Report on system demonstration, feedback workshops and training activities

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Authors: **José BORGES, João AFONSO, Tiago LOPES**
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Author(s)	José Borges (CINAMIL), João Afonso (CIGeoE/CINAMIL), Tiago Lopes (RAME/CINAMIL)
Co-Author(s)	Nelson Santos (CIGeoE/CINAMIL), Sandra Amaro (RAME/CINAMIL), Vanessa Ferreira (CIGeoE/CINAMIL), Daniela Fraga (CINAMIL and ANEPC), Hélio Fernandes (CINAMIL), Anna Nałęcz Kobierzycka (CBK PAN), Emil Wrzosek (CBK PAN), Joanna Ślusarska (CBK PAN), André Carvalho (ISQ), Joana Marta (ISQ), Massimo Facchinetti (ALPHA)
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Deliverable abstract	This deliverable reports on the planning, implementation, and results of the pilots, feedback workshops, and training activities conducted within the OVERWATCH project. It presents the technical validation of developed solutions in realistic operational environments, assesses user engagement and feedback, and evaluates training effectiveness, while consolidating lessons learned and implications for operational readiness, scalability, and sustainability. The Forest Fires Pilot validated integrated technologies for wildfire prevention, detection, and response, demonstrating improvements in situational awareness, coordination, and information sharing despite weather-related constraints. The Floods Pilot assessed integrated solutions for flood preparedness, monitoring, and response, highlighting enhanced decision-making, inter-agency coordination, and system reliability in complex scenarios. Overall findings

	confirm the operational relevance of integrated situational awareness, decision-support, and resilient communications, supported by AI-enabled analytics and Earth observation data. The report recommends further system integration, sustained end-user engagement, enhanced communication resilience, and alignment with national and European frameworks to maximise long-term impact and adoption.
Keywords	OVERWATCH Project System Demonstrations Forest Fires Pilot Floods Pilot Situational Awareness Resilient Communications Civil Protection Operations

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List of authors, contributors and reviewers

No.	Name	Role	Organisation
1	José Borges, João Afonso, Tiago Lopes	Editors and authors	CINAMIL
2	Nelson Santos, Sandra Amaro, Vanessa Ferreira, Daniela Fraga, Hélio Fernandes	Authors	CINAMIL
3	Anna Nałęcz Kobierzycka, Emil Wrzosek, Joanna Ślusarska	Authors	CBK
4	André Carvalho, Joana Marta	Authors	ISQ
5	Massimo Facchinetti	Authors	ALPHA
6	Vanina Fissore	Reviewer	ITHACA

Abbreviations

CH	Chapter
D	Deliverable
WP	Work Package
AIMS	AI-based Backend Management System
BRIGMEC	Brigada Mecanizada (Mechanised Brigade) from the Portuguese Army
AI	Artificial Intelligence
AR	Augmented Reality
ANEPC	Autoridade Nacional de Emergência e Proteção Civil
CMSM	Campo Militar de Santa Margarida
CIGeoE	Centro de Informação Geoespacial do Exército
CINAMIL	Centro de Investigação, Desenvolvimento e Inovação da Academia Militar
C2	Command & Control
DM	Decision-Making
DR	Drones / Drone-based data
EO	Earth Observation
ECS	Emergency Communication System
EMS	Copernicus Emergency Management Service
EGNSS	European Global Navigation Satellite System
XR	Extended Reality
FC	Fallback Communication
FCS	Fallback Communication System
FEPC	Força Especial de Proteção Civil
GIS	Geographic Information System
RCB	Government Centre for Security (Poland)
HEMS	Helicopter Emergency Medical Services
HAS	High Accuracy Service
LIDAR	Light Detection and Ranging
MC	Ministry of Digital Affairs
MSWiA	Ministry of the Interior and Administration
NCBiR	National Centre for Research and Development
OSNMA	Open Service Navigation Message Authentication
OC	Operational Capacity
ORDOP	Ordem de Operações (Operations Order)
PSP	Polish State Fire Service
KW PSP	Provincial State Fire Service Headquarters
RGB	Red, Green, Blue imaging
RAME	Regimento de Apoio Militar de Emergência
RZGW	Regional Water Management Boards
SAR	Search and Rescue
SIRESP	Sistema Integrado de Redes de Emergência e Segurança de Portugal
SA	Situational Awareness
CBK PAN	Space Research Centre of the Polish Academy of Sciences

UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
UC	Use Case
VTOL	Vertical Take-Off and Landing

Executive Summary

This Deliverable documents the planning, execution, and outcomes of the Pilots, feedback workshops, and training activities conducted within the OVERWATCH project. Its purpose is to provide a structured account of the technical validation of the developed solutions in realistic operational environments, assess stakeholder engagement and user feedback, and evaluate the effectiveness of the associated training actions. The report consolidates lessons learned, identifies strengths and limitations observed during demonstrations, and analyses the implications for operational readiness, scalability, and sustainability. In doing so, it supports informed decision-making for further system refinement and future deployment.

The Forest Fires Pilot aimed to validate integrated technologies and operational concepts for enhanced prevention, detection, and response to large-scale wildfires. It brought together end users, civil protection authorities, and technical partners to test advanced capabilities, such as Earth observation, aerial and ground sensing, resilient communications, and decision-support tools, in realistic scenarios. The Pilot focused on improving situational awareness, coordination, and information sharing across agencies during all phases of forest fire management. Although affected by the conjunctural weather conditions, the Pilot assessed operational effectiveness, usability, and readiness through live demonstrations, training activities, and structured feedback sessions, contributing to more robust, interoperable, and scalable wildfire response solutions.

The Floods Pilot was designed to demonstrate and assess integrated technological and operational solutions for improved preparedness, monitoring, and response to flood events. It evaluated the use of Earth observation data, hydrological and meteorological information, situational awareness tools, and resilient communication systems to support timely decision-making by civil protection authorities. The Pilot involved end users and stakeholders in a joint session that combined system demonstrations, training activities, and feedback workshops. Its objective was to enhance coordination, information sharing, and operational effectiveness across agencies, while validating the reliability, usability, and scalability of the solutions in complex flood management contexts.

The project demonstrations and pilots confirmed the operational relevance of integrated situational awareness, decision-support, and resilient communication capabilities in complex emergency scenarios. Key findings highlight improved interoperability among systems, enhanced information sharing across agencies, and increased user confidence following targeted training and feedback cycles. The validation of AI-supported analytics, Earth observation data, and communication architectures demonstrated measurable benefits for coordination and responsiveness. Strategically, these outcomes strengthen Project OVERWATCH's value proposition by evidencing its contribution to operational readiness, scalability, and cross-domain applicability. The results provide a solid foundation for further optimisation, wider adoption, and long-term impact in civil protection and crisis management operations.

It is recommended to consolidate the integration of technological components further to ensure seamless interoperability and data exchange across systems and agencies. Continued engagement with end-users should be prioritised to refine usability, align functionalities with operational needs, and strengthen training methodologies, as demonstrated in the interactions with Portuguese and Polish practitioners. Emphasis should be placed on enhancing communication resilience and redundancy to support operations in degraded environments. Future activities should also focus on scalability, standardisation, and alignment with the Member States and European frameworks to facilitate wider adoption. Finally, systematic incorporation of lessons learned from demonstrations and pilots is advised to guide iterative improvement, support long-term sustainability, and maximise the operational and strategic impact of the solutions.

1. Introduction

1.2 Context of Project Overwatch

The OVERWATCH project is being developed within the European emergency-management landscape, which is increasingly affected by climate change, extreme weather events, and complex, multi-agency crisis operations. Europe faces rising wildfire and flood frequencies, growing data fragmentation, and heightened pressure on responders who must make rapid decisions based on incomplete or dispersed information.

The OVERWATCH project was mandated to address these systemic challenges by creating a more intuitive, decentralised, and technologically enhanced crisis-management environment capable of supporting responders throughout all phases of disaster operations, from preparedness to response and recovery.

Within this broad context, the project's specific objectives focus on developing an integrated holographic crisis-management system that merges multiple technological domains into a single operational ecosystem. These include Earth Observation, drone-based data collection, Artificial Intelligence (AI) driven analytics, augmented-reality visualisation, and resilient fallback communication networks. The system aims to deliver real-time situational awareness, improved decision-making, and enhanced command-and-control workflows by fusing data from satellites, drones, sensors, and existing emergency platforms, and seeks to provide emergency responders with accurate, timely, and actionable information, improve interoperability among agencies, and reduce risks to both populations and response personnel.

The project's goal is a safer, more resilient, and knowledge-driven European emergency-response capability.

1.3 Purpose of the Pilots

The purpose of the OVERWATCH Pilots is twofold: they serve both a strategic, broad purpose within the project's overall goals of advertising and engaging the end-user community, and a set of specific, operational purposes directly linked to the technologies being developed. Together, these dimensions ensure that the Pilots function not merely as demonstrations, but as full-scale validation environments where concepts, tools, and procedures are tested under realistic conditions.

Broadly, the Pilots were designed to validate the entire OVERWATCH technological ecosystem in real operational contexts, reflecting the complexity of modern European civil-protection scenarios. The project seeks to integrate Earth Observation, drones, AI-driven analytics, augmented reality, and fallback communications into a common operational picture that supports emergency responders throughout the disaster-management cycle.

The Pilots, Portugal for wildfires and Poland for floods, therefore provide the setting in which these components can be stress-tested in scenarios that mirror real hazards, characterised by dispersed data, decision-making under pressure, and multi-agency coordination challenges. More specifically, each Pilot aims to evaluate the operational usefulness, interoperability, and resilience of OVERWATCH components when used by actual first responders, commanders, and civil-protection authorities. This includes assessing how well the technologies: collect multi-source data (satellite, drones, field sensors), process that data through AI for pattern detection, hotspot identification, and real-time alerts, display the resulting intelligence through dashboards and AR interfaces, share information across hierarchical command levels and agencies.

Beyond technology validation, the Pilots also aim to capture responder feedback on usability, training needs, and procedural integration, ensuring that systems adapt to field realities rather than forcing responders to adapt to technology. They provide a platform to identify gaps in communication resilience, interoperability, and situational-awareness workflows, thereby guiding further development toward a fully operational, responder-centred crisis-management solution for Europe.

2. Methodology

The methodology guiding the forest-fire and flood Pilots within OVERWATCH is rooted in a human-centred, end-user-driven development framework, ensuring that all technological components are designed, validated, and demonstrated under conditions that realistically reflect operational crisis-management environments. The Pilots serve as the primary mechanism for evaluating all project components and their integration, combining Earth Observation (EO), EGNSS-based positioning, drone mapping, AI analytics, augmented-reality visualisation, and resilient communication networks, under both wildfire and flood scenarios.

The Pilots are grounded in an extensive co-design process conducted at the start of the project. An Advisory Group, composed of civil protection managers, first responders, geospatial experts, and crisis-management practitioners, guided the identification of user needs, operational constraints, and mission-critical workflows. Through surveys, workshops, and iterative feedback loops, the consortium defined the functional and technical specifications that shaped the pilot design. This ensured the system architecture reflected the realities of fire-suppression operations (Portugal) and flood-response contexts (Poland).

The Pilots rely on four core technological modules, developed and integrated specifically to support high-fidelity situational awareness and operational coordination during crisis events: multi-source terrain mapping; enhanced positioning and authentication; resilient fallback communications; backend management and AR interface.

For the multi-source terrain mapping, each Pilot deploys a three-layer mapping strategy, starting with digital cartography, followed by Copernicus EMS rapid-mapping outputs, and concluding with high-resolution drone acquisitions (RGB and thermal imaging sensors). Machine-learning and deep-learning algorithms, specifically trained for burn scars, flood extent, and damage delineation, process EO and drone imagery to generate accurate, timely hazard maps. Lightweight edge-computing models on VTOL drones support real-time processing.

In the enhanced positioning and authentication, drones and field assets incorporate Galileo HAS for centimetric accuracy and OSNMA functionalities for signal authentication, reducing spoofing risks during high-pressure operations.

The resilient fallback communications employ a tethered-drone communications relay, providing a temporary local network supported by a satellite backhaul. This ensures continuity of operations even when terrestrial networks are degraded or destroyed. The airborne node supplies Wi-Fi coverage to field teams and drones.

The central backend management and AR interface integrates geodata processing, AI analytics, decision-support tools, and service orchestration. Output layers are exported to the AR holographic interface, enabling immersive 3D visualisation of terrain, assets, and hazard evolution via XR glasses.

The methodology culminates in two full-scale pilot demonstrations:

- Forest-fire pilot (Portugal) led by CINAMIL, the Emergency Military Support Regiment and the Army Geospatial Information Centre, ideally during an active wildfire event or, if not feasible, via a realistic simulated burn scenario.
- Flood pilot (Poland) led by CBK PAN and the State Fire Service, focusing on real and simulated flood dynamics.

3. Pilot Forest Fires

3.1 Overview

The Wildfires Pilot of the OVERWATCH project took place in Portugal, between 27 and 31 October 2025, constituting the project's first full-scale operational demonstration centred on a forest-fire response scenario. The exercise was geographically distributed across three primary military and geospatial facilities:

- The Centro de Informação Geoespacial do Exército (CIGeoE) in Lisbon, where the Pilot opened with partner reception, technical presentations, and initial coordination sessions.
- The Regimento de Apoio Militar de Emergência (RAME) in Abrantes, where operational briefings, technical work, logistics, and coordination activities were conducted.
- The Campo Militar de Santa Margarida (CMSM) is a restricted-access military base that served as the main field site for scenario execution, drone deployments, communications testing, and demonstrations of AR-supported decision-making.

The Pilot integrated C2-type preparation, field observation, and live operational trials across these locations. Abrantes acted as the central hub for participant accommodation and daily coordination.

3.1.1 Location, timeframe, partners involved

The exercise involved a broad consortium of OVERWATCH partners originating from Portugal, Germany, Italy, Denmark, and Poland, consistent with the project's multinational composition. Portuguese institutional participation was particularly strong. The Exército Português coordinated national implementation through its research and operational units: CINAMIL, CIGeoE, RAME, and CMSM. These entities played central roles in hosting activities, providing operational support, and leading scenario design and execution.

The Pilot also included the active participation of diverse Portuguese civil-protection organisations: the Autoridade Nacional de Emergência e Proteção Civil (ANEPC), the Força Especial de Proteção Civil (FEPC), the Sistema Integrado de Redes de Emergência e Segurança de Portugal (SIRESP), and multiple regional fire brigades contributed operational expertise and personnel to validate decision-support tools, mapping workflows, and communication procedures.

International partners from ITHACA, ALPHA, ENG, HOLO, INESCTEC, LINKS, CBK PAN, and ISQ were represented onsite, ensuring multidisciplinary assessment of EO/EGNSS integration, AR visualisation, UAV operations, and backend analytics. The event thus functioned as a comprehensive, multinational testbed for the OVERWATCH integrated crisis-management system.

The planning process for the OVERWATCH Wildfire Pilot was conducted through a highly structured, multi-agency coordination framework designed to replicate the decision-making, logistical organisation, and operational readiness required in a real large-scale incident. From its outset, the Pilot followed a phased, methodical approach that ensured the alignment of all participating entities, the availability of necessary resources, and the establishment of conditions suitable for a realistic and safe demonstration environment.

The process began with early coordination meetings involving the principal organisations responsible for hosting, supporting, and evaluating the exercise. Initial preparatory meetings started in early June, held at the facilities of BRIGMEC in Santa Margarida, established operational needs, rehearsal areas, and safety requirements, while confirming the suitability of the chosen location due to its available fuel models, controlled-burn history, and support infrastructure provided approximately 13 hectares appropriate for controlled burning, suppression manoeuvres, and reconnaissance procedures.

Planning and preparation continued through a jointly managed process involving ANEPC, FEPC, BRIGMEC, CINAMIL, CIGeoE and RAME, each organisation reviewing requirements for scenario construction, personnel readiness, communication systems, and field logistics in monthly meetings until October. These elements were captured in the official planning timeline, which defined a Planning Phase (up to the 28th of October), a Preparation Phase (the 28th of October), an Execution Phase (the 29th of October), and a Post-Execution Phase (the 30th of October). In these stages, the exercise tasks included installing support structures, validating terrain, and delivering a full briefing on the scenario and the expected sequence of actions.

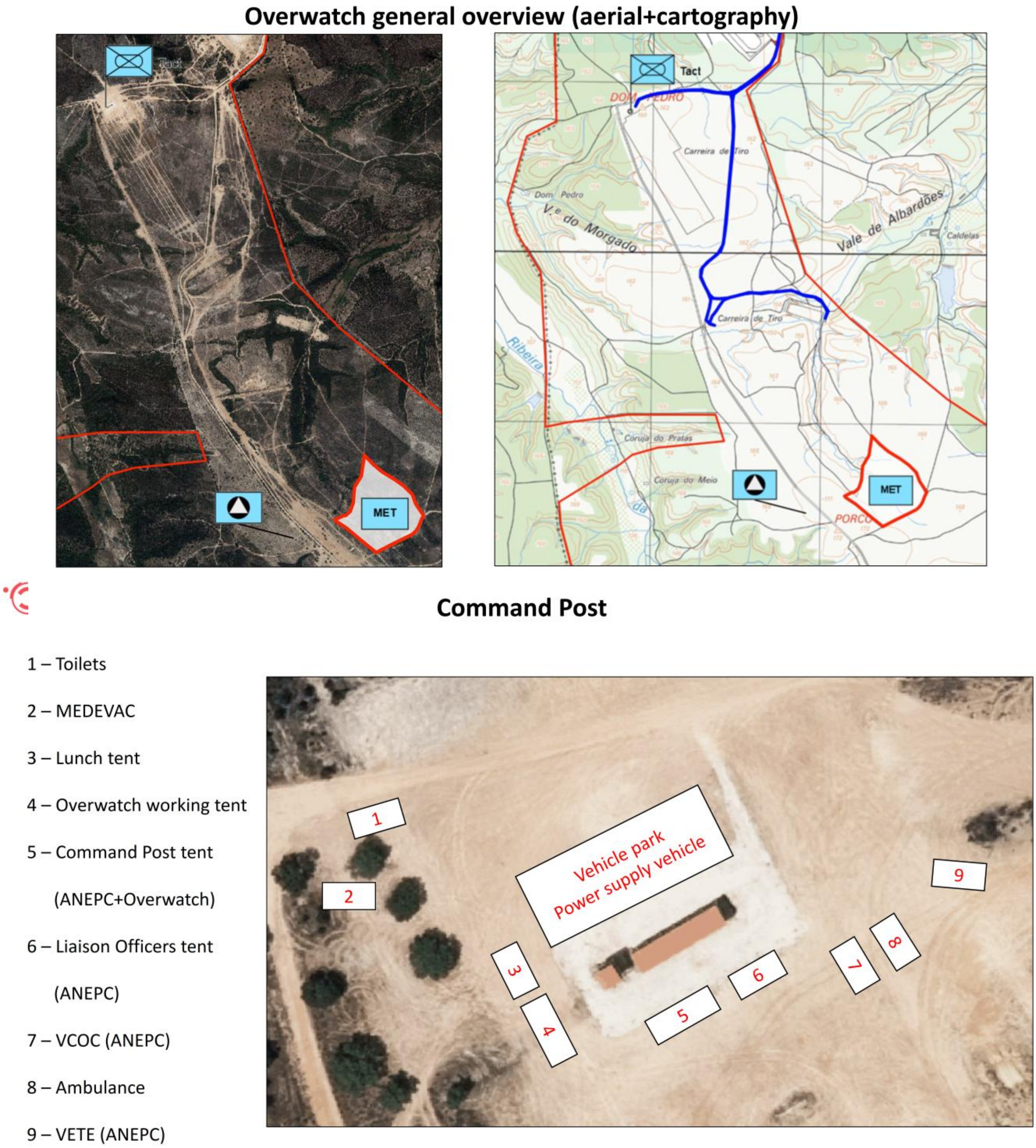

Figure 1: Planned implementation in Campo Militar de Santa Margarida

To ensure coherence among the numerous operational teams involved, a detailed order of operations (ORDOP) was issued by the Sub-Regional Emergency and Civil Protection Command of Médio Tejo (Figure 2). The document specified the exercise's objectives, the responsibilities of each entity, the coordination rules, and the communication and safety procedures. It indicated that the Pilot would simulate a real incident environment, with all participating organisations expected to act within their standard operational responsibilities and communication protocols.

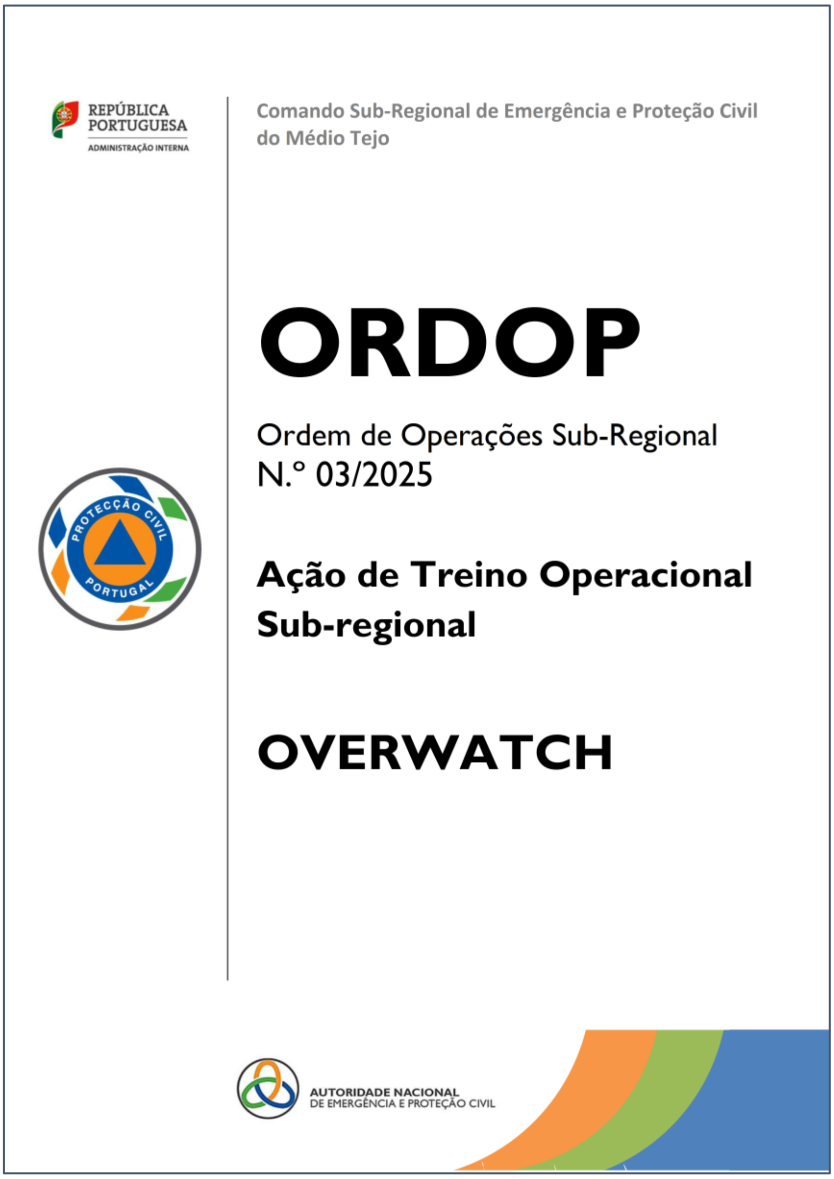

Figure 2: Operational Order for the OVERWATCH pilot

The exercise design incorporated scenario realism while preserving safety and control. FEPC's specialised fire-analysis personnel conducted reconnaissance of the selected parcels to verify vegetation density, topography, access routes, and potential hazards, including the need to manage areas where unexploded training munitions may be present. These assessments informed the final risk-mitigation measures and the establishment of safety perimeters.

Planning also required synchronising diverse technical systems, including the deployment of communication modules, sensor mapping, and decision-support tools central to the OVERWATCH platform. The structured agenda spanning 27th – 31st of October 2025 outlined sequential technical work sessions, site visits, scenario presentations, and testing periods. This ensured that all partners, both national and international, were fully integrated into the Pilot's operational rhythm, allowing the demonstration to unfold with both realism and precision.

3.1.2 Operational goals

The operational goals of the Wildfire Pilot were designed to validate the OVERWATCH system under realistic conditions while enhancing the collective readiness of all participating entities. Central to these goals was the deployment of a resilient emergency communications network, ensuring that critical information could continue to flow even when local communication infrastructure was compromised. This included testing the installation and activation of an emergency communication module following a simulated failure of the existing network.

Another major goal was to support situational assessment and reconnaissance teams, providing them with enhanced mapping, real-time imagery, and decision-support tools. This included the work of ERAS teams, which conducted rapid field assessments supported by aerial data collected from sensors and platforms integrated into the OVERWATCH architecture.

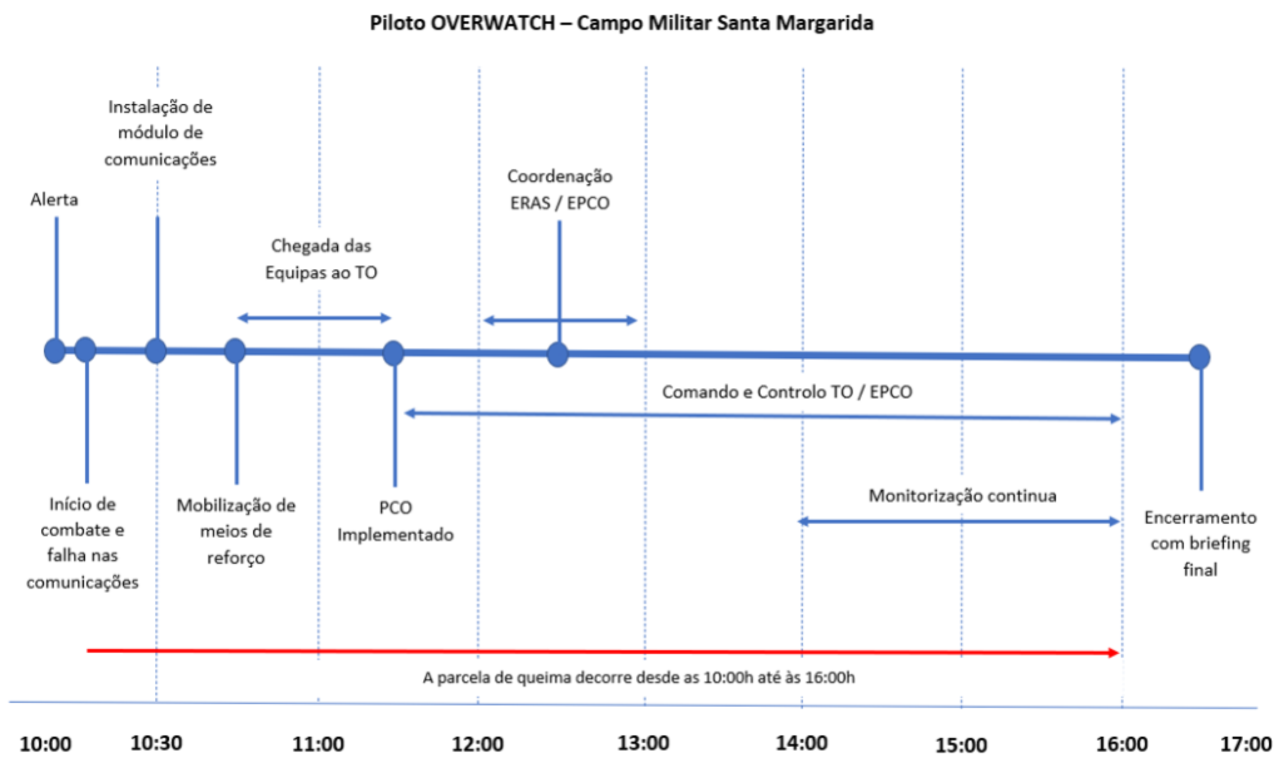

Figure 3: Pilot timeline for the 28th of October

The Pilot also aimed to strengthen the management of wildfire response operations, enabling coordinated actions between suppression teams, command-post staff, and technical specialists. Activities such as controlled fires, suppression manoeuvres, *rescaldo* (mop-up), and continuous fire-progress monitoring were conducted to refine decision-making processes and evaluate system performance in a dynamic environment.

The Pilot sought to validate interoperability, improve operational efficiency, and demonstrate the practical value of advanced technologies in supporting complex wildfire-response scenarios.

3.1.3 Specific challenges addressed

The Wildfire Pilot addressed a set of operational challenges commonly encountered in large-scale rural fire events, focusing on improving early detection, predictive capacity, and coordinated suppression efforts across diverse response teams.

The challenges for the wildfires pilot were identified earlier, in Deliverable 1.1 [RD01] as the OVERWATCH Use Cases (UC), Figure 4, as:

UC 1.2.3.WF.1 – Deploy a Resilient Emergency Communication Network

This use case addresses communication failures in rugged terrain by deploying a tethered-drone fallback communications system. The system provides a high-altitude Wi-Fi/5G hotspot with satellite backhaul, ensuring data and voice connectivity during network outages. The goal is to restore C2 coordination capability and support data-intensive workflows (maps, imagery, sensor streams).

UC 1.2.3.WF.2 – Support Situation Assessment and Reconnaissance Teams

This use case enables reconnaissance teams to rapidly characterise fire behaviour, terrain, population exposure, and resource availability. Drone swarms, EO data, and the AI-based AIMS fuse real-time imagery, environmental indicators, and GIS layers to produce actionable intelligence for C2 and tactical units.

UC 1.2.3.WF.3 – Manage the Response to a Forest Fire

The highest-level wildfire use case integrates all technologies. AIMS supports dynamic resource allocation, hazard evolution modelling, and decision support. AR holographic environments allow commanders to visualise 3D fire progression, plan manoeuvres, and coordinate ground/air assets. Fallback comms ensure resilience.

