Hydro-climatic information for water resource management: IRIDE products derived from BIGBANG.

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BILANCIO IDROLOGICO E DISPONIBILITÀ DI RISORSA IDRICA:
AGGIORNAMENTO 2025, PREVISIONI STAGIONALI E PROIEZIONI CLIMATICHE
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ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale
Sistema Nazionale per la Protezione dell'Ambiente

IRIDE system

IRIDE is one of Europe's most ambitious Earth Observation initiatives, developed in Italy with PNRR funding. Managed by **ESA** in collaboration with **ASI**, and its mission is to **provide advanced environmental monitoring, support civil protection, and improve risk management capabilities**.

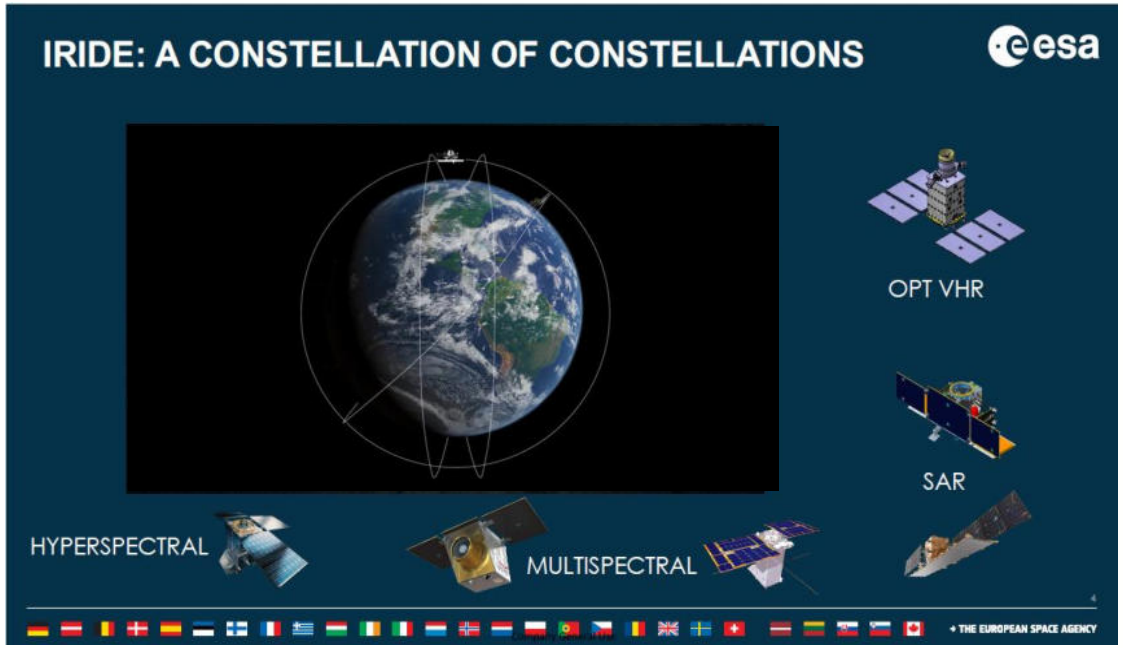
Architecture: End-to-end system with LEO constellations, a ground segment for mission control, and a service segment for Public Administration users.

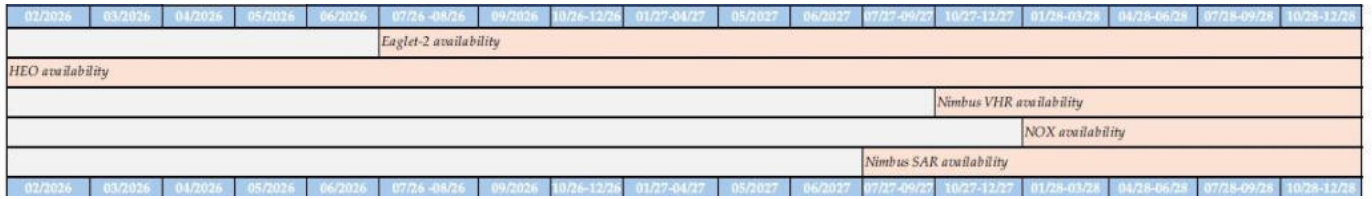
Technologies: Combines **Synthetic Aperture Radar (SAR)** with **multispectral and hyperspectral optical sensors** to ensure all-weather, day-night observation capabilities.

Integration: Complements national systems (**COSMO-SkyMed, PRISMA**) and the European Copernicus program.

A view of Rome, the first image sent by IRIDE's Pathfinder Hawk for Earth Observation (HEO) satellite

IRIDE constellation





Ground Resolution - Optical Payloads				
	HEO	Eaglet-2	NIMBUS-VHR	PLATINO- HYPER
PAN	2.7 [m]	n/a	0.9 [m]	< 5 [m]
MS	2.7 [m] (4 bands) * 5.4 [m] (3 red-edge bands)	2 [m] (RGB)	< 4 [m] *	< 21 [m] (Spotlight) < 31 [m] (Stripmap)
Swath	10.9 [Km]	18.3 [Km]	10.5 [Km]	21 [Km]

