

EO-based environmental monitoring services at national and local levels

Prof. Andrea Taramelli

Prepared by: Nico Bonora-ISPRA, Serena Geraldini-ISPRA, Michele Munafò-ISPRA, Stefano Mariani-ISPRA, Antonello Bruschi-ISPRA, Antonella Tornato-ISPRA, Giorgio Cattani – ISPRA, Daniele Spizzichino-ISPRA, Michele Stortini - ARPAE, Marco Deserti Regione ER

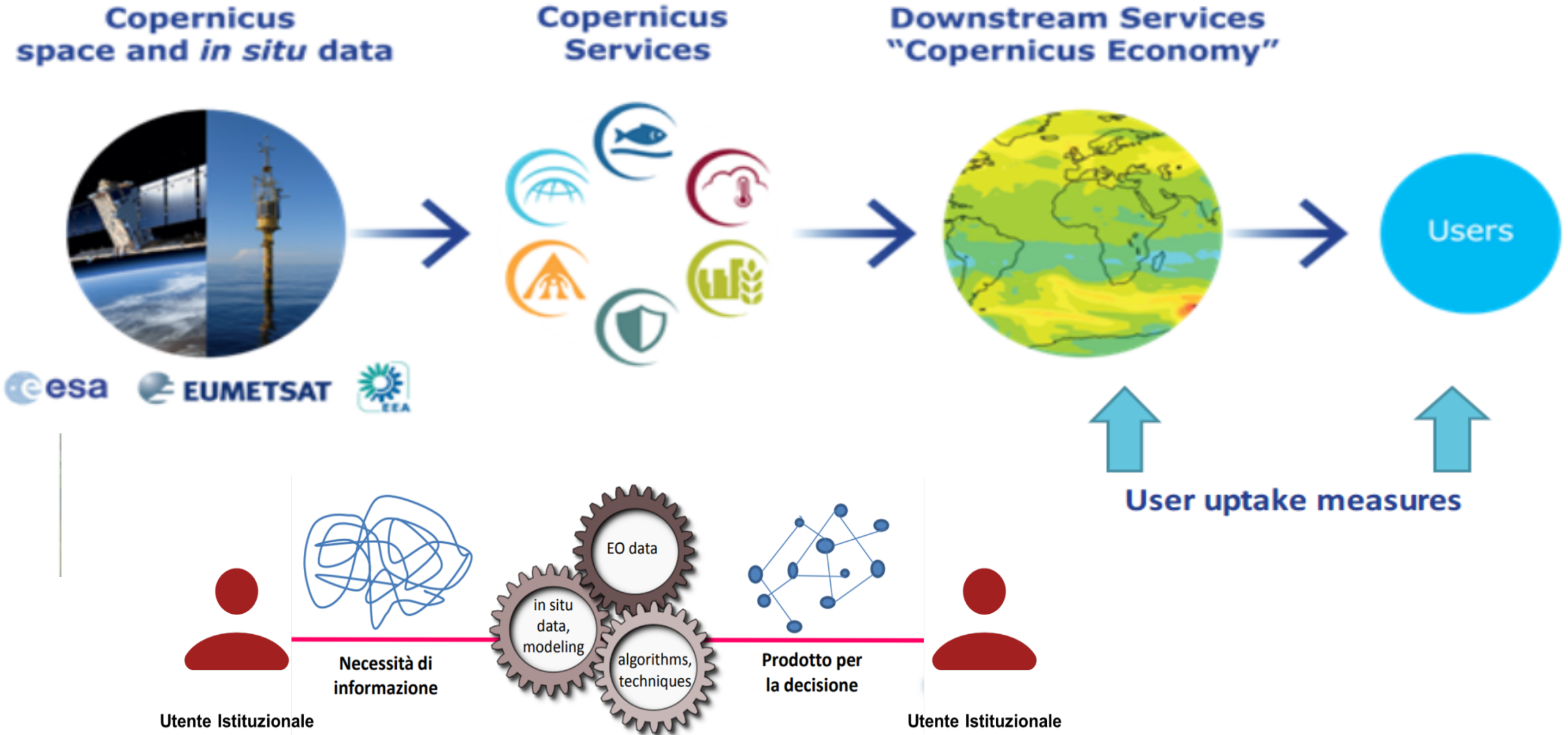
ISPRA and the Earth Observation monitoring

The Higher Institute for Environmental Protection and Research (ISPRA) carries out research activities with applicative purposes and aimed at monitoring the environment and the territory, with an increasingly consistent use of the instruments provided by Earth observation, in particular those provided by the Copernicus Program.

Earth observation and derived services can significantly contribute to improving the daily life of the population, in terms of social benefits, through the continuous supply of accurate and reliable information, bringing evident benefits deriving from a greater knowledge of territorial transformation processes and therefore offering additional elements to support the implementation of environmental policies.



The EU Earth Observation Program: Copernicus



From the collection of needs to the definition of operational services

The requirements and parameters that emerged through the interaction with individual users were examined and prioritized in order to identify the common needs between multiple players (Buyers Group) and define the thematic operational services.



Monitoring environmental and climate goals for European agriculture: User perspectives on the optimization of the Copernicus evolution offer

Emma Schiavon ^{a,*}, Andrea Taramelli ^{a,b}, Antonella Tornato ^b, Fabio Pierangeli ^c

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^b Institute for Environmental Protection and Research (ISPRA), via Vitaliano Brancati 48, 00144, Roma, Italy

^c Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Via Po, 14, 00198, Roma, Italy



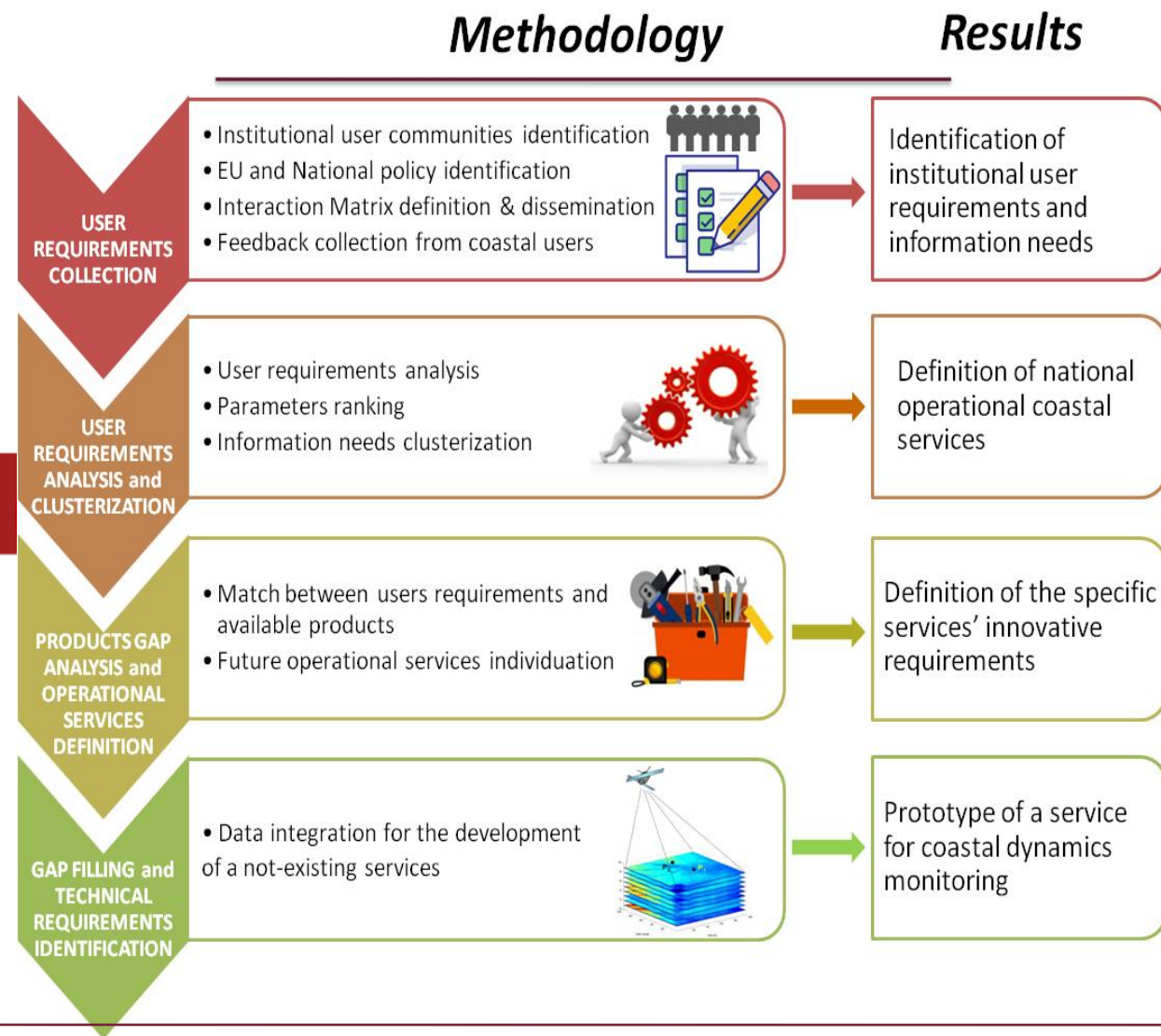
Article

User Needs Analysis for the Definition of Operational Coastal Services

Serena Geraldini ^{1,*}, Antonello Bruschi ¹, Giorgio Bellotti ² and Andrea Taramelli ^{1,3}