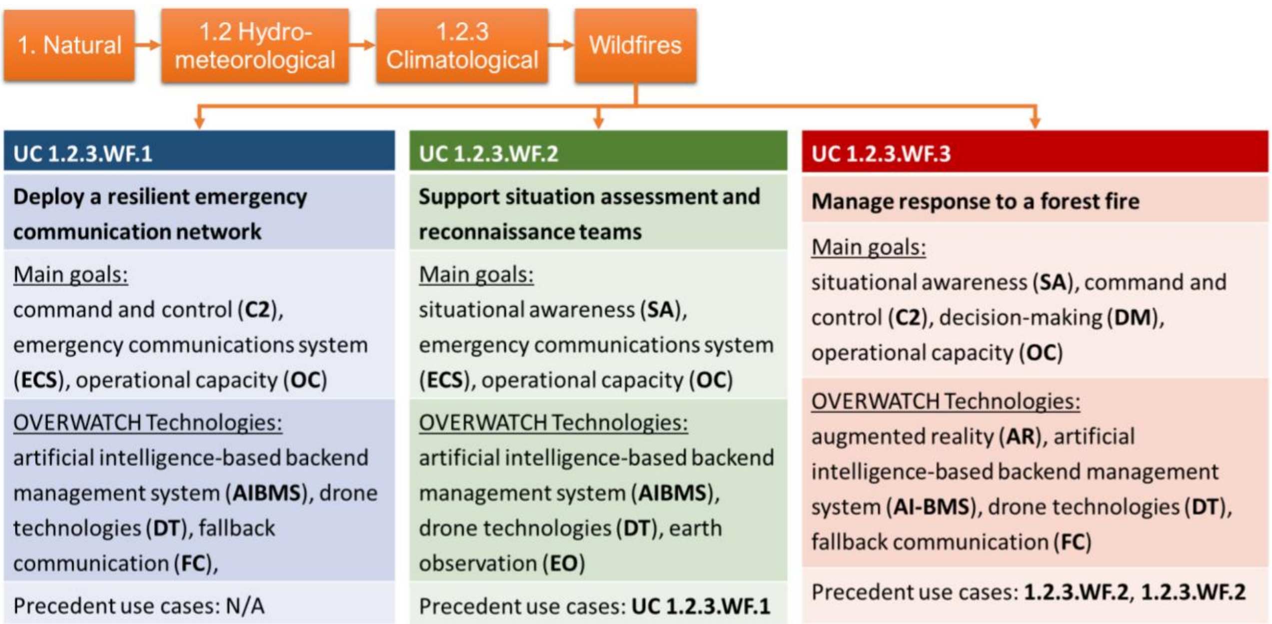

Figure 4: OVERWATCH Use Cases

These UC resulted in the specific critical challenges addressed in the planning of the wildfires pilot and aimed to enhance Situational Awareness (SA), improve Decision-Making (DM), strengthen Command & Control (C2), improve Emergency Communications (ECS), boost Operational Capacity (OC) and support Search and Rescue (SAR). These challenges aimed to shape a comprehensive testing environment that strengthened the project's ability to enhance early detection, predictive capability, and suppression coordination in real-world wildfire scenarios.

A first critical challenge was the need for timely detection and situational awareness in the early stages of a fast-evolving fire. The Pilot simulated the outbreak of a high-intensity rural fire within the designated area, requiring reconnaissance teams to rapidly validate alerts and assess the initial spread. To address this, the exercise integrated aerial information gathering through real-time imagery and sensor feeds, supporting Equipas de Reconhecimento e Avaliação da Situação (ERAS) in providing rapid confirmation of events and immediate updates to the command post. This improved the clarity and speed of early decision-making, particularly under conditions where traditional observational methods are too slow or obstructed.

A second challenge is predicting fire behaviour, particularly in varied terrain and heterogeneous vegetation. Prior reconnaissance identified areas with distinct fuel loads, including dense herbaceous and shrub vegetation, and highlighted specific risks, such as undetonated military training munitions that required additional safety precautions. These conditions complicated fire-spread forecasting. The Pilot, therefore, leveraged structured scenario planning and continuous field observations to support predictive assessments of fire propagation, enabling teams to rehearse how evolving environmental factors should influence operational priorities.

A third core challenge was coordinated suppression in a degraded communications environment. The scenario included a deliberate failure of local communication systems, which hindered coordination between field units and the command post. To mitigate this, the Pilot tested the deployment of a dedicated emergency communications module designed to restore critical information flows and maintain operational coherence. This ensured that suppression teams, including firefighting groups, controlled-burn specialists, and support units, could synchronise manoeuvres, execute rescaldo operations, and manage sector-by-sector response actions.

3.2 Technologies and Tools Assessed

The wildfire pilot of the OVERWATCH project brought together a tightly integrated suite of technologies designed to strengthen situational awareness, decision-making, and operational coordination in extreme wildfire conditions. At the core of the system were EO capabilities to provide baseline terrain knowledge, fuel-load insights, and hazard-mapping inputs by fusing satellite imagery, GIS layers, and aerial observations. These EO products informed drone deployment, extending situational awareness through real-time sensing. Equipped with high-resolution optical, thermal, multispectral, and LIDAR payloads, the drones supplied detailed imagery and environmental data, enabling teams to monitor fire behaviour, identify critical hotspots, and map the terrain.

The effectiveness of these sensing technologies depended on robust connectivity, addressed by the Fallback Communication System (FCS). Built around a tethered drone that carried Wi-Fi/5G antennas and satellite backhaul, the FCS restored communication in blackout areas, ensuring the uninterrupted flow of high-bandwidth data between field teams, drones, and command structures. This communication backbone enabled the continuous operation of the AI-based Backend Management System (AIMS), the platform's analytical engine. AIMS ingested data from EO, drones, Copernicus EMS, and other sensors, producing fused intelligence layers, 3D models, risk assessments, and operational recommendations to support tactical and command-level decisions.

These processed outputs were then visualised through Augmented Reality (AR), giving commanders an immersive operational picture in a dynamic 3D environment. AR-enabled intuitive exploration of fire perimeters, terrain models, and resource locations, significantly enhancing command and control effectiveness. Interdependence among these components was essential: EO and drones supplied sensing; FCS ensured connectivity; AIMS transformed data into actionable intelligence; and AR presented it in an operationally meaningful form. Together, they formed a coherent, resilient ecosystem capable of supporting real-time wildfire response under the most challenging operational conditions.

3.3 Pilot Execution

The OVERWATCH wildfire pilot in Portugal was conceived as a full-scale, live field demonstration integrating Earth Observation, drones, fallback communications, AI-powered decision-support and augmented reality into a unified operational ecosystem. However, despite careful planning and close coordination with national emergency forces, the Pilot was severely affected by the stormy weather conditions that struck Portugal during the scheduled week – indeed, those were abnormal days of flooding rather than wildfires (Figure 5). The intensity and persistence of the storm made it impossible to conduct most outdoor demonstrations safely, particularly those involving controlled fires, drone flights, field-team mobility, or the deployment of aerial communication nodes.

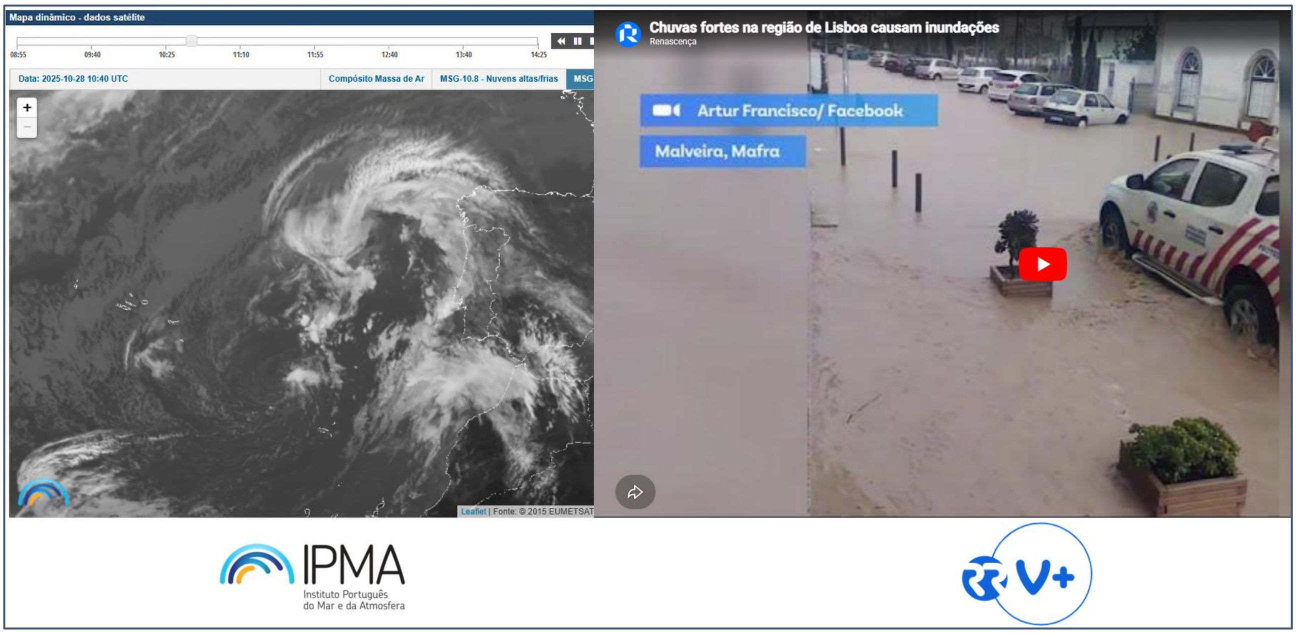

Figure 5: Storm and flood conditions at the time of the Wildfires Pilot in Portugal
Sources: Portuguese Institute for Sea and Atmosphere 2025 and national media group Rádio Renascença.

As a result, the field component had to be largely cancelled, and the consortium rapidly adapted by relocating activities indoors at the RAME facilities. Although these conditions constrained the original demonstration design, they simultaneously highlighted the importance of resilience, adaptability, and redundancy, precisely the challenges OVERWATCH seeks to address. In this regard, the Pilot delivered several important successes.

Figure 6: Portuguese emergency response teams using National and OVERWATCH platforms

First, the project partners were still able to provide firefighters, incident commanders, and civil-protection personnel with an in-depth, hands-on exposure to the OVERWATCH digital ecosystem while working with their own systems and processes (Figure 6), even in the absence of a live-fire field exercise. Using RAME as a controlled indoor environment, the team successfully demonstrated the platform's core components: Earth Observation–based mapping layers, the AI-powered AIMS's data fusion and analytical capabilities, drone-captured imagery from previous missions, and augmented-reality operational views. This allowed responders to engage with the operational picture in a realistic, scenario-oriented format, evaluating how the system ingests dispersed data sources and converts them into actionable intelligence.

Figure 7: User interaction with the AR service in OVERWATCH.

Feedback gathered during these indoor sessions reinforced several consistent messages from the responder community. Firefighters and civil-protection teams emphasised the growing operational need for real-time geospatial information, accessible interfaces, and tools that respect the tempo of emergency operations. The pilot demonstrations allowed them to see firsthand how drones, EO data, and AI analytics contribute to situational awareness, even if the full field-based workflow could not be played out due to the weather conditions. As captured in the interactions, responders repeatedly stressed that "time and accuracy of information make the difference between success and failure," and the OVERWATCH system was positively received as a means to enhance both.

What went particularly well was the opportunity to test the system's interoperability and usability under stressful, constrained conditions that mirror real disaster realities. Indoor demonstrations allowed commanders to explore the decision-support dashboards, evaluate how AIMS integrates drone, satellite, and ground data, and assess the clarity of AR-enhanced operational views. These sessions validated key findings from the Santa Margarida exercise: strong interest in mobile emergency networks, improved confidence via decision-support tools, and clear gains in situational awareness through drones and AR visualisation.

Figure 8: Dedicated training on the OVERWATCH platform

However, the adverse weather also exposed the limitations that extreme environmental conditions impose on field technologies, especially those requiring aerial deployment. Drone flights, the backbone of the reconnaissance and fallback-communication use cases, were grounded. Figure 8 provides a view of the dedicated training on the OVERWATCH platform for emergency and military personnel. Live communication-restoration demonstrations with tethered drones could not be conducted, nor could real-time wildfire-scenario reconnaissance. These weather constraints prevented a full validation of the mobile emergency network's behaviour in blackout conditions and limited the ability to demonstrate how AI analytics and AR overlays interact with newly streamed, real-time imagery in October 2025. Due to continued extreme weather conditions during the 2025/2026 winter season in Portugal, the testing of the fallback communication module had to be successively rescheduled and was delivered on the 10th of April, 2026, at the São Jacinto Military Camp, located in Aveiro, currently home to the Portuguese Army's 10th Infantry Regiment. These tests were successful, although conducted with a reduced presence of emergency response and military personnel. This echoes the remarks that communication gaps, fragmented data, and operational stress remain critical challenges when environmental conditions degrade existing systems.

Nevertheless, the Pilot demonstrated the maturity, robustness, and potential of the OVERWATCH components, even when tested in a limited indoor configuration. It also underscored a central lesson: Europe's emergency response environment is increasingly shaped by extreme and unpredictable weather, and technologies such as those developed in OVERWATCH must be designed for resilience, redundancy, and decision support across all conditions, both ideal and adverse.

3.5 Impact on Overwatch

The wildfire pilot had a significant impact on the evolution of the OVERWATCH platform, particularly in terms of component validation, system integration, and guidance for future iterations. Even though severe weather limited outdoor operations, the Pilot still provided a rich, operationally grounded environment to assess the system's maturity and alignment with responder needs.

Figure 9: Welcome address to the national and regional civil protection and military authorities present in the Pilot

The indoor demonstrations at RAME enabled firefighters, commanders, and civil-protection personnel to interact directly with the OVERWATCH components, AI-supported dashboards, drone-derived imagery, EO mapping layers, AR visualisation modules, and communication tools. Responders confirmed that mobile emergency networks improved coordination, AI-powered dashboards enhanced command confidence, and drones and AR interfaces significantly strengthened situational awareness. These findings validated the system's core capability: transforming dispersed data sources into actionable, real-time intelligence for strategic and tactical decision-making.

The Pilot demonstrated that OVERWATCH's technological pillars, EO, drones, AI, AR, and communication systems, operate effectively as a single, coherent digital ecosystem. Responders need harmonised data, seamless interoperability, and operational pictures that connect all command levels. The Pilot confirmed that the platform successfully integrates these layers, offering an intuitive workflow from data ingestion to visualisation, even under constrained circumstances.

The findings underscore several priorities for future refinement. First, enhancing interoperability, both technically and doctrinally, remains essential, as institutional fragmentation and incompatible systems continue to challenge multi-agency operations. Second, responders highlighted the need for user-oriented training, ensuring technology adapts to operational tempo rather than imposing complexity. Third, resilient, mobile communication capabilities should be expanded, given their proven value when primary networks degrade.

Future iterations should further emphasise simplified interfaces, cross-platform compatibility, and greater automation in data processing to reduce cognitive load during high-stress operations.

4. Pilot Floods

4.1 Overview

The Floods Pilot of the OVERWATCH project took place in Warsaw, Poland, between 24 and 25th[1] of March, 2025, constituting the project's second operational demonstration centred on a flood response scenario. The event was hosted at a conference facility[2], bringing together high-level experts specialising in flood-related issues from diverse organisations, to foster in-depth collaboration and knowledge exchange. Thanks to the project's experience-sharing opportunities, a smaller dedicated panel addressed forest fire issues, facilitating a meeting between specialists in this field from Poland and Portugal.

During the event, the comprehensive Overwatch solution was presented through a dedicated scenario, demonstrating the system's operation and user-facing functionalities, and providing an overview of its backend architecture and potential for adaptation and integration. Additionally, participants were given access to an AR station showcasing this innovative approach to visualising spatial data.

At the request of participants from Poland, the event was conducted in Polish, with English used alternately, and full professional interpretation provided throughout. At the same time, participants who had previously expressed interest but were unable to attend in person were granted access via teleconference, also with interpretation. This enabled three panellists to participate, despite their obligations preventing them from being on site.

The event brought together a wide consortium of OVERWATCH partners from Portugal, Germany, Italy, Denmark, and Poland, as well as external participants from Poland, Austria, and France, reflecting the project's multinational character. Participation from Polish institutions was especially prominent, with the CBK PAN (Space Research Centre of the Polish Academy of Sciences) serving as the host of the event.

4.2 Adjustment of Event Timeline and Format

Due to the project's extension, a decision was made to revise the event timing. The initial plan assumed that activities would take place no earlier than in the second quarter of the year, with the event originally scheduled for the third quarter. This approach was driven by the need to align with

[1] For participants, the event was a one-day session, while an additional day was dedicated to technical preparations.

[2] Royal Tulip Warsaw Centre, Grzybowska 49 Street, Warsaw

the exercise calendar of the Polish State Fire Service (PSP), which is developed in Q4 of the preceding year and confirmed by formal order in mid-Q1 of the current year.

At the same time, the Polish Pilot was planned with full awareness that the Portuguese Pilot could only take place within a specific time window, namely outside the wildfire season due to the inability to obtain permissions for open-fire testing, and outside the winter season, when weather conditions do not allow safe drone operations, which in practice limited the available slot to the early spring / late autumn. These constraints partially overlapped with the typical exercise calendar in Poland, making it impossible to organise both events within the same quarter.

However, the need to wait for the solutions to reach an appropriate level of technological maturity, particularly those that required redevelopment following changes in the consortium composition, further delayed the Flood Demo event, which ultimately necessitated rescheduling it to the first quarter of the year. This adjustment introduced a degree of risk, which was acknowledged and accepted both by the consortium and the Project Officer.

To mitigate this risk, consortium members agreed to be flexible in responding to the delayed confirmation of the event date. Regarding the participation of external experts, the risk was assessed as low, given their involvement in every high-level PSP-led exercise. As an alternative, a different type of event was planned: a shorter, conference-style format held in Warsaw, the capital of Poland, where the majority of national-level institutions are based. While this approach offered a less immersive demonstration, it enabled broader outreach to experts from diverse Polish institutions, including key decision-makers.

Following the official confirmation of the PSP exercise schedule, and in consultation with the funding authority, it was ultimately decided (due to the unfavourable timing of PSP-led exercise) to proceed with the alternative approach. The event was therefore organised earlier, in a one-day conference format focused on presenting project outcomes to a high-level expert audience, while still ensuring the participation of key practitioners experienced in both fire and flood-related domains.

4.3 Operational goals

The pathway for planning the Flood Pilot was outlined in Deliverable D1.1, with the overarching objective, shared with the Forest Fire Pilot event, defined as performing a full system demonstration for end-users and potential investors.

The second objective, providing validation means for WP2, WP3, and WP4 development and integration activities, was achieved during the Pilot in Portugal and its accompanying smaller events, which were implemented flexibly in response to recurring external constraints (described in Section 3.3). The Polish Pilot focused on reaching a broad range of potential users and collecting their feedback on the proposed solutions. This was supported by a discussion-oriented meeting format and thematic blocks enabling extensive exploration of the system's potential role within an emerging information ecosystem being developed by the Polish State Fire Service (PSP), the national lead for emergency response in Poland.

The primary objective was to support situational awareness of responders by providing enhanced mapping capabilities, real-time imagery, and decision-support tools. This encompassed the work of incident commanders and operational staff at the regional PSP commander's headquarters, which conducted rapid field assessments supported by satellite and aerial data gathered from various sources and integrated into the OVERWATCH architecture.

The Pilot also highlighted improvements in flood-response coordination, enabling effective cooperation among tactical response sections, command-post personnel, and technical experts. Operational tasks such as dewatering flooded areas, assessing road passability, determining the extent of inundation, supporting safe and coordinated aerial missions (accomplished by multiple manned and unmanned aircraft in a shared emergency-area air volume), and continuously monitoring flood progression were used to refine decision-making processes and present system performance.

4.4 Technologies and Tools Assessed

4.4.1 Specific challenges addressed

The Flood Pilot addressed the natural disaster scenario of floods threatening large rural areas and included three use cases. Use cases respectively focused on pre-flood infrastructure analysis, post-flood impact documentation, and flood-time rapid data collection and actionable intelligence, leveraging combinations of EO, Drones (DR), AR, an AI-based backend management system, and fallback communication to support situational awareness, assessment, and operational decision-making across different phases of flood events. The challenges for the flood pilot were identified earlier, in Deliverable 1.1 as the OVERWATCH Use Cases (UC), Figure 9, as:

UC 1.2.1.FL.1 – Pre-flood analysis of the state of infrastructure

The first use case focused on pre-flood analysis of infrastructure conditions. It leveraged EO, DR, AR, and an AIMS to support comprehensive situational understanding and preparedness activities. This use case was significantly reduced in scope due to changes in the consortium's composition, including, among other factors, the decision to discontinue the use of LiDAR sensors.

UC 1.2.1.FL.2 – Post-flood impact documentation

The second use case, "Post-flood impact documentation", employed EO, DR, AIMS, and AR technologies to enable systematic assessment and recording of flood consequences.

UC 1.2.1.FL.3 – Flood-time rapid data collection and actionable intelligence

The third use case, "Flood-time rapid data collection and actionable intelligence", integrated drones, fallback communication, AR, and the AIMS platform to facilitate real-time data acquisition and support timely operational decision-making during flood events.

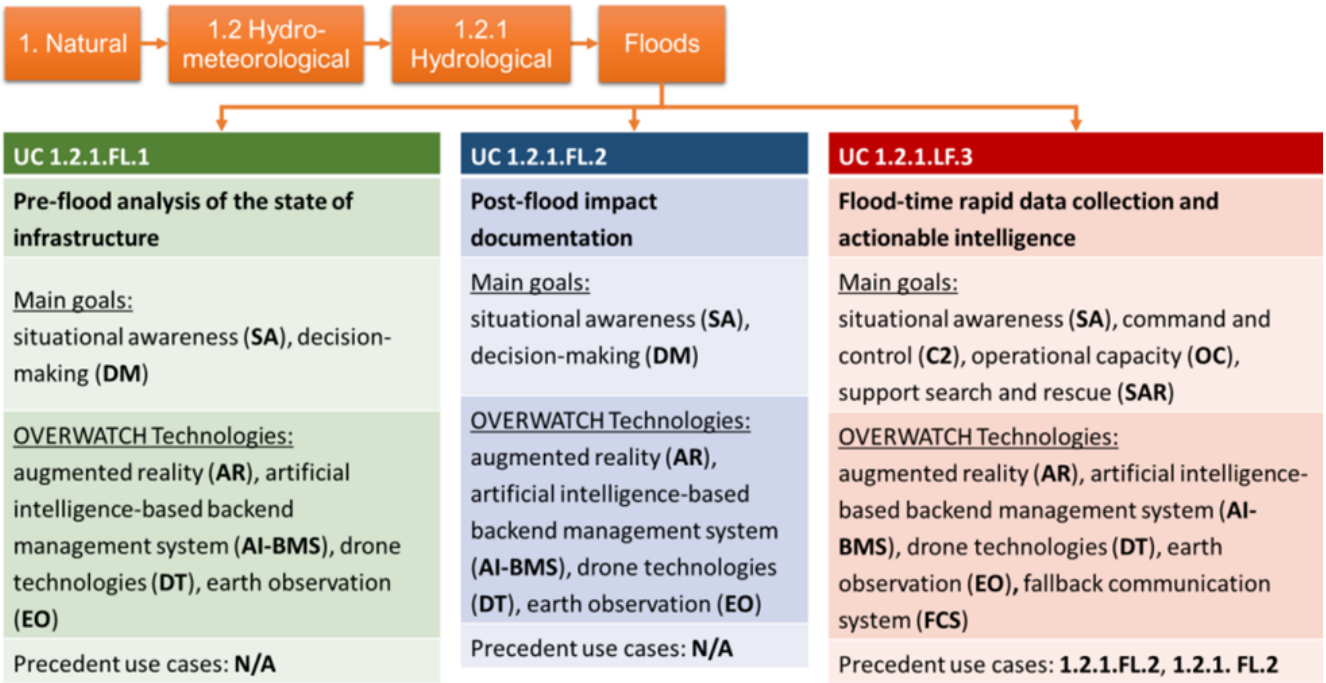

Figure 10: OVERWATCH Flood Use Cases.

4.4.2 Pilot Execution

The Polish Pilot of the OVERWATCH project focused on demonstrating the system's capabilities in a conference-based, discussion-oriented environment, with an emphasis on outreach to a broad range of potential users and stakeholders, including decision-makers and operational experts. Rather than replicating full field operations, the Pilot showcased the integrated technological ecosystem supporting flood-response scenarios, with particular attention to situational awareness, coordination, and decision support.

Earth observation components (drone mapping and satellite imagery, water extent delineation) provided the foundational geospatial context, illustrating how satellite-derived data, GIS layers, and previously collected aerial observations can support flood risk understanding and pre-event analysis. Drone technologies, which in the field deployments would normally deliver real-time sensing and high-resolution environmental data, were presented in a fully simulated mode. The simulation was based on content collected during testing activities and during the preparation and execution of the Portuguese Pilot, ensuring a realistic representation.

Connectivity functions, typically ensured by the FC system, were not exercised in live conditions but were instead demonstrated conceptually as part of the integrated architecture, highlighting their role in maintaining data flow between distributed system components under degraded network conditions. The AIMS was presented as the central analytical layer, demonstrating how it integrates EO-derived information and simulated drone data to produce fused situational layers, flood-impact assessments, and decision-support outputs.

Augmented Reality capabilities were demonstrated through an interactive station that enabled participants to explore a reconstructed flood scenario in an immersive 3D environment. This allowed stakeholders to visualise terrain conditions, water extent, and operational elements, supporting discussion of potential use cases within Poland's emerging emergency management information ecosystem.

Overall, the Polish Pilot emphasised system integration and usability rather than live operational deployment, ensuring that all drone-related functionalities were presented through a validated simulation environment grounded in real data from earlier field activities, particularly those conducted in Portugal.

4.4 Results and Findings

The Polish Pilot was executed as a structured, one-day conference-style event that combined presentations, interactive demonstrations, and panel discussions to showcase the OVERWATCH system and engage end users and stakeholders. A total of 49 participants took part in the event, including 14 consortium representatives and external attendees from 22 institutions. Among them, 5 participants joined remotely, including 3 panellists.

The event opened with the Event Kick-Off: The OVERWATCH Project and Its Activities, beginning with a brief overview of the consortium, the project's progress, and its current status. This was followed by a structured, one-way presentation providing participants with essential introductory information. It included a more detailed overview of each solution, organised into thematic blocks, along with an explanation of the overall system architecture and its adaptability. Subsequently, based on the flood scenario from September 2024 in south-western Poland, the presentation outlined how the system could be applied under such conditions and how it could support situational understanding and improve information flows across different operational levels.

A key element of the Pilot was the Interactive Demo Session, delivered in two parallel sessions that participants attended sequentially in rotating groups.

Figure 11: Interactive AR session

The first station focused on the AR environment with an applied flood scenario, including terrain imagery, water extent delineation, and a simulated dynamic drone position displayed over the affected area in its actual (simulated) position. This very specific component (aerial asset positioning) addresses the highly demanded Air Traffic Management requirements in Poland. Such awareness enables better planning and coordination between drone missions and manned aviation operating in the incident area, such as helicopters used for HEMS, reinforcing flood defences, or delivering critical equipment. The format enabled hands-on exploration of the system and direct discussion with its developers. After completing the first block, participants moved to the second station, with the session repeated for the next group.

The second station provided volunteer-operated workstations and demonstrated system navigation via a large shared display. Its objective was to guide participants through all steps required to obtain up-to-date data for a selected area under a defined flood scenario. The session also allowed participants to explore the system's map-based interface in detail and engage in technical discussions, including the water extent delineation algorithms, EO data sources, potential compatibility with internal databases, and technical requirements.

Hour	Theme
8:50	*Welcome coffee, participant registration and networking*
9:00	*Holo-light AR Geospatial AR Decision Support System Demo – Open Access*
9:30	**Event Kick-Off: The Overwatch Project and Its Activities** • Presentations of individual Overwatch solutions • Application examples based on recent flooding events in Poland and Portugal
11:15	**Interactive demo session** *A moderated group workshop presenting an AR tool and a backend management platform with implemented algorithms and integrated data sources. Participants will have the opportunity to practice the solutions and engage in discussions with their creators.*
12:15	**Panel Discussion: Forest Fire Management** • Current Forest Fire Management Capabilities • Overwatch Demonstration in Portugal *Moderator: José Borges CINAMIL* *Deputy João Pitacas, ANEPC; Maciej Lipka, Regional Directorate of State Forests in Szczecin; Artur Bernaziuk, CIK CBK PAN expert, Coordinator of Aerial Operations*
Lunch break	
13:30	**Panel discussion: useful and desired functionalities shaping the final solution. How can Earth observation data support flood response and planning?** Introductory Presentations: • Current Implementations and Development Directions from the Perspective of the State Fire Service • Applications of Artificial Intelligence in Disaster Risk Management • The "Civil Security Hub" method for implementing new innovations in the operational processes of services • Satellite-based "Last-Mile" Communication Solutions in Crisis Management – the IRIS 2 Flying Access Point *Moderator: Jakub Ryzenko, the Space Research Centre of the Polish Academy of Sciences* *Brigadier General Błażej Chamier Cieminski, Deputy Pomeranian Provincial Commander of the State Fire Service (PSP), Jacek Kuskowski, expert in geoinformation for civil security; Stefan Ostrowski, Provincial Headquarters of the State Fire Service (KW PSP) in Białystok; Edoardo Arnaudo, LINKS Foundation, OVERWATCH Project; Anna Foks-Ryznar, Crisis Information Center, CBK PAN; Emil Kowalczyk, Orange Innovation Poland*
15:00	**Guest presentation: "Social perception of drones in crisis management activities"** - results of a study conducted by the COLLARIS Network *Jasmina Schmidt, DCNA*
15:20	**OVERWATCH Perspective -** Next steps and collaboration opportunities after the project **Event Summary and Closing**
16:30	Networking dinner for all participants

Figure 12: Pilot Floods agenda

Figure 13: Presentation featuring an interactive demonstration

Figure 13 provides an example of a project presentation by the OVERWATCH Consortium.

