

# FIRE-TRACE - Advancing Greenhouse Gases Monitoring for Climate-related SDGs Reporting

**SDGs-EYES services - Using Earth observation (EO) data to support climate action and Sustainable Development Goals (SDGs)**

**13** CLIMATE ACTION



**Net green-house gas emissions from the *Land Use, Land Use Change and Forestry (LULUCF)* sector (Eurostat code: 13\_21)**

## KEY MESSAGES

**Earth observation data support the monitoring and reporting of the Sustainable Development Goals (SDGs).**

Consistent, wide-scale information on land, water, and oceans through repeated satellite observations enables tracking of environmental changes over time.

**Effective and harmonised monitoring methods are essential.**

The FIRE-TRACE service demonstrates how Earth observation-based products can be integrated into the Intergovernmental Panel on Climate Change (IPCC) inventory framework to improve reporting on greenhouse gas (GHG) emissions from fires.

**FIRE-TRACE delivers accurate and timely estimates of GHG emissions from fire.**

Leveraging Copernicus's open-source satellite data, the system provides immediate GHG emissions estimates from fire, helping statistical offices and institutions accelerate national reporting without the need to manually collect and process traditional inventory data.

**FIRE-TRACE is scalable and replicable.**

The integration of high-resolution satellite imagery from Copernicus with local biomass inventories and ground observations enhances the consistency and comparability of reports from local to national scale. This overcomes discrepancies across different reporting methods.

**FIRE-TRACE has a user-friendly interface.**

Key stakeholders were engaged in an impactful co-design process. Thanks to their inputs the FIRE-TRACE interface is intuitive and easy to use, simplifying the calculation of GHG emissions.



## Scene Setting

Greenhouse gases, such as carbon dioxide and methane, play an important role in driving climate change as they trap heat in the Earth's atmosphere, therefore causing global temperatures to rise, leading to more extreme weather events, sea-level rise, and ecosystem degradation.

**SDG 13 - Climate Action calls for urgent measures to combat climate change and its impacts.** It emphasises the need of reducing GHG emissions, integrating climate considerations into national policies, and enhancing resilience to climate-related disasters.

**Monitoring GHG emissions is pivotal to achieving these objectives, as it provides critical data to inform mitigation strategies and policy decisions.**

The **SDGs-EYES** project aligns its mission with these global priorities, supporting the efforts to **address the climate crisis through enhanced monitoring and data-driven solutions**. In this perspective, seven services have been developed under the SDGs-EYES

umbrella, to demonstrate how its methodology and decision support tools can enhance the reporting of SDG 13 - Climate Action, SDG 14 - Life below Water, SDG 15 - Life on Land. In this global context, SDGs-EYES operates within the structured scenario defined by the United Nations and national statistical systems for SDG monitoring.

The 2030 Agenda and its Global Indicator Framework, coordinated by United Nations Statistics Division (UNSTAT) and implemented by national statistical offices and custodian agencies, set the standards for how progress on SDGs is tracked. SDGs-EYES contributes to this framework by offering cost-effective Earth observation-based methodologies that can support both national statistical offices and custodian agencies. Its outputs facilitate the collection of harmonised, comparable data, particularly relevant to climate indicators under SDG 13, thereby improving international reporting, supporting evidence-based policies, and strengthening global efforts to combat climate change.

## FIRE-TRACE: A New Tool for Greenhouse Gas Emissions Monitoring

Traditional inventory-based fire emissions monitoring is slowed down by reporting delays. In contrast, advancements in Earth observation and environmental modelling have rapidly transformed the understanding of GHG emissions from forest fires.

**SDGs-EYES** has developed **FIRE-TRACE**, a new service to advance and harmonise GHG emissions monitoring. FIRE-TRACE integrates several data layers to capture the true complexity of fire behaviour. It is a research-driven, Earth observation-based tool that delivers timely maps of GHG emissions, including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and particulate matter.

