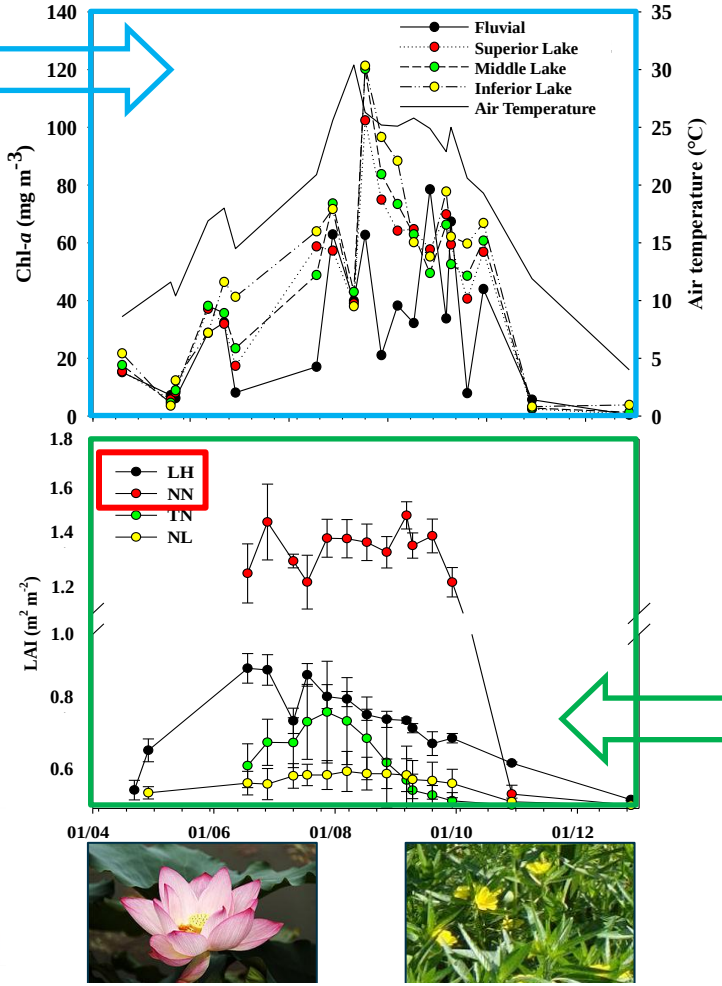
Villa et al. (2020). Impact of upstream landslide on perialpine lake ecosystem: An assessment using multi-temporal satellite data, *STOTEN*

Case study 2 – mapping PPs dynamics

Mapping intra-annual dynamics of primary producers - phytoplankton and macrophytes - in Mantua lakes system

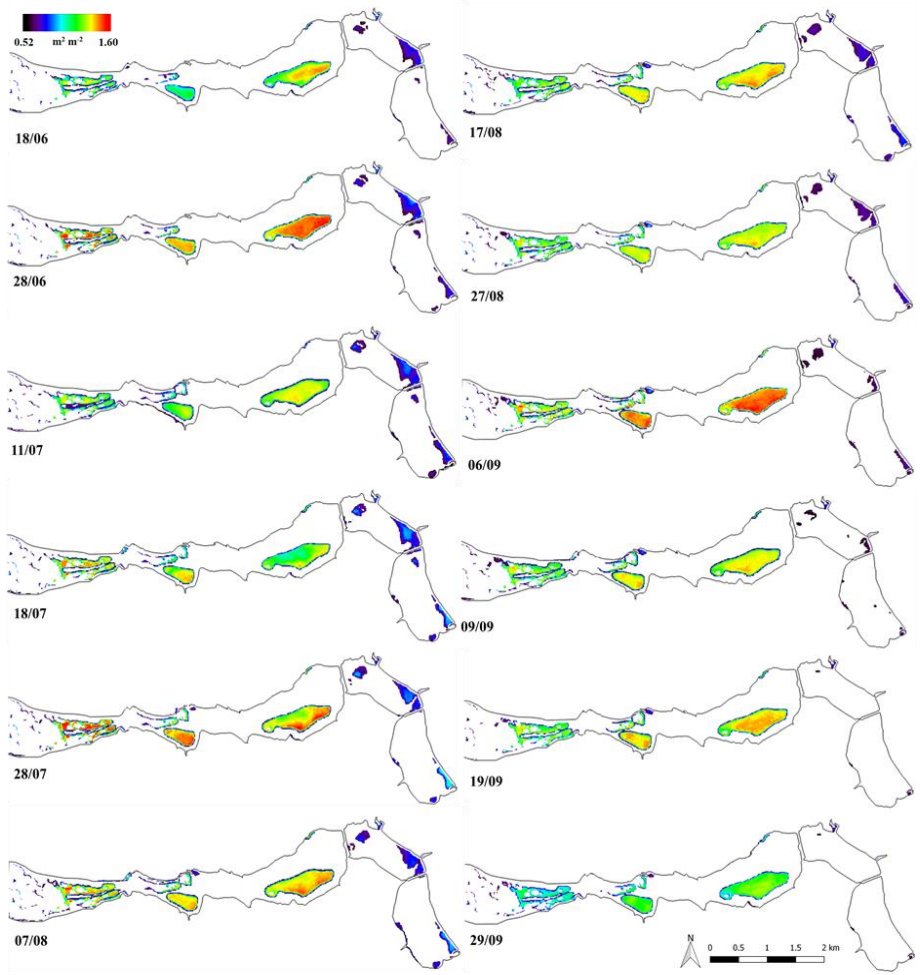


Chl-a concentration (2016)



