Perspectives on wildfire early warning, monitoring and risk assessment

European Commission - Joint Research Centre

https://effis.jrc.ec.europa.eu

https://gwis.jrc.ec.europa.eu

Jesús San-Miguel

Outline:

- Wildfires – a global phenomenon
- Wildfires and climate change
- What can we do about it?
- Wildfire danger – early warning for ALL
- Wildfire monitoring: Long-term trend analysis vs Near-Real time
- Early warning + Monitoring: Wildfire decision support systems
- Wildfire risk assessment

Wildfires: a global issue

- Humans have co-existed with wildfire since ancient times
- Wildfires are intrinsic to ecosystem dynamics and a tool in agricultural practices

However:

- Fires burn approximately 400 Million ha of land every year
- Fires emissions contribute, globally, to about 20% of greenhouse gas emissions
- The natural dynamics of wildfires has been changed by fire exclusion policies
- Wildfires are the cause of environmental degradation, leading to desertification is some regions of the world
- Wildfires are the cause of increasing losses of human lives and economic damages, mainly in the wildland urban interface (WUI)

Recent episodes in which **Climate Change** is identified as the cause of recent critical fires such as:

Alaska & Indonesia (2015),

Canada, California (2016),

Chile, Canada, Australia, South Africa, California, Europe (2017),

California & Europe (2018),

Amazon, Central Africa, Artic circle (2019),

Australia, California, west coast (USA), Amazon, Artic Circle (2020),

Europe 2021, 2022, 2023, …

Canada 2023

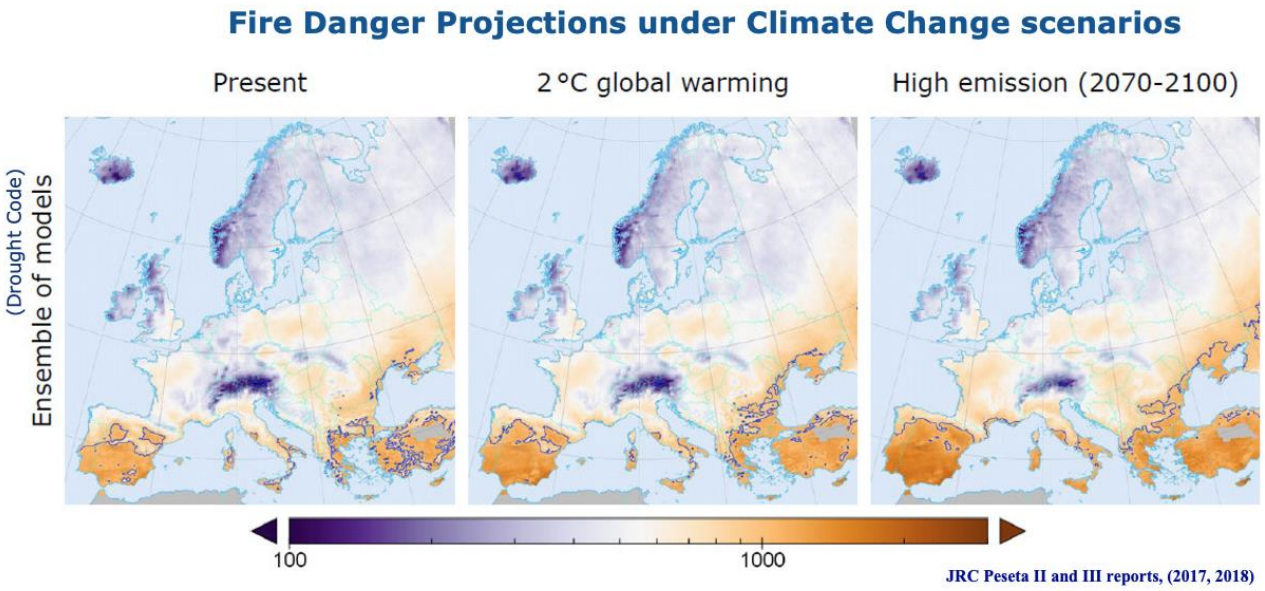
South America 2024

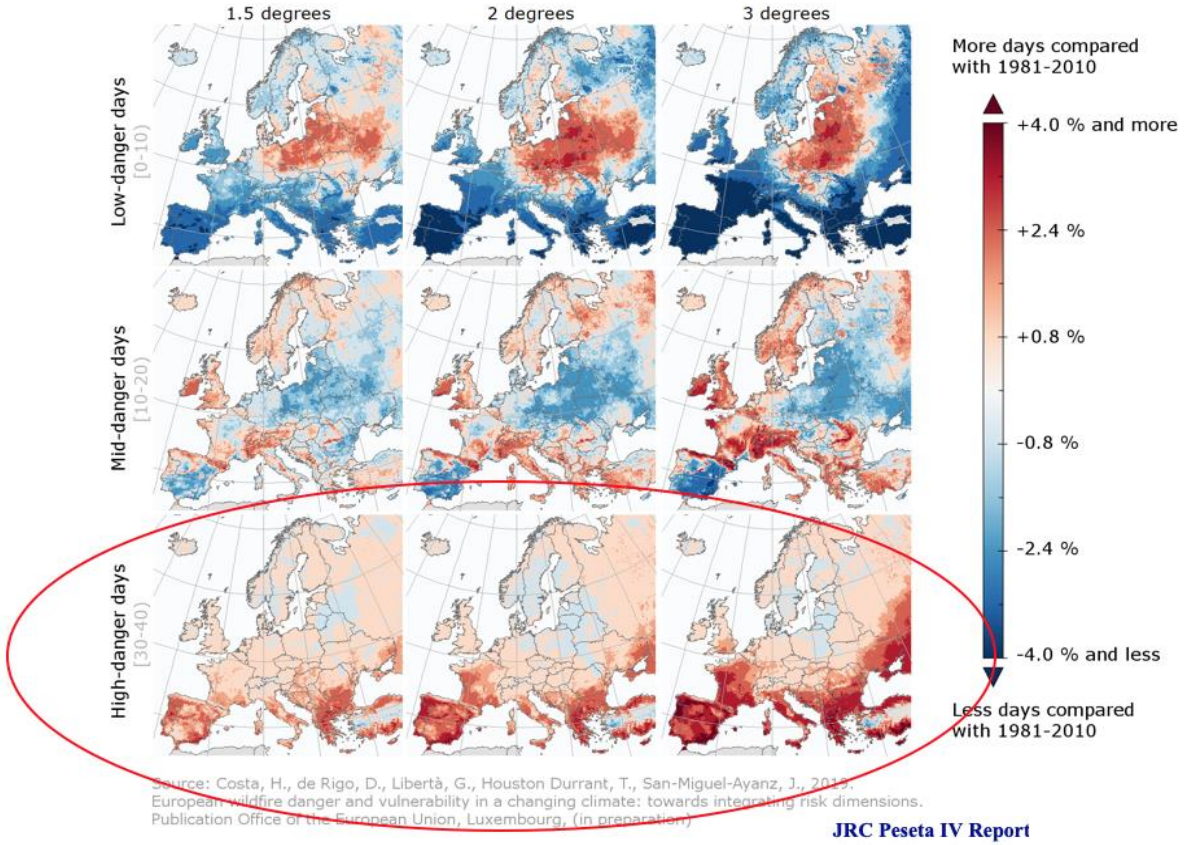
Nearly all the above were unprecedented events!

The intensity and impact of critical wildfires is increasing in Europe, and globally

A regional/global strategy is needed to minimize the impact of wildfires!

Recent studies on wildfire danger and climate change in Europe





About 85% of the variability of burnt area in the EU Mediterranean region is explained by fire danger

WHAT CAN WE DO ABOUT IT?

WILDFIRE EARLY WARNING

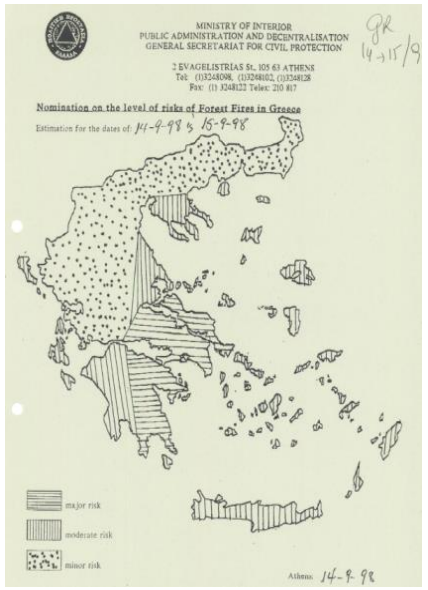
Fire Danger ⟷ Early warning

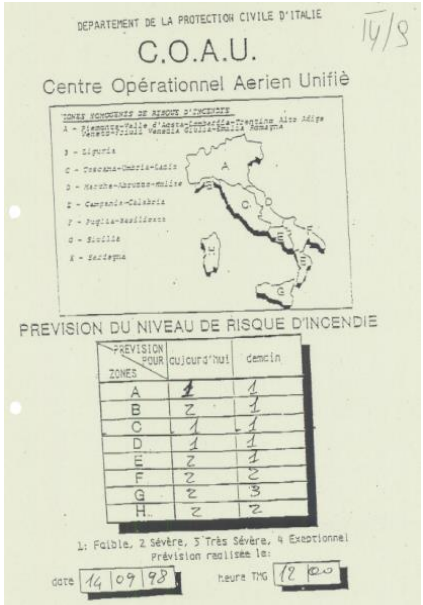
- Fire danger is a quantification of the potential for ignition, spread and intensity
- Fire danger rating identifies areas in which fires can ignite, propagate and reach high intensity
- Fire danger is key to prevention, preparedness and fire management
- It is used as a surrogate of fire intensity and difficulty in firefighting and wildfire control
- Fire early warning refers to the prediction of forthcoming fire danger conditions
- High correlation with total burnt area and wildfire size!

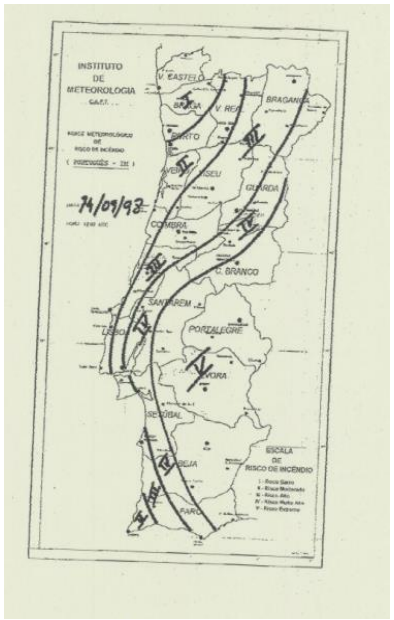
Computation and provision of fire danger

- Essential to alert fire services and population on imminent danger of wildfires
- Must be available and accessible to everyone
- UNDRR and WMO Early Warning for All (EW4ALL) initiative
- Must be harmonized/standardized for international collaboration/cross-border events

Fire danger exchange 1998… => the need for harmonization

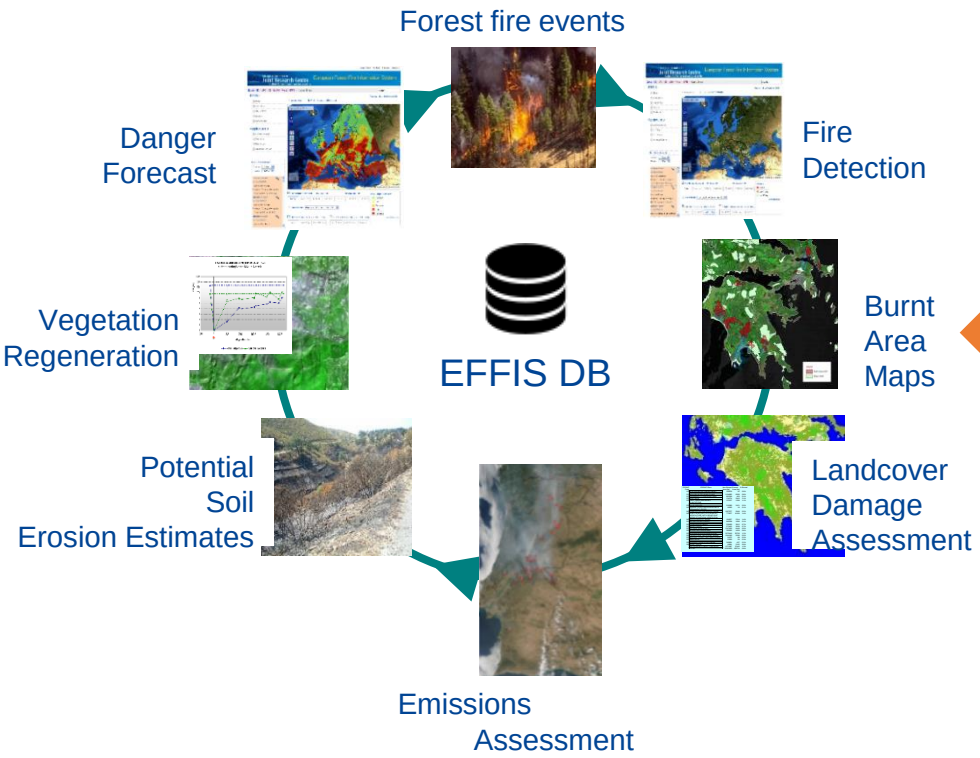


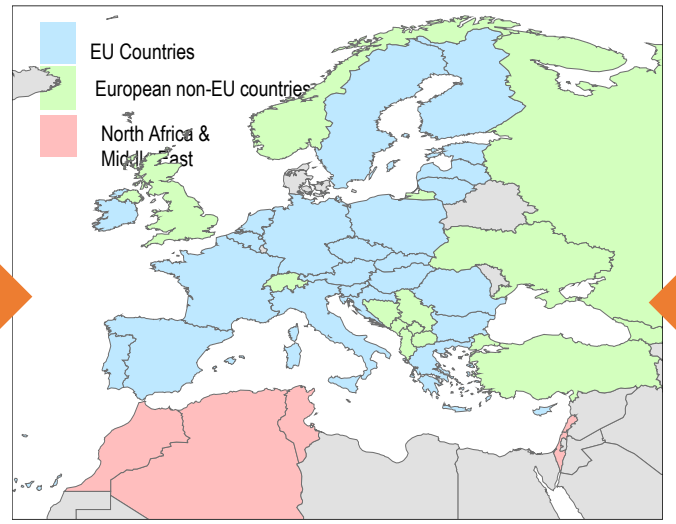


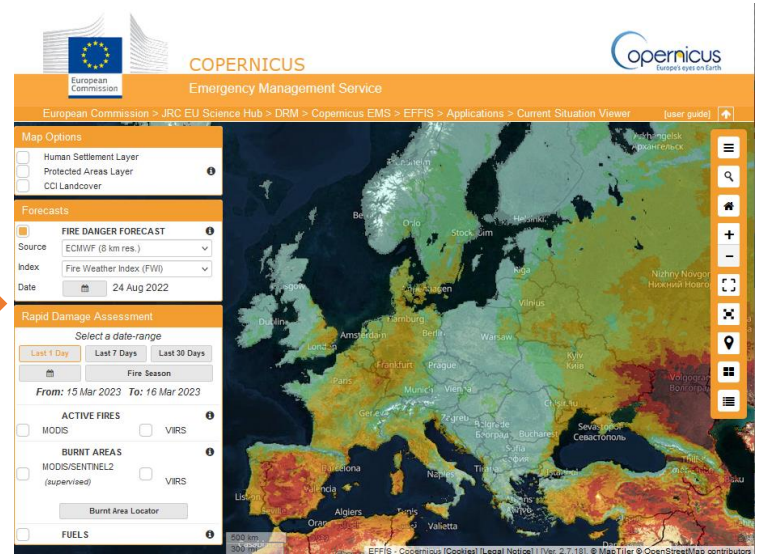


Group of Experts on Forest Fires (GEFF) established in 1998 – 43 countries and

European Forest Fire Information System (EFFIS) established in 2000







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Copernicus EMS Early Warning & Monitoring – Wildfires