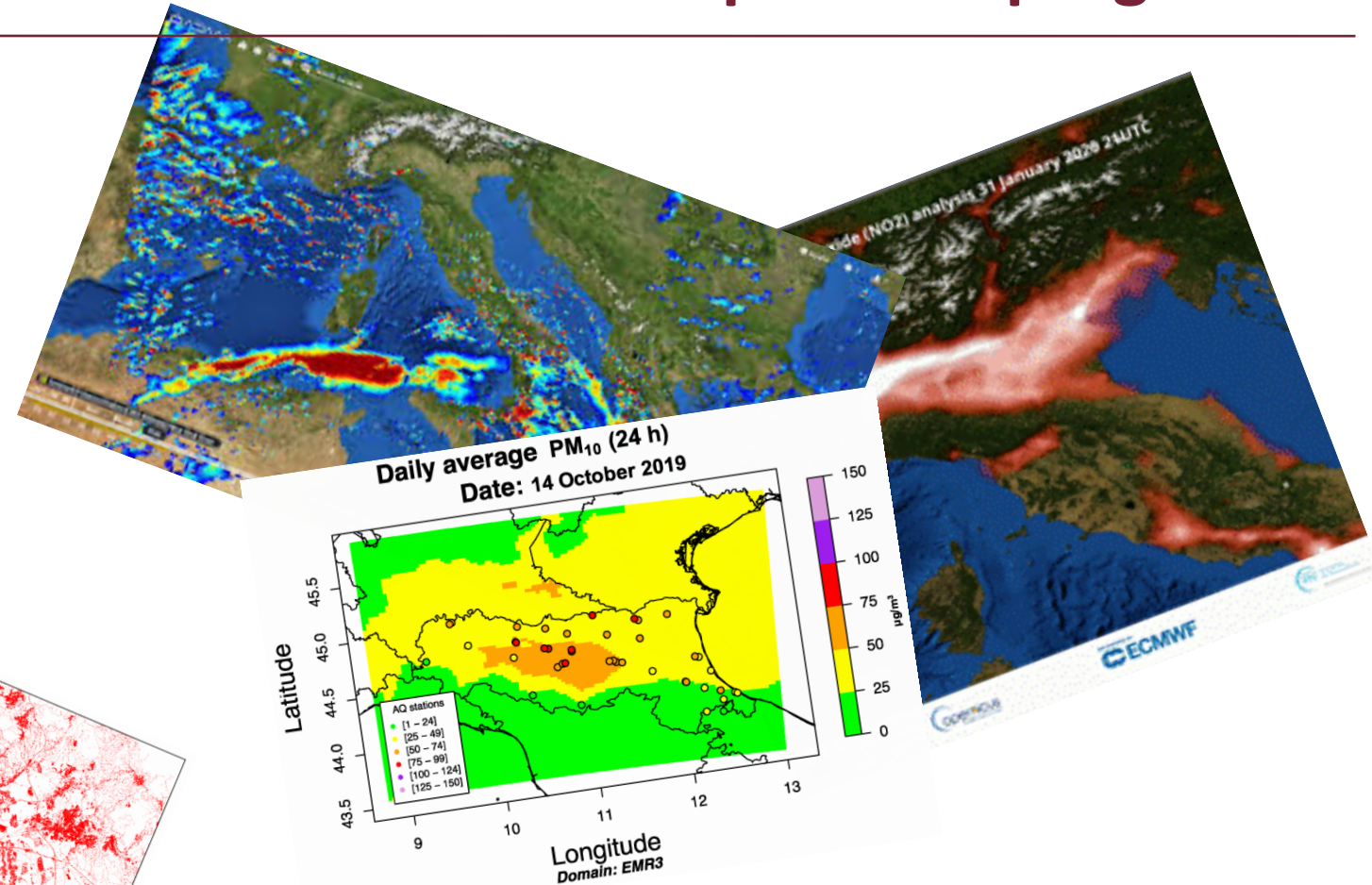
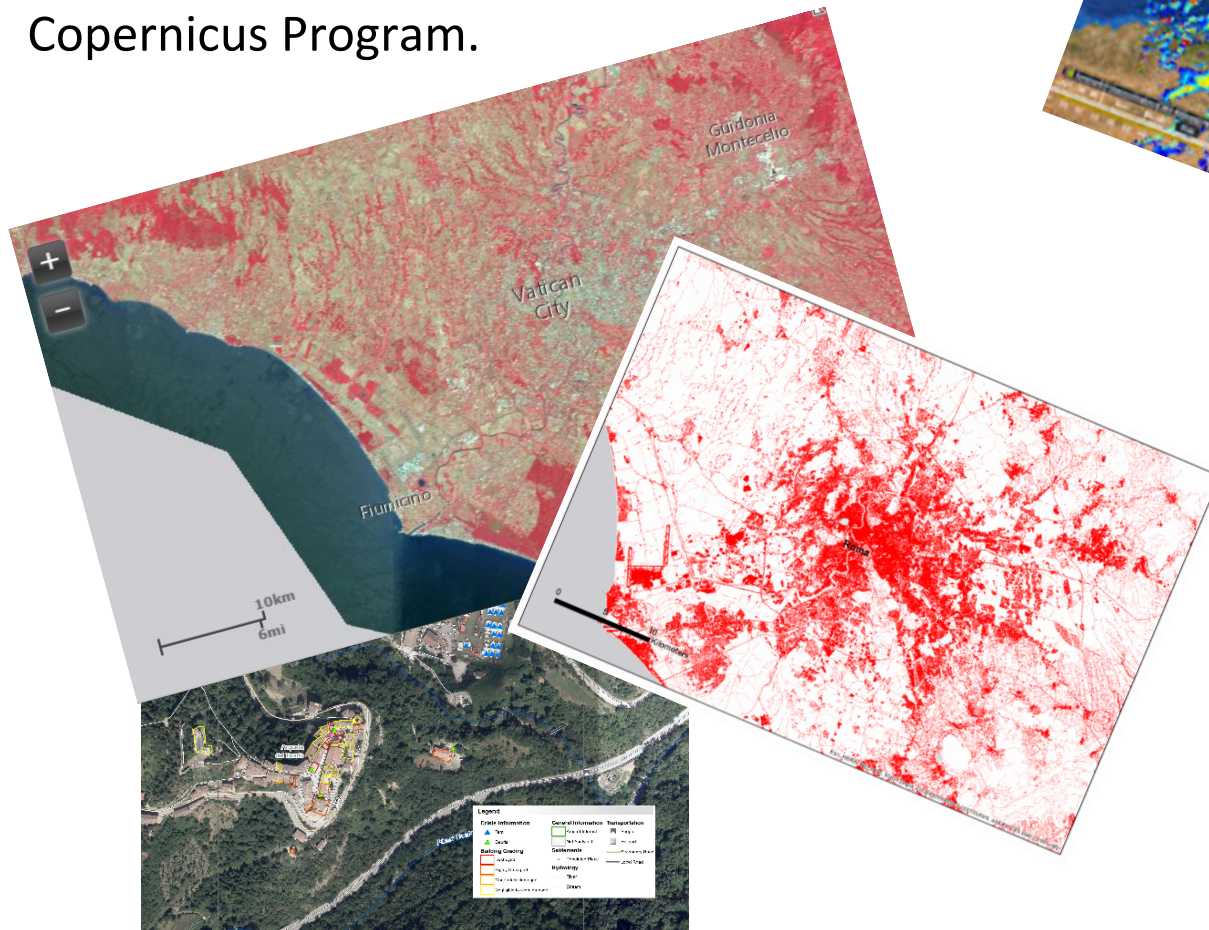


TECNOLOGICA
E LA DIGITALIZZAZIONE



The use of OT data and services of the Copernicus program

ISPRA and the National System for Environmental Protection already provide monitoring services based on the Earth observation capacity of the European OT Copernicus Program.



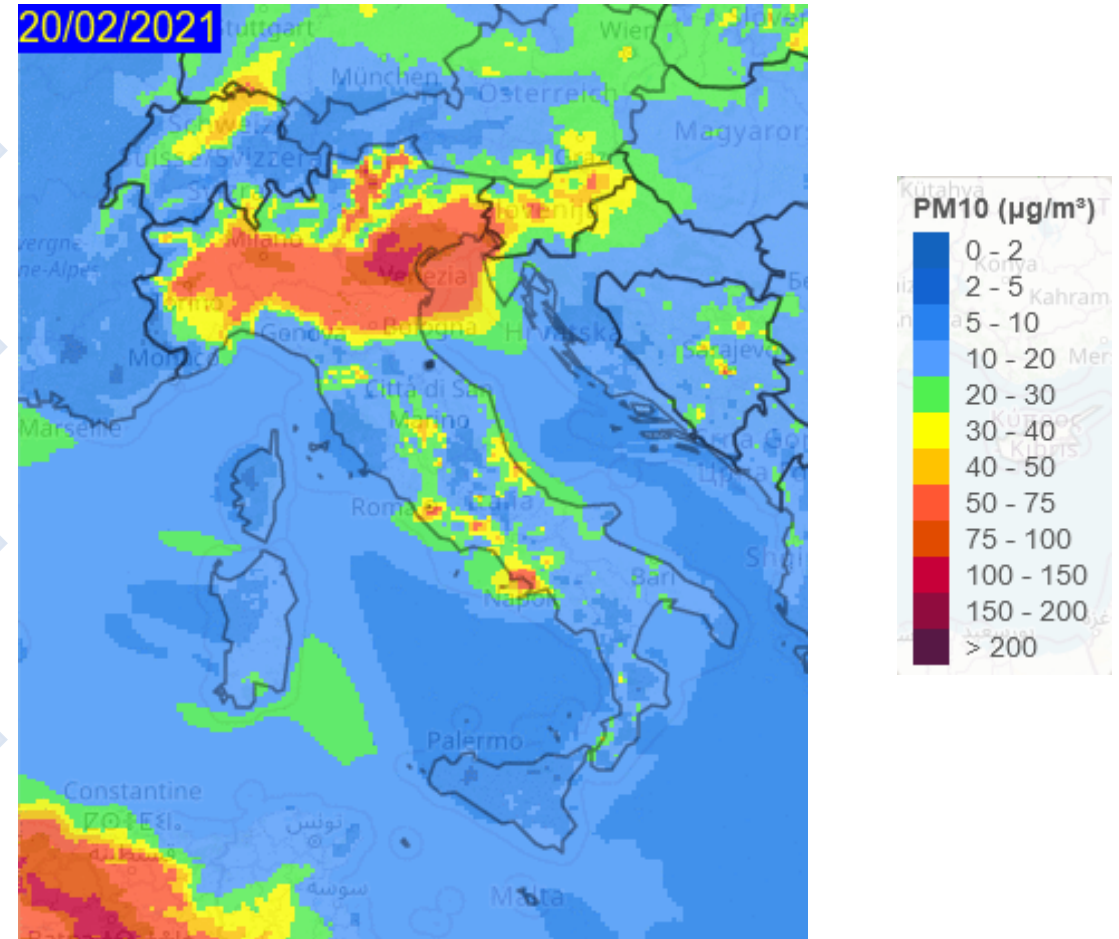
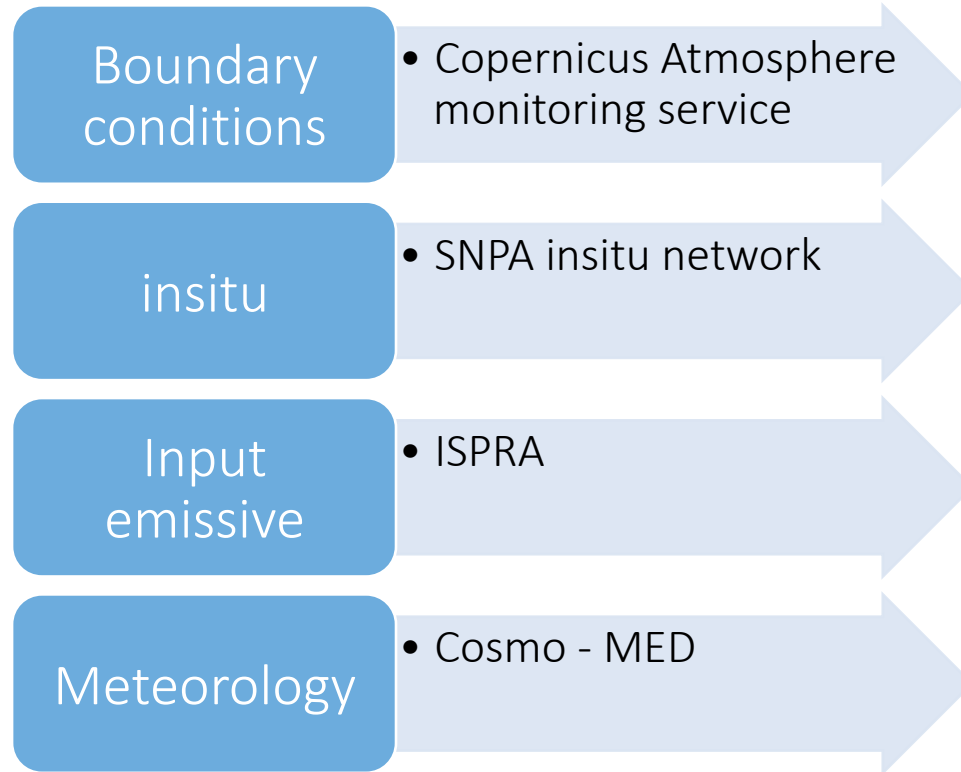
These services relate to **land consumption**, **hydraulic risk**, **coastal dynamics**, **air quality** and **habitat mapping** and **land movements**.

