D*9.2 – Report on first trial period activities for Phase A, B and C*

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Abstract:	The deliverable reports on the activities carried out in 2023 in relation to the pilot demonstration activities offering the opportunity for the end-users (fire fighters, civil protection representatives, foresters and others) the first hand experience in SILVANUS technologies. The pilot activities have been organised as both field exercises (with personnel deployed for carrying on field activities) and as table top exercises (with an extended round table discussion on a specific case-study). In both activities, the different levels of SILVANUS interventions were elaborated along with a set of detailed demonstrations of the user products (as outlined in WP8 deliverables). The interventions offered were systematically categorised into prevention, preparedness (Phase

	A), detection and response coordination (Phase B) and rehabilitation and restoration (Phase C). The deliverable presents a list of 11 pilot activities that were carried out within Europe and Internationally.

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List of acronyms and abbreviations

ACRONYM	Description
AI	Artificial Intelligence
API	Application Programming Interface
AR/VR	Augmented and Virtual Reality
CASD	Centre for Adaptation Strategies and Development
CEA	Citizen Engagement App
CO	Carbon monoxide
DSS	Decision Support System
EO	Earth Observation
EU	European Union
FSM	Fire spread model
GINA	Technology provider for UAVs
GPS	Global Positioning System
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technologies
IFM	Integrated Fire Management
IoT	Internet of Things
IoTED	IoT Edge Device
JSON	Java Script Object Notation
KML	Keyhole Markup Langauge
KPIs	Key Performance Indicator
ML	Machine Learning
MQ	Message Queue
NO2	Nitrogen Dioxide
O3	Ozone
PLA	Protected Land Area
SAL	Storage Abstraction Layer
SO2	Sulphur Dioxide
TTX	Tabletop Exercise
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
UP	User Product

WP	Work package

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Executive Summary

The overall objective of WP9 is to facilitate the continuous evaluation of the SILVANUS technology interventions to be demonstrated across nine (9) pilot demonstration sites from EU member states and three (3) international regions. The D9.2 deliverable follows up from the release of D9.1- *Report on organisational readiness of the pilot setup (submitted in M18)*, and *reports on the demonstration activities carried out during 2023 (from April to November of 2023).* The deliverable provides a comprehensive report on the pilot exercises that were organised as a part of SILVANUS project. The deliverable reports on the consortium activities that were successfully executed as a follow-up of organisational readiness steps that was were carried out and reported in D9.1. The pilot activities were executed as field exercises where the operational procedures of the fire fighters were demonstrated and tabletop exercises that were executed reviewing the details of a specific case-study that affected a specific region. The report consolidates the outcome of every pilot demonstration that took place in 2023, which included nine (9) European demonstration and two (2) international activities. For every pilot demonstration, the deliverable reports on the planning, logistics, execution, technical and operational interventions supported by SILVANUS followed by outlook for 2024 and lessons learnt. Additionally, short review of the media engagements is also presented. As a running theme, all the pilot demonstrations were organised to assess the quality of interventions offered by SILVANUS to the end-users by adopting the policies and principles of integrated fire management (IFM) which is systematically organised into three phases as outlined below.

- Phase A - Trials were dedicated to *Prevention and Preparedness* initiatives and prioritized the need for enhancing the knowledge on fire danger in a specific geographic region. As a part of the preparedness activities, the consortium establishes a strong stakeholder engagement process through which sophisticated VR/AR training for firefighters and the deployment of mobile applications within SILVANUS, fostering public awareness. Cloud services tailored for communities and companies, particularly utilities, are implemented to reduce the interaction between critical infrastructure and vegetation for enhanced fire prevention. Furthermore, a comprehensive review of EU environmental regulations and regional policies is conducted to ensure regulatory compliance.
- Phase B – Trials were focused on *Detection and Response* activities, demonstrating the automated AI driven capabilities of advanced ICT platform catering to the needs and demands of first responders, including firefighters, civil authority personnel, medical teams, and foresters and regional public administration authorities. Some of the key interventions that were evaluated and validated through the 2023 pilots include automatic detecting of forest fire ignition, AI based modelling of fire spread with parameters such as climate and weather impacts considered. Additionally, the use of unmanned aerial and ground vehicles have also been tested for their effectiveness in enabling response coordination. Additional, technological innovations that were demonstrated include knowledge gained from processing Earth Observation (EO) data repositories, granular predictive models for weather and climate conditions.
- Phase C – Trials focussed on the *Restoration and Adaptation* activities, leveraging recent innovations in simulation models to assess forest resilience to fires and various influencing factors such as climate change, human land use, and droughts. This evaluation is based on their impact on natural resources. Earth Observation (EO) technologies, encompassing both space and surface networks, will be employed to collect wildfire information. These mature technologies play a critical role in supporting fire managers, first responders, and risk managers by offering effective tools to predict severe fire danger conditions, rapidly map natural hazards, and assess impacts.

Each of the above listed activities were systematically coordinated and executed with the participation of several external stakeholders who took part in the respective pilot demonstration. This deliverable provides a first comprehensive overview of large-scale demonstration activities that took place across nine (9) pilot demonstration sites from EU member states and two (2) international regions. Following the demonstration activities reported in D9.2, a formal assessment on the technologies and interventions will be presented in D9.3 due by M30 (March 2024).

1 Introduction

SILVANUS consortium engaged in pilot planning and organisation since the beginning from October 2022 (M13) and lasted until the end of November 2023 (M26). The timeline of the various pilot demonstrations that took place is presented in Figure 1. The timeline of the various SILVANUS pilots and the associated category of pilot activity and the mode of pilot execution with the participating organisations is presented in Figure 2. For the overall coordination of the field and tabletop exercises, the end-users were presented with the holistic overview of different interventions that were being offered to the end-users to empower the stakeholders in undertaking the actions outlined in the integrated fire management (IFM). The SILVANUS project has identified four rings of protection (as presented in Figure 3), offers a set of complementary functionalities to the end-users which are designed to support decision making process with the availability of most up to date information.

Figure 1 - SILVANUS Pilots timeline from M19 to M27 (Phase - 1)

SILVANUS platform has been designed to deliver innovative solution for the environmentally sustainable and climate resilient forest management that integrates key technological solutions to provide advanced decision-making support for delivering integrated fire management methodology consisting of preparedness (Phase A), response (Phase B) and recovery (Phase C) phases. The decision support system (as outlined in D8.3) offers wildfire management cycle and increase the human, environment, and economic resilience to wildfires. The overall architecture that has been adopted within the project is presented in Figure 4 which presents the interdependency between the components of SILVANUS platform and the primary information flow resulting from the demonstration activities in Phases A, B and C. The project platform interventions have been systematically categorised into user product (UP) outcomes which have been integrated and demonstrated across each of the pilot activity as planned by the respective end-users. As noted earlier, the pilot activities include both the field and tabletop exercises both offering an opportunity for the stakeholders to visualise the SILVANUS interventions that have been offered to the first responders.

Timeline	Host organisations	Pilot exercise type/mode	Participating organisations
April 2023	HRVATSKA VATROGASNA ZAJEDNICA	Field exercise, physical	VTG, CTL, SGSP, 3MON, UASVG, ASFOR UISAV, RINI, MD
April 2023		Field exercise, physical	VTG, SGSP, FRS MB, 3MON, UISAV, ITTI, ASFOR, EXUS, EDP, TRT
September 2023		Tabletop exercise, physical	SIMAVI, ASFOR
September 2023	PUI	Field exercise, physical	VTG, CTL, TP, HM, CERTH, 3MON, MDS, SIMAVI
October 2023		Field exercise, physical	VTG, 3MON, TUZVO, SGSP, UISAV, KEMEA
OCTOBER 2023	asset	Tabletop exercise hybrid	VTG, FINCONS, UISAV, CMCC, CERTH, EXUS, CTL, ATOS, TRT, EAI, Z&P, ITTI, UASVG, PNRT
October 2023		Tabletop exercise hybrid	VTG, AUA, UTH, SGSP, PUI, KEMEA, HRT, CERTH, ATOS, EXUS, TRT, CTL, UISAV, AMIKOM
November 2023	AMIKOM	Field exercise, physical	VTG, SGSP, Z&P, MD, ITTI, UISAV, INTRA, IST
November 2023	TEPILORA	Tabletop exercise hybrid	FINCONS
November 2023	CSIRO	Field exercise, physical	VTG, Z&P, KEMEA, SGSP, ITTI, UISAV, CTL, ASSET, FRS MB, TP

Figure 2 - A summary of SILVANUS pilots and the respective participating partners in each pilot activity

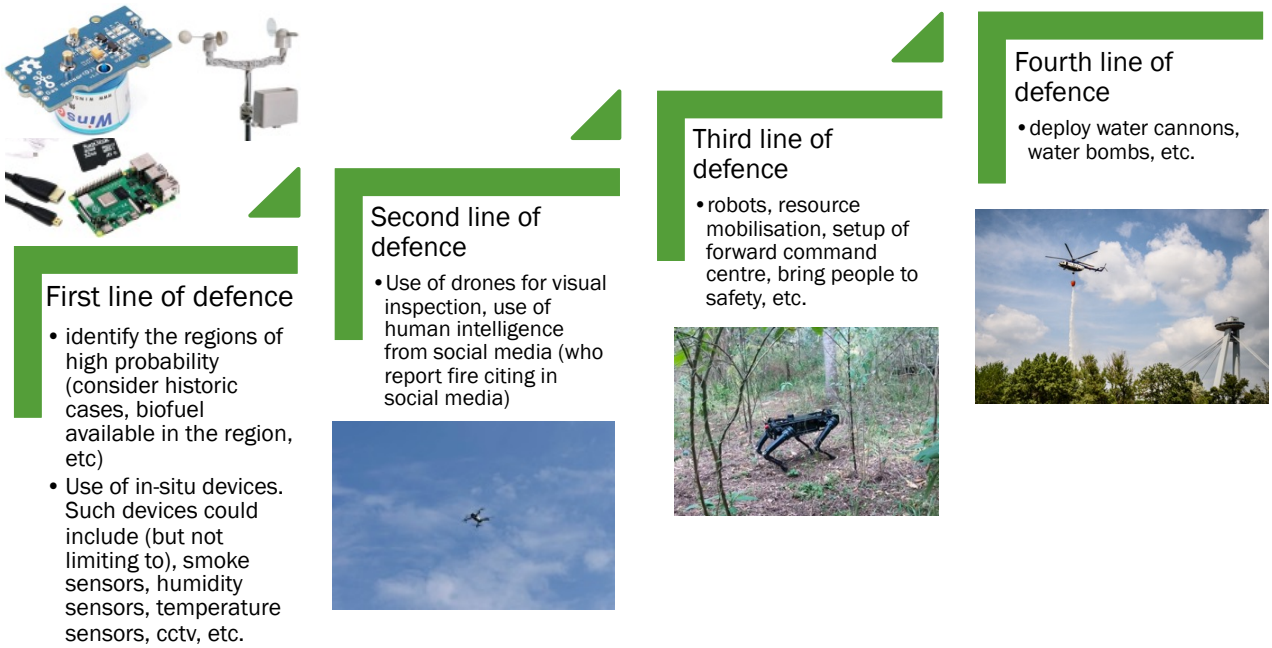

Figure 3 - SILVANUS rings of defence deployed during the pilot demonstrations

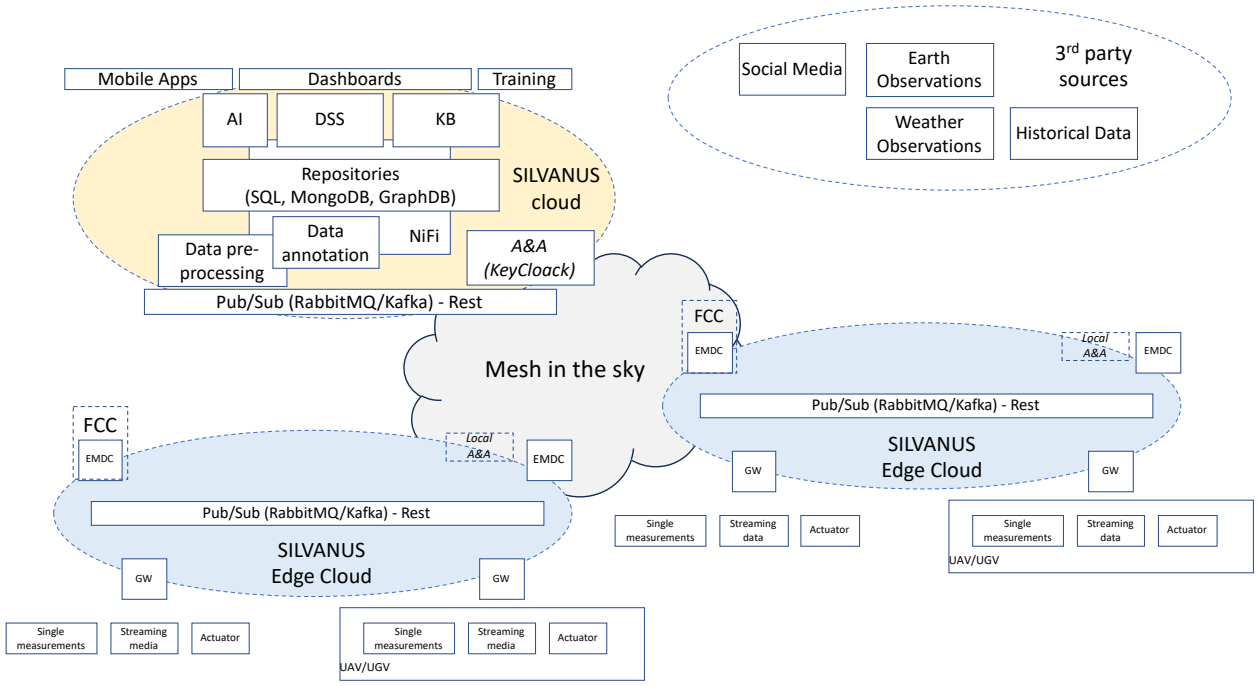

Figure 4 - SILVANUS architecture as presented in D8.1

In the preparation of the SILVANUS pilot planning, the consortium and the technological partner made a conscious decision to evaluate the validate the effectiveness of user products that have been developed to offer specific functionalities. This decision was driven by the fact that the SILVANUS platform development was carried out using the agile methodology and therefore gathering feedback and comments on the effectiveness of user products were critical to the success of the pilot outcome (which will be formally reported in D9.3). The design choices that were carried out in relation to the user product selection was driven by the need to address all the activities of integrated fire management (IFM) For example, the fire spread forecast can be used for understanding the spread of fire during a fire (Phase B), but also to understand what the most vulnerable area by can be, using several simulations runs, especially if combined with the fire danger forecast, so contributing to fire prevention (Phase A). This approach has led the consortium to effectively undertake an interdisciplinary process by bringing together the technical and scientific innovation activities that caters to the needs of stakeholders including fire fighters, civil protection authorities, environmentalists, conservationists, technology providers, forest administration authorities and local communities.

1.1 Scope of the deliverable

The deliverable D9.2 is part of the demonstration work package (WP9) titled “Large-scale demonstration activities of project outcomes”. The specific objectives addressed in this WP:

- to prepare organisational deployment of SILVANUS platform to coordinate Phase A, B and C trials in combating against wildfires.
- to evaluate the impact of wildfire spread across geographic regions.
- to model and emulate the spread of fire for quantifying the performance of detection and response capabilities.

The deliverable D9.2 is the second report published from WP9 and is a continuation of D9.1 Organisational readiness for pilot demonstration (submitted in D9.1). While the organisational readiness was reported in D9.1 that relates to the scenario specification to be demonstrated, along with identification of resources that are required to be mobilised including (but not limited) to the organisational permissions, engagement with the stakeholder community and pilot planning, the deliverable D9.2 presents the logistics of how the pilot was organised and what events were conducted. Additionally, the participation of the technical

partners has also strengthened the interdisciplinary collaboration between the consortium partners and external stakeholders. This WP is responsible for providing a comprehensive overview on demonstration activities from Phase A, B and C trials conducted during two trial periods planned in 2023 and 2024. These lessons learnt drafted from this deliverable will be used to revise the platform architecture (D8.4) and include the specification of forward command centre (also referred to as incident command post within crisis management community) that will seamlessly integrate with the backend cloud infrastructure.

The outcome of D9.2 is to report on the collection of first set of results obtained from the demonstration activities, as well as to identify the pilot planning activities to be carried out in 2024.

1.2 Relation with other WPs

In Figure 5, an overview of the SILVANUS workplan is presented, in which WP9 is closely linked and tightly coupled with WP8 (Platform design specification, interfaces and integration) activities. Following the adoption of the agile methodology for the project platform development, the implementation of the user products that are integrated within the platform have been successfully validated through demonstration activities that were planned within WP9. Additionally, the information gathered during the pilot demonstrations have been successfully disseminated and communicated to the relevant stakeholders. The demonstrations carried out in 2023 on behalf of SILVANUS user products have delivered a practice hands-on experience for the stakeholders and the results that have been visualised have offered the crisis management community an opportunity to evaluate and report on the effectiveness of SILVANUS interventions (to be reported in D9.3, by M30). Subsequently, the outcome from the pilots will also be fed into the development of WP2 activities that is focussed on the user requirements (the D2.1 has been revised in D2.4). The knowledge gathered through the pilot demonstrations will be used to create a long-term sustainable knowledge transfer centre referred to as CASD (Centre for Adaptation Strategies and Development), which will serve as a hub for delivering insights on effective methodologies to be adopted for combating against wildfires

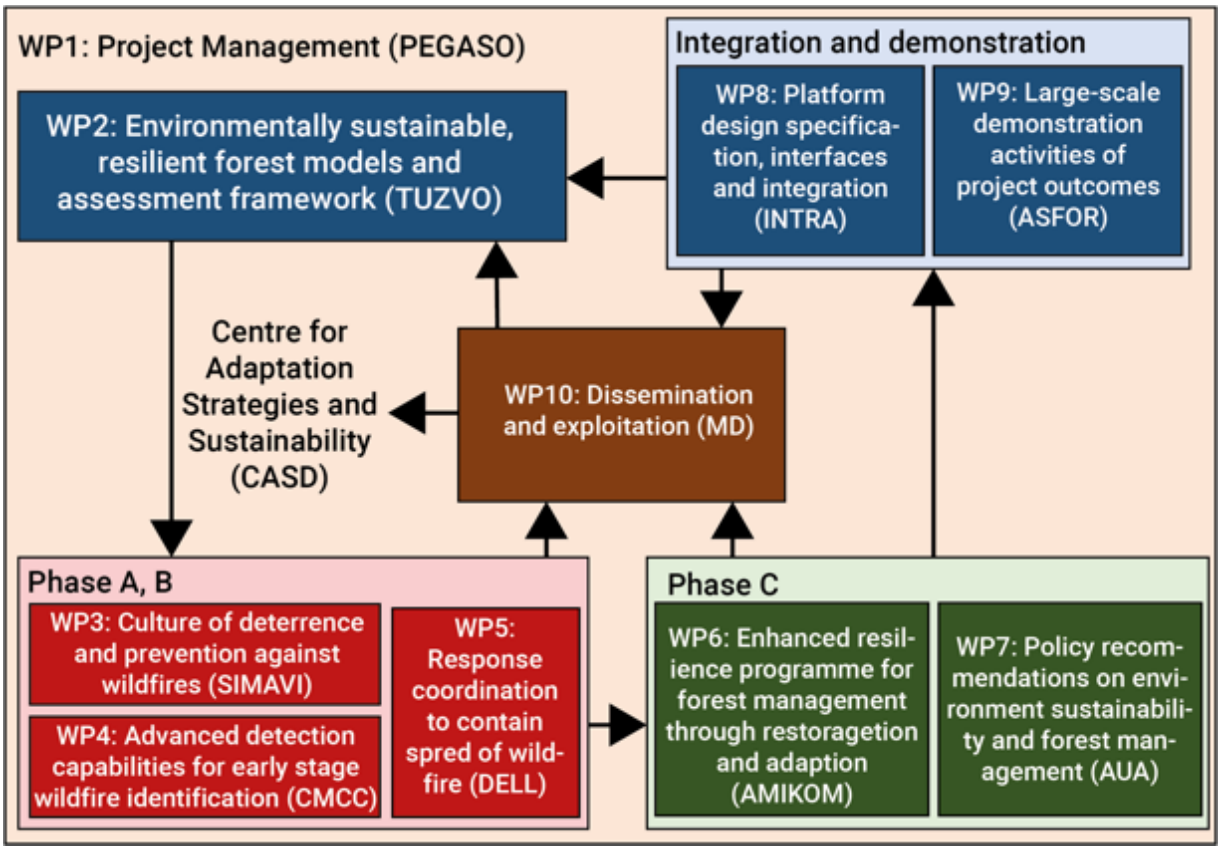

Figure 5 - SILVANUS WP interdependency

1.3 Structure of the deliverable

The deliverable is structured as follows. In Chapter 2, the list of user products which have developed for testing and during 2023 pilot has been presented. Subsequently, from Chapter 3 to 3.10, each of the pilot activity that has been carried out is presented in detail. Each pilot description consists of (i) pilot planning, (ii) objectives; (iii) pilot execution; (iv) key outcomes, both in terms of technology solutions presented to the end-users and operational procedures that has been achieved; (v) outlook for 2024 and lessons learnt from 2023 pilot activities; (vi) media reports (a detailed description has been presented in D10.3). A summary of overall challenges have been presented in Chapter 4, with conclusions and future work are reported in Chapter 6.

2 Technology solutions developed for testing within 2023 pilots

This chapter outlines the description regarding the technologies that were developed during first trial period of activities that showcased in each pilot site. The selection of the products was done in close consultation with the pilot leaders. Following the conclusion of each pilot, a stakeholder survey was completed by each participant providing comments on the pilot activity.

Chapter 2 is built around the inputs from the 10 pilot questionnaires, being structured in eight (8) different subchapters dealing with each pilot (from Chapter 3 to 3.10). The structure of the subchapters follows the same overview, presenting the information on the pilot planning, logistics, resource mobilisation for the execution of the field and tabletop exercise, documenting the key outcomes and set the vision for the outlook of 2024. Therefore, the overall objective of the first trial period activities on pilot sites covers the following aspects:

- Contextual information of each pilot area (area description and participating stakeholders) and the planning of the relevant logistics.
- Details regarding the pilot demonstration (objectives, description of performed activities and planning of 2024 pilot activities, as well as the outcomes of the first trial deployment of user products). A complete list of the SILVANUS User Products is presented in Table 1, including its description and specifications about the product functionality, as well as the phases (A, B and C) to which the product is associated.
- Identified strategic and operational challenges, in terms of key outcomes, to understand the obstacles and difficulties encountered during the first trial period activities. Specifically, key outcomes refer to issues related to the overarching goals, plans, and long-term objectives of the pilot, while operational challenges pertain to the day-to-day execution of activities within the pilot. In this sense, strategic challenges may also involve alignment with broader project organizational strategies, resource allocation, or the effectiveness of the chosen approach, while operational challenges may include logistical issues, technical problems, or other burdens faced in the practical implementation of the demonstration actions. In addition, operational challenges describe key challenges identified on the use of SILVANUS as an operational tool and the support towards an integrated fire management approach.