NN = *N. nucifera*

LH = *L. hexapetala*

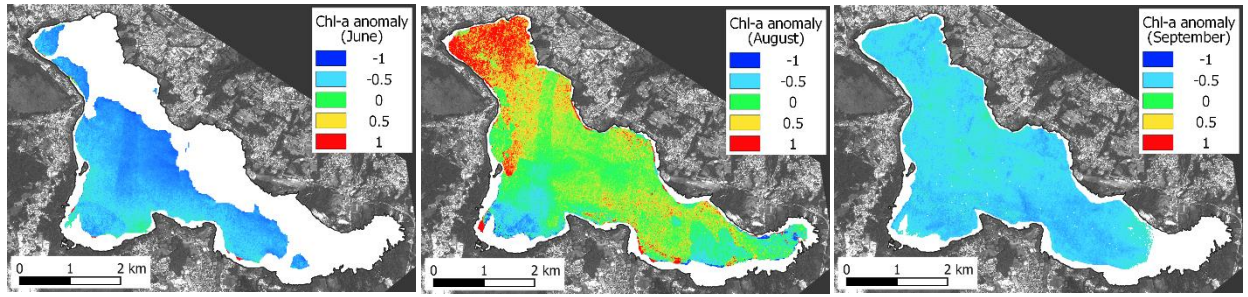


Macrophyte LAI (2016)

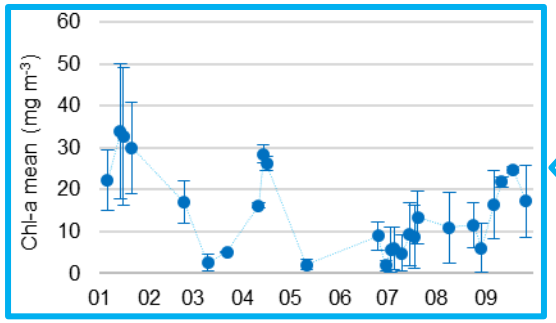
Pinardi et al. (2018). Spatial and temporal dynamics of primary producers in shallow lakes as seen from space: Intra-annual observations from Sentinel-2A, *Limnologica*

Case study 3 – monitoring seasonal PP anomalies

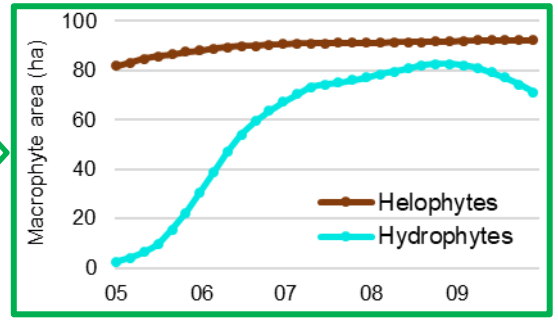
Monitoring water quality (chl-a) and macrophytes anomalies along the growing season in eutrophic Lake Varese