After lunch, the discussion portion of the event began. It was opened by a panel on current forest fire management capabilities in both Portugal and Poland. To introduce the session, the moderator, Prof. José Borges from CINAMIL, briefly outlined the Portuguese demo and initiated the discussion by asking panellists to outline their current approaches to processing and sharing geospatial information.

Commander David Lobato and Deputy Hugo Picote from ANEPC described the Portuguese information ecosystem, focusing on operational data flows and coordination mechanisms. This was followed by Maciej Lipka from the Regional Directorate of State Forests in Szczecin, who presented the central role of the Polish State Forests in wildfire detection and response, as well as the information systems maintained by the State Forests and made available to the State Fire Service. The presentation session concluded with Artur Bernaziuk, expert Coordinator of Aerial Operations, who outlined Polish methods for coordinating manned and unmanned aerial operations over large forest fires and highlighted existing gaps in geospatial information systems and aircraft positioning that may still need to be addressed.

The subsequent discussion addressed the information needs of emergency services, the systems capable of supporting these requirements, and the potential pathways for implementing the OVERWATCH solution. The panellists agreed that there is a significant and growing need for systems of this type. The discussion was also joined by an incident commander from the State Fire Service (PSP) present in the room, who had previously participated in large-scale firefighting operations in the Biebrza National Park, leading drone-supported activities during those interventions.

A general consensus emerged regarding the clear need to implement a solution such as OVERWATCH. At the same time, it was emphasised that any deployment would require full integration with the forthcoming information system of the PSP Headquarters, which has not yet been operationally introduced. This highlights a key risk for regional PSP commands: investments made at this stage could become obsolete if a centrally mandated system is later mandated. As a result, despite recognition of the existing capability gap, addressing it through independent procurement is currently considered too risky.

The final thematic panel block was titled: "Useful and desired functionalities shaping the final solution." How can Earth observation data support flood response and planning?. It was moderated by Jakub Ryzenko from the Space Research Centre of the Polish Academy of Sciences, a leading expert in the application of satellite and drone technologies for crisis response and emergency management.

Brigadier General Błażej Chamier Ciemiński, Deputy Pomeranian Provincial Commander of the State Fire Service (PSP), presented a detailed account of PSP operations during the large-scale flood event in September 2024, with particular emphasis on the information ecosystem and mechanisms of information exchange used during the response. Stefan Ostrowski from the Provincial Headquarters of the State Fire Service (KW PSP) in Białystok complemented these perspectives by presenting ongoing innovations in the regional command to integrate drone-derived data into operational scenarios, incorporating lessons learned from the 2024 flood.

This was followed by Jacek Kuskowski, former head of the IT and Communications Office of the National Fire Service Headquarters, currently Ministry of the Interior and Administration, who described how the PSP Headquarters envisions the target information ecosystem and the foundational assumptions guiding its development. Edoardo Arnaudo from LINKS Foundation then presented AI-based algorithms under development that could further extend the capabilities of the current OVERWATCH system offering. Anna Foks-Ryznar from the Crisis Information Center, CBK PAN, explained how the ESA Civil Security Hub approach to innovation testing (Innovation Pipeline mechanism) can support structured experimentation and informed decision-making for the adoption of new technologies. The discussion concluded with Emil Kowalczyk from Orange Innovation Poland, who addressed how European satellite internet connectivity solutions could provide a secure alternative to current market leaders and how well these technologies align with the OVERWATCH Fallback Communication System (FCS) concept.

The session concluded with a presentation by Jasmina Schmidt from DCNA, representing the COLLARIS Network (UCPM-KN recurring project-founded network), which brings together advanced professional drone operators, including training centres, management institutions, and regional and national command structures active in emergency management. Her presentation, "Social perception of drones in crisis management activities", addressed how drone operations are perceived by society and highlighted key aspects that should be considered in communication strategies and the overall safety and acceptance of such operations.

The closing session of the Pilot was dedicated to reflecting on the event's outcomes and outlining potential pathways for continued collaboration beyond the project's lifetime. It provided a structured overview of the OVERWATCH perspective on future exploitation, integration opportunities, and engagement with end users and institutional stakeholders. The discussion focused on how the solutions demonstrated during the Pilot could transition from a research-and-development environment to operational use cases within national crisis management ecosystems. Particular attention was given to potential adoption areas within fire and flood response structures, as well as the prerequisites for integration with existing and planned information systems operated by emergency management authorities.

The session also addressed opportunities for continued cooperation between consortium partners and external stakeholders, including joint activities in testing, validation, and further refinement of the system. It highlighted the importance of maintaining dialogue with operational services, particularly those involved in strategic-level decision-making, in order to ensure alignment between technological development and real-world operational needs.

The session concluded the event by consolidating key insights from all thematic blocks and reinforcing the shared understanding that sustained collaboration and iterative development are essential for the long-term impact and scalability of the OVERWATCH solutions.

4.5 Impact on Overwatch

The Pilot provided a comprehensive, operationally relevant setting to evaluate the OVERWATCH system's maturity and alignment with emergency responders' needs and expectations. Participants consistently confirmed a strong and growing need for advanced geospatial data and analytics in operational contexts, as well as for their integration into systems that consolidate information and support informed decision-making.

The indoor demonstrations enabled firefighters, incident commanders, and decision-makers to directly interact with the OVERWATCH components, facilitating a practical understanding of their functionality and potential applications. Responders emphasised that mobile emergency networking capabilities can improve coordination, AI-driven dashboards have great potential to increase confidence in command decisions, and the combination of drone data and AR interfaces is improving situational awareness. Collectively, these observations validated the system's core value proposition: transforming distributed, heterogeneous data sources into actionable, real-time intelligence that supports both strategic and tactical decision-making.

The Pilot further demonstrated that the technological pillars of OVERWATCH, Earth Observation, drone systems, artificial intelligence, augmented reality, and communication infrastructure, can operate as a coherent and integrated digital ecosystem. Participants highlighted the importance of harmonised data flows and interoperability. The system was shown to provide a consistent and intuitive workflow, from data acquisition through processing to visualisation, fit for constrained and complex operational conditions.

The findings also identified several key priorities for future development. Interoperability, both at a technical and institutional level, remains a critical challenge, as fragmentation across systems continues to hinder multi-agency operations. The importance of user-centred design and training was also emphasised, ensuring that technological solutions adapt to operational realities rather than introducing additional complexity. In addition, the expansion of resilient, mobile communication capabilities was identified as essential, given their demonstrated value in scenarios where primary communication infrastructure is degraded or unavailable.

5. Stakeholder Engagement

5.1 Wildfires pilot

Stakeholder engagement in the OVERWATCH wildfire activities was central to ensuring that the project responded to the real operational needs of those who manage forest-fire emergencies in Portugal. The Pilot and its preparatory phases mobilised a broad ecosystem of actors, from frontline firefighters to national authorities and local institutions, reflecting the inherently multi-agency nature of wildfire response.

A first pillar of this engagement was the direct involvement of emergency services, particularly firefighters, civil-protection personnel, and operational command structures. These actors participated not only in the planned field demonstration but also in the extensive indoor technical showcases that became necessary when severe weather made outdoor operations unsafe. Their presence was critical: as the CMINE analysis notes, emergency responders consistently emphasise the urgency of "seeing what is happening, not only receiving reports" and the operational necessity for real-time geospatial information, interoperable systems, and resilient communications. Their feedback during the demonstration sessions confirmed that technologies such as mobile emergency networks, AI-supported dashboards, drone imagery, and augmented-reality views directly enhanced confidence at the command level and improved situational awareness. Through these interactions, responders were able to articulate their operational pain points, communication gaps, fragmented data, limited interoperability, and assess how OVERWATCH components could help address them.

Equally important was the collaboration with municipalities, agencies, and institutional partners, which shaped the design and execution of the wildfire pilot. Civil-protection authorities at regional and national levels provided expertise on doctrine, coordination procedures, and multi-agency command structures. These stakeholders also helped anchor the Pilot within real-world planning–execution–assessment cycles, ensuring that, if adopted, information systems would integrate seamlessly into existing C2 practices. The institutional fragmentation, differing terminologies, and unlinked systems remain persistent challenges across Europe; the involvement of such authorities was therefore essential for validating the platform's potential to support harmonised operational workflows. Furthermore, the RAME facilities in Abrantes became a crucial collaborative space once the storm forced indoor demonstrations. Their infrastructure enabled the project team to continue engaging local responders and partner agencies despite the weather. This adaptability reinforced one of the project's core principles: technology must "adapt to the rhythm" of emergency services, not the other way around.

The wildfire pilot succeeded in creating a shared environment where firefighters, civil protection officials, military support units, municipalities, and technical partners could jointly explore how EO, drones, AI, AR, and resilient communications could transform wildfire operations. Even with the disrupted field conditions, these engagements generated valuable operational insights, strengthened inter-agency dialogue, and demonstrated the potential of OVERWATCH to serve as a collaborative, digital, and knowledge-driven response ecosystem.

5.2 Floods pilot

Stakeholder engagement within the OVERWATCH flood-related activities was essential to ensuring that the project reflected the operational realities of flood emergency management in Poland. Both the preparatory phase and the Pilot brought together a wide range of actors, from incident commanders to national authorities and local institutions, highlighting the inherently multi-agency nature of flood response operations.

The primary audience of the Floods Pilot was the State Fire Service (PSP), the institution responsible for managing and coordinating the full spectrum of flood response operations. Firefighters play a critical role in this context, as they are the primary operational force conducting field interventions while also serving as key users of geospatial information. Their activities require continuous situational awareness, and for that, they need up-to-date spatial data on flood extent, infrastructure status, terrain accessibility, and the distribution of deployed resources. In dynamic, rapidly evolving emergency conditions, such data supports both tactical decision-making on the ground and higher-level coordination by command structures, enabling more effective resource allocation and safer execution of operations. In addition, the PSP is a leading actor in the operational use of unmanned aerial systems in crisis management. Drones have become an increasingly important tool for reconnaissance, damage assessment, and real-time monitoring during flood events, significantly enhancing the ability to acquire timely, detailed situational data in areas that may be difficult or unsafe for ground teams to access.

The State Fire Service was represented by a range of institutions covering both strategic, educational, and operational levels. These included the National Headquarters of the State Fire Service in Warsaw, the Fire University (Akademia Pożarnicza) in Warsaw, the Regional State Fire

Service Headquarters in Białystok and Gdańsk, and the Provincial State Fire Service Headquarters in Białystok and Przeworsk. This multi-level representation ensured the involvement of key actors responsible for national coordination, training and research, as well as regional operational command structures directly engaged in flood response activities.

PSP also serves as the primary coordinating actor, collaborating with other drone-capable groups involved in crisis response, including organisations represented in the Pilot, such as the 3rd Subcarpathian Territorial Defence Brigade and the Aeroclub of Białystok. This cooperation reflects an increasingly networked approach to aerial support in emergency operations, where the PSP integrates and aligns data and activities from multiple UAV operators to ensure coherent situational awareness and effective task execution across different operational units.

Another key stakeholder was Państwowe Gospodarstwo Wodne Wody Polskie and its Regional Water Management Boards (RZGW), which act as the primary authority responsible for water infrastructure management. As the owner and administrator of critical hydraulic infrastructure, this institution serves as a central source of information on its operational status, condition, and potential consequences of failures. Its input is essential for assessing flood risk, understanding evolving hydrological conditions, and supporting coordinated emergency response measures.

Central-level actors play a key role in shaping policy and strategic decision-making related to the development of the State Fire Service (PSP). In the context of the event, this group was represented by the Government Centre for Security (RCB), the National Centre for Research and Development (NCBiR), the Ministry of the Interior and Administration (MSWiA), and the Ministry of Digital Affairs (MC). These institutions are responsible for defining regulatory frameworks, funding priorities, and digital transformation strategies that directly influence the evolution of emergency management capabilities, including the adoption of innovative technologies such as those demonstrated within the OVERWATCH project.

An additional important aspect is active participation and visibility within expert networks, such as the COLLARIS Network and the Disaster Competence Network Austria. Engagement in these communities supports knowledge exchange, dissemination of best practices, and strengthening of professional links between organisations involved in crisis management and disaster response. It also increases the visibility of project outcomes within specialised international environments and facilitates dialogue with practitioners and researchers working on comparable challenges.

Business partners also play an important role in fostering synergies and extending the reach and impact of the project's outcomes. In the context of the event, this group included Orange Innovation Poland, Eutelsat S.A., and GIS Partner. Their involvement supported the integration of innovative communication technologies, satellite-based connectivity solutions, and geospatial information services, thereby enhancing the broader applicability and scalability of the developed OVERWATCH solutions across operational and commercial environments.

Due to the inclusion of wildfire-related topics, the event also brought together stakeholders active in forest fire management. These included the National Emergency and Civil Protection Authority of Portugal (ANEPC), the Portuguese Civil Protection Special Force (FEPC), and the Regional Directorate of State Forests in Szczecin. Their participation ensured the presence of key operational and institutional perspectives from both civil protection and forest management domains, enabling a broader exchange of experience relevant to multi-hazard emergency response.

6. Communication and dissemination

In the aftermath of the wildfires pilot, leveraging the Horizon Result Platform[3] and Horizon Result Booster[4], the OVERWATCH project successfully planned and hosted an online Joint Workshop on the 21st of November, 2025, titled: *Implementation of new technologies in operational activities of crisis management and civil protection services. AI, Drones, and Satellites for Real-Time Situational Awareness in Disaster Response.*

Figure 14: Institutional image used in the workshop and participants' screens

[3] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform
[4] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/d-e-booster

Figure 14 provides a general perspective of the event, which counted more than 80 participants and strong engagement throughout.

All materials were collected and made available online. A dedicated page on the website has been created, where workshop materials and presentation slides can be downloaded for future reference. The full event recording is also available on this dedicated page and on the official project YouTube channel[5]. Posts were created on the main social media platforms[6], and several newsletters were produced to promote the event as widely as possible.

During the workshop, the OVERWATCH Project showed how it effectively translated technical outcomes into operationally meaningful messages for the broader responder community. The presentation highlighted Europe's evolving risk landscape, the increased frequency of extreme weather events, and the growing complexity of multi-agency coordination, contextualising OVERWATCH as a direct response to these challenges.

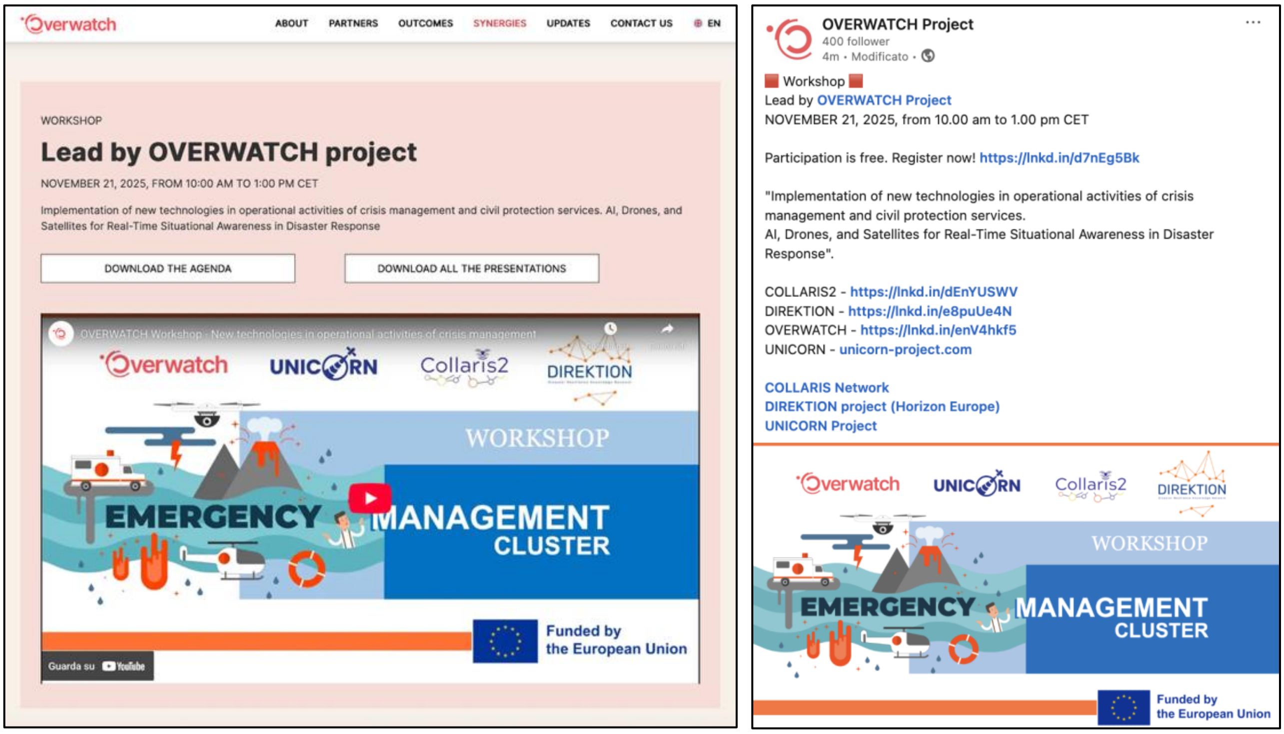

Figure 15: Dissemination materials for the Joint Workshop

By clearly articulating responder needs such as resilient communications, integrated data streams, and real-time situational awareness, the project succeeded in communicating not just technological innovation but also practical relevance for firefighters, civil protection teams, and decision-makers. This dissemination also benefited from sharing concrete lessons from the Santa Margarida field exercise, including the value of mobile emergency networks, AI-enhanced dashboards, and AR-supported operational views. These insights reinforced the importance of interoperability and user-oriented system design, ensuring that communication outputs strengthened awareness, trust, and uptake potential across agencies. The CMINE platform thus served as an effective channel to amplify the project's impact within the EU crisis-management ecosystem.

[5] https://overwatchproject.eu/en/synergies/

[6] https://www.linkedin.com/posts/overwatch-project_workshop-lead-by-overwatch-project-activity-7394302531834642433-fxoe?utm_source=share&utm_medium=member_desktop&rcm=ACoAAAWictcBmaGpMQMFVZH3lm4DtyZ11hKpMyc

In addition, thanks to footage recorded by ALPHA (and provided by INESCTED) during the demos, two videos dedicated to the demo activities were created. The videos were shared and disseminated across all our channels (and uploaded on the official OVERWATCH YouTube page). They were also used as looping content in demo sessions and presentations, and included in newsletters and posts.

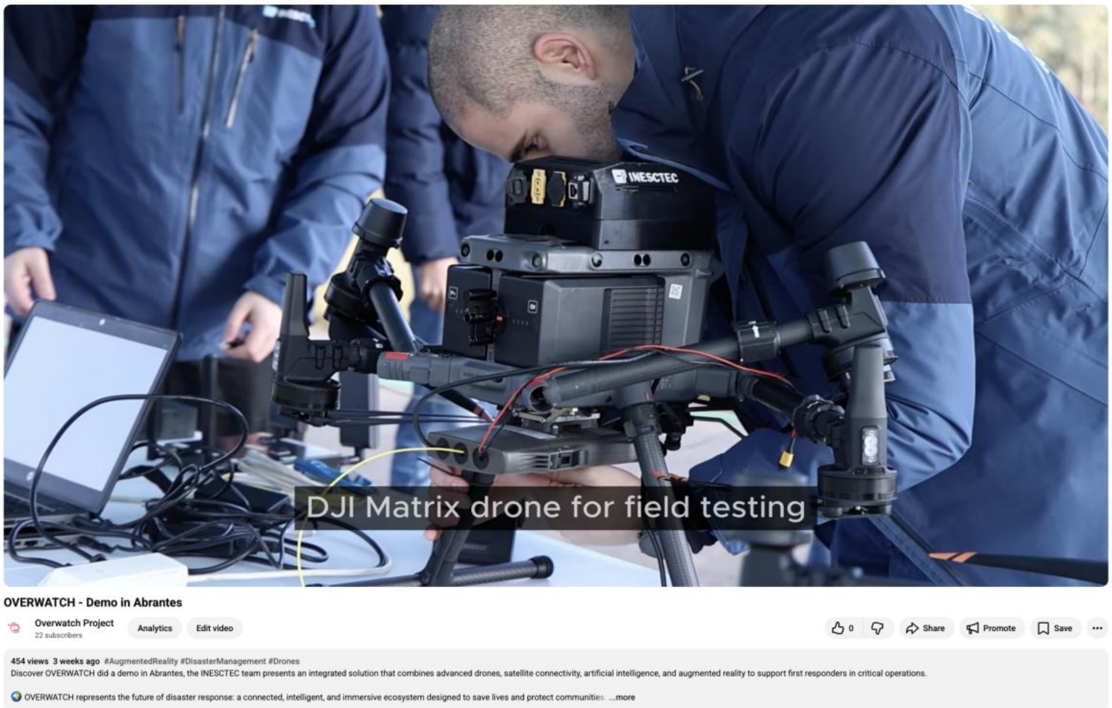

Figure 16: Video #1 produced to document the demo activities in CCMSM[7].

Figure 17: Video #2 produced to document the demo activities in CMSM[8].

[7] https://www.youtube.com/watch?v=o2N7oOo0GkM
[8] https://www.youtube.com/watch?v=xVkL9Qy9lyE&t=1s

Project Name	Description	Link
DIREKTION	Strengthening Europe's capacity for disaster response through collaboration, technology, and community engagement. DIREKTION is dedicated to enhancing disaster resilience by bringing together first responders, researchers, and industry experts. Our mission is to provide Europe with faster, more efficient access to innovative solutions and technologies in disaster response and recovery. DIREKTION is committed to fostering a strong community of practitioners, driving collaboration and innovation to meet the evolving challenges of disaster resilience.	LINK
COLLARIS2	Leveraging a networked, collaborative approach, COLLARIS is building a European capacity to enhance the use of unmanned aerial systems (UAS) in disaster risk management, covering the entire cycle from preparedness to response and recovery. The project is designing and developing a sustainable ecosystem that enables civil protection actors, first responders, and engineers to work together to share knowledge, harmonise procedures, and deploy drones efficiently during crisis situations. The network will allow the collaboration of different user profiles-first responders, crisis managers, and technical experts-who will share best practices, develop training, and test new solutions through joint exercises and virtual simulations. This collaborative environment will foster a comprehensive, shared understanding of how to integrate drone-based solutions into civil protection and emergency management. COLLARIS provides a networking platform within the Union Civil Protection Knowledge Network, supporting information exchange, joint experiments, and hands-on training. The project supports proactive disaster preparedness and response, contributes to a more coordinated European crisis management system, and shapes a future in which drones are an integral part of saving lives and protecting the environment during emergencies.	LINK
UNICORN	UNICORN aims to address the growing challenges posed by climate change, particularly in managing emergencies and geohazards. It addresses key issues such as inadequate preparedness, inaccurate risk assessment, and the limited scalability of current solutions. The initiative targets various sectors, including first responders, insurance, forest industries, and utilities, by offering tools for real-time hazard monitoring, risk assessment, and proactive response.	LINK
CMINE	CMINE is an open, cooperative, and inclusive information network for sharing experiences, best practices, and lessons learned among individuals, crisis management organisations, research entities, industry, and policymakers throughout Europe and beyond. CMINE provides an environment where members and others can participate in and observe discussions on project-related issues, thereby enabling unprecedented knowledge sharing across all fields of the project. CMINE also links stakeholders from existing projects, networks and initiatives to reduce repetition and fragmentation whilst encouraging new ideas and identifying innovative solutions to improve European resilience.	LINK

Table 1: Established synergies

This "Emergency Management Initiative" brought together three Horizon Europe projects: UNICORN, COLLARIS2, DIREKTION, and OVERWATCH. The workshop offered a unique opportunity to engage with a network of EU projects at the forefront of emergency management innovation. Participants gained insights into new technologies such as AI, drones, and satellites that are transforming real-time situational awareness and disaster response, enabling the development of future-ready solutions tailored to increasingly complex disaster scenarios in Europe. Table 1 summarises established synergies.

7. End-users' feedback

The OVERWATCH Pilots were twofold: validating technical system performance and assessing its alignment with real operational practices, constraints, and decision-making processes. Beyond technical validation, particular emphasis was placed on understanding how the system supports operational workflows, situational awareness, and coordination under realistic conditions.

To this end, the project organised dedicated demonstrations of the dashboard and the AR/VR environments for end-users. Participants were given hands-on access to the system, enabling them to explore functionalities and interaction mechanisms. The primary objective of this exercise was to gather user feedback regarding system usability, performance, system integration and operational relevance within existing crisis-management workflows.

Particular attention was given to identifying gaps related to usability, interoperability, training needs, and system reliability under stress conditions.

The feedback was collected through semi-structured interviews, allowing a balance between predefined criteria and open-ended reflections. This approach enabled the capture of both quantitative perceptions (ratings) and qualitative insights grounded in operational experience.

The interview sample reflected a multi-level operational perspective. Participants included:

- Command-level officers involved in strategic decision-making
- Operations and information officers responsible for coordination and data interpretation
- Frontline emergency responders, including civil protection and firefighting personnel

This diversity ensured that the feedback captured both strategic requirements at the command level and practical constraints encountered during emergency response operations. The interview addressed the following evaluation dimensions:

- Usability and intuitiveness (dashboard and AR/VR interfaces)
- Technical performance (responsiveness, latency, stability)
- Visual clarity and immersion (AR/VR)
- System integration and synchronisation
- Decision-making support and relevance of information
- Collaboration and communication in crisis management contexts
- Reliability under real operational conditions
- Overall satisfaction and recommendations for improvement

The OVERWATCH dashboard was widely perceived as intuitive and easy to use, requiring minimal guidance even for first-time users. In contrast, the AR/VR interface presented a steeper learning curve, particularly for users without prior experience. Interviewees consistently stressed that effective use of immersive tools depends on structured training and regular familiarisation.

Technical performance was assessed positively, with the system generally meeting expectations for planning and situational awareness. However, users reported occasional latency and responsiveness issues, particularly in AR/VR interactions and data-layer loading. Such delays were highlighted as potential constraints in high-stress operational environments.

Immersive visualisation was acknowledged as a strong added value for understanding terrain and operational scenarios. Nevertheless, most respondents considered AR/VR to be currently more appropriate for training, preparedness, and post-event analysis than for immediate, real-time operations. Improvements in visual clarity, immersion, predictive capabilities, and fire-behaviour modelling were identified as potential areas for future enhancement.

The integration between the dashboard and AR/VR environments was well received, though some barriers emerged, such as manual refresh requirements and small, delayed updates.

Decision-making support emerged as a key strength of the platform. Users emphasised the value of integrated visual and real-time information for enhancing situational awareness, with participants describing the system as providing "eyes to the operation."

Collaboration and communication capabilities were consistently viewed as strong aspects. The ability for multiple users to interact with the system simultaneously, combining dashboard management and immersive analysis, was seen as a clear advantage, particularly for distributed command and coordination scenarios.

Finally, users emphasised that system reliability must be validated under extreme and realistic operational conditions, including heat, smoke, wind, and degraded communications. Across all interviews, training was identified as a critical prerequisite for successful operational deployment.

Dimension	***Indicative Avg. Score (1–5)***	***User Perspectives (Summary)***
Usability & Intuitiveness	4.5	Dashboard is widely perceived as intuitive; AR/VR requires initial familiarisation.
Technical Performance	4.0	Good functionality; some delays and responsiveness issues observed.
Visual Clarity & Immersion (AR/VR)	3.5	Valuable for understanding terrain and scenarios; more suited to training contexts
System Integration & Synchronisation	3.5	Integration concept validated; some issues with real-time updates and synchronisation.
Decision-making Support	3.5	Provides relevant and integrated information; enhances operational awareness.
Collaboration & Communication	4.0	Enables multi-user interaction and shared situational awareness across roles.
Reliability in Real Conditions	3.0	Promising performance but requires validation under extreme conditions.
Overall Satisfaction	4.0	Positive perception across users; usefulness linked to training and context.

Table 2: Feedback summary of interviews

The feedback collected from end users confirms that the OVERWATCH platform delivers substantial operational value, particularly in enhancing situational awareness, supporting decision-making, and enabling collaborative workflows across multiple levels of command. Key strengths include the intuitive dashboard, the integration of visual information for decision support, and the platform's capacity for distributed, multi-role collaboration.

Overall, the results validate the strategic direction of the OVERWATCH initiative, demonstrating strong alignment between the platform's technological capabilities and emergency responders' needs. The system is well-positioned as a responder-centred crisis-management solution, with the potential to support increasingly complex emergency scenarios across Europe.

8. End-User Training Guide

To support the training activities and system demonstrations described in this report, a dedicated OVERWATCH End-User Guide was developed to provide structured, operationally focused guidance for end users.

The OVERWATCH End User Guide supports the effective adoption and operational use of the OVERWATCH system by emergency responders, civil protection personnel, and command-level decision-makers. It responds to the need for clear guidance and instructions for effective use, complementing hands-on training.

The guide is available in two complementary formats: a written End User Guide and an interactive e-learning version. Together, these formats support both initial familiarisation and iterative learning, allowing users to reinforce knowledge before, during, and after training and system demonstrations.

The guide is structured into two main sections. The first section introduces the OVERWATCH web-based dashboard and explains how users access the system, build situational awareness, request and view map information, work with external map layers, manage drone activities, and use fallback communication features.

The second section focuses on the OVERWATCH AR application, covering system requirements, core functionalities, and step-by-step operational workflows.

Content is organised into short, modular units supported by annotated visuals, enabling self-directed, task-oriented learning and rapid consultation during operations. For AR-related functionalities in particular, the guide provides a preparatory layer that reduces the learning curve prior to immersive use. The End-User Guide does not replace training activities but complements them by serving as a reference during and after operational use, alongside the interactive e-learning module. The guide is provided in full as Annex A.

9. Conclusions

9.1 Overall achievements

The OVERWATCH Pilots delivered a set of clear, measurable achievements that validate the project's technological vision and confirm its operational relevance for European emergency-management authorities. Despite the contrasting conditions of the two demonstrations, one constrained by extreme weather in Portugal, the other executed in a controlled, conference-based format in Poland, both Pilots consistently demonstrated that the OVERWATCH ecosystem is mature, resilient, and aligned with the real needs of responders.