In detail...

Air Quality Monitoring (1/3)

Operational services on a national scale (SNPA): Numerical models for forecasting air quality (up to 72 hours) and daily analysis. Horizontal resolution: 7x7 km

ASI-ISPRA "Air Quality" project



Air Quality Monitoring (2/3)

Reanalysis on a national scale (SNPA): Statistical models with daily temporal resolution.
Horizontal resolution: 1x1 km

Explanatory
variables

- Meteorology (ERA5)
- Land use (CORINE)
- Emission (ISPRA)
- AOD (NASA)
- Road Network (OPEN STREET)

Response
variable

- Concentration measured (SNPA network)

Atmospheric Environment 248 (2021) 118192.

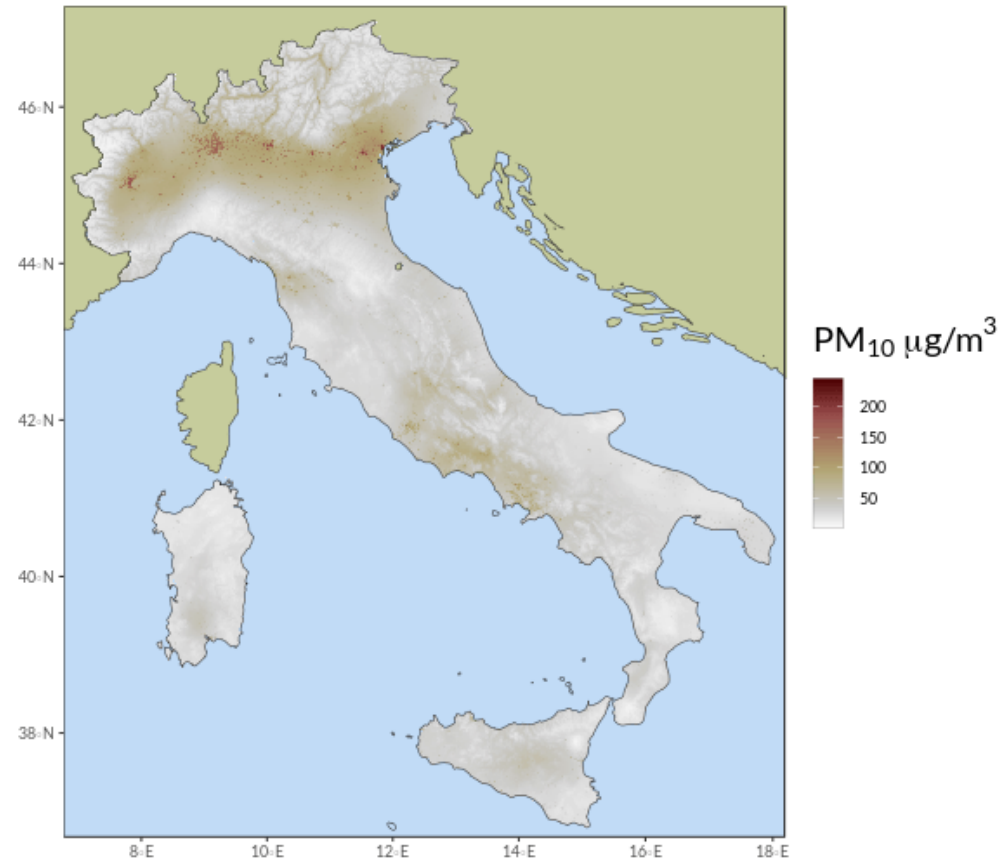
Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: <http://www.elsevier.com/locate/atmosenv>



Day: 2015-01-02



ASI-ISPRA "Air Quality" project

Air Quality Monitoring (3/3)

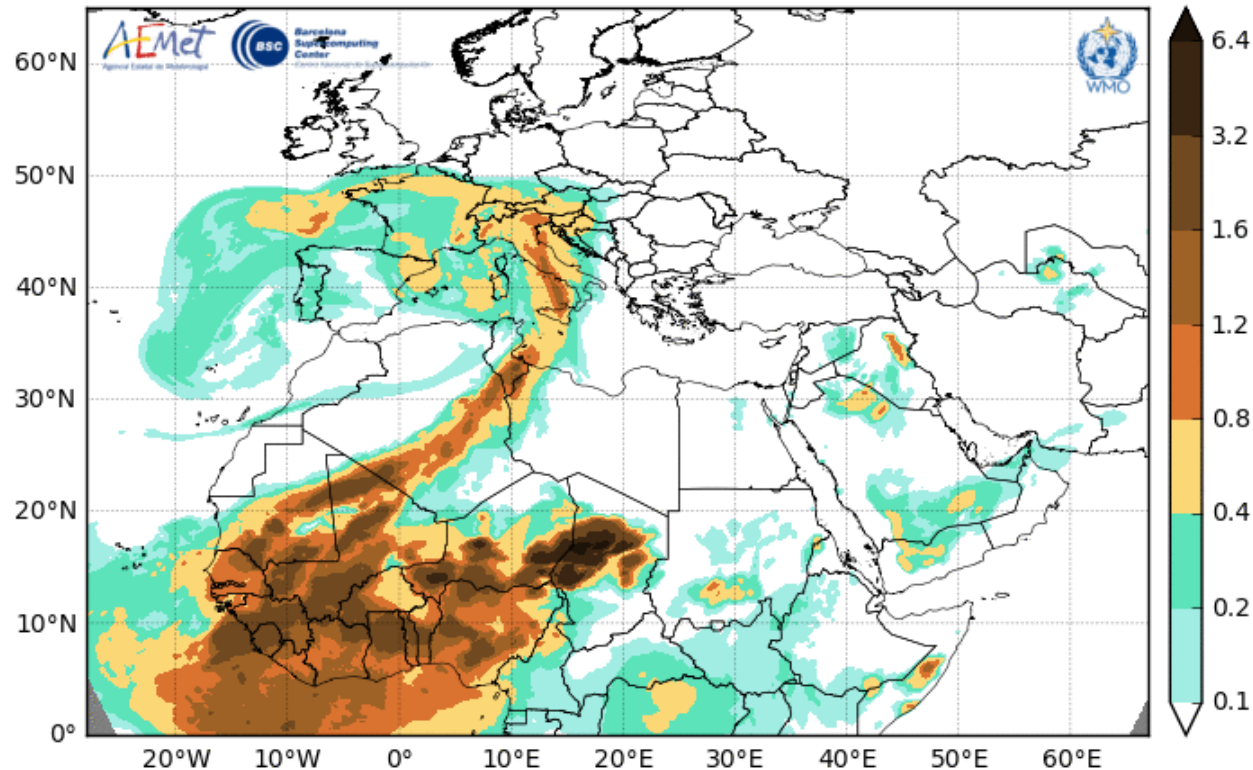
Annual / seasonal assessment of desert dust transport events and quantification of the contribution to PM₁₀ concentrations - (ISPRA - ARPA LAZIO)

ASI-ISPRA "Air Quality" project

Barcelona Dust Forecast Center - <http://dust.aemet.es/>

NMMB-MONARCH Res:0.1°x0.1° Dust Load (g/m²)

Run: 12h 24 JAN 2020 Valid: 12h 24 JAN 2020 (H+00)



Input Data:

- Stations of the national monitoring network
- *National database of "events"*: days in which the results of the BSC NMMB model indicated a Saharan contribution in the cell containing the station considered - automatic generation of daily input procedure developed for over 500 national stations

ASI-ISPRA "Habitat Mapping" project

Land cover classification

Thematic cartography consistent with the 2007/2 / EC directive, with the Copernicus High Resolution Layers (HRL) product classification system and with the second generation Corine Land Cover products, thus designing a monitoring system that can be quickly updated



Article

Multispectral Sentinel-2 and SAR Sentinel-1 Integration for Automatic Land Cover Classification