(*) Red, Green, Blue, NIR bands

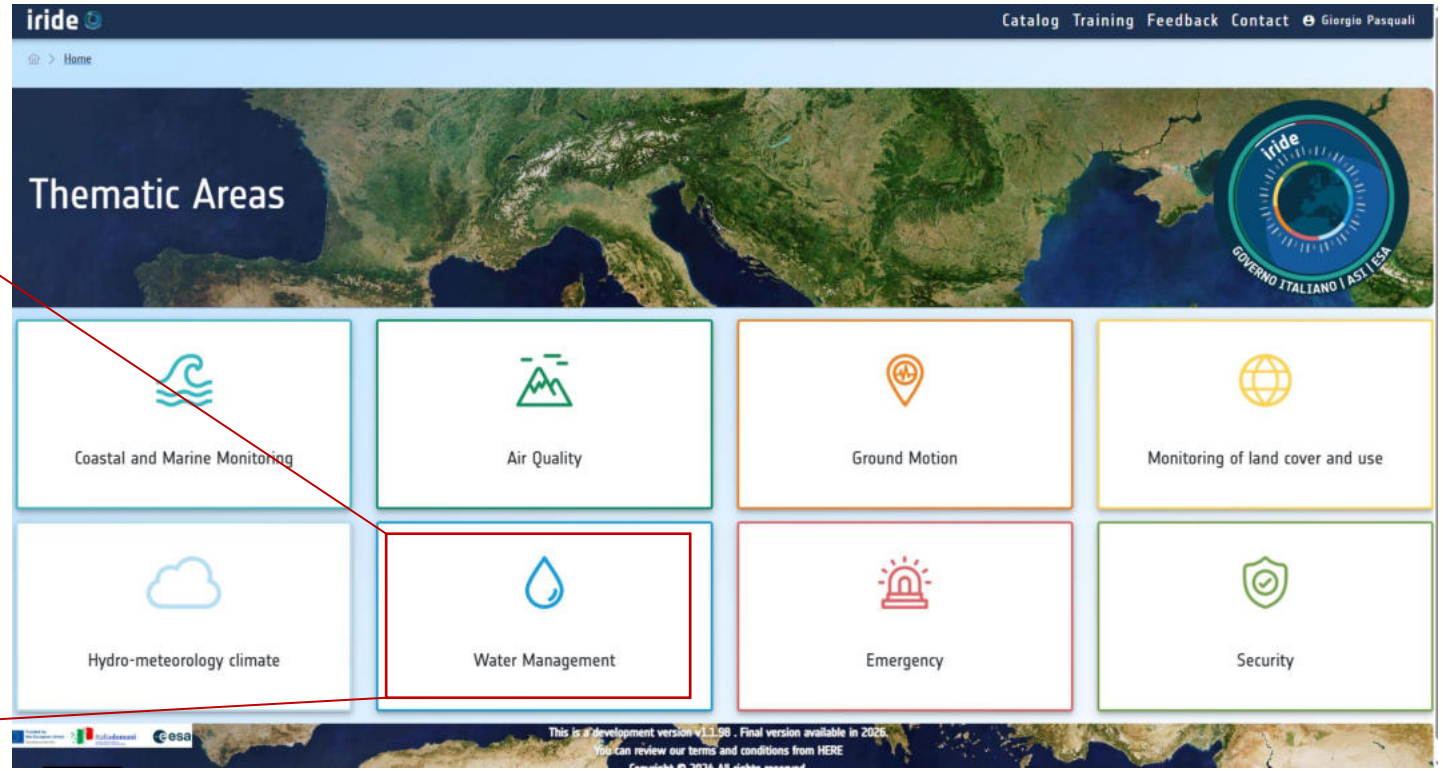
Ground Resolution - SAR Payloads		
	NIMBUS-SAR	NOX-SAR
Spotlight	0.5 [m] – Swath: 2.5 [Km]	1.5 [m] – Swath: 10 [Km]
Stripmap	2.7 [m] – Swath: 27.5 [Km]	3 [m] – Swath: 30 [Km]
Scansar	11 to 17 [m] – Swath: 100 [Km]	6 to 10 [m] – Swath: 50-80 [Km]

Thematic domains

Hydrological and Hydraulic modelling, flood forecasting and sediment management
[SE-S6-01]

River hydromorphological mapping and channel dynamics
[SE-S6-02]

Integrated water resource management
[SE-S6-03]



SE-S6-03 Integrated water resource management overview

The service provides a set of **indicators supporting integrated water resources management**, focused on two thematic areas: **water** and **drought**. Using **Earth Observation data** (Copernicus and IRIDE) combined with **numerical modelling**, it delivers high-resolution, high-frequency indicators covering the **entire national territory**.

ID PRODUCT	PRODUCT NAME	ACTIVATION MODE	TEMPORAL RES.	UPDATE FREQUENCY
OU-S6-03-01	SPEI12 - 12 Months Standardized Precipitation-Evapotranspiration Index	Systematic	Monthly	Monthly
OU-S6-03-02	CDI12_3 - 12-3 Months Combined Drought Indicator			
OU-S6-03-03	SMA3 - 3 Months Soil Moisture Anomaly			
OU-S6-03-04	FAPAR Anomaly			
OU-S6-03-05	NDVI VHR			
OU-S6-03-08	Hydro-climatic water balance (1km)			
OU-S6-03-09	Aridity Index - AI (1km)			
OU-S6-03-10	Runoff Index - RI (1km)			
OU-S6-03-12	SPI1 - 1 Month Standardized Precipitation Index			
OU-S6-03-13	SPI3 - 3 Months Standardized Precipitation Index			
OU-S6-03-14	SPI6 - 6 Months Standardized Precipitation Index			
OU-S6-03-15	SPI12 - 12 Months Standardized Precipitation Index			
OU-S6-03-16	Hydro-climatic water balance (500m)		Weekly (7 days)	
OU-S6-03-17	Aridity Index - AI (500m)			
OU-S6-03-18	Runoff Index - RI (500m)			

IRIDE + BIGBANG: Why This Integration Matters

🔗 **National-scale coherence**
Ensures **consistent hydrological indicators** across the entire country, using harmonized EO inputs and model outputs.

