IDENTIFICATION AND CHARACTERIZATION OF PIT LAKES AT CATCHMENT SCALE USING SATELLITE IMAGERY

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ABSTRACT

This study focuses on the historical analysis of satellite imagery in order to assess the occurrence and quality status of pit lakes in the Po River Basin. The primary aim is to quantify the number, distribution, and major characteristics of these lakes/waterbodies in order to assess under what conditions they can provide ecosystem services previously supplied by natural lakes and waterbodies which were lost due anthropogenic pressures.

INTRODUCTION

In Italy, about 68×10^6 tons of sand and gravel were extracted in 2014, of which ca. 60% was mined in the Po River basin, corresponding to approximately 300 m^3 km^{-2} y^{-1} [1]. The quarrying activity determines the formation of depressions that modify the morphology and the drainage system in the hydrographic basins. In general, these artificial ecosystems can have both positive and negative impacts on the territory, depending on morphology and morphometry, location and anthropogenic pressures in the watershed.

- *Precious water resource;*
- *Habitat for many organisms (e.g. birds);*
- *Increased overall biodiversity;*
- *Reduction of nitrates and phosphates in groundwater;*
- *Tourism and recreational purpose (e.g. fishing).*

- *Surface runoff from surrounding farmland;*
- *Increased occurrence of waterborne disease;*
- *Risk of eutrophication → Algal blooms;*
- *Increased evotranspiration.*

STUDY AREA – MATERIALS & METHODS

The study area is represented by the **Po River basin**, with an extension of 71’000 km^2.
This area includes 8 regions: Piemonte (25’387 km^2), Valle d’Aosta (3448 km^2), Lombardia (23’663 km^2), Trentino Alto-Adige (1746 km^2), Veneto (948 km^2), Liguria (1789 km^2), Emilia-Romagna (13’998 km^2) e Toscana (21 km^2).