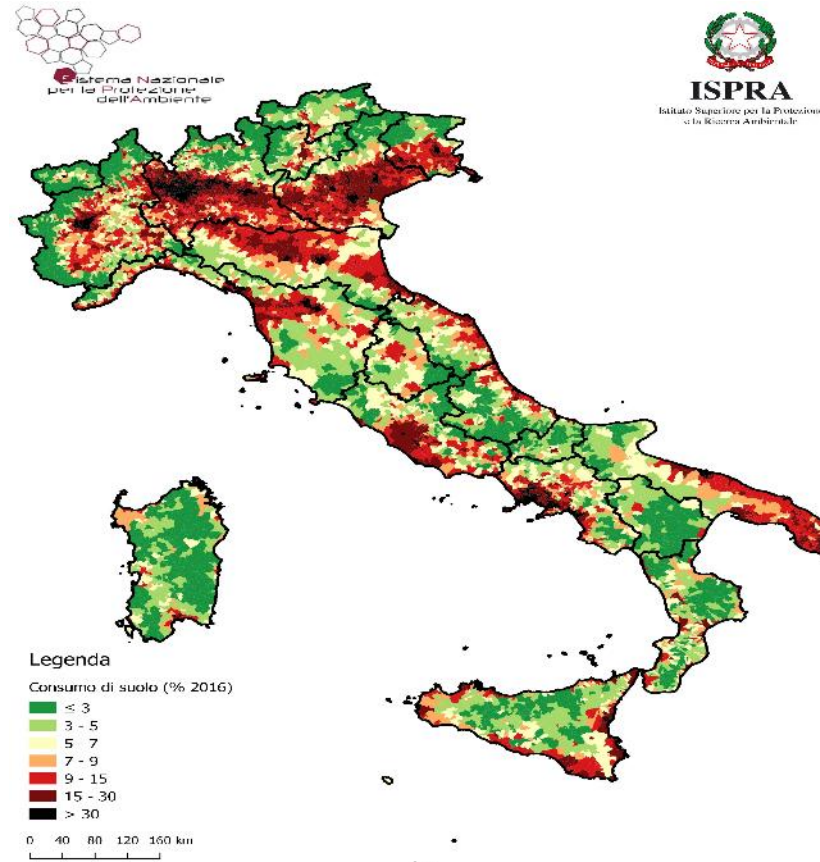
Paolo De Fioravante ^{1,3}, Tania Luti ^{1,2,*}, Alice Cavalli ³, Chiara Giuliani ¹, Pasquale Dichicco ⁵, Marco Marchetti ⁴, Gherardo Chirici ⁵, Luca Congedo ¹ and Michele Munafò ¹



Review

Monitoring Green Infrastructure for Natural Water Retention Using Copernicus Global Land Products

Andrea Taramelli ^{1,2}, Michele Lissoni ¹, Laura Piedelobo ^{3,*}, Emma Schiavon ¹, Emiliana Valentini ², Alessandra Nguyen Xuan ² and Diego González-Aguilera ³



1. Superfici abiotiche non vegetate

- 1.1 Superfici artificiali
- 1.2 Superfici naturali



2. Superfici biotiche vegetate

- 2.1 Vegetazione legnosa
 - 2.1.1 Latifoglie
 - 2.1.2 Conifere
- 2.2. Vegetazione erbacea
 - 2.2.1 Vegetazione erbacea permanente
 - 2.2.2 Vegetazione erbacea periodica



3. Superfici idriche

- 3.1 Acqua liquida
- 3.2 Acqua solida



Prodotti Corine Land Cover di seconda generazione

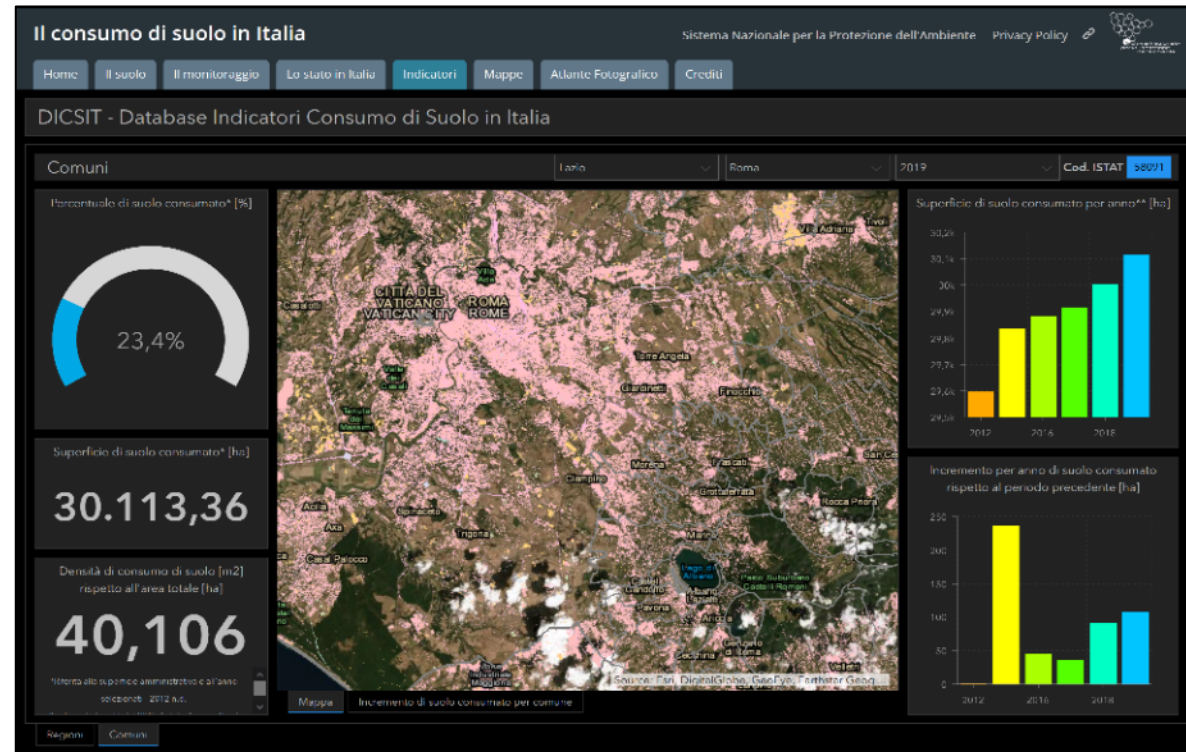
Territory and land consumption monitoring (1/2)

ISPRA and the SNPA ensure the annual monitoring of the territory and of land consumption.

The maps and indicators are accessible in open format.



www.isprambiente.gov.it



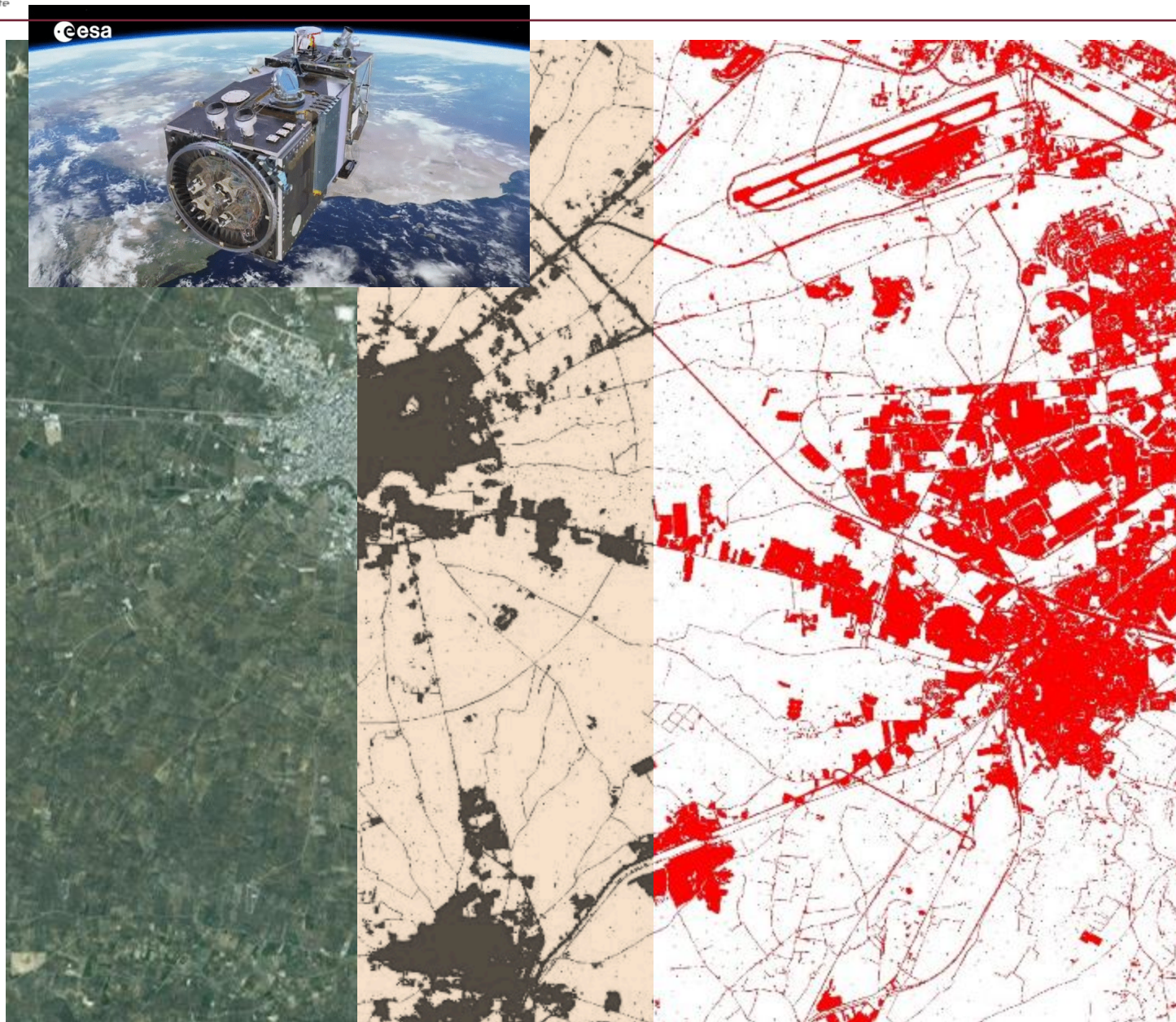
ISPRA
ARPA Piemonte
ARPA Valle d'Aosta
ARPA Liguria
ARPA Lombardia
ARPA Bolzano
ARPA Trento
ARPA Veneto
ARPA Friuli Venezia Giulia
ARPA Emilia-Romagna
ARPA Toscana
ARPA Umbria
ARPA Marche
ARPA Lazio
ARPA Abruzzo
ARPA Molise
ARPA Campania
ARPA Puglia
ARPA Basilicata
ARPA Calabria
ARPA Sicilia
ARPA Sardegna



