Leveraging EO Data for Environmental, Government, and Business Applications for Agriculture: Introducing the EO4EU Platform

Rob Carillo[1], Vasileios Baousis[2], Claudio Pisa[2] et al.
[1]Trust-IT Services - [2]ECMWF

EO FOR AGRICULTURE UNDER PRESSURE 2024 WORKSHOP
May 13 - May 16
ESA-ESRIN

Funded by
the European Union

Consortium

The EO4EU consortium comprises 16 partners from 11 countries and is led by the University of Athens (NKUA)

HELLENIC REPUBLIC
National and Kapodistrian
University of Athens
— EST. 1837 —

ECMWF

novelcore
RESEARCH & INNOVATION

CINECA

Vilniaus universitetas
· 1579 ·

LATVIJAS UNIVERSITĀTE

ILMATIETEEN LAITOS

cmcc
Centro Euro-Mediterraneo
sui Cambiamenti Climatici

SISTEMA
ENVIRONMENTAL INFORMATION MINING

danans
SHIPPING CO LTD

KeMeA

Hes·so

COMMpla
Communication Platforms
and Online Solutions

eBOS

Trust-IT Services
communicating to markets

ENGINEERING
THE DIGITAL TRANSFORMATION COMPANY

IES Solutions

MEEO

Fraunhofer

https://www.eo4eu.eu - Claudio Pisa (ECMWF)

Challenges for exploiting EO data

Diverse sources of information

Data fragmentation

Difficulty to find and retrieve relevant data

Lack of tools to download and process EO data

https://www.eo4eu.eu - Claudio Pisa (ECMWF)

Solution with EO4EU Platform

AI-augmented ecosystem for Earth Observation data accessibility with Extended reality User Interfaces for Service and data exploitation, or **EO4EU**, is a European Commission funded innovation project which aims at creating an advanced platform for searching, discovering, processing and analyzing EO data.

The platform leverages **machine learning** to support handling of the characteristically-large volume of EO data as well as a combination of **cloud computing** infrastructure and **pre-exascale high-performance computing** to manage processing workloads.

EO4EU Platform

The EO4EU Platform* allows for searching, discovering processing and analyzing EO data and is based on a series of innovative technologies which allow to:

- Access** EO data from different sources (e.g., Copernicus, Galileo, ECMWF)
- Support a sophisticated representation of data through a semantic-enhanced **Knowledge Graph**
- Use **Machine Learning** from marketplace to EO data processing
- Visualize EO data through easy-to-use graphical interfaces and **Extended Reality** applications
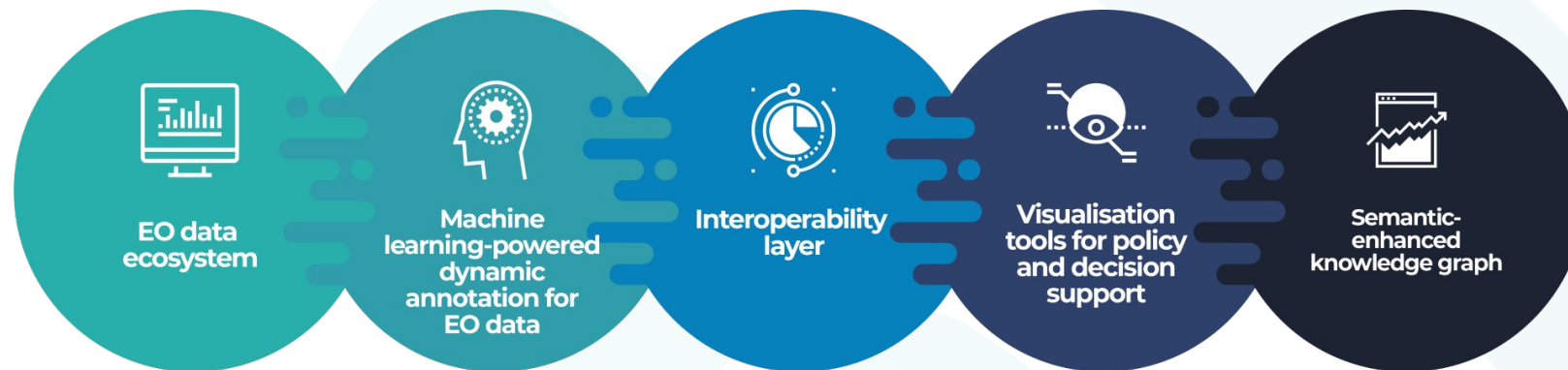
* _https://www.eo4eu.eu/platform_
** _Public user access: May 2024_