The first achievement was validating the integrated technological architecture. Across both Pilots, Earth Observation, drone-based sensing, AI-powered analytics, augmented-reality visualisation, and fallback communications were shown to operate as a coherent, end-to-end system capable of transforming dispersed data into actionable intelligence. As noted in the report, responders repeatedly emphasised that "time and accuracy of information make the difference between success and failure," and the Pilots confirmed that OVERWATCH directly addresses this operational imperative.

A second achievement was the strong confirmation of user acceptance and operational value. Firefighters, civil-protection personnel, and command-level officers consistently recognised the platform's ability to enhance situational awareness, support decision-making, and improve coordination. The Pilots demonstrated that the dashboard is intuitive, the AR environment adds value to planning and training, and the AI-driven AIMS engine significantly improves the clarity and timeliness of information flows. Interviewed responders described the system as providing "eyes to the operation," highlighting its contribution to both strategic and tactical workflows.

A third achievement was the demonstration of resilience and adaptability, both technological and organisational. The severe storms that disrupted the Portuguese Pilot forced a rapid transition to indoor demonstrations, yet the system continued to perform effectively. This unexpected stress test validated the platform's robustness and underscored the importance of redundancy and flexibility in crisis-management technologies. The report notes that these conditions "highlighted the importance of resilience, adaptability, and redundancy," reinforcing the project's strategic relevance in a Europe increasingly affected by extreme weather.

A fourth achievement was the successful engagement of a broad, multinational community of stakeholders. Both Pilots brought together emergency responders, civil-protection authorities, military units, geospatial experts, and policy-level institutions. This engagement not only validated the system's interoperability across agencies but also strengthened the foundation for future adoption and integration into national information ecosystems. The Polish Pilot, in particular, demonstrated the system's relevance for institutions shaping the future digital architecture of emergency response.

The Pilots provided critical insights that will guide future development. They identified priorities such as enhanced interoperability, streamlined interfaces, expanded communication resilience, and structured training pathways. These insights ensure that OVERWATCH will continue to evolve as a responder-centred solution, grounded in operational reality rather than technological abstraction.

These achievements confirm that OVERWATCH has delivered a functional, integrated, and operationally meaningful crisis-management ecosystem. The Pilots demonstrated technological success and moderate strategic impact, positioning OVERWATCH as a significant contribution to Europe's preparedness, resilience, and capacity to manage increasingly complex emergencies.

9.2 Added value to crisis response

The OVERWATCH Pilots demonstrated a clear and substantial added value to crisis-response operations by showing how an integrated technological ecosystem can overcome long-standing limitations in situational awareness, communication resilience, and multi-agency coordination. Across both wildfire and flood scenarios, the system proved capable of transforming fragmented data streams into a coherent operational picture, enabling responders to act faster, with greater precision, and with a shared understanding of evolving hazards.

A central contribution lies in the platform's ability to fuse multi-source data, satellite imagery, drone acquisitions, Copernicus EMS layers, and field observations into actionable intelligence. This directly addresses the challenge described in the report, where responders often operate with "incomplete or dispersed information," a condition that slows decision-making and increases operational risk. By consolidating these inputs through the AIMS analytical engine and presenting them through intuitive dashboards and AR interfaces, OVERWATCH significantly enhances the clarity, timeliness, and reliability of information available to field teams and command structures.

Another key added value is the strengthening of communication resilience. The wildfire pilot highlighted how quickly operations can be compromised when networks fail, and the project's fallback communication module, based on a tethered drone with satellite backhaul, proved essential for restoring connectivity in degraded environments. This capability directly supports command-and-control continuity, ensuring that critical data flows remain uninterrupted even under extreme conditions.

The platform also adds value by improving coordination across agencies and operational levels. The Pilots brought together military units, civil-protection authorities, firefighters, geospatial experts, and technical teams, demonstrating that OVERWATCH can serve as a shared operational environment that bridges institutional boundaries. This interoperability is particularly important in complex emergencies where multiple actors must synchronise actions under time pressure.

The system contributes to crisis response by enhancing training, preparedness, and post-event learning. The AR environment and structured pilot methodology allowed responders to rehearse decision-making, explore hazard evolution, and evaluate operational strategies in a controlled yet realistic setting. As noted in the document, the Pilots were designed to "validate the entire OVERWATCH technological ecosystem in real operational contexts," ensuring that lessons learned translate directly into improved readiness.

9.3 Strategic alignment with EU priorities

The OVERWATCH project aligns closely with the European Union's strategic priorities under the European Green Deal, the EU Climate Adaptation Strategy, and broader initiatives aimed at strengthening resilience to climate-driven disasters. By addressing the rising frequency and severity of wildfires and floods, two of Europe's most disruptive climate-related hazards, the project directly contributes to the EU's objective of building a climate-resilient Union by 2050.

A central element of this alignment is the project's focus on improving situational awareness and decision-making in the face of extreme weather events. The document highlights that Europe is "increasingly affected by climate change, extreme weather events, and complex, multi-agency crisis operations," underscoring the need for advanced tools that can support rapid, informed responses. OVERWATCH responds to this need by integrating Earth Observation, AI analytics, drone-based sensing, and resilient communications into a unified operational ecosystem that supports all phases of the disaster-management cycle.

The project also supports the Green Deal's emphasis on digital transformation as a driver of environmental resilience. By fusing satellite data, real-time drone imagery, and predictive modelling, OVERWATCH enhances the EU's capacity to monitor environmental conditions, anticipate the evolution of hazards, and reduce the ecological and human impacts of climate-driven emergencies. This aligns with EU priorities on leveraging space-based services, particularly Copernicus and Galileo, to strengthen climate adaptation and civil-protection capabilities.

Furthermore, the project contributes to the EU's goal of improving cross-border and multi-agency cooperation in disaster response. The Pilots brought together military units, civil-protection authorities, fire services, and scientific institutions from multiple Member States, demonstrating the system's potential to support interoperable, pan-European crisis-management frameworks. This directly supports the EU Civil Protection Mechanism's objective of enhancing shared preparedness and coordinated response across the Union.

OVERWATCH advances the EU's commitment to protecting citizens and ecosystems from climate-related risks by enabling faster detection, more accurate hazard mapping, and more effective operational coordination. As the report notes, the project aims to deliver "a safer, more resilient, and knowledge-driven European emergency-response capability," reflecting the core ambitions of both the Green Deal and the Climate Adaptation Strategy. In this way, the project addresses immediate operational challenges and contributes to the long-term strategic transformation required for the EU to adapt to a rapidly changing climate.

9.4 Policy-level considerations

The OVERWATCH Pilots highlight several policy-level considerations essential to strengthening Europe's capacity to manage climate-driven emergencies and to ensure that advanced technological systems can be effectively integrated into national and EU-wide crisis-management frameworks. These considerations extend beyond the project's technical achievements and point to structural, regulatory, and governance needs that must be addressed to realise the benefits of next-generation emergency-response technologies fully.

A first conclusion in this series of Pilots concerns the need for harmonised data-sharing frameworks across agencies and Member States. The Pilots repeatedly demonstrated that responders operate in environments where information is "incomplete or dispersed," and where incompatible systems and fragmented data hinder multi-agency coordination flows. Establishing common standards for geospatial data, drone imagery, AI-generated intelligence layers, and AR-ready operational products would significantly enhance interoperability and accelerate decision-making during cross-border or multi-regional emergencies.

Communication resilience constitutes a strategic capability of critical importance. The wildfire pilot showed how environmental conditions or data networks can compromise operations, and how essential fallback communication systems are for maintaining command-and-control continuity. Policymakers may therefore need to consider integrating aerial communication relays, satellite backhaul, and decentralised network architectures into national civil-protection doctrines, ensuring that redundancy becomes a mandatory component of emergency-response planning.

Another policy-level implication concerns the governance of AI-enabled decision-support systems. As the project integrates machine-learning models for hazard mapping, hotspot detection, and predictive analytics, clear guidelines are needed to ensure transparency, accountability, and human oversight. The Pilots confirmed that AI can significantly enhance situational awareness, but its outputs must be embedded into decision-making frameworks that preserve responder autonomy and comply with emerging EU regulations on trustworthy AI.

A fourth consideration involves the institutionalisation of immersive technologies, such as AR-based operational planning and training, within civil-protection organisations. The Pilots demonstrated that AR environments can improve understanding of terrain, hazard evolution, and resource allocation, offering value not only during emergencies but also in preparedness and training. Policymakers may therefore consider integrating immersive technologies into national training curricula, certification pathways, and simulation-based exercises.

The Pilots underscore the importance of sustained investment in multi-agency collaboration and capacity-building. The OVERWATCH project aimed to contribute to "a safer, more resilient, and knowledge-driven European emergency-response capability," a goal that requires long-term institutional commitment. Policy frameworks that support joint exercises, shared innovation programmes, and cross-border operational readiness will be essential to ensure that systems like OVERWATCH can be adopted, maintained, and continuously improved across the EU.

References

ID		Title		Revision		Access Date
RD01		D1.1 End-users requirements. Source link		1.0		2026
RD02		D1.2 Functional/Technical requirements & System architecture. Source link		0.5		2026
RD03		Horizon Result Platform. Source link				2026
RD04		Horizon Result Booster. Source link				2026
RD05		Overwatch Project Synergies. Source link				2026
RD06		LinkedIn. Source link				2026
RD07		Video #1 - demo activities in CMSM. Source link				2026
RD08		Video #2 - demo activities in CMSM. Source link				2026

Annex A

End user Guide

Work package: WP4
Dissemination level:
Lead partner: ISQ
Authors: Joana Marta, Rita Frutuoso

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Deliverable No.	
Work Package	4
Dissemination Level	Public
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Co-Author(s)	Manoj Shah, H.; Nicoletti, T.;
Date	
Status	Final version
Version	1.0
Reviewed by (if applicable)	Manoj Shah, H.; Nicoletti, T.; Carvalho, A. Milczarek, M.

Contents

OVERWATCH

AIM

OVERWATCH is an **integrated holographic crisis management system** that **enhances communication**, **information gathering**, and **coordination** between disaster response teams. It aims to support emergency and crisis management for wildfires and floods.

The platform provides a unified operational environment that combines Earth Observation data, drone-based intelligence, Artificial Intelligence, and geospatial visualisation tools to support decision-making in emergency management.

OVERWATCH enables emergency teams to move from fragmented information sources to a shared and consistent operational picture, ensuring that critical information is accessible, timely, and actionable.

It is an intuitive, decentralized, informed, precise, safe, and resilient tool for managing disasters while reducing the risk to humans and material goods.

Operational context

Emergency response operations are increasingly complex, requiring coordination across multiple agencies, rapid decision-making, and access to reliable and timely information.

OVERWATCH answers to challenges such as:

- Communication gaps and network failures
- Decision-making under time pressure
- Fragmented and non-integrated data sources
- Limited access to real-time situational information

OVERWATCH supports the full emergency management cycle:

Planning

Defining risk areas and preparing response strategies

Response

Real-time monitoring and coordination

Assessement

Analysing impacts and supporting decision-making

The platform enables a shared operational picture across all levels of command.

BENEFITS and VALUE

The OVERWATCH system enables visualization of map data, metadata, and weather information, as well as distance measurement and information feedback, thereby enhancing situational awareness in emergency management operations.

It integrates multiple data sources, including Earth Observation (EO), drone-based data, and environmental information, into a single operational platform, allowing users to access and interpret complex information in a unified and intuitive way.

OVERWATCH supports emergency teams in quality mission planning, providing an insightful starting point and, in the aftermath of a disaster, a detailed overview of the consequences. It supports risk assessment, provides historical data of past natural hazards, and identifies areas where other natural hazards have the potential to cause significant harm.

RELIABLE GEOSPATIAL DATA

EO services: single image and pre/post event analysis
Real-time and historical satellite data
Automated requests and status tracking

ON THE GROUND DATA COLLECTION

Built-in drone mission planning
Multi-sensor support (RGB, thermal, LiDAR)
Onboard map generation

System Overview

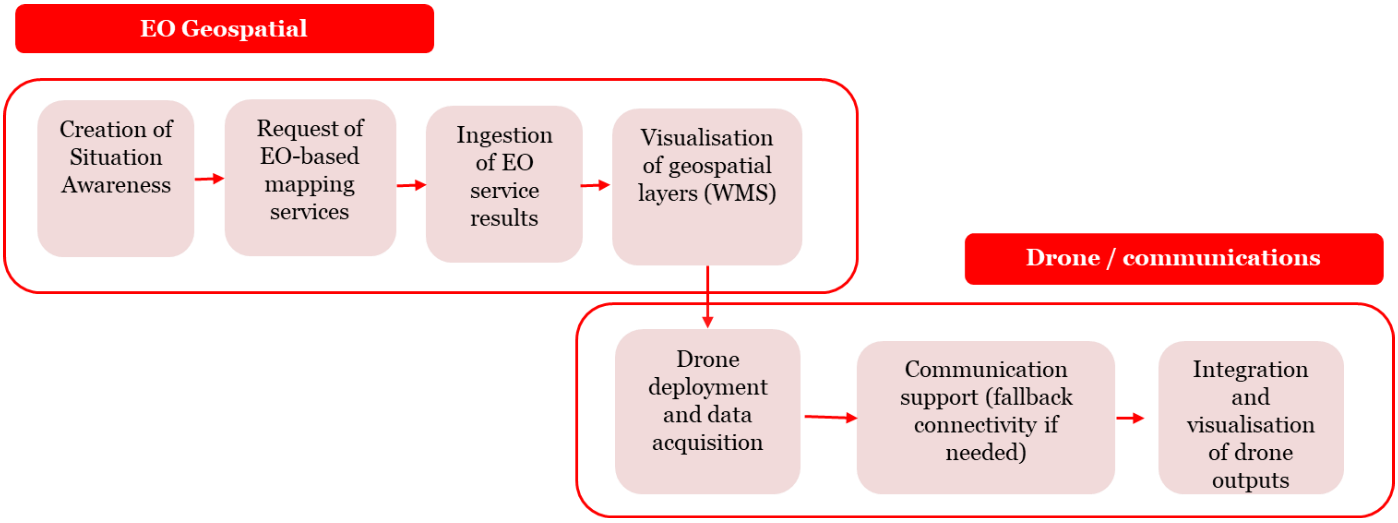
The OVERWATCH system is an integrated crisis management platform that combines multiple technologies into a unified operational environment.

It includes:

- A web-based dashboard for command and planning
- A geospatial data infrastructure (map server, data repository)

- Earth Observation (EO) services for satellite-based analysis
- Drone-based data acquisition
- AI-based processing for hazard detection and analysis
- Augmented Reality (AR) for immersive visualisation
- Fallback connectivity for resilient communication

The OVERWATCH platform follows a structured operational workflow aligned with real emergency response procedures, enabling users to move from situation definition to decision-making.



The OVERWATCH system is designed to **support situational awareness** and rapid response in the context of environmental hazards such as wildfires and floods. Through OVERWATCH you can perform a series of actions that combine satellite-based analytics, GIS layers, and drone-based reconnaissance. Below is a breakdown of the system's core functionalities:

1. Define a Geographical Scope of interest

Select a specific area on the map to focus their analysis by drawing a polygon or selecting predefined administrative boundaries.

This geographical scope serves as the foundation for all subsequent operations, including data requests, drone missions, and map visualizations.

2. Select Services to Gather Information

Choose from a suite of EO (Earth Observation) services to retrieve relevant data. These services include single-image and pre-event/post-event analysis.

The system connects to external WMS (Web Map Services) to fetch satellite-derived layers and overlays them.

3. Launch a Drone Deployment Mission

For higher-resolution and real-time data needs, users can initiate drone missions directly from the dashboard.

4. Perform a Comprehensive Analysis of the Event

The system enables users to conduct **in-depth assessments** by combining EO data, GIS layers, and drone imagery. This can be used to **prepare for a mission** (e.g., identifying risk zones) or to **assess the aftermath of a hazard** (e.g., damage extent). The dashboard supports **multi-layer visualization**, **temporal comparisons**, and export of analytical results.

OVERWATCH DASHBOARD
Step by step

Login

Access the OVERWATCH Dashboard at: [OVERWATCH Dashboard]

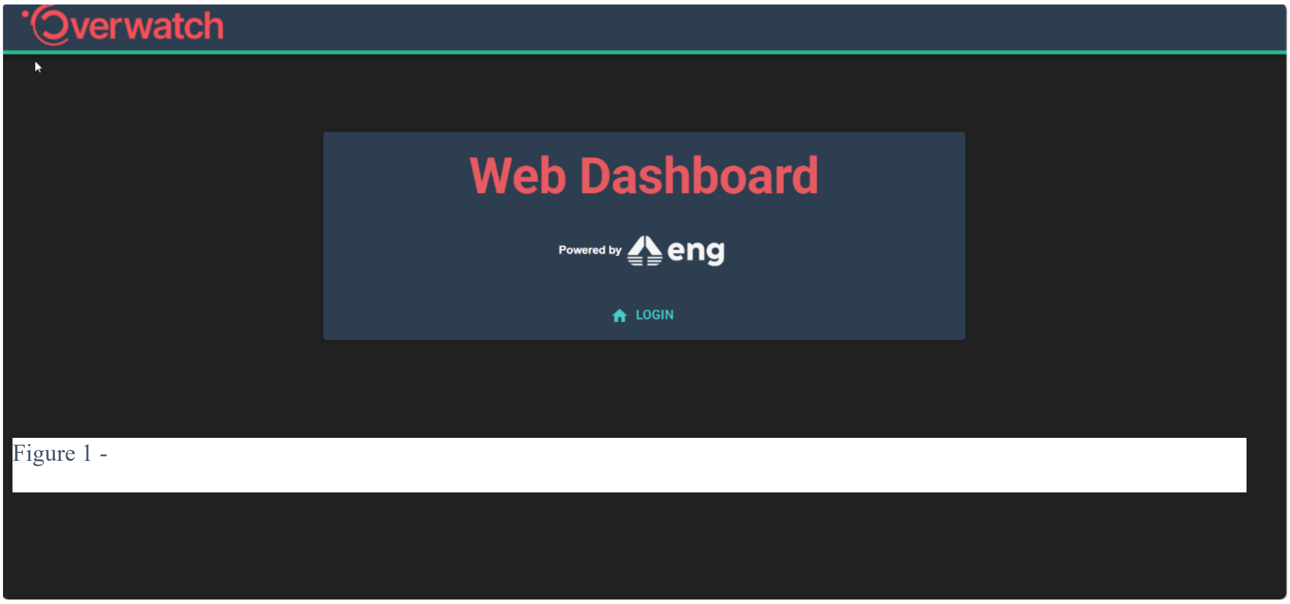


Figure 1 -

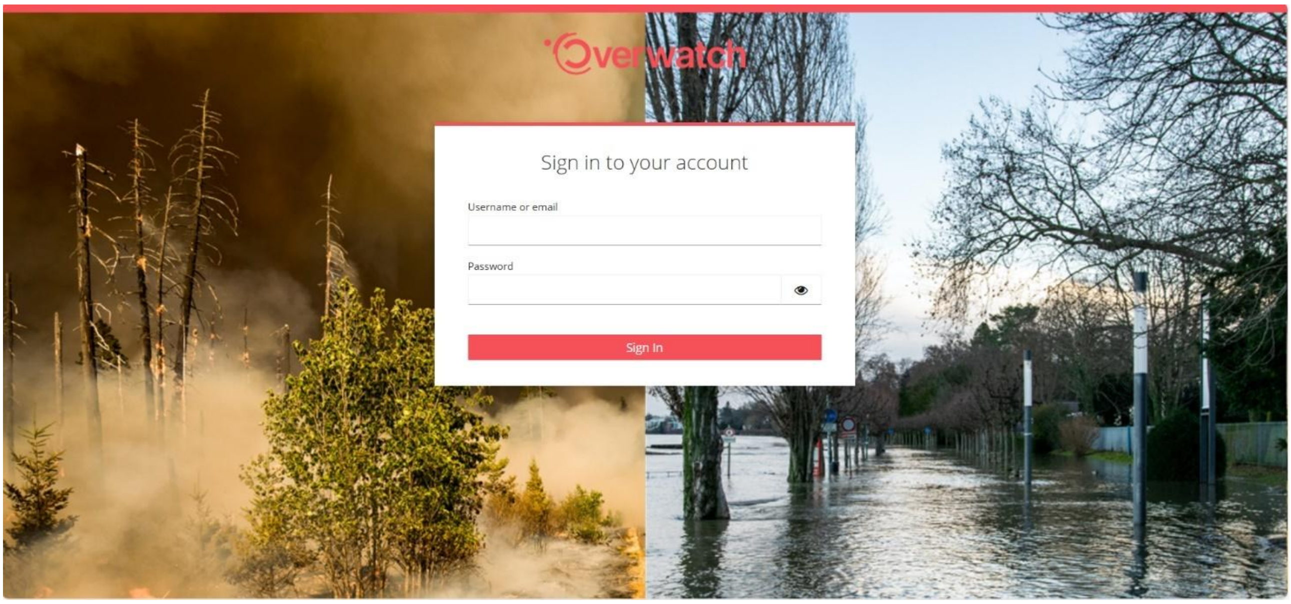


Figure 1 - Access the OVERWATCH Dashboard

1. In the Login form, enter username or email and password (Figure 1)
2. Click **Sign in**
3. Access the dashboard after sucessful authentication

Logout

To log out,

1. Click on the user icon in the top right corner
2. Click **Log out**.

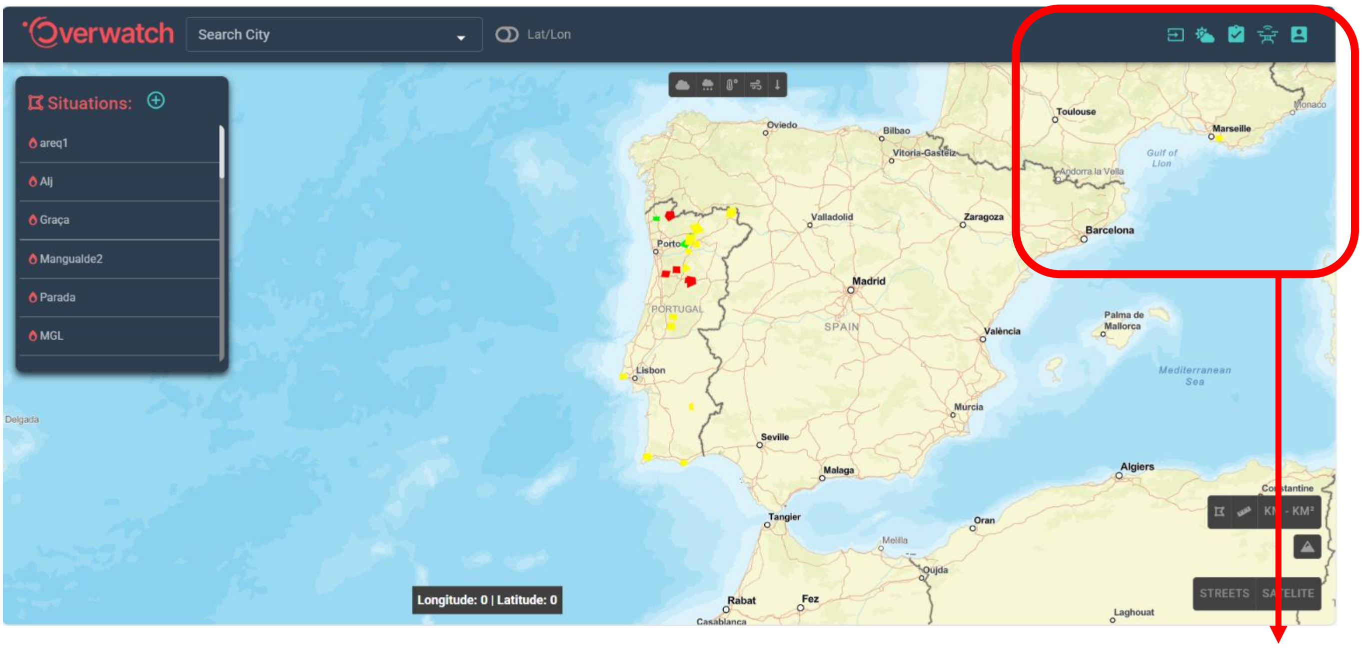


Figure 2 - User icon and Logout button

Get Familiar

Use standard mouse controls to interact with the map.

- Use the mouse wheel to zoom in and out
- Drag the map to navigate

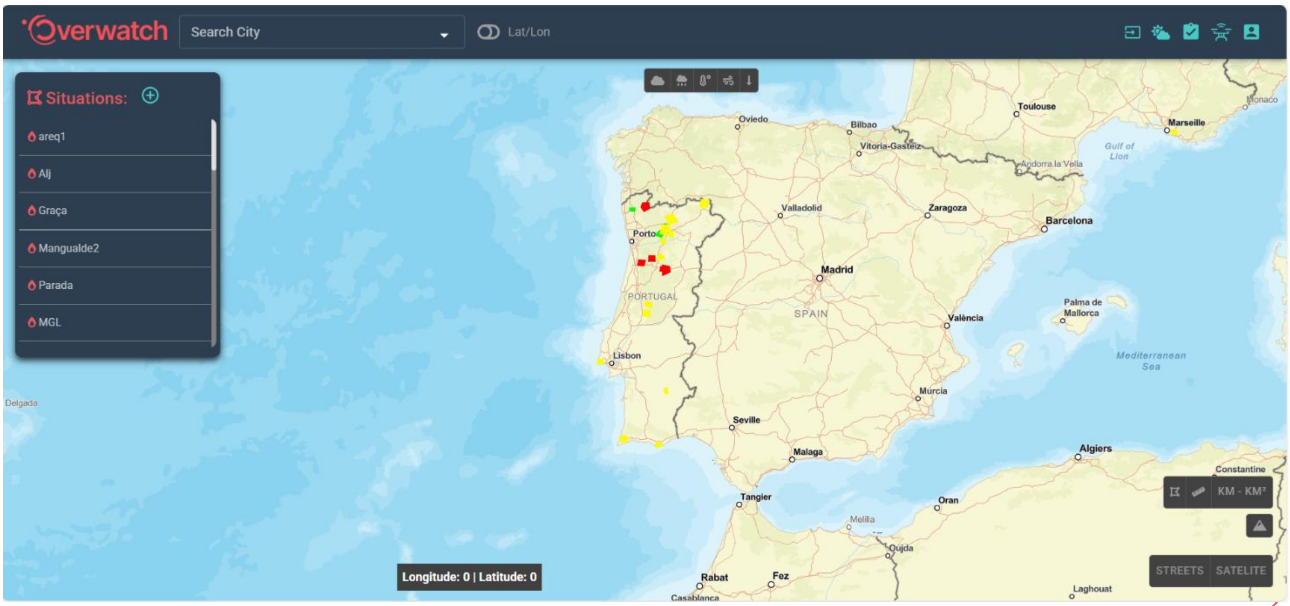


Figure 3 - Map-based view and controls

The map-based view and controls are organised in the top right corner of the screen. Main functionalities include:

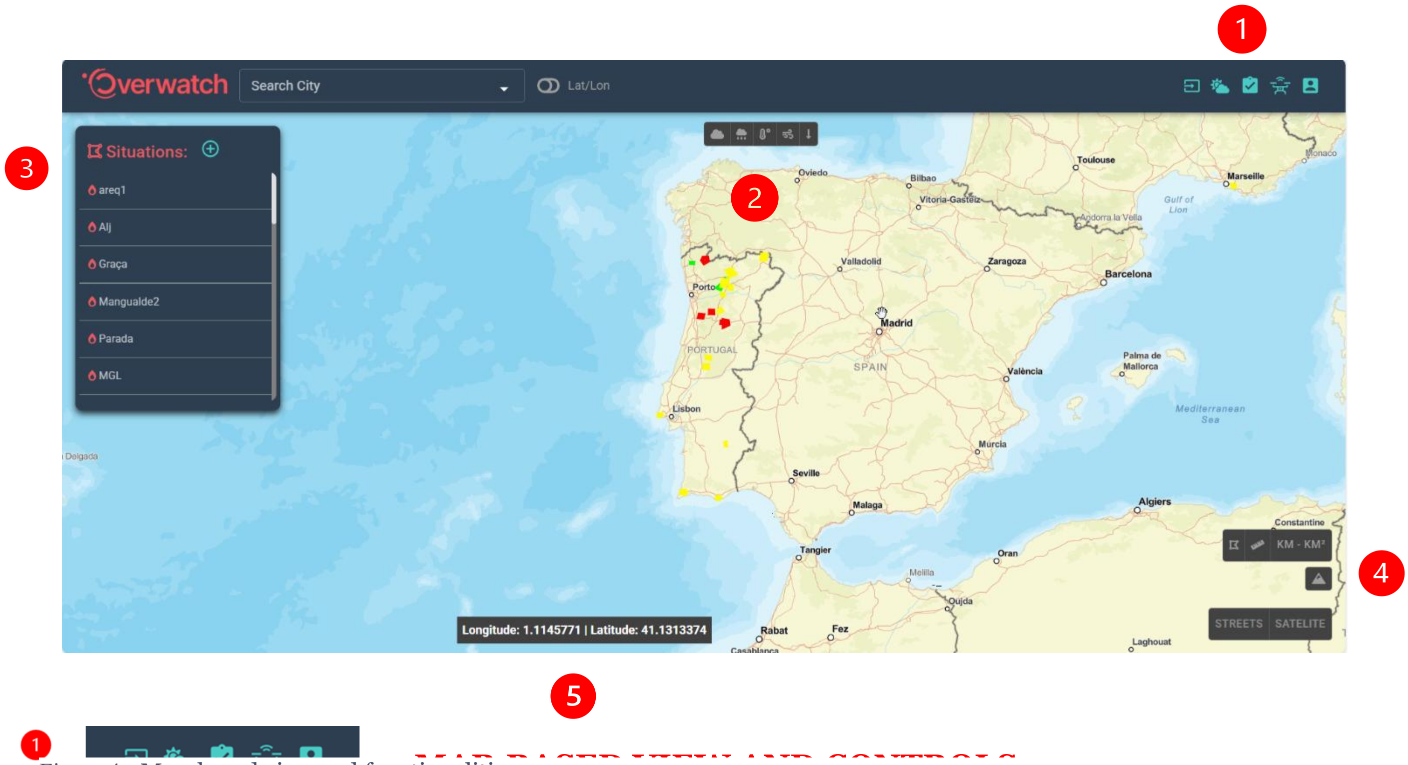


Figure 4 - Map-based view and functionalities

Change **Map View** into default or a slicer

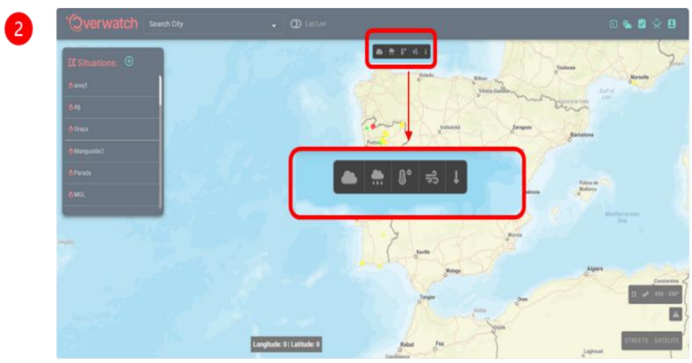
Enable **Weather Overlay:** to visualize weather conditions on the map

Access **Missions**

View **Drone Traffic**

Access **user profile**

Figure 5 – Map-based view controls



WEATHER OVERLAY

View weather parameters:

- **Clouds**,
- **Precipitation**,
- **Wind** and
- **Pressure**

The platform provides detailed weather forecasts to support operational decision-making.