Territory and land consumption monitoring (2/2)

Land Consumption Monitoring with SAR Data and Multispectral Indices

Tania Luti ^{1,2}, Paolo De Fioravante ^{1,3,*}, Ines Marinucci ¹, Andrea Strollo ¹, Nicola Rittano ¹, Valentina Falanga ¹,
Lorella Mariani ¹, Luca Congedo ¹ and Michele Munafò ¹



Servizi Copernicus
Land (EEA)

National land use
map
(ISPRA / SNPA)

National data on land use ensure better accuracy, resolution and timeliness than European products and are obtained through the classification of Copernicus images (Sentinels 1 and 2) and other missions

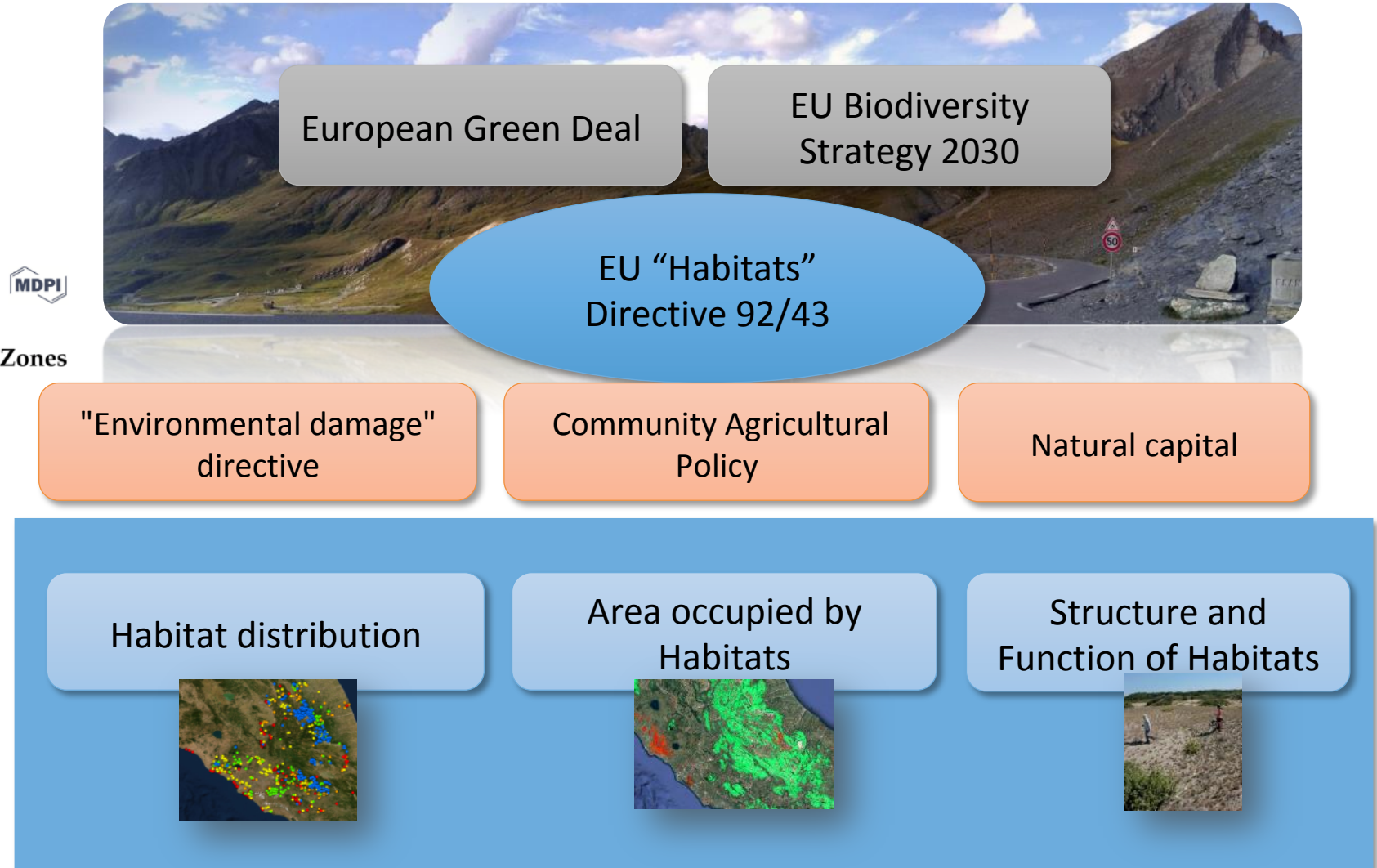
Biodiversity monitoring (1/2)

ASI-ISPRA "Habitat Mapping" project



Article
**Assessment of Green Infrastructure in Riparian Zones
Using Copernicus Programme**

Laura Pieldebo ¹, Andrea Taramelli ^{2,3,*}, Emma Schiavon ², Emiliana Valentini ³,
José-Luis Molina ¹, Alessandra Nguyen Xuan ³ and Diego González-Aguilera ¹



Biodiversity monitoring (2/2)

BIG DATA

In situ data

- ✓ Environmental databases
- ✓ Drone surveys

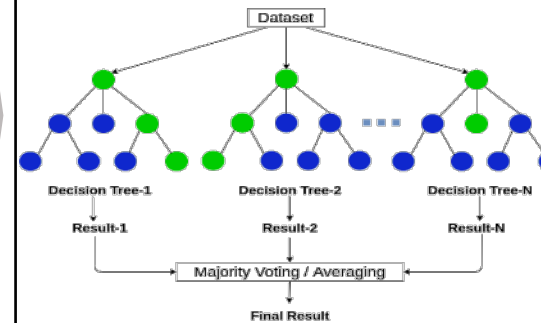
Earth Observation

- ✓ Spectral analysis
- ✓ Multitemporal analysis

ARTIFICIAL INTELLIGENCE

*MACHINE LEARNING
MODEL*

Random Forest

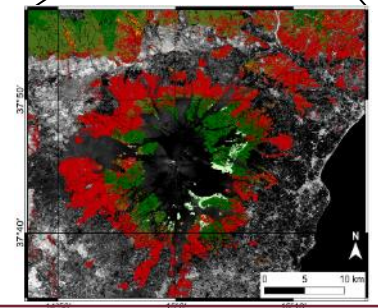
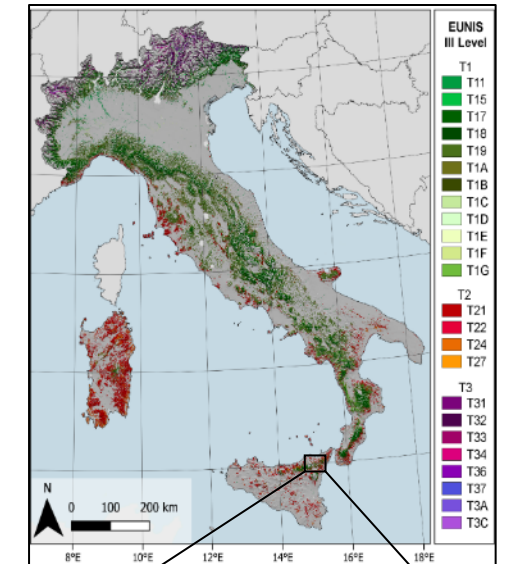


Ensamble

*PREDICTIVE
MAPS*

PRODOTTI E SERVIZI

*MONITORING
changes in space
and time*



River morphology and hydraulic risk

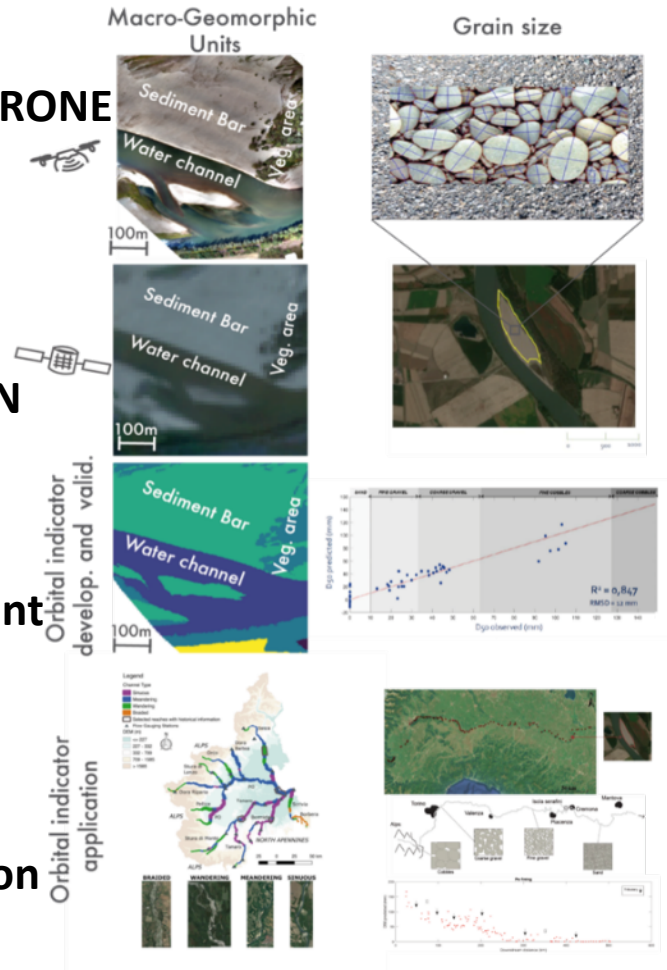
ASI-ISPRA "Habitat Mapping" project

CAMPAIGNS OF MEASUREMENTS WITH DRONE

EARTH OBSERVATION

Research&development

Operarional application



Approach for monitoring, mapping, large-scale assessment of the local characteristics of rivers (e.g., habitat morphology, river corridor, grain size classes, potential hydraulic risk areas).