Table 1 - Complete list of SILVANUS user products that were selected and presented during the pilot demonstrations in 2023

No.	User product name	Description and functioning	Associated phases
UP1	**Augmented Reality / Virtual Reality Training for Firefighters**	It is a complex toolkit for training first responders (firefighters) through virtual modelling environments and real-life situations and wildfires simulations. The AR/VR platform allows first responders to experience training exercises and complex simulations, based on the real data from operational scenarios. The solution provides the first responders relevant information in real-time about the event (wildfire), status and environment, to speed up decision-making in case of major incidents and critical situations. It acts both as a player and as an authoring tool, enabling the users to participate in training programs and create also training scenarios based on their specific needs.	Phase A

UP2	**Fire Danger Assessment**	It provides an indication of the fire danger, i.e. a broad scale assessment of the conditions that reflect the potential, over an area, for a fire to ignite, spread and require suppression action. Fire danger is expressed as a semi-quantitative index from very low to very high risk (using 6 classes). The Fire Danger is provided for different temporal scales (nowcasting, daily, monthly and seasonal).	Phase A Phase B
UP3	**Fire Detection Based on Social Sensing**	Three Social Media Crawlers collect in almost real time posts based on user-defined keywords and certain accounts from three different social media sources Twitter, Facebook, Websites. The posts that are collected by the crawlers are processed through a comprehensive Social Media Analysis Toolkit. This toolkit utilizes advanced algorithms to extract valuable higher knowledge from the textual and visual content of the posts. The extract knowledge assists in the detection of relevant fire events and to gain a deeper understanding of the potential fire incidents. A Fire Event Detection Module monitors the social media posts and produces fire events when a significant number of posts related to fires accumulates in a certain amount of time in specific geographic region. The social media sensing and concept extraction tool comes along with a visualization Dashboard, a friendly Web interface that visualizes the fire events as pop ups on a map.	Phase B
UP4	**Fire Detection from IoT Devices**	The IoT Edge Device (IoTED) has been developed as a means for an early fire/smoke detection mechanism, as well as a monitoring device for rural areas. Unlike other (current) approaches, this device was designed to be power independent and most importantly to process the collected data on the spot (edge), to reduce any latencies and identify possible critical events as soon as possible. The IoTED consists of a waterproof case, with a strap for fastening it on trees/poles and encloses widely used sensors and components. It is powered by a power bank that will be recharged with the help of solar panels, making it fully power independent as electricity is not always available. Pre-trained fire and smoke detection Machine Learning (ML) models are employed (on the IoTED) for the assessment of possible fire/smoke events in the newly captured image. In the case of an identified fire/smoke event, the device sends a warning message to the SILVANUS framework, along with complimentary data (i.e., geo-location), to inform the first responders (e.g., firefighters) to take any necessary actions.	Phase A Phase B

UP5a	**UGV monitoring of Wildfire behaviour**	The Unmanned Aerial Vehicle (UAV) provides a full algorithmic solution based on Artificial Intelligence and Computational Geometry to support the use of Unmanned Aerial Vehicles, also known as drones, to effectively survey areas affected by wildfires from the air. By entirely automating the process of calculating smart work division and optimized sweeping pattern trajectories for the drones, the User Product cuts through the operator's complexity burden, saving substantial time, guaranteeing optimal use of resources, and allowing adaptive, on-the-fly mission planning and decision support in the command centre. UAV fleets are a lightweight and convenient solution to seamlessly cover large zones quickly with multiple sensor types (cameras, thermal sensors, lidars) so as to procure the information necessary to either detect new wildfires or monitor existing ones while avoiding putting human personnel in any close contact with the danger zone.	Phase A Phase B
UP5b	**UAV Monitoring for Wildfire Behaviour**	The Unmanned Aerial Vehicle (UAV) provides a full algorithmic solution based on Artificial Intelligence and Computational Geometry to support the use of Unmanned Aerial Vehicles, also known as drones, to effectively survey areas affected by wildfires from the air. By entirely automating the process of calculating smart work division and optimized sweeping pattern trajectories for the drones, the User Product cuts through the operator's complexity burden, saving substantial time, guaranteeing optimal use of resources, and allowing adaptive, on-the-fly mission planning and decision support in the command centre. UAV fleets are a lightweight and convenient solution to seamlessly cover large zones quickly with multiple sensor types (cameras, thermal sensors, lidars) so as to procure the information necessary to either detect new wildfires or monitor existing ones while avoiding putting human personnel in any close contact with the danger zone.	Phase B
UP6	**Fire Spread Forecast**	The Fire Spread Model (FSM) is a machine learning (ML) tool aiming to predict the development and spread of wildfires over the next 24-hour period. The FSM uses several parameters as inputs including: the terrain (elevation, slope, aspect), meteorological forecasts (temperature, wind speed, wind direction, etc.), fuel parameters (fuel type, moisture, canopy characteristics, etc.), barriers (firefighter efforts, roads, bodies of water, etc.), and the current location of the fire front. Given this information, the tool will generate a series of images depicting the fire-front location at 28 indicative times over the upcoming 24-hour period.	Phase B Phase A
UP7	**Biodiversity Profile Mobile**	The mobile app provides biodiversity tagging and analysis for improved awareness and support, with a significant	Phase A

	App (Woode App)	database with ground truths, entailing crowdsourced and augmented data, based on deep learning-based classification and recognition solutions. The pictures captured by the application is geotagged for marking the spatial location using Global Positioning System (GPS) information often associated with the latitude and longitude measures. The novelty of the proposed application is the ability to function when operated under uncontrolled environment and requires no additional intervention from the landscape owners and foresters to complete the processing. The Woode App integrates several key communication protocols that enables multi-stack services which allows for data exchange to take place from the mobile application to the backend services. The communication API seamlessly integrates with the available communication mode of operation such as WiFi and mobile network. It is also noted that in case if there is no network coverage available across the farming field, the image captured and packaged with the GPS coordinate will be stored in the cache and once the network is re-established the cached information will be posted to the backend system, in background mode of operation that requires no intervention from the users. Once the image collected have been successfully posted to the backend server for postprocessing, a data handling pipeline is initiated, in which the algorithms for augmentation, segmentation, super-resolution are applied to improve the overall quality of the image that has been gathered from the field. The sequence of algorithms that have been applied enables the processing of images collected from uncontrolled environment that is most suited for citizens, landscape owners and foresters to capture the data from the field. The main feature of Woode App is to enable the creation of a network of nature enthusiasts to actively engage with nature and exchange information about the trees and nature conversation among their peers.	Phase C
UP8	**Citizen Engagement Mobile App**	The mobile application was designed to empower citizens and provide them with the right tools to become crucial actors in Forest Fire Management. The Citizen Engagement App aims to cover all three Phases of the SILVANUS Project, by providing a holistic toolkit for Citizen Preparation, Response and Recovery through interactive educational and situational awareness modules. The app goal is to ensure that all users will always be informed, prepared and connected during Fire Incidents.	Phase A Phase B Phase C

		The mobile application allows to utilize modules for reporting fires or getting warnings about alerts.	

An overview of the different user products which have been demonstrated and evaluated across SILVANUS pilots in 2023 is presented in Figure 6.

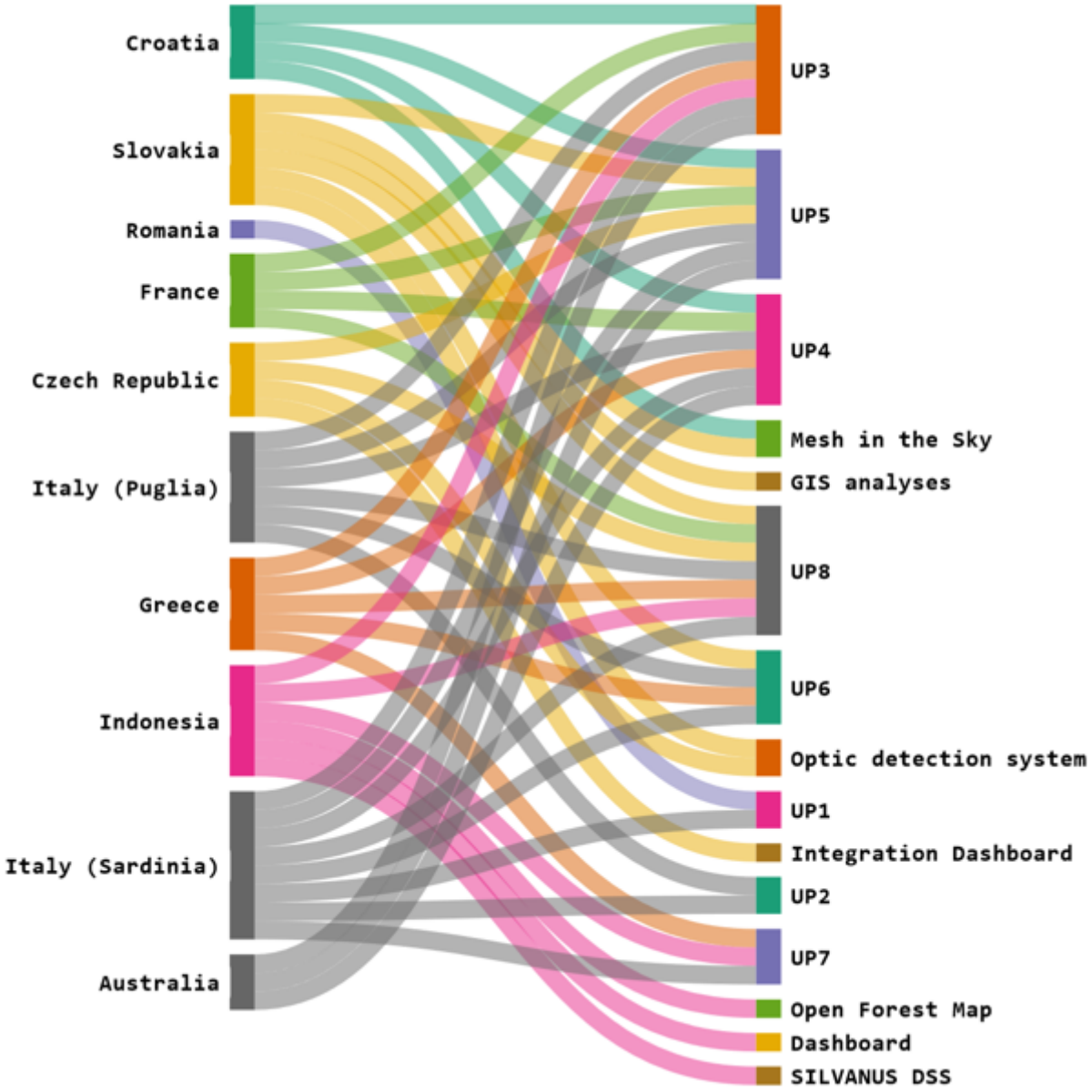

Figure 6 - Mapping of pilots against the user product evaluation carried out

3 Presentation of the pilots

This chapter presents the activities carried out in each individual pilot.

3.1 Croatia pilot

The first SILVANUS pilot was organised in Croatia and was conducted in two stages. The first one was the awareness campaign and a poster exhibition that was launched in the City of Rijeka from 3rd April to 12th April of 2023. The second pilot activity was scheduled as a field exercise that took place in the Training Centre Šapjane on 18th and 19th of April 2023, which is located approximately 20 kilometres from Rijeka. The public awareness campaign was organised with the help of local authorities (City of Rijeka, Primorje-Gorski Kotar County).

The exhibition was launched on 3rd April 2023 in the main pedestrian street of Korzo in Rijeka and featured 10 two-sided bilingual (Croatian and English) posters, focusing on:

- The main activities and objectives of SILVANUS
- Key messages and advice for citizens in the fight against extreme wildfire
- Announcement of the citizen engagement mobile app
- Description of Croatian Firefighting Association activities in SILVANUS and beyond

The formal opening of the exhibition was led by the Mayor of Rijeka Marko Filipović, the Deputy Prefect of Primorje-Gorski Kotar County Vojko Braut, the Chief Croatian Firefighting Commander Slavko Tucaković, and the Primorje-Gorski Kotar County Firefighting Commander Mladen Šćulac. The following posters were promoted during the public awareness campaign that was launched in April 2023. A list of posters that were presented in the city of Rijeka is presented in Figure 7 to Figure 10. The media presence and the visits of the regional authorities is presented in Figure 11 to Figure 13.

Figure 7 - SILVANUS in a nutshell poster to raise awareness on the project activities

Figure 8 - SILVANUS capabilities promoted through lines of protection

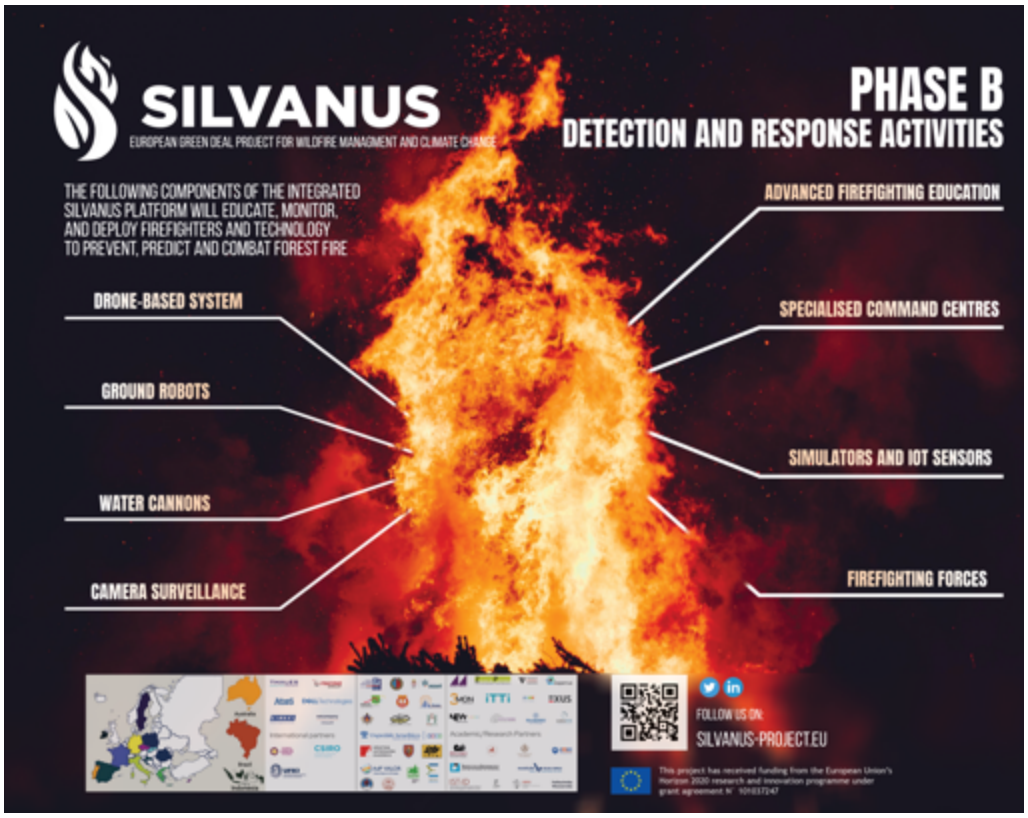

Figure 9 - SILVANUS technology capabilities for fire detection and response coordination

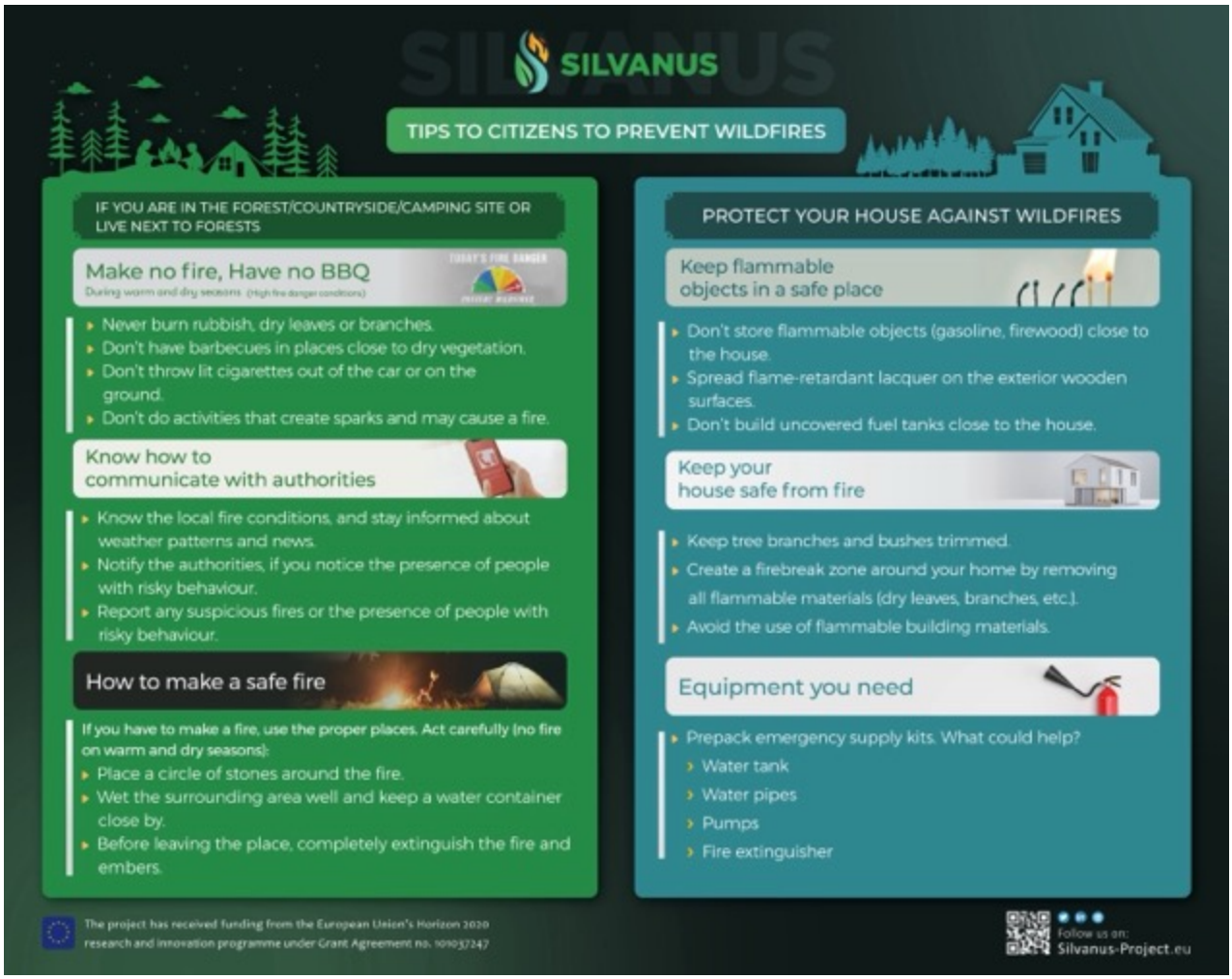

Figure 10 - SILVANUS citizen engagement awareness on the threat of uncontrolled wildfire

Figure 11 - SILVANUS posters being displayed in the main pedestrian pathway in Rijeka

Figure 12 - The exhibition launch visited by the city authorities

Figure 13 - Media gathering covering the SILVANUS public awareness campaign launch in the city of Rijeka

Following the public awareness campaign, the two-day field exercise was carried out between 18th and 19th of April 2023, in the region of Sapjane, Croatia. The agenda for the event is presented in Table 2 and Table 3.

Table 2 - Agenda for Day 1 of Croatian pilot on 18th April 2023

09.00 – 09.30	Institutional greetings – [HVZ-Main Fire-fighting Commander of Croatia]
09.30 – 10.00	Program of Activities in the Implementation of Special Fire Protection Measures of Interest for the Republic of Croatia [HVZ]
10.00 – 10.20	Fire Protection system from vegetation fires in in Primorsko-goranska county: fire-protection plan [HVZ/Fire-fighting Association of Primorsko-goranska County]
10.20 – 10.40	Fire protection from vegetation fires in Nature Park Učka [external advisory board member Nature Park Učka]
10.40 – 11.00	Break
11.00 – 11.20	Integrated web fire-management system in Croatia with integrated ICT applications: data bases, alarming, tracking, GIS [HVZ]
11.20 – 11.50	SILVANUS Presentation, Krishna Chandramouli, Venaka Treleaf GbR
11.50 – 13.00	Lunch
13.00 – 13.20	Video surveillance system in Croatia [HVZ/external advisory member OiV]
13.20 – 13.40	Integrated GIS system of Opatija county [HVZ/external advisory member Professional Fire Brigade of Opatija]
13.40 – 14.00	Presentation of Fire-fighting Coommand posts [HVZ/Fire-fighting Association of Primorsko-goranska County]
14.00 – 14.20	UGV: Robots in vegetation fire-suppression [external advisory member Civil Protection Directorate of Croatia/DOK-ing d.o.o.]
14.00 – 14.40	UAV: Drones in vegetation fire-suppression [HVZ/Professional Fire Brigade Zagreb]
14.40 – 15.00	Break
15.00 – 15.20	Modern communication systems: Mesh in the sky [RINI]
15.20 – 15.40	Modern communication systems-satellite communication systems-data collection [HVZ/Professional Fire Brigade Rijeka]
15.40 – 16.00	State hydrometeorological Institute: Forest fire danger index [external advisory member State Hydrometeorological Institute of Croatia]
19.00 –	Social dinner in Hotel Admiral, courtesy of Croatian Firefighting Association

Table 3 - Agenda for Day 2 of Croatian pilot on 19th April 2023

09.30 – 10.00	Participant welcome and safety protocols
10.00 – 10.10.45	Exercise one: Fire ignition and mitigation within elevated terrain. Participants: HVZ Equipment: Fire trucks, drones, and pass over flight

10.45 – 11.00	Break
11.00 – 11.45	Exercise two: Fire detection and response coordination using SILVANUS. Participants: HVZ, RINI, CTL, 3MON Equipment: IoT devices, Wireless communication mesh, AI/ML algorithm for fire detection, Ground robots
11.45 – 14.00	Networking Lunch, press report, Summary of the demo outcomes.
14.00 – 14.30	Wrap-up and closing of Day 2

3.1.1 Location

The Croatian Pilot was in Pasjak 70, Šapjane (Municipality of Matulji), Primorje-Gorski Kotar County (Figure 14) at the Šapjane Centre for Training of Emergency Services of the Primorje-Gorski Kotar County. The GPS coordinates of the Croatian Pilot are: 45.4739540, 14.2419480 (latitude, longitude).

The municipality of Matulji was formed within its current boundaries by the adoption of the Law on the Territories of Counties, Cities and Municipalities in the Republic of Croatia (Official Gazette 90/92), with its seat in town of Matulji and located in the Primorje-Gorski Kotar County. Until the adoption of the aforementioned Act, it was part of the Municipality of Opatija.

The municipality of Matulji is a border municipality of the Republic of Croatia with the Republic of Slovenia, which is significant for its spatial position. The length of the border line in the north of the municipality is approximately 24 km. Two international road border crossings (Rupa and Pasjak), an international railway border crossing (Šapjane) and two planned road border crossings (Mune and Lipa) have been established on the territory of the Municipality. Furthermore, the Municipality of Matulji also borders the region of Istria in the northwest, and in the Primorje-Gorski Kotar region with the Cities of Opatija, Rijeka and Kastav and the Municipality of Klana.

The area covered by the Municipality of Matulji is approximately 176.5 km2.

The area of Matulji Municipality is characterized by two units in the orographic sense:

- the northwestern slopes of Ćićarija, as a mountain massif with a southeast-northwest direction and
- the karst valley between the massifs of Ćićarija and Obruč, which gradually rises from the Kvarner Bay via Matulje, Rupa towards Ilirska Bistrica and Postojnski vrata, and is oriented in a southeast-northwest direction.

The mountainous part of the municipality is closed from the west by a crown of relatively high peaks, Kadički vrh 1112 m, Vodička griža 1143 m, Gomila 1241 m (the highest point in the municipality), Šija 1086 m, Oštri Vrh 1162 m, Orljak 808 m. The crown descends gradually into the aforementioned karst valley.

The karst valley begins at a height of 100 m above Preluk and ends in Rupa at 460 meters above sea level.

