

Integration of MODIS NDVI data into Tuscany meteorological fire risk bulletin

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Operational Context

The Tuscany Regional Government, together with the LaMMA Consortium and CNR-IBE, operates a Spatial Data Infrastructure (SDI)-based decision support system that provides a daily wildfire danger rating for every municipality. The system is driven by the Canadian Forest Fire Weather Index (FWI), whose components are calculated from in-situ observations and numerical weather predictions to quantify the predisposition of forest fuels to ignition and spread. Outputs are disseminated through web-GIS and daily bulletins, supporting PREVENTION, EARLY WARNING, and OPERATIONAL RESPONSE during fire season.

Strategic Relevance

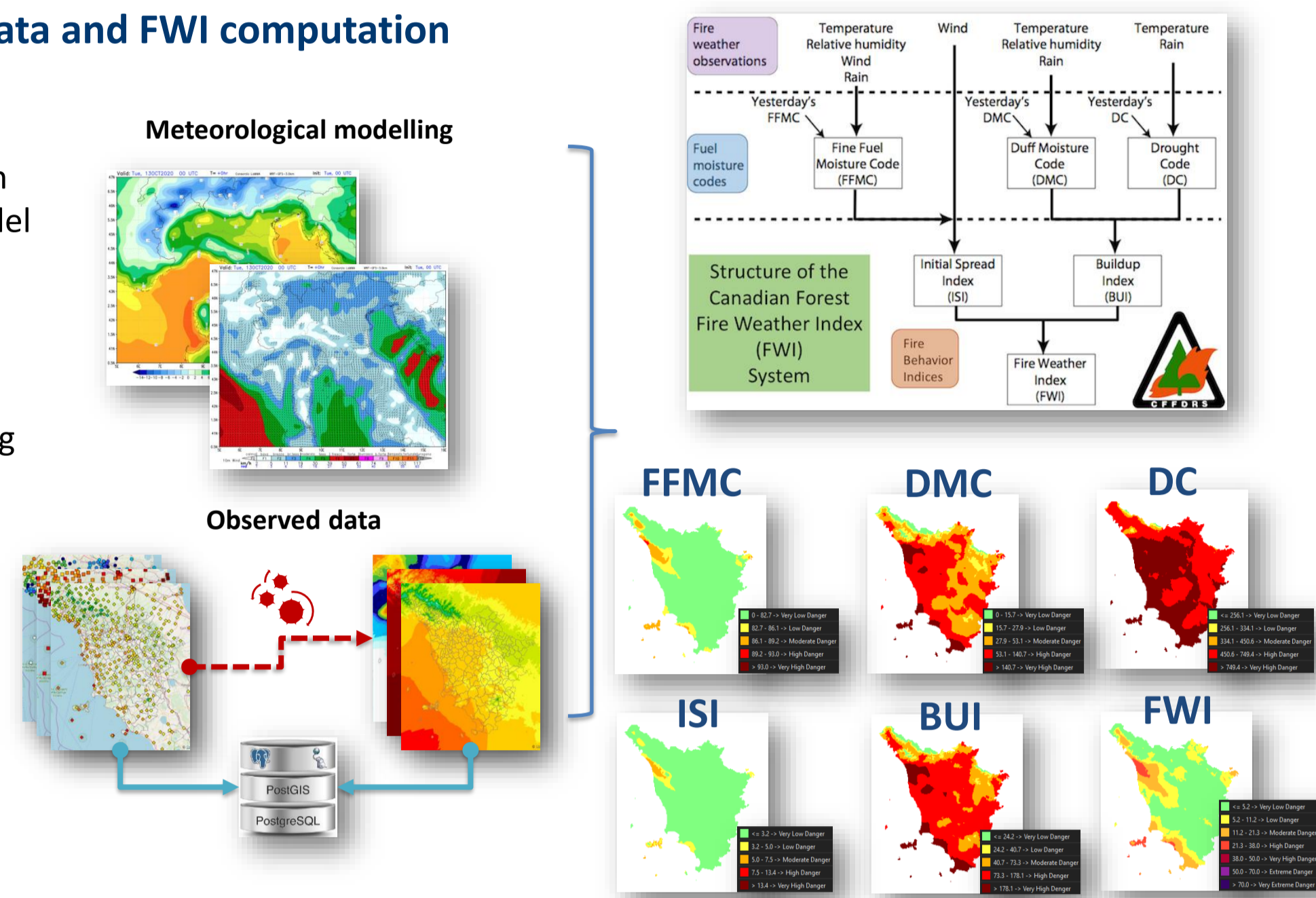
Wildfire danger assessment is a core tool for prevention, early warning and suppression and is formally embedded in the Tuscany Wildfire Management Plan (Piano AIB 2023-2025), the three-year policy framework that allocates strategies, resources and procedures in a risk landscape exacerbated by climate change, wildland-urban interface expansion and farmland abandonment. Its overarching goals are to keep events within the regional suppression capacity, minimise burned area and safeguard Tuscany's forest and infrastructure assets.

