

Paola Di Lauro
Co-Authors: D. Drimaco, D. Iasillo,
V. De Pasquale, T. Fazio, W. De
Simone, V. Santarsiero,
L. Congedo, M. Munafò,
L. Stamenkovic, L. Faucqueur, O.
Arino

StateO

5-7 May 2026 | ESA-ESRIN | Frascati (Rome), Italy



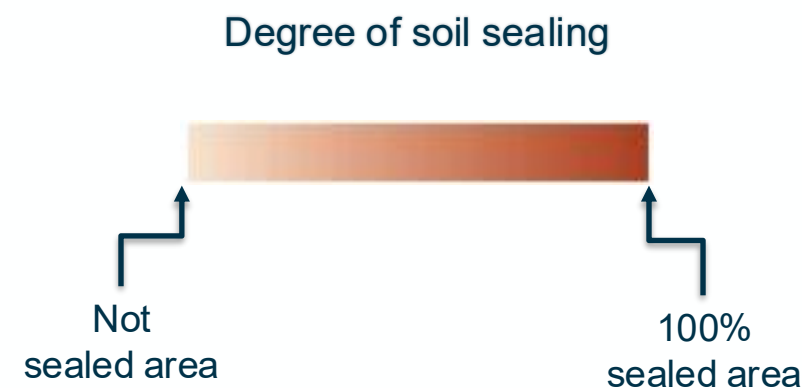
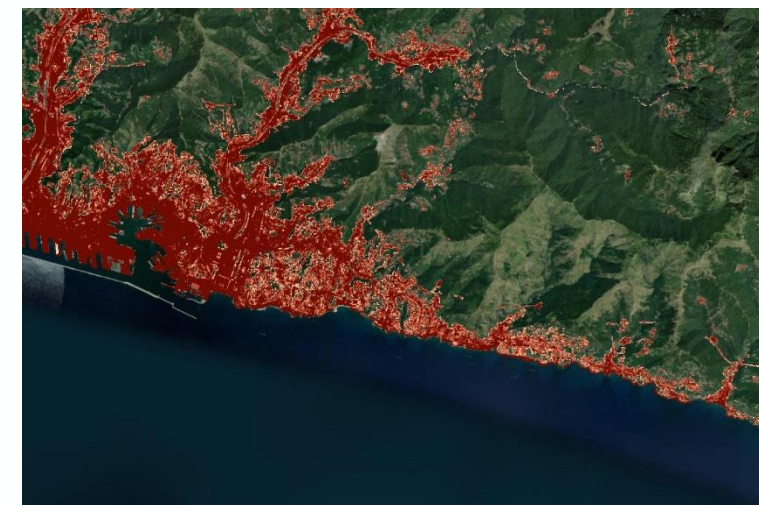
Spatial Indicators of Soil Sealing for Environmental Monitoring in the Mediterranean: The Ulysses Med Land Approach



