Talking Chestnuts

New monitoring techniques for the assessment of chestnut C balance and health conditions

www.castagniparlanti.it

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European chestnut days
14. - 16. September 2023

Chestnut fruit cultivation

Restoration within a forest matrix: opportunities and constraints

- Chestnut has a dual role as fruit and forest species
- In the absence of cleaning and pruning, the chestnut grove turns into a mixed forest, subject to the rules of Forestry Regulations
- Local regulations allow the recovery of the chestnut grove on small surfaces (500 m^2) without particular constraints for the elimination of other species and undergrowth, but…
- …chestnut plants are immersed in a matrix of taller plants, with the risk of being shaded and decaying

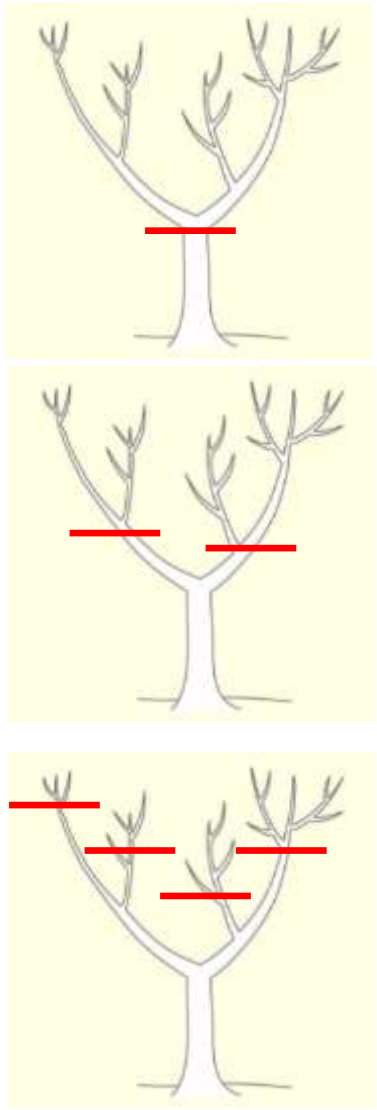
Needed:

- High pruning that (i) stimulates the development of an expanded canopy and (ii) avoids shading by the surrounding forest
- Reduce costs (very low in pollarding, high with tree climbers and careful pruning)
- Evaluate the effects on water use, growth and carbon fixation

Methodologies of chestnut restoration

Restoration methodologies compared

- pollarding (from the ground, low cost)
- pruning at first branching order (*tree climber*, moderate cost)
- pruning at second branching order (*tree climber*, high cost)
- control (no pruning)



Castagni Parlanti: project objectives

The aim of the project is to **assess the ecological footprint of different methods of chestnut restoration to fruit production**, in terms of C fixation and sequestration in the soil-plant system, water use and soil cover.

The project therefore aimed to :

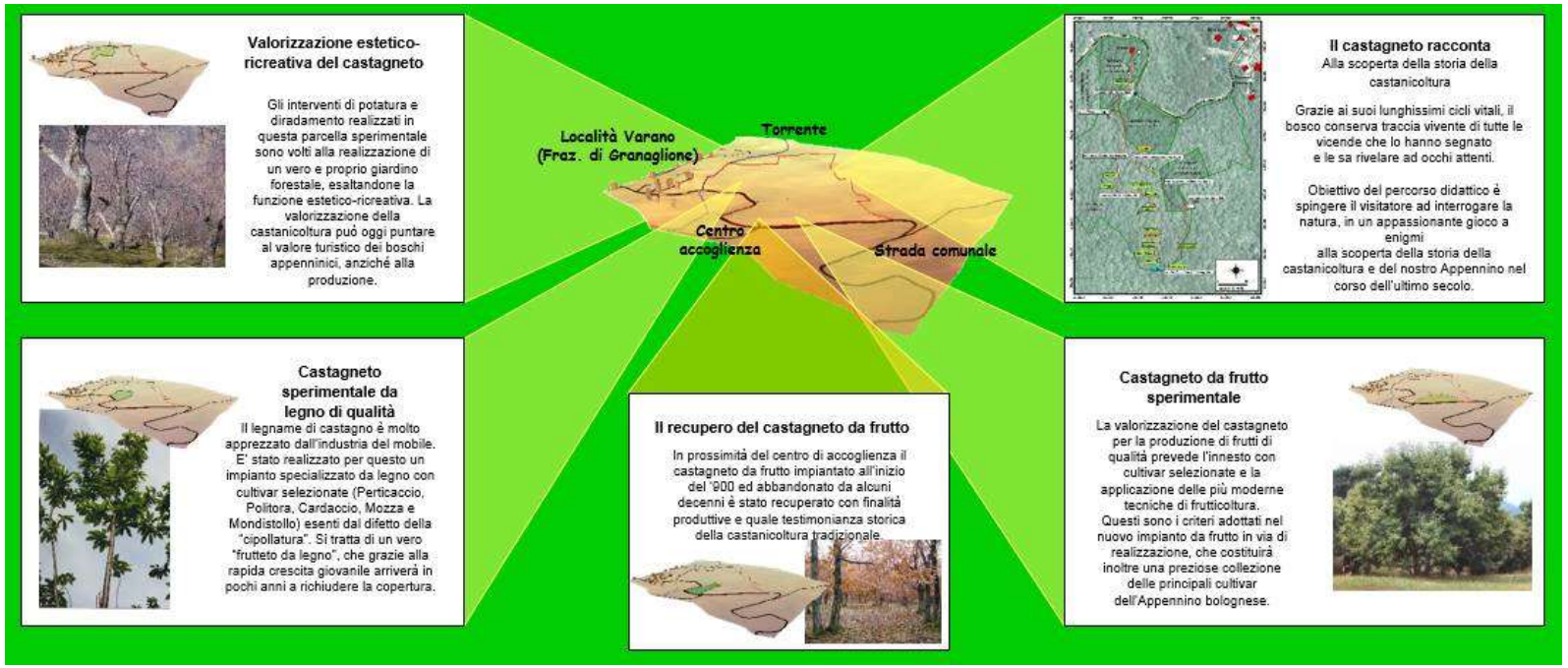
- ❑ disseminate Land Suitability Analysis techniques for the identification of areas potentially suitable for the restoration to cultivation and fruit production
- ❑ apply smart and low-cost technologies to monitor the environmental impact and the C cycle recovery of different chestnut restoration techniques
- ❑ apply these methodologies to monitor its response to climate change
- ❑ raise awareness among the population on the topic of chestnut restoration potential and the effects of climate change