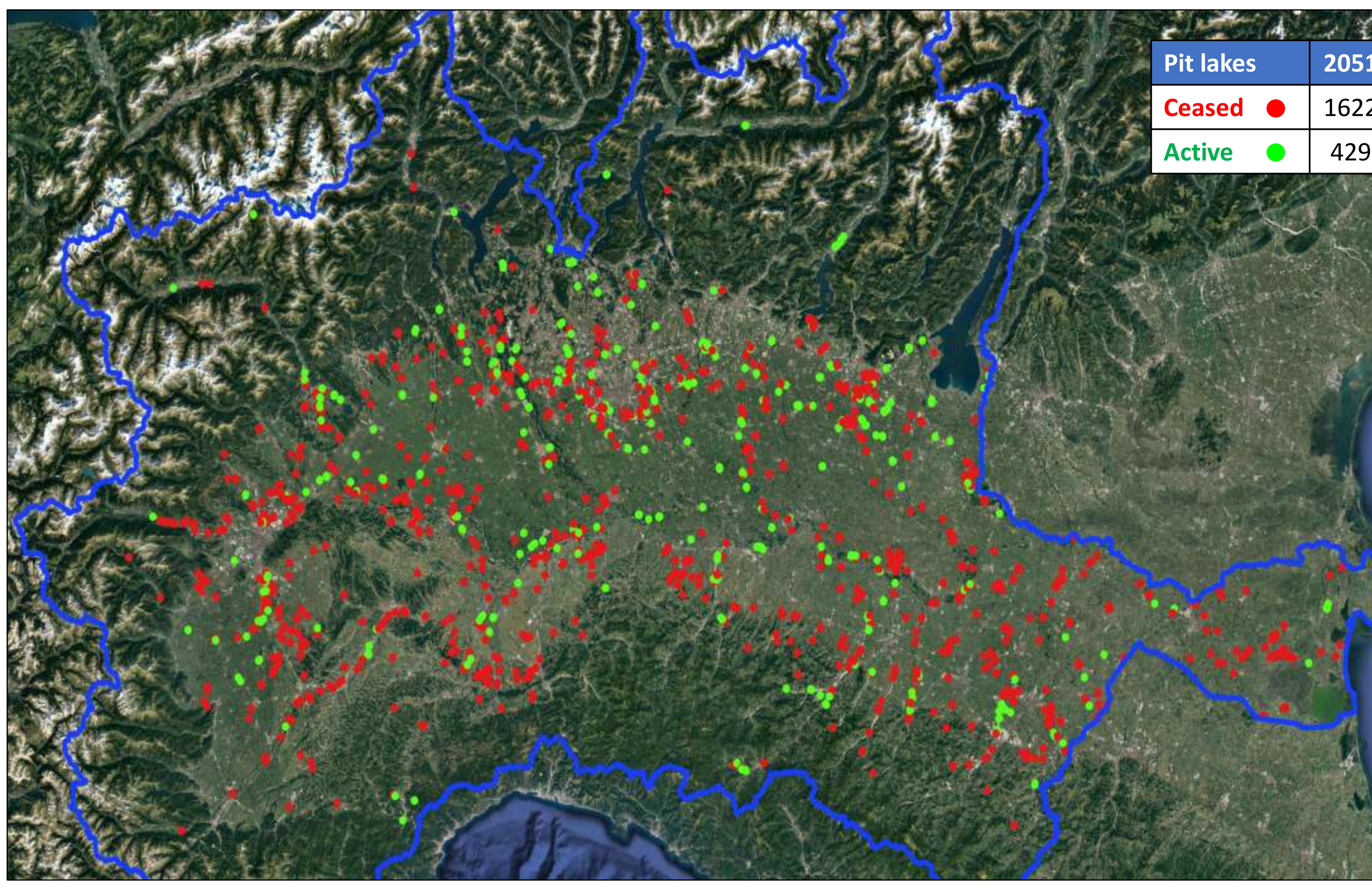

Figure 1: active (green dots) and ceased (red dots) pit lakes in the Po river basin.

Step 1: *identification of all watersheds in the Po river basin using regional database.*
TOT = 12’655

Step 2: *identification of all pit lakes in the Po river basin.*
TOT = 2051

Step 3: *morphological and morphometric analysis:*

- Perimeter (L)
- Area (A)
- Sinuosity index (DL)

$$DL = \frac{L}{2\sqrt{\pi A}}$$

AIM OF THE STUDY

The main objective of this work will be to quantify the number, distribution, and major characteristics of these environments, in order to assess the water quality status of pit lakes in the Po river basin in relation to anthropic pressures and in the broader context of climate change.

The innovation of this project lies in the integration of ***limnological*** and ***remote sensing*** techniques for the analysis of water quality indicators of pit lakes and the factors responsible of water quality change.

SUBSAMPLE ANALYSIS

Creation of a heterogeneous dataset based a **subsample of pit lakes** differentiated by several factors: ***optical properties***, ***location*** (isolated or connected to the river), ***morphology*** and ***age*** (based on cessation of mining activity).