The ulysses project: overview

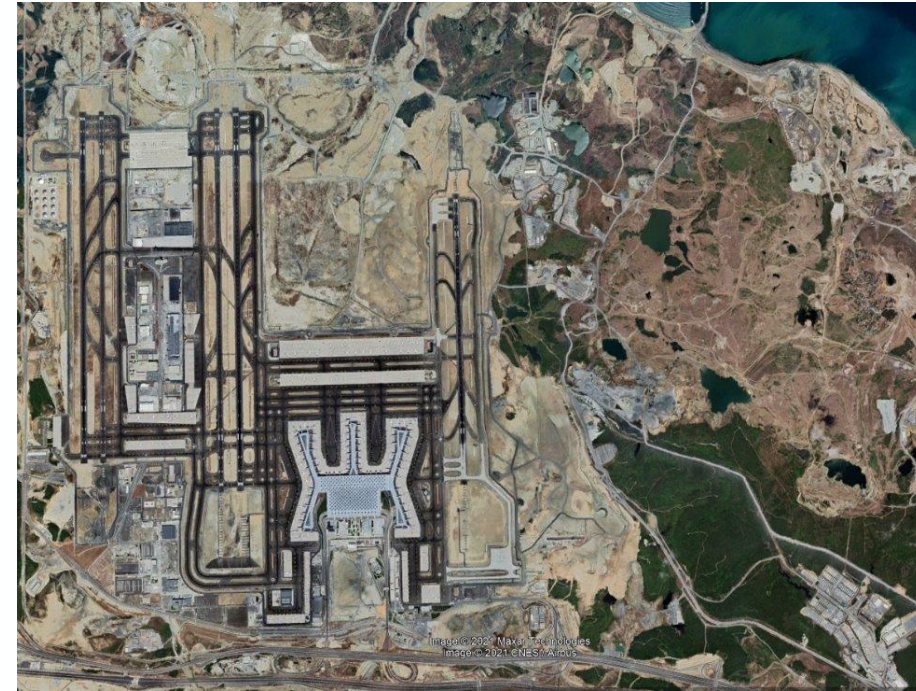


Customer: ESA
Program: EO Science for Society, MED Initiative
Dates: Phase 1: 2020-2022
Phase 2: 2023-2024
Extension: 2024-2025
Product: Soil Sealing Degree map
Area: Mediterranean basin (20 km strip)
Italy, France, Spain, Greece (overall country)
Years: 2018, 2019, 2020, 2021, 2022, 2023, 2024
Partners: Planetek Italia (prime), ISPRA and CLS (subcontractors)



The ulysses project: definitions

Soil sealing is defined change in the nature of the soil leading to its impermeability



A totally automated process

INPUTS



Satellite Imagery

Sentinel-2 L2A time-series
(2018–2024)
10 m spatial resolution

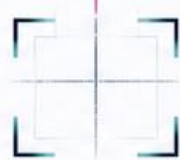


Ancillary Data

Supporting datasets for
atmospheric correction,
masking, and validation
(e.g., DEM, LULC, NUTS)

CORE OBJECTIVE

Develop a standardized, highly accurate
methodology to monitor **coastal soil sealing**
using free, accessible Copernicus
satellite data.

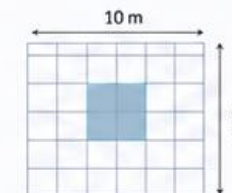


KEY CHARACTERISTICS



Spatial Resolution

10 meters
(10x10m pixel grid)



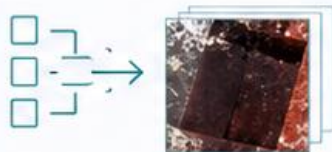
Temporal Coverage

7 years of consistent
observations
(2018–2024)



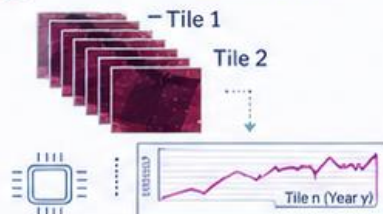
METHODOLOGICAL WORKFLOW: 5 PROCESSING STEPS

1 INGESTION & PRE-PROCESSING



Raw S2 L1C data
transformed to L2A and L3.

2 BASIC PROCESSING UNIT



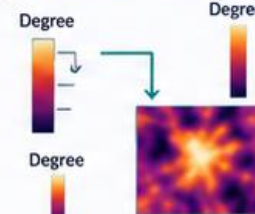
Time-series ingestion for Tile 1
through Tile n (Year y).

3 INTERMEDIATE GENERATION



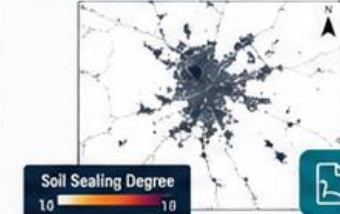
Built-up classification
mapping and QA refinement.