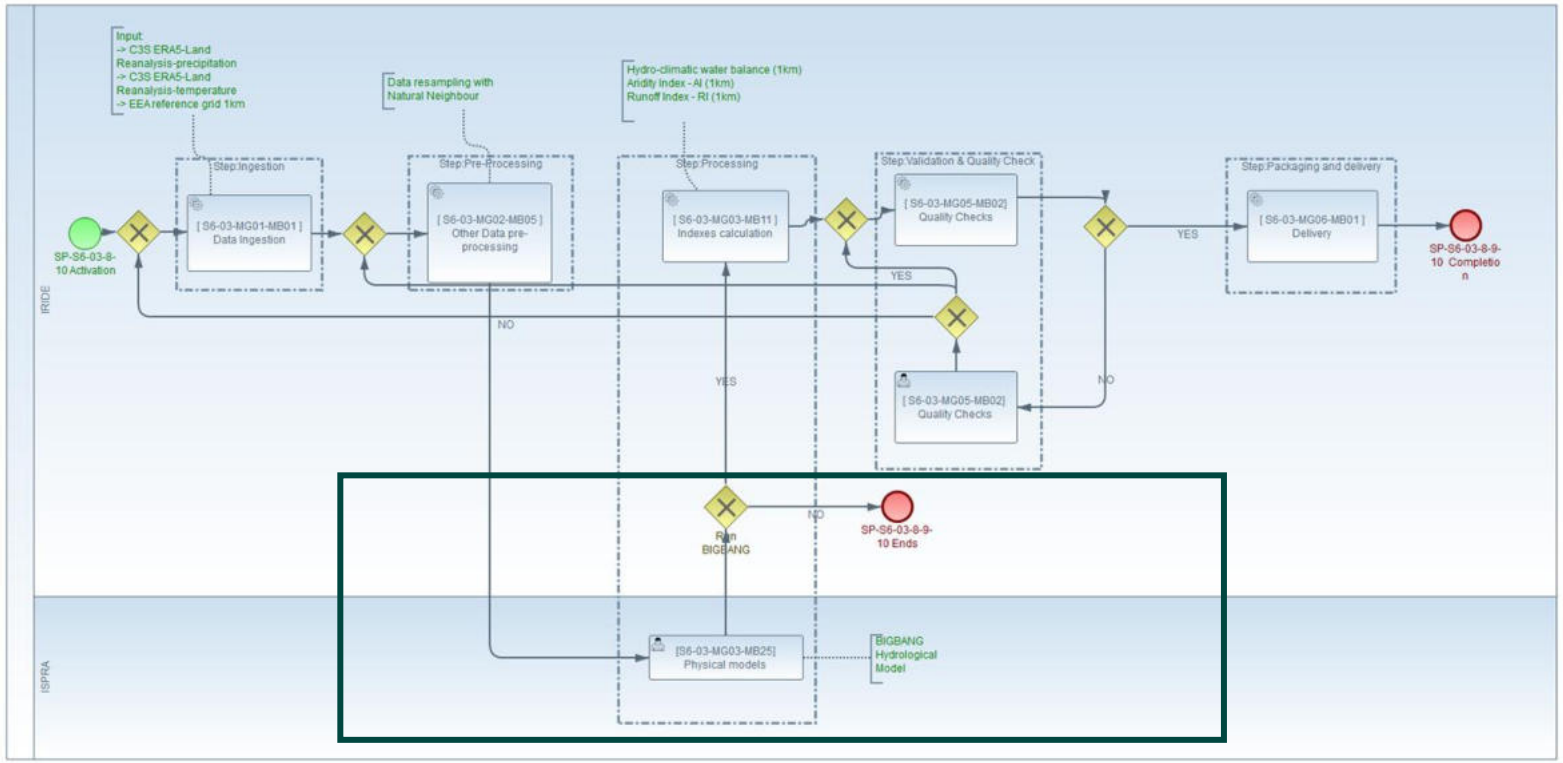
📡 **Operational readiness**
Provides **high-frequency, high-resolution indices** (HWB, AI, RI) ready for systematic service delivery within IRIDE.

🧪 **Scientific robustness**
Bridges **model-based hydrology** (BIGBANG) with **EO-driven monitoring**, enabling cross-validation and improved reliability.

🏛️ **Institutional quality assurance**
Incorporates **ISPRA-validated hydrological layers**, strengthening the credibility and authority of IRIDE services.

🧩 **System-level value**
Enhances the entire IRIDE service chain, turning raw EO data into **actionable, interoperable, decision-support products**.

OU-S6-03-08 to OU-S6-03-10 - Hydro-Climatic Water Balance, Aridity Index, Runoff Index (1 km)



HOW ISPRA IS INVOLVED IN THE WORKFLOW?

