Realistic daily dynamics of olive and olive fly at 250 m resolution using MODIS LST calibrated with MODIS NDVI

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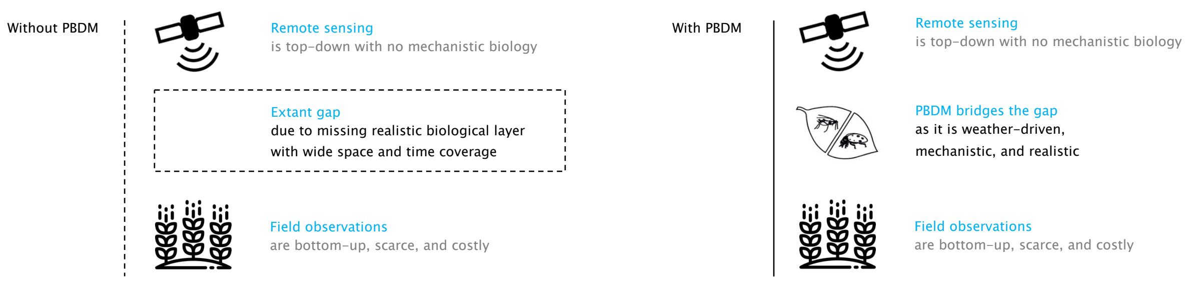
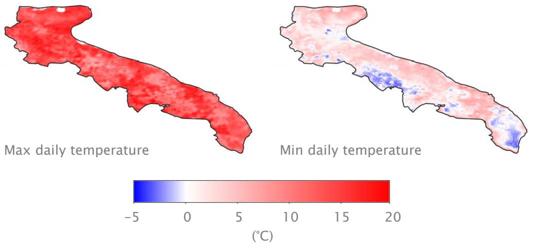
Physiologically based demographic modeling (PBDM) provides realistic biological patterns that are otherwise unavailable



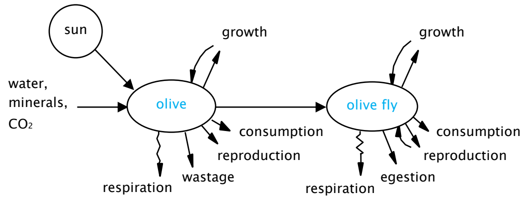
Daily temperature at 250 m is derived for 2003–2023 in Puglia from MODIS LST and calibrated with MODIS NDVI

Calibration achieves higher accuracy than interpolation from weather stations

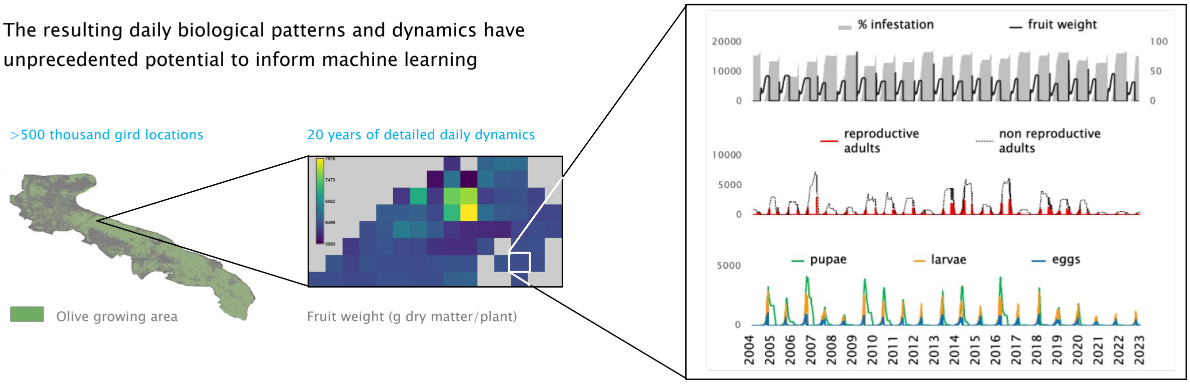


PBDM simulation for olive and olive fly uses daily weather from MODIS LST (and AgERA5) as input

Model output has same space/time resolution and coverage as MODIS input



The resulting daily biological patterns and dynamics have unprecedented potential to inform machine learning



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Realistic daily dynamics of olive and olive fly at 250 m resolution using cloud-gap-filled canopy temperature data from MODIS LST calibrated with MODIS NDVI

Luigi Ponti[1,2], Andrew Paul Gutierrez[2,3], Markus Metz[4], Julia Haas[4], Elisabeth Panzenböck[4], Markus Neteler[2,4], Ferdinando Baldacchino[1], Alfredo Ambrico[1], Gerardo Baviello[1], Maurizio Calvitti[1], Alessandro Dell'Aquila[1], Sandro Calmanti[1], Elena Lampazzi[1], Valerio Miceli[1], Daniela Cuna[1], Federica Stocchino[5], Davide Carroccio[5]