EO4EU
Earth Observation Data & Service Accessibility

- 🏠 Home

⌂ Home

> Knowledge Graph

> Workflow Editor

> File Explorer

> XR/VR

- 📊 Data Visualization
- 🌐 Map Visualization
- ▣ Console
- 🔖 Preferences
- 👤 Account
- ⟲ Sign Out

EO4EU Multi-cloud infrastructure

Configuration Management and Day2 Operations

Ansible   ANSIBLE   Terraform

Kubernetes Platform Manager
RANCHER

Central Monitoring/Logging
Thanos   OpenSearch   Grafana

Auxiliary/Support
GitLab Git Repository and Container Image Registry

WEkEO Cloud Infrastructure

Kubernetes Downstream Cluster Agent
RANCHER

Monitoring/Logging Shippers
Prometheus Metrics Exporter   fluentd Fluentbit Log Exporter

Auxiliary/Support
GitLab CI/CD Runners

CINECA Cloud Infrastructure

ML
Fusion
Knowledge Graph
Data (object or block)

Data and ML Tier

Kafka Messaging Layer

Monitoring   Predictive Allocation   DSL Backend
Resource Registry   Communication Manager   Resource Registry

Platform Core

Provision Service   Event-driven Workflow Automation

Platform Manager

Platfrom Frontend GUI
CLI
Workflow Editor
OpenEO API
User Managemet Service

CFS

HPC Task Scheduling (e.g., Model Training)
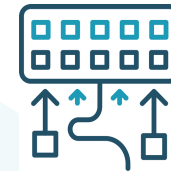
CINECA HPC Infrastructure

Key results

EO Data Ecosystem

Semantic Enhanced Knowledge Graphs

Data Fusion Techniques

Dynamic Semantic Annotation and Learned Compression

Augmented/ Extended Reality
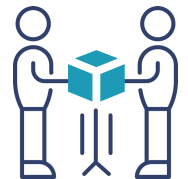
Data Analytics Visualisations

Who benefits?

Researchers and Academia:
Supports research institutions with more accessible EO data

Policy-Makers:
Supports evidence-based policy-making and climate action

EO data providers:
Promotes further usage of EO data through value added tools

Private sector:
Encourages innovation through more accessible EO data for non-technical users

Citizens and scientists:
Enables new actions to reduce and monitor the impact of climate change

Standards Development Organisations:
Contributes to the revision of standards related to EO data

EO4EU Use Cases

EO for Personalised Health care Services: expand mobile allergy and airborne hazards forecasting

Food Security: improve adaptability of food production using EO4EU for live climate data tracking and analysis

Soil Erosion: Integrate rainfall datasets through EO4EU to assess soil susceptibility to water erosion

Civil Protection: Improve disaster and calamity prevention and response using EO datasets

Ocean Monitoring: optimise shipping industry travel time across different oceans considering live weather data

Forest Ecosystems: Improve forest productivity using EO4EU to simulate water, anergy and carbon fluxes