1) BIGBANG Model Execution

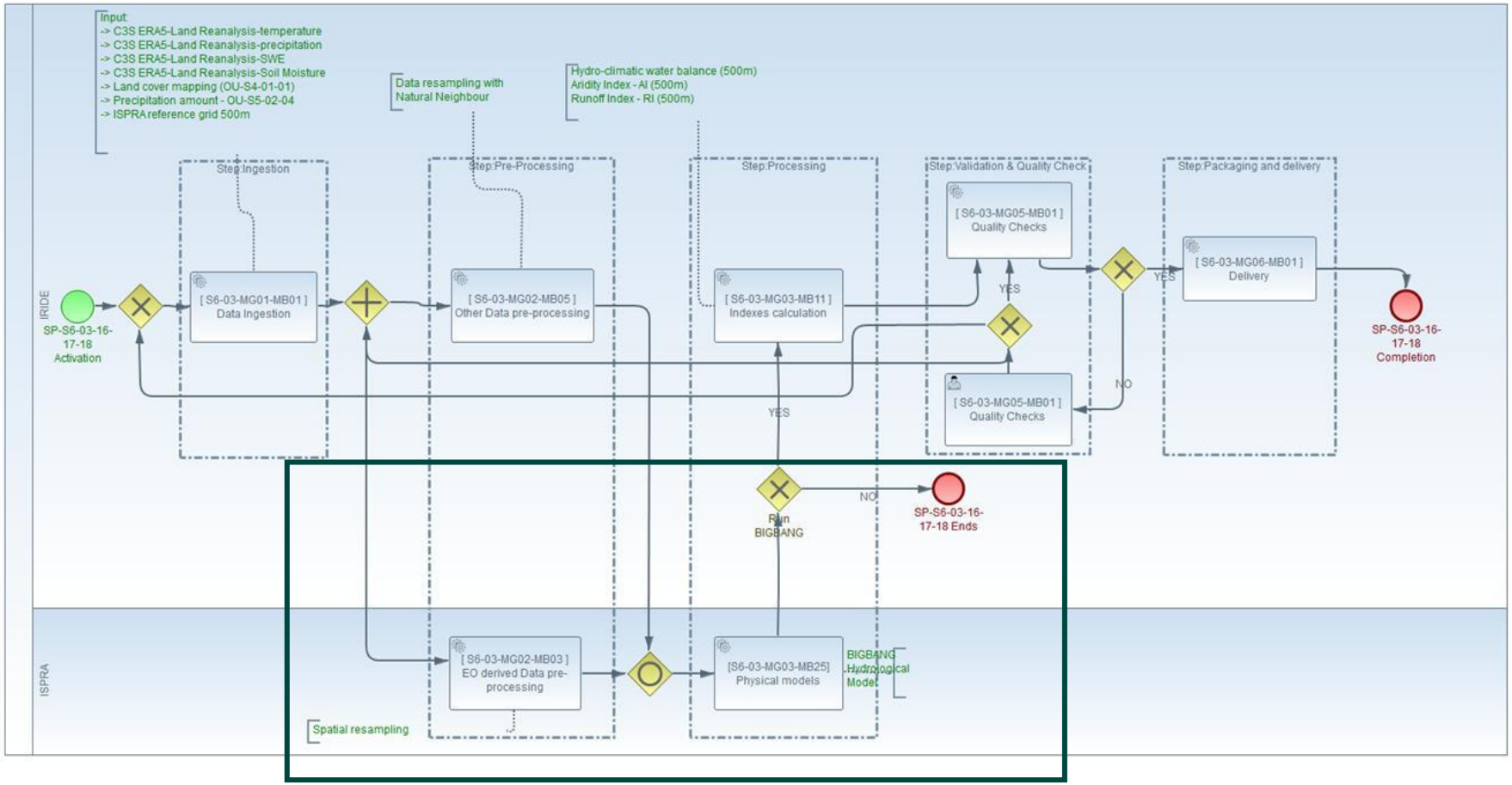
ISPRA runs the **BIGBANG model** using the monthly aggregated inputs (precipitation and temperature):

- Monthly **Evapotranspiration**
- Monthly **Runoff**

2) Data Delivery

ISPRA uploads the BIGBANG outputs to a **dedicated S3 bucket**.

OU-S6-03-16 to OU-S6-03-18 - Hydro-Climatic Water Balance, Aridity Index, Runoff Index (500 m)



HOW ISPRA IS INVOLVED IN THE WORKFLOW?

1) BIGBANG Model Execution

• ISPRA runs the **BIGBANG model** using the weekly aggregated inputs (precipitation, temperature, SWE, soil moisture, land cover).

• The model produces:
  - **Weekly Evapotranspiration (ET)**
  - **Weekly Runoff**

2) Data Delivery

•ISPRA uploads the BIGBANG outputs to a **dedicated S3 bucket**.

OU-S6-03-08 Hydro-Climatic Water Balance Index (1 km)

Using *Monthly Evapotranspiration and Runoff data* calculating from BIGBANG, **Hydro-climatic water balance** (*HWB*) is obtained as the difference between precipitation (P), and potential evapotranspiration (PET): *HWB = (P-PET).*

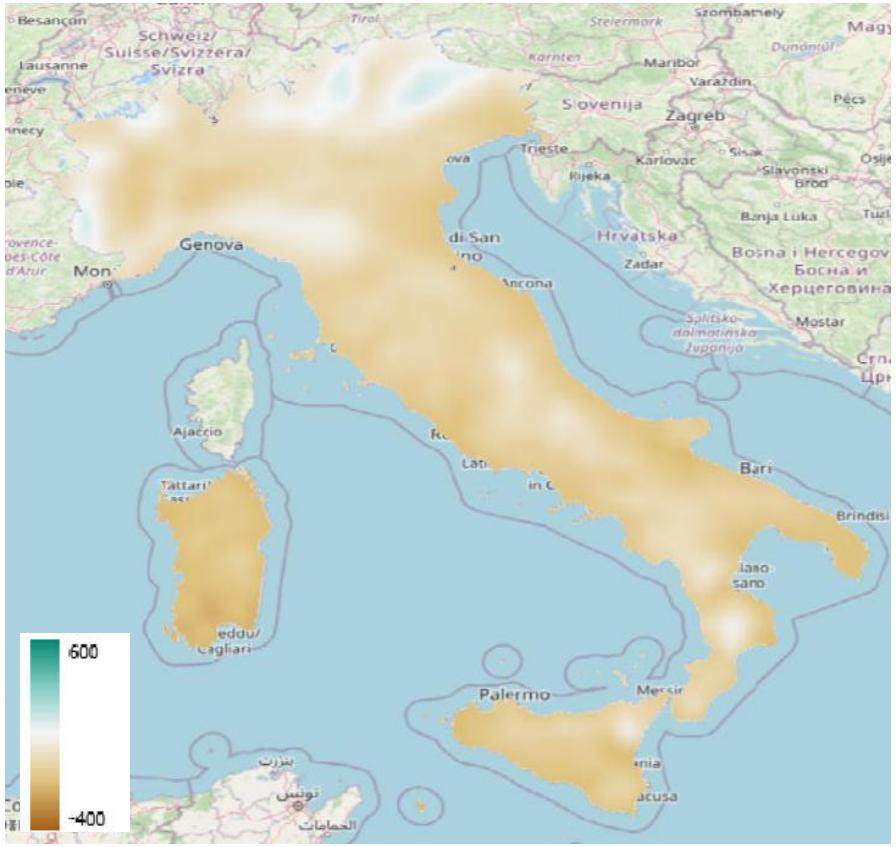
Classes or range values:
-400 to 600 mm

Format specification:
GeoTIFF

Spatial resolution:
1000 m

Temporal resolution:
Monthly

Target Thematic/ Numerical accuracy:
R^2>75%



HWB map referred to August 2022

Input data:
- C3S ERA5-Land Reanalysis-temperature
- C3S ERA5-Land Reanalysis-precipitation
- ISPRA reference grid 1000m

HWB is only computed for irrigation season months, from April to September.