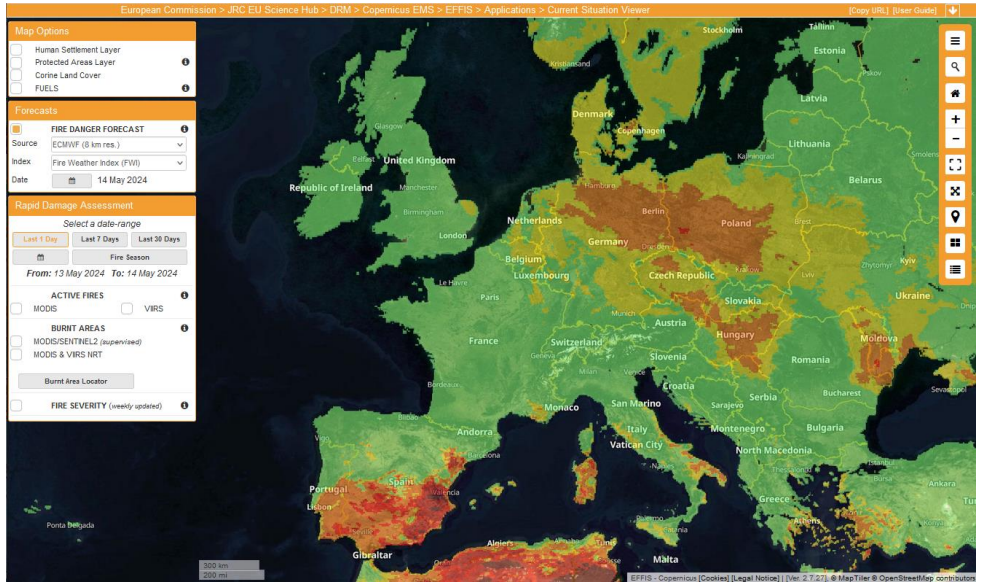
Emergency Management

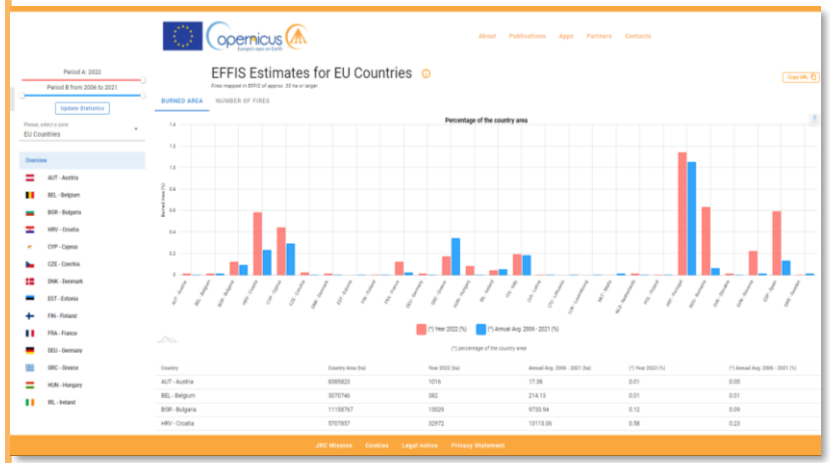
European Forest Fire Information System (EFFIS)

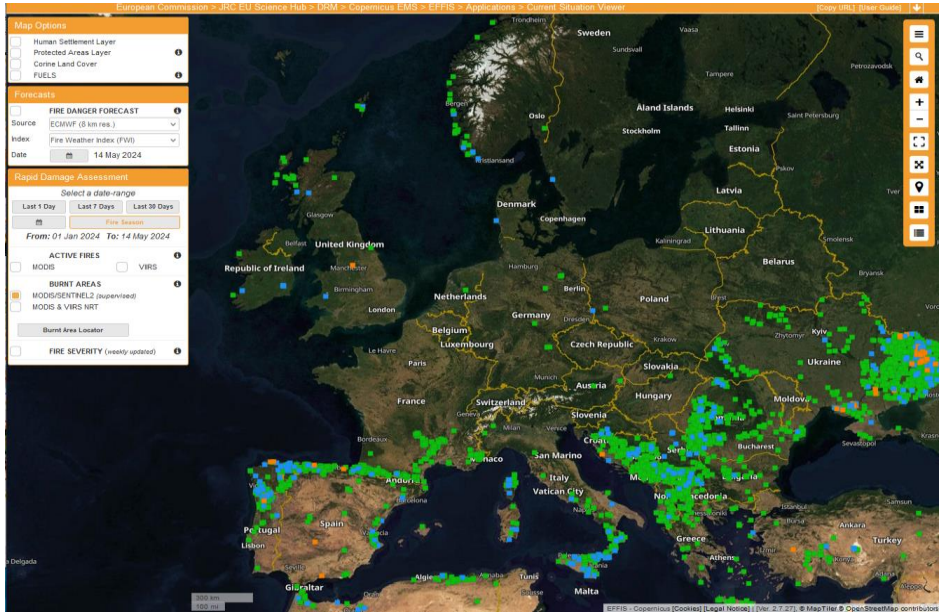
EFFIS provides early warning of fire danger, complementing information from national systems.

EFFIS' compatibility with national systems makes it flexible and adaptable to specific needs and methodologies..

EFFIS is the source of information for EU wildfire services in ECHO, ENV, AGRI, CLIMA, REGIO, REFORM, etc.







https://effis.jrc.ec.europa.eu/

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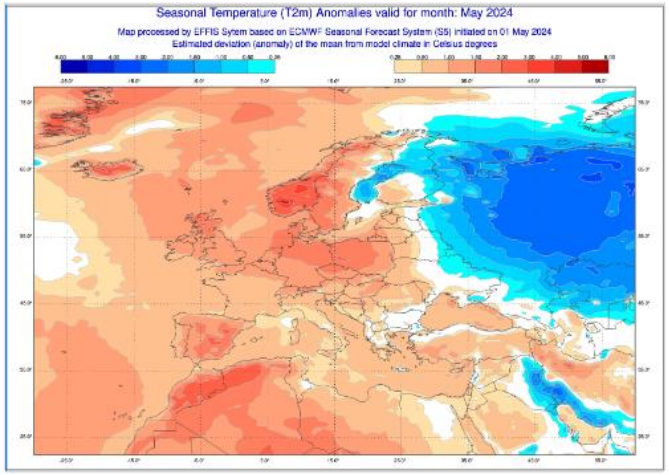
Copernicus Europe's eyes on Earth

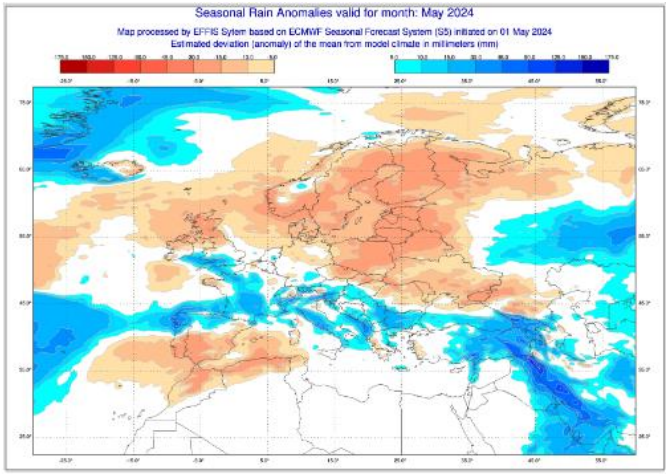
Long-term fire weather and fire danger assessment

Fire Weather Anomalies –May 2024

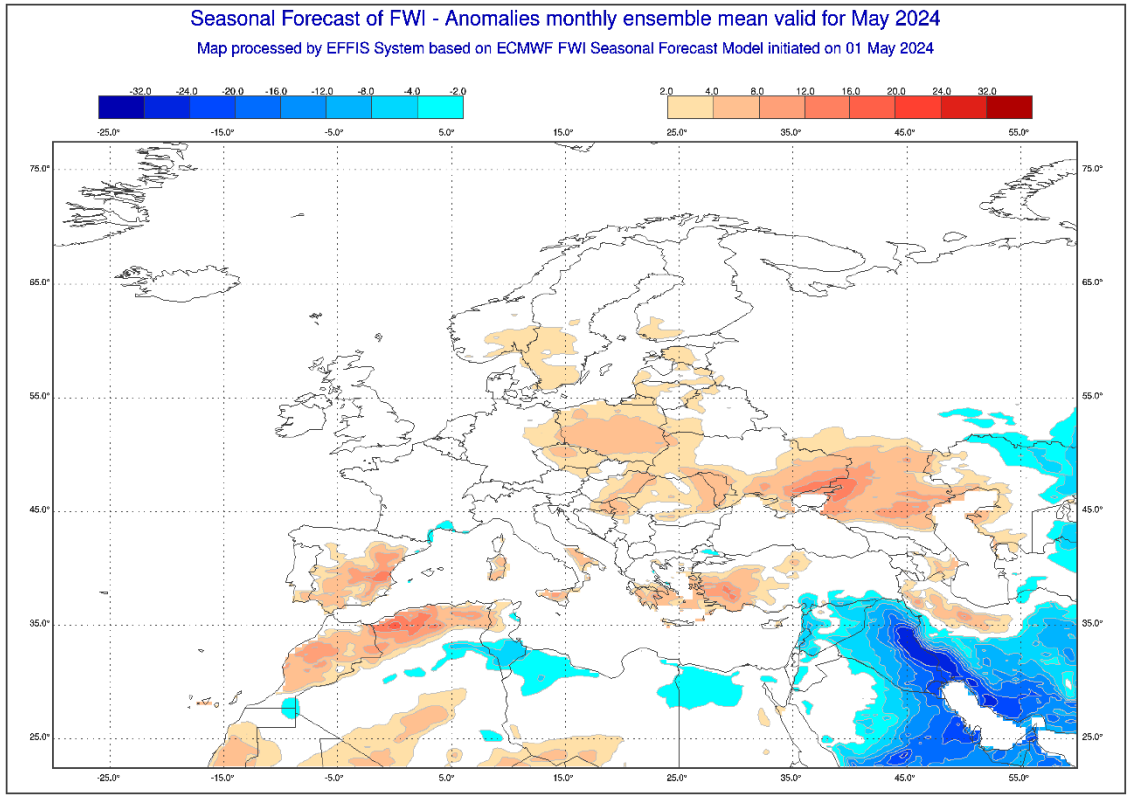
Temperature anomalies



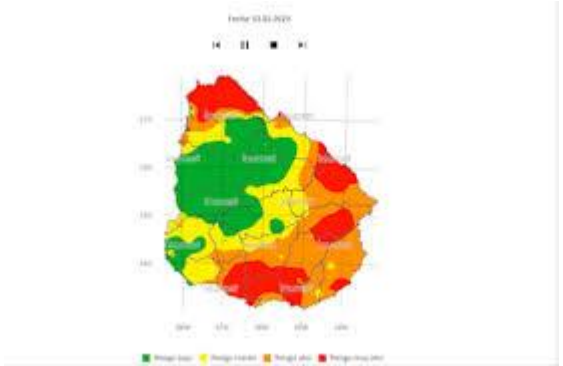
Rain anomalies

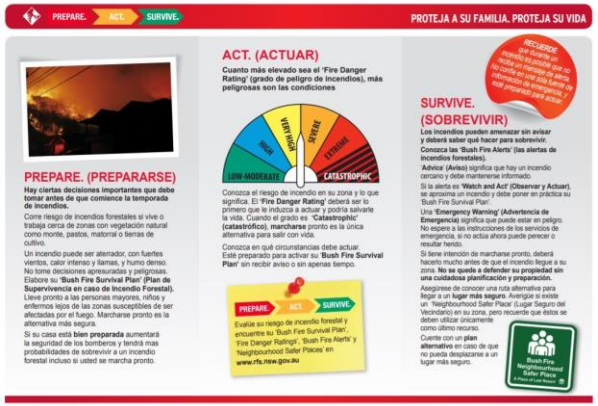


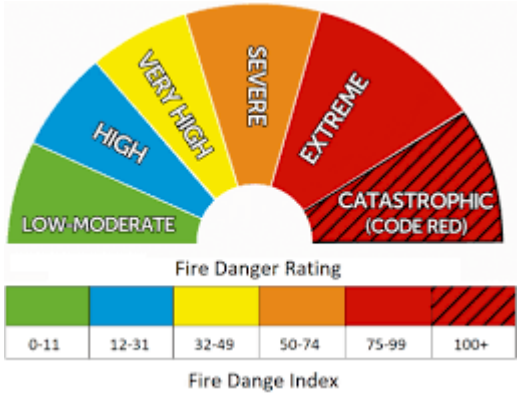
Seasonal Fire Weather Index (FWI) anomaly May 2024



Fire Danger Rating








Queimadas no Brasil: veja quais são as áreas com maior risco de serem atingidas neste sábado