Environmental Pests: Locust plague impact assessment and prediction

Visit https://eo4eu.eu/use-cases
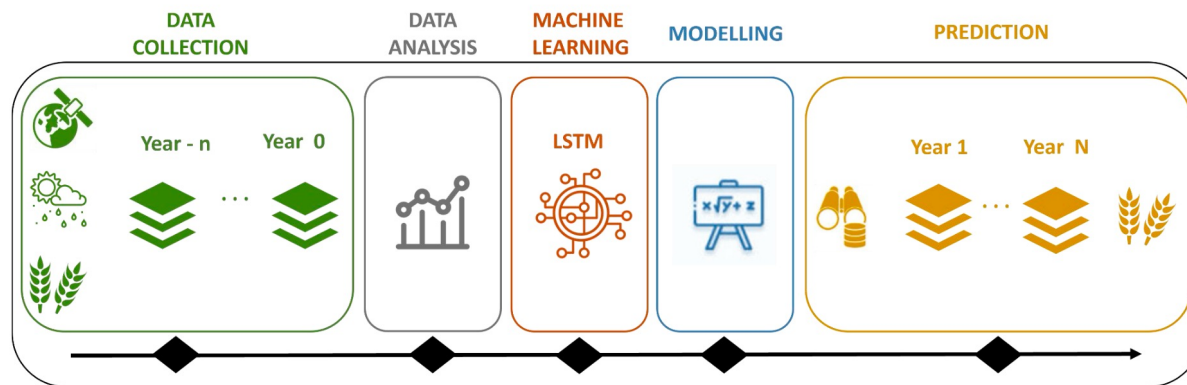
EO4EU Use Case - Food Security 1/2

Description

- Analyse the impacts of climate change on agricultural crops
- Estimate the risk of yield loss over time
- The chosen target crop is industrial tomato, because of its importance on the Italian territory (target area)

Methodology

- Climate indicators were identified to define optimal and stress conditions of tomato and they were correlated with AgERA5 reanalysis climate data
- Adverse climate conditions to the crop yield were identified
  - comparing the curve of NDVI values of tomato fields over three years (2021-2023) with a reference curve derived from aggregated satellite data

Initial Results

- Industrial tomato so far has not been affected by climate change on all fronts and it may expand its geographical range in the future
  - Further analyses will confirm or refute these preliminary results

More information Today at 6:00 pm

Poster2: Poster Session with Social Event

Location: **Marquee**

Time: **Wednesday, 15/May/2024: 6:00pm - 7:00pm**

The Marquee is outside the Big Hall Conference room

Combining Earth Observation data and Machine Learning to estimate industrial tomato yield response to climate change in Piacenza province, Italy

Sara Magazzino[1], Maria Luisa Quarta[1], Noemi Fazzini[1], Maximilien Houël[2], Monia Santini[3], Sofia Pellegatta[4], Rob Carrillo[5]

[1]MEEO S.r.l., Italy; [2]SISTEMA GmbH, Austria; [3]CMCC Foundation, Italy; [4]Alma Mater Studiorum - University of Bologna, Italy; [5]Trust-IT Services, Italy

EO4EU Use Case - Forest Ecosystems
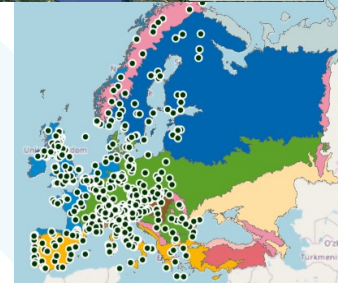
Description

- Goal: create a **digital twin of forest and non-forest areas**
  - at national level at 10m resolution and according to the standard FAO-FRA forest definition
- Increase the frequency of forest cover maps at annual or sub-annual intervals to ensure standardisation of National GHG reporting, ensuring consistencies between countries when tracking country-level emission trends

Methodology

- LSTM model trained on high resolution in-situ dataset from the Land Use/Cover Area frame Survey (LUCAS), combined with:
  - EO, in terms of input data, parameters or initial state variables
    - closer to reality than generalized information extracted from literature
    - Pixel-based timeseries data from different indices/bands allows separation into forest/non forest classes