It includes:

- Forecast panel
- Wind graph
- Detailed parameters

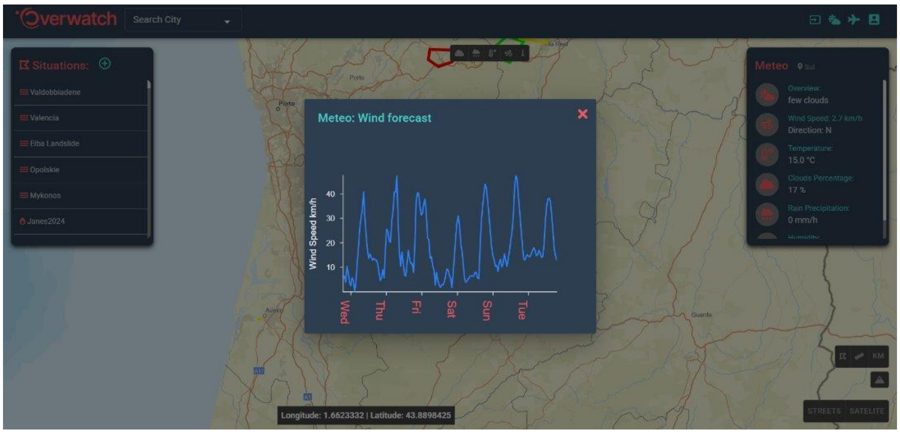


Figure 7 – Detailed weather forecast

3

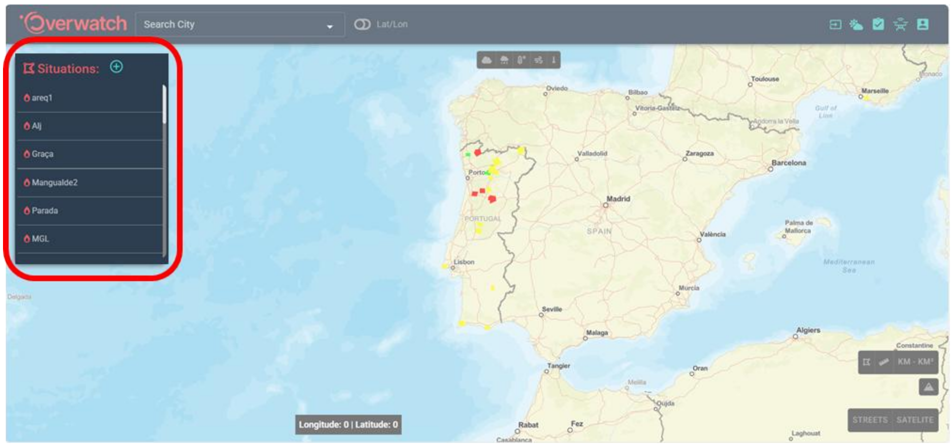


Figure 8 – Situations panel

SITUATIONS PANEL

Check active situations

4

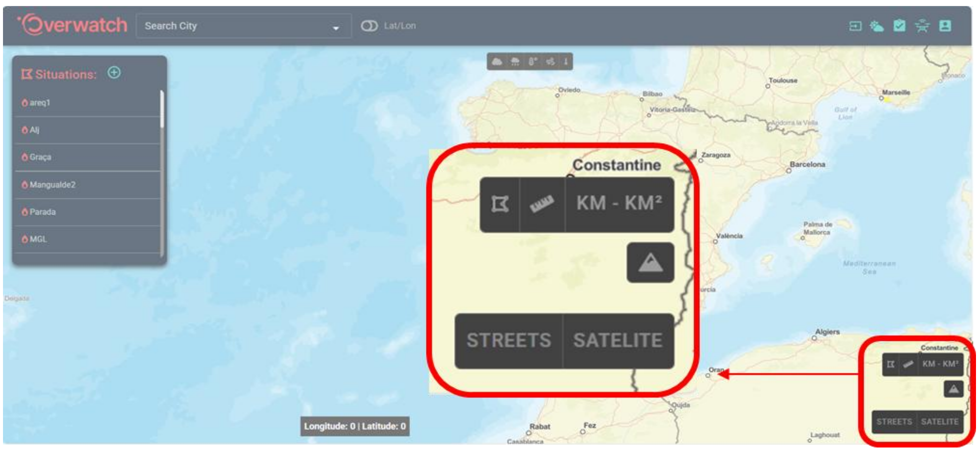
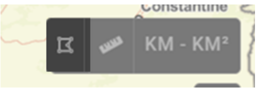
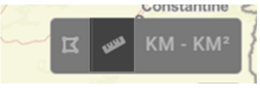


Figure 9 – Bottom-right corner controls

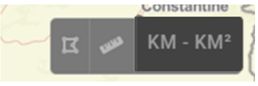
In the bottom-right corner, you will find the following:



Enter draw mode when defining a new situation

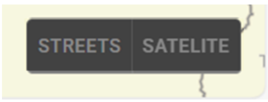


Measure tool: a map interface for distance measurements



Change the length unit from km to miles

Attitude Indicator: displaying current map elevation data.



Choose the map view (Satellite or street view)

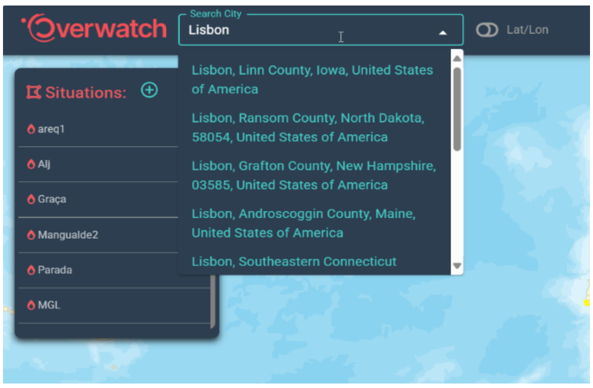
A. Creation of a Situation Awareness

1. Define Basic Info

1. Select the **location** for your analysis.

Search for a specific location using the research field.

OR Enter latitude and longitude by ativating the button



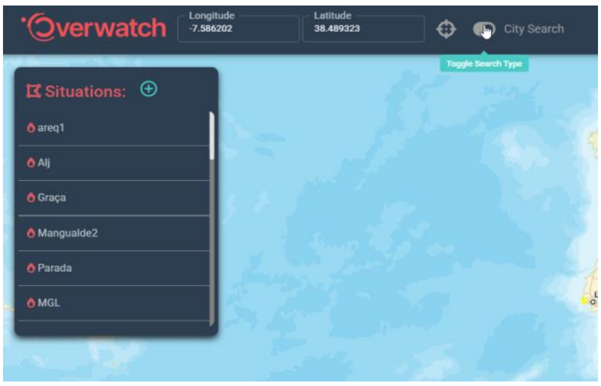


Figure 10 – Research field or coordinates location search

2. Click the + icon.
3. Activate the draw mode.
4. Draw a polygon on the map.

5. Triple-click to close the shape.

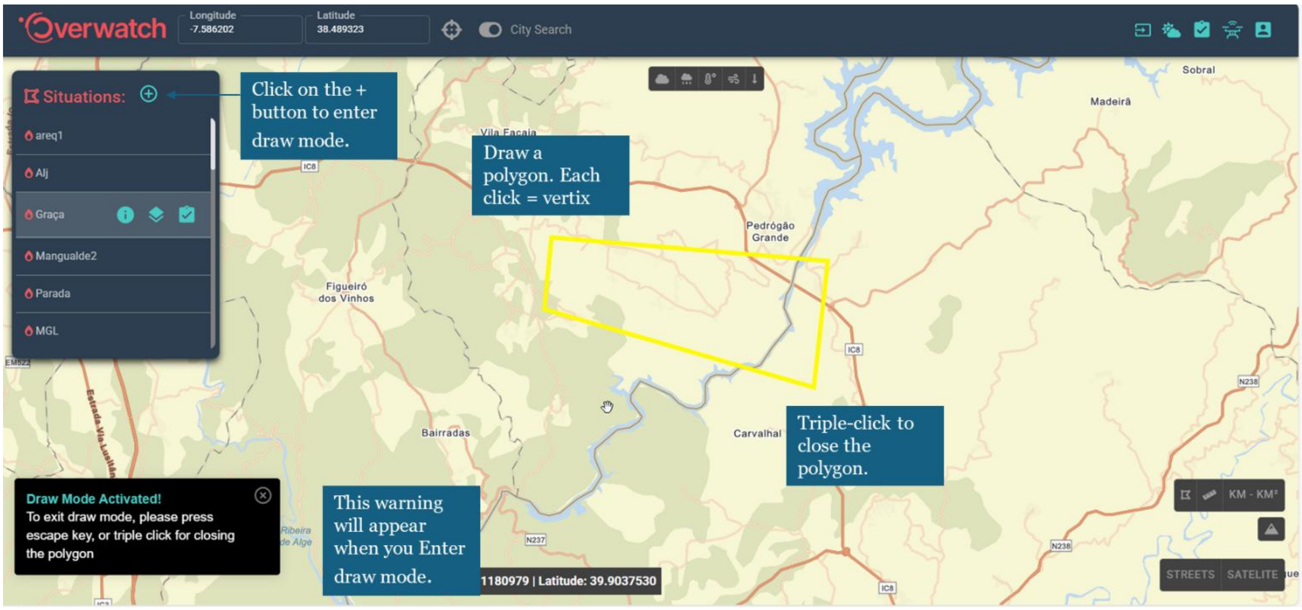


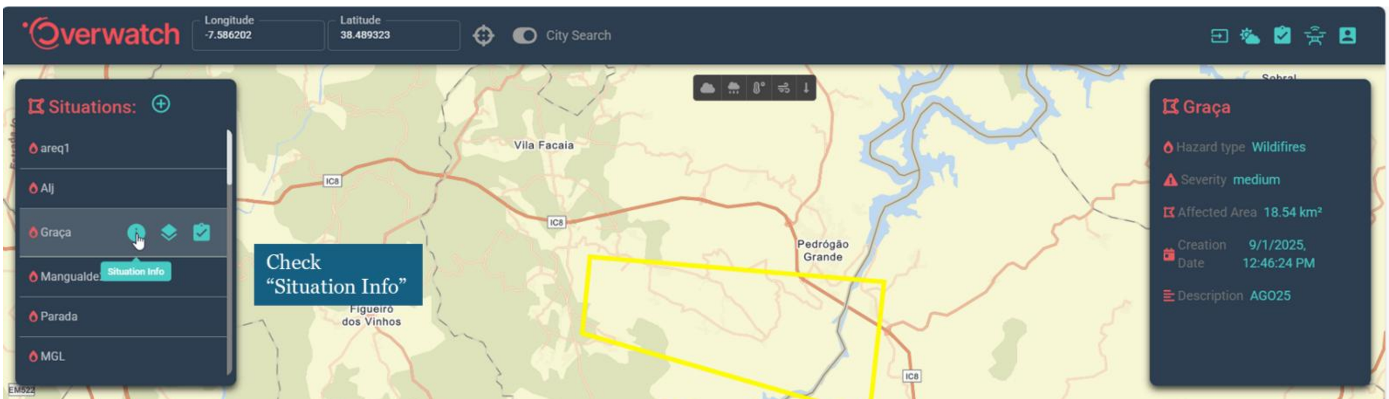
Figure 11 – Instructions for defining a area of interest

4. Fill in all mandatory fields describing the situation.
5. Click **Save**.

Area Name: name for the situation
Hazard Type: Wildfire or flood
Layer type*: hazard-dependent layers such as burnt are burn severity (if you select wildfire) , or water body delineation, flooded area (if you select flood)*
Description*: extra information for context*

Different services will appear according to the hazard type.

Figure 12 – Details for defining a new situation



7

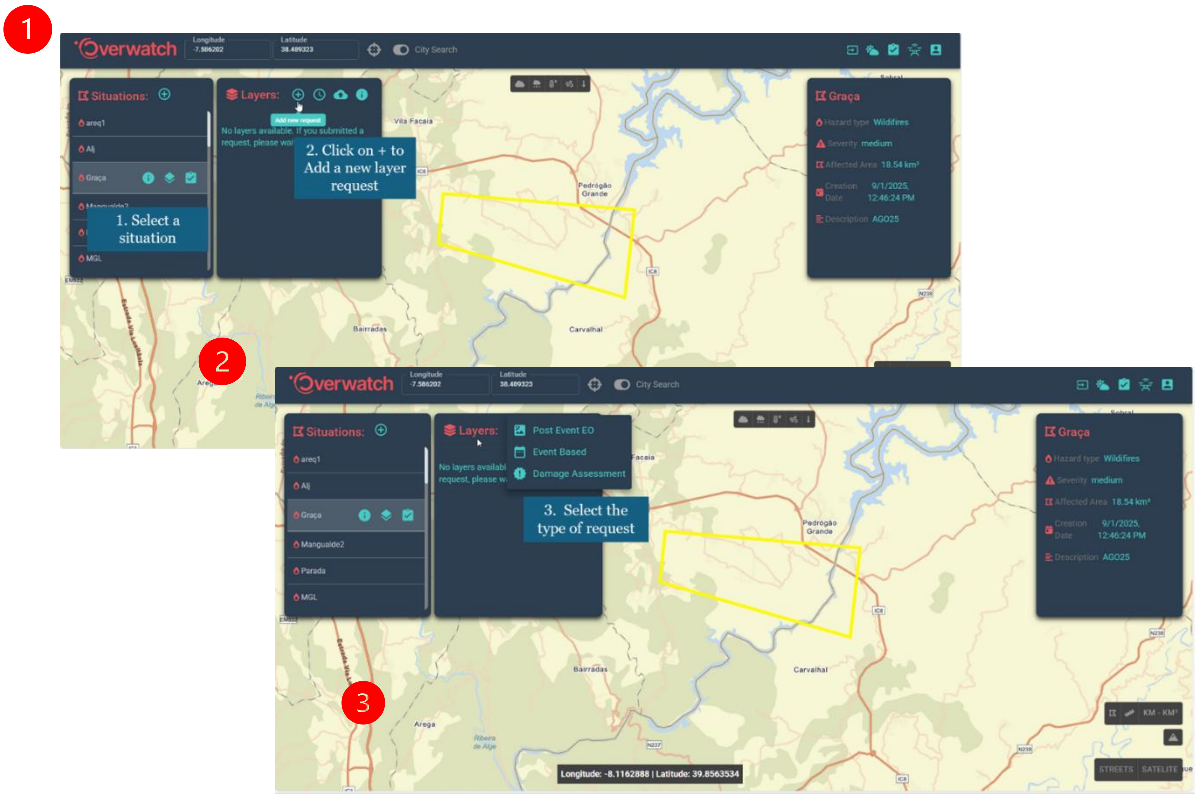
B. Request for EO-based layers

1. **Select a situation.**
   - After defining Situation Awareness, choose a relevant situation from the defined situations.
   - Click on the one you want to analyze further.

2. **Create a map request**
   - Click on the ⊕ to initiate a request. A request will be created for a **EO mapping Layer**.
   - Select a **time window** for the analysis.

3. **Choose Services**

Once you've **selected a situation**, you'll be presented with **three types** of map requests: single-image, or "post-event-only" services, event-based, or "pre-post" requests, and damage assessment requests. While the first two will provide different options depending on the hazard type of the situation, the latter can be used for any kind of damage assessment.



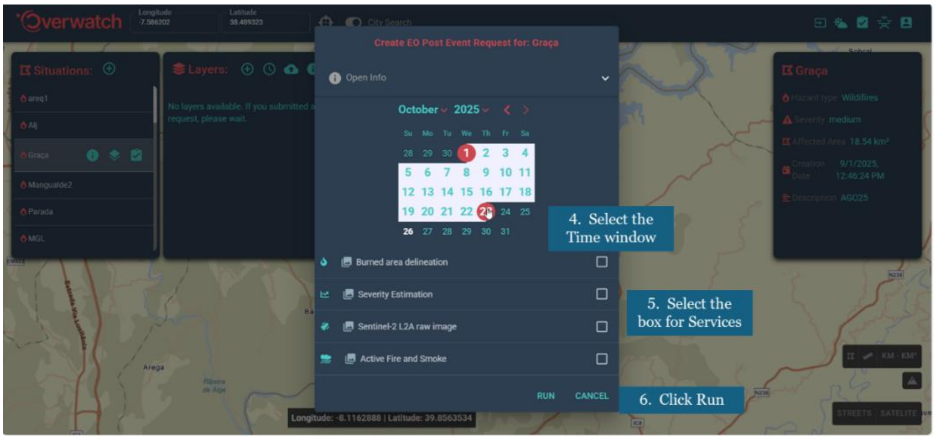


Figure 14 – Septs for choosing services to analyse a situation

3.1. How map requests work

When you submit a map request, you're asking the system to analyze satellite images of a specific area to help assess damage from disasters like floods or fires.

To do this effectively, we need a few key pieces of information from you:

- the location you want to monitor (your *area of interest*), and
- the time period you want to analyze.

In practice, think of it like telling the system "***where** to look*" and "***when** to look*".

Behind the scenes, our system searches through archives of satellite images to find the clearest pictures of your area during your specified time period. Satellites pass over different parts of Earth at different times, and weather conditions like clouds can affect image quality. By giving us a date range, you allow the system to search through multiple images and automatically select the best ones (e.g., the cleanest and closest to the event date). Once the right images are found, our AI models analyze them to detect water bodies, floods, burned areas, or other changes caused by disasters. The system then automatically creates thematic maps from these inputs, showing what happened (depending on what you chose to delineate) and where.

3.2. Why do we need dates?

Satellite images are captured at different moments in time, and not all of them are usable. Some may have clouds, fog, or other obstructions that make them unclear. When you provide a date range with a start date and end date, our system searches through all available satellite images taken during that period and selects the clearest ones to create an accurate map for you. This approach ensures you receive reliable results even when weather conditions vary across different days. If you are not satisfied with the results, try to refine the date interval with a new request to target a specific period or specific image. See **Erro! A origem da referência não foi encontrada.** for a visual explanation of these concepts.

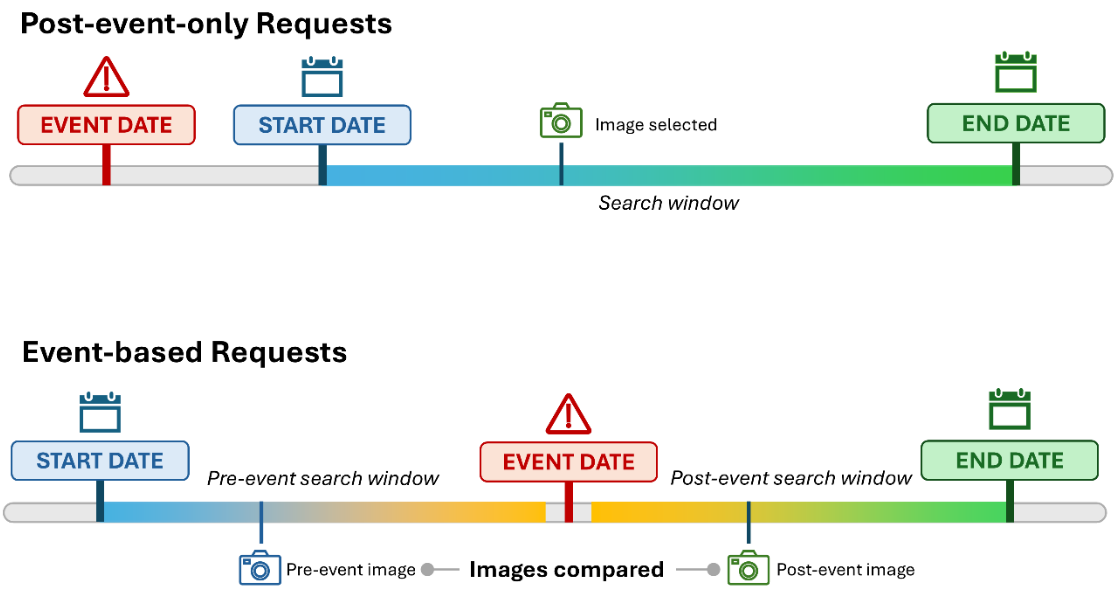


Figure 15 - Visual representation of the difference in time windows for post-only and event-based map requests

You can also find this information on the Type of Layers you select.

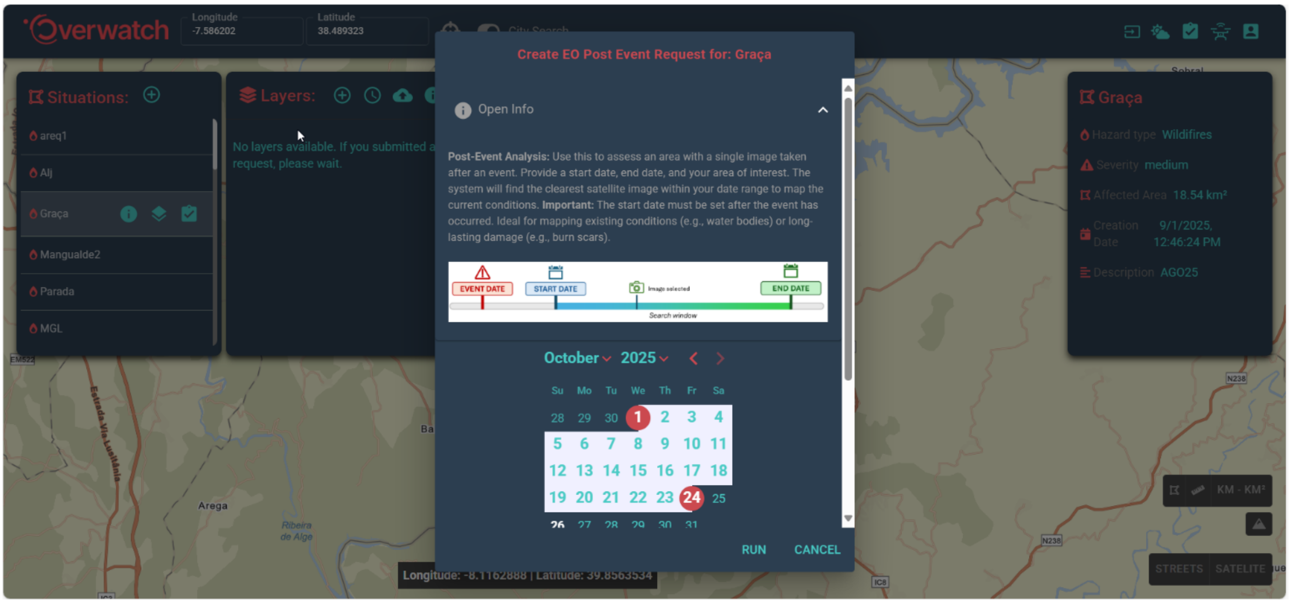


Figure 16 - Type of Layers information

Map requests come in two flavors:

- Standard **post-event** requests, and
- **Event-based** requests.

3.3. Single-image, Post-event requests

This type of request works with a single image, providing a **start date**, an **end date**, and your **area of interest**. This is designed for situations where you want to assess the current state of an area after an event has already occurred. It's important to note that **the start date should be set after the event**: it can be as close as possible to the event time, but it needs to be posterior if you want to analyze what has happened. The system will search for images between your start and end dates, find the clearest satellite image closest to your start date, and analyze it to create your map showing the current conditions. This request type is ideal for tasks like mapping current water bodies where you simply need a snapshot of conditions at a specific time, or delineating burned areas where the damage remains visible for weeks or months after a fire, making it possible to assess the impact without needing pre-event imagery for comparison.

3.4. Event-based requests

This request type is specifically designed for disasters that evolve quickly, like floods, or simply to get a better estimate than only using the post-event image, concentrating on finding out what changed. In addition to providing a start date, end date, and area of interest, **you also specify an event date** marking when the disaster occurred. This creates two time windows: a ***before window*** running from the start date to the event date, and an ***after window*** running from the event date to the end date. The system finds the clearest image from before the event and the clearest image from after the event, then compares them to show you exactly what changed because of the disaster. The before image is always taken prior to the event date, and the after image is always taken after the event but before your end date, ensuring an accurate comparison. The internal mechanisms used by the system to select the images in each window are the same employed in the previous map request type.

3.5. Damage assessment requests

This request type is designed for detailed infrastructure damage analysis using very high-resolution (VHR) imagery, such as photos from drones or specialized satellites. Unlike the other request types, you need to provide both the pre-event and post-event images yourself. This is because the level of detail needed to assess damage to individual buildings and roads requires much higher resolution than standard satellite services provide, and these specialized images often come from targeted imaging missions flown specifically in response to a disaster (i.e., the system cannot retrieve them automatically). Once you provide the images, our system analyzes them to identify buildings and roads, then compares the before and after images to detect and measure the extent of damage to infrastructure in the affected area.

4. Add External WMS Layers

The platform supports the integration of external Web Map Service (WMS) layers from national and European services.

1. Open the WMS layers panel.
2. Select **Add WMS URL.**

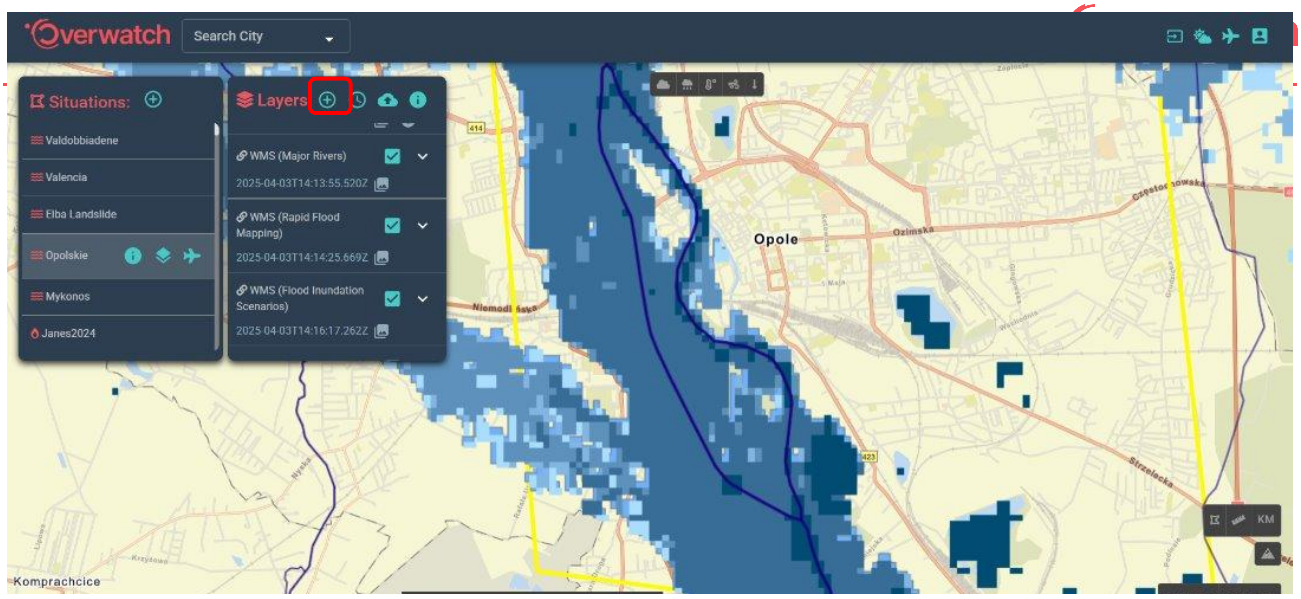


Figure 17 - WMS layers panel

3. Enter the service URL.
4. Load available layers.
5. Select and display the desired layer.

Use this feature to integrate external data sources such as:

- Fire danger forecasts (EFFIS)
- Flood information services (EFAS)

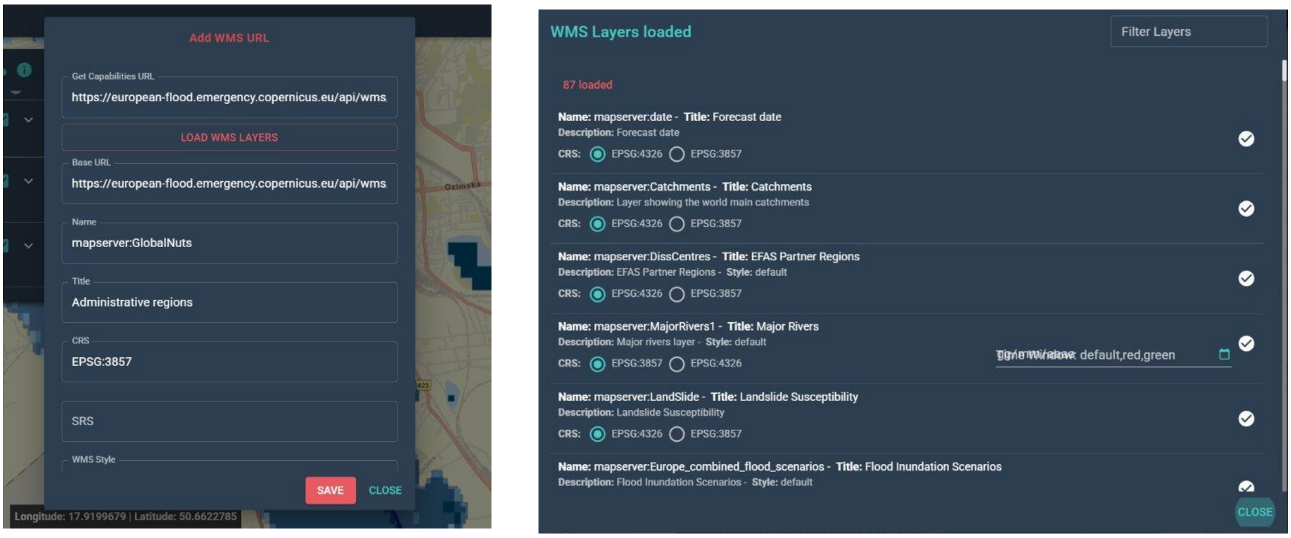


Figure 18 – WMS URL and loaded layers panel

Use this feature to integrate external data sources such as:

- Fire danger forecasts (EFFIS)
- Flood information services (EFAS)

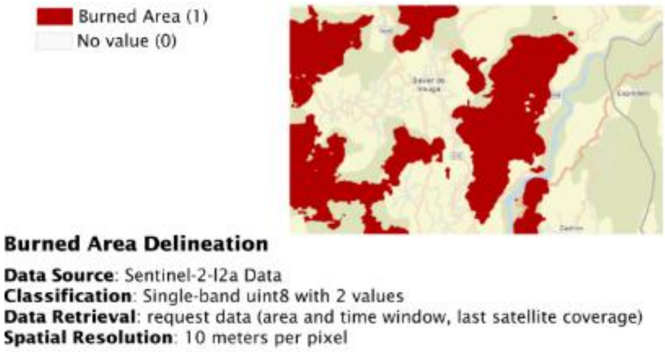
This functionality extends the platform by enabling access to additional authoritative geospatial datasets.