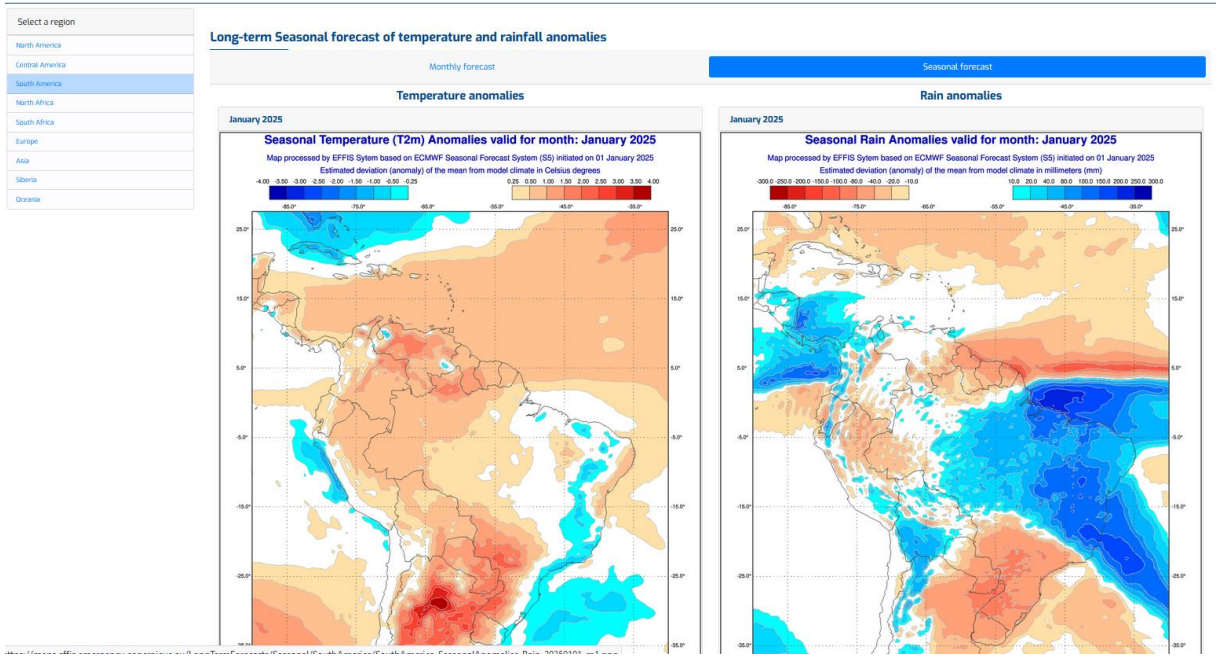
MetSul alerta para riscos de incêndios em áreas de Minas Gerais, São Paulo, Rio de Janeiro, Goiás, Tocantins, Piauí, Ceará e outros

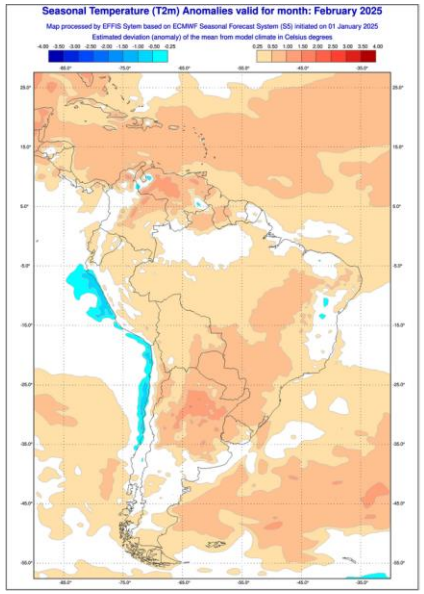
Por O Globo — Rio de Janeiro

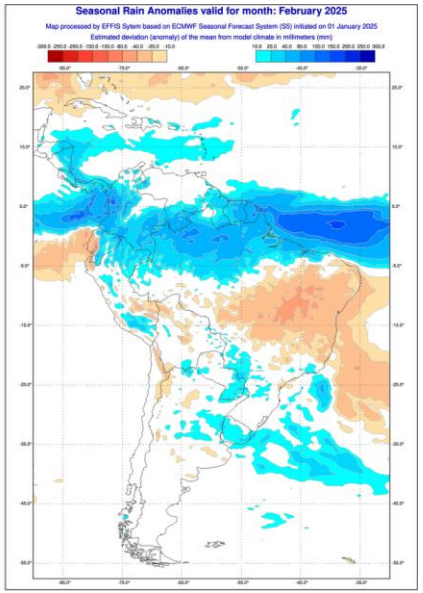
GWIS applications – fire danger forecast

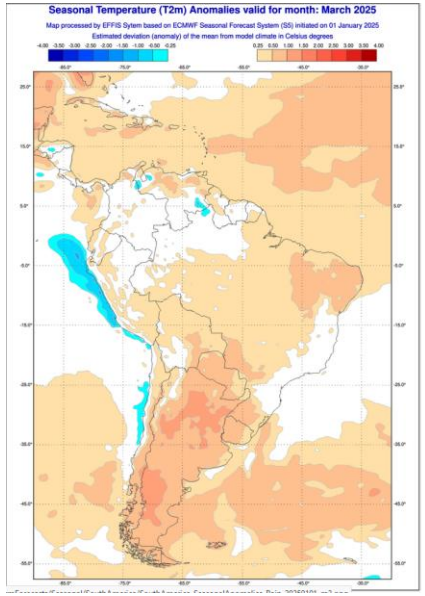
Global Wildfire Information System (GWIS)

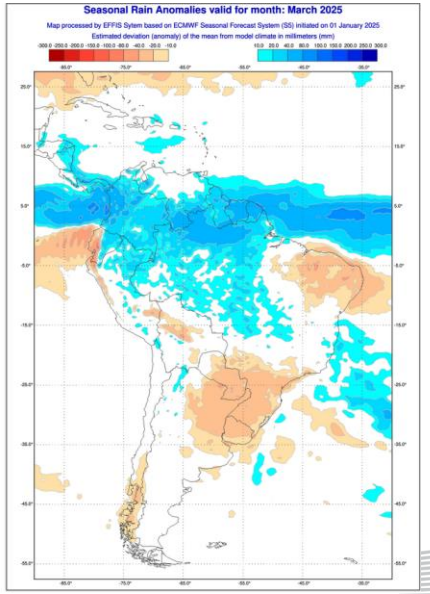
Long-term fire weather anomalies











https://gwis.jrc.ec.europa.eu/apps/country.profile/

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Limitations on:

- The prediction of fire ignition probability
- The early warning of critical wildfire is essential, note that they occur under extreme wildfire danger..
- Compatibility among regions/countries
- Accessibility to sources (mobile platforms used 60% in the access to EFFIS).
- Calibration to local regional conditions, fuel condition, etc. not an index for all!
- Long-term fire weather anomalies & long-term fire danger assessment

WILDFIRE MONITORING

HISTORICAL TRENDS ANALYIS vs REAL-TIME

WILDFIRE MONITORING

HISTORICAL TRENDS ANALYIS

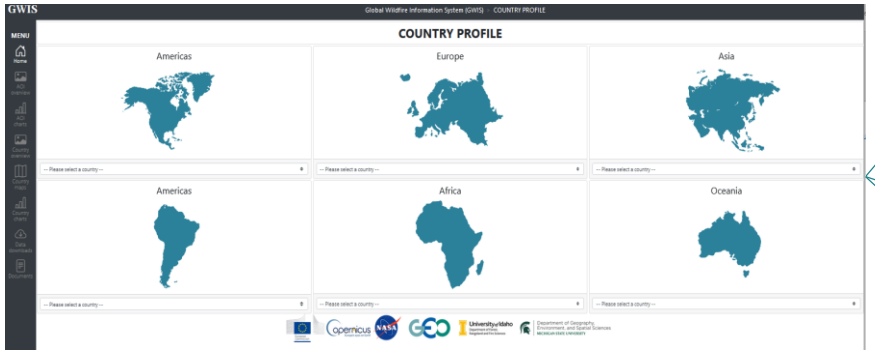
Wildfire science is at a loss for comprehensive data

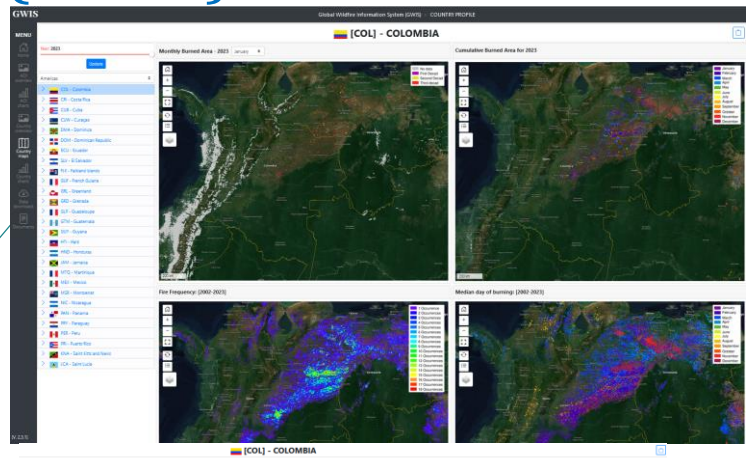
An international monitoring initiative is crucial for understanding wildfires and reducing their damage

Nature (Bowman, July 2018)

Global Wildfire Information System (GWIS)

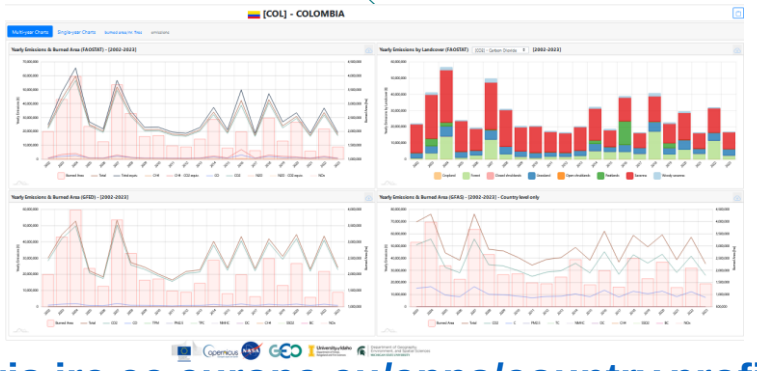
Country& state Profile (23 years stats)





Burnt area distribution/frequency

Burnt areas,
number of fires,
land cover damage,
fire size,
fire seasonality



Emission of fire pollutants

https://gwis.jrc.ec.europa.eu/apps/country.profile/

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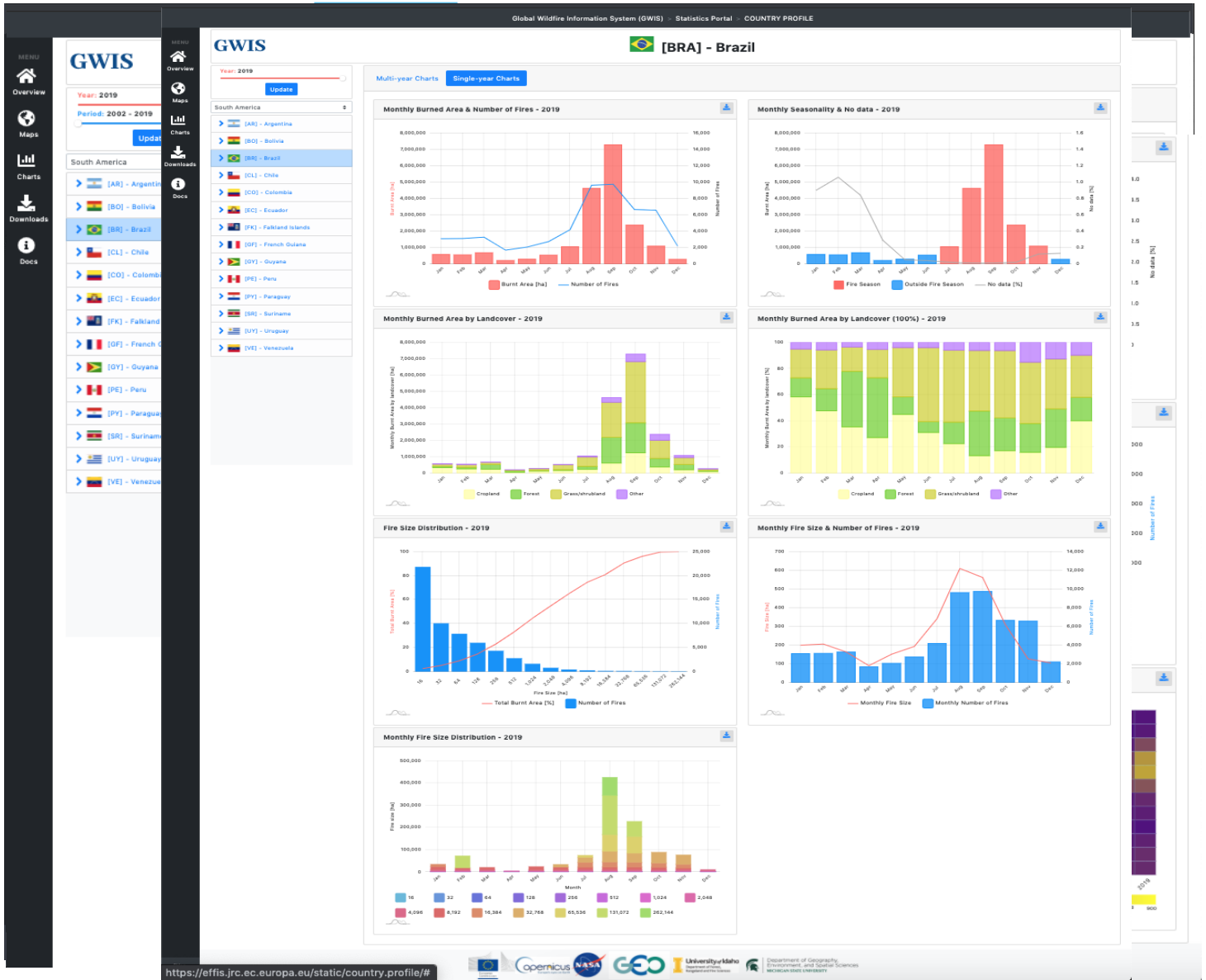
GWIS Country Profiles (launched in 2021)

GWIS – Country Profiles:

Burnt area extent
Fire frequency
Seasonality
Landcover damage
Damage to protected areas
Etc…



Long-term wildfire monitoring for Country Profiles:

- Wildfire statistics are key to success in wildfire mitigation and planning
- Seasonality of fires, fire size, landcover damage, etc.
- Long time series limited by reduction on field data collection
- Long time series limited by remote sensing data availability and suitability (only trends are reliable)

WILDFIRE MONITORING

NEAR-REAL TIME MONITORING

NRT Fire Monitoring:

- Why is it needed? Info to firefighters, to policy makers, to citizens, general public
- Fire monitoring in Europe and other multi-state countries and regions
- Recent enhancement of remote sensing and computer power allows:
    - NTR monitoring at 20 m, since 2018, in Europe
    - NRT monitoring at 500 m, since 2020 globally.
- Impact on research, media, etc. given the data availability (graphs of GWIS access, globally)
- Limitation in the data availability for real time: cloud cover, spatial resolution, classification algorithms (even AI), etc.