OU-S6-03-16 Hydro-Climatic Water Balance Index (500 m)

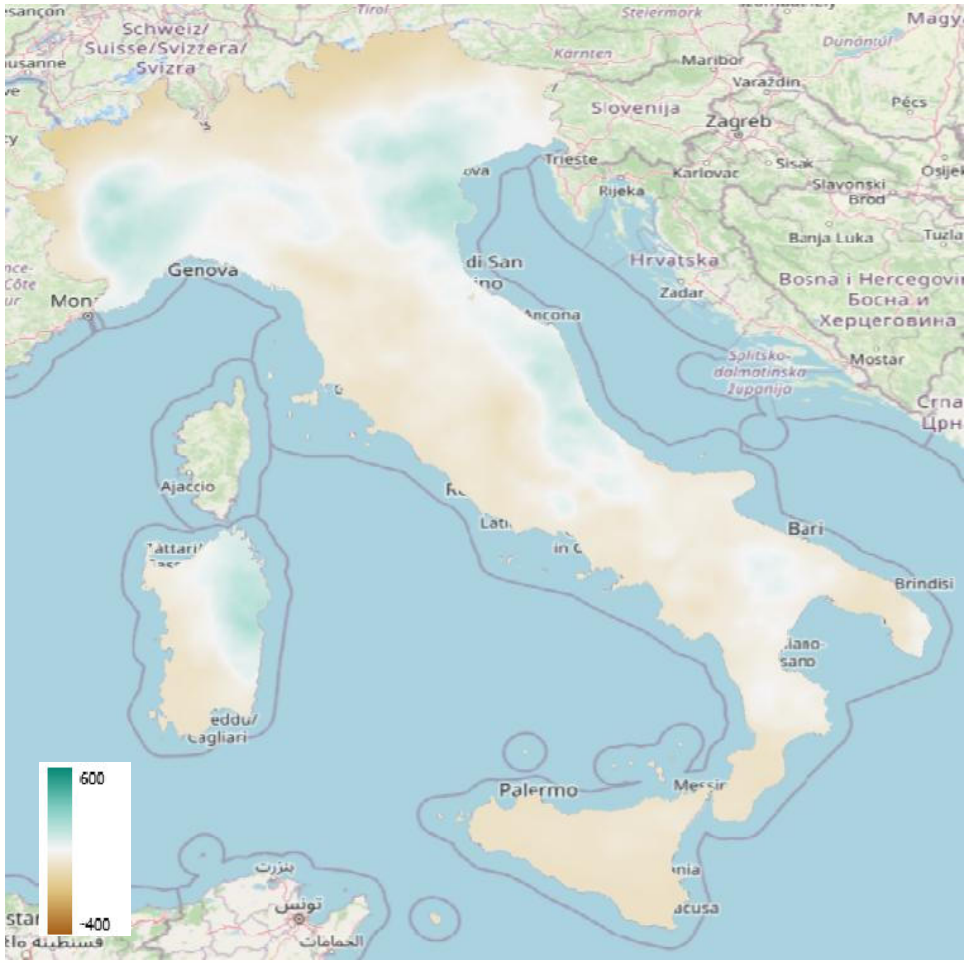
Classes or range values:
-400 to 600 mm

Format specification:
GeoTIFF

Spatial resolution:
500 m

Delivery timeliness:
Weekly

Target Thematic/ Numerical accuracy:
R^2>75%



Input data:

- C3S ERA5-Land Reanalysis- temperature, precipitation, soil moisture and SWE
- Land cover mapping - OU-S4-01-01
- Precipitation amount - OU-S5-02-04
- ISPRA reference grid (500m)

HWB map referred to August 2024

OU-S6-03-09 Aridity Index (1 km)

Using *Monthly Evapotranspiration and Runoff data* calculating from BIGBANG, **Aridity Index** (AI) is obtained as the ratio between precipitation and potential evapotranspiration: *AI = P/PET*

