Factsheet
Earth Observation Thematic Strand

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Purpose

This Factsheet sets out the background and approach used by the Earth Observation Thematic Strand (TS) to develop a common understanding of the possible contribution of Earth Observation in wildfire risk assessment. This TS aspires to demonstrate earth observation features and their implications to the various WG topics for effective WFRM.

We define Earth Observation as the gathering of information about the Earth's surface, atmosphere, oceans, and land masses using a variety of remote sensing techniques and instruments. This can include the use of satellite imagery, aerial photography, and ground-based measurements. The data and information collected through earth observation can be used for a wide range of applications, such as monitoring natural resources, predicting weather and climate patterns, detecting and responding to natural disasters, and studying the effects of human activity on the environment. This information is useful for research and policy makers, enabling a monitoring of the environment and a forecasting of natural hazards.**[1]**

Rationale: Why is Earth Observation important in WFRM?

Earth observation (EO) provides an effective way of exploring the physical, chemical, and biological information related to the Earth **[2]**. EO satellite data is an indispensable tool to provide measurements and support for related environmental, social, political, and economic studies. From forecasting weather to monitoring disasters and the health of ecosystems, communities and citizens, EO data informs, locates and provides context to various sectors from research to policy-making, supporting transition towards sustainable societies **[3]**.

Moving beyond research, EO has the opportunity to contribute to some of the most pressing global societal challenges, such as those identified by the 2030 Agenda for Sustainable Development. Satellite, airborne, and Unmanned Aerial Vehicle (UAV) acquisitions provide data at multiple scales for monitoring the state of natural ecosystems, natural resources, oceans, coasts, land, and built infrastructure as well as their changes over time **[7]**.

More specifically, EO data is also a critical tool of universal applicability for detecting, monitoring, and assessing the damaging impacts of wildfires **[8]**, **[9]** and of post-fire soil erosion and loss potential **[10]**, **[11]**. Both optical and radar satellite remote sensing have proven to provide significant insight in wildfire events. The European Commission has developed the European Forest Fire Information System (EFFIS) to provide a fire risk forecast and a fire danger assessment in EU countries. EFFIS is one of the Copernicus Emergency Services and becomes an essential tool for providing most up-to date information on fire danger in EU, identify the evolution of wildfires and help national authorities to monitor these wildfires **[12]**.

In the past decades, several algorithms utilizing data from Earth observation satellites have been developed to assist wildfire risk management. The figure below depicts how EO services can contribute to the disaster risk management cycle and some examples of potential services in each phase