Copernicus EMS Early Warning & **Monitoring** – Wildfires

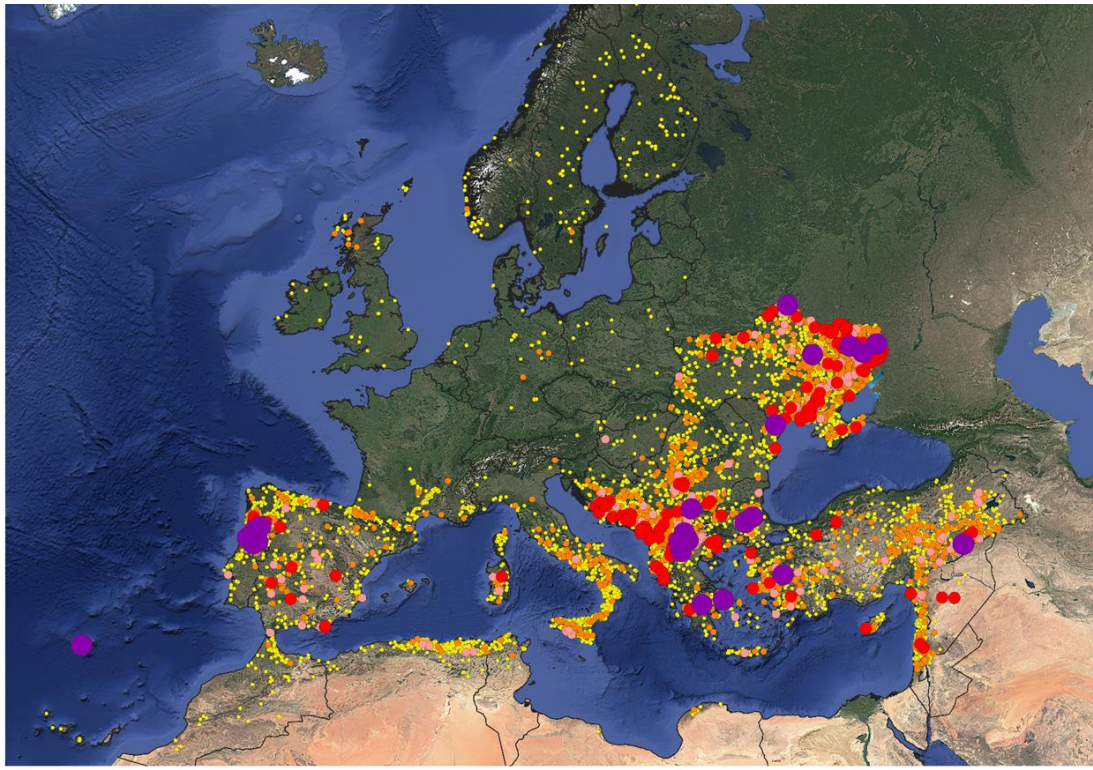
Emergency Management

European Forest Fire Information System (EFFIS)

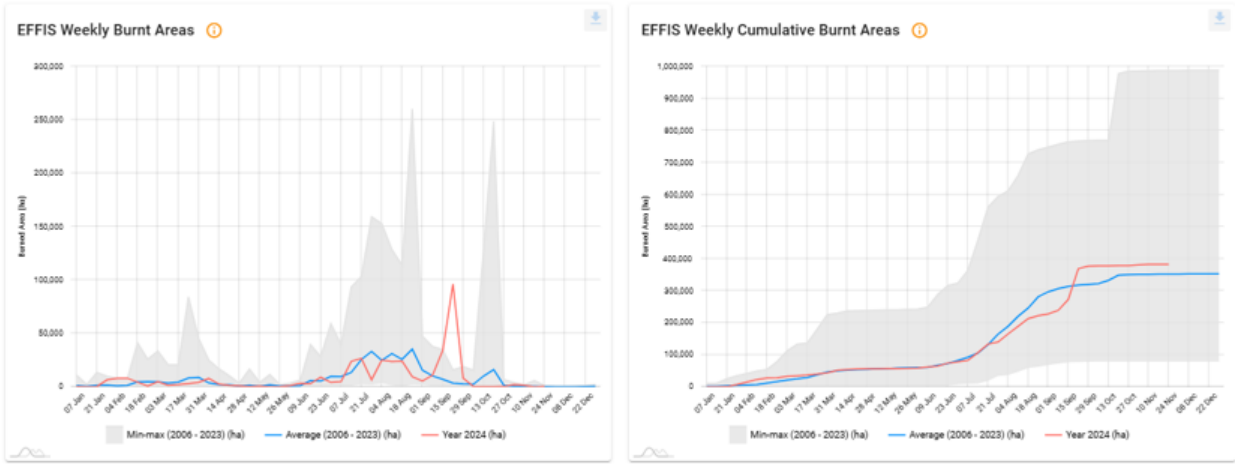
EFFIS real-time information on fires at 20 m spatial resolution, complementing information from national systems.

EFFIS' compatibility with national systems makes it flexible and adaptable to specific needs and methodologies..

EFFIS is the source of information for EU wildfire services in ECHO, ENV, AGRI, CLIMA, REGIO, REFORM, etc.



Burnt areas - weekly trends in 2024



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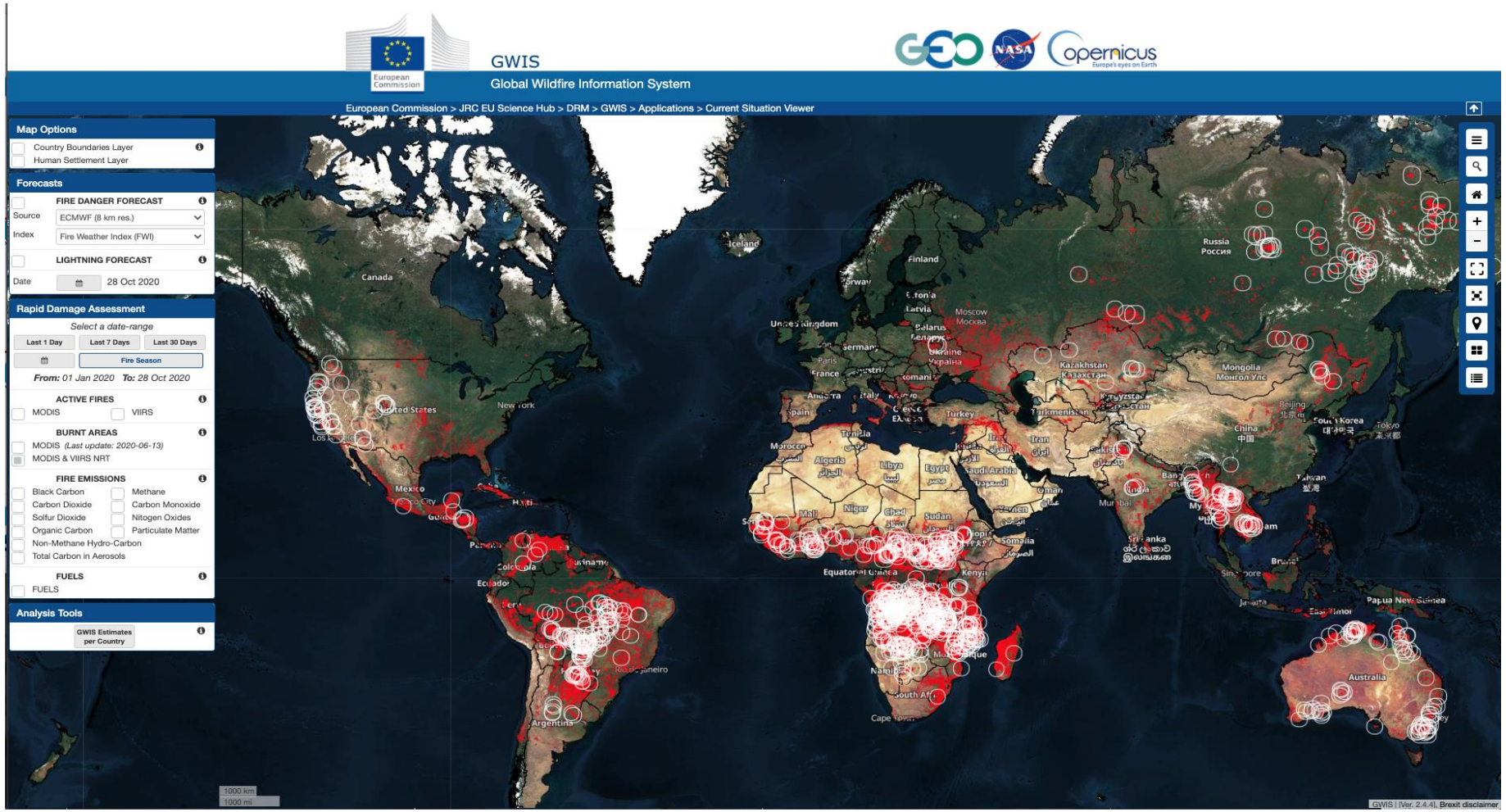
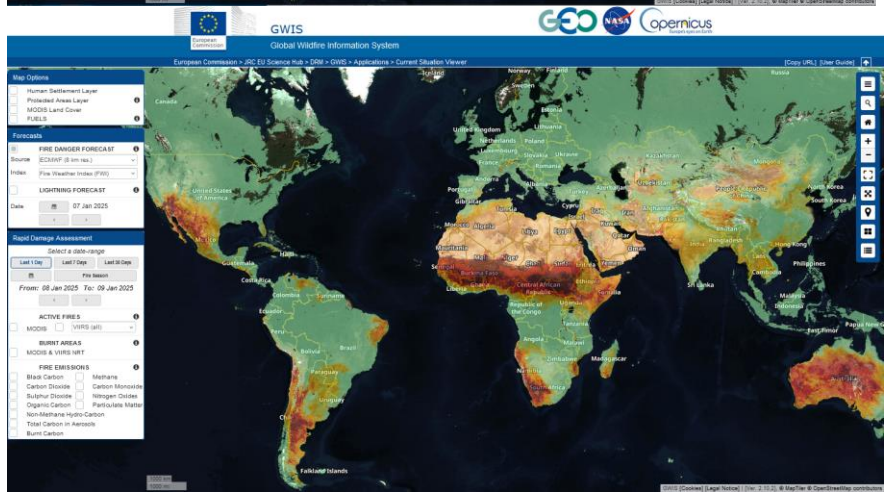
GWIS applications – active fire and burnt area mapping

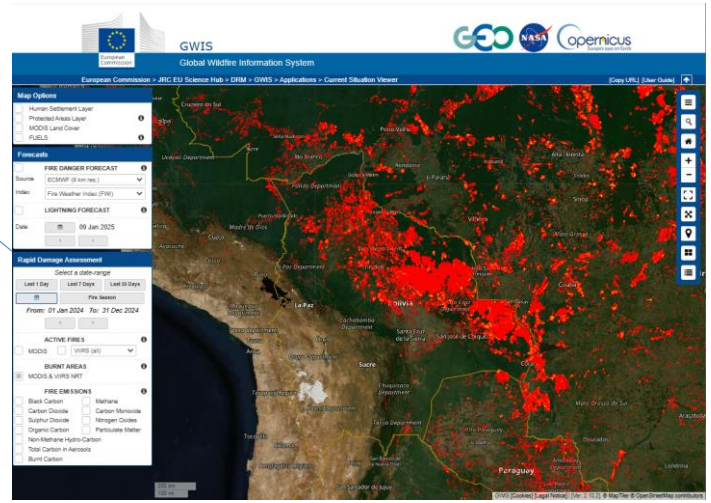


Global Wildfire Information System (GWIS)

Current Situation Viewer



Active fires
x 8 times /day

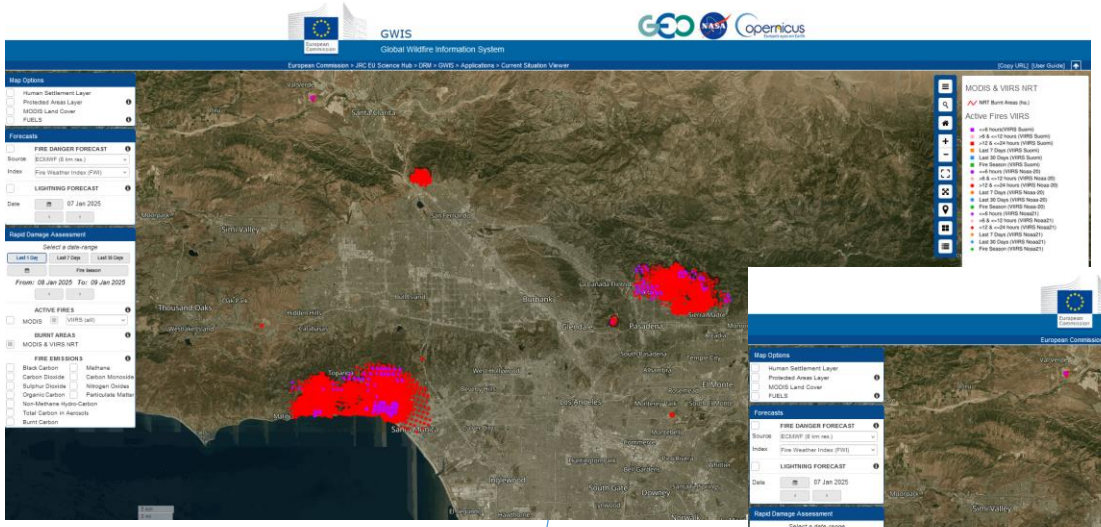


Extent of
burnt areas
x 8 times/day

https://gwis.jrc.ec.europa.eu/apps/gwis_current_situation/index.html

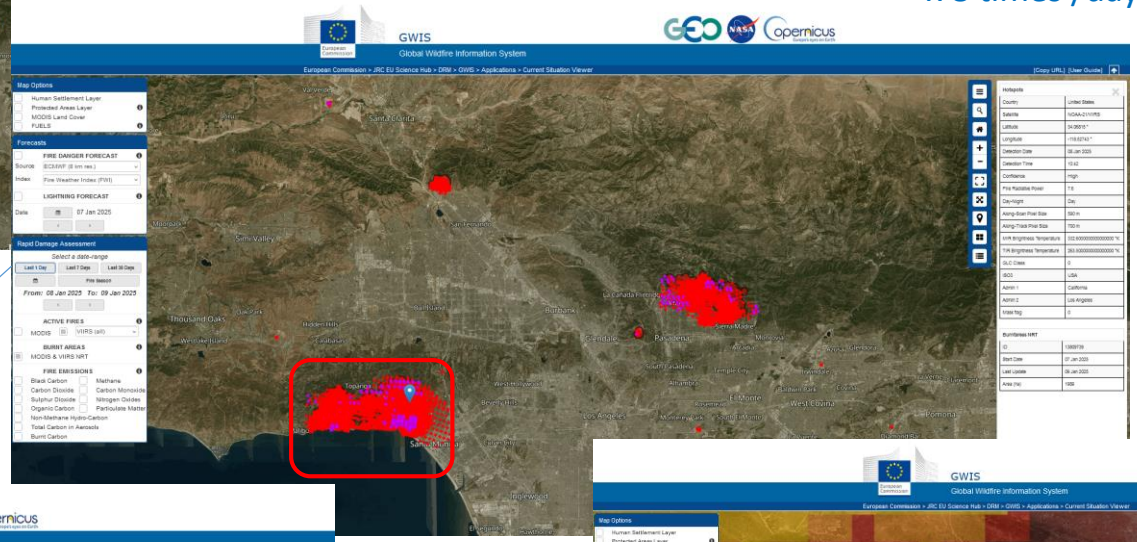
Global Wildfire Information System (GWIS)