FONDAZIONE CASSA DI RISPARMIO IN BOLOGNA

An ideal location

National Centre for Forest Biodiversity Conservation

Experimental chestnut and cultival collection in Granaglione (CaRisBo Foundation), managed by the National Academy of Agriculture

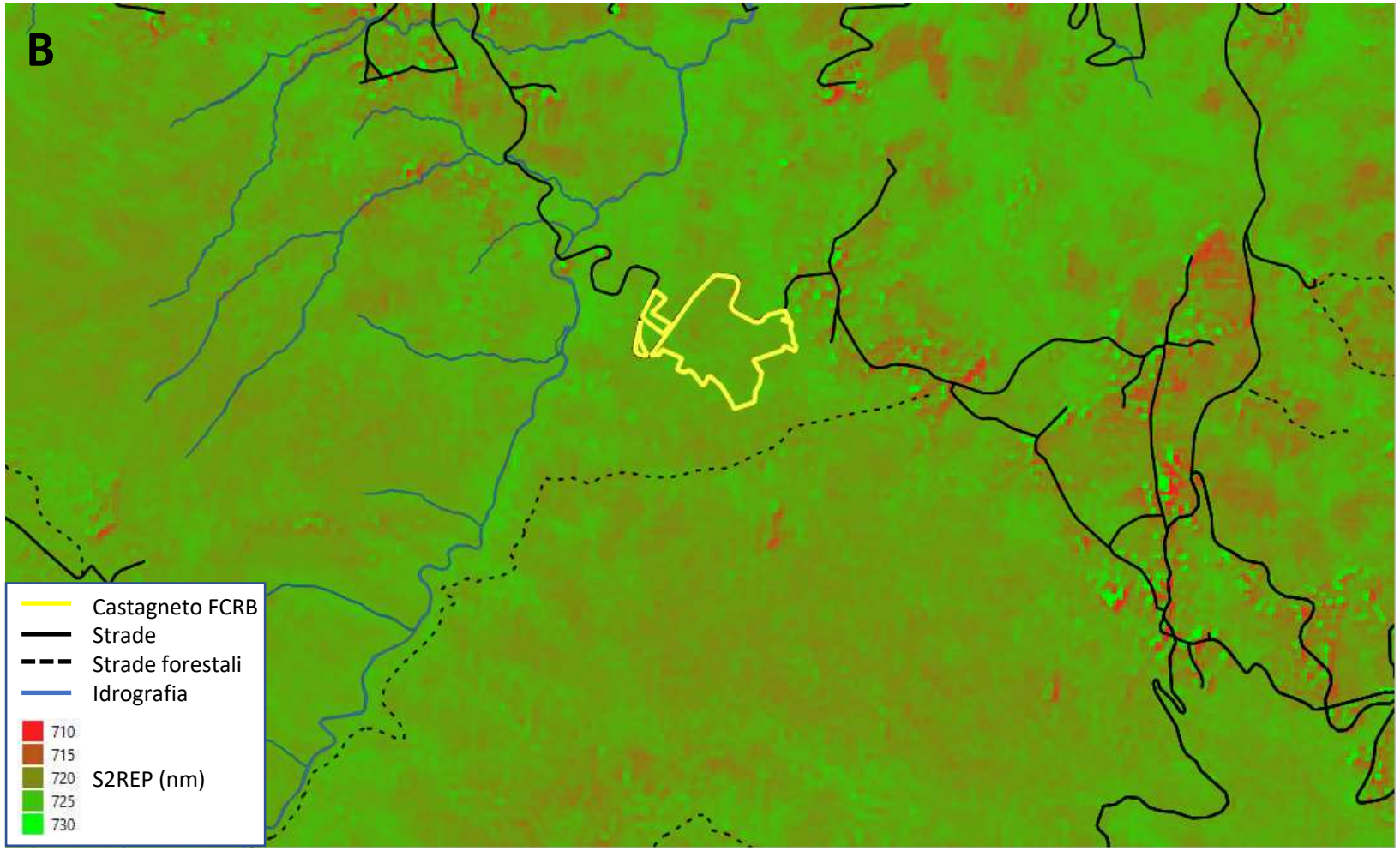