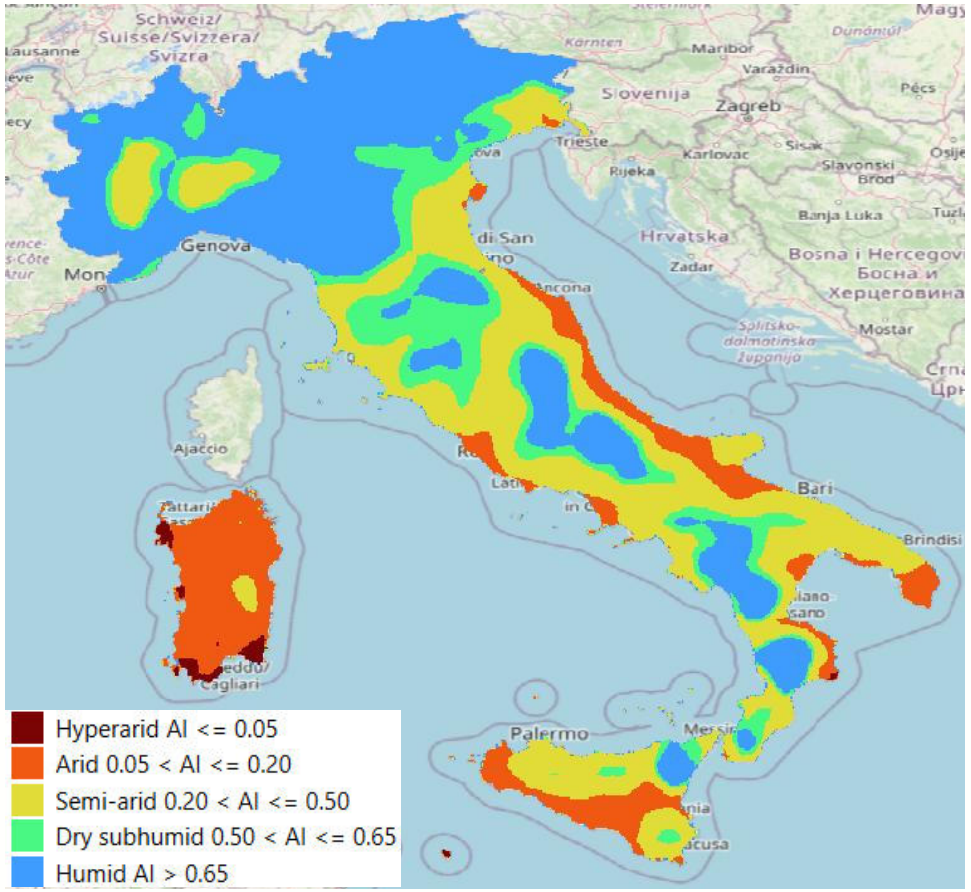
Classes or range values:
Hyperarid AI <= 0.05; Arid 0.05 < AI <= 0.20; Semi-arid 0.20 < AI <= 0.50; Dry subhumid 0.50 < AI <= 0.65; Humid AI > 0.65

Format specification:
GeoTIFF

Spatial resolution:
1000 m

Temporal resolution:
Monthly

Target Thematic/ Numerical accuracy: R^2>75%



Input data:
- C3S ERA5-Land Reanalysis-temperature
- C3S ERA5-Land Reanalysis-precipitation
- ISPRA reference grid 1000m

AI map referred to August 2022

OU-S6-03-17 Aridity Index (500 m)

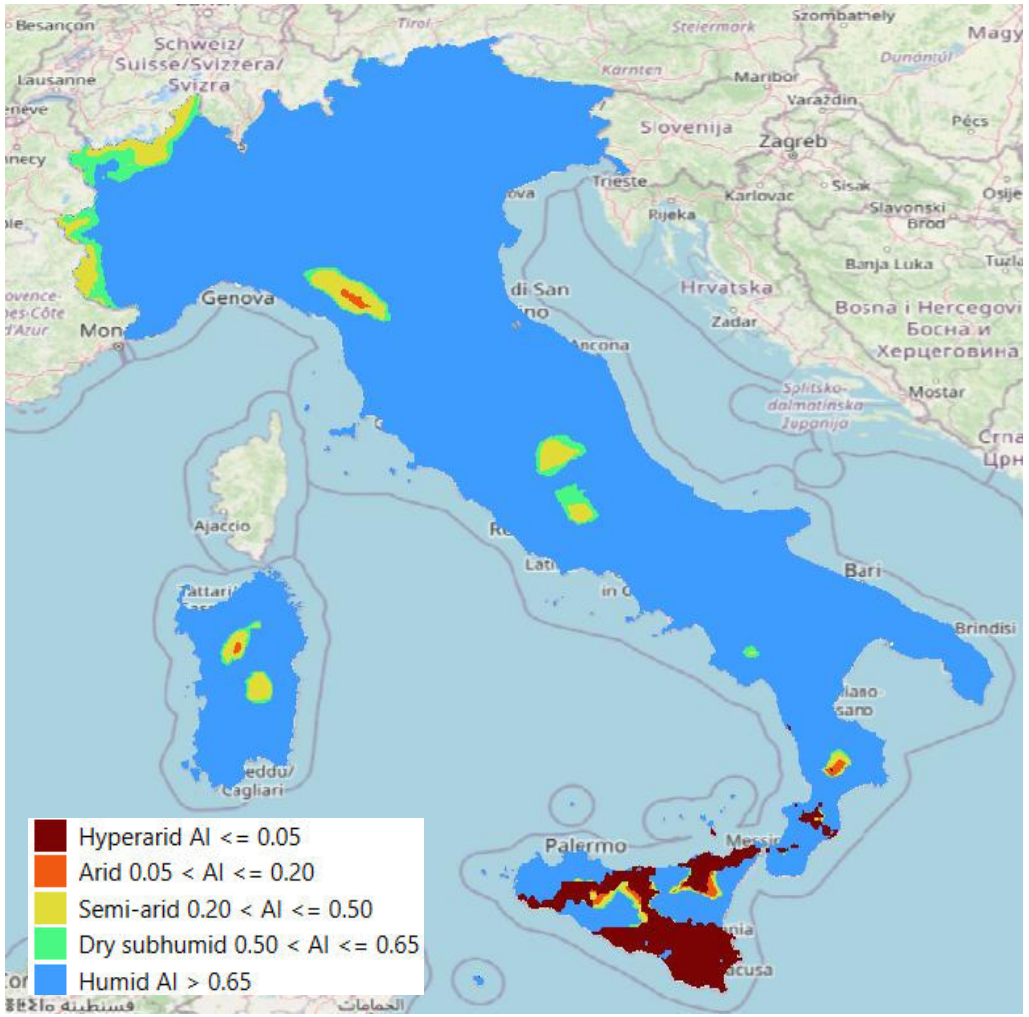
Classes or range values:
Hyperarid AI <= 0.05; Arid 0.05 < AI <= 0.20; Semi-arid 0.20 < AI <= 0.50; Dry subhumid 0.50 < AI <= 0.65; Humid AI > 0.65