Current Situation Viewer (fires in California)

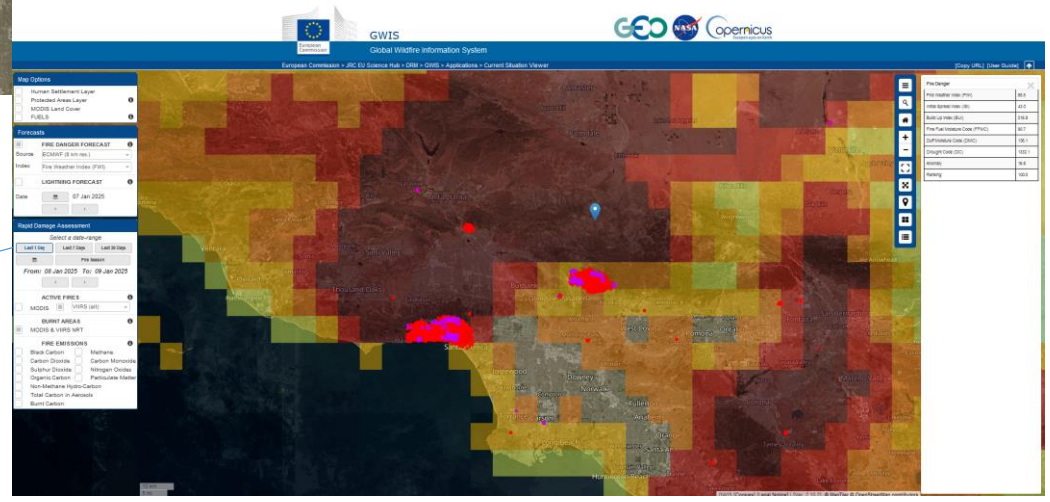


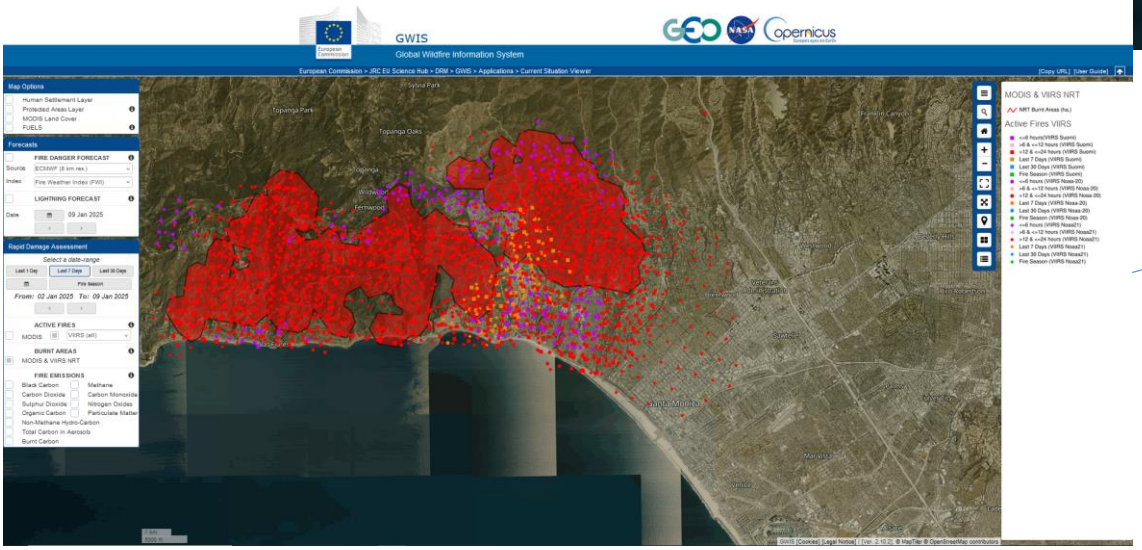
Active fires
x 8 times /day

Burnt area
x 8 times /day



Fire danger
Forecast x 9 days





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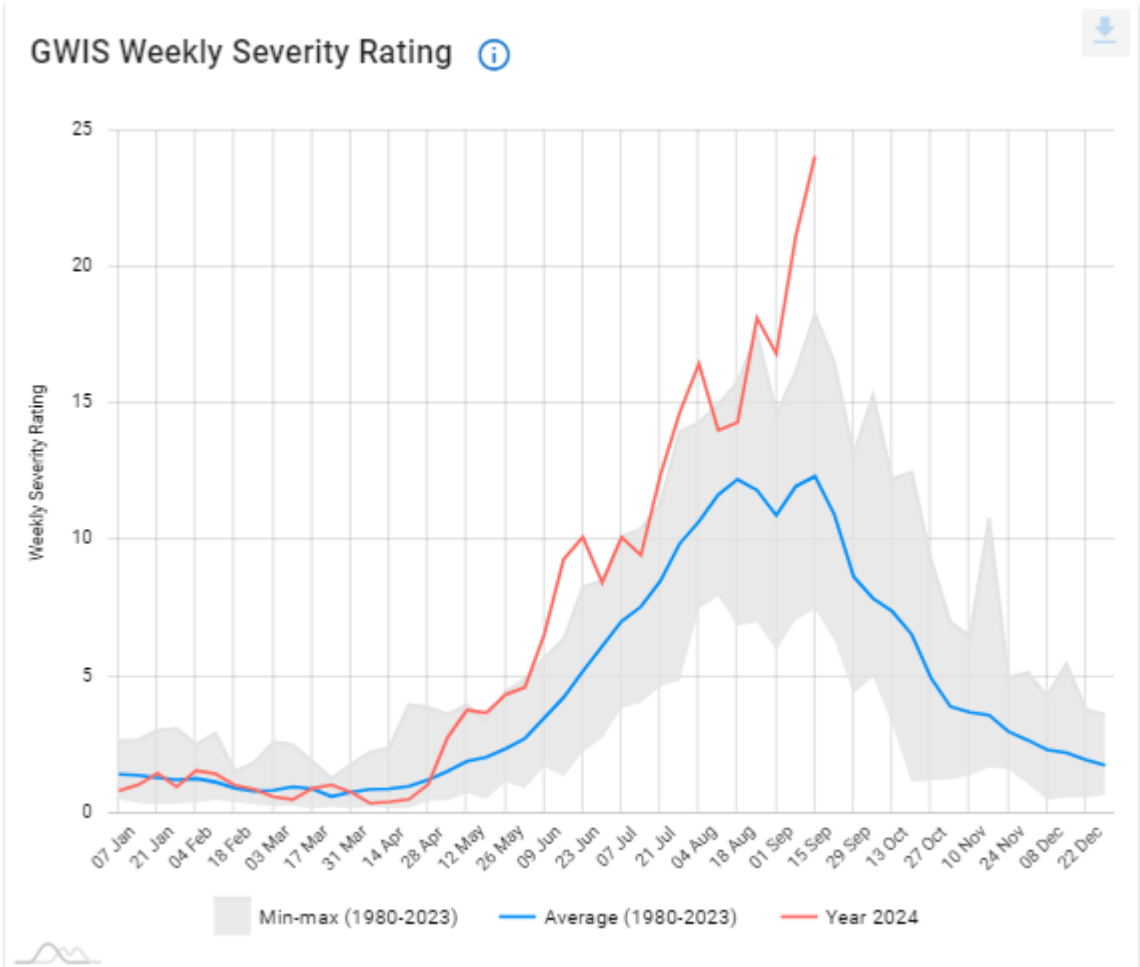
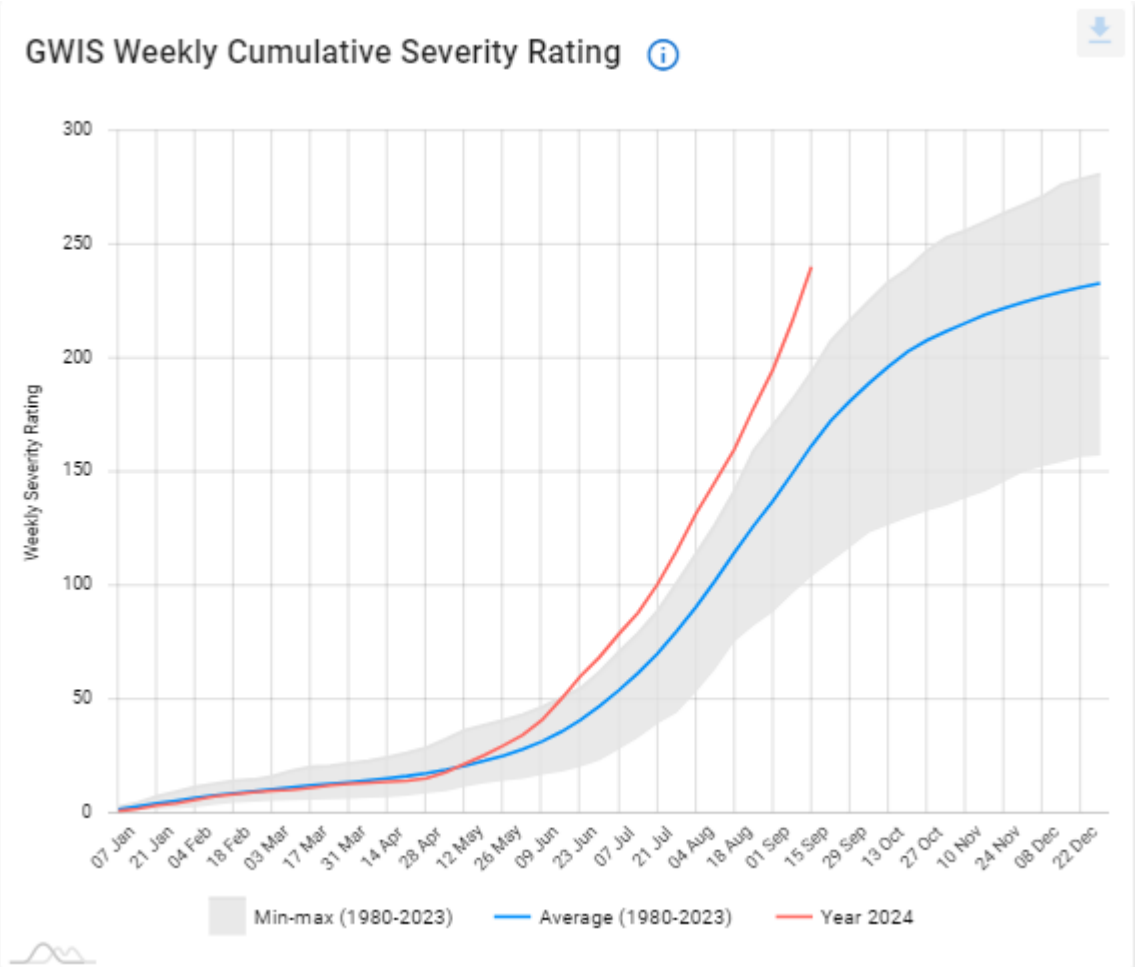
Current trends of **fire danger** - Brazil





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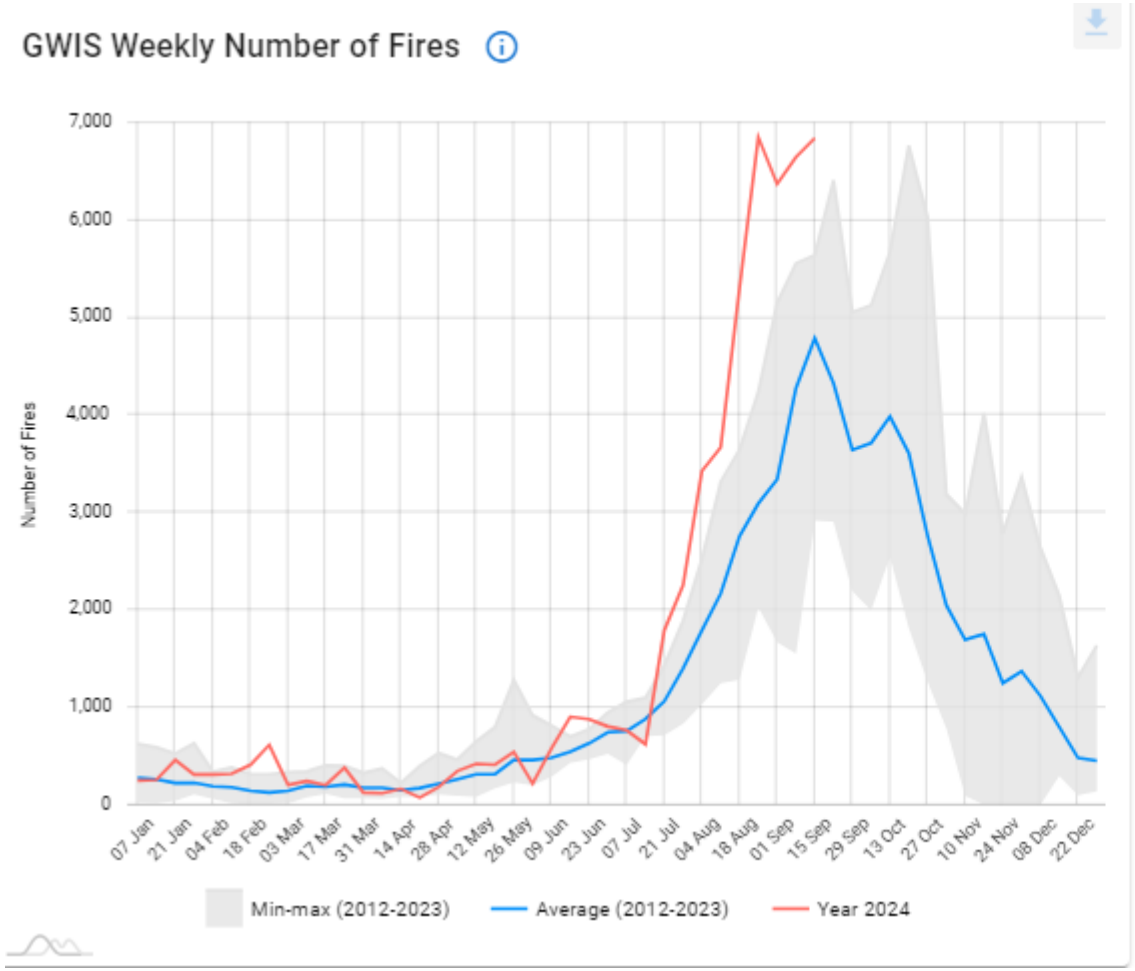
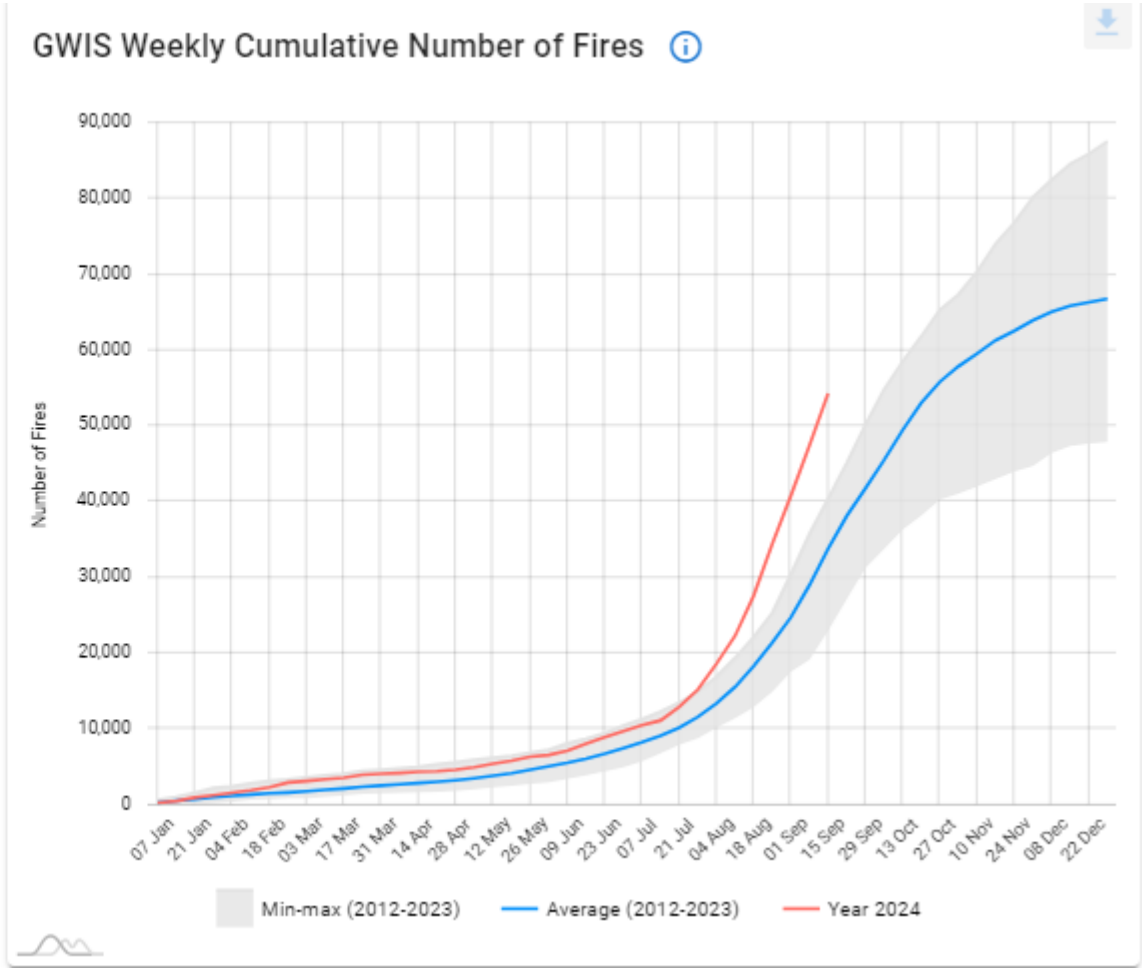
Current trends of **number of fires** - Brazil