4 DEGREE PROCESSING



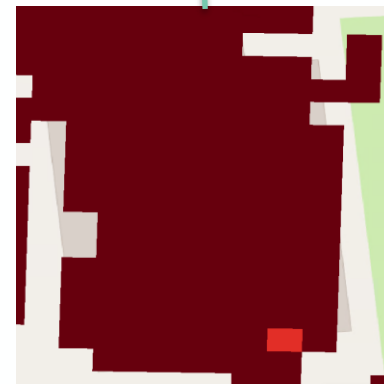
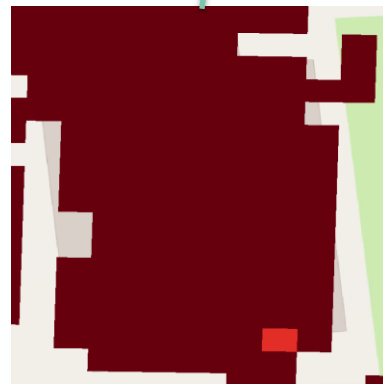
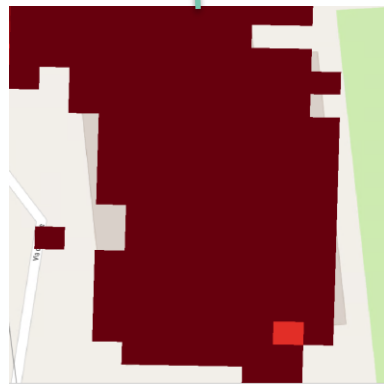
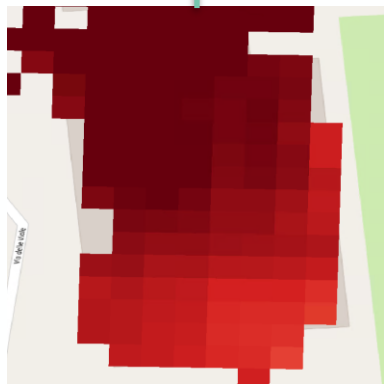
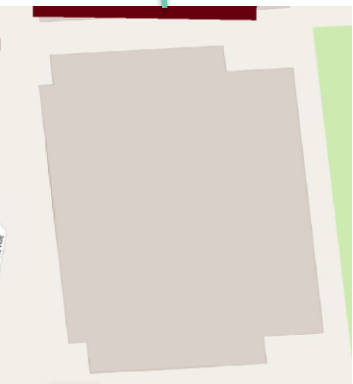
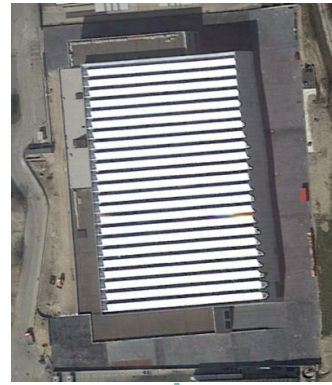
Soil Sealing Degree Processing
(Steps 1 & 2) applied to all
intermediate data.

5 FINALIZATION



Automatic post-processing
yielding the final multitemporal
Soil Sealing Degree product.

Example of soil consumption



Soil Sealing Analytics product specifications



SOIL SEALING ANALYTICS



Content

Sealing Percentage
(buffer 500 m, 1km, 2 km)



Format

CVS



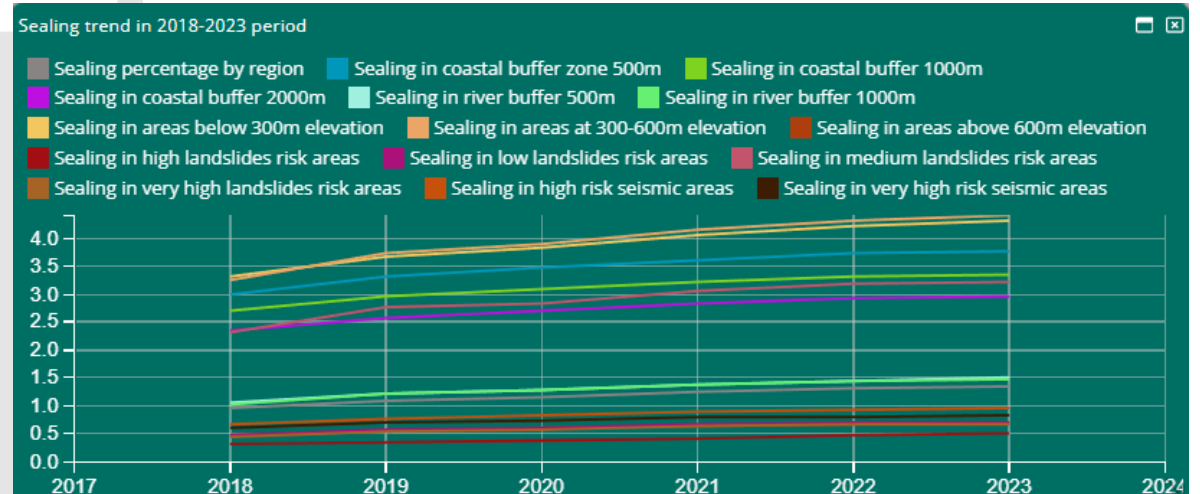
Years

From 2018 to 2024



Area

20 km buffer landward
from the coastline of
Mediterranean basin
(MED)
Country-level (Italy,
France,
Greece, Spain)





ISPRA suggested the set of indicators

based on national reporting needs and operational experience, ensuring relevance, comparability and applicability.