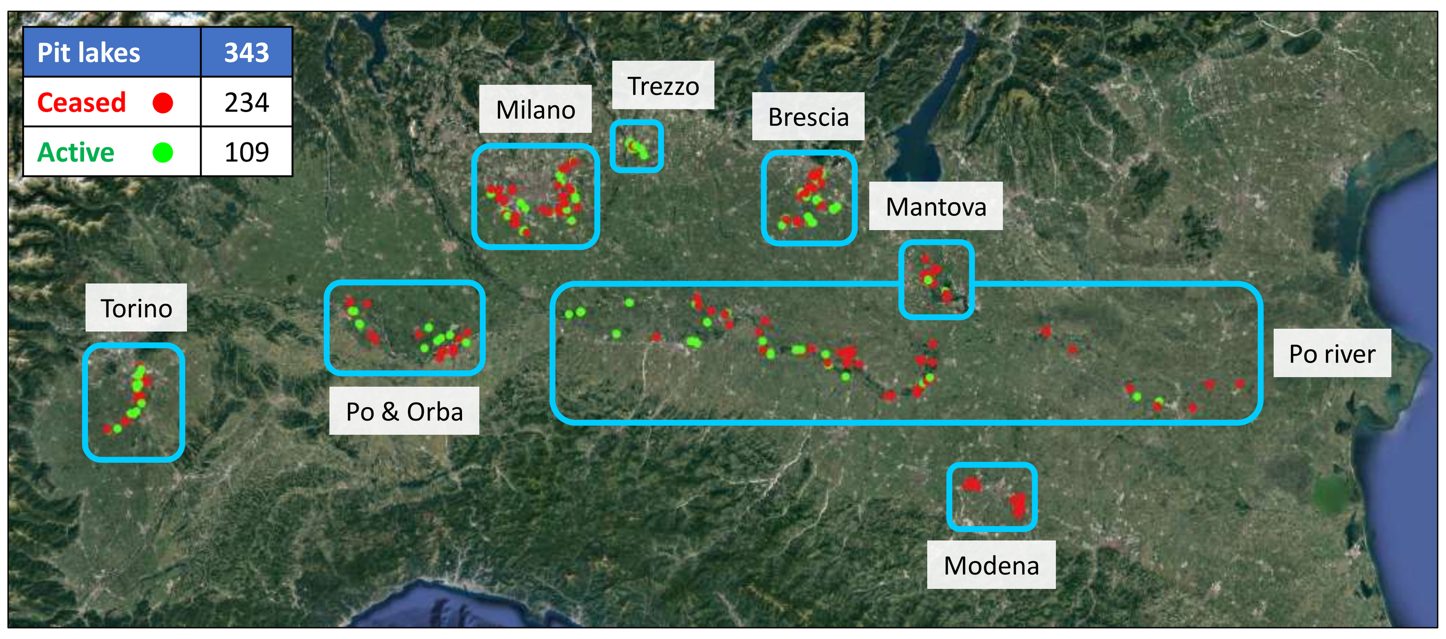

Figure 2: active (green dots) and ceased (red dots) pit lakes in the subsample analysed.

Step 4: *Identification of riparian vegetation and vegetated perimeter.*

Step 5: *Temporal evolution of land use around pit lakes:*

- *Artificial surfaces*
- *Agricultural areas*
- *Forest and seminatural areas*
- *Wetlands*
- *Water bodies*

Corine Land Cover

NEXT STEPS

1. Acquisition and processing of satellite images at medium/high spatio-temporal resolution:
   - **Landsat** (Multispectral, spatial resolution of 30 m, from 1980s);
   - **Sentinel-2** (Multispectral, spatial resolution of 10 m, from 2015);
   - **PRISMA** (Hyperspectral, spatial resolution of 5 m with panchromatic band, from 2019).

2. Identification of the ***dominant wavelength*** (water color) for each pit lake, through chromaticity diagrams [2]. Observation of the dominant wavelength is an efficient and intuitive way to assess water quality [3] and for identifying the optical water type [4,5].

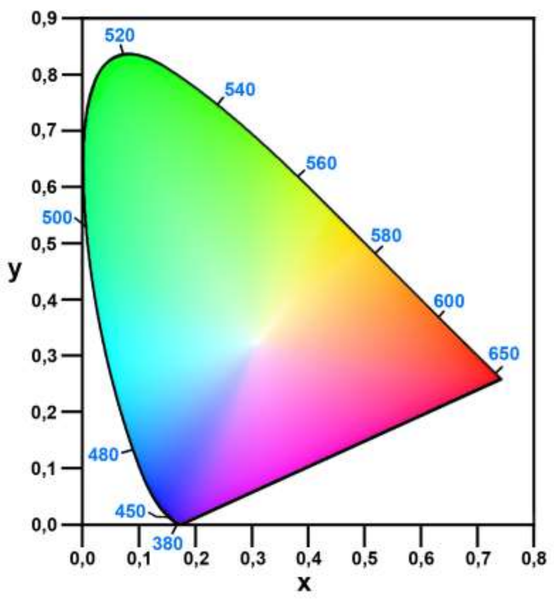

Figure 3: chromaticity diagram.