### Main Features of FIRE-TRACE

**More accurate and realistic data.** Recognising that only a portion of standing biomass is consumed during a forest fire, FIRE-TRACE combines Copernicus (freely-available) satellite data with novel partial-combustion models and local biomass inventories. This replaces outdated assumptions of complete biomass loss with more accurate estimates of emissions.

**Near-real-time data.** By leveraging Copernicus's available satellite archives, FIRE-TRACE delivers data without

the need for heavy on-site infrastructure. The platform is cloud-based, cost-effective, and features an intuitive interface, making it accessible even to smaller administrations. It offers a faster and potentially more reliable alternative to traditional national inventories, which typically report emissions data annually.

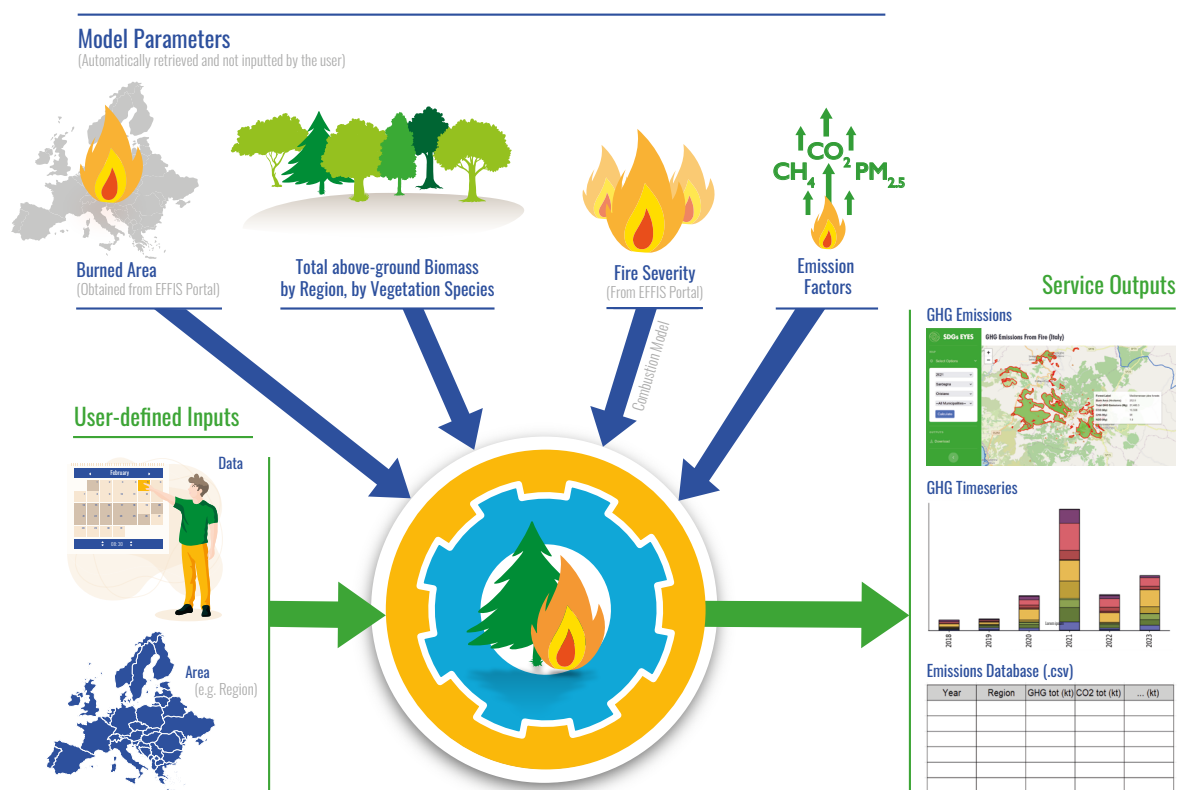
**Co-design process.** Developed through a sustained co-design process, FIRE-TRACE reflects the needs of its end-users, including national statistical offices, environmental agencies, and forest managers. By incorporating the feedback gathered through workshops and webinars, the platform has ensured compatibility with existing monitoring frameworks and reporting standards.