EARTH SURFACE PROCESSES AND LANDFORMS

Earth Surf. Process. Landforms (2020)

© 2020 The Authors. Earth Surface Processes and Landforms published by John Wiley & Sons Ltd

Published online in Wiley Online Library

(wileyonlinelibrary.com) DOI: 10.1002/esp.4955

UAV-based training for fully fuzzy classification of Sentinel-2 fluvial scenes

P. E. Carboneau,^{1*} B. Belletti,^{2,3} M. Micotti,² B. Lastoria,⁴ M. Casaioli,⁴ S. Mariani,⁴ G. Marchetti^{2,5} and S. Bizzi⁶

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² Department of Electronics, Information and Bioengineering, Polytechnic University of Milan, Milan, Italy

³ CNRS UMR5600-EVS, University of Lyon, Lyon, France

⁴ Water Protection Department, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Rome, Italy

⁵ Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy

⁶ Department of Geosciences, University of Padova, Padova, Italy

Development of innovative national services for the observation of water bodies from satellite (Copernicus Sentinel 1 and 2)

EGU General Assembly 2021

EGU21-14945

<https://doi.org/10.5194/egusphere-egu21-14945>

EGU General Assembly 2021

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Machine learning-based grain size mapping from satellite images

Giulia Marchetti¹, Simone Bizzi², Barbara Belletti³, Barbara Lastoria⁴, Stefano Mariani⁴, Marco Casaioli⁴, Francesco Comiti¹, and Patrice Carboneau³

¹Free University of Bozen, Faculty of Science and Technology, Bolzano-Bozen, Italy (giulia.marchetti@unibz.it)

²Department of Geosciences, University of Padova, Padua, Italy

³CNRS UMR5600-EVS, University of Lyon, Lyon, France

⁴Water Protection Department, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Rome, Italy

⁵Department of Geography, Durham University, Durham, UK

A comprehensive understanding of river dynamics requires the quantitative knowledge of the grain size distribution of bed sediments and its variation across multiple temporal and spatial scales. Several techniques are already available for grain size assessment based on field and remotely sensed data. However, the existing methods permit to cover small areas and short time scale, thus the operational measurement of grain size distribution of river bed sediments at the

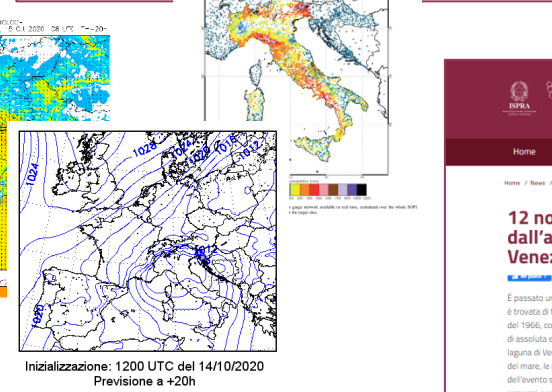
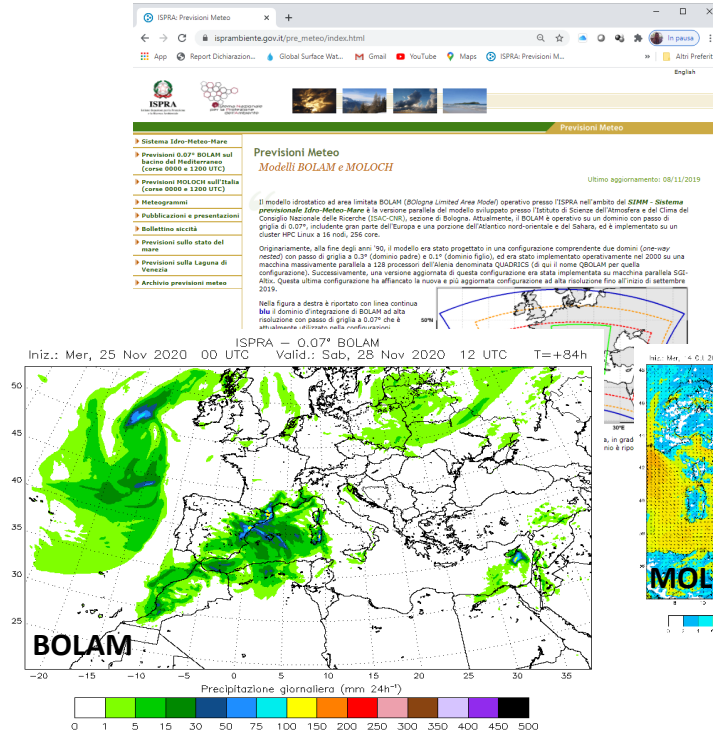
IDRAIM national reference framework

European directives of reference:

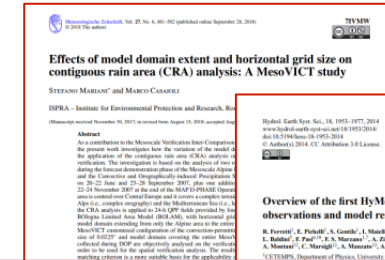
Water Framework Directive WFD 2000/60 / EC

Floods Directive FD 2007/60 / EC

Monitoring and analysis of extreme hydro-meteorological and meteo-marine events



WMO initiatives with collaboration between SNPA, SNPCand the national and international scientific community



- **ISPRA Hydro-Meteo-Sea forecasting system + SNPA / SNPC observation networks and satellite data:** weather and marine-coastal forecasting and monitoring on Italy and the Mediterranean and high water forecasting and monitoring on the Upper Adriatic and Venice
- Collaboration agreement with the Italian Air Force
- **ISPRA «Weather Agency» for ItaliaMeteo**
- Tide forecast table: Municipality of Venice, ISPRA, CNR-ISMAR
- MOLOCH-BOLAM Consortium: ISPRA, ARPAL, LAMMA, CNR-ISAC
- Forecast verification: evaluation of model predictive capabilities
- [HTTP://WWW.ISPRAMBIENTE.GOV.IT/PRE_METEO/](http://www.isprambiente.gov.it/pre_meteo/)

Coastal Monitoring (1/2)

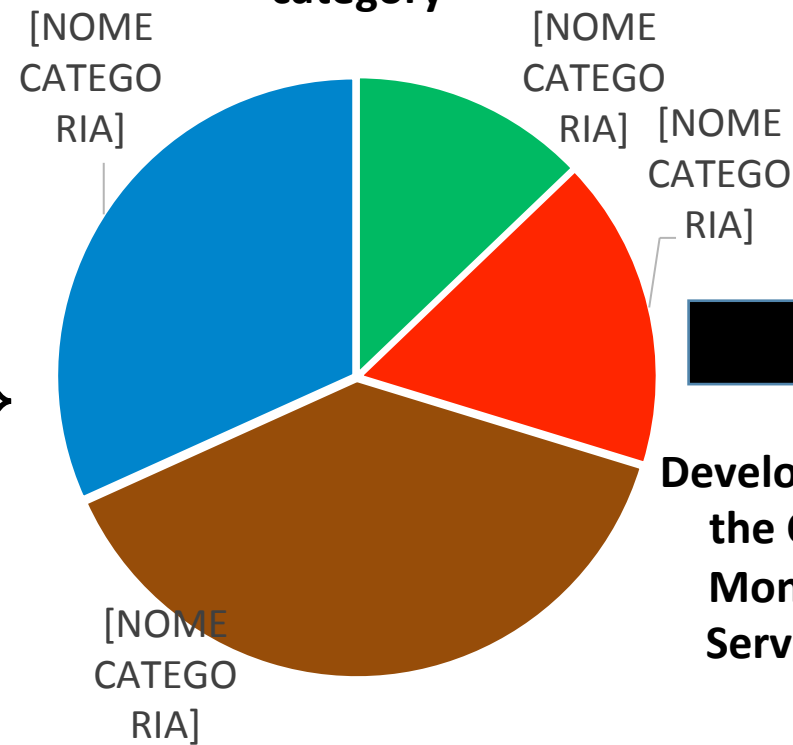
Coordinating the analysis of national coastal users needs and development of a Coastal Service (S1) in the framework of the Mirror Copernicus:

Institutional users: SNPA, SNPC, Coastal Erosion Table (MITE, Regions, Basin Authorities), MIT and Coastal Guard, MIPAAF, MIBACT, MD

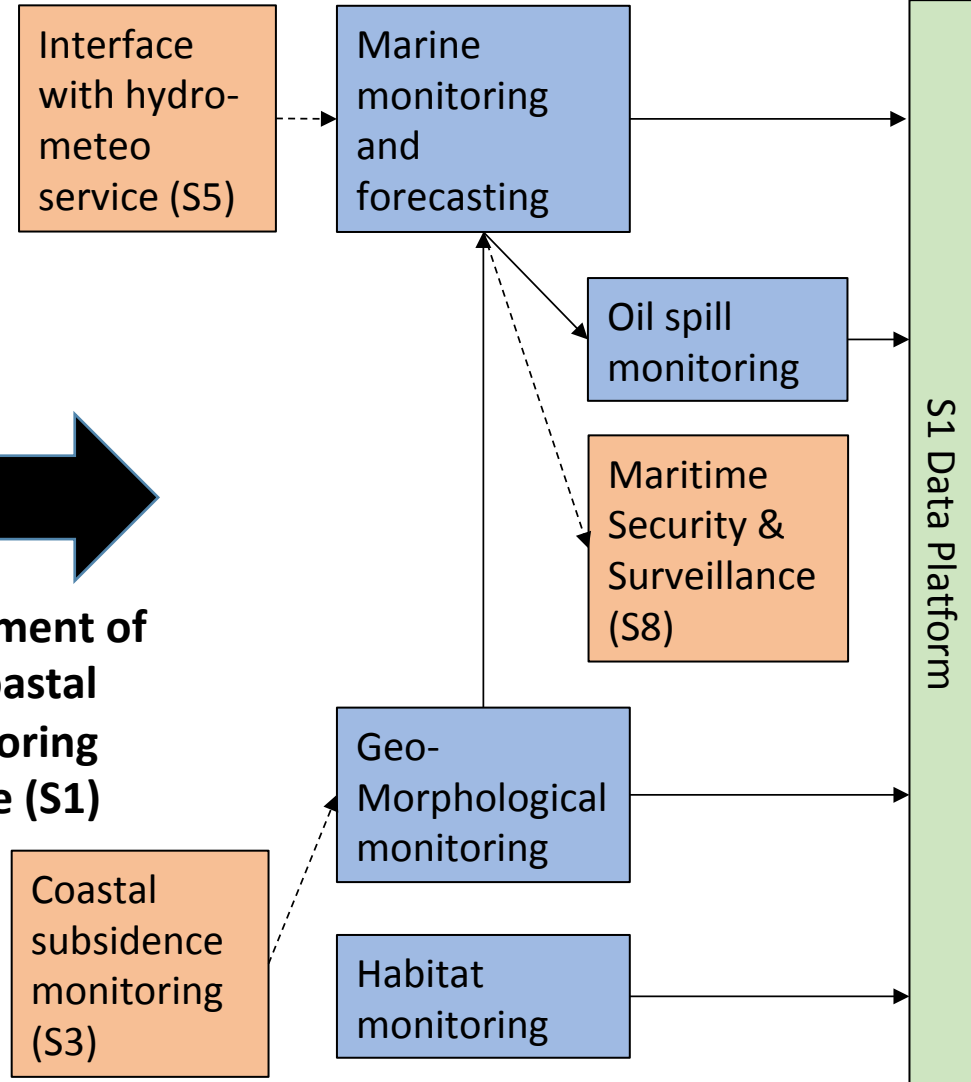
Coastal Group of the National Copernicus User Forum: coastal experts, both end users and intermediate users

Coastal Implementation Group within the National Copernicus User Forum: Stakeholders related to coastal activities at all levels (maritime activities, research, insurances, multiservice companies, financial activities, etc.)