Figure 14 - Location of the Pilot in Croatia

3.1.2 Participating stakeholders

The stakeholders in the Croatian pilot exhibit a diverse range of typologies, each contributing with distinct activities and roles to the SILVANUS project as shown in Table 4.

Table 4 - Stakeholders' roles and activities, Croatia pilot

Stakeholder	*Activity Engaged*	*Role*
Croatian Firefighting Association (HVZ)	Organization of the pilot demonstration in Šapjane, seasonal integrated public awareness campaign, prevention, education and suppression activities, monitoring via integrated national surveillance system of cameras, organization and integration of firefighting forces via national Fire-fighting Management system and National firefighting activation plan, provision of a separate command post, creation of advanced education programs and new guidelines	End user and pilot demonstration owner, consultants, technology provider, administrative support, logistics, practical demonstration involvement with forces and resources
Firefighting Association of Primorsko-goranska County	Overseeing and commanding the pilot demonstration, seasonal integrated public awareness campaign, providing County Fire-fighting plan, providing professional and volunteer fire brigades, providing a mobile fire-fighting Operational centre, mapping of site via UAVs	Pilot demonstration host, consultations, practical demonstration lead with forces and resources, logistics, technology provider
RiniGARD	Mapping of site via UAVs, providing Mesh in the Sky system for transferring monitored data from the sensors deployed on drones	Consultations, technology provider, practical demonstration involvement with UAV
Ministry of Defence of the Republic of Croatia	Providing aerial firefighting forces	Technology provider
DOK-ING	Monitoring and other activities by UGV	Consultations, technology provider
3MON	Testing GINA application, providing IoT sensors, mobile meteorological station and UGV	Technology provider
Catalink	Providing fire detection from IoT devices	Technology provider
University of Applied Sciences Velika Gorica	Technology provider	Providing administrative support
University of Split - Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture	Providing GIS based wildland fire spreading simulator	Technology provider
PB Croatian Forests	Providing a susceptibility of territory to wildfire risk assessment plan, providing maps of fire danger,	Consultations, Technology provider

State Hydrometeorological Institute	Providing a susceptibility of territory to wildfire map	Consultations, Technology provider
OIV Digital signals and networks	Communication technology consultants	Consultations
Nature Park Učka	Consultations on the regional forest and biodiversity	Consultations
Micro Digital	Consultations on the public awareness campaign and overall project	Consultations

This collaborative network showcases a multidimensional engagement of stakeholders, combining end users, technology providers, consultants, and institutions with diverse expertise to enhance the success of the SILVANUS project in Croatia.

3.1.3 Objectives

The objectives, at the strategic and operational level, are summarized as following:

- Fire prevention through integrated public awareness campaign (fulfilled 2 weeks earlier in the city of Rijeka by a poster campaign),
- Mapping of the area,
- Coordination of local and regional firefighting forces with aerial firefighting forces,
- Deployment of drones, UGVs, video cameras, IoT sensors, a mobile meteorological station and a separate command post.

3.1.4 Description of performed activities

Following the description provided in D9.1, the field exercise that was carried out in Sapjena included both the Phase A and Phase B activities included in the Integrated Fire Management (IFM) procedures. To this wend, the Croatian pilot focused its demonstration planning in two sectors as indicated below.

Phase A: Prevention and Preparedness

- Phase A1 Seasonal integrated public awareness campaign with info billboards
- Phase A2 Environmental and ecological mapping and assessment of exercise ground within the project demonstration
- Phase A3 Surveillance of demonstration site
- Phase A4 Gathering of microclimate data at the demonstration site

Phase B: Detection and Response

- Phase B1 Coordination of activities through fire-fighting management system
- Phase B2 Monitoring of onsite activities through fire-fighting operational centres
- Phase B3 Usage of UAV and UGV systems

The scenario of the first trial period activities developed in the Croatian pilot is presented below.

1st SECTOR

Residents of Šapjane noticed the occurrence of a forest fire, which was reported to Regional Firefighting Operation Centre in Rijeka and local firefighting forces began to suppress the fire. The site also represents the setup of SILVANUS components to assist in fire suppression activities as presented in Figure 15 and Figure 16. The engagement of the stakeholders that took place on the 18th April to review the operational scenarios is presented in Figure 17 and Figure 18. In Figure 19 the sector 1 activities as planned and executes is presented.

Figure 15 - The pilot site setup with SILVANUS technologies

Figure 16 - Command and control for the deployment of ground robots in fire suppression activities

Figure 17 - SILVANUS banners presented within HVZ premises for the stakeholder engagement

Figure 18 - Stakeholder engagement activity taking place for the presentation of SILVANUS and gather feedback on operational procedures from stakeholders

Figure 19 – Demonstration actions in the Croation Pilot (1st sector)

2nd SECTOR

The sudden increase in wind power caused the fire to move along the road and the railway line, which began to spread across the meadow in a North-Easterly direction, endangering buildings along the railway line. Firefighting UGVs were used in extinguishing (Figure 24). The demonstration of the operational scenario is being presented in Figure 20 to Figure 26. At the same time, air assistance was alerted, which after 30 minutes joined in extinguishing the fire, in accordance with the National firefighting activation plan.

Figure 20 – Demonstration actions in the Croation Pilot (2nd sector)

Figure 21 - Operational demonstration of fire suppression using Canadair

Figure 22 - Operational demonstration of fire suppression using Canadair

Figure 23 - Operational demonstration of fire suppression using Canadair

Figure 24 - Demonstration and validation of fire suppression using ground robots

Figure 25 - Water spray evaluation for fire suppression

Figure 26 - Fire suppression with two different ground robots and performance assessment

Figure 27 - CTL and RINI engineers setup in-situ and Mesh in the sky services for field testing

Figure 28 - Media briefing of SILVANUS field exercise outcome

The opening of the SILVANUS poster exhibition in Rijeka, Croatia on April 3rd was covered by local, regional and national Croatian television (HRT). Mayor of Rijeka Marko Filipović and Chief Croatian Firefighting

The setup of Catalink IoT device and the interconnectivity with Mesh in the Sky system to establish communication is presented in Figure 27

Commander Slavko Tucaković opened the exhibition, which gave the project an additional marketing value that proved to be efficient in attracting viewers, as presented in Figure 28.

The video of the national TV coverage, which featured interviews with Mr. Filipović, Mr. Tucaković, Deputy Primorje-Gorski Kotar County Prefect Vojko Braut and County Firefighting Commander Mladen Šćulac, is available on SILVANUS YouTube channel with English subtitles, which was promoted through the SILVANUS YouTube channel as presented in Figure 29.

Figure 29 – Croatian National Television Coverage of SILVANUS Exhibition in Rijeka

The pilot exercise on 18th and 19th of April was covered by local, regional and national television. The news report featured interviews with Mr. Tucaković, Mr. Šćulac, the County Prefect Zlatko Komadina, the Matulji Municipality Officer Vedran Kinkela and Simona Kalinovska from SILVANUS partner 3MON, who demonstrated the use of ground robots for suppressing wildfire. Nikica Tramontana from HVZ concludes the 10-minute news report with a summary of the entire pilot exercise. The recording, made by the regional Novinet Tv channel, is available on SILVANUS YouTube channel.

Other media presentations and promotions were also carried out as shown in Figure 30 to Figure 34.

Figure 30 - Nikica Tramontana preseting the Croatian Pilot Exercise for Regional Television

Two press releases were made on the announcement and the report of the SILVANUS poster exhibition in Rijeka, Croatia. The release was named "An exhibition was opened on the Korzo Street in Rijeka on wildfire prevention" and it was published in seven local and national media outlets on April 3rd, 2023.

Figure 31 – Press Article on SILVANUS Poster Exhibition in Rijeka, Croatia (Croatian National Radio and TV)

A press release, named "The SILVANUS project has demonstrated a wildfire suppression pilot exercise", was published on April 20th, 2023, and published in nine media outlets.

Vježba Silvanus / foto: HVZ

Proveden demonstracijski pilot u sklopu EU projekta SILVANUS

Objavio **Aleksandar Olujić** - 19 travnja, 2023

Figure 32 – Example of a Press Article about the Croatian SILVANUS Pilot Exercise (Ps-portal.eu)

On July 5th, 2023, an article was issued on the Osservatorio Balcani e Caucaso Traseuropa (OBC Transeuropa think-tank) website, titled „Croatia shows how to deal with worst wildfires“. The article, written by Chiara Marchesini, featured an overview of SILVANUS and included interviews with SILVANUS dissemination manager Lovorko Marić and Croatian Firefighting Association Željko Cebin. Along with a general description of SILVANUS and the pilot exercises, the Croatian pilot was described in detail.

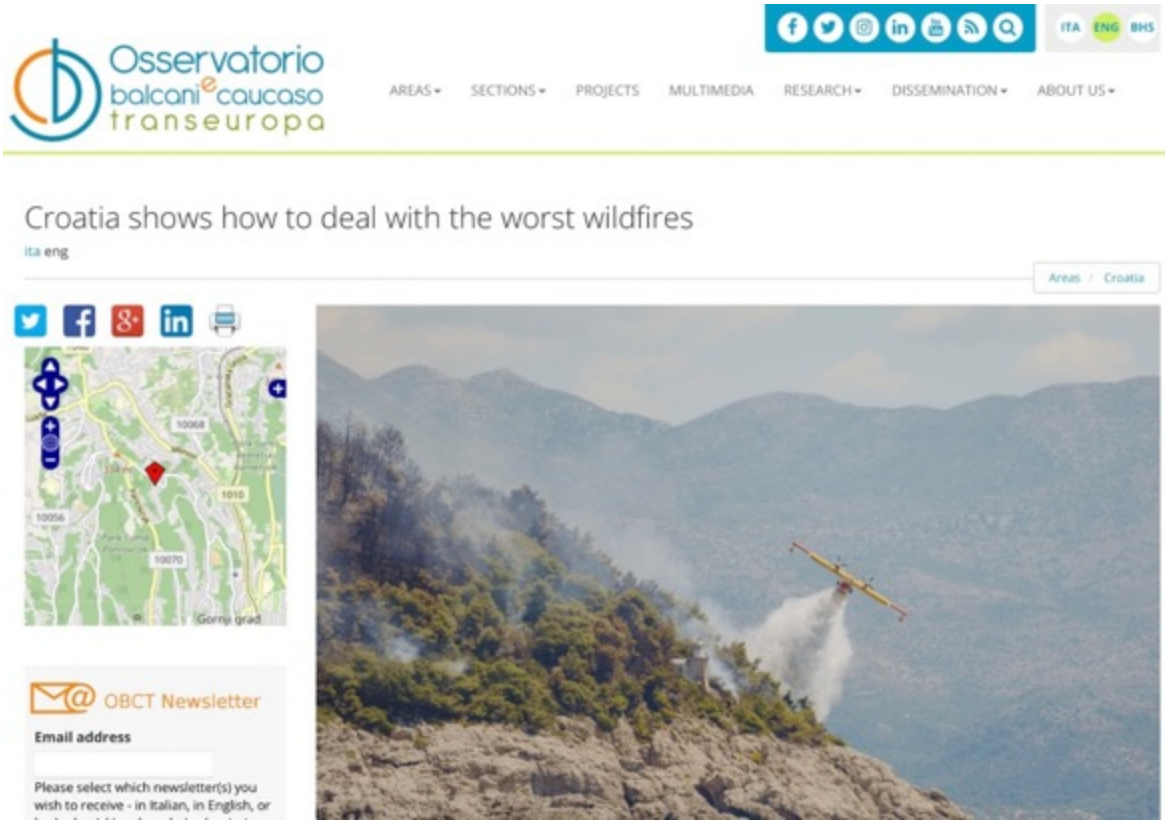

Figure 33 - The OBCT Article on the SILVANUS Pilot Exercise in Croatia - "Croatia shows how to deal with wildfires"

An interview was published in December 2023 with SILVANUS dissemination manager Lovorko Marić for Alter! - Alternative League for the Transition to European Resilience blog, funded by the MAIA project. The

interview was conducted within the article “Summer Wildfires in 2023: A Global Crisis”. The discussion revolved around how SILVANUS can contribute to wildfire prevention, the role of climate change in fire propagation, how citizens can play a key role in reducing the threat of fire, and which actions are taking place to improve land resilience. The Croatian pilot was mentioned as the first conducted exercise where these topics were covered and where the platform was tested.

Full interview is available at these links: https://alterclimatechange.com/publication/summer-wildfires-2023 and https://alterclimatechange.com/publication/interview-with-lovorko-maric.

SILVANUS is working with different pilot exercises to test this technological platform. How is it approached?

We have 12 pilot sites in 11 countries focused on different phases. For example, the Indonesia pilot is centred on phase three, which deals with biodiversity restoration and adaptation. Other pilots are working on detection and response, this is the case in countries such as Croatia and Slovakia, where we have specific pilot exercises already implemented. There, we have to deal with state-of-the-art technology using all the data that is integrated into the platform, from weather climate models to social media reports to remote sensing and so on. We work on the integration of all these components for an efficient and most productive possible technology deployment in order to detect and respond to wildfires as soon as possible, detecting the cause as well. Besides these two pilot exercises already implemented, we have ten more pilots to go in the first trial period, and each of them has its own specificity based on the phases mentioned before. Moreover, we try to focus on the causes and escalation of potential wildfires in different countries and different geographical locations. For instance, in one pilot site in Portugal, we assess the potential impact on power infrastructure and water supply, not only in that region but in the whole country. There is another one in France centred on a wildfire close to an industrial location and facilities that could cause explosions and further wildfire escalations. In summary, many situations are taken into account related to local communities affected by wildfires and regarding the electricity sector, water supply sector, IT business and so forth.

Figure 34 - Excerpt from the Alter! Interview on SILVANUS Pilots

3.1.5 User product validation

Table 5 presents the UPs that has been tested during the execution of the Croatian pilot, providing a short description of each one and their outcome from the tests.

Table 5 – User product, Croatian pilot

Phase (A,B,C)	*Tested user product*	*Description*	*Outcome*
Phase A, B	UP5 UAV	Use of UAV systems for monitoring and UGV systems for monitoring and fire extinguishing activities	Reconnaissance, mapping
Phase A	UP3 Fire detection	Detection of the fire	Successful testing and demonstration of the smoke and fire detection solutions.
Phase B	UP6 UGV	Fire suppression, Deploying and route planning of UAVs; Data collection, mapping.	Transmitting data
Phase B	Mesh in the Sky	Communication between drones	A crucial role in detecting and monitoring forest fires, especially during their initial stages, is played by the rapidly deployable ad-hoc wireless mesh networks. The mesh network ensures that information from various sensors is relayed efficiently to a central control centre or gateway node, allowing firefighters to take swift action. In the developed SILVANUS mesh network, each sensor node communicates directly with neighbouring nodes, ensuring robustness and fault tolerance. If one node fails or gets damaged due to fire, the network can still function because other nodes maintain connectivity. The developed Mesh-in-the-Sky network allows dynamic routing, adapting to changes in the network topology caused by fire or environmental factors. During the completed trials it was proven that the developed network enables efficient communication, early detection, and accurate alerts during forest fires, contributing to disaster prevention and ecological preservation.
Phase A	UP7 Woode App	Capturing of biodiversity information from the pilot site	Successful testing of the first release of the mobile application.

3.1.6 Strategic and operational challenges

At present, the Croatian Pilot did not encounter any strategic and operational challenges.

In terms of mitigating potential challenges that may appear, the Croatian Pilot proposes including meetings with developers and explanations on how to implement them in the pilot, in KPI's user products of Silvanus, in spring 2024.

3.1.7 Planning of 2024 pilot activities

- Internal meetings in Croatian Firefighting Association
- External meetings with Croatian partners and stakeholders
- 2024 pilot is scheduled for October, with date to be determined.

3.1.8 Conclusions

The Croatian Pilot showcased the efficacy of integrated forest fire management systems within the SILVANUS project. Involving diverse stakeholders such as the Croatian Firefighting Association (HVZ) and technology providers, the pilot successfully executed activities focused on fire prevention, mapping, and coordinated response. Testing UAV and UGV systems, fire detection cameras, and communication networks, the pilot demonstrated seamless operations.

The performed activities in Phases A and B included a seasonal integrated public awareness campaign, environmental and ecological mapping, surveillance of the demonstration site, gathering microclimate data, coordination of activities through firefighting management systems, monitoring of onsite activities through firefighting operational centres, and the usage of UAV and UGV systems. The scenario involved real-time response to a simulated forest fire, showcasing the capabilities of the integrated system in different sectors.

User product validation in the Croatian Pilot involved testing UAV systems for monitoring and UGV systems for monitoring and fire extinguishing activities, fire detection, fire suppression, deploying and route planning of UAVs, data collection, mapping, communication between drones, and smoke and fire detection.

Notably, no significant challenges were encountered, and proactive measures are planned for potential issues in the future.

The planning of 2024 pilot activities will include internal meetings in the Croatian Firefighting Association, external meetings with Croatian partners and stakeholders, with the pilot scheduled for October, and the date to be determined. The Croatian Pilot stands as a testament to successful collaboration, effective system implementation, and strategic planning within the SILVANUS project, contributing to the advancement of integrated forest fire management systems.

3.2 Slovakia pilot

The Slovak pilot was organised in the month of April 2023 (M19 of the project duration) with the following programme, extended for 3 days as presented in Figure 35 to Figure 37.

Figure 35 - Day 1 programme of the Slovak Pilot

PROGRAMME OF THE SLOVAK PILOT DEMONSTRATION

SILVANUS

Wednesday, 26. 04. 2023, Meeting on the results of the pilot study, Hotel Kaskády, Sielnica

10.00 – 10.15	Opening of the meeting
10.15 – 10.45	Presentation of the SILVANUS project
10.45 – 11.15	Summary of the demonstration of the Slovak pilot study
11.15 – 12.00	Benefits and shortcomings of deployed technological and information support in forest fire management – discussion
12.00 – 13.00	Lunch
13.30 – 13.45	Forest fire risk management under climate change - discussion
13.45 – 14.00	Conclusions on the results of the pilot study and outcomes of the meeting
14.00 – 14.15	Implementation of the questionnaire survey
14.15	Meeting closing

Figure 36 - Day 2 programme of Slovak pilot

Figure 37 - Day 3 of Slovak pilot

In Slovak Pilot the surface/ground fire which continues to crown fire was demonstrated, while the surfaces fire is the most common regime of fire in Slovakia and its transition to crown fire is the worst scenario which requires deployment of nor only fire trucks but also helicopters for fire localization and suppression. The demonstration was divided to three days and solution s and activities for all wildfire phases (A, B, C) including stakeholders' engagement were demonstrated and discussed.

3.2.1 Location

Slovak pilot activities were provided in the territory of Podpoľanie region, specifically Poľana Biospheric Reserve located in the Central part of Slovakia (Figure 38, Figure 39, Figure 40).

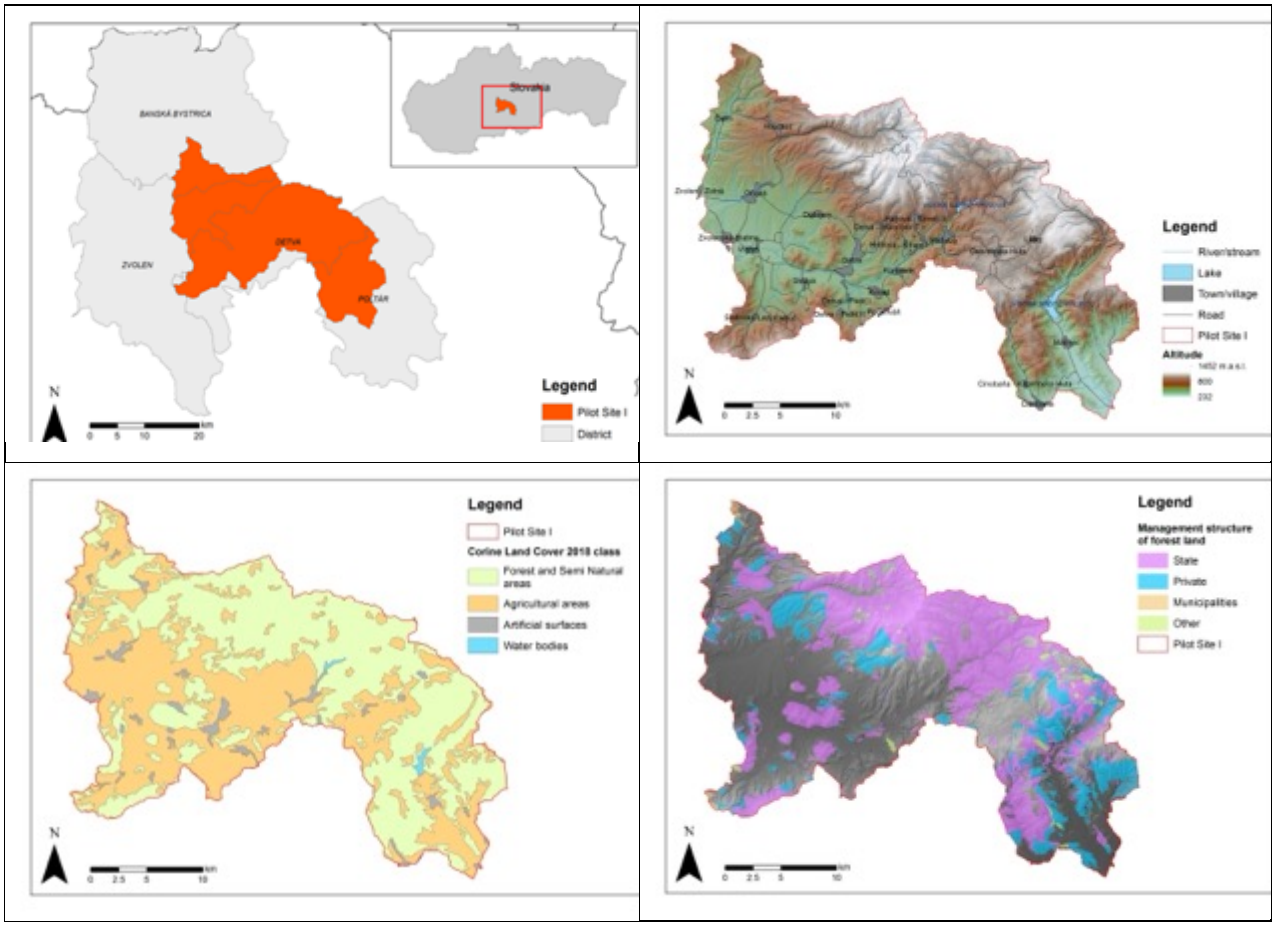

Figure 38– Location and the area characteristics of the Poľana Pilot in Slovakia

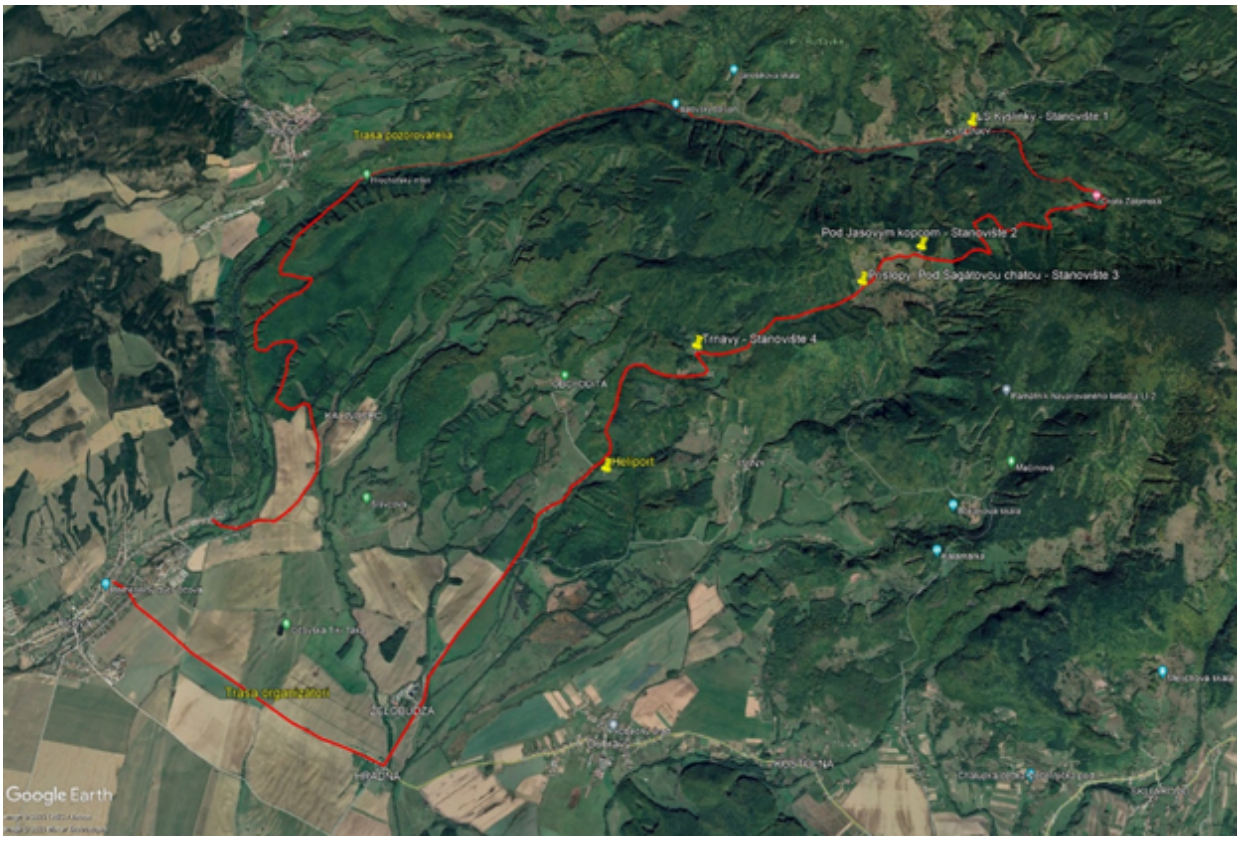

Figure 39 – Map of the demonstration site with the Outposts 1-4, with the heliport and the roads used to access the area by the vehicles, Slovak Pilot

Figure 40 – Poľana Biospheric Reserve, Slovak Pilot

The Pilot Site (forest) is under nature protection, particularly it belongs to Protected Landscape Area Poľana - the Poľana Biosphere Reserve. Protected Landscape Area (PLA) Poľana was launched in 1981 for the protection of inanimate nature, plant, and animal communities as well as a special landscape character and declared on the territory of 20 360.48 ha. Of these, there are 3,001.41 ha of agricultural land and 17,102.36 ha of forest land, 102.50 ha of water areas, 48.62 ha of urban areas and 105.60 ha of other areas. Agricultural land like the mountain meadows and pastures is either mowed or grazed by cattle and sheep. Re-cultivation in the recent past, to some degree has changed the original floristic composition of the grasslands. Despite this, enough natural plant and animal communities are still present.