FIRE-TRACE enables timely, spatially explicit information for decision-makers at local, regional, and national levels, while also enhancing the accuracy and reliability of GHG emissions data.

## The Technical Side of FIRE-TRACE

FIRE-TRACE refines the estimation of GHG emissions from forest fires by integrating high-resolution satellite data from the Copernicus programme (three satellite-derived data layers from Copernicus: 1) burnt area from EFFIS; 2) fire severity from European Forest Fire Information System (EFFIS); 3) corine land cover with local biomass inventories and ground-based observations. This approach allows for precise assessment of **partial combustion**, replacing generalised assumptions with context-specific analysis.

FIRE-TRACE builds on IPCC guidelines and introduces **location-sensitive refinements** that account for differences in fire intensity, seasonal variation, and vegetation types. The methodology has been embedded in an interactive digital platform featuring **maps and dashboards**, enabling transparent and spatially detailed support for **evidence-based climate reporting and decision-making**. This process is explained in **Figure 1**.



**Figure 1.** FIRE-TRACE enables automated estimation of greenhouse gas emissions from forest fires. Upon user input of the date and region, the tool integrates remotely sensed data on burned area and fire severity (from EFFIS), above-ground biomass, and emission factors. The outputs generated are spatially explicit GHG emission maps, time series analyses, and a downloadable emissions database.



# What Does This Mean for Policy?

Using FIRE-TRACE, public authorities - from local government to national statistical offices - can gain access to a robust evidence-based tool that fills data gaps, enhances granularity, and supports cross-validation against traditional inventories. This will help them in fulfilling their tasks while overseeing and

monitoring climate trends, forest management, and sustainable land-use planning. The ultimate goal of FIRE-TRACE is enabling policy makers to anticipate hotspots, allocate firefighting resources more effectively and integrate updated emission figures into national GHG emission inventories.

**By bridging research and practice, FIRE-TRACE empowers governments to meet SDG 13 - Climate Action with greater precision and confidence.**

## From Barriers to Action: Enabling Earth observation-based SDG Reporting

### Data Fragmentation

**The Challenge:** Earth observation, inventory and field data often come in incompatible formats, scales, and structures, making integration difficult.

**Strategic Response:** Promote open data standards, agreed data formats (e.g. OGC) and cloud-based automation to harmonise diverse datasets into a unified, actionable format.

### Institutional Inertia

**The Challenge:** Agencies fear that introducing Earth observation data may disrupt long-term reporting consistency and time-series integrity.

**Strategic Response:** Work with statistical offices to co-design phased transition plans, using side-by-side comparisons to validate Earth observation outputs, maintain historical baselines and build trust in the new data.

### Capacity Gap

**The Challenge:** Many local authorities lack the infrastructure and technical skills to effectively process and interpret Earth observation data.

**Strategic Response:** Provide targeted training, use cloud platforms and offer on-demand support to strengthen internal capacities without requiring major infrastructure investments.

### Weak Ground Validation

**The Challenge:** Limited access to ground-truth data reduces confidence in satellite-derived emission estimates.

**Strategic Response:** Partner with forestry agencies and research bodies to expand field data collection, and apply standardised protocols for consistent validation.

### Resources Constraints

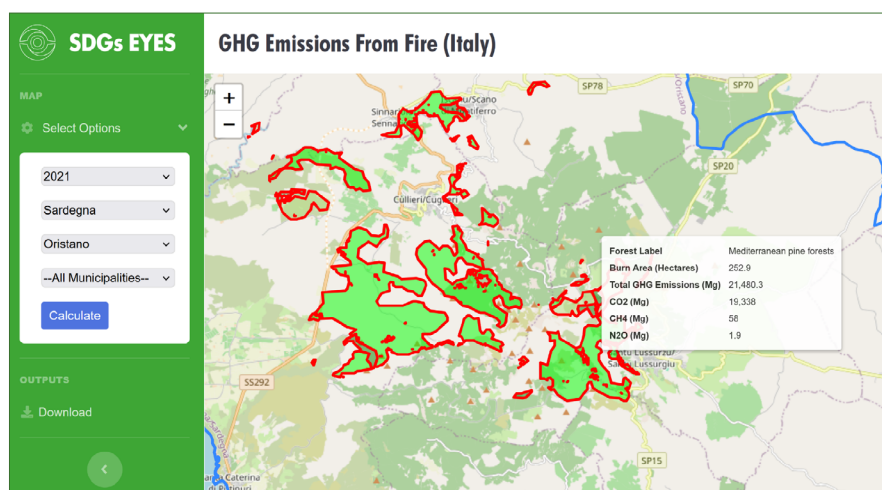
**The Challenge:** Sustaining Earth observation systems, infrastructure and skilled personnel is financially challenging, especially for smaller administrations.