Required parameters, by category



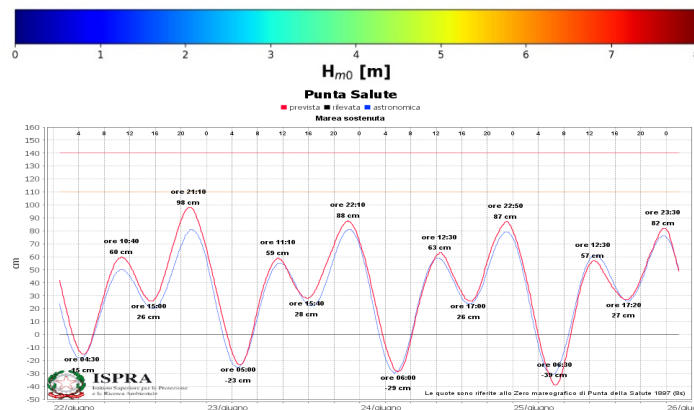
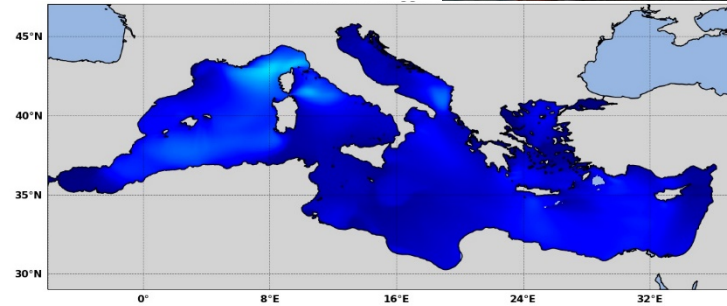
Development of the Coastal Monitoring Service (S1)



Coastal Monitoring

Coastal Monitoring in ISPRA: in-situ, remote sensing, mathematical models and data analysis

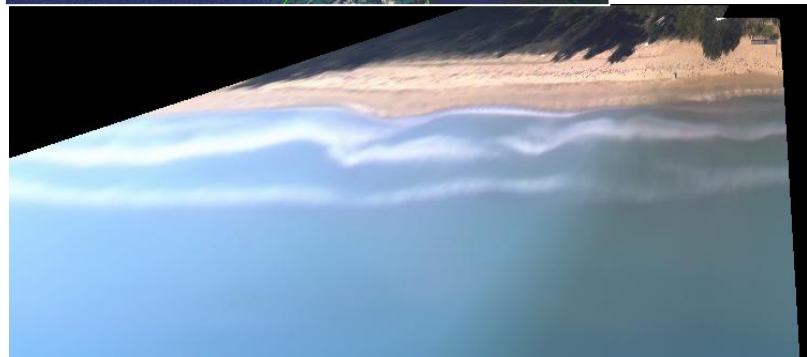
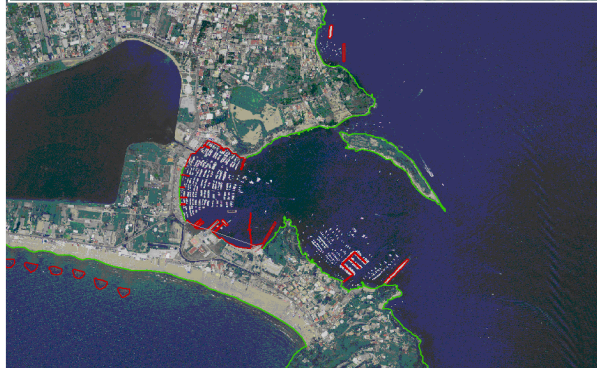
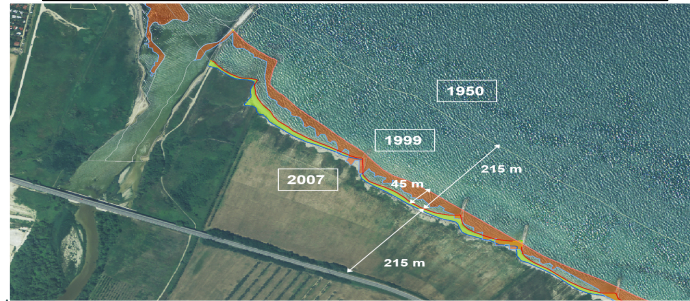
Marine monitoring and forecasting



In situ: waves
and sea level

Forecasting models :
waves and sea level

Geo-Morphological monitoring

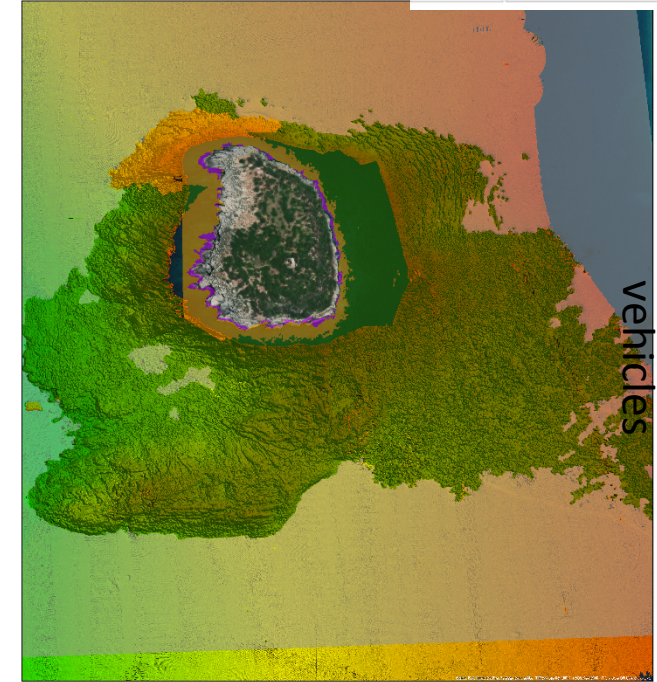


Coastline

Coastal
defences and
structures

Coastal video-monitoring

Habitat monitoring

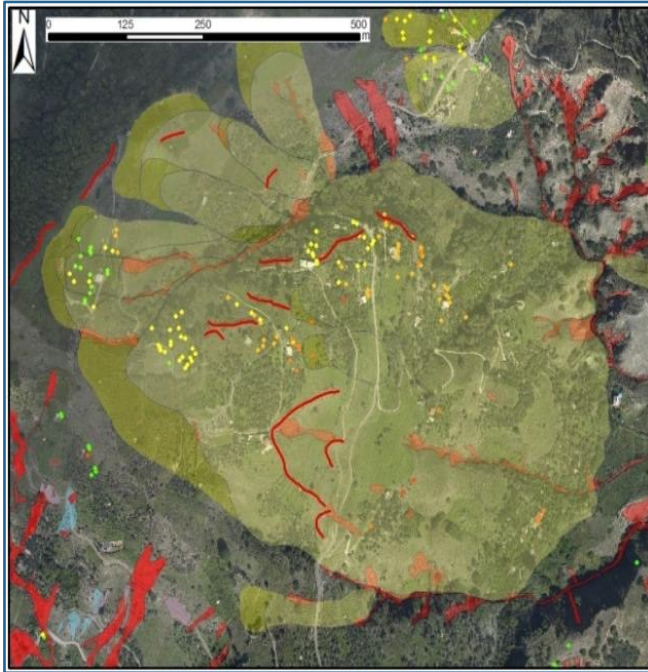


In situ and remote sensing
(satellite, drones, surface
vehicles)

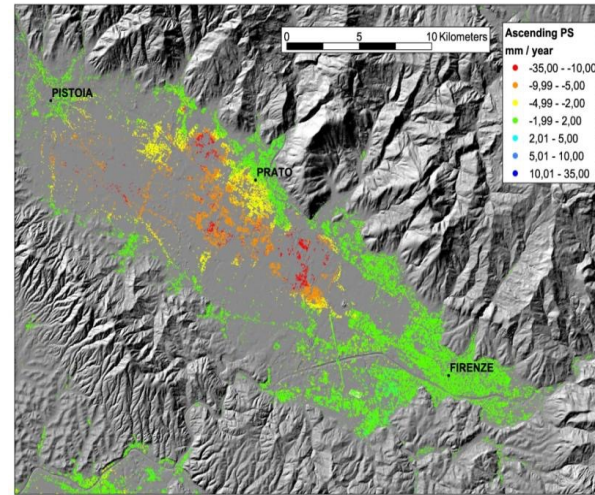
- Sentinel 1A e 1B
- Dal 2014

- CosmoSkyMed
- Dal 2016

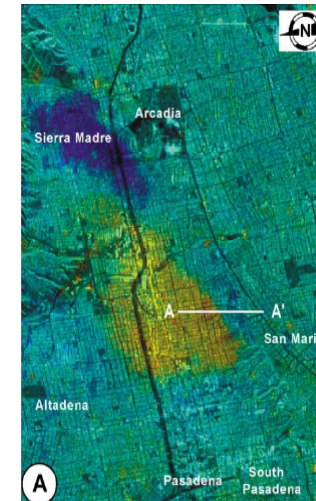
Satellite Radar Interferometry APPLICATIONS