The forests existing in the Pilot site area are managed and administrated by the Forests of the Slovak Republic, S.E., specifically the Forest's branch plant Kriváň. The forest management plans are elaborated after the negotiation with the Biospheric Reserve Poľana representatives as well as representatives of forest private owners' association. The wildfires in the Podpoľanie micro-region are caused mostly by human activities. Most often, it is a deliberate human activity associated with the burning of agricultural and grassland areas close to the forest. This activity is typical throughout the territory, particularly in the spring and autumn seasons. It is most pronounced in the period of the survey of meadows and pastures in the territory of the Slovak Republic, which is carried out by the Ministry of Agriculture of the Slovak Republic and the outputs of which are used for redistribution of subsidies for haying of meadows and pastures to their owners or users. This is carried out at 10-yearly intervals. The last survey was carried out in 2022.

3.2.2 Participating stakeholders

The stakeholders in the Slovak pilot exhibit a diverse range of typologies, each contributing with distinct activities and roles to the SILVANUS project as shown in Table 6.

Table 6 - Stakeholder roles and activities, Slovakia pilot

Stakeholder	*Activity Engaged*	*Role*
Self-governing region Banská Bystrica	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at regional level.
Municipality Očová	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at municipality level.

Municipality Lieskovec	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at municipality level.
Municipality Hrochoť	Observer	Passive role in demonstration. Active role when discussing and preparing the strategies for fire prevention at municipality level.
Municipality Detvianska Huta	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at municipality level.
Slovak Environment Agency	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at municipality level.
State Forest Enterprise	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at national level.
Ministry of Agriculture and Rural Development of SR	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at national level.
Ministry of the Environment of SR	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at national level.
Ministry of Interior SR	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at national level.
Directors of District Directorates of Fire and Rescue Service	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at district level.
Fire and Rescue Service Regional Headquarters Banská Bystrica	Organizing the sources and resources in competence of the Fire and Rescue Service at regional level, preparing the plan of the tactical exercise, providing sources and resources for exercise, participation at evaluation of the demonstration. Providing data transfer and communication, coordination at incident site.	Active role. Organizer / Demonstrator.
YMS, a.s.	Observer	Passive role. Gathering knowledge and experience on technical solutions to support the incident commander.
Fire Prevention Officers	Active participant at the workshop organized by CASD on April 26, 2023.	Active role. Stakeholder engaged in discussions and proposing the fire prevention strategies at national level.

Municipality Zvolen	Observer on exercise. Active participant at the workshop organized by CASD on April 26, 2023.	Passive role in demonstration. Active role when discussing and preparing the strategies for fire prevention at municipality level.
State Forest Enterprise, management unit of Kriváň	Active participant at the exercise, in the phase of exercise preparing, organization, issuing permissions. Active participant at the workshop organized by CASD on April 26, 2023.	Active role. Permit issuer. Organizer / Demonstrator.
Volunteer Fire Brigades (7 brigades)	Providing activities related to data transfer among command staff and volunteer fire brigades, fire extinguishing using fire trucks, system of ponds, hand equipment. Active participant at the workshop organized by CASD on April 26, 2023.	Active role. Organizer / Demonstrator.
Fire Brigades of Armed Forces (3 brigades)	Providing activities related to data transfer among command staff and volunteer and military fire brigades, fire extinguishing using helicopter and fire trucks. Geeting the permission for deployment of drones from Armed Forces of SR – the Sliač Airport.	Active role. Organizer / Demonstrator / Permission issuer.
Students	Observers	Passive role. Getting experience and knowledge on wildfire management and data and technology support
Media	Providing text, audio, and video outputs	Active role in providing information on the demonstration and project in TV, radio, news
3MON	Technological partner. Providing real-time localization of vehicles i the field, deployment of Optix camera smoke/fire detection system, Colossus UGV deployment	Active role. Organizer / Demonstrator.
UISAV	Technological partner. Mobile crowdsourcing application deployment, SWARM of drones, production of ortho photo map	Active role. Organizer / Demonstrator.
Technical University in Zvolen	Coordination of partners and other stakeholders involved in the Pilot demonstration, providing geospatial analyses and geodata representing the	Active role. Organizer / Demonstrator.

	wildfire susceptibility, fire danger and prognosis of fire spread in GIS and FARSITE. Those data were available as a data source for decision-making of incident commander or command staff.	
PLAMEN	Coordination of activities related to firefighters management and deployment in the field. Coordinator of meetings with other fire brigades and elaboration of exercise plan from fire tactics point of view, performance of firefighting activities in the field.	Active role. Organizer / Demonstrator.
CASD	Organization and coordination of the workshop on April 26, 2023	Active role. Organizer/Demonstrator.
VTG	Technological partner, observer	Active role, pilot coordination
ASFOR	Technological partner, observer	Passive role
EDP	Technological partner, observer	Passive role
Thales Research and Technology	Technological partner, observer	Passive role
University of Patras	Observer	Passive role
EXUS	Technological partner, observer	Passive role
SGSP	Observer	Passive role
Fire Brigade of the Moravian-Silesian Region	Observer	Passive role
Dronmedia	Slovak SME. Providing and coordination of UAV to demonstrate the activities with swarm of drones.	Active role. Demonstrator
Aliter	Slovak SME. Providing the GSM network (mesh) by integration of UAV and Starlink	Active role. Demonstrator
Optix	Bulgarian SME. Camera smoke /fire detection with transfer of data to command staff	Active role. Demonstrator
Biosphere reservation of Poľana	Permission issuer, active participant at the workshop, provider of best practices of landscape management in cooperation of foresters, nature	Permit issuer/Observer/ Active participant at the seminar.

	conservancy workers and firefighters	
Association of Owners of Community and Private Forests of the Banská Bystrica Region	Observer	Passive role in demonstration. Active role when discussing and preparing the strategies for fire prevention at national level.
State Nature Conservancy	Observer	Passive role in demonstration. Active role when discussing and preparing strategies for fire prevention at national level.

The stakeholders in the Slovakian pilot exhibit diverse levels of engagement, from active demonstrators to passive observers and media participants.

3.2.3 Objectives

The aim of Slovak Pilot Study was to demonstrate as holistic as integrated approach to wildfire management. The holistic approach was based on the risk assessment of the territory of Biospheric Reserve Poľana / Podpoľanie region.

The Slovak pilot within the SILVANUS project focuses on enhancing resilience to wildfires through training, leveraging an integrated technological platform for decision support in wildfire management. Key aspects include continuous surveys for fire risk assessment, integrating technology, science, environment, and human factors. The initiative develops infrastructure, utilizing big-data software and algorithms to prevent and manage forest fires, incorporating wireless communication and drone surveillance. By employing onboard data analytics, the project aims to extend UAV flight time. Overall, the multistakeholder platform addresses challenges across Phases A, B, and C, emphasizing high-impact interventions.

3.2.4 Description of performed activities

The programme of the demonstration was divided to 3 days.

The first day, **April 24th, 2023**, there were organized 2 activities:

Activity 1: SIBYLA forest growth simulator, using the data from Pilot site to visualise the structure of forest stands in the Pilot Site and to model and simulate the different alternatives of forest growth according to the forest management activities and their consequences on the biodiversity and forest sustainability. The results of modelling and simulation were visualised in 3D cave using the VR/AR technology (Figure 41). This activity was fully in correspondence with objectives of Phase C dealing with forest reconstruction and recovery after the fire. It allows to prognose the forest stand growth and resilience to harmful agents based on alternative of forest management activities implemented after the fire occurrence.

Figure 41 – Visualisation of SYBILA simulation outputs in 3D cave

Activity 2: There was also organized a demonstration of testing the efficiency of extinguishing substances friendly to wildland environment (Figure 42, Figure 43). The efficiency was evaluated based on data gathered by thermocouples and IR camera. Both provided the information about temperature course during the controlled fire. This is also information which is necessary for incident commander when deciding on fire tactics and selection of suitable and effective extinguishing agent.

Figure 42 – Testing the efficiency of extinguishing substances friendly to wildland environment

Figure 43 – Setup of the Testing Site

In the second day, **April 25th, 2023**, there was organized the demonstration in form of full-scale exercise in the Pilot Site (Figure 44, Figure 45, Figure 46, Figure 47), starting at 9.00 AM and ending at 4.00 PM. There were actively involved as the firefighters (professional, volunteer, and military fire brigades), as forest managers, nature conservancy workers, civil protection workers, municipality representatives and technology providers in the exercise activities. Also, the head of the Banská Bystrica self-governing region and directors from the district directorates of the Fire and Rescue Service attended this demonstration.

Figure 44 – Full-scale Exercise Initial Coordination Meeting at Outpost 1, Slovak Pilot

Figure 45 – Full-scale Exercise Outposts 2 – Water pumping, Slovak Pilot

Figure 46 – Full-scale Exercise Outposts 3 – Drones and Surveillance, Slovak Pilot

Figure 47 – Slovak Pilot – Full-scale Exercise

During the demonstration, there were provided the following activities:

- smoke/fire detection by camera surveillance/monitoring system (Figure 48);
- communication and data transfer about fire among stakeholders and operational centers/command centers; GINA application was tested to navigate the vehicles to fire incident and for spatial decision support of incident commander in the field (GIS data included);
- demonstration of the mobile app for citizen engagement and crowdsourcing information by the Fire Reporting module – to be used also for fire danger notification from tourists located in the affected area (Figure 49);
- real-time automatized vehicle and fire localization (Figure 50);
- preventive fire monitoring with UAVs; swarm of drones and production of ortho photo map; building a GSM network using integration of UAVs and satellite internet (Figure 51);
- demonstration of coordination of firefighting forces and activities from arrival to the incident site; terrain and situation reconnaissance, different ways of fire tactics / extinguishing (including the fire extinguishing using helicopters – Figure 52, Figure 53);
- monitoring of fire situation from the ground, transport of firefighting equipment and injured firefighter, extinguishing provided by UGV – Colossus robot (Figure 54);
- providing geospatial information on fire susceptibility (Figure 55), fire danger, fire spread prognoses (Figure 56); providing information on weather and wind parameters measured directly in the field; information and technological support of command staff in case of severe wildfires directly in special command truck (Figure 57).

Figure 48 – Smoke/fire detection by camera monitoring system

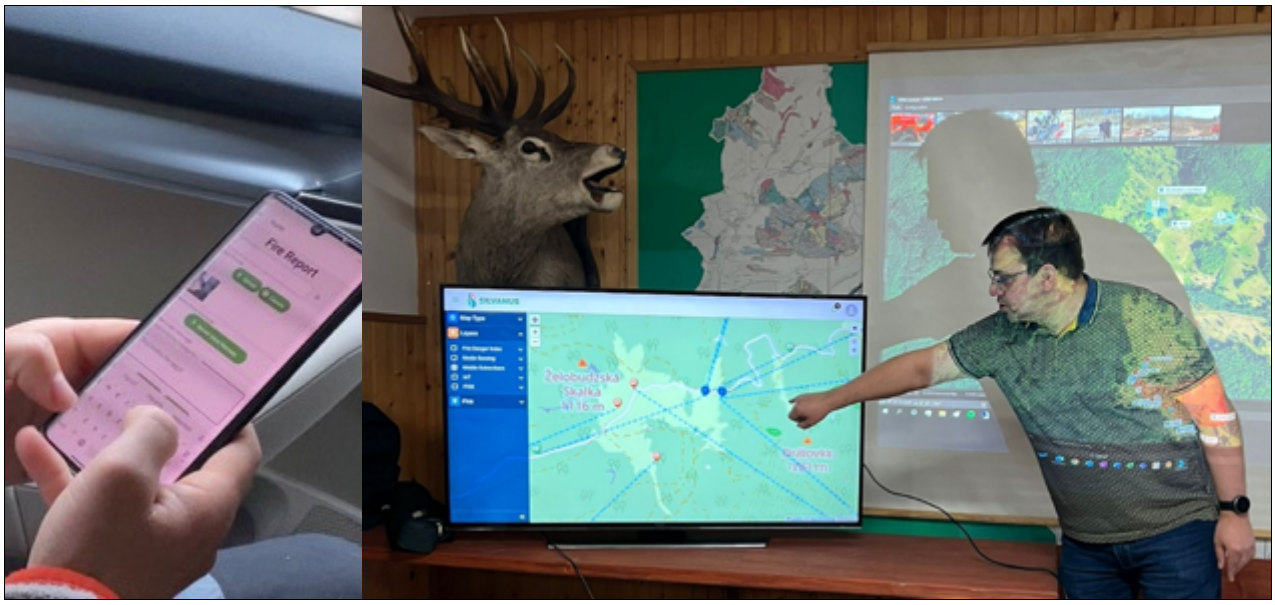

Figure 49 – Mobile app demonstration – crowdsourced information from the Fire Reporting module

Figure 50 – Real-time automatized vehicle and fire localization

Figure 51 – Image and data outputs from drone UAV surveillance – video and images to support the decision-making process of the command & control

Figure 52 – Approach of a fire extinguishing helicopter with water bomb

Figure 53 – Deployment of a fire extinguishing helicopter with Bambi bucket and its coordination with other units and forces

Figure 54 – UGV deployment in the field

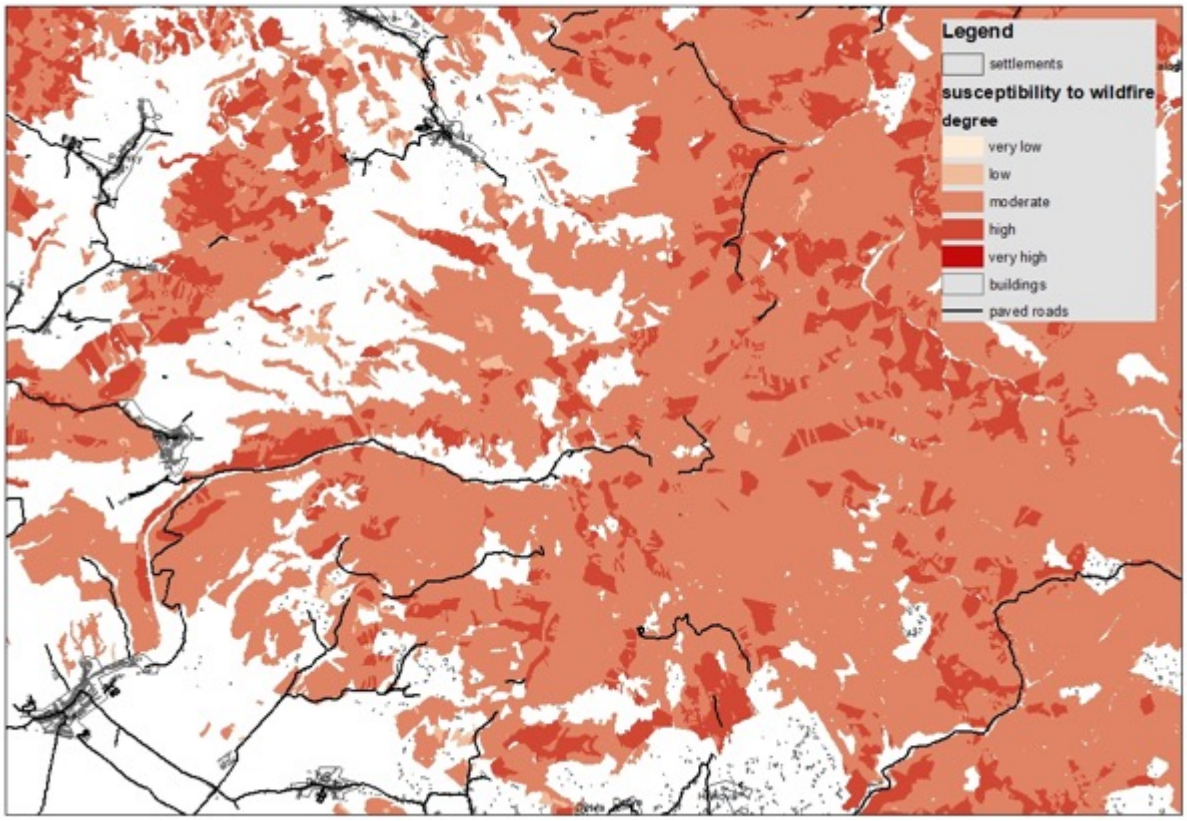

Figure 55 Geodata on fire susceptibility in the Pilot Site territory

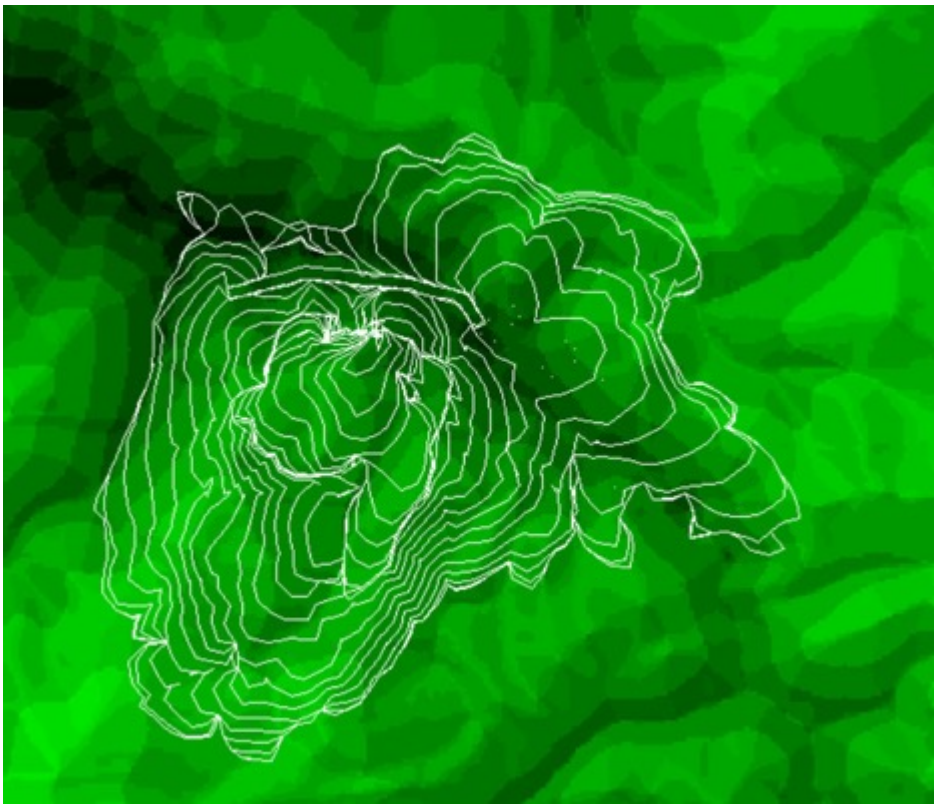

Figure 56 - Fire simulation output from FARSITE (line represent the uncontrolled fire spread in 1 hour intervals)

Figure 57 – Mobile Command Center deployment

In the third day of demonstration, on April 26th, 2023, there was organized a workshop in form of negotiations of different types of stakeholders who attended the demonstration to negotiate the pros and cons of provided information and technological support for wildfire management as well as the need for

integrated approach to landscape management and elaboration of a joined action plan to prevent and fight the wildfires (Figure 58).

Figure 58 – Day 3: Workshop with stakeholders

There were successfully demonstrated all the use cases as planned before the demonstration.

The results of the Slovak Pilot were reported in many media and press news (please see D10.3). The most prominent media appearance was a special issue of the Experiment magazine[1] in the Slovak national TV channel STV2 (Figure 59) where Andrea Majlingova (TUZVO) and Zoltan Balogh (UISAV) gave a comprehensive report about how SILVANUS fights forest fires as well as about the results of the Slovak Pilot carried out in Poľana, Slovakia.

Figure 59 - Screenshots from the Experiment magazine broadcasted in Slovak national TV channel STV2.

3.2.5 User product validation

Table 7 presents the UPs that has been tested during the execution of the Slovak pilot, providing a short description of each one and their outcome from the tests.