Firelogue

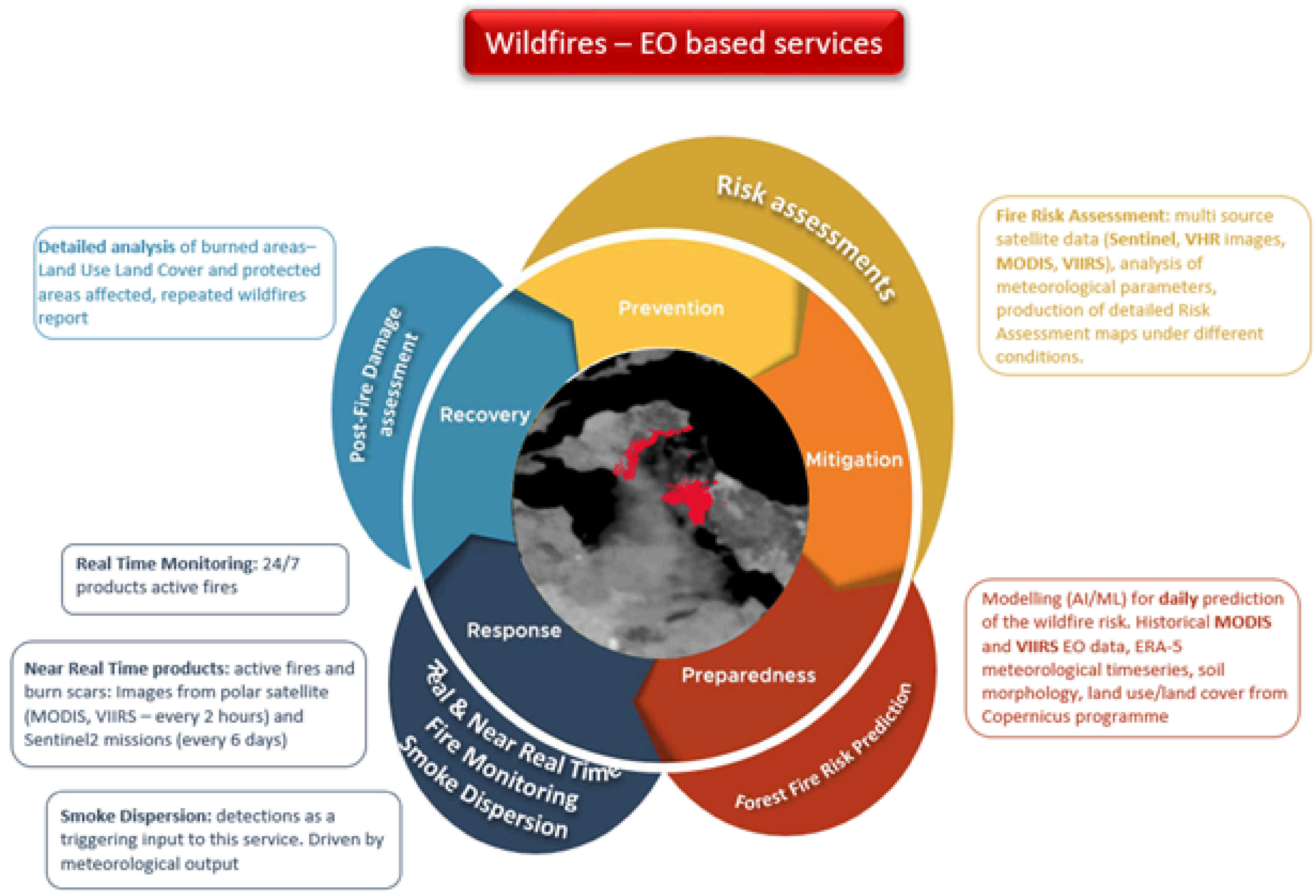

Figure 1: Examples of EO services through the disaster risk management cycle

Much of the focus of disaster wildfire activity is currently on the response phase, during which rapid action can save lives. Satellite EO is a recognized solution for enabling more efficient relief actions and supporting aid actors with objective and up to date information. It is however widely accepted that increased efforts on risk reduction during the mitigation and preparedness phases of a wildfire will save more lives and protect property by reducing the exposure of populations to the hazard.

Earth observation in prevention, mitigation and preparedness

Preparedness efforts offer WFRM managers the best opportunity to save lives and protect property. Mitigation activity covers on-going monitoring of fire hazard and certain elements at risk. Comprehensive monitoring can lead to improved ability to warn before a wildfire strikes. Preparedness also refers to scientific efforts undertaken to better understand the nature of the risks involved. This is the case for example for fire modelling.

Below are some indicative examples of how distinguished EO services that can assist before a fire occurs:

- Enhanced Early Warning Systems: Through short-term predictive fire risk maps by using Machine Learning (ML)-based models and/or fire danger rating systems, accurate next-day fire risk predictions can be produced and communicated to the Fire Services via daily fire risk probability maps.
- Scenario-based fire-spread: The considering ignition points and extreme wind characteristics. This is a process of simulating the spread of a fire under different scenarios, such as different weather patterns, fuel conditions, and topography. Scenario-based fire spread can be used to help predict the potential impact of a wildfire and to develop strategies for mitigating its effects.
- Sub-seasonal and seasonal predictions of fire weather indices: This predicts the likelihood and severity of wildfires. Sub-seasonal predictions cover a period of about two to eight weeks, while seasonal predictions cover a period of several months to a year

Earth observation in Response

Warning and alert activities flow directly from on-going preparedness. When a risk area is monitored on a regular basis, it is usually possible to determine that an event may be imminent, requiring different observation periods and the generation of information specifically tied to the predicted event.

In the immediate aftermath of a wildfire, the primary issue is timeliness. Satellites can provide rapid situational awareness over a large area, typically on a daily basis.