From Data to Decision: The Fire Weather Chain

Meteorological data and FWI computation

Observations & MOLOCH forecast

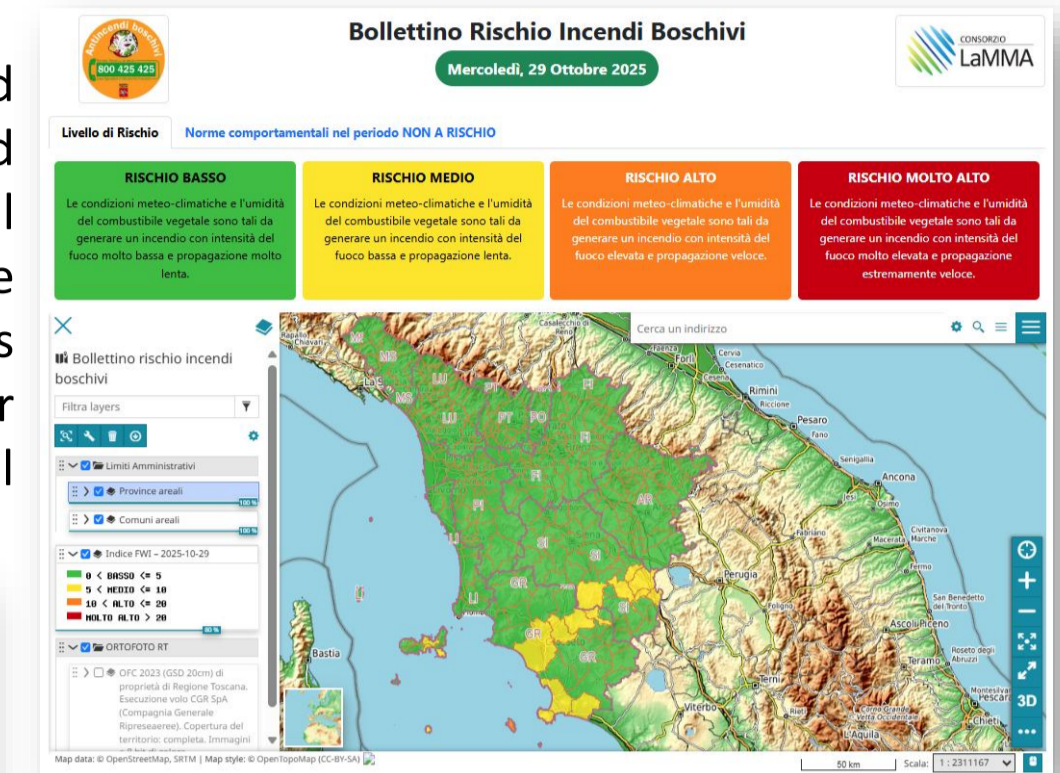
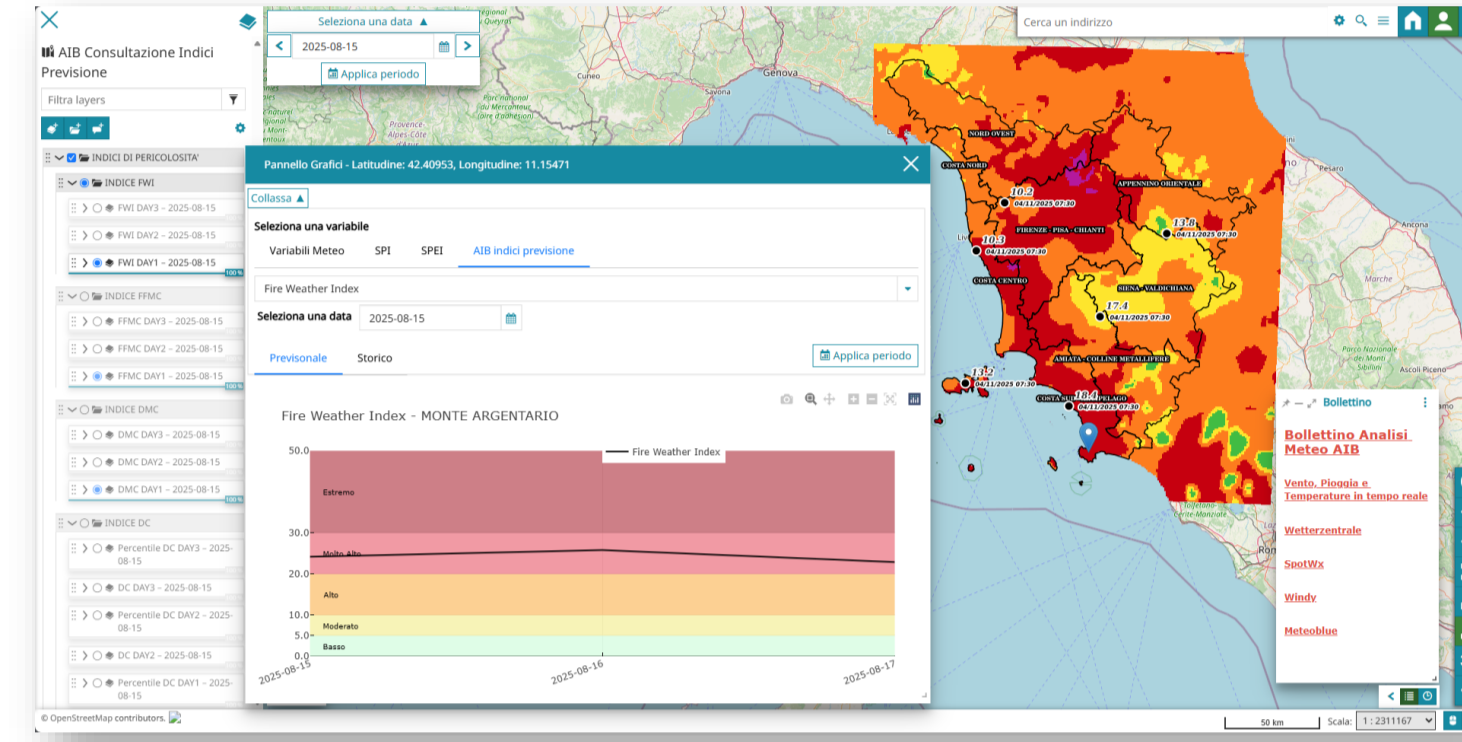
- Meteorological forecast data from the MOLOCH model (initialized with ECMWF data).
- Data from meteorological stations measuring thermometric, pluviometric, hygrometric, and anemometric parameters in the area of interest.