Table 7 – User product, Slovak pilot

Phase (A,B,C)	***Tested user product***	***Description***	***Outcome***
Phase A	GIS spatial analyses	Opening-up analysis to deploy fire trucks, fire susceptibility, fire danger (scale 1:10 000).	Successfully demonstrated
Phase A	Crowdsourcing Mobile Application (FireReport module) and EmerPoll **SILVANUS UP8**	Crowdsourcing application for fire reporting, response aggregation and citizens engagement.	Successfully demonstrated Please find the detailed outcome presentation in the text below the table.
Phase B	FARSITE	Fire spread modelling – combination of surface and	Successfully demonstrated

[1] Experiment magazine, STV2: https://www.rtvs.sk/televizia/archiv/15377/423977#1532

		crown fire. Graphical and numerical results for 30 min intervals. Results available for Command Staff in Mobile Command Center.	
Phase B	**UP6** – Fire Spread Model	As above	Demonstration of Silvanus in-house alternative to FARSITE Please find the detailed outcome presentation in the text below the table.
Phase B	OPTIX	CCTV camera fire / smoke detection with outputs available to intervention staff in terrain command vehicle, to operational center staff, and to command staff	Successfully demonstrated
Phase B	UAV for monitoring **SILVANUS UP5**	Fire site monitoring	Successfully demonstrated Please find the detailed outcome presentation in the text below the table.
Phase B	Swarm of UAVs **SILVANUS UP5**	Fire site mapping, ortho photo creation	Successfully demonstrated Please find the detailed outcome presentation in the text below the table.
Phase B	Mesh Network (UAV + Satellite Internet)	Creation of mesh network in the localities were no GSM even radio-communication signal was available	Successfully demonstrated
Phase B	Fire inspection with UGV **SILVANUS UP6**	Robot Colossus used for monitoring of the area under the tree crown closure, fire suppression and equipment and injured persons transportation purposes	Successfully demonstrated
Phase B	GINA	Application based on GIS and allowing the integration of data from drones and its visualization in the Mobile Command Center.	Successfully demonstrated
Phase C	SIBYLA	Simulation of tree / forest growth scenarios, forest management alternatives in biodynamic simulator SIBYLA and visualization of its outcomes in 3D cave	Successfully demonstrated

		using VR technology – possibility to visualize the forest structure, health condition and biodiversity according to selected management alternatives.	
Phase A	UP7 Woode App	Capturing of biodiversity information from the pilot site	Successful testing of the first release of the mobile application.

During the demonstration, there were successfully (according to planned activities and scenarios) tested several information and technological platform but only four of them also representing the user products which are being developed in the framework of the SILAVNUS project and which will be also a part of SILVANUS platform. Further, we introduce the validation only for these products:

Mobile App and Crowdsourcing information using the FireReporting module (SILVANUS UP8)

The CEA mobile application was demonstrated and partially validated by sending fire reports in the initial phase of the exercise (Figure 60). Pre-prepared fire incident scenarios were generated to illustrate the CEA mobile application's capabilities on the SILVANUS dashboard with aggregated data from the EmerPoll system. In the morning session, the real-time testing of the CEA mobile application involved reporting location details, uploading photos, and providing situation descriptions, all of which were presented to the audience. The CEA was connected to the Internet through local WiFi hotspots facilitated by a satellite connection. Initial integration of EmerPoll with the SIVALNUS Dashboard was demonstrated using pre-generated data (Figure 49).

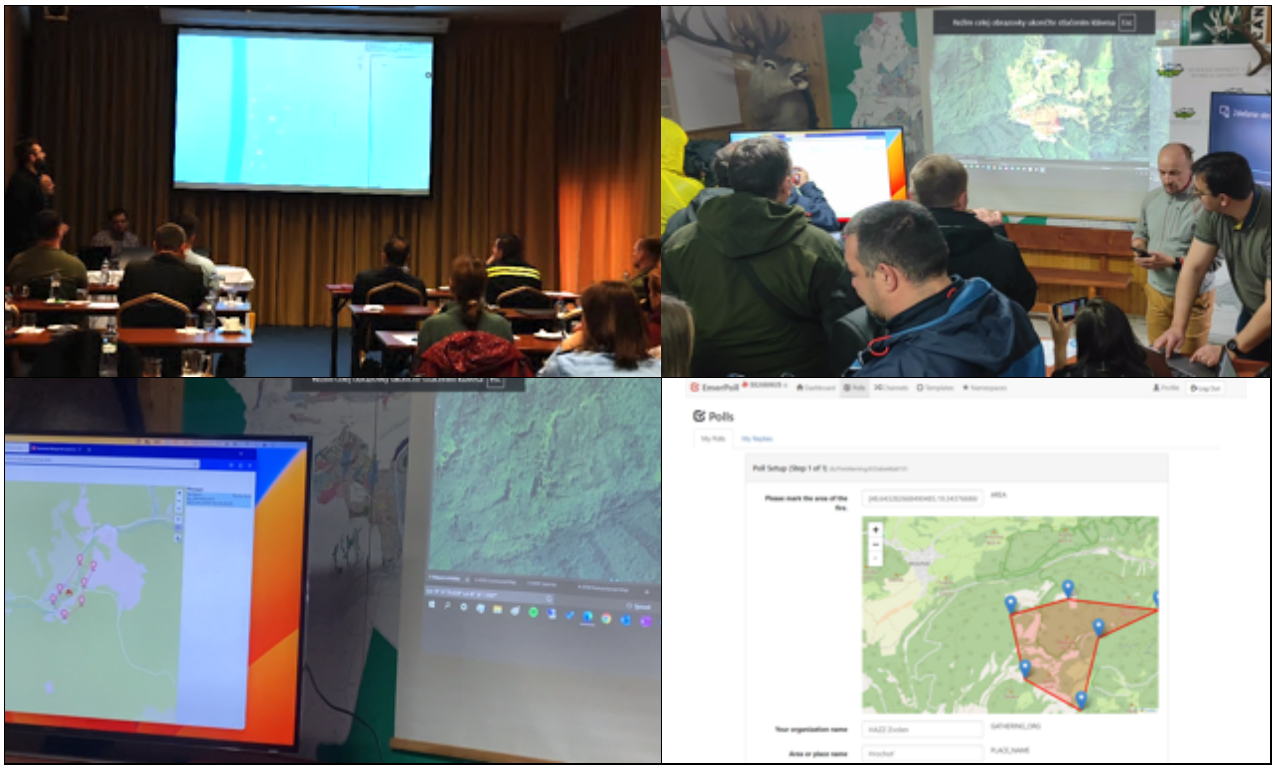

Figure 60 – Demonstration and initial validation of the Citizen Engagement Mobile App (UP8) and the EmerPoll system configured for the Slovak pilot settings

UAV for monitoring (SILVANUS UP5)

In the morning session, the real-time testing of the fire monitoring by UAV was done and were presented to the audience. The video stream was connected to the Internet through local WiFi hotspots facilitated by satellite internet connection.

Swarm of UAVs (SILVANUS UP5)

The Coordination Algorithm service processes the parametrized request (send from EmerPoll system) and generates the output – a temporal plan as KML file for a provided number of drones and pilots. The service send a message and created KML files back to the EmerPoll system. The EmerPoll provides comprehensive coordination and aggregation of data from individual drones in the swarming the proposed demonstration scenario. The testing of the coordination algorithm involved monitoring a selected area of interest by the one and by a group of UAVs. Individual missions were done during the Slovak pilot with respect the current Slovak legislative requirements for UAV. The coordination algorithm services was successfully tested (Figure 61, Figure 62), and conclusion and results of the missions (ortho-photo map - Figure 63) was presented to the audience on the debriefing meeting at the next day.

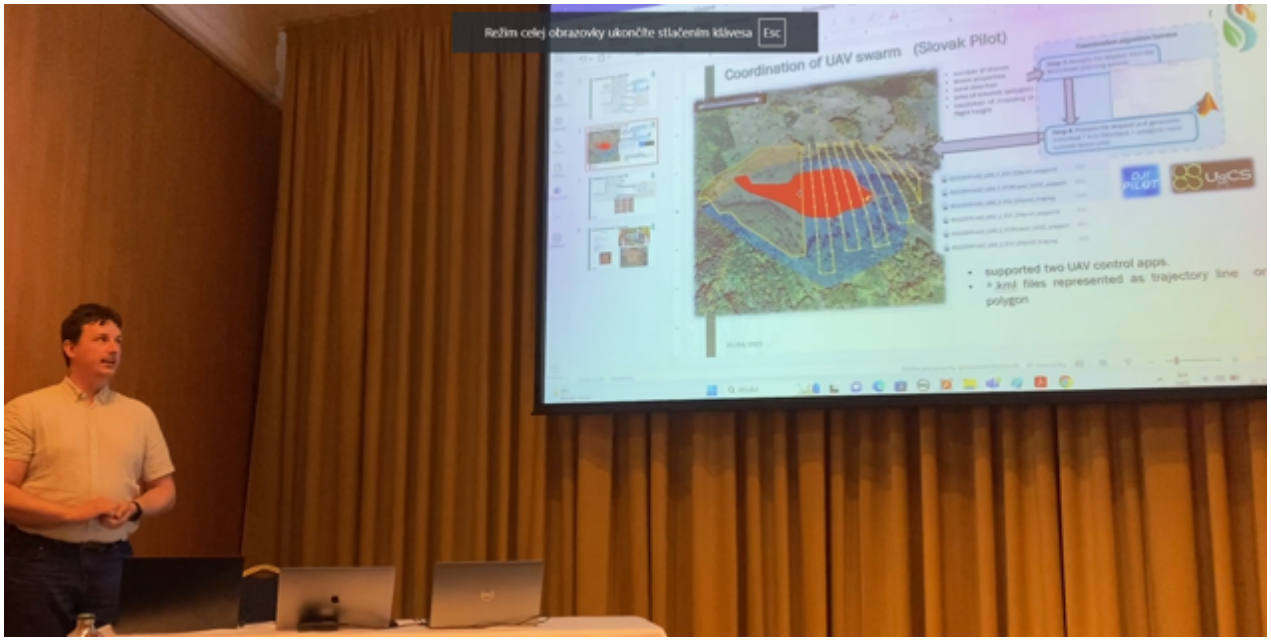

Figure 61 – Presentation of the deployment of the drones swarm, Slovak Pilot

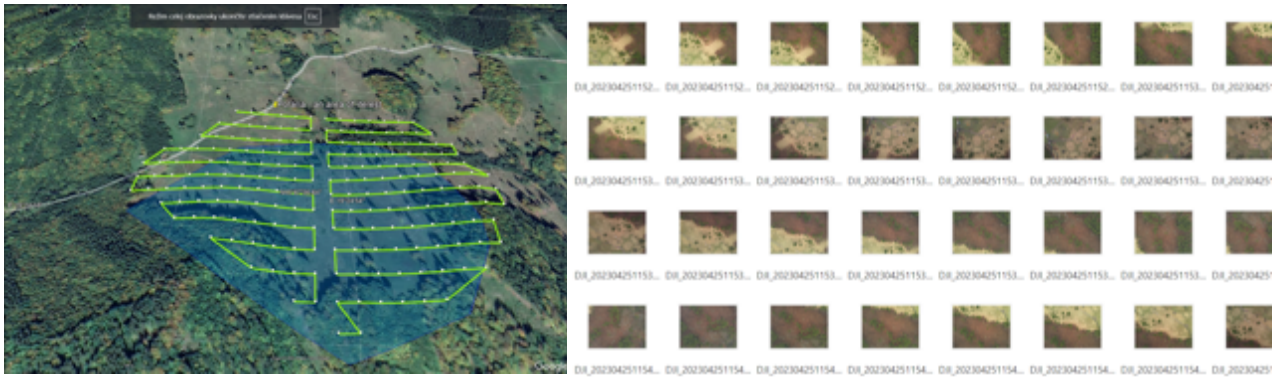

Figure 62 – Mission flight plan for a swarm of 2 drones and some of many individual photos taken by drones, Slovak Pilot

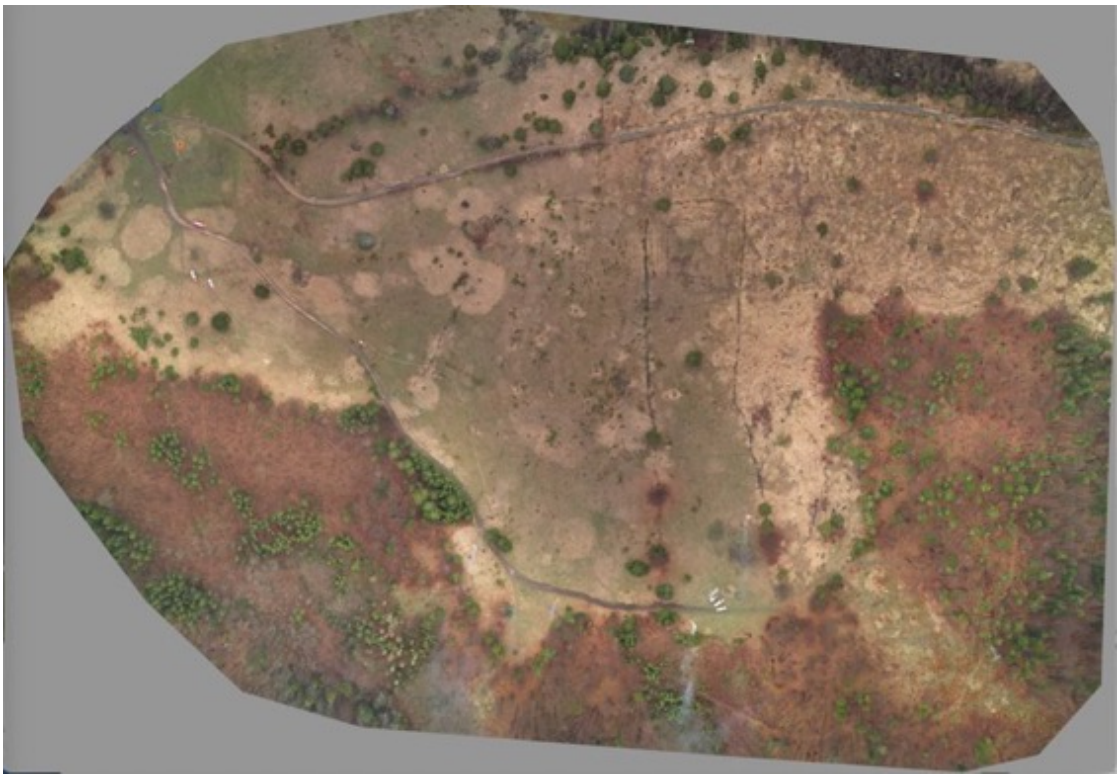

Figure 63 – Result of two drone flights – a large single large ortho-photo map created by stitching several hundreds of individual photos, Slovak Pilot

Fire inspection with UGV (SILVANUS UP6)

There was deployed the robot Colossus for monitoring the fire area from the ground what is very important in forest fire to get the information on fire dynamics under the tree crown. The robot was successfully tested, and the image outputs were demonstrated in the command staff to support the decision-making process of incident commander and other command staff members.

In general, the validation of all deployed user product across different phases in the Slovak pilot demonstrated their effectiveness in various aspects of firefighting and emergency response. The validation outcomes underscore the diverse and effective use of user products in enhancing fire response capabilities, from spatial analyses and citizen engagement to sophisticated modelling, surveillance, and visualization techniques. The successful demonstrations in each phase highlight the adaptability and utility of these tools in different firefighting scenarios.

3.2.6 Strategic and operational challenges

The Slovak pilot encountered the following strategic and operational challenges during the first trial period activities:

- Communication challenges: Disseminating demonstrated tactical procedures and decision-making support using new ICT and remote sensing technologies among professional, volunteer, and military firefighters, managers, and state authorities.
- Logistical and resource challenges: Undertaking additional demonstrations and testing of technologies.
- Connectivity and communication challenge: Addressing challenges related to the lack of GSM network and radiocommunication issues, exploring solutions such as Mesh in the Sky or a combination of Starlink + UAVs.
- Strategic planning and coordination challenge: Developing a feasibility study for Slovakia and formulating a National Action Plan to Manage Wildfire Risk.

- CEA fire reporting field orientation challenge: Identifying the approximate fire location was challenging from the CEA map perspective, particularly in dense forest areas. A solution was suggested to utilize the mobile device's compass to address this issue.

Considering the connectivity and communication challenges, there were successfully disseminated and demonstrated communication as well as decision-making support based on available ICT and remote sensing (UAV, UGV, Optix) technologies and their outputs among professional, volunteer, and military firefighters, forest managers, civil protection workers, nature conservancy workers and municipality and state authorities. Those provided mostly the real-time image data with coordinates to be used for command staff which was established as in a specific building (interior) as in the field. Also, in the Pilot Site area, there was no GSM signal to transfer the data or provide radio communication among operational centra, command staff and fire brigades in the field. To overcome this problem the solution based on integration of UAV and Starlink was used for provision of GSM mesh. It should simulate the possibilities of the Mesh in the Sky SILVANUS user product which is under development of Croatian partners. This was evaluated by firefighters as the most important technological component of promoted SILVANUS platform to support the wildfire suppression activities. Another utilisation of UAVs is to equip them with radio communication apparatus to establish the radio communication network in the field. For wildfire occurrence notification the mobile crowdsourcing application under development of UISAV was tested. It was evaluated as beneficial not only for wildfire notification purposes but also other forestry and nature conservancy purposes.

When considering the logistical and resource challenges, there were involved all types of fire brigades in Slovakia (professional, volunteer and military firefighters). The demonstration was provided in form of large-scale exercise allowing providing joint communication and training activities in cooperation with forest managers and foresters themselves. Involving military firefighters allowed us to deploy military helicopter in the exercise as well as to get the permissions for UAVs to fly in the area. Also, the procedures and communication about deploying UAVs when helicopter was deployed was tested. The deployment of those fire brigade types together showed to be best practise to prepare the fire brigades for joint interventions in the future when severe wildfires are expected also in Slovak conditions. Also, the material and technical equipment sharing, and integration showed be a solution for management of severe emergencies. As another advantage, mostly for forest fire monitoring under the tree crown closure and potential fire extinguishing local fires the UGV technology (robot Colossus) was successfully tested, too. Except these activities it was also deployed to transport the firefighting equipment to long distances and for transportation of injured firefighter.

Strategic planning and coordination challenge is in preparing such joint exercises, where all relevant stakeholders are actively involved in the process of wildfire management and specification of efficient preventive measures for the future. The problems with logistics, communication and information support are identified in the field and discussed during debriefing. After those are included in strategic planning or directly operationally implemented in practice of relevant services.

For this purpose, the Feasibility study for Slovakia and National Action Plan to Manage Wildfire Risk are going to be elaborated in cooperation of project partners with relevant stakeholders in Slovakia in 2024.

3.2.7 Planning of 2024 pilot activities

1. Feasibility study elaboration for Slovak conditions according to conclusions from Pilot demonstration (January to June 2023). Responsible are all Slovak partners.
2. Organizing national workshops with relevant stakeholders' representatives to prepare the draft of the National Action Plan to Manage the Wildfire Risk using existing knowledge and technology coming from SILVANUS project / platform (every 3 month). Responsible is Slovak CASD.
3. Organization a promotion action for Czech and Slovak stakeholders to promote the SILVANUS project and its user products (April 2023). Responsible are all Slovak partners. It will be promoted

in Zvolen during the National Forestry Days, which are organized by the National Forest Centre in Zvolen with support of the Ministry of Agriculture.

4. Public campaigns organized by CASD and PLAMEN at municipality, district and region levels.

3.2.8 Conclusions

The Slovak Pilot showed the way how to provide the integrated approach to forest management. For this purpose, there were identified relevant stakeholder types and representatives. They were asked for cooperation and participation at the demonstration as well as in the discussions in the framework of workshop organized before the demonstration. Some of them were more actively involved because they became the organizers together with Slovak project partners (firefighters, foresters, nature conservancy workers).

The demonstration of available data sources and technologies as well as their advantages in management of wildfires was well accepted. Several solutions to actual problems of firefighting and forest management practice were found (building GSM network in the field, different types of emergencies notification by citizens and tourists via crowdsourcing application, the purposes to ask for getting permissions to deploy UAVs in protected landscapes or NATURA 2000 sites. New communication channels, personal contacts and cooperation relationships were established.

Slovak CASD was established which organized also the third day of the demonstration in Slovakia, the workshop with all relevant stakeholders who were attending the demonstration. The demonstration was also beginning of CASD work in Slovakia. It started to cooperate with relevant state authorities on their networking, supporting their cooperation, preparing the agreement on cooperation also related to elaboration National Action Plan to Manage the Wildfire Risk in Slovakia.

Another advantage of the Slovak demonstration was the cooperation and integration of Slovak partners involved in the project and with their specific focus on different aspects of wildfire risk management. Valuable were also the previous contacts and cooperation which the partners had/have with the stakeholders and state administration bodies in Slovakia (forest managers, forest owners, firefighters, nature conservation workers, municipalities). Slovak Pilot fulfilled all the expectations and pre-defined Use Cases, including the participatory processes (workshop organised and stakeholders involved in demonstration in active and passive form). The technological and information support demonstrated was evaluated as necessary and the requirement for elaboration of Feasibility study for Slovak conditions was specified during the workshop. In the future, more technologies and user products developed in the framework of the SILVANUS project are going to be integrated and demonstrated (promoted) at one site.

3.3 Romania pilot

The Romanian tabletop exercise was carried out over a two-day period in the Rodnei Mountains national park between 14th to 15th September of 2023. The agenda for the tabletop exercise is presented in Table 8 and Table 9.

Table 8 - Day 1 of the Romania tabletop exercise on September 14th 2023

No.	*Time*	*Topic*	*Responsible*
1.	10:00- 10:30	Presentation of SILVANUS project, the context of the tabletop exercise and the timetable of the project	Ciprian Muscă Mircea Segărceanu
2.	10:30- 10:45	Institutional presentation including the presentation of the pilot site- Rodna National Park Administration	Mihaela Poll- Director of Administration of Munţii Rodnei National Park
3.	10:45- 12:30	Roundtable discussion on the pilot scenario	All participants
4.	12:30- 13:15	Requisite permits, procedural steps and necessary procurement needs for simulating a forest fire	Chirea Florin- Commandant General Inspectorate for Emergency Situations
5.	13:15- 14:15	Lunch	All participants
6.	14:15- 14:30	Presentation of the VR solution	SIMAVI
7.	14:30- 15:45	Validate the VR solution	SIMAVI
8.	15:45- 16:30	Plan for the field visit	Mihaela Poll

Table 9 - Day 2 of the Romanian tabletop exercise scheduled on September 15th 2023

No.	*Time*	*Topic*	*Responsible*
1.	10:00- 10:30	Gathering of participants for field departure	All participants
2.	10:30- 11:00	Arriving at the pilot site	All participants
3.	11:00- 12:30	Assess the area and discuss the pilot scenario at the pilot location	All participants
4.	12:30- 13:30	Lunch	All participants
5.	13:30	Departure	All participants

The objective of the Romania Pilot is to approach fire ignition caused by human negligence. For the first trial period activities, ASFOR organized a tabletop exercise in Rodna Mountains National Park for two days, September 14 and 15. The pilot was organised in an isolated location named Rotunda, which is located 29 kilometres from the Administration of the Rodna Mountains National Park.

3.3.1 Location

The "Rodna" Mountains National Park is the second largest national park in Romania, with an area of 47.177 ha (Figure 64). The importance of this protected area is due both to the geology and geomorphology of the mountains, and to the presence of numerous species of fauna and flora, endemics, and glacial relicts. One of the main attractions of the pilot area are its offering of hiking trails and camping areas, so human negligence is an important factor to consider in the prevention and mitigation of forest fires. Most forest

fires occur during springtime (March and April), followed by the summer months July and August. These periods also coincide with the increased influx of tourist on the hiking trails and camping sites.