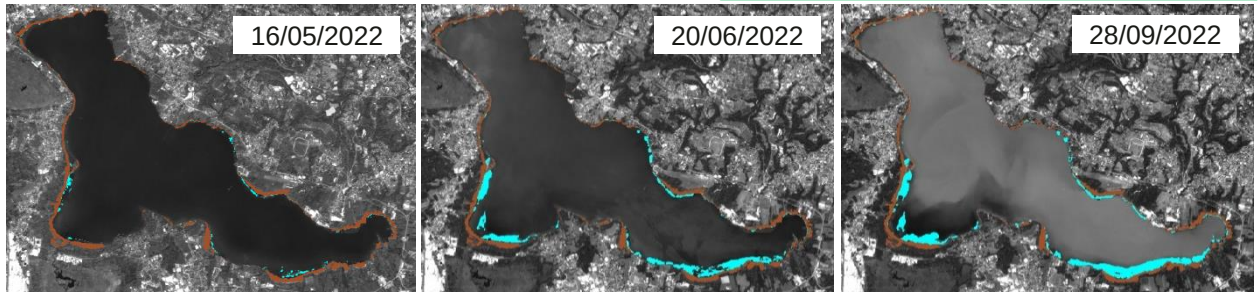


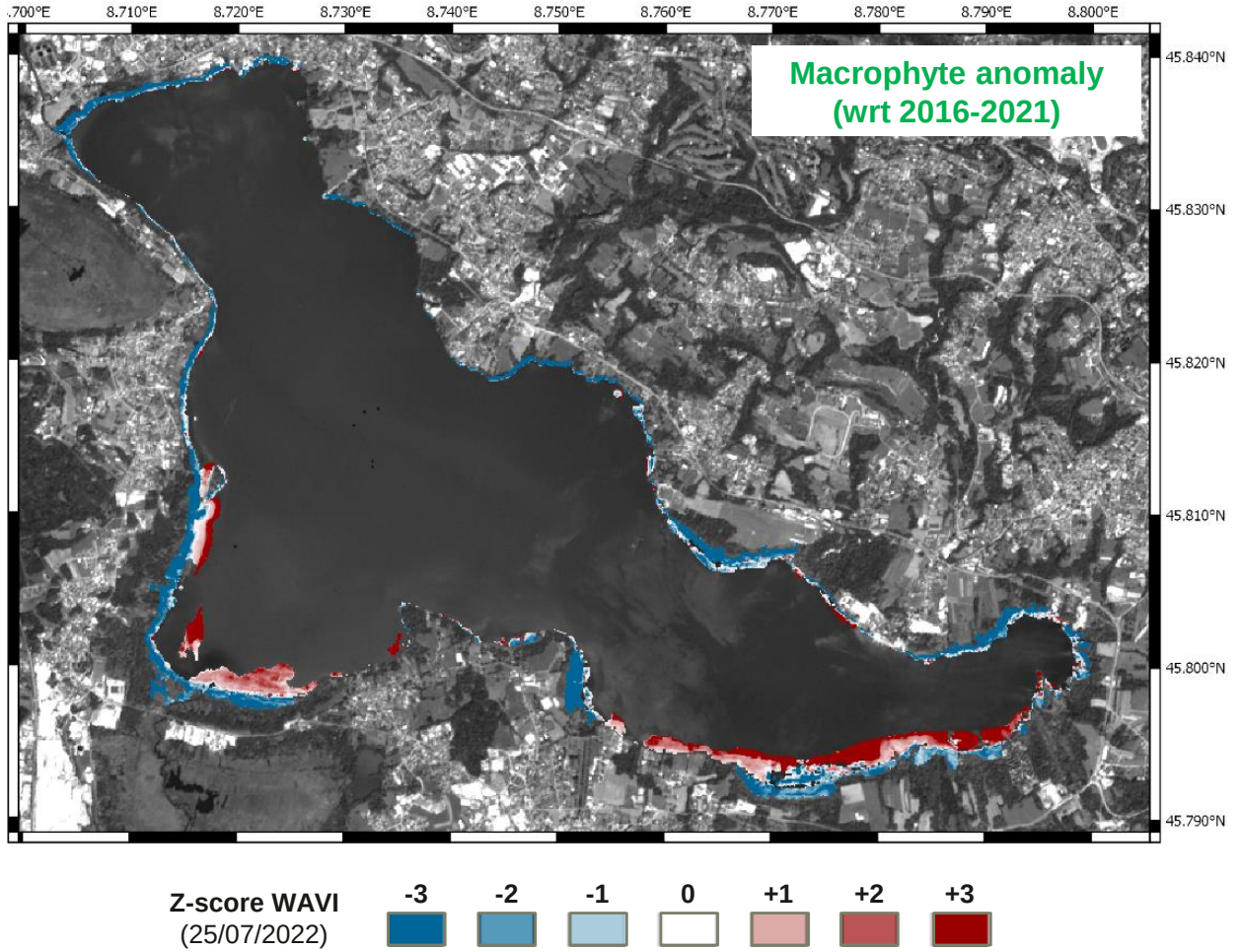
Chl-a anomaly (wrt 2021)



Macrophyte cover







Z-score WAVI (25/07/2022)

-3 -2 -1 0 +1 +2 +3

Source: Agreement for the protection and ecological recovery of Lake Varese (Lombardy Region – CNR)

EO for aquatic ecosystems assessment

Challenges

- **Heterogeneous** analysis **techniques**
- Spectral - biophysical **features overlapping**
- **Observation scale** and FOV
- Ecologically **relevant features** or spectral **bias**?
- Need for **cross-disciplinary**, unifying approaches.

Opportunities

- High-throughput, **quantitative** data
- **Efficient**, large coverage (few logistic constr.)
- **Synoptic** picture in space and time (**dynamics**)
- Allows straightforward comparisons **across sites**
- **Multidimensional** integration, big data mining

Recommendations

- Designing and implementing EO-based products **including external validation** against reference data (existing or to be collected) into **operational workflows**
- Linking EO-based monitoring and retrospective analysis to short and medium term **predictions** through physical and ecological **modelling**