More information at https://eo4eu.eu/use-cases/forest-ecosystems
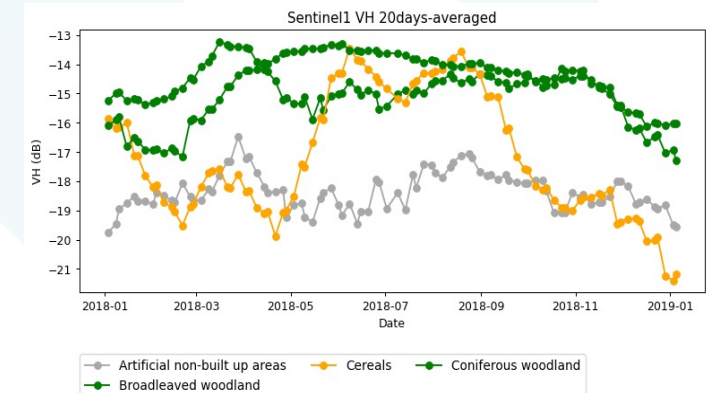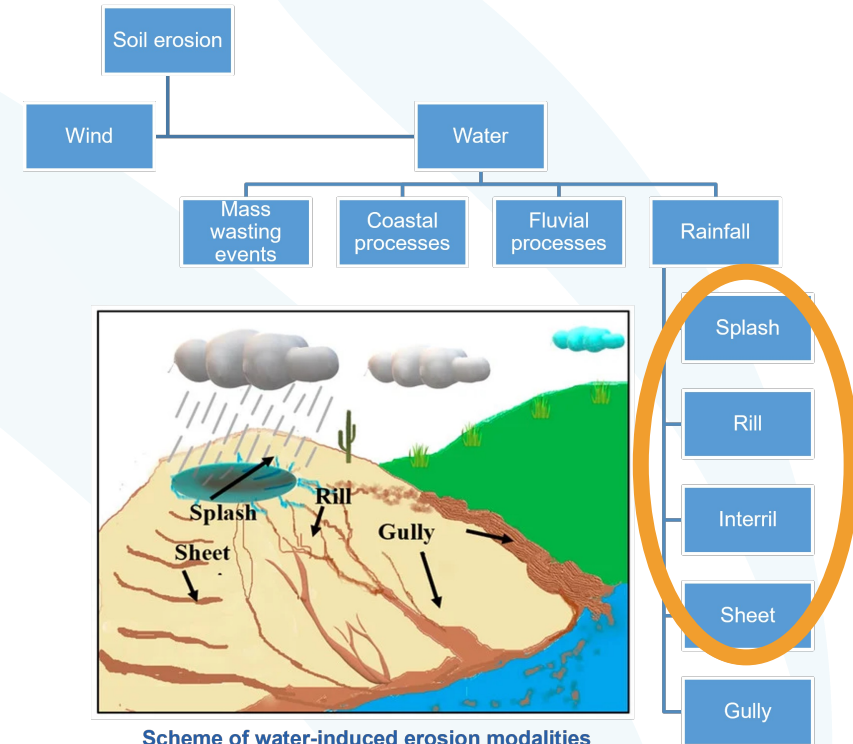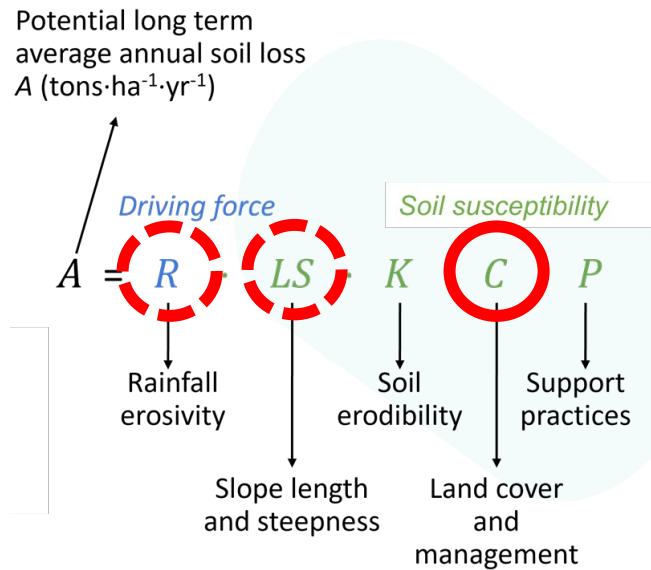
EO4EU Use Case - Soil Erosion 1/2

Description

- Produce an updated, high-resolution and cutting-edge service for the evaluation of soil erosion in Italy
    - Soil erosion by water is one of the primary causes underlying land degradation
    - Rainfall-induced soil erosion is extremely critical

Methodology

- Satellite data and artificial intelligence
- Leverage empirical approaches, e.g. the Revised Universal Soil Loss Equation (RUSLE)