SDI & Geoportail

GeoServer - MapServer WMS/WMTS, OGC services

The SDI has been implemented using OpenSource technologies, and geospatial data are shared through interoperability standards defined by the Open Geospatial Consortium (OGC). The SDI is exploited by all AIB (Anti Incendi Boschivi) operational bodies to enhance the management of prevention and response services. Hazard maps trigger or lift AIB Alert States, set Operational Attention Levels for winter-fire zones and govern the opening/closure of Provincial Operation Centres.



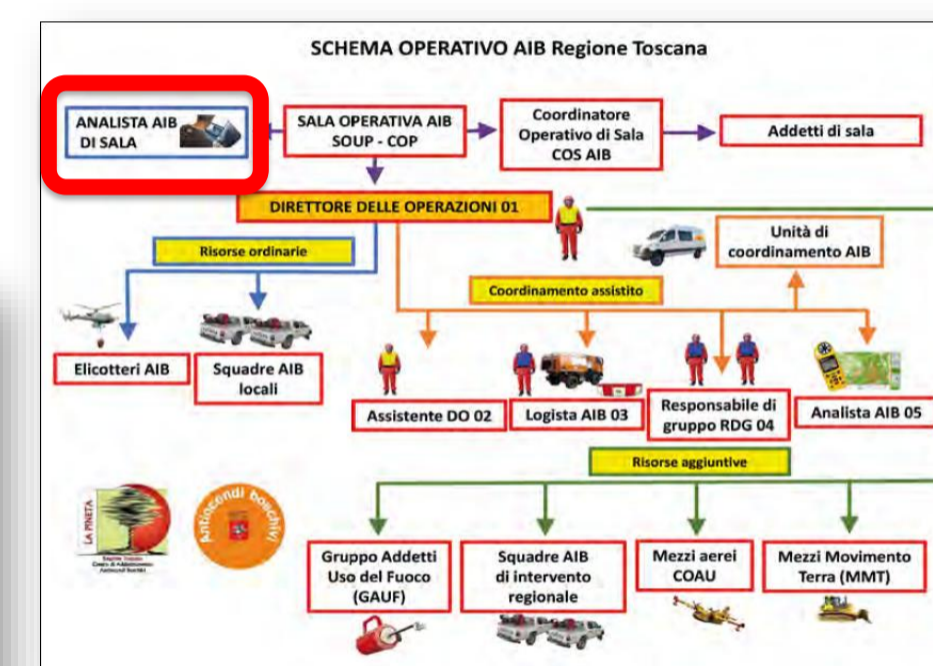
Public Bulletin

Hazard maps also strengthen forecast-based monitoring under high-danger conditions and underpin the issuance of regulatory notices and public bulletins that promote compliance with fire-prevention rules.

Wildfire Meteorological Analysis Bulletin and Tools

AIB daily bulletin & alert states. Drought Code percentile, Haines Index, HDW Index, AIB Digital Twin

During the peak risk season (typically July–August) a dedicated Bulletin is produced daily, containing FWI metrics, fire-weather indices and additional atmospheric parameters over the administrative areas (municipalities) of Tuscany Region. The AIB on-duty operator uses this information to provide operational guidance on anticipated fires, their behaviour, and regional hotspots requiring heightened readiness.



In case of VERY HIGH risk conditions (red FWI), the Forestry Department, by 12:00 p.m., sends via email the Wildfire Meteorological Analysis Bulletin (AIB Bulletin) to the AIB Analysts, Fire Operation Directors, the SOUP, AIB Provincial Operation Centers (COP AIB), and AIB Volunteer Organizations.

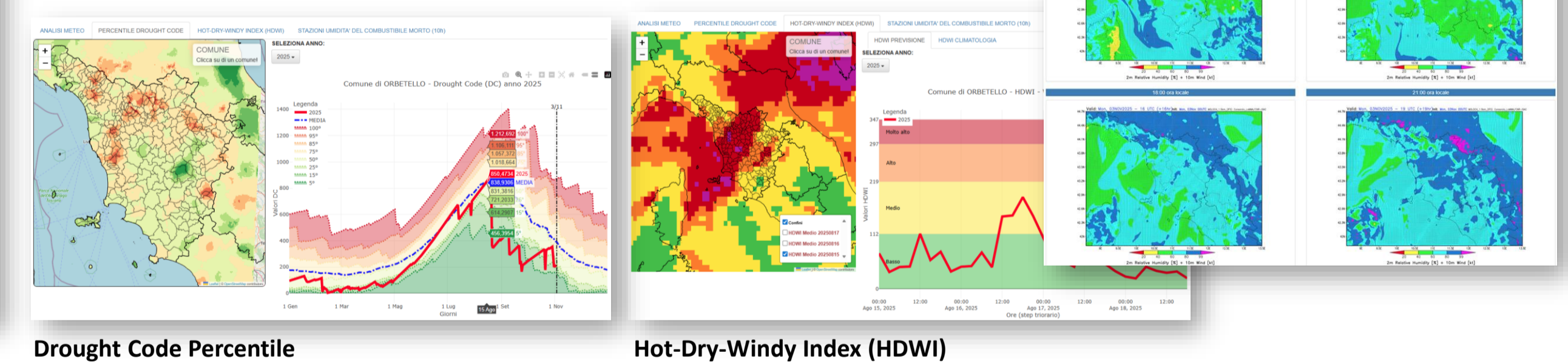
The AIB Meteorological Analysis Bulletin consists of two sections: WHAT WE HAD and WHAT WE EXPECT.