Implemented indicators for Medland

(20 km buffer from coastline)

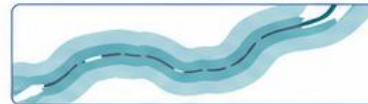
- Soil consumption
- Soil consumption in coastal areas (buffers from coastline: 500 m, 1 km, 2 km)



Implemented indicators for Italy, Spain, France and Greece

(regional and national level)

- Soil consumption in river buffer zones (buffers: 500 m, 1 km)
- Soil consumption for elevation classes (3 different classes)
- Soil consumption in landslide hazard zones (4 different classes)



- Soil consumption in seismic hazard (2 different classes) – **Italy only**



Outcome

A consistent, accurate and reproducible Soil Sealing Degree baseline to support land monitoring, policy making and sustainable land management across the Mediterranean.



User-driven and co-designed



Aligned with reporting needs in Europe



Transferable to Mediterranean countries in Africa



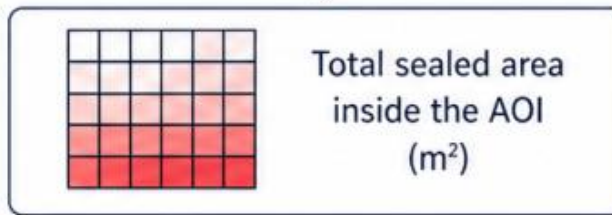
Relevant, consistent, comparable over space and time

1. PIXEL VALUES inside the area (AOI)



2. AGGREGATE SEALED AREA (sum of pixel % × pixel area)

$$\sum_{i=1 \dots n \text{ pixels}} (\text{Pixel \%} \times \text{Pixel area})$$



3. NORMALIZE BY TOTAL AREA OF THE AOI

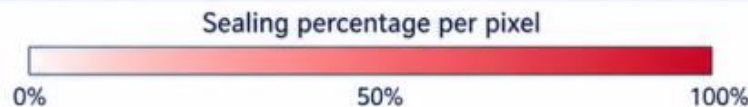
$$\text{Indicator (\%)} = \frac{\text{Sealed area (m}^2\text{)}}{\text{Total area (m}^2\text{)}} \times 100$$



EXAMPLE

20 pixels with 50% sealing × Pixel area = 100 m² × Sealing percentage per pixel = 1,000 m² sealed