1. ENEA | https://sostenibilita.enea.it/
2. CASAS Global | https://www.casasglobal.org/
3. University of California, Berkeley | https://ourenvironment.berkeley.edu/ecosystem-sciences
4. mundialis GmbH & Co. KG | https://www.mundialis.de/
5. Recube Srl | https://recube.it/

Luigi Ponti
luigi.ponti@enea.it

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1 Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Centro Ricerche Casaccia, Via Anguillarese 301, 00123 Roma, Italy. E-mail luigi.ponti@enea.it | maurizio.calvitti@enea.it | alessandro.dellaquila@enea.it | sandro.calmanti@enea.it | elena.lampazzi@enea.it

2 Center for the Analysis of Sustainable Agricultural Systems Global (casasglobal.org), 37 Arlington Ave., Kensington, CA 94707, USA

3 Division of Ecosystem Science, College of Natural Resources, University of California, Berkeley, CA 94720-3114, USA. E-mail CASAS.Global@berkeley.edu

4 mundialis GmbH & Co. KG, Koelnstrasse 99, 53111 Bonn, Germany. E-mail metz@mundialis.de | haas@mundialis.de | panzenboeck@mundialis.de | neteler@mundialis.de

5 Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Centro Ricerche Trisaia, S.S. 106 Jonica km 419,500, 75026 Rotondella MT, Italy. E-mail ferdinando.baldacchino@enea.it | alfredo.ambrico@enea.it | gerardo.baviello@enea.it

6 Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Centro Ricerche Brindisi, Via Appia km 706, 72100 Brindisi BR, Italy. E-mail: valerio.miceli@enea.it | daniela.cuna@enea.it

7 Recube Srl, Via Cunfida 35, 00195 Roma, Italy. E-mail: federica.stocchino92@gmail.com | davide.carroccio@recube.it

Physiologically based demographic modeling (PBDM, https://www.casasglobal.org/) of olive (*Olea europaea*) interacting with its major pest, the olive fly (*Bactrocera oleae*), was implemented on a cloud computing Web application programming interface (Web API; Ponti et al. 2024, https://doi.org/mk4c) and run for the Italian region of Puglia at 250 m resolution for years 2003 to 2023, using daily input weather data including maximum and minimum temperature (Tmax and Tmin, respectively), solar radiation, precipitation, relative humidity, and wind speed.

Specifically, Tmax and Tmin were derived (Metz et al. 2017, https://doi.org/gh5bg2) from freely available MODIS land surface temperature (LST) satellite data (Wan et al. 2021, https://doi.org/mk4d | see https://www.mundialis.de/en/products/surface-temperature-data/) and calibrated using MODIS normalized difference vegetation index (NDVI) data (Didan et al. 2021, https://doi.org/gskkhx). MODIS LST data calibrated with MODIS NDVI data have been shown to estimate olive grove canopy temperature more accurately than interpolation from meteorological stations (Blum et al. 2013, https://doi.org/f426r2). A preview of daily Tmax developed for Puglia using this method is available on Zenodo (Ponti & Metz 2023, https://doi.org/mk4f).

Other weather input variables were resampled at 250 m from AgERA5 data (Boogaard et al. 2020, https://doi.org/hp7n). AgERA5 is a downscaled and bias-corrected daily weather dataset based on the ERA5 reanalysis of weather observations including satellite data (Hersbach et al. 2020, https://doi.org/gg9wx7) that was developed by the Copernicus Climate Change Service (https://cds.climate.copernicus.eu/) to serve as input for agro-ecological studies. PBDM simulation output was mapped using the open source geographic information system (GIS) GRASS (https://grass.osgeo.org/ | see Neteler et al. 2012, https://doi.org/fx7vsr).

The olive fly component of the PBDM system (Gutierrez et al. 2009, https://doi.org/b77vfb) was previously implemented in Israel to successfully simulate seasonal population dynamics of olive fly (Blum et al. 2015, https://doi.org/hpmz). However, PBDM/GIS spatial and temporal patterns of olive/olive fly dynamics should be considered a heuristic tool rather than a tool for predicting olive yield or olive fly infestation locally or regionally in Puglia (and elsewhere) under observed weather or projected climate change (see also caveats in Ponti et al. 2024, https://doi.org/mk4c).

This PBDM/GIS analysis provides realistic spatiotemporal patterns of olive and olive fly dynamics at fine spatial (250 m) and temporal (daily) resolution that are otherwise unavailable, are designed to support strategic analysis of crop management, and could inform machine learning of big Earth Observation data. The present work was conducted under project TEBAKA (ARS01_00815) co-funded by the European Union ERDF-ESF, “PON Ricerca e Innovazione 2014-2020” (https://www.dtascarl.org/en/projects-and-initiatives/use-case-technology-transfer/tebaka/).