**Strategic Response:** Leverage EU grants, and establish public-private partnerships to share investment costs. Deploy open-source Earth observation tools to minimise recurring expenses and support long-term sustainability.

# FIRE-TRACE - Experimental Results and Operational Validation

Accurate, spatial, and temporal estimates of fire-related GHG emissions are essential for informed forest and land management policies. Earth observation data support the development of targeted strategies for forest protection and climate change mitigation. FIRE-TRACE gives essential support on the identification of areas that need special attention and where dedicated policy needs to be framed.

FIRE-TRACE shows that between 2018 and 2023, Italy experienced an average annual loss of approximately 109 km<sup>2</sup> of forested land due to fires - equivalent to around 15,000 football pitches. The Cosenza province alone saw about 8 km<sup>2</sup> (roughly 1,000 football pitches) affected each year. During this period, the GHG emissions resulting from these fires exceeded 1,000 Gg of CO<sub>2</sub> eq nationally and approximately 550 Gg within Cosenza. This indicates that policy has to be steered to protect Italian forests and forests in Cosenza province.



## Forward Looking

**Local/national authorities.** Local administrations are on the front lines of climate monitoring but often lack timely access to data and technical capacity. FIRE-TRACE offers a user-friendly, cloud-based platform that will support GHG emissions reporting by providing timely, spatially explicit data. With minimal infrastructure requirements and tailored training support, **local authorities can confidently integrate Earth observation into environmental management, enhancing transparency, efficiency and local decision-making.**

**EU authorities.** Timely and accurate climate data is essential for aligning with SDG 13 and international commitments under the Paris Agreement. **FIRE-TRACE bridges the gap between traditional inventory methods and modern Earth observation capabilities, enabling faster, more reliable emissions reporting without disrupting long-term datasets.** By supporting the use of Earth observation-integrated methods like FIRE-TRACE, policy makers can streamline national reporting, support evidence-based planning and future-proof climate governance.

**Funding and granting authorities.** **Investment is needed to scale innovative tools like FIRE-TRACE.** The tool demonstrates how Earth observation data can be operationalised at low cost at local and national levels, promoting interoperability, transparency, and cross-border comparability. Supporting FIRE-TRACE through targeted funding and inclusion in EU programmes can accelerate climate action while ensuring inclusivity for under-resourced administrations.



# SDGs-EYES in short

SDGs-EYES aims to boost Europe’s capacity to monitor the Sustainable Development Goals by harnessing the power of Copernicus Earth observation data. The project focuses on building a portfolio of decision-support tools to enhance the production and use of SDG indicators, with an emphasis on accessibility, reliability, and impact.