Total area of AOI = 10,000 m² → Indicator = 10%



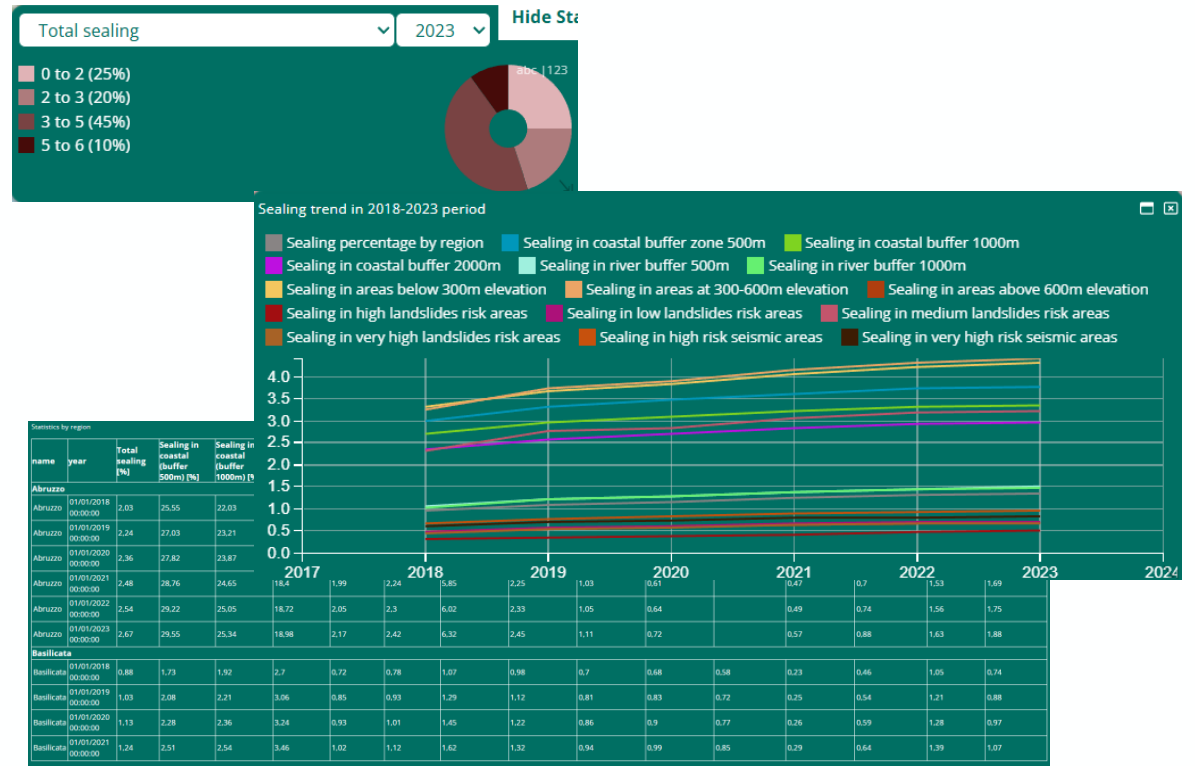
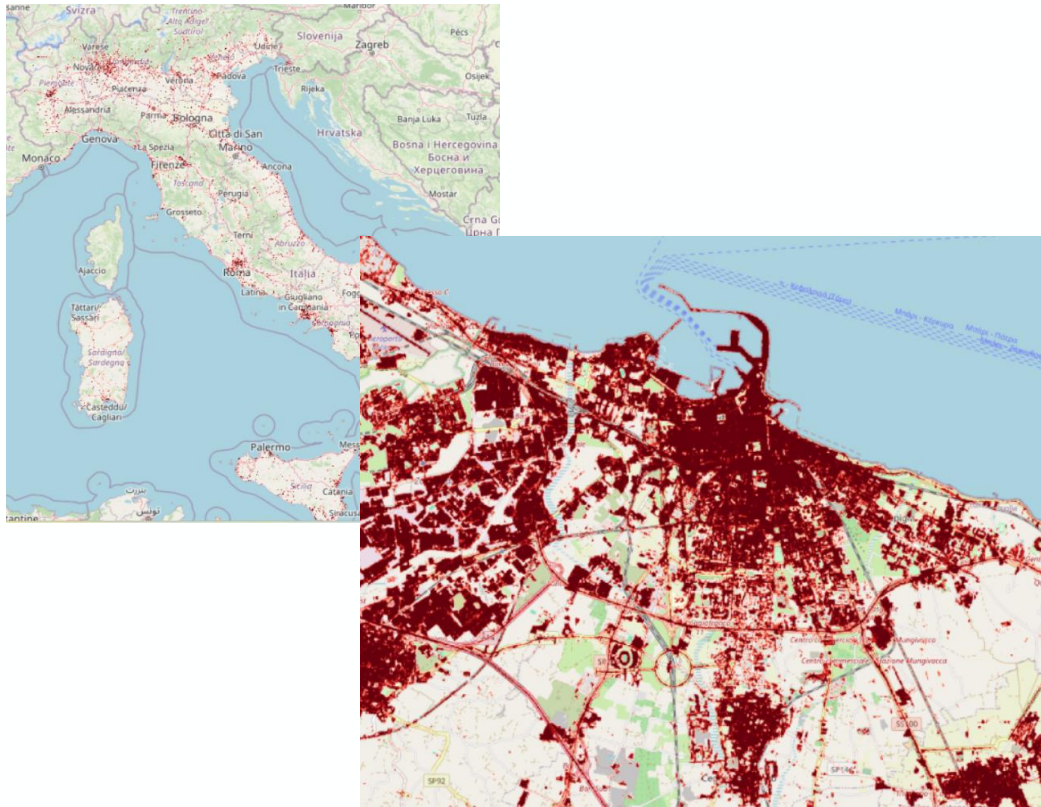
Soil sealing products