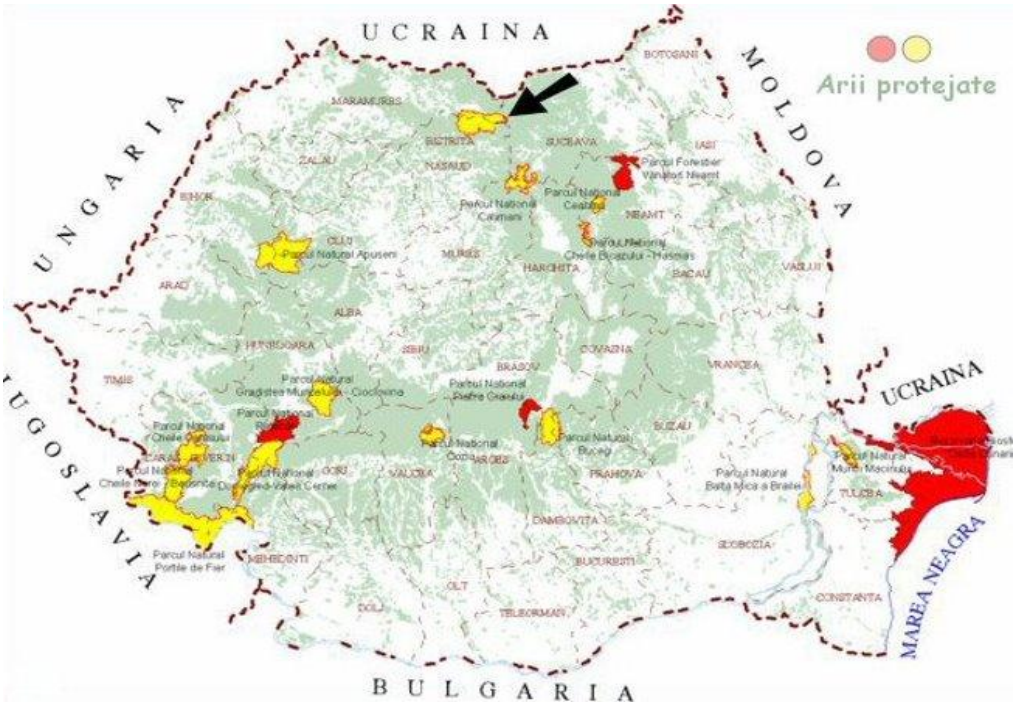

Figure 64 - Location of the Rodna Mountains National Park, Romania pilot

Pasul Rotunda (Figure 65) is 1217 m high and only spruce and sporadically other species of deciduous trees are found. In the pilot area, the internet connection works well, so communication between the stakeholders and the testing of technologies occurs without any problem. Near the pilot area is a sheepfold and the shepherd will be part of the pilot scenario being the first person to acknowledge about a fire in the area. The roads are not in the best conditions but they allow access for firefighting intervention. For a more efficient intervention in the area, it is necessary to install at least one portable water tank because access to the water is not available. The pilot scenario was adapted in such a way that pilot demonstration will be deployed with minimum impact on the ecosystem. The geographical position of the Romanian pilot is presented in Figure 66.

Figure 65 – Image from Rodna Mountains, Pasul Rotunda, Romania pilot 1st exercise

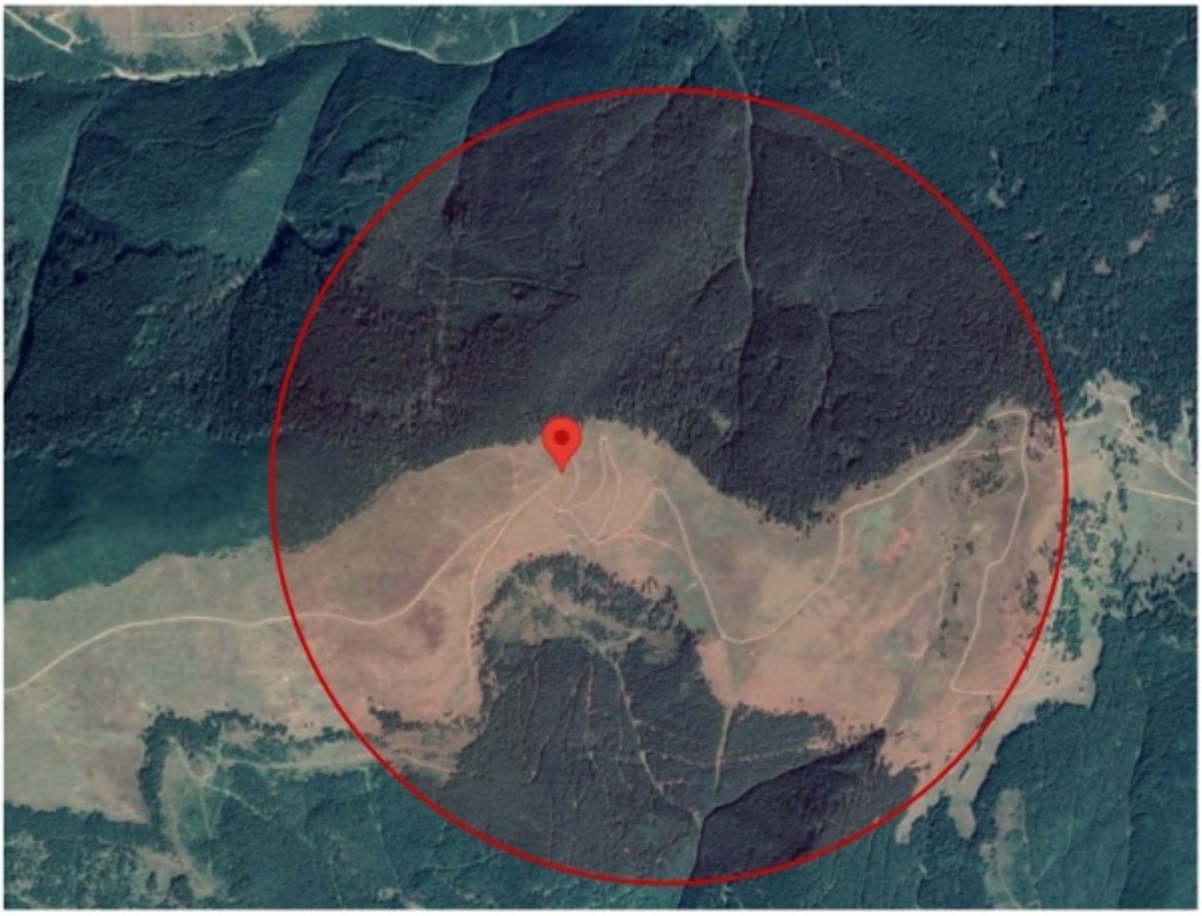

Figure 66 - Map of the Romanian Pilot

3.3.2 Participating stakeholders

The participation of external stakeholders and their contribution to the pilot activity is summarised in Table 10.

Table 10 - Stakeholder roles, Romania pilot

Stakeholder	*Activity Engaged*	*Role*
Asociatia Forestierilor din Romania (ASFOR)	Identification of activities and technologies to be implemented in the framework of SILVANUS	Pilot coordinator
Fundatia pentru SMURD (FptSMURD)	Facilitation of data collection from firefighters needed for the AR/VR module and facilitation of technical discussions with firefigthers	Liaison with local fire fighters
SOFTWARE IMAGINATION & VISION SRL (SIMAVI)	Development of AR/VR training module and training of firefighters and forest rangers for intervention scenario;	Technical Partner in Romanian Pilot
Local firefighters (ISU Bistrița)	Operational procedures and establishment of the forest fire exercise plan	Availability of firefighters for the pilot exercise
Rodna Natural Park	Expertise in park management and first on scene for any fire report	Provides access to the natural park where the pilot is located

Table 11 - Summary of Photo grammatry






The stakeholders' system in this tabletop activity forms a collaborative network involving various entities with distinct roles and responsibilities, contributing to the successful execution of the pilot demonstration, according to Table 11. At the core of this system are the following key stakeholders:

- **ISU Bistrița** (Local Firefighters Branch) has been primarily responsible for providing expertise on deployment procedures, potential helicopter use, and ensuring the intervention team's

preparedness. Its particular involvement in the trial implies the following tasks - to obtain permits, to specify procedural steps, and to actively participate in the simulated forest fire intervention.

- **Rodna National Park Administration** has been designated as a primary responder in the pilot scenario, tasked with preparing the field for local firefighters' intervention. Their involvement was based on mobilizing participants from three forest administrations, equipping the intervention team, and coordinating transportation logistics.
- **Voluntary Service for Emergency Situations** (SVSU) has collaborated with the Rodna National Park administration as primary responders, supporting the preparation of the intervention field. Specifically, it assisted in mobilizing participants, providing necessary equipment, and facilitating transportation arrangements.
- **SIMAVI (Technological Partner**) has contributed with technological solutions, particularly VR technology (UP1) for training purposes. Its role was to demonstrate and receive feedback on the VR technology during the tabletop exercise evaluation session, ensuring its alignment with the training objectives (Figure 67).

Figure 67 - VR Demonstration

- **Local Firefighters** have been key participants in the simulated forest fire intervention, actively engaging in the tabletop exercise. Their role was to evaluate the VR technology, provide feedback on its effectiveness, and ensure its potential as a valuable training module for real-world scenarios.

Field Visit Participants have been actively involved in verifying the practical alignment of the planned scenario with actual field conditions. They have revisited the scenario, identified positions, and specified areas of intervention during the field visit, contributing to a well-coordinated and effective final pilot demonstration.

3.3.3 Objectives

The tabletop exercise defined the forest fire simulation intervention scenario for 2024, deciding interventions, roles and an in-field visit for planning. The detailed scenario will be integrated into ISU Bistrita's exercise for the following year.

The primary objectives underlying the organization of the Romanian tabletop exercise encompassed the following:

- Proactively assess and address challenges to enhance preparedness for the demonstration.
- Establish a robust communication framework to facilitate smooth collaboration and information exchange among all involved parties.
- Establish a well-defined scenario that addresses stakeholder needs and informs necessary acquisitions for a successful pilot demonstration.
- Gather valuable feedback from stakeholders to refine and optimize the VR technology for enhanced performance during the pilot demonstration.

Basically, the demonstration activities conducted during periods #1 to #3 were 'soft' in nature, dealing with the involvement and engagement of stakeholders to become active participants in the 'hard' phase of demonstration, which encompasses the following activities:

- Phase A *Prevention and Preparedness activities* involves developing AR/VR training for firefighters, installing a monitoring system with strategically placed sensors, ensuring connectivity and electricity for a forward outpost, and organizing awareness campaigns to enhance prevention and preparedness for wildfires.
- Phase B *Detection and Response activities* includes simulating intervention scenarios for forest fires, and testing and validating SILVANUS technologies to analyse territory accessibility, map water sources, ensure continuous monitoring, and facilitate information transfer to the Operational Command Centre of the Fire and Rescue Service during fire incidents.

3.3.4 Description of performed activities

For two days, September 14 and 15, ASFOR organized a tabletop exercise in Rodna Mountains National Park, in an isolated location named Rotunda, which is located 29 kilometres from the Administration of the Rodna Mountains National Park.

The Romanian tabletop exercise was designed as a preparatory phase for the upcoming final pilot demonstration. The initial step involved coordination with stakeholders, extending invitations to ensure their attendance, and confirming their presence at the location. On September 14, stakeholders met at the administrative centre of Rodna Mountains National Park, engaging in a detailed discussion of the pilot scenario.

Representatives from the local firefighters' branch (ISU Bistrița) delineated their contributions to the pilot demonstration, outlining the requisite permits and procedural steps for the deployment of the intervention team to the designated pilot area. In a favourable scenario, ISU Bistrița expressed the potential use of a helicopter dispatched from the ISU county base, if no other emergencies arise during the pilot demonstration. Moreover, ISU Bistrița articulated specific procurement needs for simulating a forest fire, including masks, water tanks, fire blankets, forest fire protection suits, and fire simulators.

Rodna National Park administration and the Voluntary Service for Emergency Situations (SVSU) were designated as the primary responders in the pilot scenario. Their responsibilities encompassed preparing the field for the intervention of local firefighters, which involved mobilizing participants from three forest administrations near the pilot area, equipping the team with fire beaters, and arranging for transportation.

Following the establishment of stakeholder roles in the pilot scenario, the session progressed to the evaluation of the VR technology developed by SIMAVI. The solution received positive feedback from local firefighters, who recognized its potential as a training module before engaging in field interventions.

On September 15, a field visit was conducted to verify that the planned location aligned with the on-paper scenario. Stakeholders revisited the scenario, allowing each participant to identify their position in the field and specify their area of intervention. This comprehensive exercise aimed to ensure alignment between planning and practical execution, fostering a well-coordinated and effective final pilot demonstration.

Briefly, the tabletop exercise included the following specific activities:

1. **Evaluate Deployment Procedures**: Assess the effectiveness of the deployment procedures outlined by ISU Bistrița, including obtaining necessary permits and procedural steps for the intervention team's deployment to the designated pilot area.
2. **Test Emergency Response Coordination**: Evaluate the coordination and efficiency of emergency response efforts involving Rodna National Park administration and the Voluntary Service for Emergency Situations (SVSU) as primary responders in the pilot scenario.
3. **Validate Procurement Needs**: Confirm the adequacy and functionality of the procured equipment, such as masks, water tanks, fire blankets, forest fire protection suits, and fire simulators, required for simulating a forest fire during the demonstration.
4. **Assess Technological Integration**: Evaluate the VR technology developed by technological partner SIMAVI to determine its applicability and effectiveness in training local firefighters for field interventions.
5. **Verify Practical Alignment:** Ensure alignment between the planned tabletop exercise scenario and the actual field conditions, allowing participants to identify their positions and areas of intervention.

3.3.5 User product validation

Table 12 – User product, Romanian pilot

Phase (A,B,C)	***Tested user product***	***Description***	***Outcome***
Phase A	UP1 VR/ AR solution (SIMAVI product)	Development of VR/ AR training module and training of firefighters and forest rangers for intervention scenario	The AR glasses stood out for its adaptability, giving users the ability to customize the experience according to their preferences. The innovative features offered users the experience of a virtual environment very close in feeling to the real environment.

After testing the VR solution as presented in Table 12, the stakeholders appreciated that in the context of a forest fire intervention, a VR solution can significantly enhance capabilities by providing an advanced and immersive toolset for firefighting personnel by revolutionizing the way teams respond to and manage forest fires. The VR solution creates highly realistic simulations of diverse fire scenarios, allowing firefighting personnel to train in a virtual environment that mirrors the challenges they might face in real-life situations. Firefighters can undergo extensive virtual training sessions to enhance their decision-making skills, teamwork, and familiarity with different firefighting strategies. The VR environment allows them to handle

various equipment, simulate emergency scenarios, and refine their coordination with team members. By being trained before the pilot demonstration with the VR solution, the firefighters will be able to respond to the incident with more accuracy and coordination. The round table discussion carried out during the table top exercise is presented in Figure 68

Figure 68 - Round table discussion on the impact of AR/VR for training firefighters

3.3.6 Strategic and operational challenges

The tabletop exercise did not impose many challenges but during the roundtable meeting some risks regarding the next year pilot demonstration has been discussed:

- Coordinating the availability of the necessary equipment, personnel, and resources for both the physical and virtual components of the demonstration can be challenging, especially in remote or difficult-to-access areas.
- Integrating a VR solution into the existing workflow firefighting operations can be demanding.
- Participants in the demonstration, including firefighters, may have varying levels of familiarity with technology. Offering adequate training and ensuring users are comfortable with the equipment is crucial to avoid potential disruptions during the simulated scenario or even during real-life situations.

3.3.7 Planning of 2024 pilot activities

For a successful pilot demonstration there are significant steps to be taken:

- Conduct a new assessment to identify the specific requirements and objectives of the pilot demonstration.
- Ensure an active involvement of the stakeholders in the planning process and gather valuable input to tailor the demonstration to the needs of the end-users.
- Make the necessary purchases and equipment which have been already discussed during the tabletop exercise.
- Install a weather station to gather information about temperature, humidity, and atmospheric pressure.
- Provide comprehensive training for participants and stakeholders.

- Plan the logistics of the demonstration, including the availability of equipment, personnel, and resources.
- Consider transportation of participants to the pilot area, accommodation if necessary, and any other logistical requirements.

The next year pilot demonstration will take place in October 2024.

3.3.8 Conclusions

There were some differences between the scenario's assumptions and actuality during the tabletop exercise when it was being discussed, as reported in Table 13.

Table 13 – Expectations versus Reality, Romania pilot

Expectation	***Reality***
In the case of a fire forest the access to the water is assured.	It's necessary to install at least one water tank in the pilot area.
The demonstration will enhance the overall preparedness of firefighting teams for future simulated incidents.	Ongoing training and adjustments may be necessary to optimize the effectiveness of the simulated fire intervention in various scenarios.
The stakeholders have already the equipment for a response in the case of a forest fire.	New purchases should be done for assuring the safety of the first responders (Rodna National Park Administration and Voluntary Service for Emergency Situations).
A helicopter from ISU Bistrița will be available during the pilot demonstration in order to extinguish the fire.	The integration to the intervention of a helicopter depends on the emergencies from the pilot demonstration day.

After the tabletop exercise some details were observed that can improve future pilot exercise:

- Establish a constant feedback mechanism to collect insights from the stakeholders through online meetings, informal meetings, phone calls.
- Constantly refine the established scenario to make it more realistic and to demonstrate how the developed technologies improve the performance of firefighters.
- Foster open dialogue to ensure all parties are informed and engaged.
- Ensure that technology aligns with existing systems and can adapt in the firefighting operations.

As such, post-exercise reflections recommend establishing a constant feedback mechanism, refining scenarios for realism, fostering open dialogue, and ensuring technological alignment with existing firefighting systems for continuous improvement in future simulations. These insights underscore the dynamic and iterative nature of emergency response preparedness.

3.4 France pilot

The French field exercise took place between 28th September to 30th September and the programme for the activity is presented in Table 14.

Table 14 - France field exercise programme

Date	Location	Hours	Topic and presentation	Responsible partner
28th September	Limoges	All day long	Welcome and transfer to the hotel from the railway station or the airport	PUI
29th September	Hotel NOVOTEL	8h30 am	Briefing about the agenda, scenario and security,	Tomas Piatrik (VTG), PUI and partners
29th September		9h00 am	Presentation of the forest and biodiversity in Haute-Vienne,	UNISYLVA
29th September	Site of the pilot	9h30 am	Departure to the site of the pilot in St Sylvestre for the pre-screening, assessment on the field of the local forest with UNISYLVA, meeting with the mayor of St Sylvestre,	PUI and UNISYLVA
29th September	Site of the pilot	14h00 pm	Demonstration and tests of the technologies: • robot, • AR/VR, • UAV, • fire truck, • new PPE and tools for firefighters • training in VR, • Presentation of Woode App by VTG	PUI and UNISYLVA VALLFIREST
29th September	City Hall Limoges	18h00 pm	Meeting with the mayor of Limoges; opening ceremony of the exhibition about prevention of fire and protection of biodiversity, (SILVANUS posters)	PUI
30th September	Site of the pilot	8h00 am 9h00 am	Departure to the site of the pilot for the test, Start of the exercise, STARTEX ENDEX -start of fire, of human origin (arsonist) on the side of the road and near a SEVESO 2 installation of explosives and ammonium nitrate in St Sylvestre, -AR/VR Toolkit by SIMAVI,	PUI and partners

			-Citizen engagement mobile application with french version, population and children, -Fire detection from IoT devices with Catalink (CTL), -Fire detection using UAV/UGV - 3MON/UISAV with support of PUI drones, -Fire spread forecast, -User interface by ITTI. -simulation of use of **Twitter** (**PUI account**) and social media during the pilot,	
30th September	Fire station Ambazac	13h30 pm	Debriefing of the pilote in the Fire station of Ambazac,	Tomas Piatrik (VTG)
30th September	Novotel hotel	20h00 pm	Social dinner	

3.4.1 Location

The forests surrounding the municipality of Saint-Sylvestre make an essential contribution to the environment and local life. They play a vital role in regulating the climate by absorbing carbon dioxide and producing oxygen, which is crucial for our survival. These wooded areas are also thriving habitats for a variety of animal and plant species, contributing to the preservation of biodiversity. Numerous trails crisscross the woods and allow locals and visitors alike to immerse themselves in nature. Beyond their ecological role, Saint-Sylvestre's forests play an important role in protecting water quality and preventing flooding by regulating rainfall. Thus, the forests of Saint-Sylvestre represent a precious balance between man and nature, a resource to be preserved and respected for future generations. In Figure 69 and Figure 70, an overview of the geographical context and the measurements of the tree information available from the region is presented.

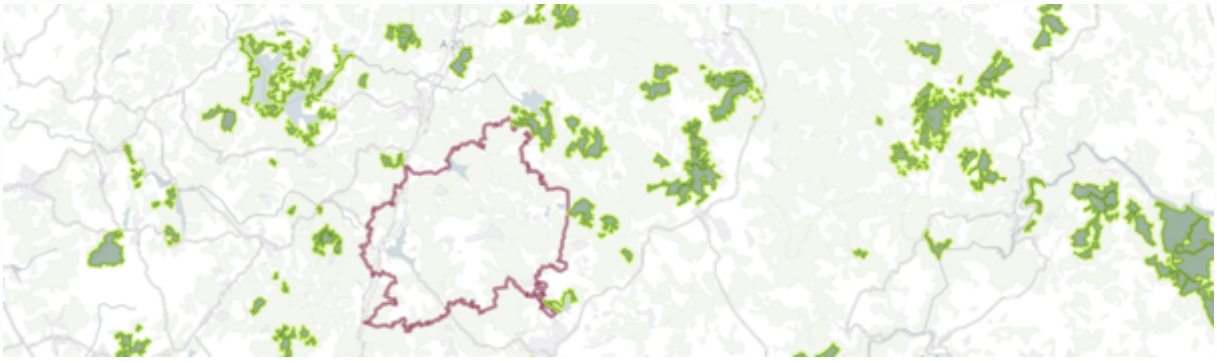

Figure 69 - Forests around St Sylvestre

Figure 70 - Tree information present in the forest

The French Pilot was centered around the scenario of forest fire with industrial accident in highly explosive plant, a challenge related to the production of smoke cloud and explosive. Many industries with a high risk with regards to human dimensions such as SEVESO industries are situated near residential or rural areas. Therefore, the forest fire scenario has three active fronts, moving towards sensitive targets. With a large amount of smoke and a wind exceeding 70km / hour, the firefighters urgently need priority information: (a) mapping of the area; (b) identification of access paths, (c) urbanized areas, (d) roads and access routes; (e) temperature, dehydration of plants, (f) speed and direction of the wind, (g) -anticipation of fire development and development axes.

Coordinates:
The French Pilot took place in the Municipality of St Sylvestre – EPC site: Le Package des Boeufs
Pilot location (latitude, longitude):
-site of fire: 46° 1' 9" N 1° 22' 30" E
-site SEVESO 2 : 46° 1' 18" N 1° 22' 40" E

The Pilot Case in France (St Sylvestre) has been realized very close to the SEVESO company “EPC” including the 2 **phases A and B** of SILVANUS project activities. The pilot was organized near a real activity of explosives in a company SEVESO 2 with a storage of 50 tons of explosives and a special storage of detonators. In 2019, a real big forest fire impacted the forest near the company with a large deployment of firefighters from all the districts.
In Figure 71 to Figure 74, an overview of the examples of fire incidents from the past are presented, along with the pilot locations where the field exercise was organised to be carried out. Additionally, the regional municipalities affected by an accidental explosion from the industry are also highlighted.