Currently

Sentinel 2 for chestnut monitoring and LSA

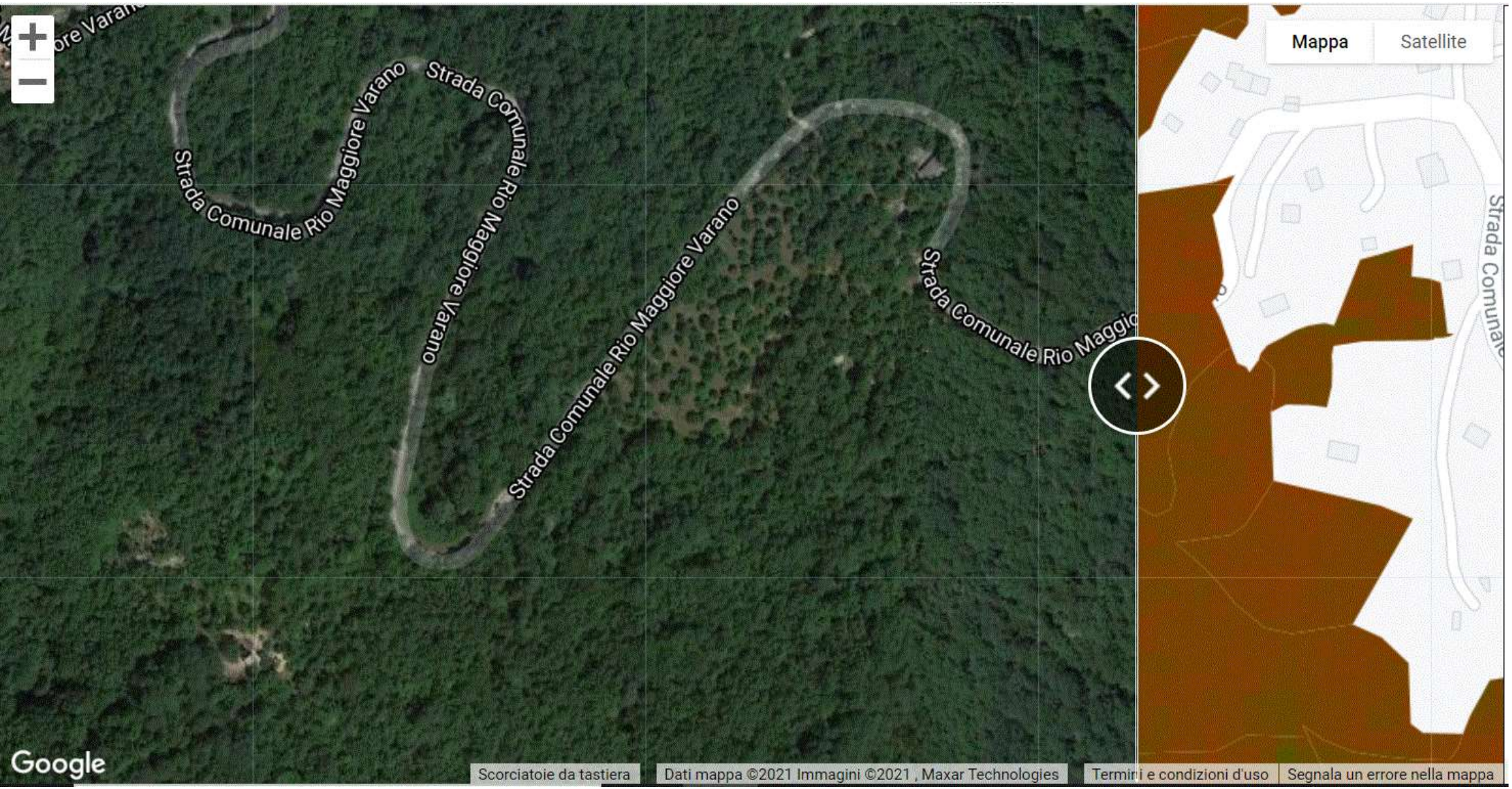
Canopy chlorophyll content

Images from ESA Sentinel 2 satellite make it possible to study vegetation conditions with a resolution of 10 m and a frequency of 5 days