SOIL SEALING MAPS



SOIL SEALING ANALYTICS



Demonstration activities



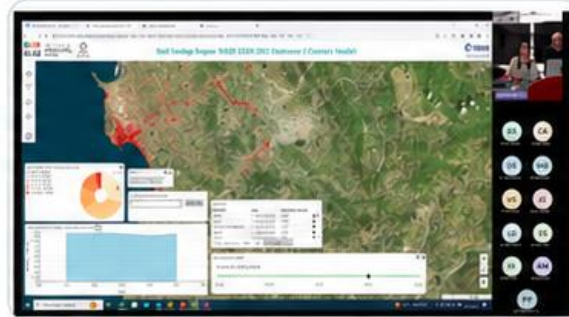
ENGAGEMENT AND OUTREACH



Webinar – 5 February 2025

~20 organizations contacted

- Local, regional and national authorities, especially those in charge of water policy at the level of urban agglomeration and basin agencies (3)
- Research laboratories (1)
- Space agencies (1)
- Private companies (1)



Positive feedback

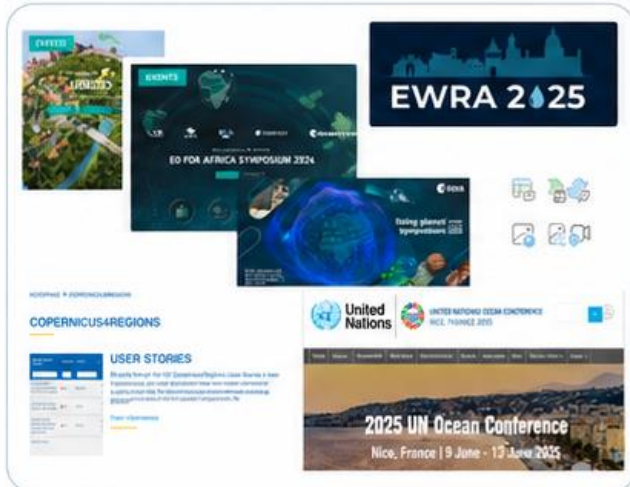
Participants expressed interest in strengthening the link between soil sealing and artificialisation.

Key questions focused on possible overlaps and differences in the interpretation of these two types of information.



Communication and visibility

The project was presented and promoted through international events and platforms, reaching a wide audience and fostering new collaborations.



DEMONSTRATION EVENTS



Italy – Ecomondo Side Event

6 November 2024, 14:00 – 15:00
Sala Gardenia Pad.D7, Ecomondo

Le coste del Mediterraneo viste da satellite. Dal progetto Ulysses l'evoluzione del grado di impermeabilizzazione del territorio costiero



Greece – National Meeting

19 September 2024
Location: Municipality of Athens
Presentation of Ulysses platform and results to national and local stakeholders.



Participants:

- EEA
- Municipality of Athens
- Occitanie Region
- Municipality of Malta
- PAP/RAC
- NEREUS



Building connections, sharing knowledge, driving impact



Strong interest from public authorities and agencies working on water, land and coastal management.



Demonstration activities fostered dialogue, validated user needs and supported future collaboration.



Ulysses results showcased in key events, increasing visibility and supporting policy relevance.



Conclusion, future works and recommendations



Our maps provide a **robust evidence base** to assess soil consumption



All algorithms are **transferable and scalable** across countries and over time



Open and readily available data



Applicable to other countries



Replicable for future years

FUTURE WORK



We are working on producing ISPRA soil consumption indicators from **higher resolution inputs**, using the new **IRIDE constellation data at 3 meters**.

3 KEY RECOMMENDATIONS FOR THE CONFERENCE ORGANISERS

1



Ensure a continuous dialogue with ISPRA to align Earth Observation to operational needs

2



Support the use of Earth Observation to strengthen statistical offices and policy making

3



Foster the expansion of these maps to more regions and countries