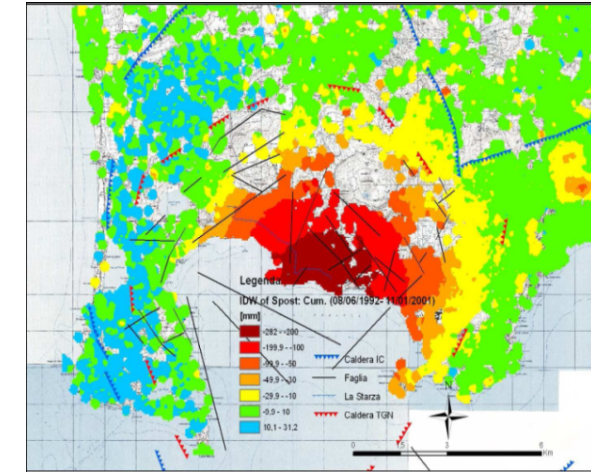
landslide



Subsidence



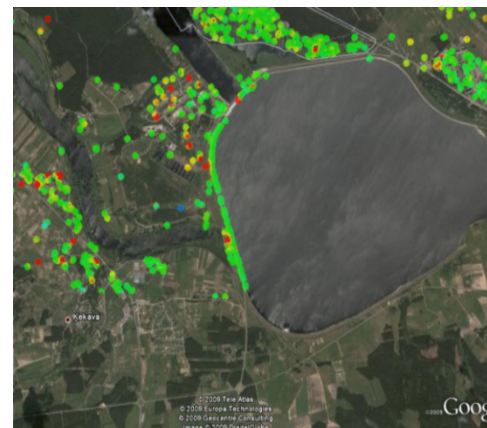
Tectonics



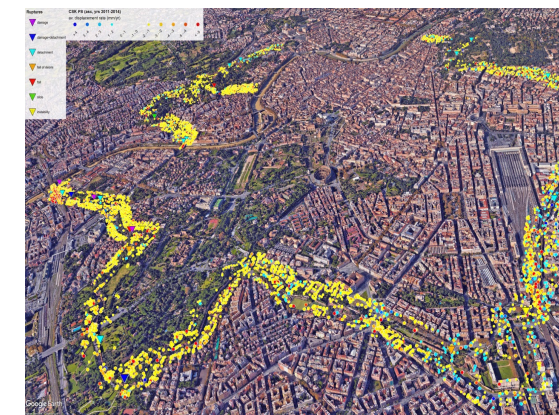
Volcanic activity



Single building



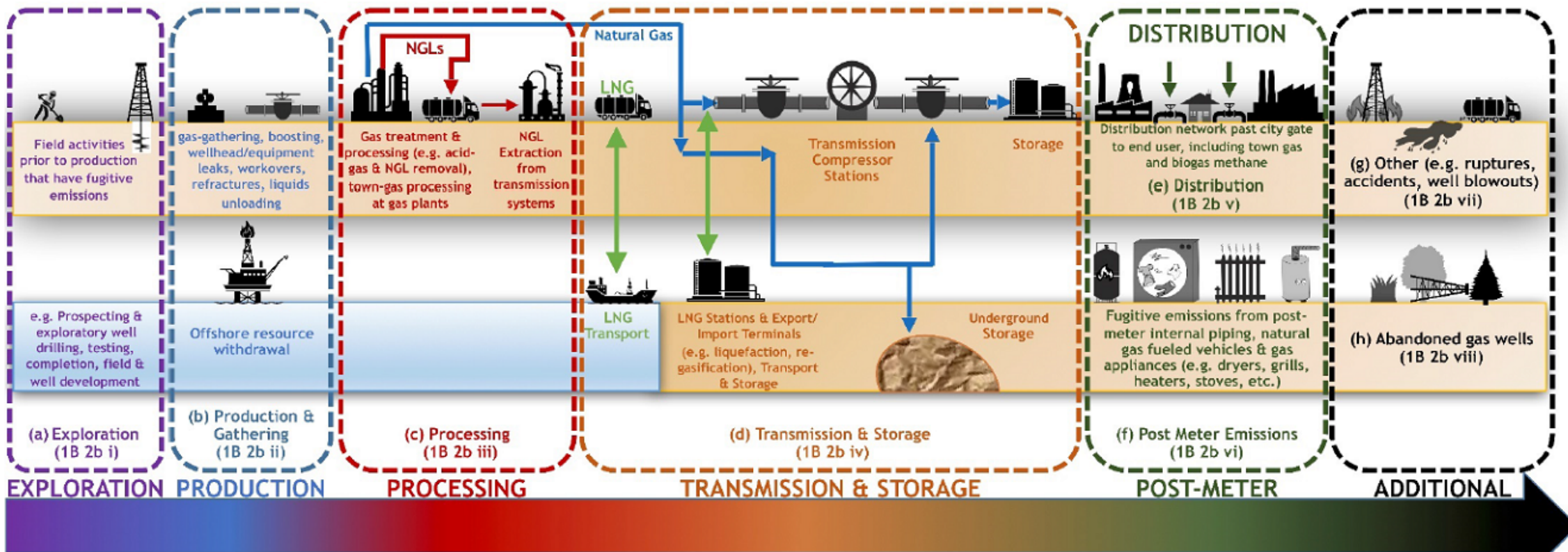
Dams monitoring



Cultural Heritage

Identification of use cases linked to the methane and industry

Key segments included in Natural Gas Systems (1B 2b)



Storage sites Oil spill

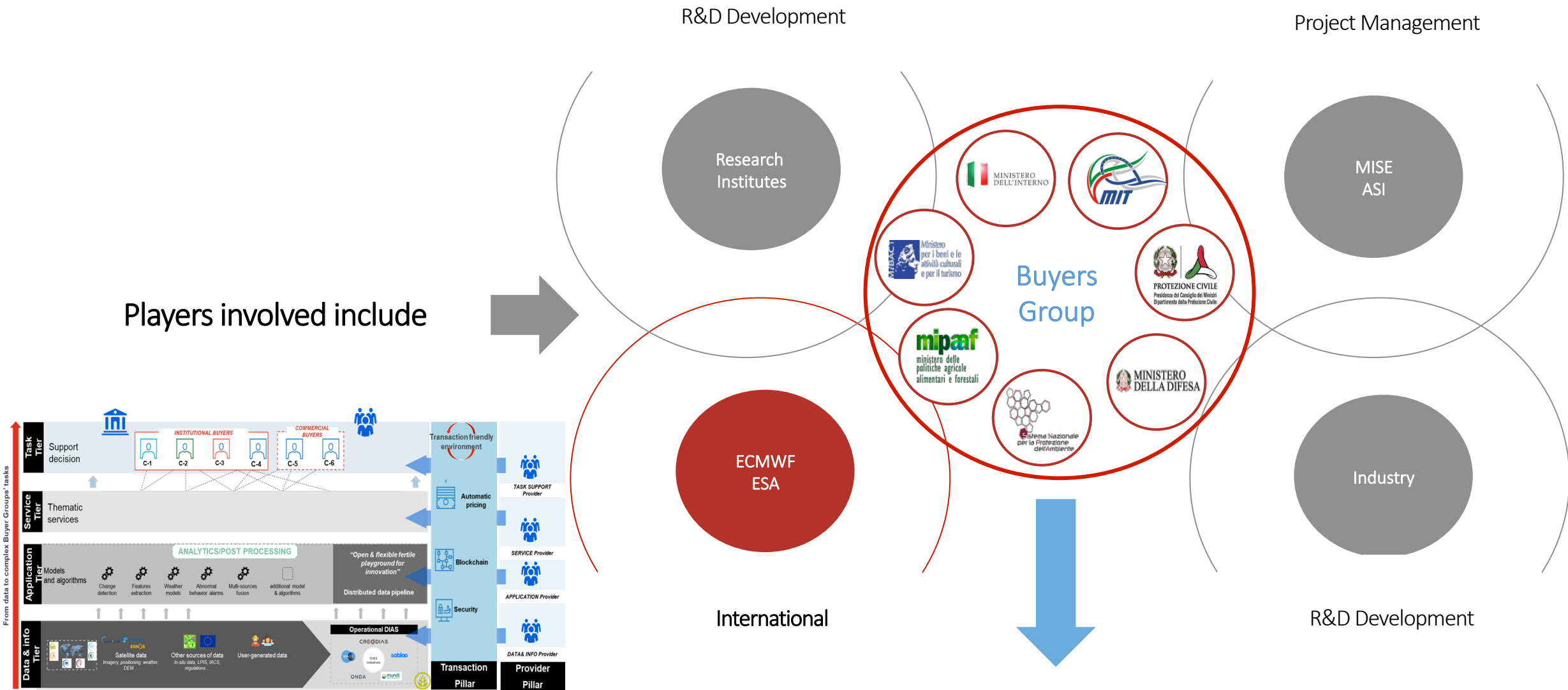
Ground movements monitoring
in correspondence of
structures / infrastructures

Monitoring of
networks / pipelines

Liquid / gaseous
emissions
monitoring

Landfills /
accidents

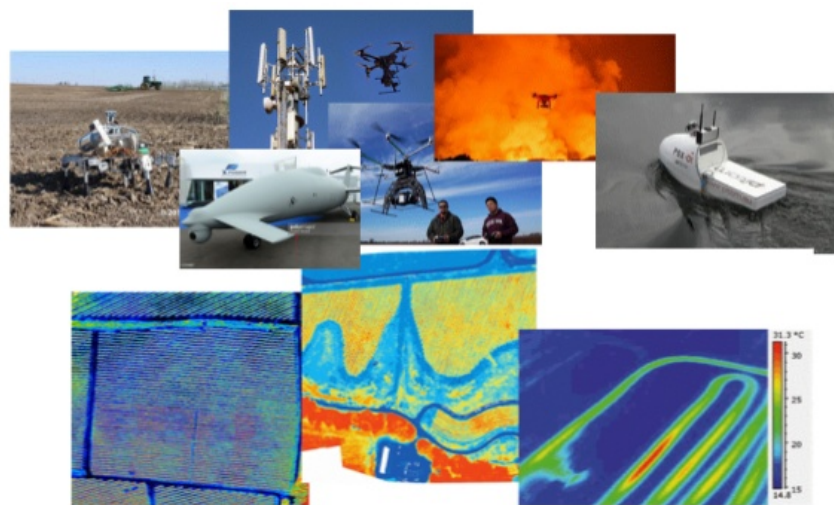
Operation of the Copernicus Mirror



Sets requirements for specific services, grouped in different **Thematic Services**, in accordance with their institutional goals and legislative provision

Role of ISPRA/SNPA in Copernicus

ISPRA and the SNPA provide Copernicus with information and data in situ through the EIONet (European Environment Information and Observation Network) of the EEA (European Environment Agency).



Contribution
ISPRA/SNPA



Contribution and
management
of the In Situ
component
of Copernicus



ISPRA also contributes to the European developments of Compliance Assurance by participating in planning activities of Uptake of Geo-Intelligence services in the Copernicus area (FP-CUP Program), with the aim of combating crimes and environmental crimes.