Figure 71 - Examples of fire incidents from pilot location

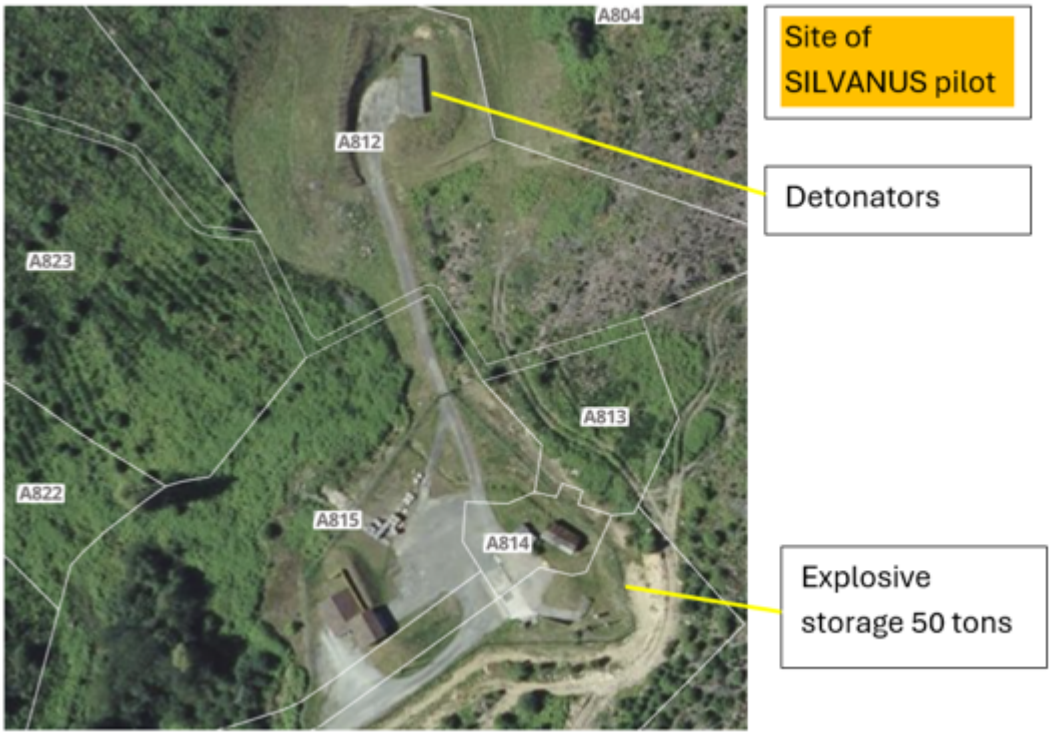

Figure 72 - Location of the Frence pilot in St Sylvestre: SEVESO company (explosives)

Figure 73 - Approach to the industrial site

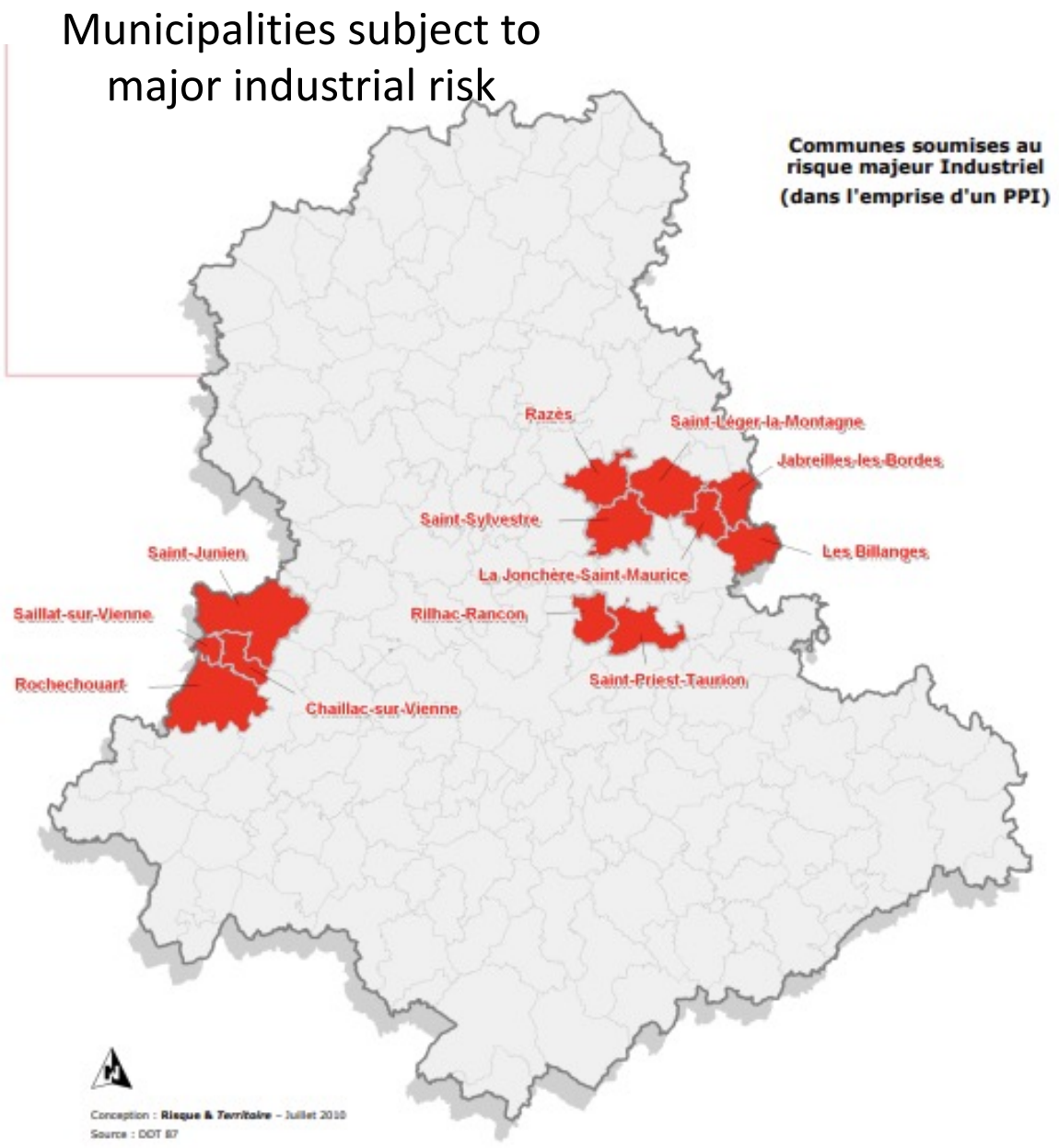

Figure 74 - Regions under threat from an industrial explosion

3.4.2 Participating stakeholders:

During the pilot **organised on 29-30th of September 2023**, several practical tests was performed, as shown in Figure 75:
-drone for mapping and detection,
-drone with AR and glasses,
-detection by sensors and camera,
-robot for extinction of the fire,
-firefighters deployment for extinction of the fire, new process to treat the fire border with new tools,
-information in real time on social media,
-test of the APP for citizens and municipalities.

Figure 75 - Presentation of SILVANUS by Tomas Piatrik (VTG)

Table 15 - Stakeholders and partners, French Pilot

Stakeholder	***Activity Engaged***	***Role***
VTG	Presentation of Woode App	Scientific and technical coordinator of SILVANUS
SIMAVI	Training FR in VR/AR, simulation of real fire	Scientific and technical partner
MDS	Speaker Test on the field with people, school children, municipality	Technical partner
CTL	Speaker Detection of the fire	Technical partner
3MON/UISAV	Speaker Reconnaissance, analysis of the air, mapping, detection	Technical partner
PUI France	Speaker Firefighters, drones and AR vision	First responders, international firefighters
CERTH	Speaker UP3-Fire Detection based on Social Sensing	Technical partner
Fire department Haute-Vienne	Speaker Deployment of fire trucks and test of the robot, and new tools for firefighters	Firefighters, fire service Haute-Vienne
CMC Cyprus	Auditor Crisis Management Centre	External
UK-MED	Auditor	External
EPAYPS Greece	Auditor First responders USAR and fires	External

OEDD Greece	Auditor Volunteers' firefighters Greece	External
DEVELOPIA Foundation - Spain	Auditor, Specialist in training and e-learning	External

The stakeholders involved in the French pilot form a diverse network, each contributing distinct activities and expertise to the SILVANUS project, according to Table 15. This collaborative network brings together scientific, technical, firefighting, and social sensing expertise, highlighting a multidisciplinary approach to addressing the challenges of fire management in the French pilot of the SILVANUS project. For instance, SIMAVI engages in training using Virtual Reality/Augmented Reality (VR/AR) and simulating real fire scenarios. By using the AR/VR platform, first responders were able to experience training exercises and complex simulations, based on the real data from operational scenarios.

During this pilot, PUI, coordinator of the pilot, has collaborated with all the partners:

- consortium members, technical and first responders,
- municipality,
- citizens,
- fire service,
- international participants: Cyprus, Greece, Spain.

In the scenario prepared by PUI, several technologies were deployed:

- PUI deployed his team of drones and telepilots with several equipment and a large screen to share photos and videos of the site. A new drone, the Avata, with a flight in immersion, was deployed and tested by several partners,
- CTL, specialist in fire detection, deployed a sensor with a camera on a tree, to detect and inform in real time the fire service, and citizens through social media; a computer showed in real time, the video of the fire and the smoke, and the information on social media,
- MDS deployed his APP on 5 smartphones to test with citizens, municipalities, firefighters, first responders and international visitors; a questionnaire of evaluation was proposed to the participants,
- 3MON/UISAV deployed his robot with the collaboration of the firefighters and PUI, to test the progression of the robot in the forest with height difference, and different type of path and the ease of handling the robot by people who do not have experience with this technology ; with the collaboration of 2 forest fire truck, the robot showed the capacity to use a cannon spear and a pipe on a long distance,
- CERTH tested the diffusion of information on social media, to inform the citizens, and to facilitate the operation of the fire services.
- VTG demonstrated the Woode App for the collection and documentation of the biodiversity profile of the forest landscape

The French press was very present to follow the pilot with numerous reports in the FRANCE 3 newscast, as well as in the written and radio press; many articles have been disseminated.

3.4.3 Objectives

The main objectives of the French Pilot include:

- Training FR in VR/AR, simulation of real fire;
- Test of the APP on the field with people, school children, municipality;
- Detection of the fire;
- Reconnaissance, mapping, detection with sensors;
- Platform with information about the fire and social media information,
- Anticipation of the spread, information to the command post;
- Interface of users;
- Fire Detection Based on Social Sensing (monitoring social media posts).

Phase A (Prevention and Preparedness)

- Evaluation of monitoring tools and techniques (including SILVANUS UPs) in addition to the standard direct observation;
- Detection of the fire and smoke with drones, and detection by sensors and camera in the sensor box,
- Improvement of awareness related to fire events, engagement of citizens of St Sylvestre with SILVANUS app to be used to indicate fire events and to have information about the fire and the evacuation of the population in case of big fire and risk of explosion.

Phase B (Detection and Response)

- Use of new technologies, such as sensors installed directly in the trees of the area to reduce time of alert and deployment of the fire brigade after fire detection (detection of a fire by IoT Gateway);
- Control and assessment of the situation on the computer, in real time, of the intervention;
- Use of the drone to control the spread of the smoke, the security of the teams of firefighters and the detection of citizens in the forest or on the road near the site; test of the diffusion of a message of information for population with the loud speaker of the drone;

3.4.4 Description of performed activities

The pilot was executed on September 29th and September 30th in Limoges, France. The scenario for the exercise is as follows:

1. A forest fire started very close to an explosive manufacturing company (Figure 6).
2. The sensors placed in the forest detect the fire and inform the local fire brigade. This phase is to test the detection sensors, the effectiveness of the developed command and control algorithm and user interface, and the community engagement app.
3. The fire brigade responds to the fire with fire trucks, drones, and a robot. This phase covers the firefighter training for forest fires, practicing different firefighting equipment and methods, testing the ground robot for firefighting, testing the drone's capability for surveillance, and testing AR/VR goggles. The forest fire scenario has three active fronts, moving towards sensitive targets. With a large amount of smoke and a wind exceeding 70km/hour, the firefighters urgently need priority information on:
    - identification of access paths,
    - mapping of the area,
    - urbanized and industrial areas,
    - roads and access routes,
    - temperature, dehydration of plants,
    - speed and direction of the wind,
    - anticipation of fire development and development axes,
    - integration of changing weather conditions.

In the scenario of the pilot, the fire spread was considered to the direction of a SEVESO2 company with explosives storage, detonator and one truck with Ammonitrate (explosive) in the car park of the company.

In the following section, Figure 76 to Figure 85, a series of the activities that were carried out is presented.

Fire regime: The fire is being developed depending on the wind's direction with a speed progressing with at least 3% of the wind's speed. Then, under the influence of the swirling wind, the fire takes different directions producing vortices, while the height of the flames is increasing.

Figure 76 - Fire starting exercise in French pilot

Safety and security: Safety and security measures have been diligently implemented for the pilot, as evidenced by an official decree from the Mayor of St Sylvestre, stipulating the closure of the road throughout the duration of the pilot with police control (Figure 77). This proactive decision reflects a keen awareness of potential risks, and the remedy involves stringent control measures to ensure the safety and security of the area during the pilot activities. A meeting was organized with the military police to present the pilot and the participants.

Drones: were utilized as first responders and by members of civil protection during the pilot in St. Sylvestre, with authorization granted for the use of PUI drones. The Prefecture was duly informed and actively participated in overseeing the pilot.

Figure 77 - Security zone established in French pilot

The demonstration activities included: a) Realisation of a command-and-control centre providing real time info to the fire brigade and b) Deployment of a community engagement app providing information and guidelines to the citizens (Figure 78). Users can also report fires to the command-and-control centre by using the app.

Moreover, the demonstration activities included: a) Installation of fire hose to the ground robot and b) Water spray from the ground robot (Figure 78). The robot is battery-powered, can deploy 3000L of water per minute (with 5 bars on the pump), and can operate for up to 5 hours with one charge and it takes 2-3 hours to charge it full.

Figure 78 - Installation of firehose to the ground robot and testing of water spray capacity from the ground robot

Finally, the first trial period activities included the deployment of a drone for aerial surveillance, as well as the actions of testing the AR/ VR google (Figure 79).

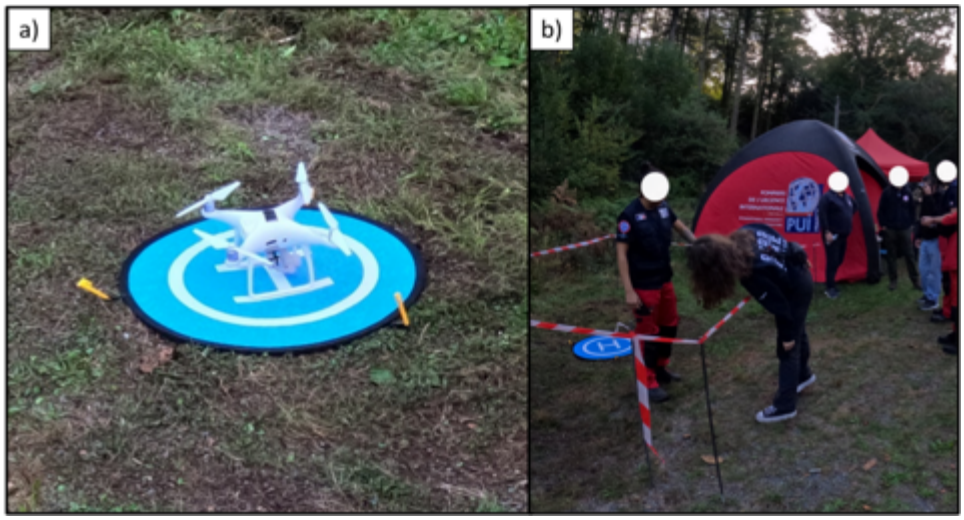

Figure 79 - Drone for aerial surveillance and testing of AR/VR google

This is the different phases of the scenario for the pilot:

(1) Deployment of the logistics in advance and set-up the command post, communication, and logistics for the partners.
(2) mapping of the area and the site with drones.
(3) set-up of the sensors in the forest, fire Detection with the sensors, camera, and UAV (thermal camera).
(4) Deployment of the first responders and firefighters with trucks, to fight the fire in the forest.
(5) Deployment of the robot to complete the deployment of the firefighters.

(6) Information on the social media trough the platform and through the APP SILVANUS with citizens.

(1) Setup

After the arrival on the logistics area for the pilot, we decided to set-up the command post with communication and WIFI router to improve the network. The signal was not sufficient on the logistics base, so we decided to find a location very closed to the area of the test of the sensors and camera.

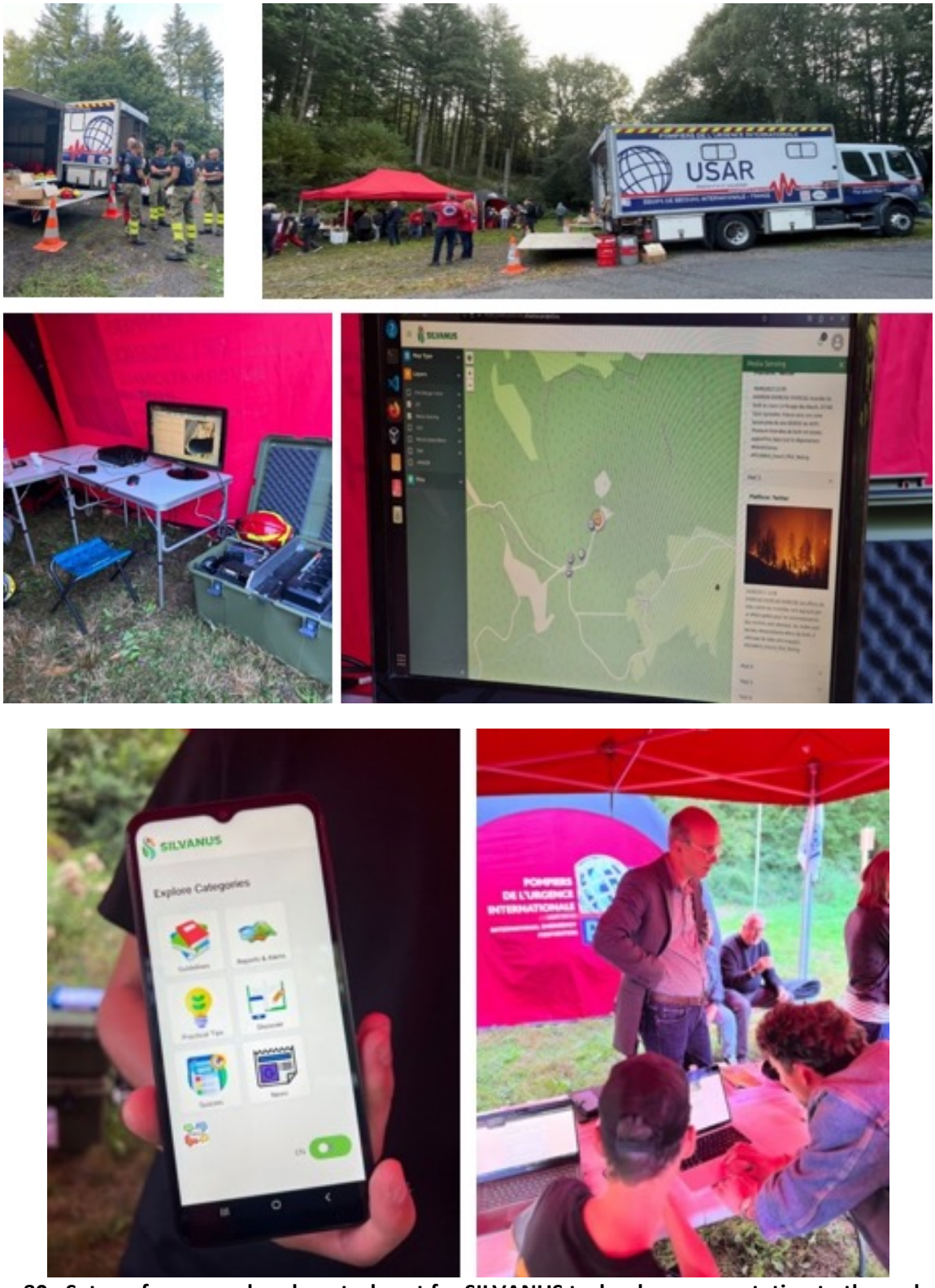

Figure 80 - Setup of command-and-control post for SILVANUS technology presentation to the end-users

(2) Area Mapping with UAV

The team of PUI drones mapped the area from a specific zone with 2 drones (Figure 81):
-MAVIC enterprise with thermal camera and loud speaker,
-AVATA with specific glasses for an immersive flight.

Figure 81 - Drone surveillance being deployed in French pilot

(3) Fire Detection with sensors (IoT Gateway)

We setup a sensor in a tree, at 3m of the ground, placed just in front of the road to access to the SEVESO company. The distance from the sensor to the computer with the platform SILVANUS was around 20m (Figure 82).

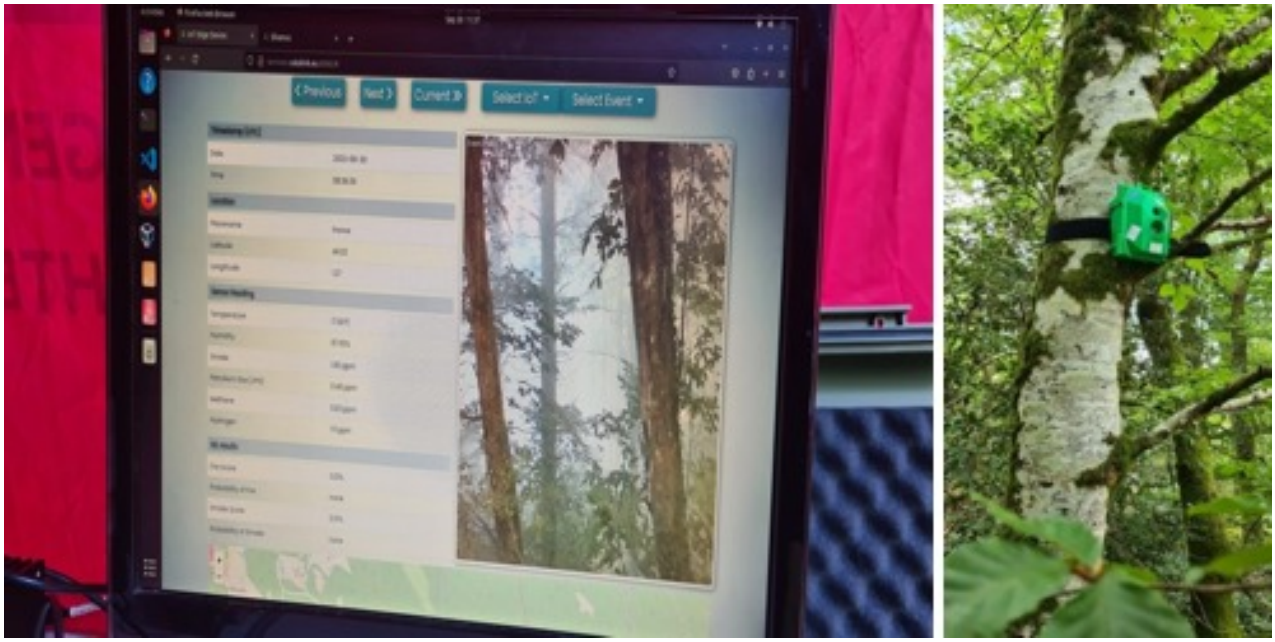

Figure 82 - Demonstration of IoT Devices for fire detection using in-situ device installation within the forest

The different parameters measured and displayed on the platform was:

- Date and time,
- GPS coordinates, (latitude/longitude),
- Temperature,
- Humidity,

- Smoke concentration (ppm),
- LPC Petrolium gas (ppm),
- Methane concentration (ppm),
- Hydrogen concentration (ppm),
- Probability of smoke (%) and
- Probability of fire (%).

The results were conformed to the reality with a detection of smoke and fire, and a good GPS location.

4) First test: real fire and smoke

Figure 83 - Creation of smoke for technology validation

To protect the forest and for security reasons (real SEVESO company), we decided to put the fire in a container with potato starch (Figure 83). The results were very efficient with smoke and fire in the container; the detection of the fire and smoke was possible. After this phase of fire, in real time, we decided to:

- Wait for the detection of the fire by the sensor.
- Mobilize the first responders and firefighters with 3 fire trucks, with the goal to fight the fire with a pick-up, pump, and new tools, and with the trucks and the robot (Figure 84, Figure 85).
- Monitor the information on the social media in automatic mode and
- Use the APP with the population on the site.