C. Explore Available Services

Wilfire Services

1. Burned Area Delineation (single-image)

- Estimates areas affected by fire using a single post-wildfire satellite imagery.
- Produces binary layers 0/1 (not burned / burned).

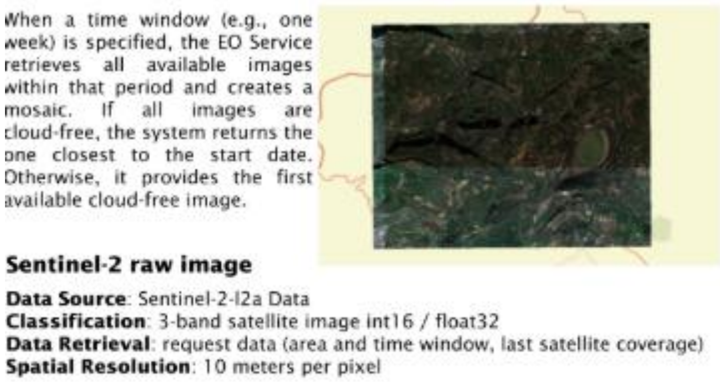


⚠️ Affected by cloud or smoke coverage.
⚠️ Post-wildfire only.
✅ Good estimate using a single

Figure 19 – Burned area information

2. Sentinel-2 raw image

- **Given a date interval, this option retrieves a raw satellite image** respecting the minimum requirements in terms of cloud coverage. If the date range is the same, this option is also useful to retrieve the same image selected to delineate burned areas for visual confirmation.
- **Creates a mosaic** from all available images in that range.
- **Returns the best image** based on clarity and proximity to the start date.



⚠️ The system selects the **first *clean* image** available. Even if other images are closer to the event date, if the cloud cover is above a given threshold, the image will be discarded.
✅ Good visual inspection for the AI-based delineation results.

Figure 20 - Sentinel raw image information

3. Severity Estimation

Similar to the burned area delineation, this option provides a burn severity estimation from a single post-event acquisition.

⚠️ Post-wildfire only
⚠️ Affected by cloud cover
✅ Does not require a pre-event image.
image

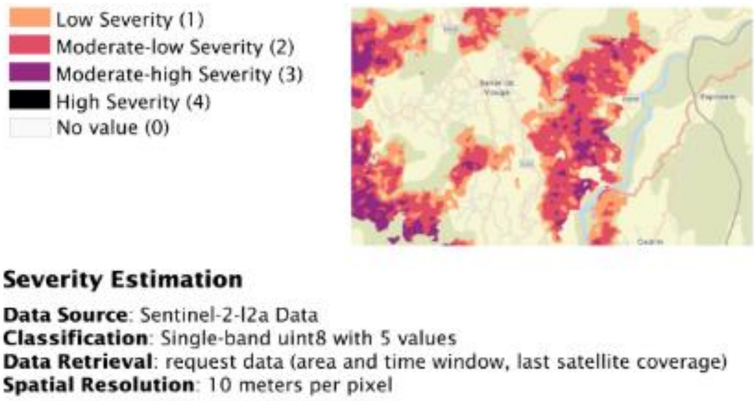


Figure 21 – Severity estimation image information

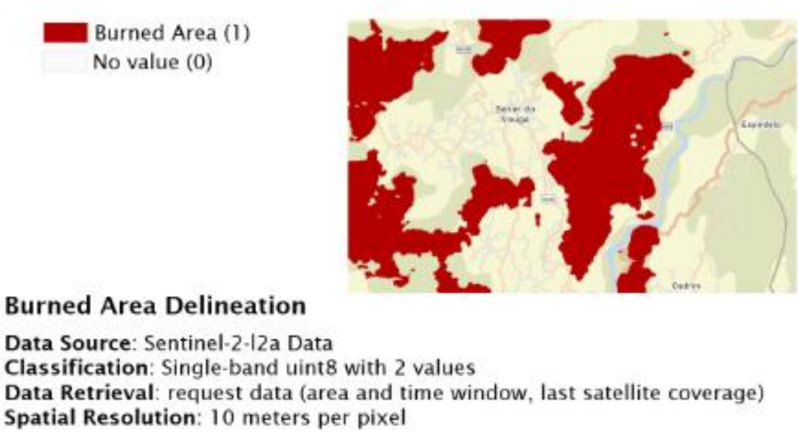
4. Active fire and smoke detection

Identifies an active fire present in the area and highlights smoke plumes.

⚠️ Clouds may affect the smoke delineation
✅ Active fire detection is robust to thin clouds.

5. Burned Area Delineation (event-based)

Estimates the burned area in a given area and time frame, using pre- and post-event images, producing a binary layer.

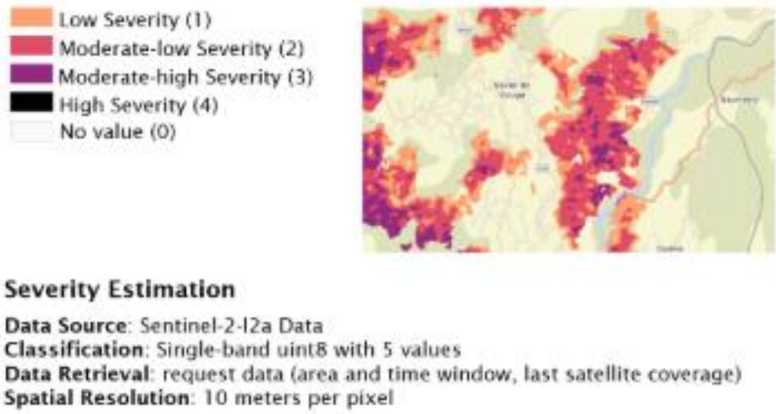


⚠️ Affected by cloud or smoke coverage.
⚠️ Requires an additional pre-event image.
✅ Better estimate than using a single image.

Figure 22 – Burned Area delineation image information

6. Severity Estimation (event-based)

Estimates the burn severity in a given area and time frame, using pre- and post-event images, producing a binary layer.



⚠️ Affected by cloud or smoke coverage.
⚠️ Requires an additional pre-event image.
✅ Better estimate than using a single image.

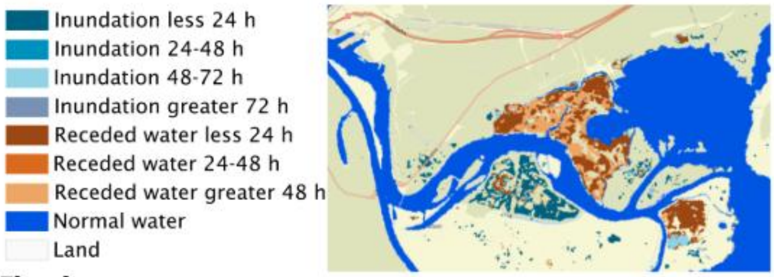
Figure 24 – Event -based severity estimation image information

Flood Services

1. CBK Floods EO Service

Identifies and classifies flood extent and water recession over time

⚠️ Not an on-demand service: each layer is produced and pushed automatically, without user intervention, whenever a new Sentinel-1 image is available.
⚠️ Covers only Poland.
✅ Enhanced information compared to the on-demand layers.



Flood

Data Source: Sentinel-1 satellite imagery covering Polish territory
Classification: Single-band uint8 with 9 classes
Data Retrieval: Query-based, dependent on images uploaded by EO services
Coordinate System: EPSG:32634
Spatial Resolution: 13.9 meters per pixel

Figure 25 – CBK Floods EO Service image information

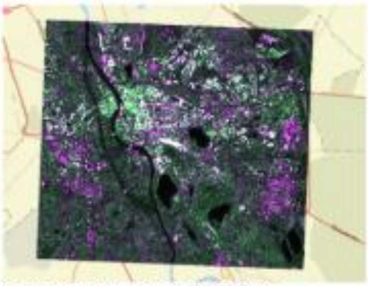
2. Sentinel-1 SAR image

Retrieves a raw Sentinel-1 RTC image, in VV-VH format, in the provided date range.

If the date range is the same, this option is also useful to retrieve the same image selected to delineate water bodies for visual confirmation.

⚠️ SAR image, no optical information.
✅ Not affected by clouds.

2-Band Image



Sentinel-1 raw image

Data Source: Sentinel-1Radiometric Terrain Corrected (RTC) Data
Classification: 2-band satellite image VV-VH float32
Data Retrieval: request data (area and time window, last satellite coverage)
Spatial Resolution: 20 meters per pixel

Figure 26 – Sentinel-1 SAR image information

3. Water body delineation (single-image)

Delineates the extent of any water body in the area, using a single image.

⚠️ Covers SAR “shadows” (e.g., mountains) may produce false positives.
✅ Not affected by clouds

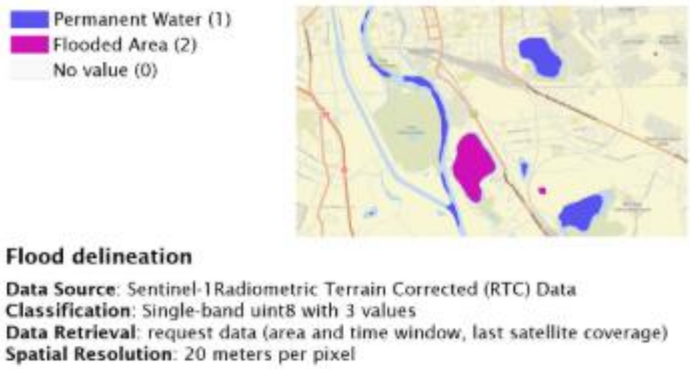


Figure 27 – Flood delineation single image information

4. Flood delineation (event-based)

Delineates the extent of a flood, producing a water delineation on the selected pre-event image, another on the post-event, then comparing the two results.

⚠️ SAR shadow area (e.g., mountains) may produce false positives.
✅ Not affected by clouds

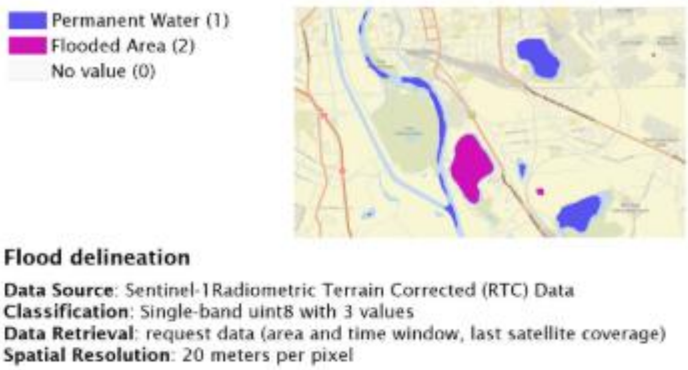


Figure 28 – Flood delineation event-based image information

Damage Assessment Services

1. Change Detection

Produces a “heatmap” of the damage degree, covering the full image extent, estimating the damage caused by the event.

⚠️ Requires the user to upload pre- and post-event images.
⚠️ Reported changes might be affected by other factors different (e.g., construction works, or any human-derived factors).
✅ Not constrained by the hazard type

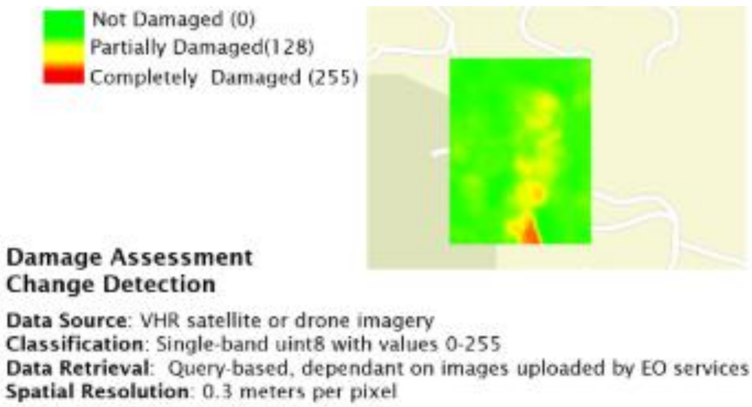
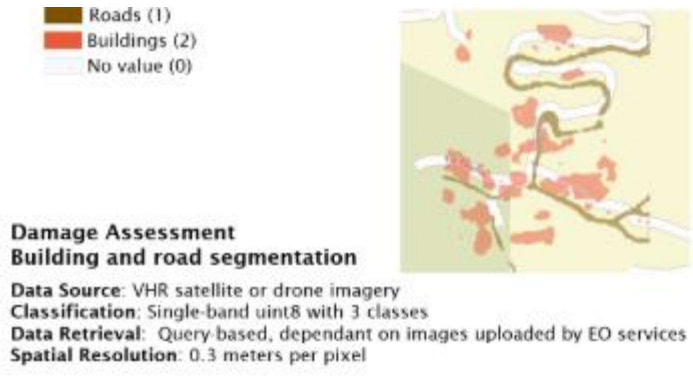


Figure 29 – Damage assessment image information

2. Road and building segmentation

Produces a semantic segmentation map, identifying roads and buildings in the image (taken from the pre-event image).



⚠️ Requires the user to manually upload images.
⚠️ Requires the user to upload pre- and post-event images.
⚠️ Delineations might be approximate.
✅ Estimates are based on the observed image (i.e., they could be more "up-to-date" when compared to other sources like OpenStreetMaps).

Figure 30 – Building and road segmentation image information

3. External Raster Upload

The platform allows the integration of custom raster images for advanced analysis.

1. Open the layers panel
2. Select Upload image
3. Choose a raster file from your device
4. Upload the file

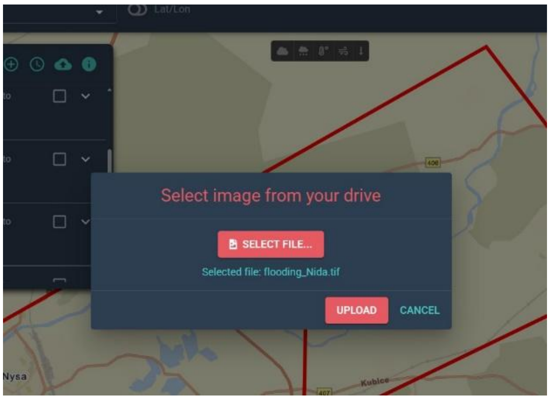


Figure 31 – Upload image for external raster

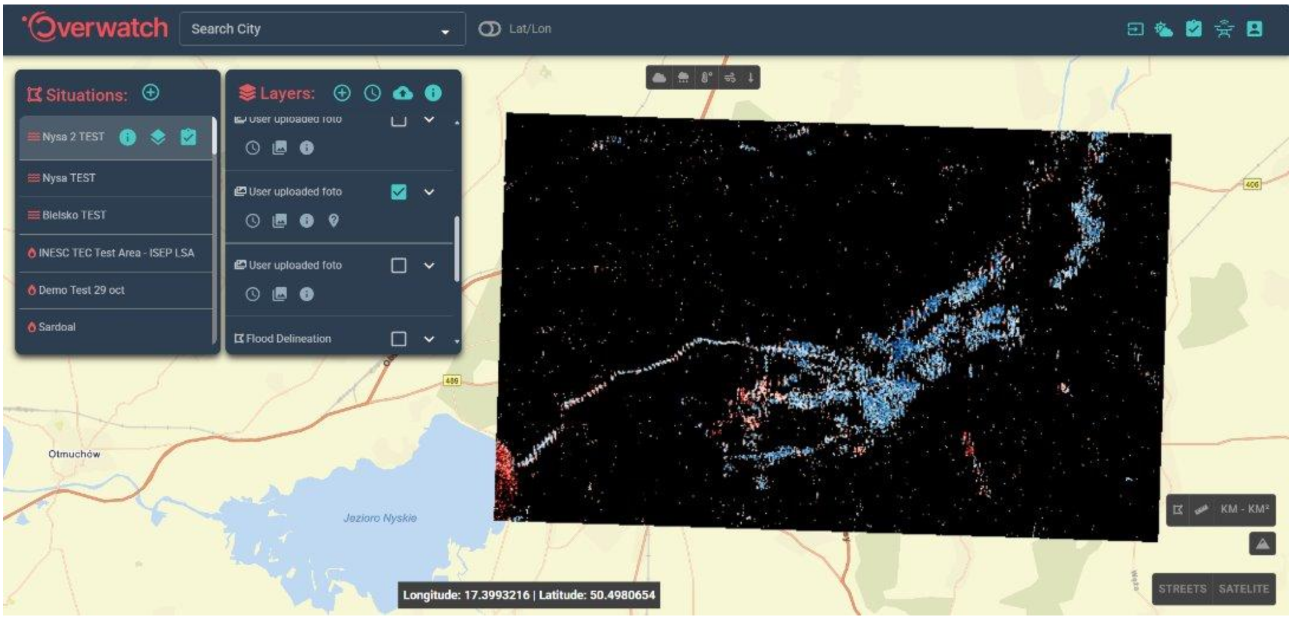


Figure 32 – Map layer from uploaded raster image

Uploaded images are displayed as map layers and can be used for:

- Detailed damage assessment
- Comparison with EO or drone data
- Custom analysis workflows

Other functionalities:

1. Monitor Status Request

Use the dashboard to track the processing status of your selected services. You'll see updates on progress, delays, and data readiness.

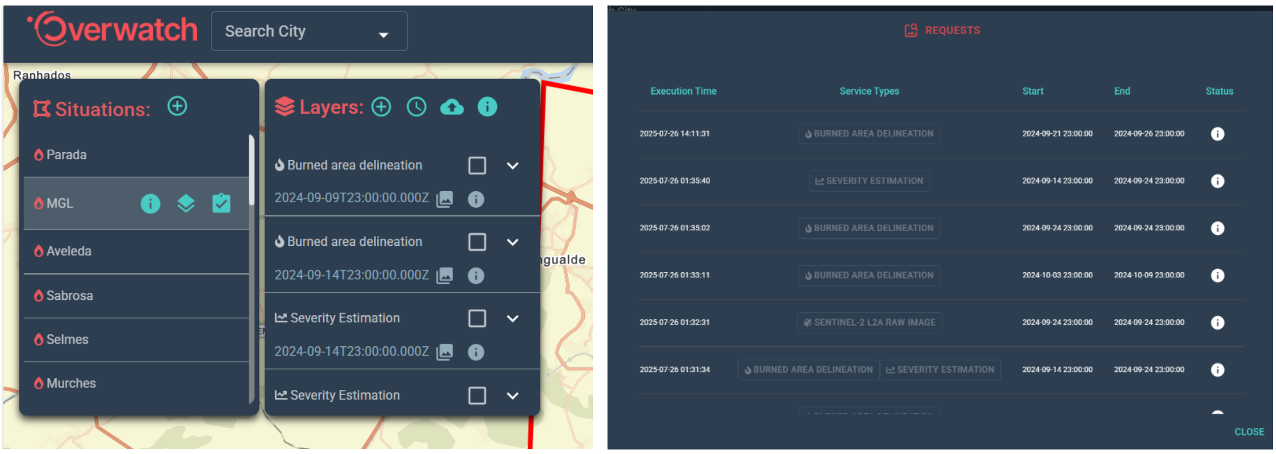
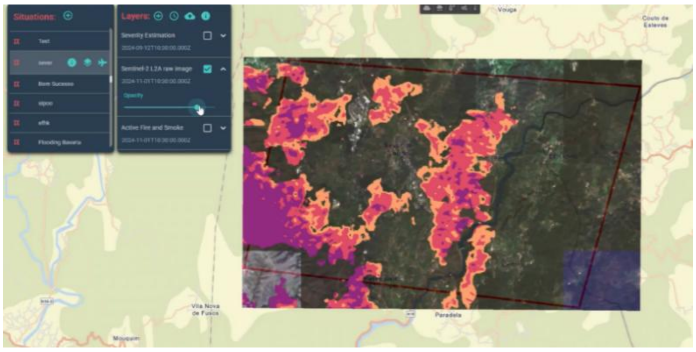


Figure 33 – Monitor status request display

2. Adjusting Layer Opacity

- To enhance visual analysis, the dashboard allows you to **adjust the opacity** of each WMS layer.
- Use the **opacity slider** to control how transparent or solid the layer appears.



This helps you **compare multiple layers** or view the base map underneath.

Figure 34 – Opacity slider display

3. View Relevant Instants

To understand when the data was captured, each layer displays **key timestamps**.
These include:

- **Local Time** – the time in your current time zone.
- **Zulu Time (UTC) -** Coordinated Universal Time
- **Time Ago** – how long ago the data was recorded.

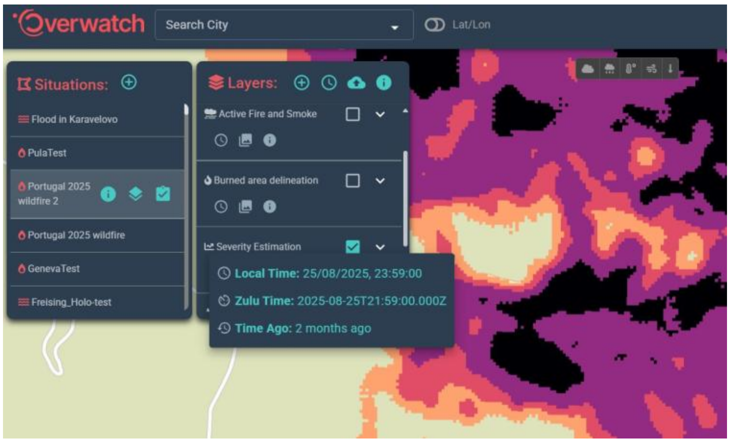


Figure 35 – Relevant instants display

4. Download Layer Data

To access detailed information, the dashboard provides **download options** for each selected layer.
You can:

- **Download Metadata** – includes descriptive details about the layer.
- **Copy Layer Name** – useful for referencing or sharing.
- **Download Source File** – retrieves the original data file for further analysis.

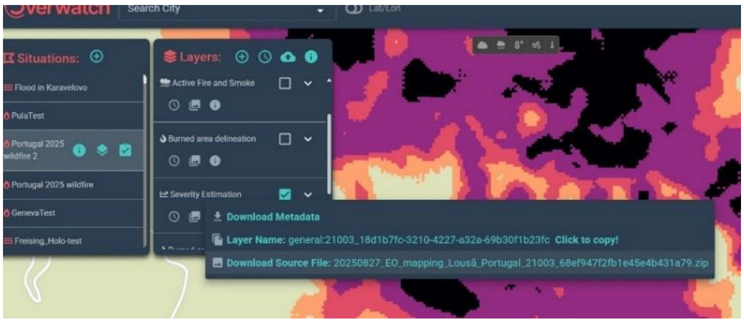


Figure 36 - Download Layer Data display

5. Get Pixel Information

To analyze specific map areas, the dashboard allows you to **click on the map to retrieve pixel-level details**.

When activated, clicking on any point displays:

- **Attribute values** (e.g., GRAY_INDEX: 2 in this example).
- Relevant data for the selected layer.

Figure 37 – Pixel information display

D. Visualize WMS layers

Once the request is completed, the resulting data becomes available through **WMS Layers**.
These layers are visualized directly in the dashboard.
Use the layers to:

- Understand how the event evolved
- Explore different analytical perspectives
- Support decision-making with geospatial insights

E. Drone deployment

Drone deployment supports tactical reconnaissance and real-time situation assessment. Captured drone data (e.g., RGB and thermal imagery) are processed using AI-based services to generate geospatial layers such as:

- Burned area delineation
- Fire severity estimation
- Vegetation and fuel analysis

These outputs are integrated into the platform's geospatial repository and made available for situation assessment.

Once the situation is defined and services requested, you can initiate a drone mission to collect high-resolution, real-time data.

1. **Create Drone Mission**
    - Go to the **situation panel** and select the relevant entry.
    - Click on the drone icon
    - Draw a the mission area.
2. **Fill in the mission details**
    - **Name** the mission
    - Set **flight altitude**
    - Select **drone** from available fleet.
    - Click **start** to initiate the mission.

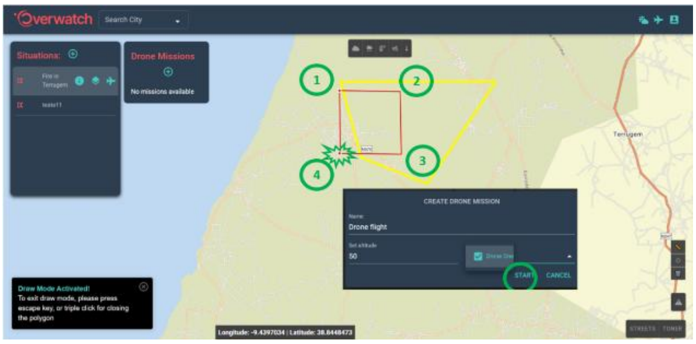


Figure 38 – Drone mission definition display

3. **Deploy the drone**
    - Once the mission is configured, launch the drone.
    - You can monitor its progress in real time:
        - A moving marker on the map shows the drone's position and flight path.
          This helps ensure full coverage and track mission progress.

Figure 39 – Drone mission marker

- Replay drone flight

This feature allows you to **replay the drone's mission path** on the map.

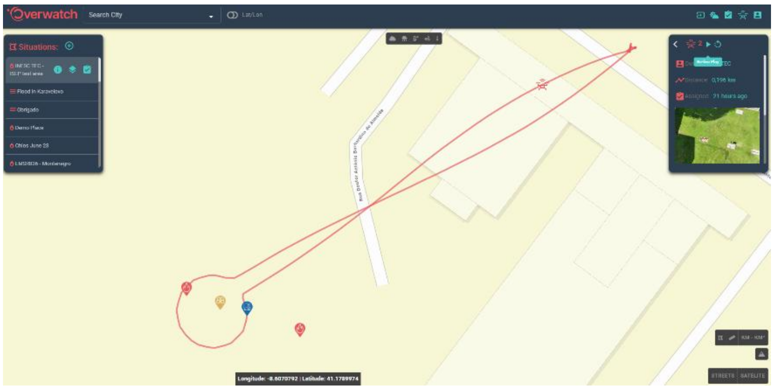


Figure 40 – Drone flight display

  - Mission markers icons bounce when the related item from the list is hovered

Figure 41 – Drone mission markers display

  - Mission polygon increase in line width when the item from the list is hovered.