Format specification:
GeoTIFF

Spatial resolution:
500 m

Temporal resolution:
Weekly

Target Thematic/ Numerical accuracy:
R^2>75%



Input data:

- C3S ERA5-Land Reanalysis- temperature, precipitation, soil moisture and SWE
- Land cover mapping - OU-S4-01-01
- Precipitation amount - OU-S5-02-04
- ISPRA reference grid (500m)

AI map referred to August 2025

OU-S6-03-10 Runoff Index (1 km)

Using *Monthly Evapotranspiration and Runoff data* calculating from BIGBANG, **Runoff Index** (*RI*) is obtained as as the ratio between surface runoff (*R*) and precipitation (*P)*: *RI = R/P*

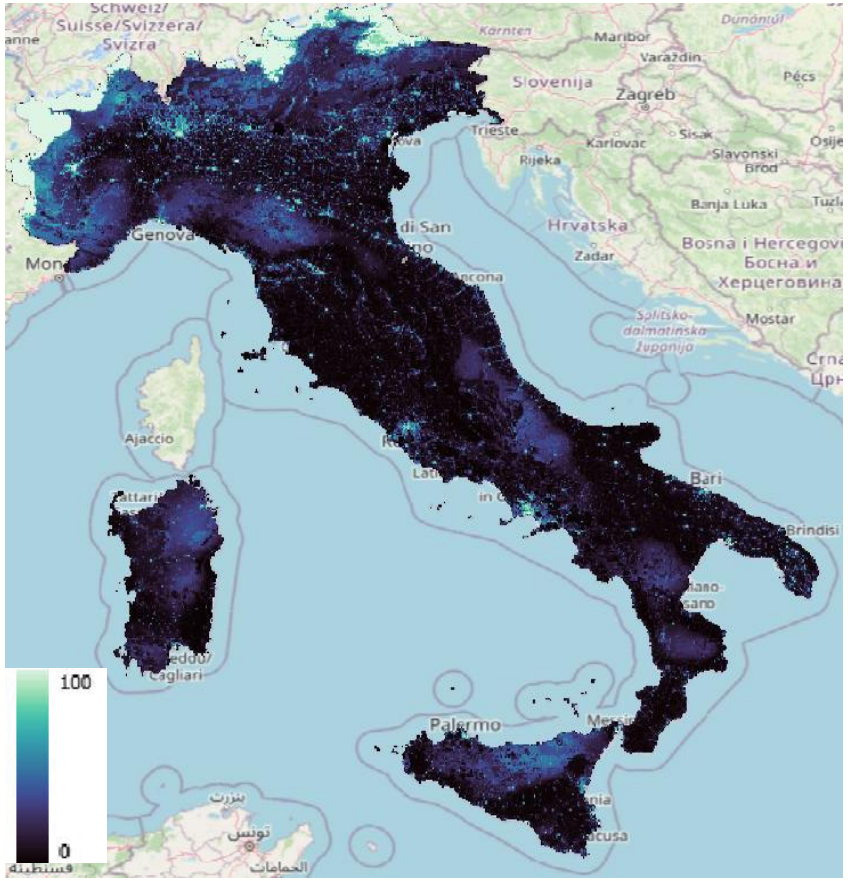
Classes or range values: 0 to 100%

Format specification:
GeoTIFF

Spatial resolution:
1000 m

Temporal resolution:
Monthly

Target Thematic/ Numerical accuracy:
R^2>75%



Input data:

- C3S ERA5-Land Reanalysis-temperature
- C3S ERA5-Land Reanalysis-precipitation
- ISPRA reference grid 1000m

RI map referred to May 2022

OU-S6-03-18 Runoff Index (500 m)