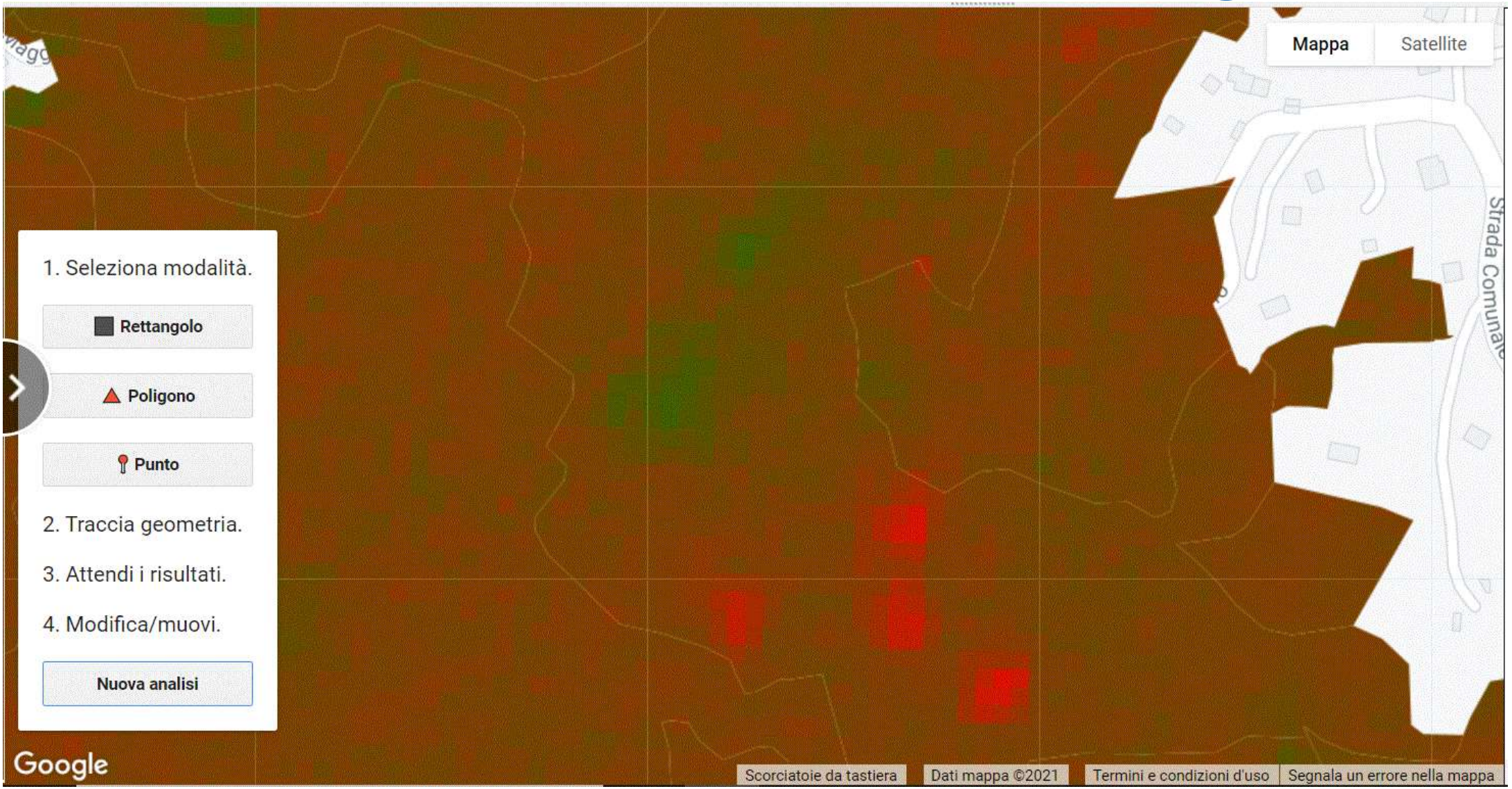
The S2REP (Sentinel 2 Red-Edge Position) index estimates leaf chlorophyll content, for early detection of any states of stress