WHAT WE HAD:

This section reports information on the number, geographic distribution, and characteristics of wildfires that occurred in Tuscany during the previous day.

WHAT WE EXPECT:

This section provides a detailed analysis of the forecasted meteorological conditions for the day, broken down by time intervals.



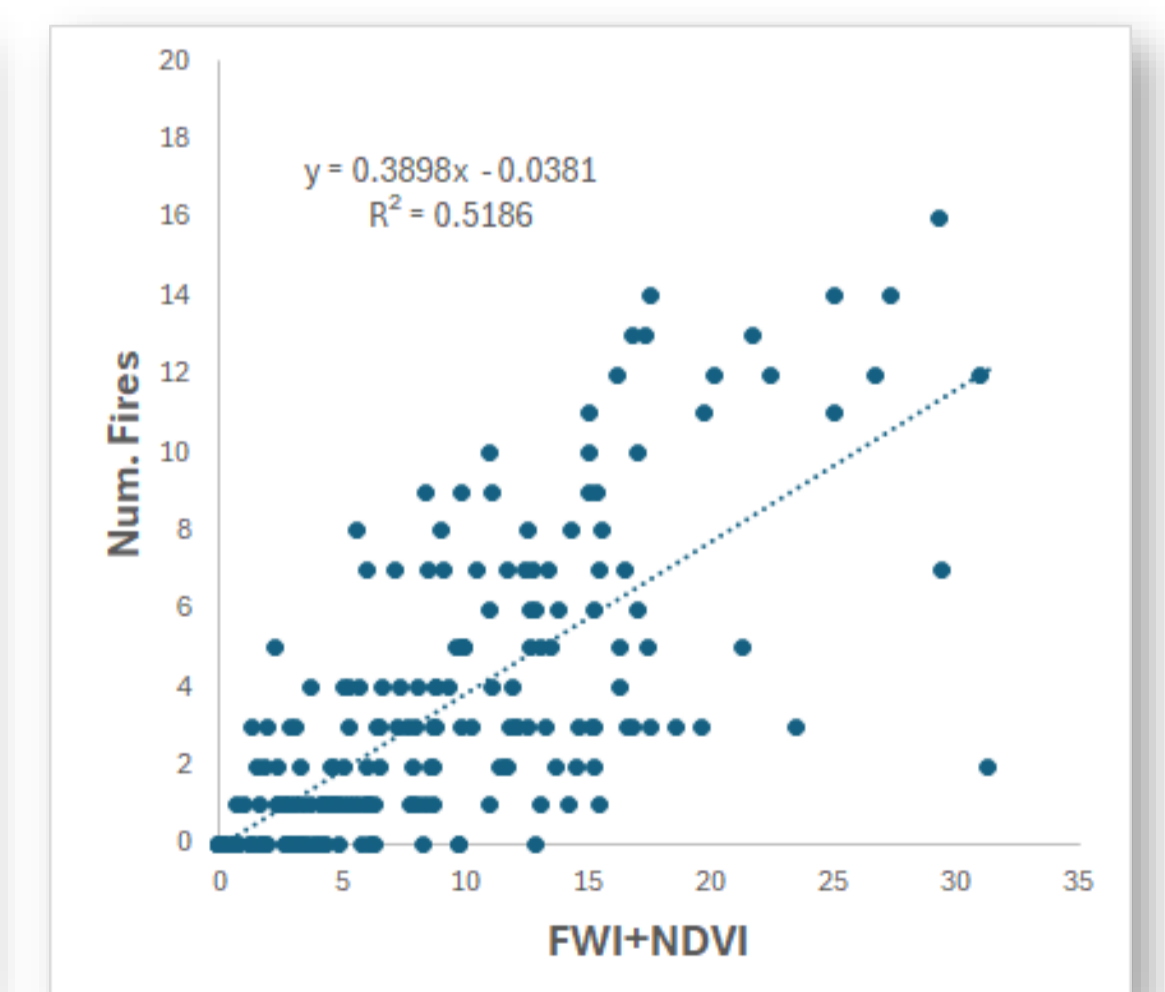
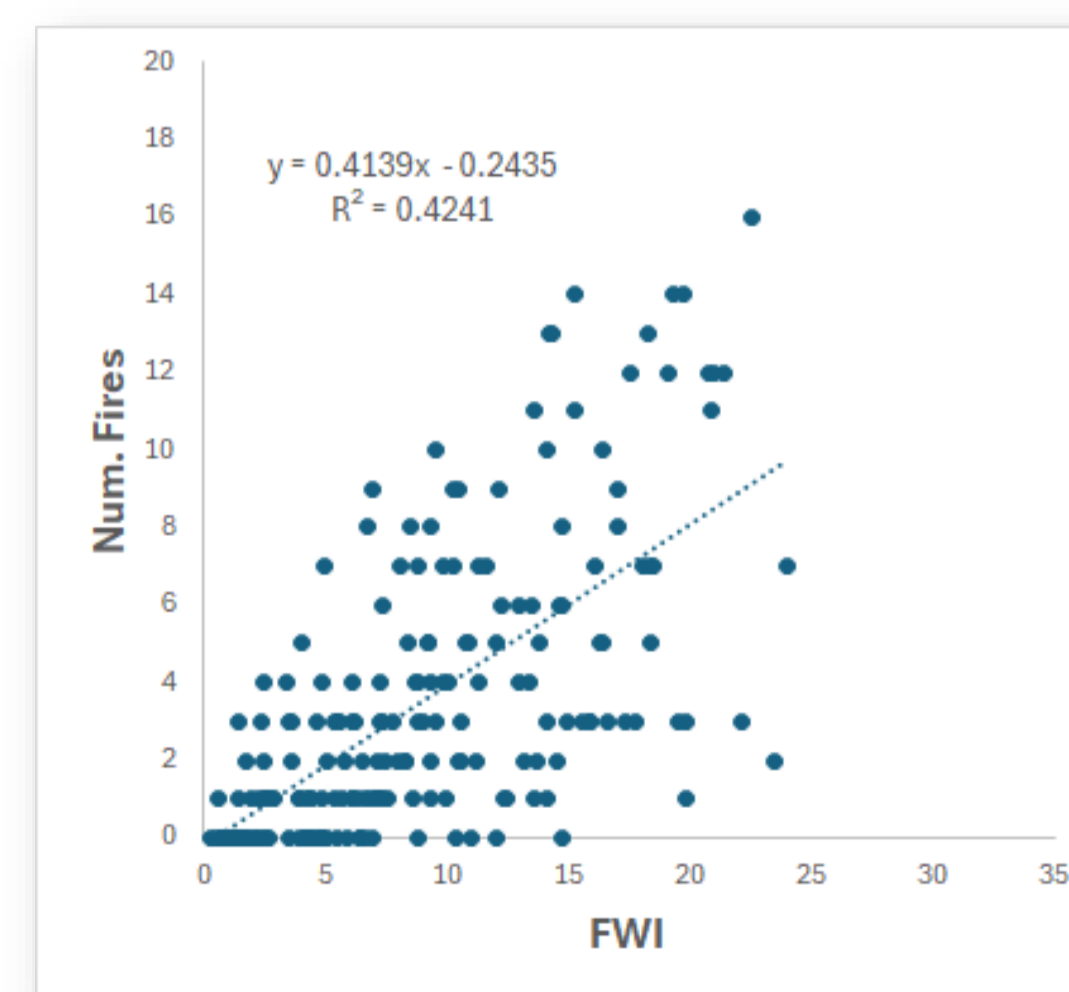
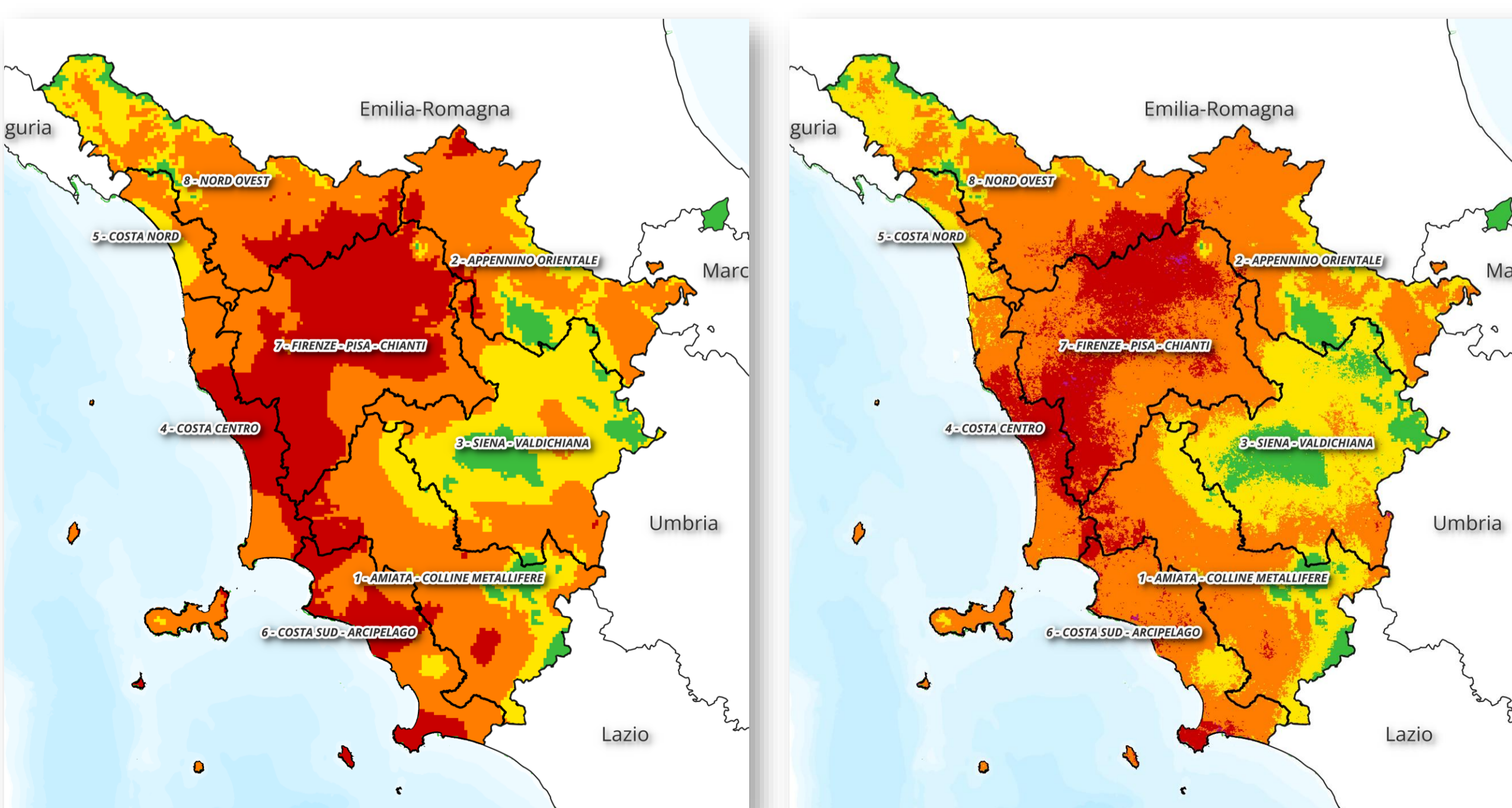
Future developments – NDVI Integration into AIB Bulletin

Aim of the work: evaluating the possibility to integrate MODIS NDVI data into the AIB fire risk Bulletin.

Rationale: NDVI data are informative on forest condition in response to dryness, which obviously affects fire risk. This information is potentially complementary to that obtained from meteorological observations through the FWI.

Data used:

- Statistics (e.g., number of fires and burnt area) about forest fires in Tuscany from 2000 to 2024.
- MODIS NDVI (MOD13Q1) imagery having 16-day temporal frequency and 250-m spatial resolution. These images are collected over Tuscany for the 2000-2024 period.



On the left the number of fires occurred in mid-July 2000-2024 over Tuscany area n. 7 is regressed versus the classical FWI. On the right the same regression is shown versus the new FWI-NDVI index, which is obtained by exploiting the NDVI inter-annual variability related to vegetation status (Maselli et al., Remote Sensing of Environment, 2003, 86:187–197).

Conclusion

- The use of the MODIS NDVI data collected since 2000 enables to find out useful information to more accurately assess the fire risk in Tuscany.
- The preliminary results currently obtained show that this use could induce significant improvements in the prediction potential of the conventional FWI.
- This opens the way to include the FWI-NDVI index in the operational bulletin of Tuscany fire risk.