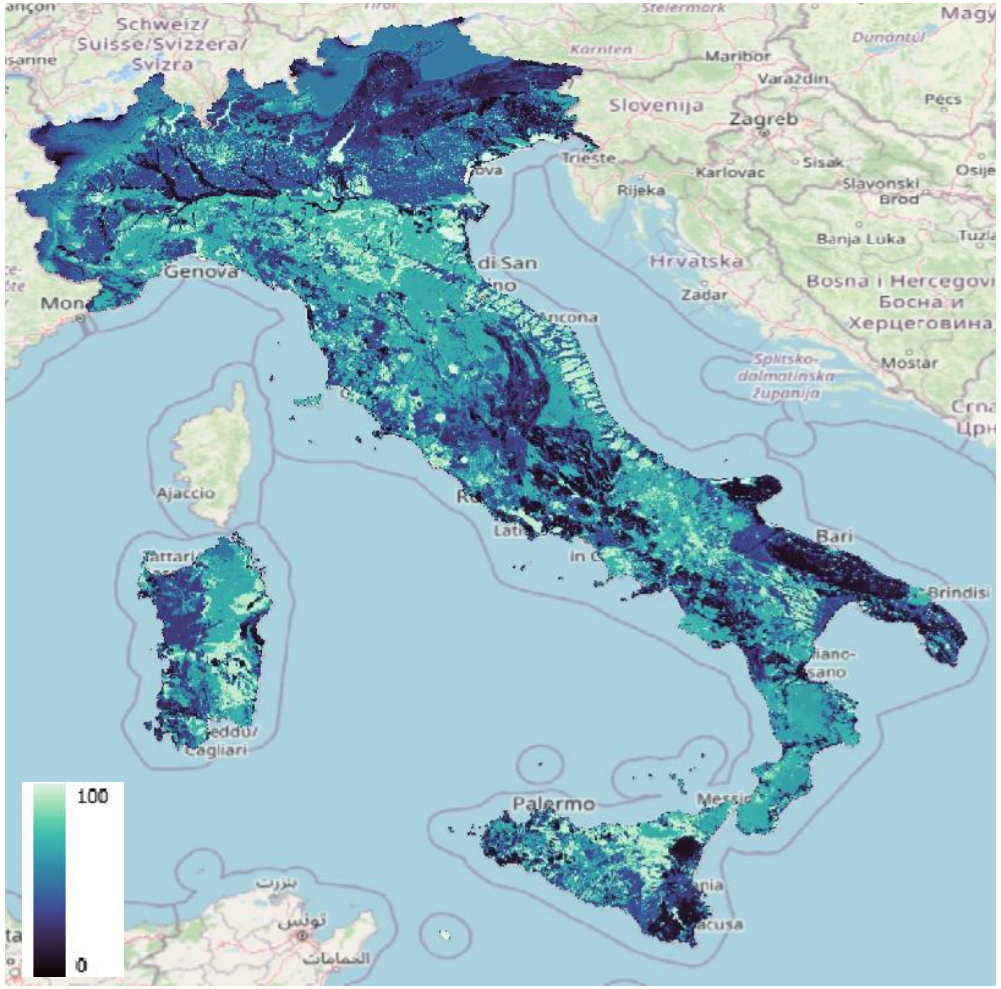
Classes or range values: 0 to 100%

Format specification:
GeoTIFF

Spatial resolution:
500 m

Temporal resolution:
Weekly

Target Thematic/ Numerical accuracy:
R^2>75%



Input data:

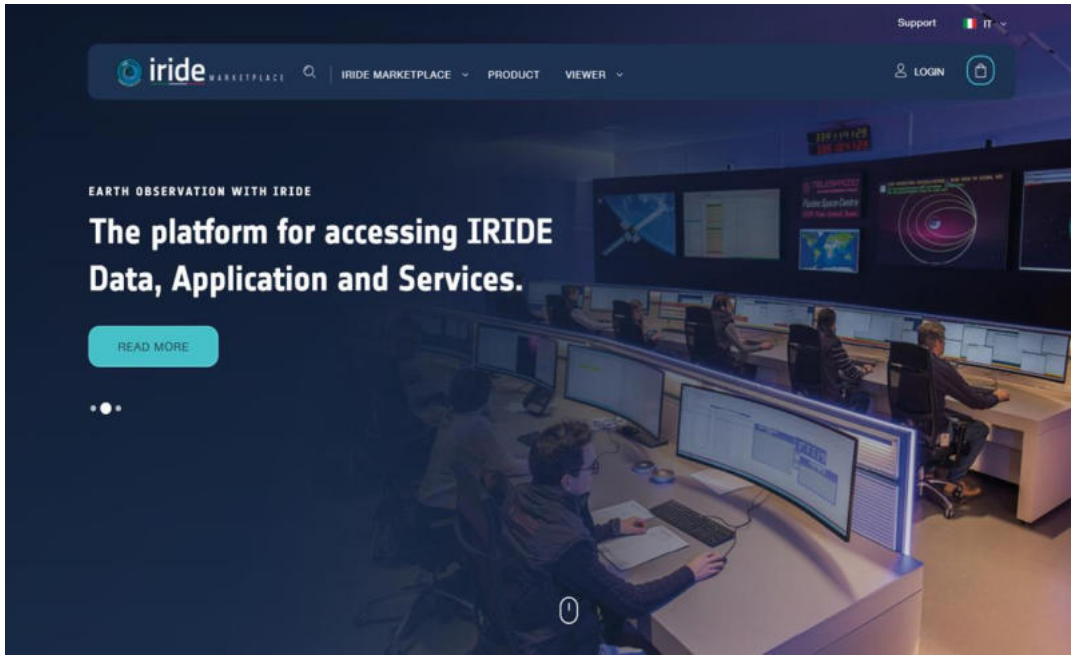
- C3S ERA5-Land Reanalysis- temperature, precipitation, soil moisture and SWE
- Land cover mapping - OU-S4-01-01
- Precipitation amount - OU-S5-02-04
- ISPRA reference grid (500m)

RI map referred to May 2024

IRIDE Services for Public Administrations

📌 Services Provided to Public Administrations

- The IRIDE constellation will provide **free services** to Public Administrations.
- The **owner of the system is ASI** (Italian Space Agency).
- **ESA is completing the development** of the platform and related components.



🗓️ Expected Operational Date

- The operational deployment of the service chain is expected in **July 2026** *(date confirmed by ASI).*

🔑 Where Do You Access the Services?

- The **Marketplace (MKPL)** is the **single access point** to IRIDE data and services.
- All IRIDE services and datasets will be accessible **exclusively through the MKPL homepage**.

Conclusions

🔍 Value of IRIDE Services

- Delivers integrated indicators for water resource management—covering quality, quantity, availability, drought, and scarcity—and supports regional authorities in monitoring hydrological parameters, land use, and water demand, with a focus on agricultural irrigation during drought conditions.
- Provides actionable, operational information to competent authorities and decision-makers.
- Fully support the implementation of the **Water Framework Directive 2000/60/EC**, the **Floods Directive 2007/60/EC**, and related Italian legislation.

🌐 Integration with ISPRA's BIGBANG Model

- BIGBANG outputs enable the computation of:
  - **Hydroclimatic Water Balance**
  - **Aridity Index**
  - **Runoff Index**

These indicators strengthen IRIDE's capacity to deliver actionable, satellite-enhanced water management products.

🌱 Water Governance and Resilience

- Contributes to ISPRA's strategic priorities for sustainable water governance in a context of declining natural availability due to climate change.
- Promotes integrated and basin-scale management approaches to improve efficiency and reduce risk.

📖 Monitoring and Open Data

- Initiatives such as **WHOW** connect water quality, water use, and health data, enhancing transparency and shared knowledge.

THANK YOU FOR YOUR ATTENTION!

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