Potential long term average annual soil loss A (tons·ha^{-1}·yr^{-1})

Driving force   *Soil susceptibility*

$$A = R \cdot LS \cdot K \cdot C \cdot P$$

Rainfall erosivity   Slope length and steepness   Soil erodibility   Land cover and management   Support practices

Scheme of water-induced erosion modalities (Senanayake et al., 2020)

EO4EU Use Case - Soil Erosion 2/2

Progress

- Data collection
    - AoI: 5 Italian regions
    - Tasks:
        - Access to sub-hourly (1' to 30') rain gauge measurements from 2002 to 2022
        - Setup of algorithms for data harmonization
        - Preparation of a harmonised dataset
- Algorithm (incl. ML) design/selection for computation of soil susceptibility factors

Next Steps

- Continuing data collection and preparation for main inputs and sub-AoI
- Algorithm training, validation and testing under main inputs for soil susceptibility and rainfall erosivity
- Retrieving data for use case extension across all AoIs and adding scenarios

More information at https://eo4eu.eu/use-cases/soil-erosion

Engage with us

Join our community to get the latest updates on:

- **EO4EU Platform** and its components
- **Real-world applications** of the platform
- New **publications**
- Invitation to our **demos, webinars, workshops and events**

Join the EO4EU community to get access to:

- Early adopter opportunities
- Unique use cases
- Tools available for use

Subscribe to our Newsletter

eo4eu.eu/newsletter

- **Metadata** should be defined and be accessible for all the provided EO data (not all services have the same level of metadata quality)
  - ➔**Semantic annotation** allowing advanced search and optimised data access and retrieval
- **Standardised** means of accessing and retrieving EO data (each service follows different data access means)

→ THE EUROPEAN SPACE AGENCY
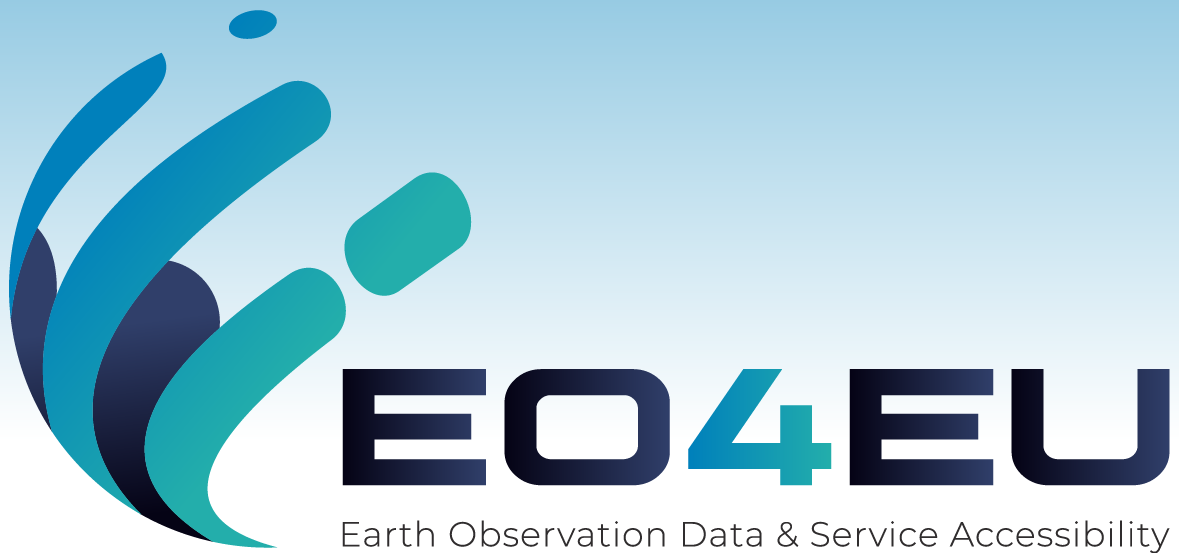
Thank you

Claudio Pisa
Cloud Computing Analyst at ECMWF
Claudio.Pisa@ecmwf.int

www.eo4eu.eu

🐦 **@EO4EU**

in **/company/EO4EU**

Funded by
the European Union