Figure 42 – Drone mission polygons display

4. **View Results in WMS layers**

After the drone completes its mission, the drone imagery is automatically processed. The results are integrated into the dashboard as WMS Layers, providing **High-resolution RGB and thermal imagery**

Mission "**Point Scan**" outcome

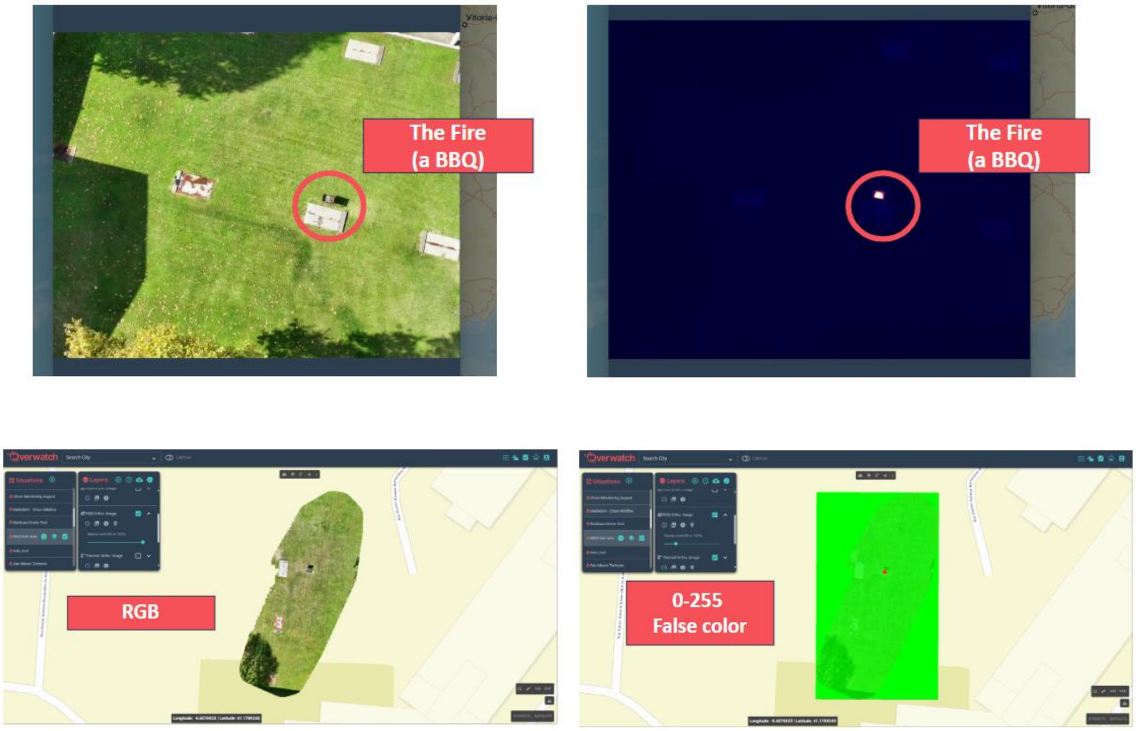


Figure 43 - **WMS layers** image examples

F. Communication and Connectivity

Reliable communication is essential in emergency operations, particularly in environments where standard network infrastructure may be unavailable.

OVERWATCH includes a Fallback Connectivity (FC) module that ensures continuous communication between field teams and command centres.

This is achieved through:

- Deployment of a tethered drone equipped with satellite backhaul
- Creation of an aerial Wi-Fi hotspot for field operations
- Real-time exchange of voice, images, and operational data

This capability ensures operational continuity and supports coordination even in degraded communication environments.

OVERWATCH AR APP

AIM

The **OVERWATCH AR application** is designed to **enhance situational awareness** and **decision-making** for first responders and emergency management teams during disaster response operations.

The application leverages Augmented Reality (AR) technology to provide an **immersive, interactive 3D visualization of the operational environment**. It integrates and visualises a variety of geospatial and contextual data—such as base maps, elevation data, situation and drone data as well as weather information—from multiple sources including Copernicus services, unmanned aerial systems (UAS), and other external platforms.

The objective of this solution is to **enhance operational efficiency**, **elevate situational awareness**, and **improve the quality and accessibility of information to support coordination and decision-making** among disaster response teams during crisis scenarios, including but not limited to flooding and wildfires.

The AR application is used in conjunction with the OVERWATCH Dashboard. The **dashboard** allows the end-users to **create the situations** and **missions** and the **AR application** helps in **3D situation visualisation and analysis.**

The primary **aim** of the application is to:

- Deliver **real-time operational insights** directly within the **user's field of view**.
- **Support mission planning** and **coordination** through visualized situational data.
- Facilitate **faster**, more **informed decisions** in the field by combining **multiple data sources** (satellite imagery, drone feeds, environmental sensors).
- Provide a **shared AR workspace** for collaborative assessment and action.

BENEFITS and VALUE

The AR application introduces a new level of operational capability for disaster management, civil protection, and emergency response. Its key benefits include:

Operational Benefits

- **Enhanced Situational Awareness**: Real-time visualization of incidents such as floods or wildfires enables users to perceive spatial relationships and evolving conditions intuitively.
- **Integrated Data Access**: Combines satellite layers, drone trajectories, and sensor data in one unified view—eliminating the need to switch between multiple systems.
- **Faster Decision-Making**: Immediate access to critical information (e.g., weather forecasts, elevation data, or hazard zones) allows for rapid evaluation and prioritization of actions.
- **Increased Efficiency:** Streamlined workflows through direct interaction with 3D maps and virtual panels reduce the cognitive load on users.

Collaborative and Strategic Value

- **Shared Operational Picture**: Enables multiple users (on-site and remote) to view and interact with the same holographic scene, supporting coordinated planning and resource deployment.
- **Improved Training and Preparedness**: The application can also serve as a training tool, allowing personnel to simulate disaster scenarios in realistic AR environments.
- **Scalable and Secure Deployment**: Built on Unity and Hololight Stream SDK, the app runs securely on a central server and streams to XR devices like HoloLens 2 and Quest 3—ensuring performance consistency and data protection.

Long-Term Value

- Promotes **data-driven response strategies** and **reduces human error** in dynamic, high-stress situations.
- Supports **interoperability** with existing data infrastructures (e.g., Copernicus Sentinel Hub) and drone systems.
- Lays the foundation for next-generation decision-support systems in crisis management, where human expertise and digital intelligence work seamlessly together.

PLATFORM REQUIREMENTS

System Requirements

CPU Recommendations

Component	**Minimum Recommendations**
Operating System	Windows 10 Windows 11
CPU	Intel Core I7 (9th Generation) AMD Tyzen 7
Cores	6
RAM	16GB
GPU	See Below
VRAM	8GB

GPU Recommendations

XR Client	**Minimum Recommendations**
Microsoft HoloLens 2	NVIDIA RTX 2080 NVIDIA Quadro RTX 6000
Meta Quest 2 Meta Quest Pro Meta Quest 3S	NVIDIA RTX 3080 NVIDIA A5000
Meta Quest 3	NVIDIA RTX 4080 NVIDIA 5000 ADA

Network Requirements

Network	Wi-Fi 6
Network frequency	5 GHz
Bandwidth	min. 40 Mbit
Rpund Trip Time	max. 50 ms

SYSTEM OVERVIEW AND FEATURES AND FUNCTIONALITIES

System Overview

The OVERWATCH AR application is an **Augmented Reality-based situational awareness and decision-support** tool developed using the Unity game engine and the Hololight Stream SDK.
The application architecture is designed for secure, high-performance streaming from a central server to XR headsets such as the Microsoft HoloLens 2 and Meta Quest 3.

The AR app provides a real-time, interactive 3D operational environment where users can visualise and analyse disaster-related data—such as floods, fires, and other emergencies—directly within their field of view. By integrating geospatial layers, sensor data, drone feeds, and environmental information, the application delivers a comprehensive operational picture for informed decision-making in the field.

System Components

- **Server-side Application**: Hosts the Unity-based AR application, processes data layers (e.g., satellite imagery, elevation models, weather data), and streams it securely to the connected XR devices.
- **Client Devices** (XR Headsets): HoloLens 2 or Quest 3 devices receive the streamed AR content and allow the user to interact with the application via hand gestures, controllers, or stylus input.
- **Data Sources and Integrations:**
  - Web Map Service (WMS): Mapbox Static Tiles API services are used.
  - Copernicus Sentinel Hub: Provides digital elevation models (DEM) and satellite imagery.
  - Drone Data Interface: Enables visualization of drone trajectories and detected hotspots.
  - Weather Services: Supplies localized weather data and forecasts.
  - Photon Unity Network: Used for the data synchronisation for all users connected to the multiplayer session
  - Management Backend (ENG):
    - Extra map layers such as floor delineation and Search and Rescue (SAR) Image are fetched via HTTPS requests.
    - Fetch Situation, Request, Mission and Drone information on start as well as in real-time via Rabbit MQ message broker.
- **Network Infrastructure**: Ensures secure, low-latency communication between the server and XR clients through encrypted streaming and authentication protocols.

This architecture ensures a lightweight XR experience, offloading computation to the server while maintaining smooth performance and data security.

Features and Functionalities

The AR application includes a suite of interactive tools and features that enhance situational awareness, mission analysis, and operational coordination.

1. Hand Menu Interface

The hand menu acts as the central user interface, allowing intuitive access to all core features. Users can open panels, toggle tools, and configure settings directly through gesture-based interaction or controller input.
Main menu categories: Situations, Map Tools, Drone, Map Settings, Input Settings

Figure 44 - Hand Menu Interface

2. Situations Management

The Situations section allows users to explore and analyse different operational scenarios, such as floods or wildfires.

- Displays a list of active situations available for review.
- Selecting a situation opens a Situation Panel that includes:
  - Situation overview and metadata.
  - Associated missions or response tasks.
  - Map layers with satellite imagery and other geospatial information.
- Layers can be toggled on/off for customized visualization, and each layer has a movable legend for clarity in the AR space.

3. Map Tools

Provides quick-access tools to assist in spatial understanding and environmental assessment:

- **Weather Tool**: Displays real-time and forecasted weather data (wind speed, humidity, temperature) for any point on the map.
- **Altitude Tool**: Shows the elevation of any selected location.

- **Distance Tool**: Allows users to measure the distance between two or more points directly on the 3D map.

4. Terrain and Elevation Visualization

Integration with the Copernicus Sentinel Hub enables:

- Visualization of Digital Elevation Models (DEM) to understand terrain variations.
- Display of contour lines for enhanced topographical analysis. These tools support better situational planning, particularly in flood-prone or mountainous areas.

5. Drone Visualization

The Drone feature provides an aerial perspective by integrating real-time or recorded drone data.

- Opens a Drone Panel showing: drone identifiers, mission details, and operational status.
- Visualizes flight trajectories and detected hotspots (e.g., fire locations) directly over the map.

This feature allows to **cross-reference aerial** and **ground-level data** for more accurate assessments.

6. Map Settings

Provides tools to adjust the spatial configuration of the 3D map in AR space:

- **Placement**: Reposition or resize the map to a desired virtual location.
- **Orientation**: Rotate or tilt the map to view it horizontally, vertically, or at custom angles.
- **Elevation and contour toggle**: Toggle elevation and contour views on/off.

These features ensure that users can adapt the visualization to their environment and task needs.

7. Input and Configuration Settings

The Input Settings section allows full customization of the interaction experience:

- Adjust zoom intensity and navigation speed (for Quest 3 controllers).
- Change ray pointer color and thickness for better visual contrast.
- Calibrate the Stylus Pen for precise input and control.

8. Multi-Panel Interaction

Users can open and arrange multiple information panels (e.g., Situation, Drone, Weather) simultaneously in AR space.

Panels can be freely moved, resized, or closed, allowing for a personalized workspace that adapts to each user's analysis and workflow.

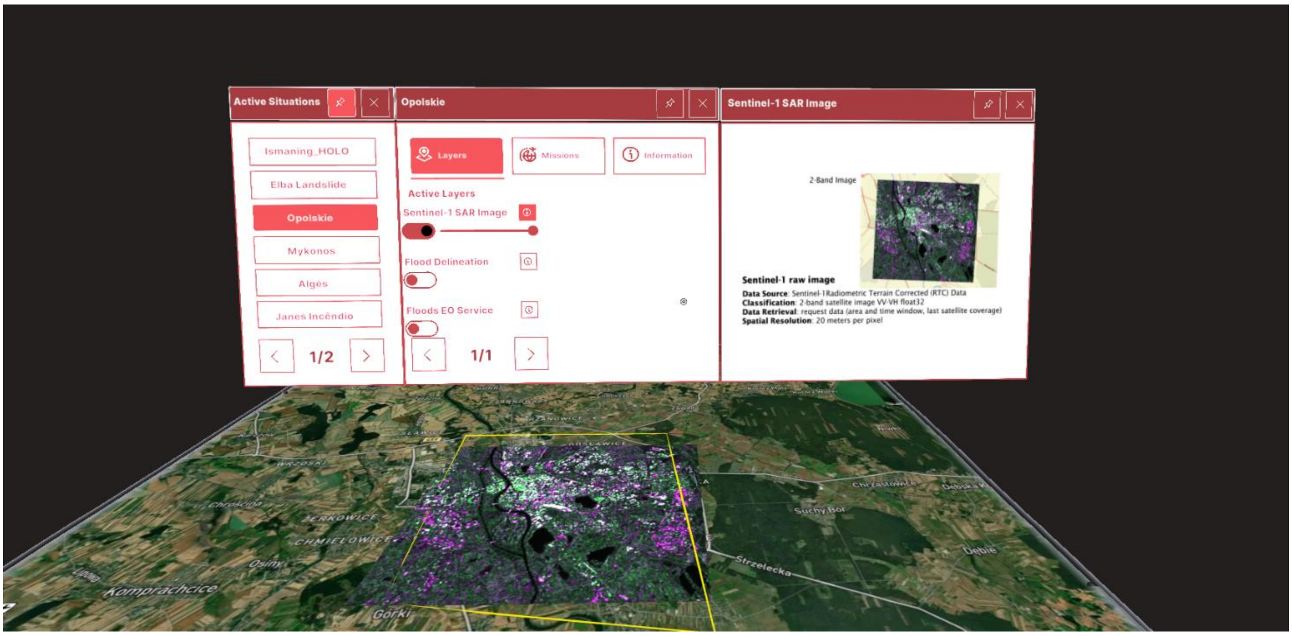


Figure 45 – Multi- panel interaction AR display

9. User Interface and Design

The UI is fully aligned with the OVERWATCH brand and design guidelines. It follows a minimal, clean, and intuitive layout, ensuring that users can operate efficiently even in field conditions.
The interface is optimized for comfort and clarity, minimizing distractions while maintaining visual fidelity in complex AR scenes.

STEP BY STEP WORKFLOW

Prerequisites (before step 1)

1. Host PC with pARanoptes server installed and running.
2. XR headset (HoloLens 2 or Quest 3) with OVERWATCH Stream app installed.
3. Headset and PC must be on the **same Wi-Fi network** (5 GHz recommended).
4. Confirm required data sources (satellite, weather, drone) are available on the server.

Step 1 – Server Launch

1. On the host PC, launch the server application.
2. Verify the Unity service and Hololight Stream SDK session are running.
3. Confirm all required data sources (satellite, weather, drone) are connected.

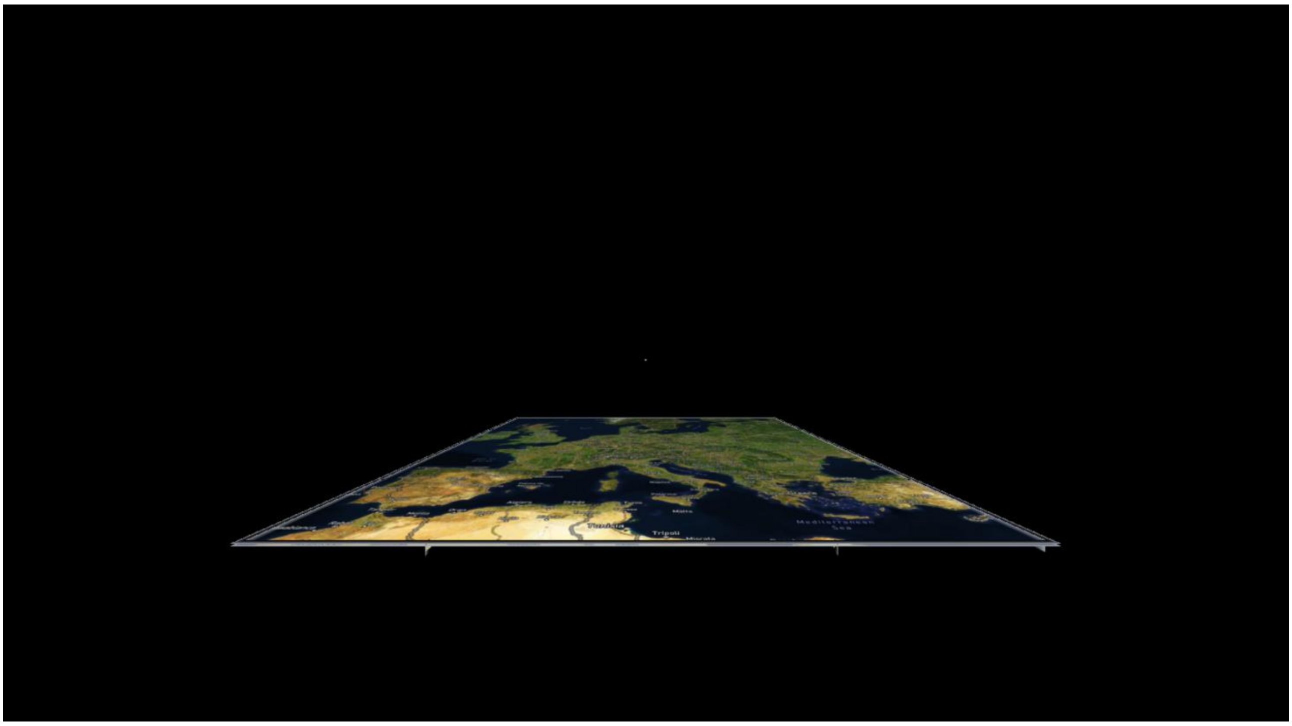


Figure 46 – Server launch display

Step 2 – Client Connection

1. On the headset, open the OVERWATCH Stream.
2. Ensure the headset is connected to the same Wi-Fi network as the PC.
3. From the device interface, enter the **server IP address**.
4. Click “**Connect**”.

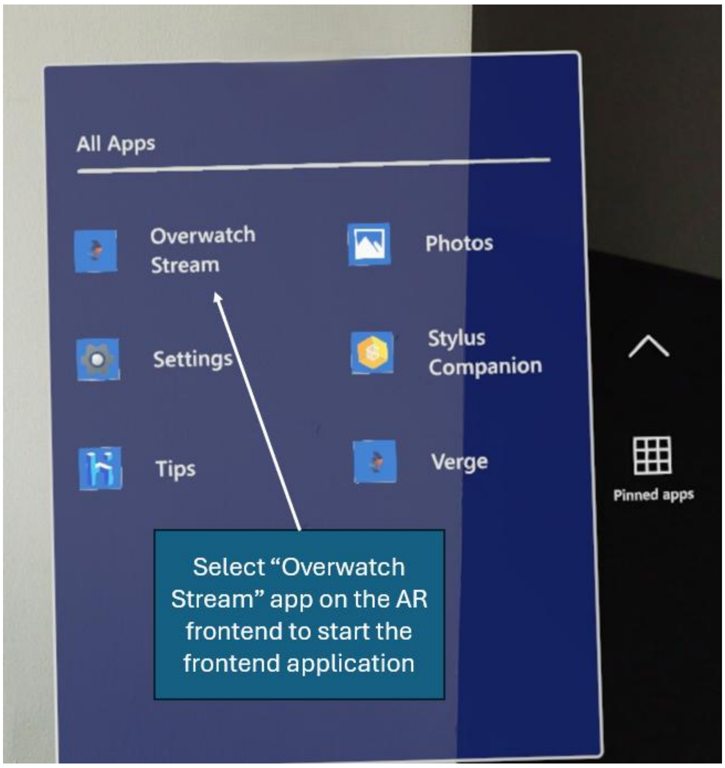


Figure 47 – AR frontend

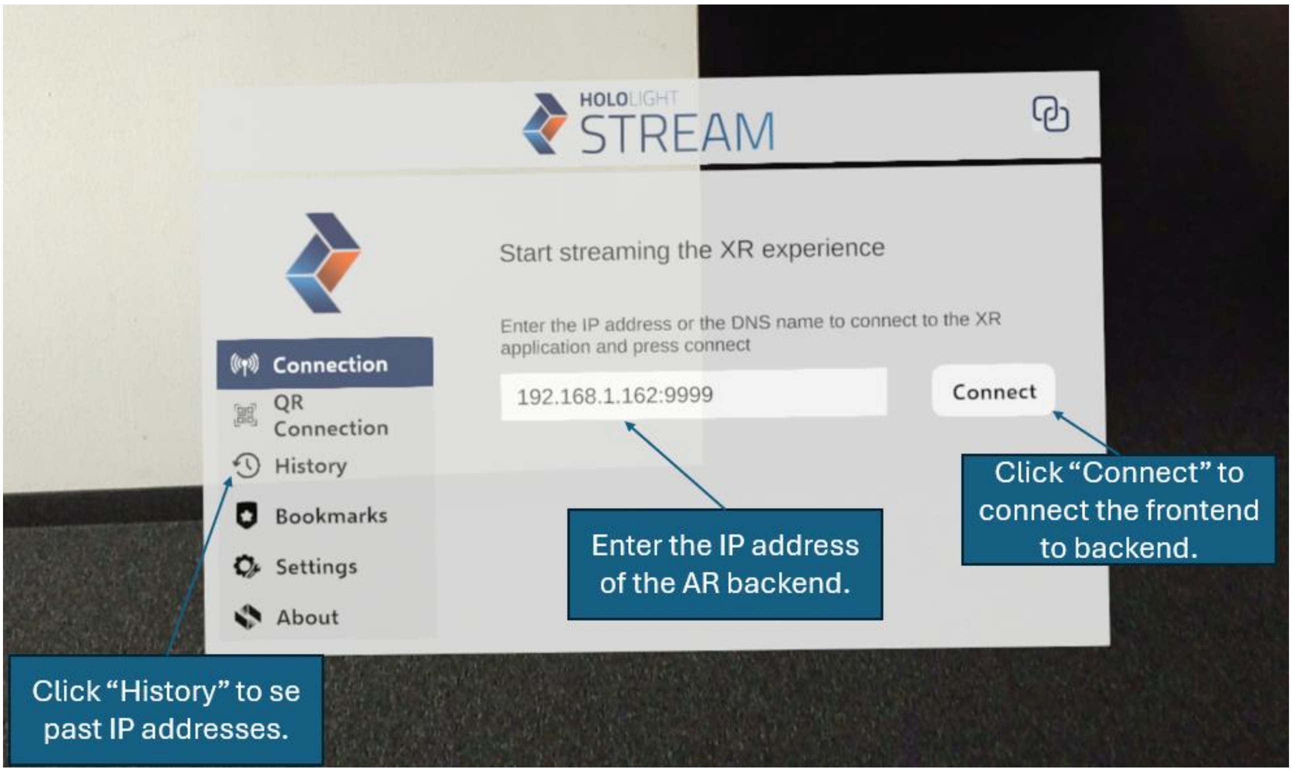


Figure 48 – HoloLight Stream display

5. Wait for the stream to start — the geospatial map and AR environment will load.

Step 3 – Interact with Situations

To quickly focus on a specific incident or analysis area:

1. Open the **Hand-Menu**(raise palm).

Figure 49 – Hand menu display

2. Select “**Situations**”.
3. The Situation Panel opens showing situations overview, metada and related missions.
4. Choose a situation from the list.
5. Toggle the map layers you need for customized visualization. Move legends as needed for readability .

Step 4 – Interact with Drone Traffic

To cross-reference aerial and **ground-level data** for more accurate assessments:

1. Open the **Hand-Menu** (raise palm).
2. Select a drone or mission
3. The Drone panel opens, showing drone identifiers, mission details, and operational status.
4. Visualize flight trajectories and detected hotspots (e.g., fire locations) directly over the map.

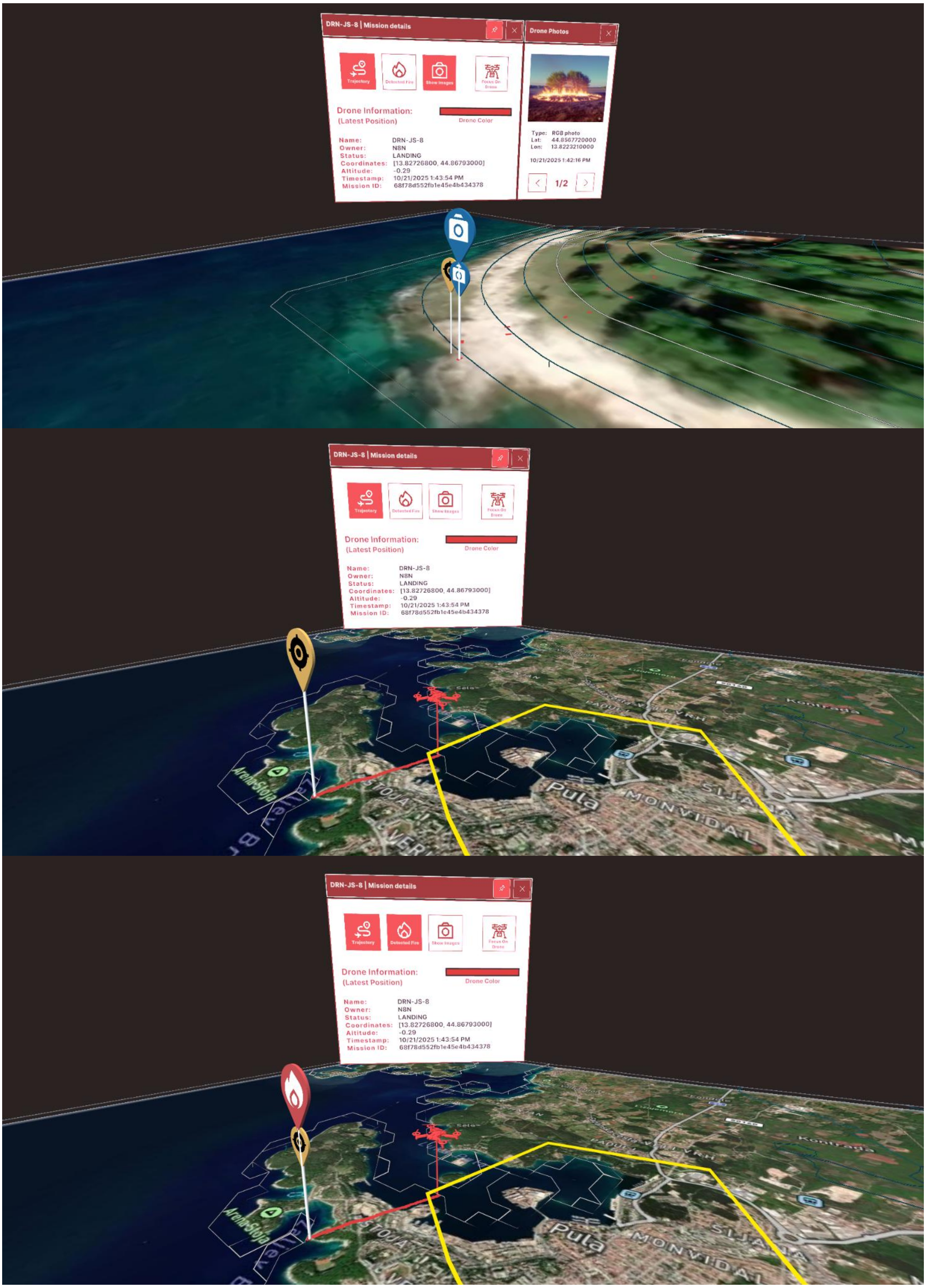


Figure 50 - Drone mission details AR display

Step 5 – Map Tools

1. Open the **Hand-Menu** (raise palm).

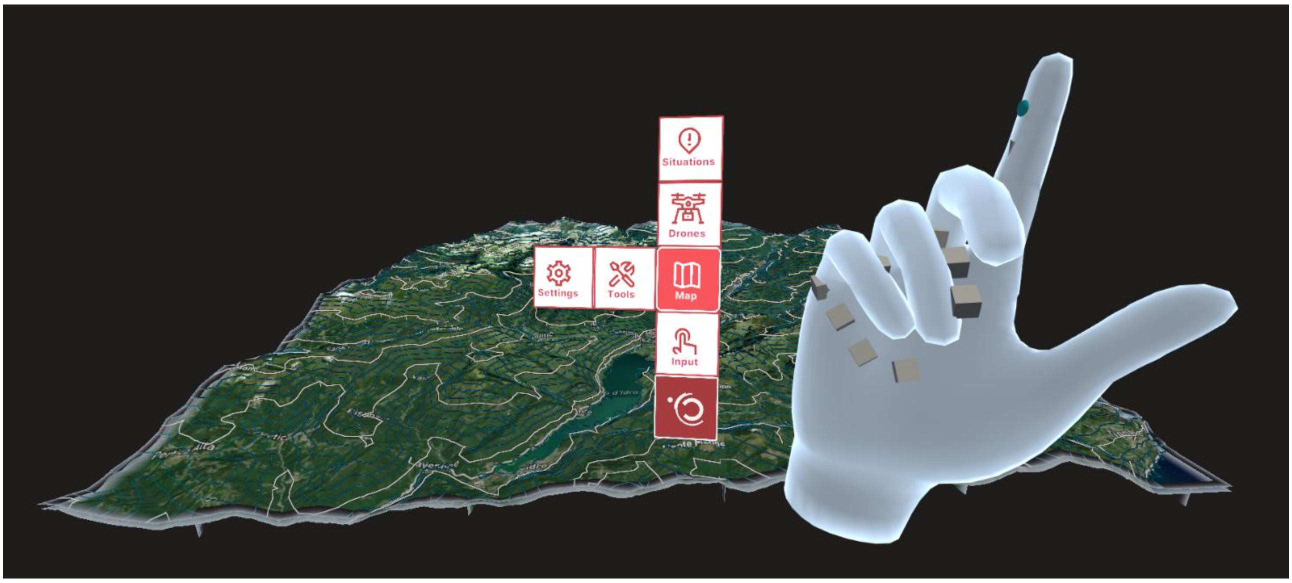


Figure 52 – Hand menu display

2. Select Weather, Altitude or Distance on the Map Tools Panel.
3. Point to location.

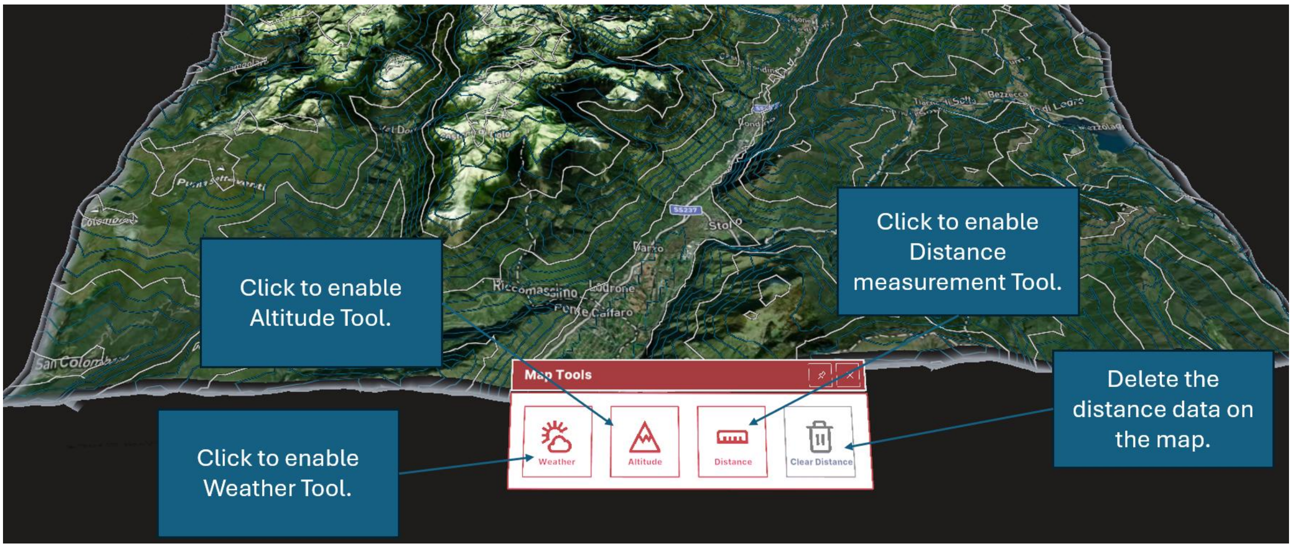


Figure 53 – Map tools display

Weather:

1. Select the "**Weather**" button to enable the weather feature.
2. *Wait for the pointer to change color from white to red* - Point the ray at the desired location and press **Select.**

3. A Short-format weather display and a detailed weather panel open on the virtual space- see the forecast for Wind, Temperature, Cloud Percentage, and Rain precipitation.
4. Detach the Main weather Panel and the individual forecast by grab the header of the title and move it conveniently in the virtual space.