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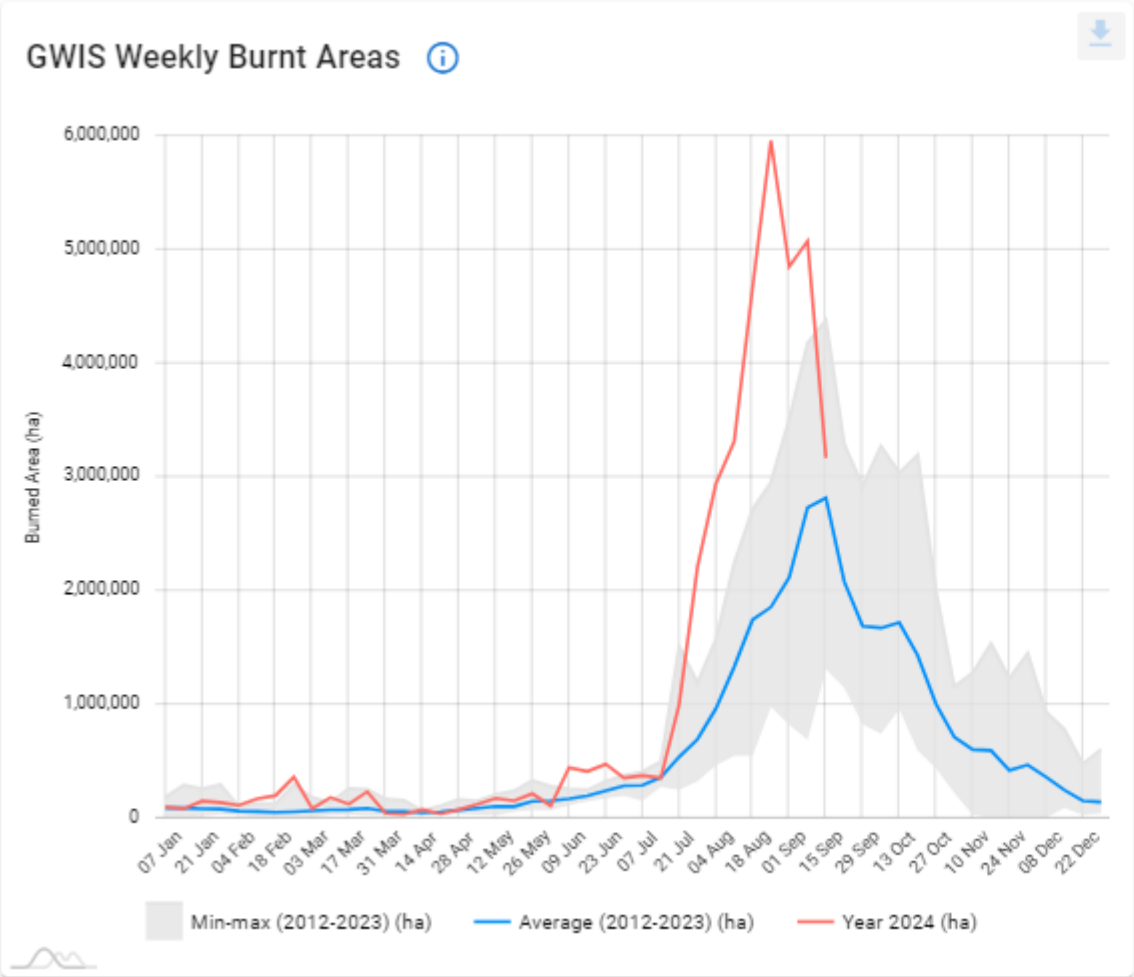
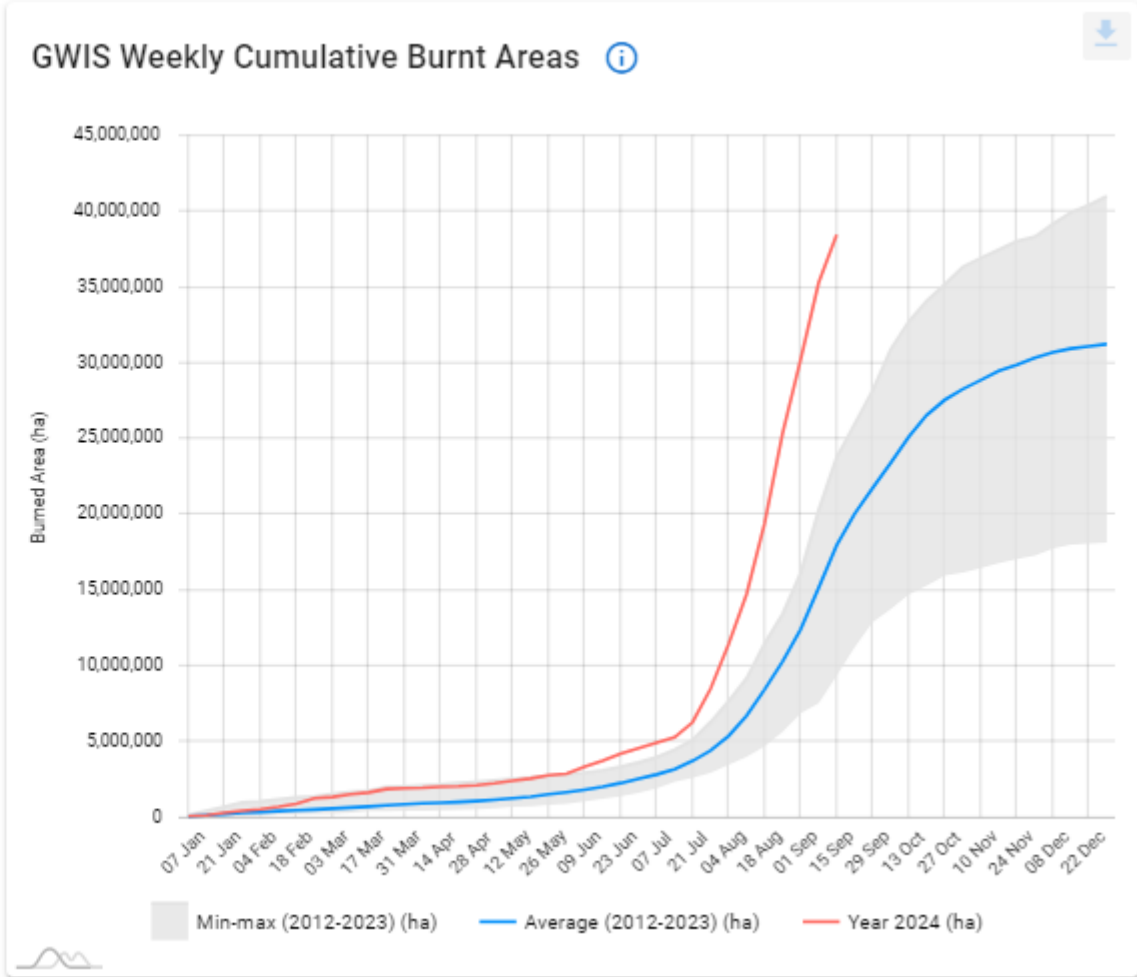
Current trends of **burnt areas** - Brazil





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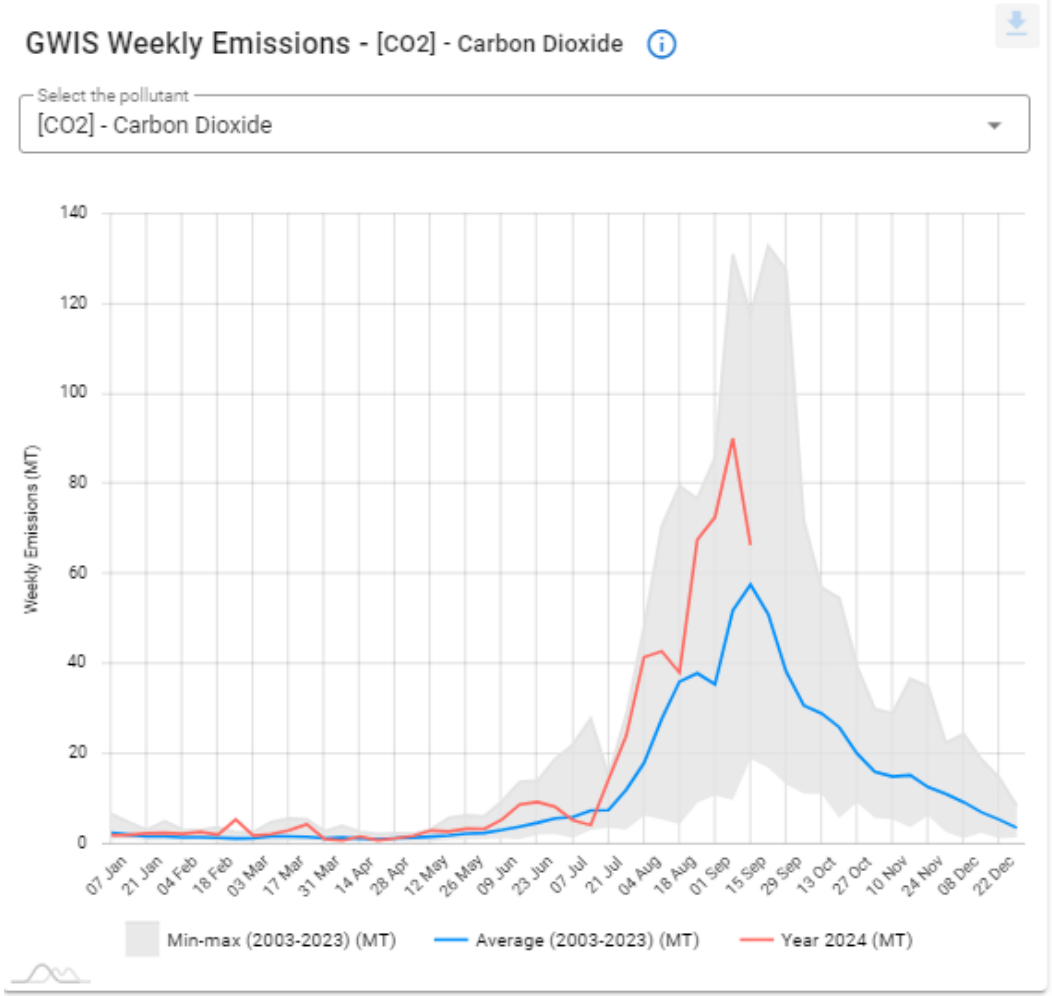
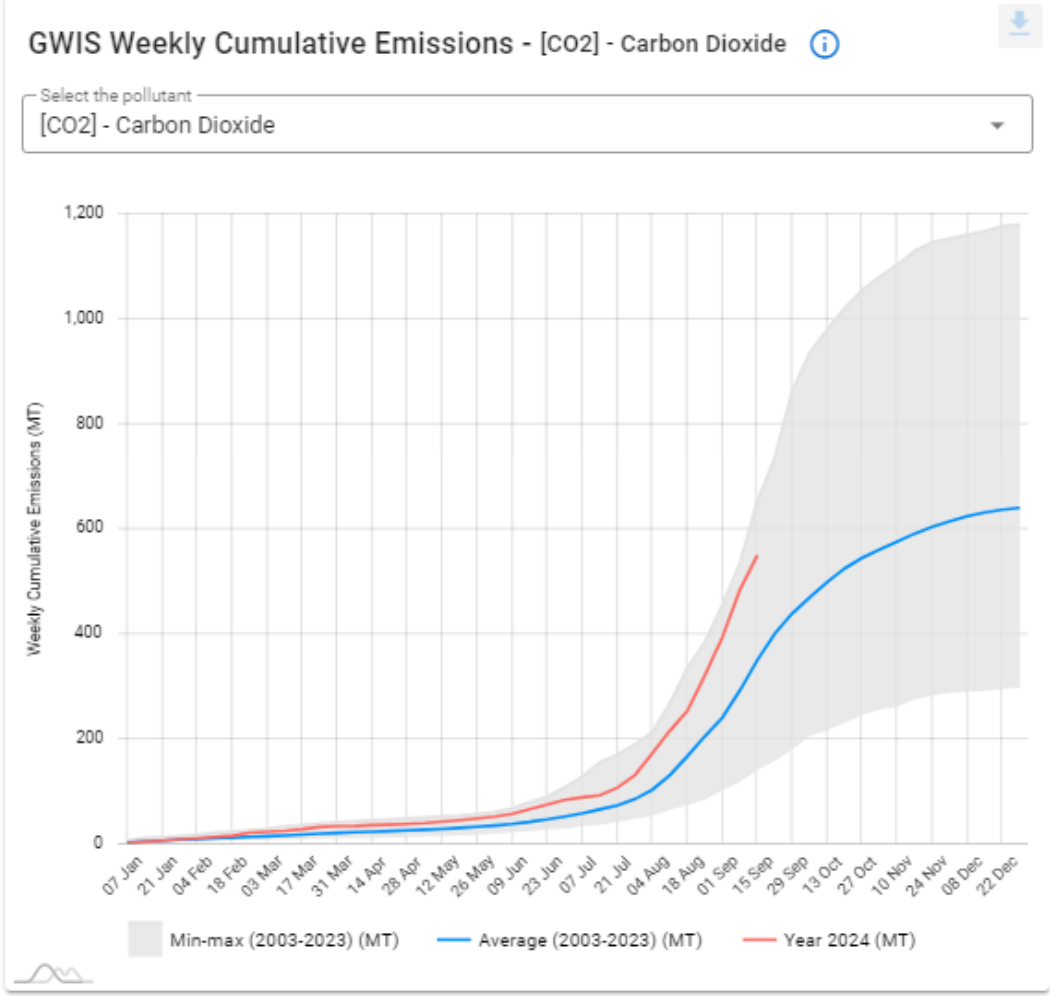
Current trends of **wildfire emissions** - Brazil