Firelogue

Please find below some illustrative examples of distinguished EO services that can provide assistance during the occurrence of a fire:

- Spatiotemporal fire-spread information: EO can be used to capture high-resolution images of fires from space, which can be used to track the location and size of the fire over time as well as sensors on aircraft, drones, or other platforms can be used to collect data about the fire, such as temperature, smoke density.
- Risk assessment and evacuation plans considering vulnerability, exposure and critical infrastructure: It is important to have evacuation plans in place before a wildfire occurs, practice them regularly so that everyone knows what to do and use them appropriately in the event of an emergency.
- 24/7 active fire detection service for effectively monitoring forest fires in near-real time: These services can also be connected to a central monitoring system that can send out alerts and initiate response procedures in the event of a fire.

Investing in the response phase is key. In Europe, the European Commission has established Emergency Management Services to address the integration of satellite data for emergencies and is currently collaborating with the International Charter to provide Value Adding services to support the exploitation of imagery supplied via the Charter to European organisations for response in areas pertinent to the policy sectors of Europe, primarily in its territories and in regions where humanitarian assistance is invoked.

Earth observation in Response

The recovery phase of wildfire management refers to the efforts taken to restore and rebuild impacted communities and ecosystems after a wildfire has occurred. The recovery phase of wildfire management is a complex and multifaceted process that requires the coordination of multiple stakeholders and the allocation of resources to address the various impacts of the wildfire. Satellite EO can offer cost savings in monitoring of large areas or especially complex disasters where large number of organisations are present in the field and where recovery operations remain in place for several years.

Examples of EO services in the recovery phase of WFRM can be:

- Fast-track hazard assessment maps for cascading events such as soil erosion, floods and landslides: This includes information on the location and intensity of hazards, as well as the potential impacts on people, infrastructure, and the environment. Fast-track hazard assessment maps can be used by emergency responders, government agencies, and other stakeholders to identify the most critical areas and resources to protect in the event of a cascading event.
- Identification of critical points: Providing emergency assistance to those who have been mostly affected as well as rehabilitating heavily impacted ecosystems.
- Proposal of short-term mitigation measures: This includes implementing fire-safe land management practices, such as cleaning up dry leaves and debris, mowing grass, and maintaining a buffer zone around structures; as well as long-term measures, e.g. implementing land use planning policies that consider wildfire risk.

Conclusion & suggested points for discussion in WG exchange

Considering the several ways that Earth Observation can be used to relate with wildfires, all Working Groups should take into consideration the important contribution of EO. This information can be used to improve wildfire management and planning, and to reduce the negative impacts of these fires on people and ecosystems. Due to the increasing future wildfire risk, wildfire community will have to embrace Earth Observation through the disaster risk management cycle: Prevention, Mitigation and Preparedness; Response and Recovery, adopting effective strategies to mitigate risk.

Firelogue

Key references and sources for further information

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Table 1: Earth Observation discussion topics proposed for WG exchange

	Topic 1 (Prevention and preparedness)	Topic 2 (Response)	Topic 3 (Recovery)	Other comments
Environmental & Ecology WG	Policy-making: By employing EO methodologies to examine previous occurrences, understand wildfires' causes and consequences on environment and inform strategies for mitigating their negative impacts. Integration of EO imageries, machine learning, and geospatial analysis to identify areas prone to wildfire occurrence to improve the accuracy of models. EO technology for continuous updating of land cover and canopy fuel data for relevant fire management.	Monitoring: Cost-efficient manner to monitor real time and near-real time wildfires' location, extend, intensity, behaviour and impacts on the environment.	Recovery: Monitor the regrowth of vegetation and the return of wildlife EO data can be used to track the recovery of vegetation and ecosystems after a wildfire. This information is essential for determining the long-term impact on the environment and assessing the potential for future wildfires in the area.	Example of EO: Usage of on-board sensors on drones, such as synthetic aperture radar and hyperspectral imagery, for soil moisture calculations and improving simulation models for forest fire prediction. UAVs offer detailed mapping of affected areas, helping assess ecological impact, enable timely decision-making to protect ecosystems, wildlife habitats, and biodiversity, support post-fire assessments, facilitating environmental recovery efforts and informed land management decisions (TREEADS, SILVANUS)
Societal WG	Policy-making: Inform the development of policies and programs aimed at mitigating the impact of wildfires on society, by comprehending the underlying factors and repercussions of wildfires. Integration of EO imageries, machine learning, and geospatial analysis to identify areas prone to wildfire occurrence to improve the accuracy of models.	Societal awareness: In case of emergency, provide EO outputs and information through social media, news, and other channels. Assist in issuing timely warnings and coordinating firefighting efforts through understanding fire behaviour and predicting its spread.	Impact assessment and Community support: Identify post-wildfire threats to human life and safety, property, and critical resources as well as provide delineation of priority zones for restoration purposes.	**UAVs** contribute to wildfire risk management for society and citizens by enabling early detection, providing real-time monitoring, enhancing communication, assessing fire behavior, mapping affected areas, supporting evacuation efforts, improving overall situational awareness, helping to ensure the safety of communities during wildfires and facilitating timely and targeted responses to protect lives and property. (TREEADS, SILVANUS)