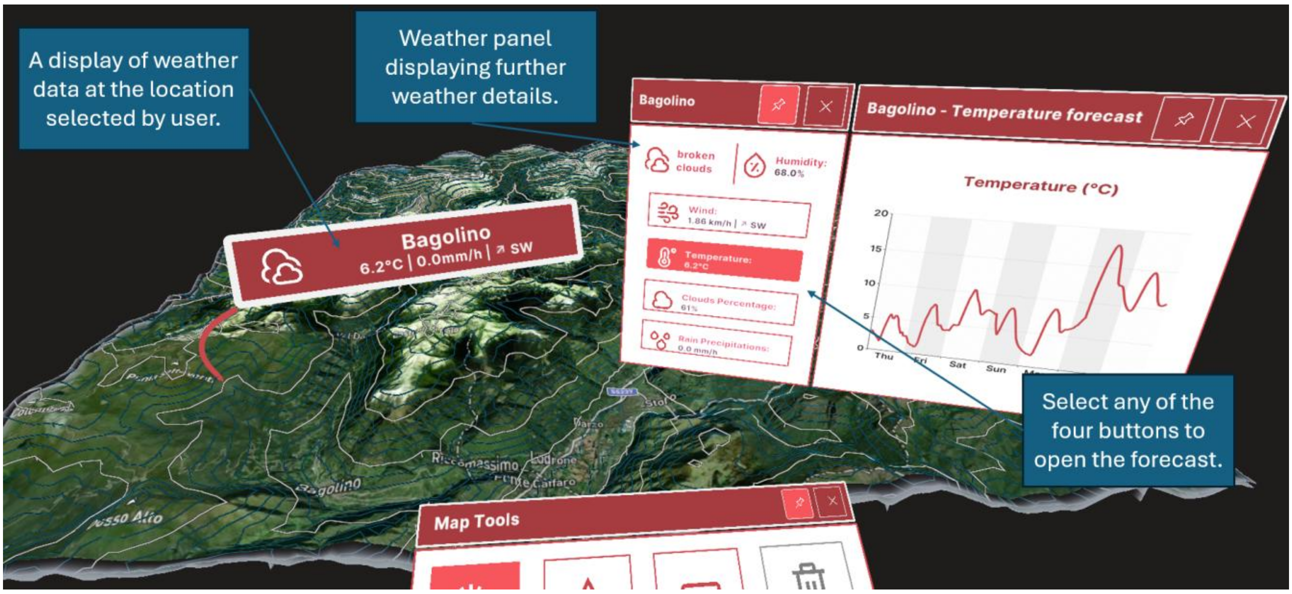


Figure 54 – Weather panel display

Altitude:

1. Select the "**Altitude**" button to enable the altitude feature.
2. *Wait for the pointer to change color from white to red* - Point the ray at the desired location and press **Select.**
3. The display will show coordinates and altitude (m) of the location – auto-hide after 10s.

Figure 55 – Altitude display

Distance:

1. Select the "**Distance**" button to enable the distance measurement feature.
2. *Wait for the pointer to change color from white to red* - pick two points to measure distance and altitude difference and **select.**

3. Distance measurement and altitude difference information between the two locations selected by the user will appear on the map.
(Altitude difference is the difference of the second point to the first point - A positive value means the second point is higher than the first point; a negative value indicates the first point is higher in altitude than the second point).
4. Press "**Clear Distance**" button to remove.

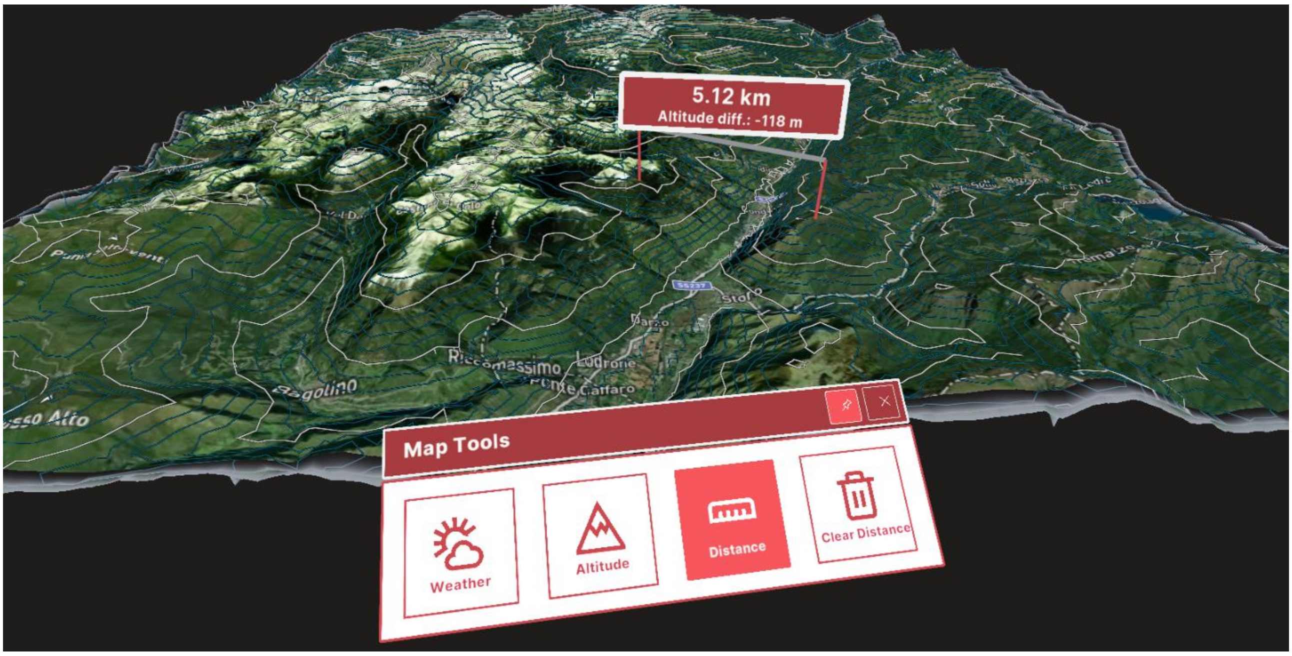


Figure 46 – Distance display

Step 5 – Map Settings

1. Open the **Hand-Menu** (raise palm).
2. Select "**Settings**". The following **map settings** panel will appear.

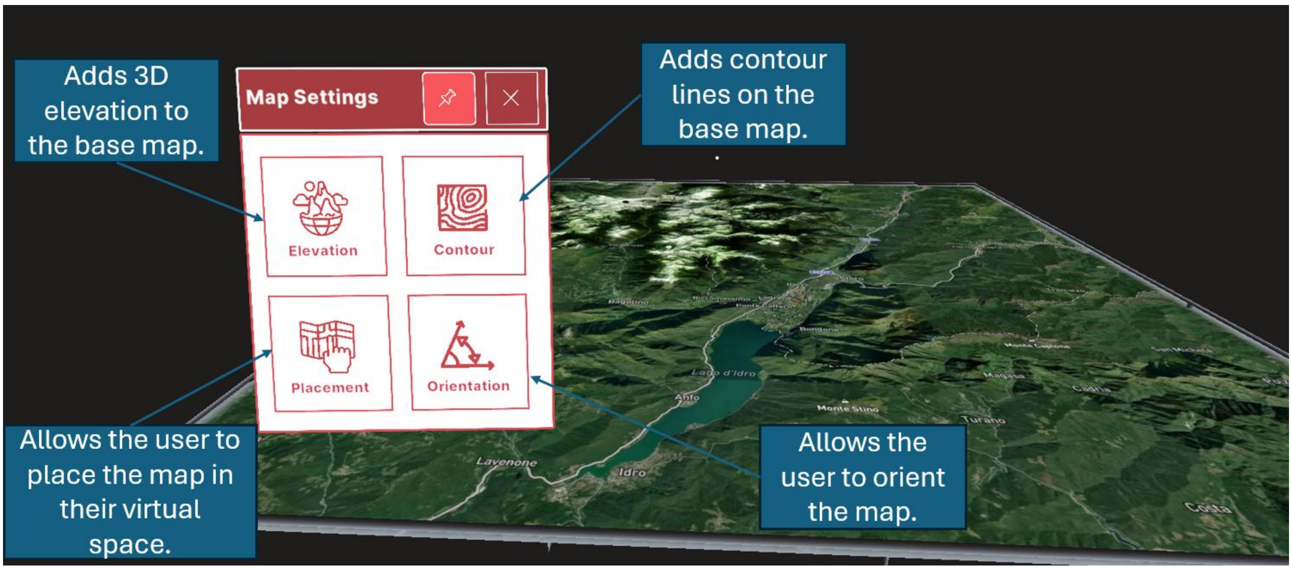


Figure 57 – Map settings display

3. "**Elevation**": toggle to enable/disable the 3D elevation data on the map.
4. **Contour**": toggle to enable/disable the contour lines over the elevation data on the map. Contour requires Elevation on.
5. "**Placement**": toggle and point at the desired location. Grab and move the map. Toggle off to lock the map in place.
6. "**Orientation**": toggle and use the solid circle, moving it up and down to change the orientation of the map between horizontal and vertical in 15-degree intervals.

Step 7 – Input Settings and Stylus Calibration (optional)

1. Open the **Hand-Menu** (raise palm).
2. Select **Input Settings**.

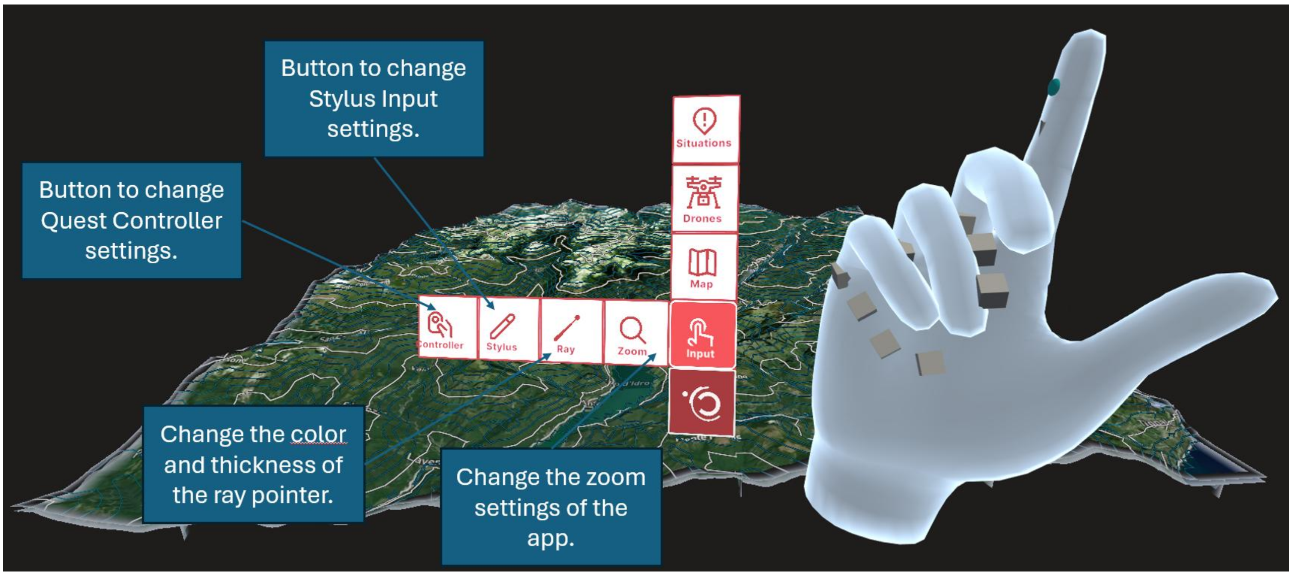


Figure 58 - Input Settings display

3. Adjust **zoom intensity** and **navigation speed**.

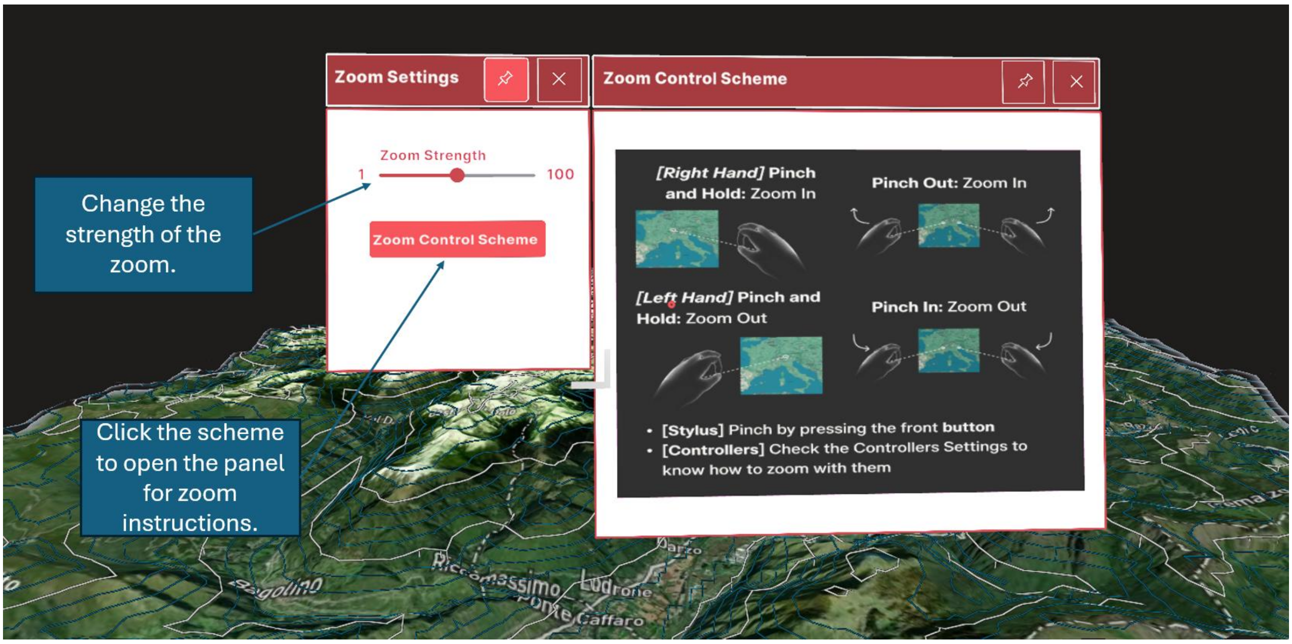


Figure 59 – Zoom Settings display

4. Change ray pointer **colour** and **thickness** for better contrast in bright/dim environments.

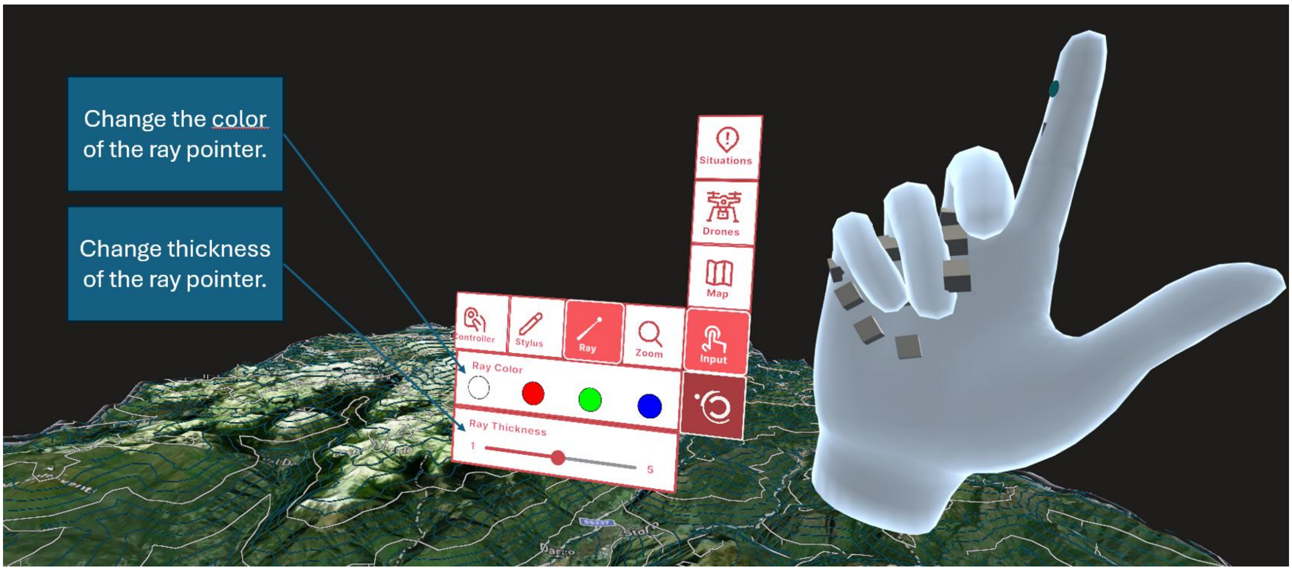


Figure 60 – Ray pointer settings display

5. Change controller settings.

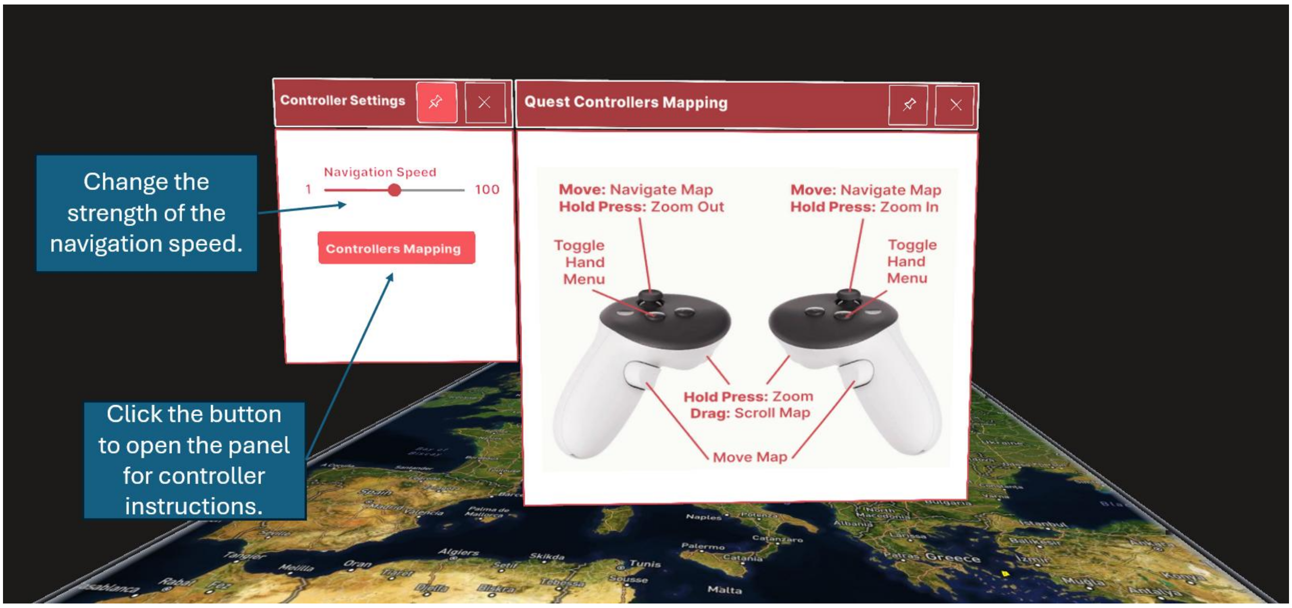


Figure 61 – Controller settings display

6. **Stylus Calibration**: run calibration routine if using stylus for precise drawing or selection.

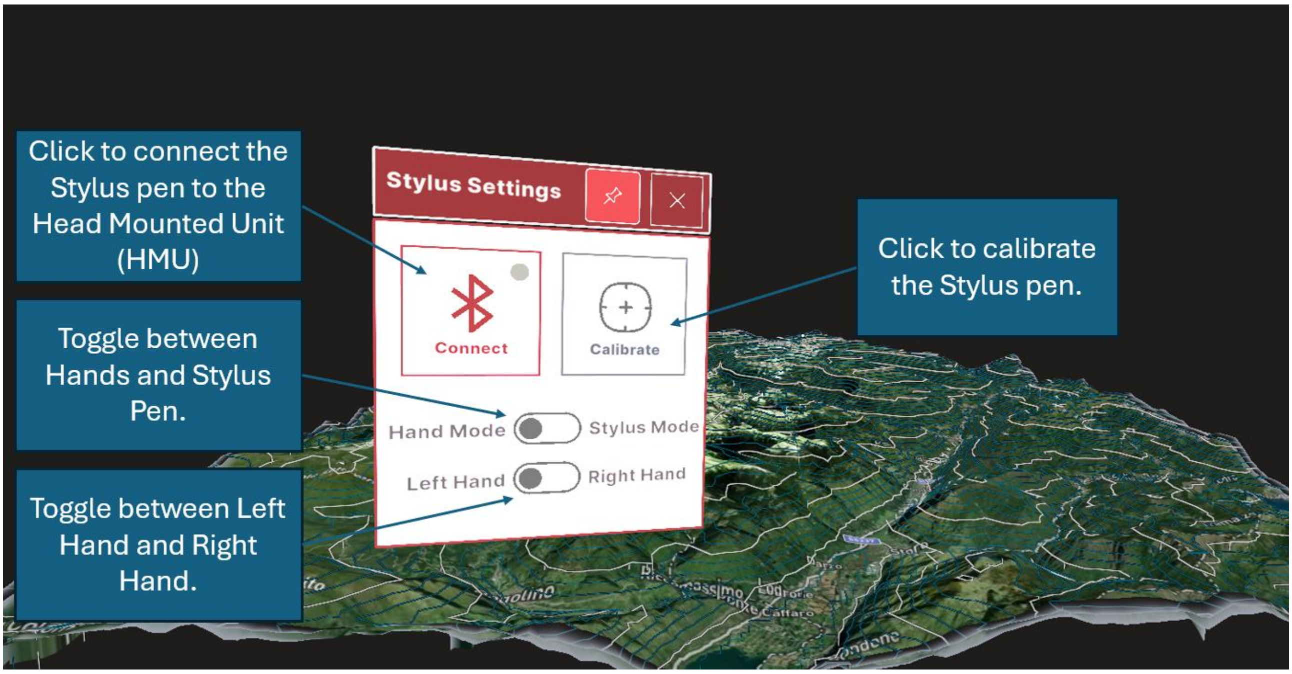


Figure 62 – Stylus settings display

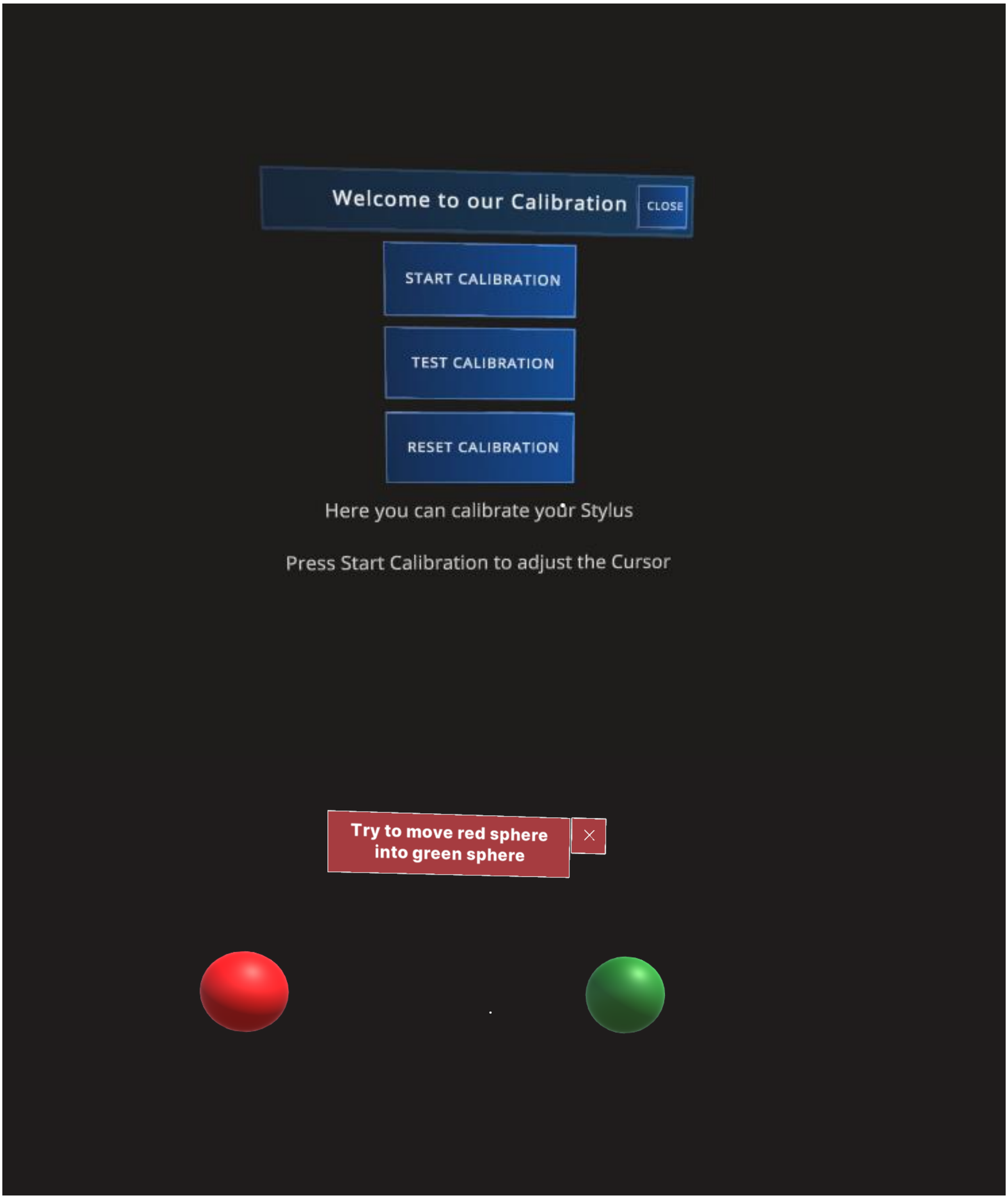


Figure 63 – Stylus calibration display

Step 8 – Multi-user Session (Optional)

The OVERWATCH AR application supports multi-user sessions, enabling multiple users to interact within the same shared operational environment.

To start a multi-user session:

1. Ensure all devices are connected to the same network.
2. Launch the application on each device.
3. Select the multi-user session option.
4. Join the session using the session ID or host connection.

Once connected, users can:

- View the same geospatial data
- Interact with shared layers and objects
- Collaborate in real time

This feature enhances coordination and supports joint decision-making in emergency scenarios.

Key Takeaways

OVERWATCH is designed to support emergency responders in managing complex and rapidly evolving situations by providing access to reliable, timely, and integrated information.

Through the combination of Earth Observation services, drone data, and advanced visualisation tools, the platform enables users to monitor events, assess impacts, and support decision-making across all phases of emergency management.

By facilitating a shared operational picture and improving coordination between field teams and command centres, OVERWATCH contributes to more efficient and effective response operations.

- **Use the platform to build a shared operational picture**
  Combine satellite data, drone observations, and geospatial layers to understand the situation in a consistent and comprehensive way.

- **Leverage multiple data sources for better analysis**
  Use EO services, drone data, weather information, and external WMS layers together to improve accuracy and confidence in decision-making.

- **Use drone missions for real-time insights**
  Deploy drones to collect high-resolution data and complement satellite analysis, especially in dynamic or rapidly changing scenarios.

- **Monitor data and system outputs continuously**
  Track processing status, review timestamps (UTC/Zulu Time), and validate results before use in operational decisions.

- **Integrate OVERWATCH into operational workflows**
  Use the platform alongside existing tools and procedures to enhance coordination between field teams and command centres.

OVERWATCH is designed to support informed, data-driven decision-making in emergency management. Its effectiveness depends on the appropriate use of its functionalities and the integration of its outputs into real operational contexts.
By combining multiple data sources into a unified platform, OVERWATCH enables safer, more coordinated, and more efficient emergency response operations.