## Enhancing Access and Usability of Earth observation Data

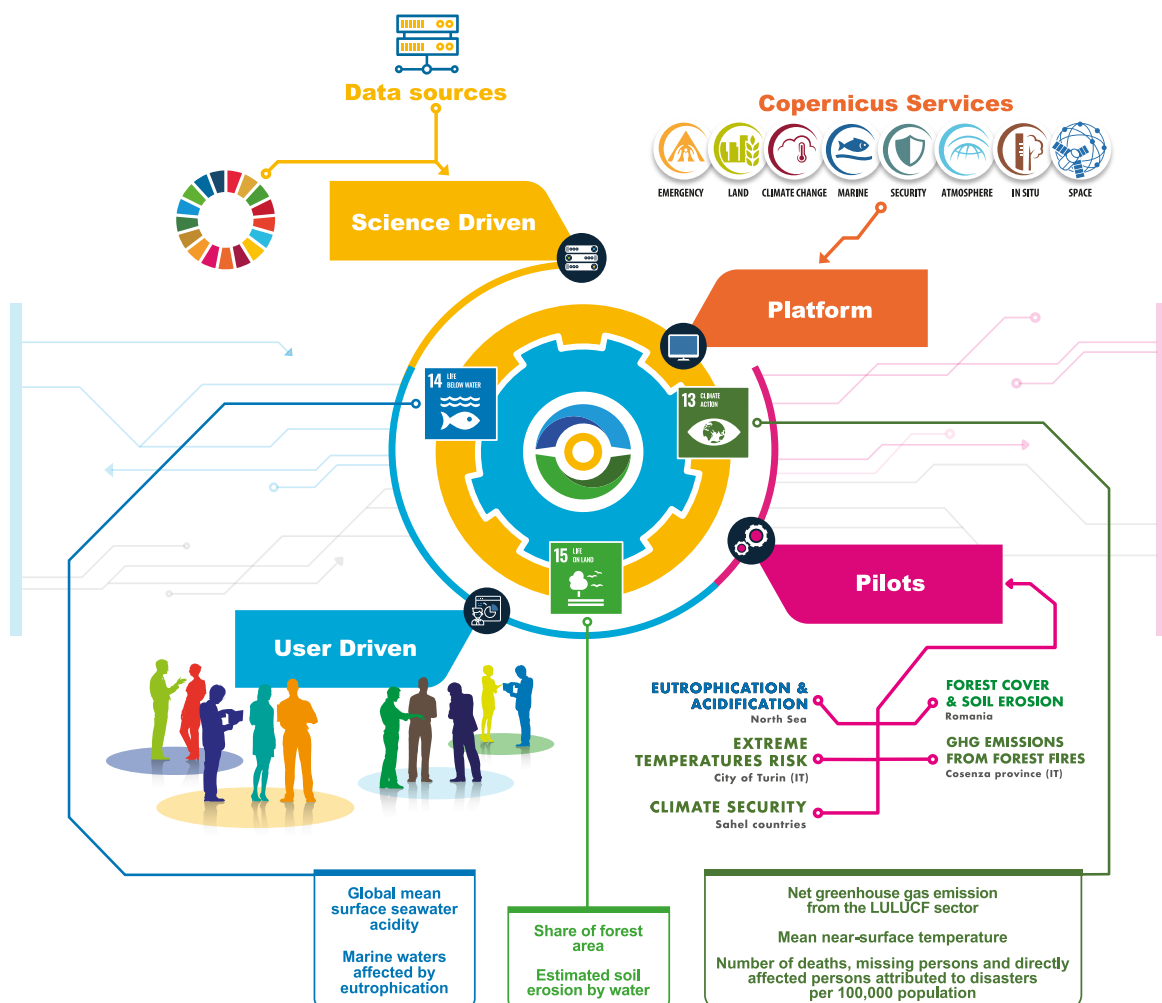
SDGs-EYES develops a scientific and technological framework to build robust and accurate indicators. It aggregates and processes data from Copernicus’s six core services - along with space-based and in situ sources - to make Earth observation information more accessible and actionable.

## Improving the Quality of SDG Indicators

The project demonstrates Copernicus-enhanced measurement for seven indicators across three SDGs goals (SDG 13 - Climate Action, SDG 14 - Life Below Water, SDG 15 - Life on Land). A cross-cutting indicator has been developed to assess the exposure of vulnerable communities to multiple and overlapping climate extremes.

## Building Stakeholder Capacity for Societal Impact

SDGs-EYES delivers service-oriented data products that simplify the tracking and reporting of SDG indicators. These tools have been co-designed with users - including public authorities, researchers, and environmental agencies - to ensure usability and relevance in decision-making contexts.



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## Find Out More

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## SDGs-EYES Partners



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