Infrastructure WG	Planning; design and impact assessment: 1) detailed maps of high-risk areas to identify suitable locations for infrastructure projects; 2) assess the potential environmental impacts of infrastructure projects, including the effects on WFRM.	Maintenance and monitoring: Monitor the extent and behaviour of wildfire for better planning and resource allocation to mitigate potential damage and ensure the safety of CI. Monitor affected infrastructure and identify any potential issues in order to plan immediate repairs and reconstruction efforts, as well as to identify vulnerabilities in the infrastructure network.	Disaster management: In the event of a wildfire, assess the location and extent of the wildfire, the damage to infrastructure and plan for recovery and reconstruction efforts.	Usage of **LiDAR** for characterizing power lines and monitoring surrounding vegetation, as well as the use of satellite-based remote sensing for estimating vegetation height and classifying burnt areas (TREEADS). **UAVs** provide rapid aerial surveillance, early detection capabilities, real-time monitoring of fire behavior, and detailed mapping of affected areas. Enhance situational awareness, aid in resource allocation, support communication relay in remote locations (CI can be), assess post-fire damage and assist in the targeted deployment of firefighting resources to protect CI. (TREEADS, SILVANUS)
Insurance WG	Insurance products and pricing: EO to inform for high-risk areas to charge higher premiums for coverage or to develop insurance products specifically tailored to cover wildfire risk.	Quick estimate of what is burnt: Assist the parametric insurance: if a certain parameter threshold is reached in a specific location	Damage assessment: used by insurance companies helping to determine the extent of coverage that is required and to speed up the claims process and the processing of compensation for affected communities.	**UAVs** contribute to wildfire risk management for insurance by providing timely and detailed aerial assessments, offering high-resolution imagery for claims processing, aiding in accurate damage assessment, assisting in risk modeling and data collection, allowing insurance companies to better understand and mitigate wildfire-related risks. This technology improves overall efficiency in claims settlement and helps insurance companies make informed decisions regarding coverage and premiums. (TREEADS, SILVANUS)

Civil Protection WG	Risk assessment: Assess the risk of wildfires in a given area and prepare for an imminent disaster. By monitoring large areas from space, these technologies contribute to the timely identification of wildfire outbreaks. Use of EO for mapping fuel types to model fire behavior at regional to national scales to provide valuable information for civil protection related to wildfires, especially in areas where on-ground data collection may be limited or restricted. Updated vegetation maps derived from EO data contribute to understanding the distribution of flammable vegetation, which is essential for assessing wildfire risk and planning preventive measures.	Monitoring: assist the rapid response, deployment of resources and the evacuation of people and livestock, through modelling and simulating the monitoring the spread of a wildfire in real-time.	Damage assessment: assisting authorities to prioritize their response efforts and to identify areas that may require additional support. Enable the assessment of the extent of wildfire damage, aiding civil protection agencies in evaluating the impact on the environment, infrastructure, and communities.	**UAVs** provide early detection, rapid response, real-time monitoring capabilities, aid in assessing fire behavior, mapping affected areas, and improving situational awareness, support communication relay, identify hazardous materials, assist in post-fire assessments, and enable efficient coordination and resource management for enhanced civil protection during wildfires. (TREEADS, SILVANUS)