Sentinel 2 for chestnut monitoring and LSA



Zoom on the area of the Granaglione chestnut stand

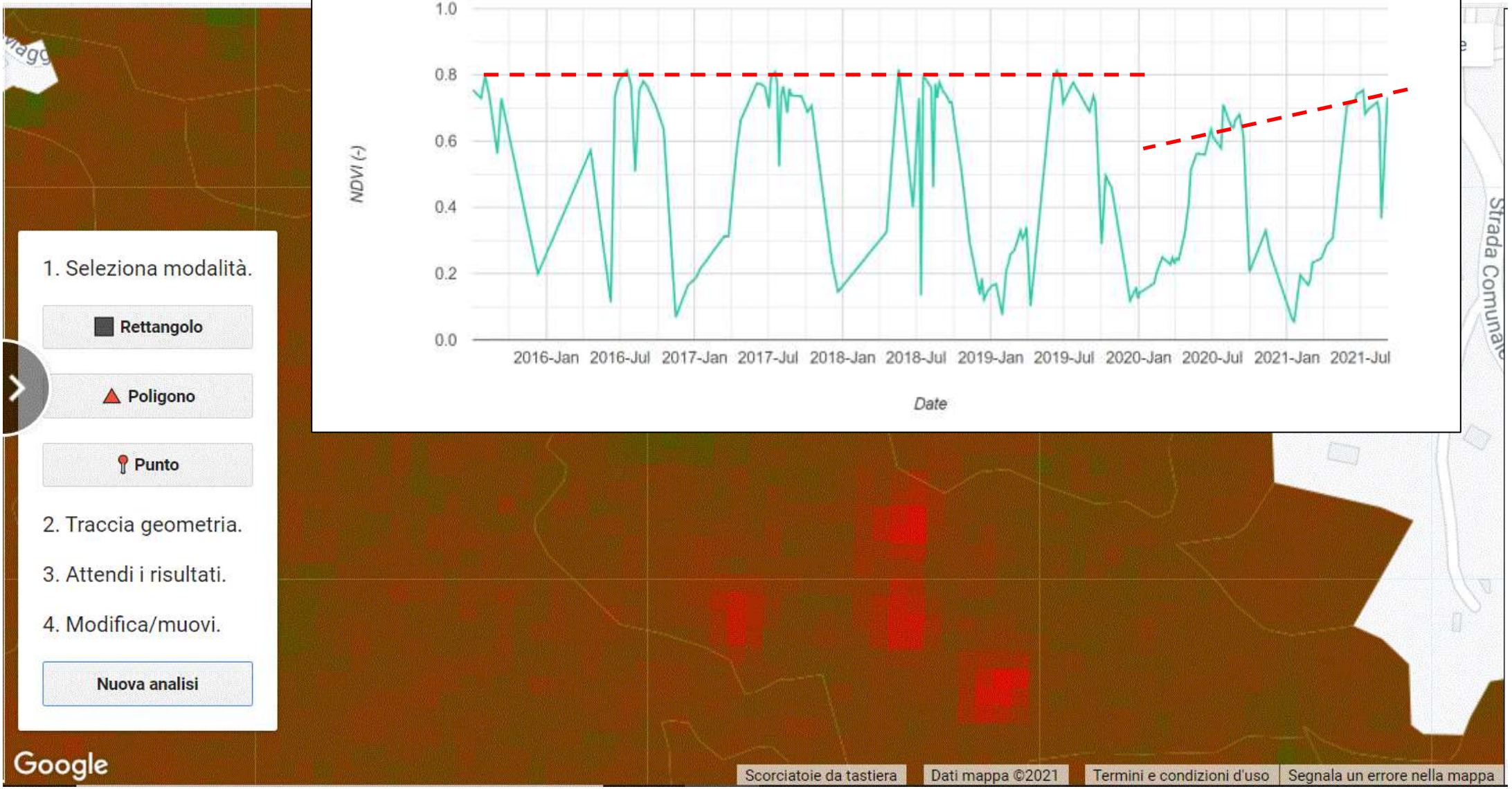
Sentinel 2 for chestnut monitoring and LSA



The 4 chestnut restoration areas are apparent from the 2020-2019 comparison (in red = reduction in NDVI)

Green shows areas recovering from chestnut pruning the previous year

Sentinel-2 for chestnut monitoring and LSA

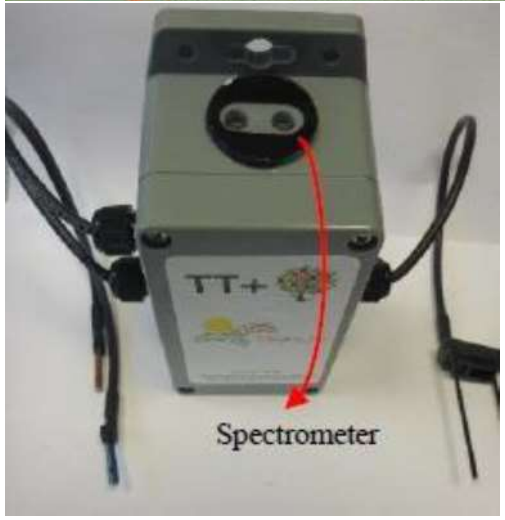


Seasonal trend of the NDVI index (Leaf Area Index) starting from 2015 in one of the study areas. The effect of pruning is apparent

TreeTalker for chestnut tree monitoring

Developed by Prof. Riccardo Valentini (Tuscia University, CMCC). Continuous measurement of:

- tree radial increment
- sap flow
- spectral incoming irradiance
- tree swaying



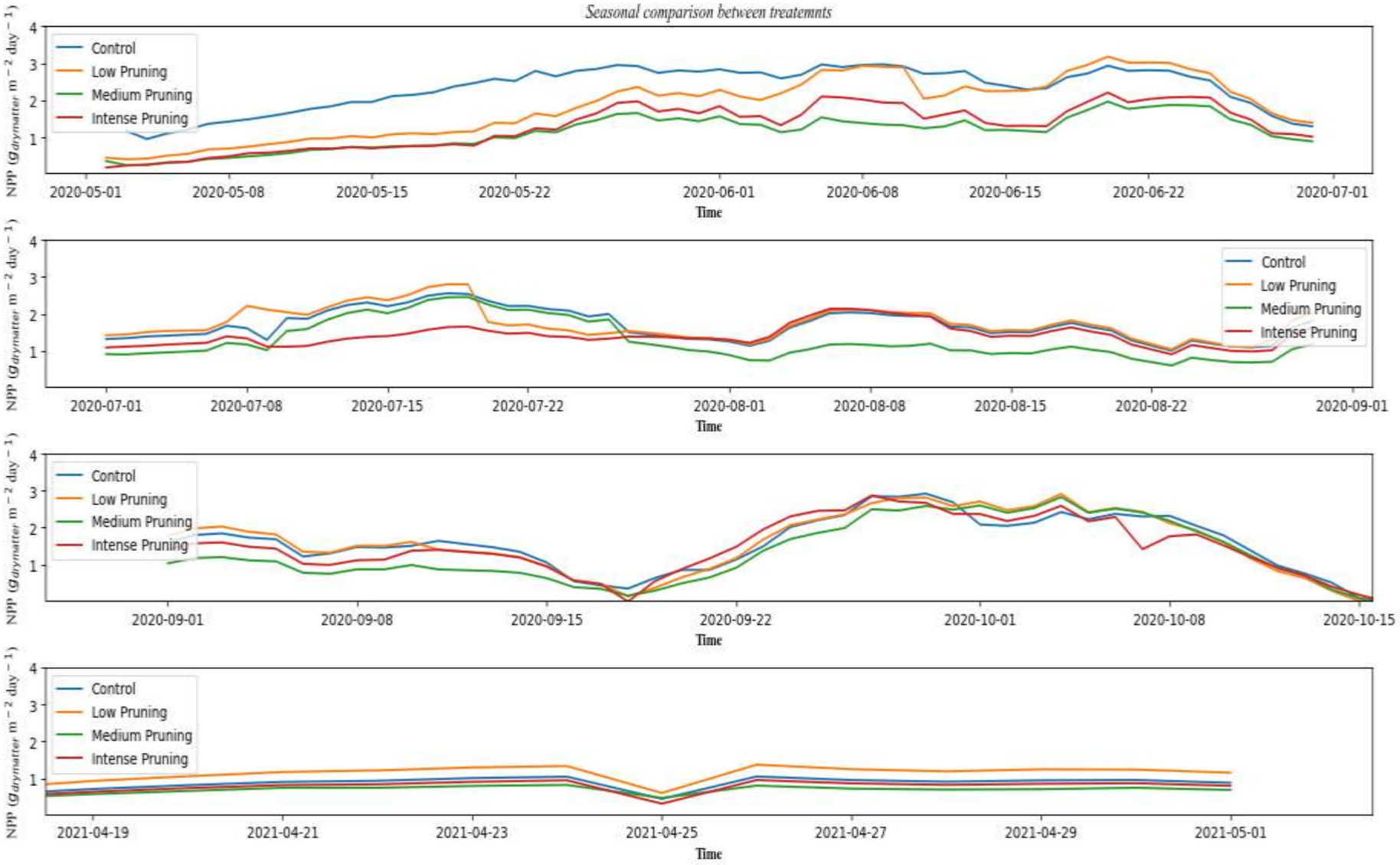
Makes it possible to assess:

- growth and C fixation (**NPP**)
- tree water use
- tree leaf area (**NDVI index**)

Data automatically uploaded to project server for pre-processing, project portal and app

Tree Talker monitoring - NPP potential

Higher values correspond to greater C sequestration potential per unit leaf area

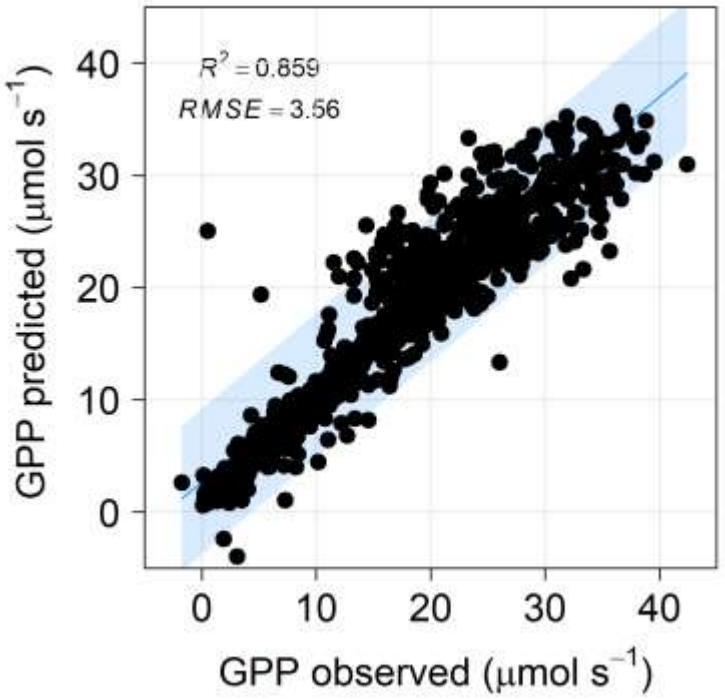


- Control and low-intensity pruning, with denser canopy, display a higher C sequestration potential (peak of 3 g DM m^{-2} day^{-1} in June)
- From mid-July onward, medium- and intense-pruning trees recovered their C sequestration capacity, thanks to later canopy development
- From mid-September, all treatments show a similar trend, with high photosynthetic activity over the Autumn (comparable to June values). Similar trend observed the following year