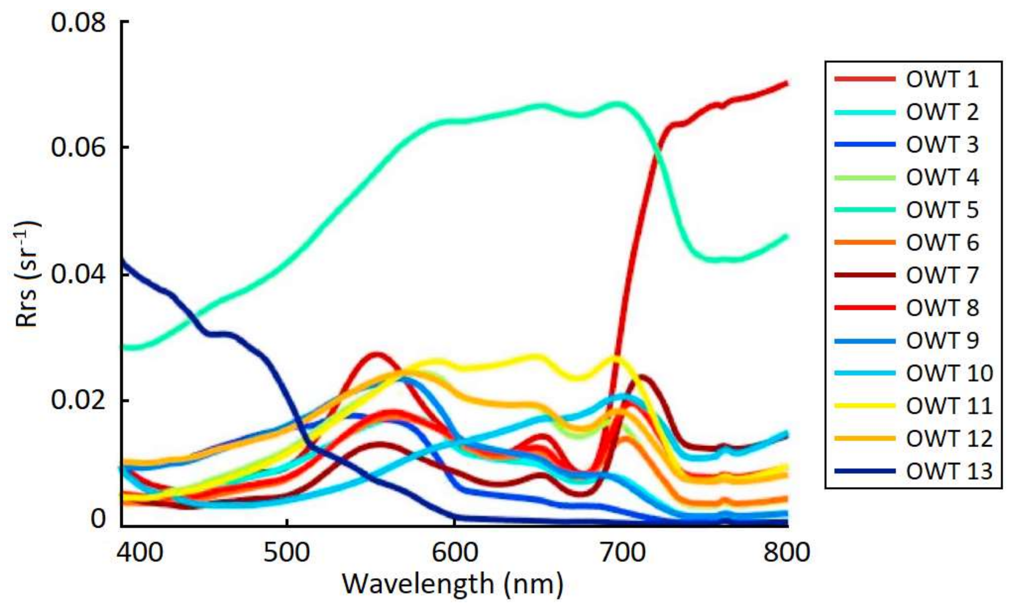

Figure 4: average Rrs spectra per optical water type [5].

3. Creation of thematic maps, using ***ACOLITE*** [6] and ***BOMBER*** [7], related to water quality parameters: suspended solids, Chl-a, bathymetry and bottom coverage.

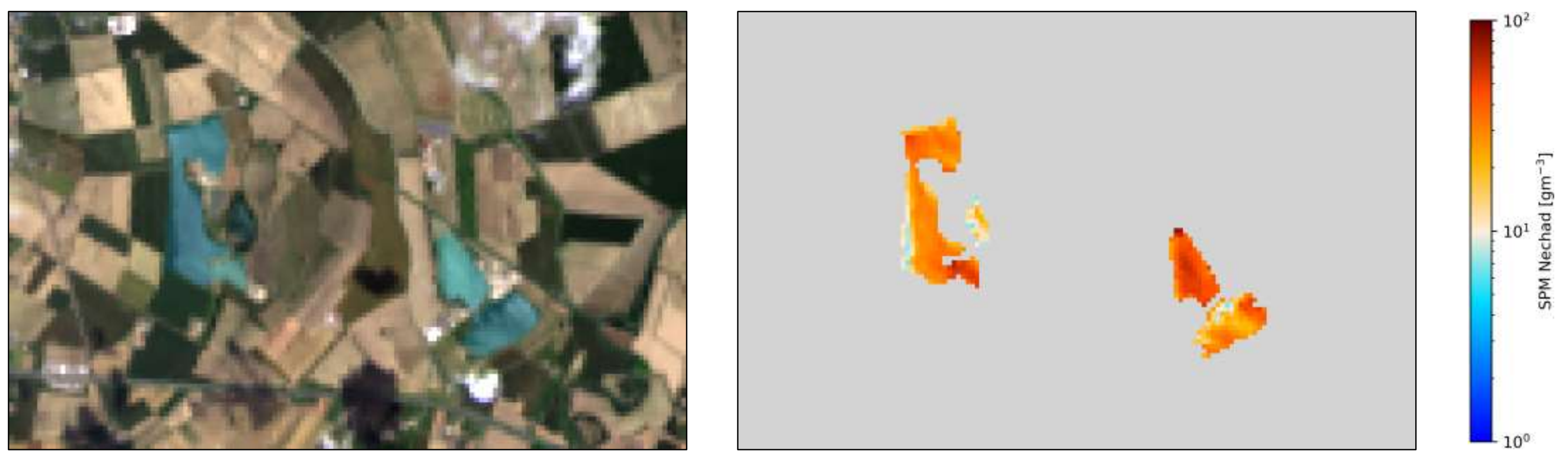

Figure 5: *on the left: true color Landsat-8 (OLI), 2013-05-29 (10:13 UTC); on the right: ACOLITE output SPM Nechad, 2013-05-29 (10:13 UTC).*

4. In addition to the remote sensing data, meteo-climatic and *in situ* measurements will be conducted. If performed in sync with satellite data, they will be useful for their validation.

In conclusion, the multi-temporal dataset, in combination with meteorological, climatic, and basin conditions, will allow analysis of the evolution of water quality in pit lakes in the broader context of land use and climate change.

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