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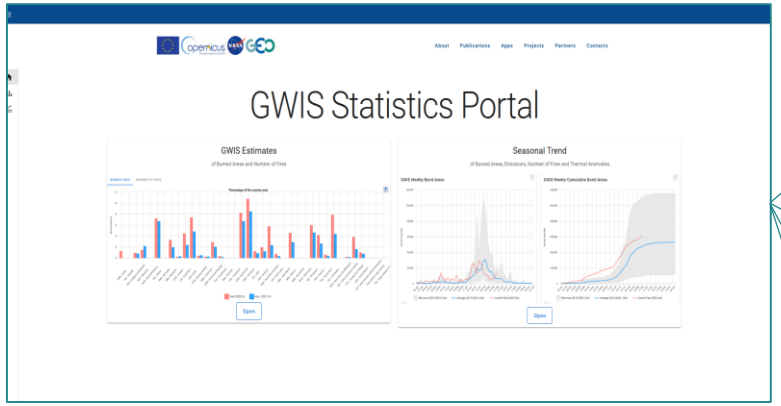
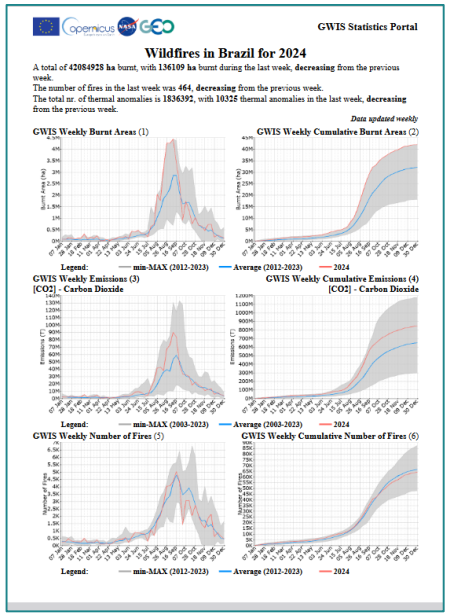
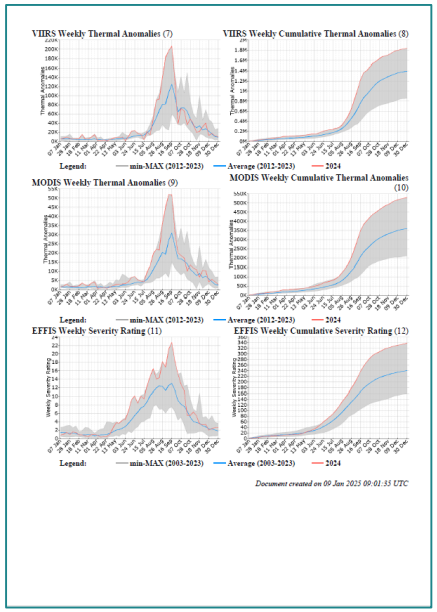
Global Wildfire Information System (GWIS)

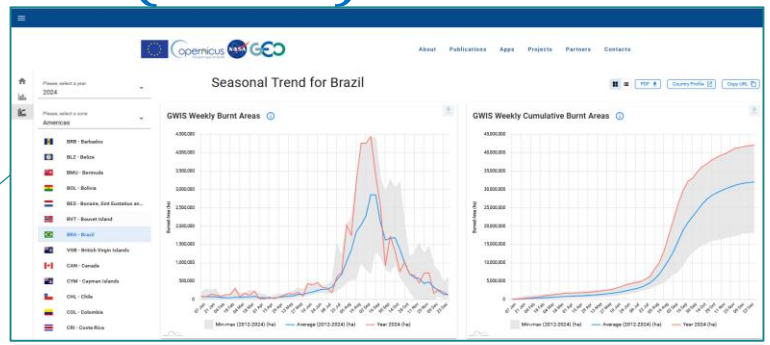
Statistics portal



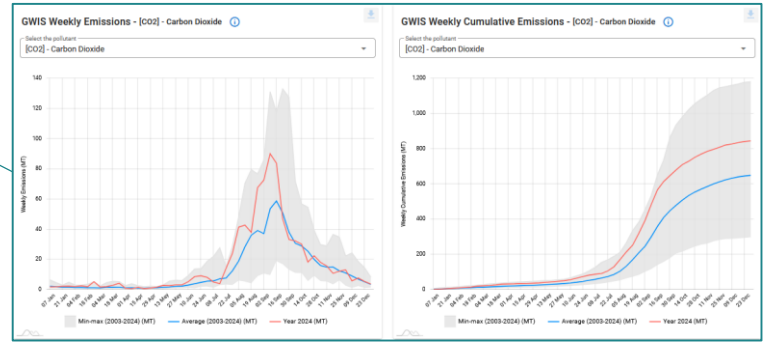
Real-time country report on wildfire trends



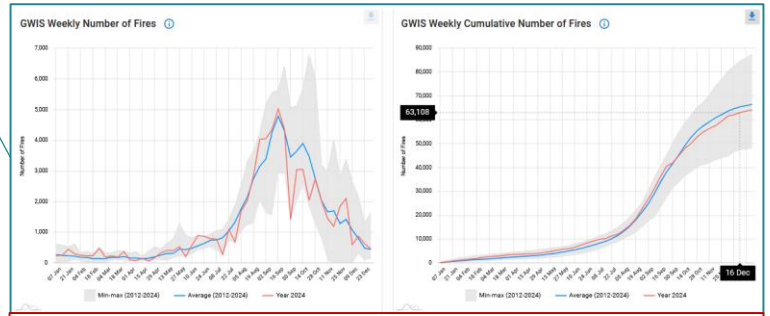




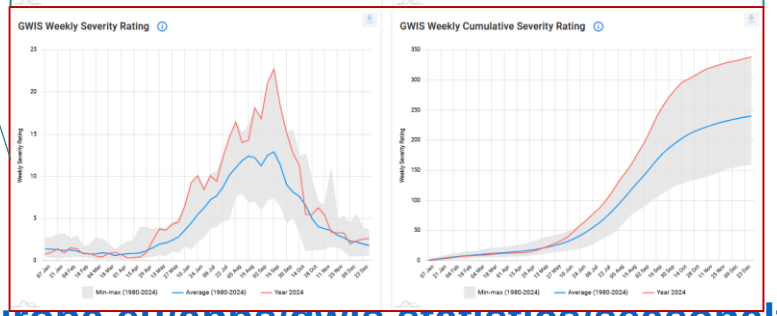
Burnt areas



CO2 emissions



Number of fires



Fire danger

https://gwis.jrc.ec.europa.eu/apps/gwis.statistics/seasonaltrend

European Commission

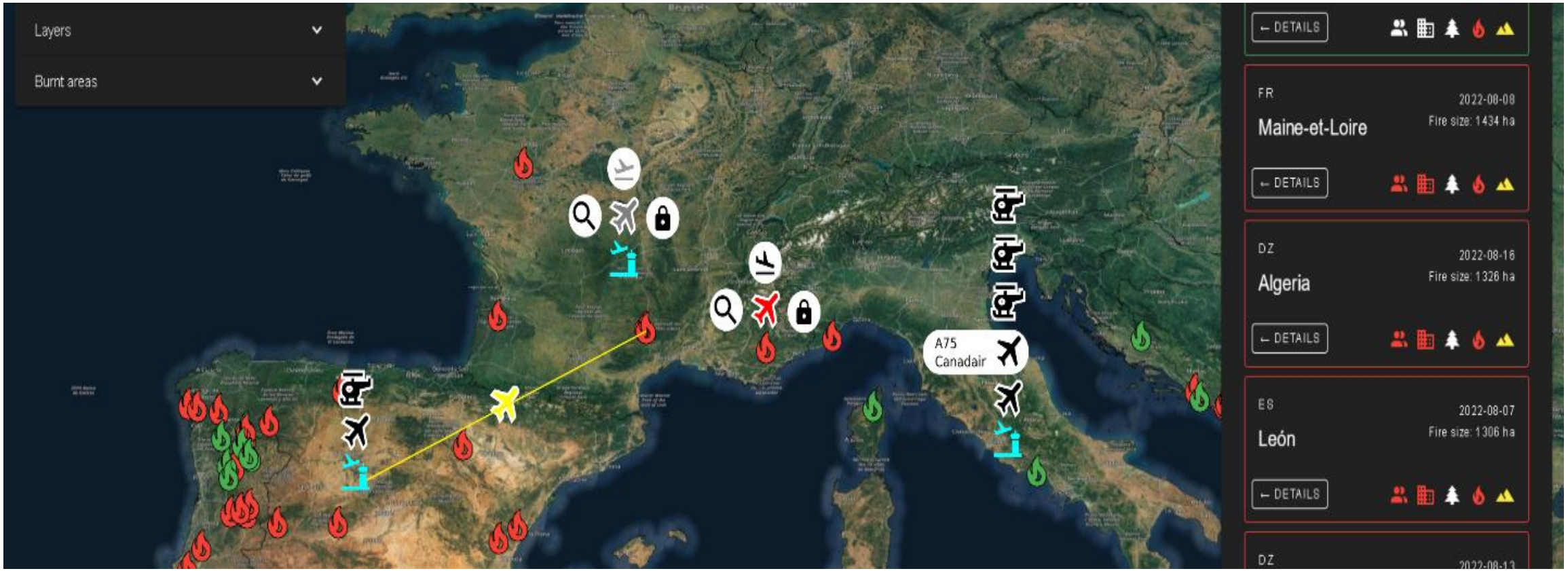
NRT and long-term monitoring are converging, although not used for the same purpose:

- (1) support to firefighting, severity assessment, restoration
- (2) mitigation, adaptation, land management for wildfire prevention

EARLY WARNING + MONITORING ➔ DECISION SUPPORT SYSTEMS

Wildfire modeling, specially in the WUI, becomes essential

EFFIS Decision Support System



Images from the European Forest Fire Information System (EFFIS) Decision Support System for Europe

Collaboration between DG JRC, DG CNECT (AI Office) and DG ECHO on AI based tools for wildfire management

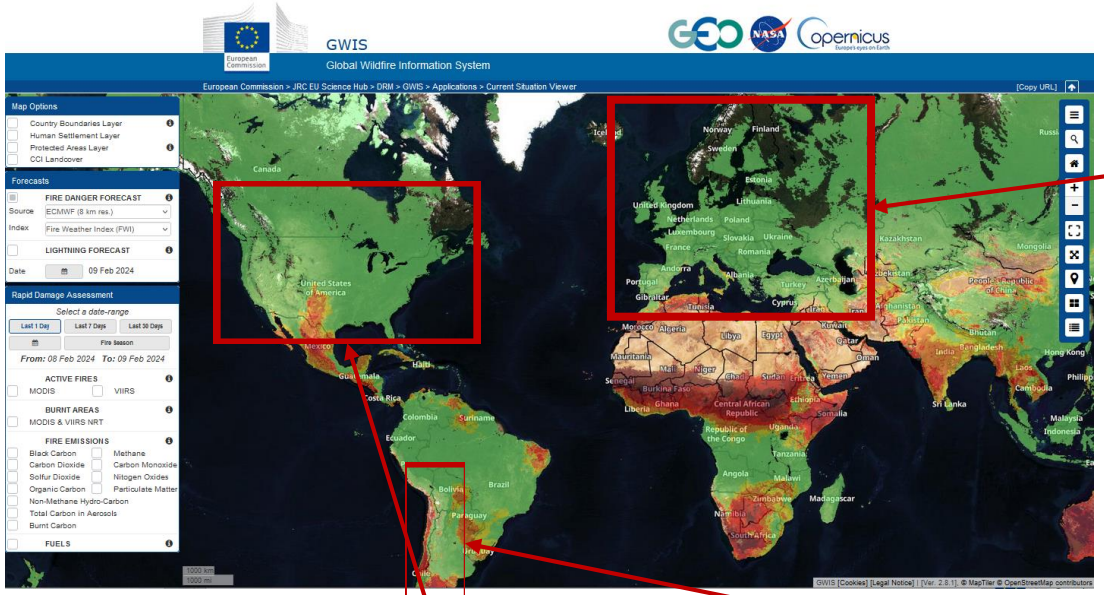
- In the frame of the **US & EU collaboration on AI for Public Good***
- Within the EU **AI Office** activities on AI for Public Good
- Overall development of a multi-hazard management system, 2024-2026
- **Focus on a Global Wildfire Decision Support System**, based on JRC's Global Wildfire Information System (GWIS)
- **AI tools used on active fire detection, wildfire behavior modelling, firefighting deployment and response and wildfire impact assessment**

Images from the European Forest Fire Information System (EFFIS) Decision Support System for Europe,

* Administrative Arrangement on the use of AI for Public Good signed in January 2023 between DG CONNECT and US Department of State,

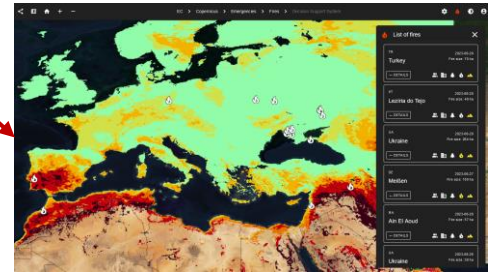
Global Wildfire DSS - development and testing