MoniPAM monitoring of photosynthetic activity

MoniPAM sensors continuously measures chlorophyll fluorescence and estimates leaf photosynthetic activity over the course of the day and season.Preliminary measurements have demonstrated the possibility of using them to estimate the gross primary productivity (GPP) of the entire plant

GPP = s(Φ_p) + s(PAR) + s(dPAR)

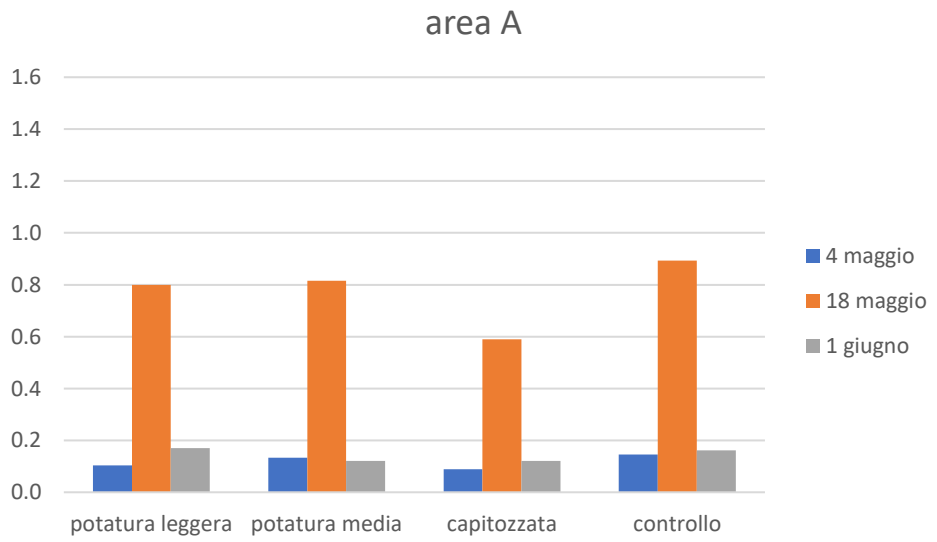


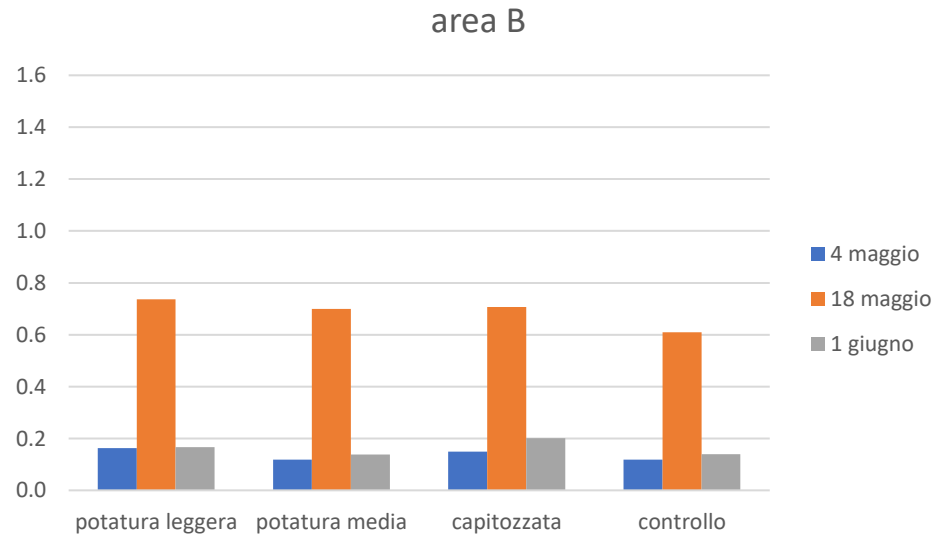
Measurements did't show any differences between treatments at leaf and tree level