Global

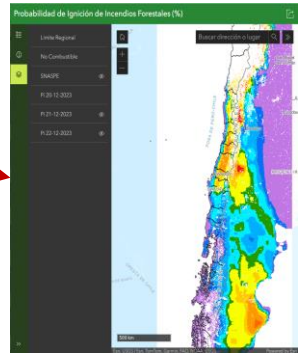


Regional

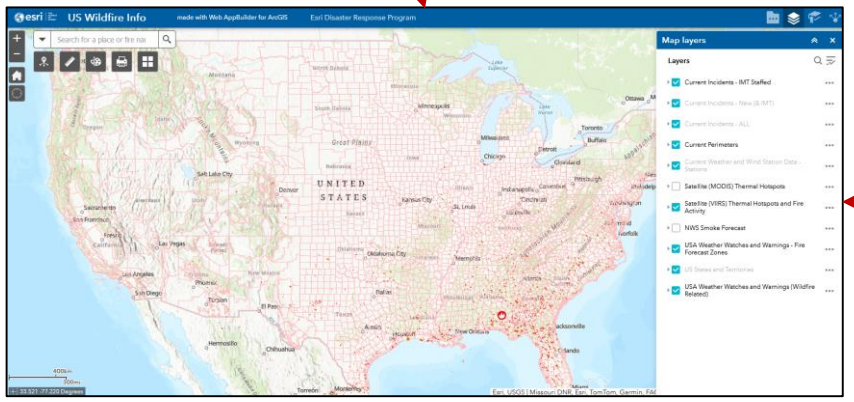
EFFIS DSS



National



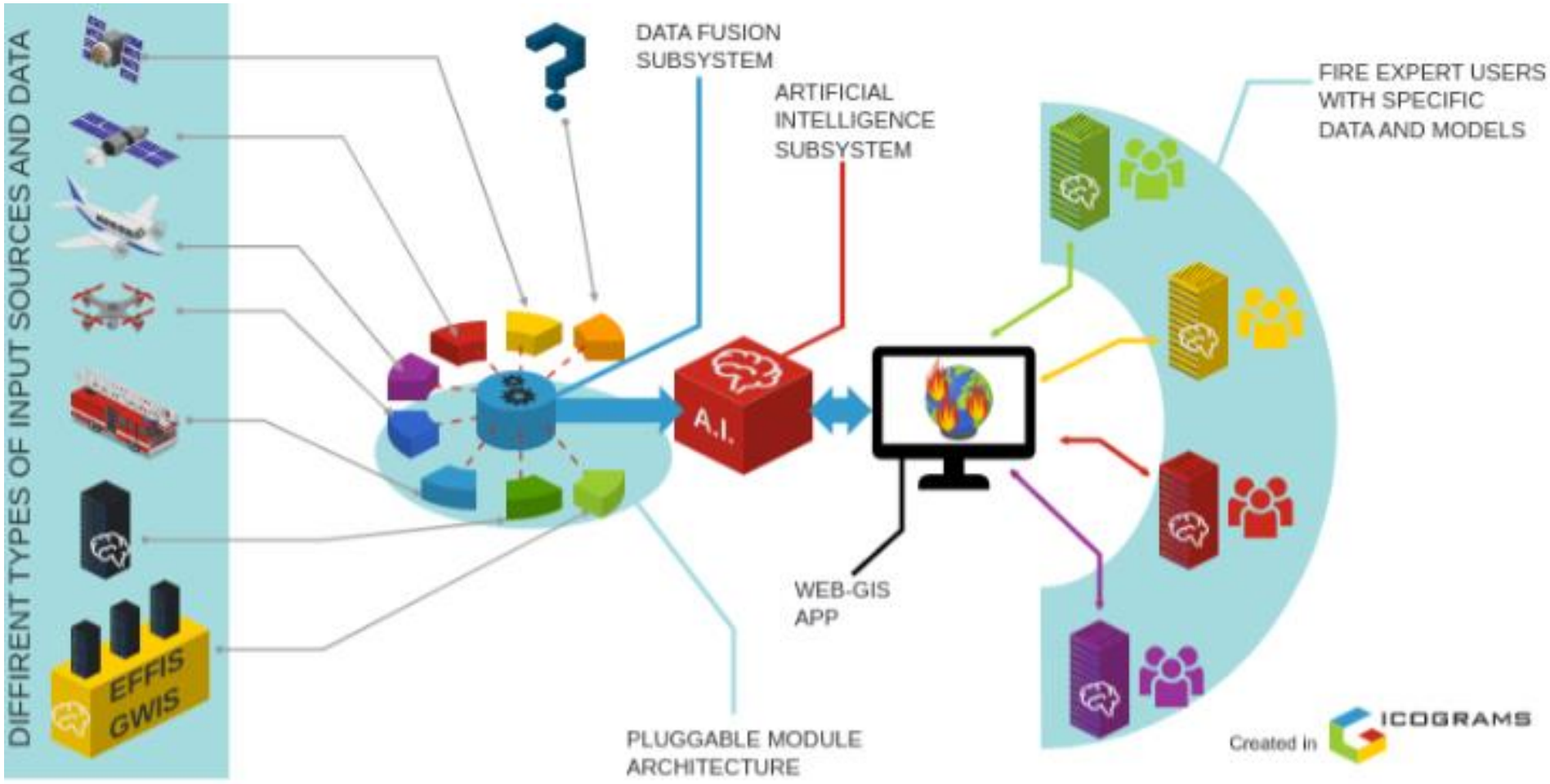
National



Inciweb

- Supports and is supported by regional and national systems
- Provides an open DSS for regions/countries that lack it
- Provides, through an open platform, technical advise by wildfire analysts
- Provides a testbed for AI software development and testing
- Provides a global overview of critical wildfires and international collaboration

Overall scheme - Global Wildfire Decision Support System

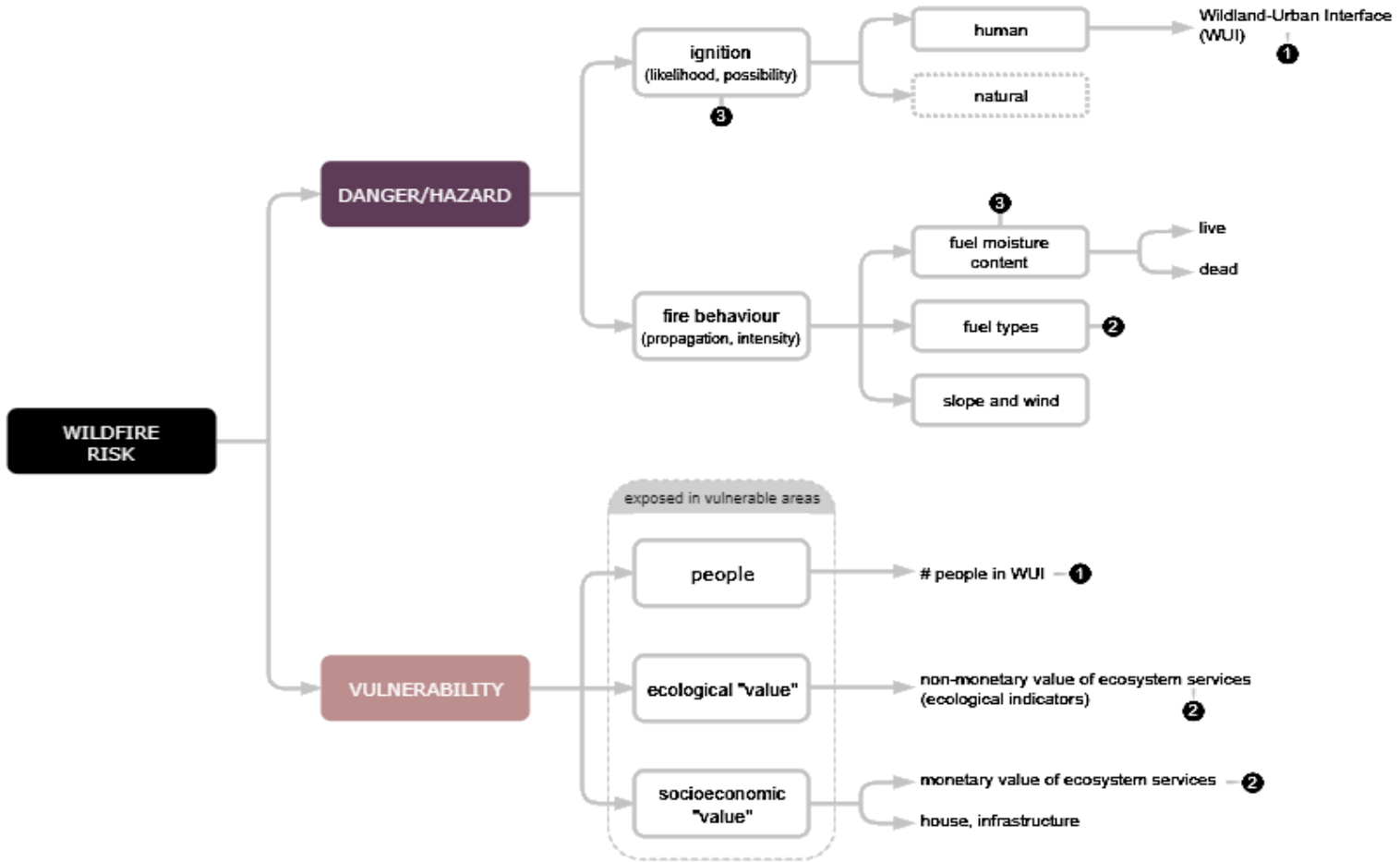


Limitations of wildfire Decision Support Systems:

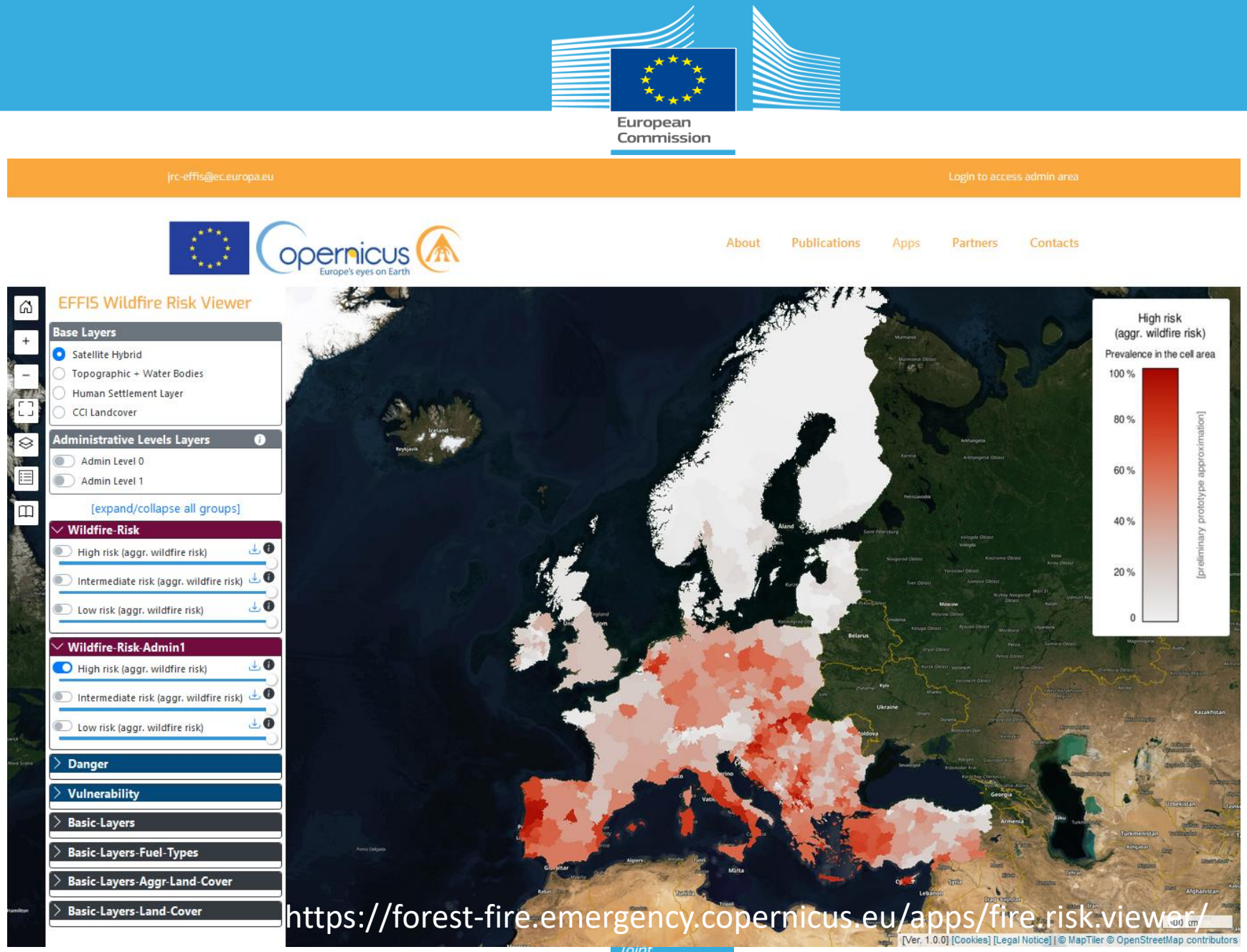
- Availability of fuel models, difficult to obtain and update
- Prediction of fire behavior, as regards fire spread, including the WUI
- The prediction of fire intensity and extreme wildfire behavior, e.g. critical fires such as those in Chile, USA, Portugal, Greece, etc.

WILDFIRE RISK ASSESSMENT

PAN-EUROPEAN WILDFIRE RISK ASSESSMENT



- MODIS **thermal anomalies (2003-2020)**
- **EFFIS burned area (2003-2020)**
- **Corine Land Cover (4 years)**
- **FWI** index and sub-indexes; components such as ISI, BUI.
- **Fuel types/Corine classes ranking**
- MERIT **DEM** (~90m)
- Wildland-urban interface-**WUI**
- IRR, WDPA
- Restoration cost
- GHSL
- MODIS NDVI



https://forest-fire.emergency.copernicus.eu/apps/fire.risk.viewer/

SUMMARY:

- Fair advance on fire danger assessment, with limitations on early warning for the prediction of fire probability and extreme fires
- Fair advance of long-term fire monitoring, with limitations on global data accuracy
- Good advance of near-real time monitoring, with increase number of satellite sensor availability
- Some advance on wildfire decision support systems, with limitations on wildfire behavior, due to non-availability of fuels models and fire behavior models trained on them.
- Advances on wildfire risk assessment, although not widely implemented for policy making

THANK YOU

https://effis.jrc.ec.europa.eu

https://gwis.jrc.ec.europa.eu

jrc-effis@ec.europa.eu