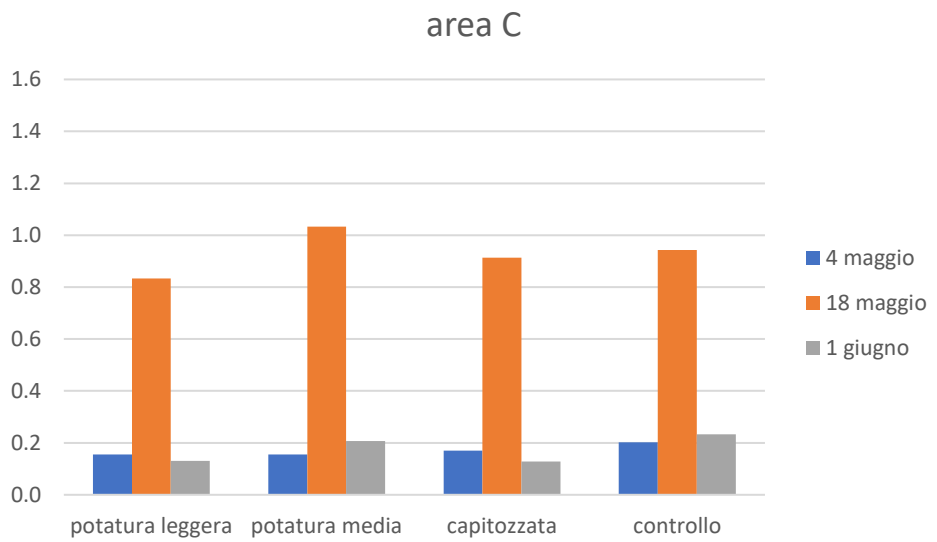
Monitoring soil CO_2 emissions

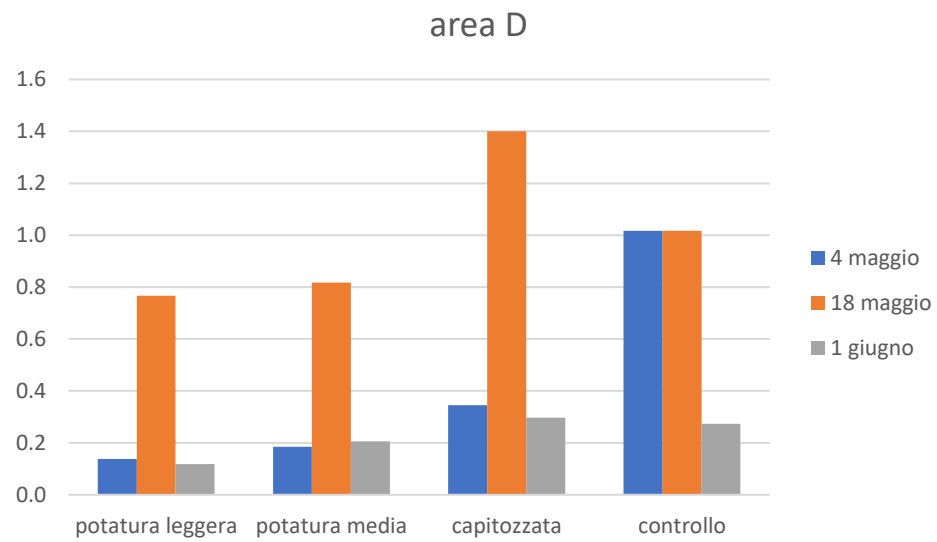
Three soil heterotrophic CO2 monitoring campaigns were carried out during the vegetative and flowering period (4 May, 18 May, 1 June)

Monitoring soil CO_2 emissions









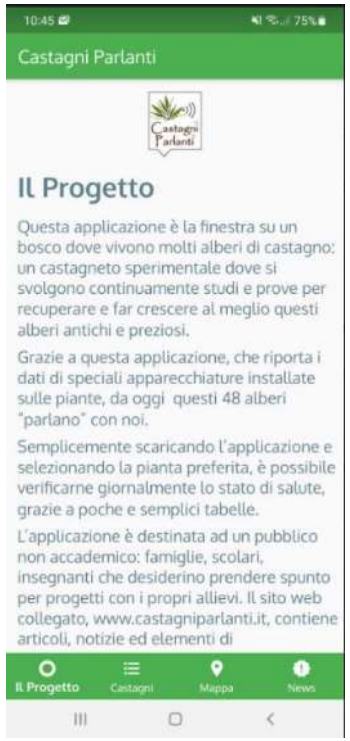
Implications of tree monitoring results

- Medium-intensity pruning and Pollarding strongly reduce the need for water compared to Low-intensity pruning and Control treatments over most of the annual vegetative cycle. Climate change could intensify and prolong periods of drought, favouring pruning techniques with lower impact on soil water status
- Lighter pruning (Control and Low-intensity) guaranteed a greater capacity for C sequestration per unit leaf area. The advantage relative to more intense pruning disappeared in mid-summer. The latter enjoyed better sun exposure even for those leaves in the lower part of the foliage that are typically shaded when the foliage is dense.
- Even the most intense pruning does not seem to have compromised the health of the plants
- The large C absorption observed in autumn is interesting: the rise in temperatures in autumn stimulates photosynthetic activity and delays leaf senescence, thus expanding the useful period for C sequestration
- The indicators calculated from Tree Talker data prove useful and reliable for monitoring the health status of the plant and for determining the phenological cycles of chestnut trees.

Extension: the project portal (www.castagniparlanti.it)

Extension

Extension: the mobile app



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