Figure 84 - Testing of fire suppression mechanisms

Figure 85 - Demonstration of ground robots for testing fire spray for suppression

We organized 2 simulations:
-1 in the forest with the deployment of firefighters and the robot, with the support of the drones,
-1 simulation only with firefighters, to simulate the deployment with new tools: pipe carrying rack, tool GORKI, pick-up with a high pressure pump (40 bars).

3.4.5 User product validation

The complete list of user products tested in the French pilot is presented in Table 4, highlighting the UP description, as well as the outcome.

Table 16 - User products, French pilot

Phase (A,B,C)	*Tested user product*	*Description*	*Outcome*
Phase B	**UP3 - Fire detection based on social media sensing**	UP3 represents a significant advance in fire management, leveraging social media readiness to gather information in real time. At the heart of this system is the analysis of X's (Tweets) for identifying clues of possible fires.	UP3 in collaboration with the PUC leader produced 26 synthetic X's (Tweets) representing fire-related scenarios and generated a corresponding fire event. Subsequently, successfully posted these X's on X (Twitter) and meticulously crawled the data through the dedicated X crawler. The evaluation of this data was conducted through the user interface of SILVANUS via the Media Sensing layer..

Phase B	**UP4 - Fire detection from IoT devices**	UP4 uses machine learning algorithms for real-time video analysis, automatically identifying and reporting fires. This solution uses state-of-the-art neural networks to detect patterns and thermal anomalies that indicate the presence of fire.	UP4 was successfully deployed on the French site. Please find detailed information in the activities presented above.
Phase A, B	**UP 6 Fire Inspection using UGVs (Robots)**	Fire Inspection using the Unmanned Ground Vehicle (UGV) is developed to navigate ground vehicles autonomously to and from a fire-front, to report images, geolocation and the results of any partner sensors and to use the lidar data to estimate local forest characteristics, (i.e. leaf and tree density).	UP6 was successfully deployed in the French pilot. Please find detailed information in the activities presented above.
Phase A, B	**UP8 Citizen's engagement mobile App**	Citizen Engagement Mobile App provides a holistic toolkit for Citizen Preparation, Response and Recovery through interactive educational and situational awareness modules. The app ensures that all users are always informed, prepared and connected during Fire Incidents.	UP8 was successfully deployed in the French pilot. Please find detailed information in the activities presented below.
Phase A, C	**UP7 Woode App**	The Woode App was successfully tested and demonstrated to the stakeholders on the functionality of creating and sustaining a community of users who could share information about natural conversation schemes.	UP7 was successfully validated on the functionality. Please find detailed information in the activities presented below.

UP3 – Social Media Sensing

CERTH demonstrated the pipeline used for capturing, aggregating, and displaying X's reporting a fire. The system crawls X's API (or posts on a Facebook group, or a particular website). If it detects potential reports, based on certain keywords, they are captured and unpacked (date, location, X text). Once this is done, the reports are aggregated and analysed. Those marked as real are then forwarded to the SILVANUS Cloud, which allows the dashboard to display them on the map (Figure 86).

24 post on "X" (Tweet) was prepared to facilitate the communication on the social media. The information on the social media was very relevant.(Figure 87).

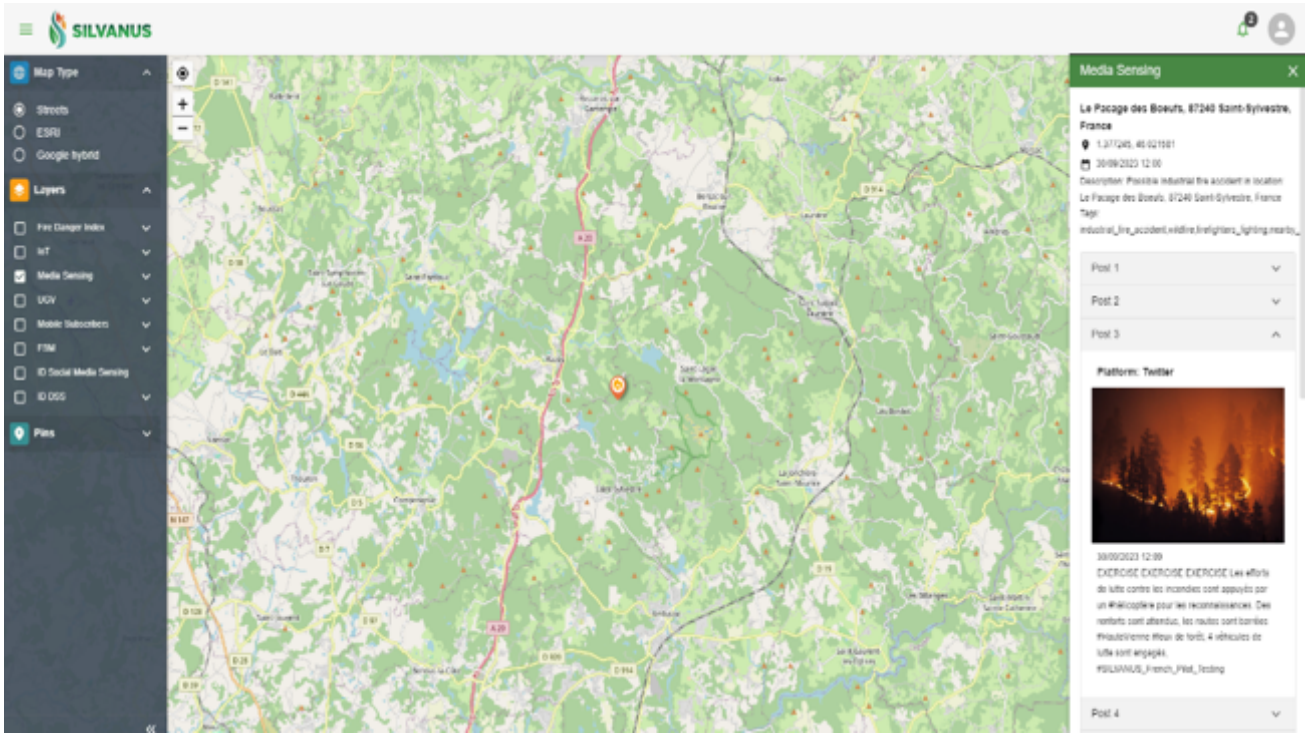

Figure 86 - SILVANUS Dashboard

Examples of tweets in french:

1. EXERCICE EXERCICE EXERCICE Incendies de forêt en France. samedi 30 septembre 2023, un incendie de forêt vient de se déclarer près du site SEVESO, industrie d'explosifs, *Le Pacage des Bœufs, 87240 Saint-Sylvestre, France*. La canicule et le vent violent propagent le feu, Laissez les voies de circulation dégagées pour les véhicules de secours, #feuxdeforets, #explosion, #seveso #SILVANUS_French_Pilot_Testing

2. EXERCICE EXERCICE EXERCICE Incendie de forêt en *cours Le Pacage des Bœufs, 87240 Saint-Sylvestre, France* dans une zone boisée près du site SEVESO de #EPC. Plusieurs incendies de forêt ont éclaté aujourd'hui dans tout le département #HauteVienne – les pompiers s'efforcent de les contenir. #SILVANUS_French_Pilot_Testing

3. EXERCICE EXERCICE EXERCICE Les efforts de lutte contre les incendies sont appuyés par un #hélicoptère pour les reconnaissances. Des renforts sont attendus, les routes sont barrées #HauteVienne #feux de forêt, 4 véhicules de lutte sont engagés, #SILVANUS_French_Pilot_Testing

4. EXERCICE EXERCICE EXERCICE #HauteVienne : l'incendie de *Le Pacage des Bœufs, 87240 Saint-Sylvestre, France* est hors de contrôle, la #préfectureHauteVienne appelle à la prudence et va activer un poste de commandement à la #MairieStSylvestre, #SILVANUS_French_Pilot_Testing

5. EXERCICE EXERCICE EXERCICE Le risque de propagation du feu, *Le Pacage des Bœufs, 87240 Saint-Sylvestre, France* oblige à l'évacuation des habitants situés dans la zone de destruction en cas d'explosion du site SEVESO, #feuxdeforets, #France, #explosifs,

Figure 87 - Example of social media tweets being aggregated from online platform X (previously Twitter)

3.4.6 Media impact:

The SILVANUS pilot was followed by several French media with several reports (Figure 88):
-French national TV,

-Newspapers,
-Radio.

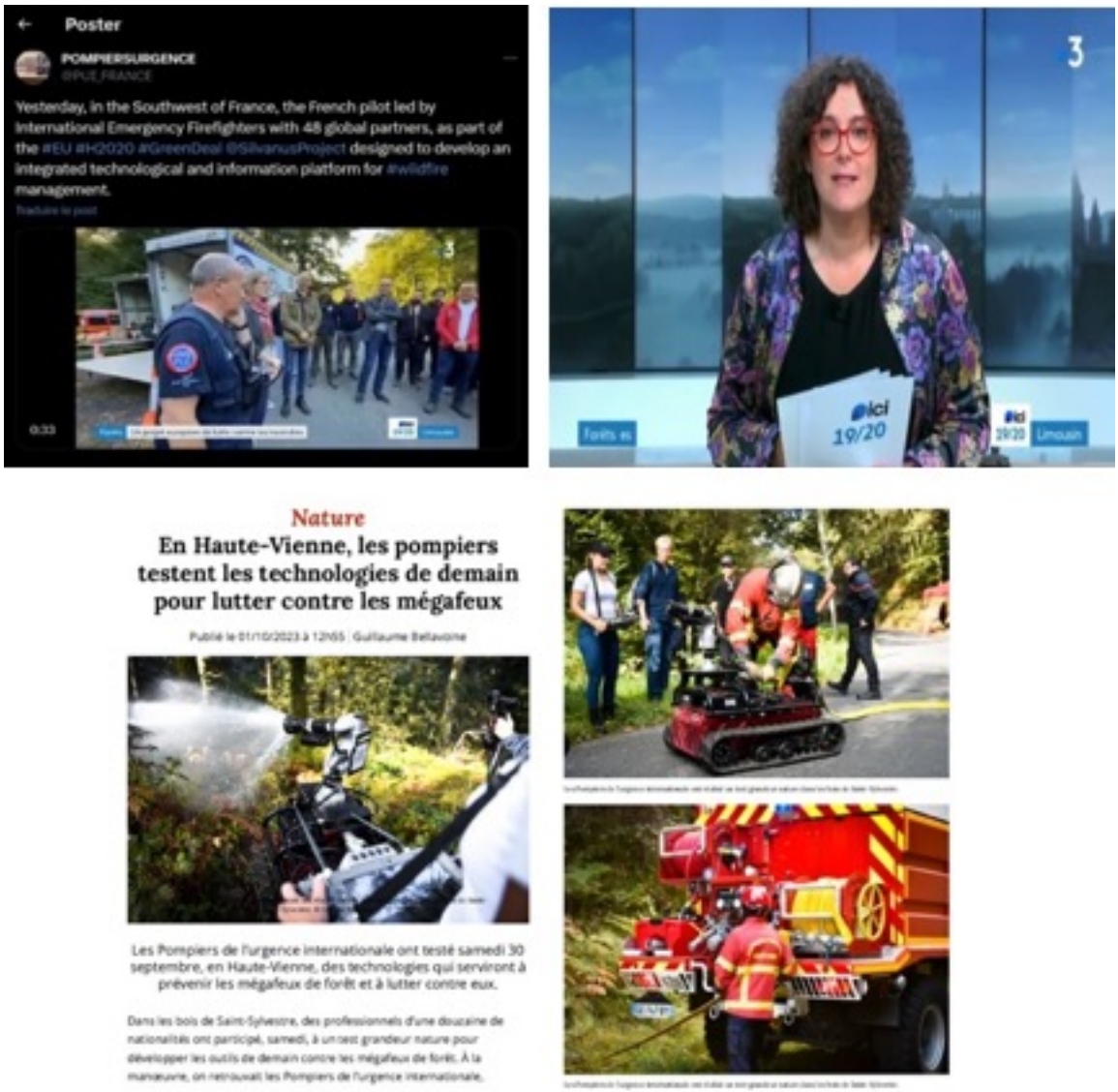

Figure 88 - French pilot being covered by Media

Exhibition:
In the hall of Limoges town hall, we installed an exhibition based on the posters prepared, translated into French by the SILVANUS consortium; the inauguration was carried out by the Mayor of Limoges in the presence of the city's partners and elected officials. This exhibition remained for several weeks and raised public awareness of the risk of forest fires and the prevention and fight against these disasters. More than 2000 people have visited the exhibition in the hall of the city hall (Figure 89).

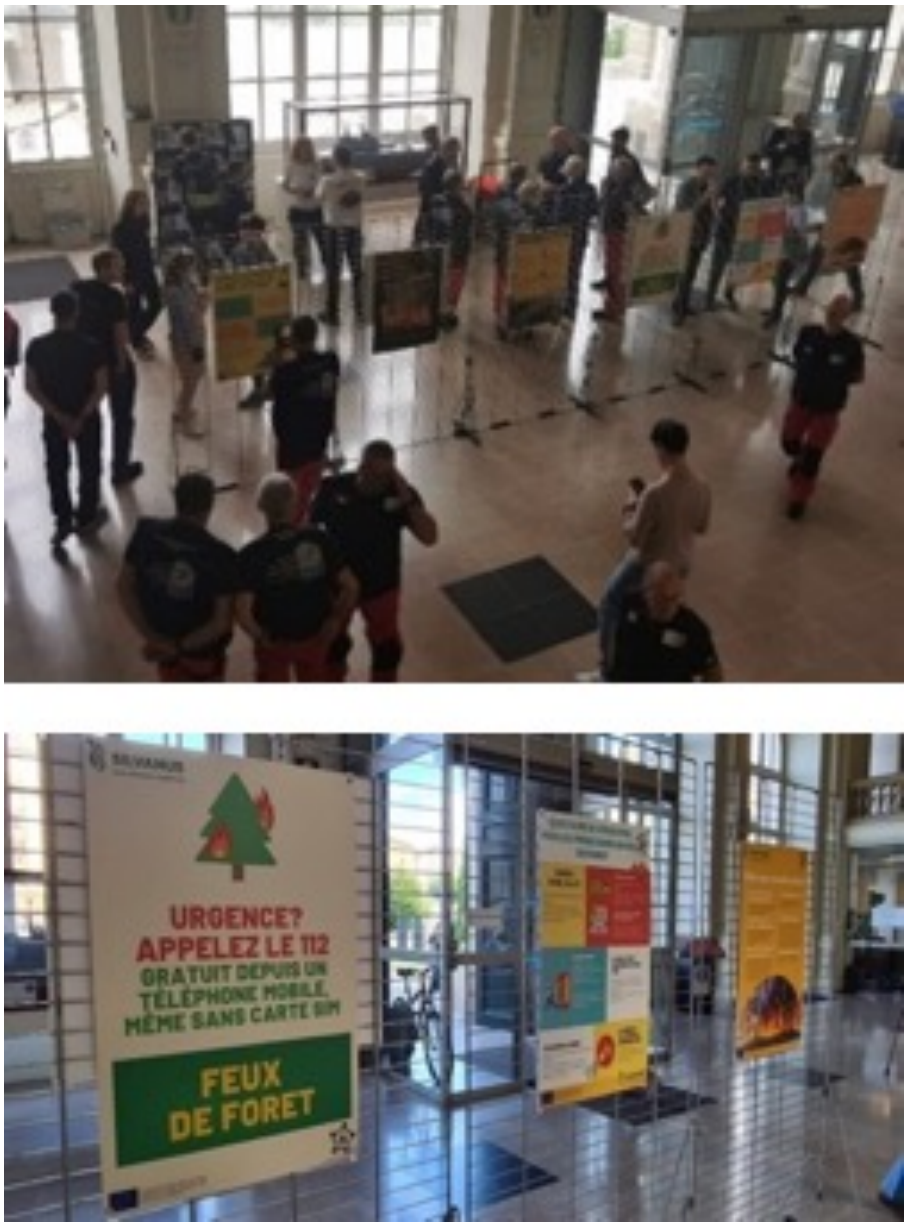

Figure 89 - Organisation of SILVANUS exhibition to promote fire safety

3.4.7 Strategic and operational challenges

The relevant challenges, at a strategic and operational level, are summarized below:

- Communication during the deployment of the different technologies and ease of use,
- rapid mapping of the area and the road and access,
- anticipation of the spread of the fire in relation to the vulnerability of the explosive company,
- deployment of the robots and drones to monitor the situation and analyse gases, smoke, temperature and different parameters which could put the storage in danger,
- deployment of teams and fire vehicles to fight the fire.

More specifically, from the interaction and discussions with local stakeholders, the main challenges and gaps that are crucial for the specific pilot area, have been found to be as follows:

Phase A: Prevention and Preparedness

Phase A1	Monitoring tools and techniques in addition to the ongoing direct observation

Phase A2	Improvement of awareness related to fire events, engagement of young population involving schools, app to be used to indicate fire event

Phase B: Detection and Response

Phase B1	Monitoring tools and techniques such as sensors to be installed in the territory and satellite data, reduction of intervention time after fire detection through installing new sensors
Phase B2	Direct, digital, and real time control and evaluation of the intervention

Phase C: Restoration

Phase C1	Engagement of different stakeholders such as municipalities, external experts, public authorities, private landowners
Phase C2	Analysis of three kind of rehabilitation (through planting new trees and monitoring them)

3.4.8 Planning of 2024 pilot activities

On 31st of January 2024, during the SECOURS EXPO exhibition in Paris, PUI will be invited to participate to a conference about the various fires which have affected France and Europe in recent months and years, and which are more and more frequent and violent: What prevention, what organization at the local level, what means national, what collaboration between the different emergency services, what techniques to fight fire, what areas for improvement to be even more effective in the field, etc. The organizer asked PUI to present the Silvanus Program during this conference and for this conference, different people will be present: The ERCC, the representative of a municipal forest fire committee from the South of France, the national association of French firefighters, etc.

3.4.9 Conclusions

The French pilot has demonstrated a comprehensive and multidisciplinary approach to fire management, involving a diverse network of stakeholders with distinct expertise. The collaborative efforts have focused on addressing the challenges through innovative technologies and training methodologies. The objectives, activities, and outcomes of the pilot highlight significant progress in various phases of fire management.
Among the gains from the first trial period activities, the French pilot includes:

- **Training advancements:** The use of VR/AR for firefighter training is a notable achievement, providing a realistic and immersive experience. This technological advancement enhances the preparedness of first responders in dealing with complex fire scenarios.
- **Technological integration**: The successful deployment of various user products, including fire detection based on social media sensing, IoT devices, Unmanned Ground Vehicles (UGVs), and Citizen's engagement mobile app, demonstrates the effective integration of cutting-edge technologies in fire management.
- **Community engagement:** The development and deployment of a community engagement app plays a crucial role in disseminating information to citizens. This interactive tool empowers the community to actively participate in fire management efforts and report incidents to the command-and-control centre.

However, some important challenges have been faced during the first demonstration phase:

- **Communication Challenges**: during the deployment of different technologies and ease of use highlight the importance of seamless communication among stakeholders. Planning a pilot program is a time-intensive process, requiring meticulous attention to detail. Pilot leaders and organizers

must proactively engage with technology providers, stakeholders, the media, as well as local and national authorities well in advance to inform them of the upcoming exercise.

- **Rapid mapping and anticipation**: Challenges related to rapid mapping of the area, anticipation of fire spread, and vulnerability assessment of critical infrastructure, such as the explosive company, underscore the need for advanced mapping technologies and real-time risk analysis.
- **Deployment of Robots and Drones**: The deployment of robots and drones for monitoring and analyzing environmental parameters presents operational challenges. Overcoming these challenges requires continuous refinement of deployment strategies and enhancing the capabilities of these technologies. Telecommunication is essential in remote areas. If technologies are unable to communicate with each other or with first responders, they will not fulfil their intended purpose.
- **Technology deployment**: It is essential to understand what type of technologies will be tested on site and what do they need for a successful operation (power, water, Wi-Fi, special equipment, etc.). Prior to the pilot, a clear purpose for each technology should be defined, along with its Key Performance Indicators (KPIs) and evaluation methods.

3.5 Czech Republic pilot

Czech pilot demonstration (CPD) was held on 3rd and 4th October 2024 in the pilot territory in Krásná municipality, Moravian-Silesian Region, the Czech Republic. CPD was dedicated for Phase B of SILVANUS project and the CPD theme was the forest-firefighting.

The CPD agenda consisted of pre-exercise workshop and showcase held on 3rd October in Ostrava city (the regional capital), the second CPD day was dedicated to in-field exercise and lesson learned summary.

Tuesday 3rd October 2023 - Pre-Exercise Workshop

VŠB - Technical University Ostrava, Faculty of Safety Engineering (Ostrava City)	
8:30	Registration
9:00	Opening Session Opening speeches of FRB MSR, VSB – TU Ostrava and SILVANUS project Coordinator representatives
9:30	SILVANUS User Products UISAV – Citizen Engagement Mobile App UISAV – Dashboard 3MON – UGV 3MON – forest fires detection system
10:15	Fire Rescue Service - forest firefighting appliances and equipment
10:30	Break
10:40	Exercise Scenario Exercise tasks, KPIs, institutions and stakeholders involved, scenario introduction, logistic, discussion
11:45	Faculty of Safety Engineering – presentation
12:00	Lunch
13:00	Faculty of Safety Engineering – special laboratories and workplaces visit
Fire rescue Brigade of Moravian-Silesian Region, Regional Headquarter (Ostrava City)	
14:00	Pilot Case Exercise Showroom Pilot Case exercise technology showroom - appliances, technologies and SILVANUS user products
Pilot Case Location Visit (Kyčera territory, municipality Krásná)	
15:00	Pilot Case Location Visit

	Additional, voluntary, activity for technology partners and SILVANUS project partners (estimated duration 3 hours)

Wednesday 4th October 2023 - Pilot Site Exercise

Fire rescue Brigade of Moravian-Silesian Region, Regional Headquarter (Ostrava City)	
7:45	Registration
8:00	Departure to Exercise Location
Pilot Case Exercise Location (Kyčera territory, municipality Krásná)	
9:00	Water-Pumping Post
9:30	Firefighting Sector Alfa Portable high capacity water tanks, special forest firefighting appliances
10:00	Command Post Remote control room, command post, drone team (survey and data-sharing), Mobile-App and SILVANUS Dashboard, forest-fire detection system, forest firefighting appliances and equipment
11:00	Firefighting Sector Bravo Portable high capacity water tanks, special forest firefighting appliances, D-house system, UGV, special firefighting equipment
12:00	Departure to Ostrava
VŠB - Technical University Ostrava, Faculty of Safety Engineering (Ostrava City)	
13:00	Lunch
	Additional, voluntary, activity for technology partners and SILVANUS project partners (estimated duration 2 hours)
14:00	Exercise Evaluation and Lessons Learned
15:00	Pilot Case Exercise Ending

3.5.1 Location

The Czech pilot is located in Krásná municipality, on the territory of Protected Landscape Area Beskydy, Moravian-Silesian Region, the Czech Republic (Figure 90, Figure 91). The GPS coordinates are 49.5958567N 18.4543853E.

Figure 90 - Czech Republic, the location of the pilot territory, source: Mapy.cz

The pilot case area is in the north-east part of the Czech Republic and east part of Moravian-Silesian Region, at the territory of Moravian-Silesian Beskids Mountains. Beskyds Mountains are the northern territory of Protected Landscape Area Beskydy (PLAB). The territory of Beskyds Mountains is home to the most visited tourist resorts in the Czech Republic. The overall area of the Protected Landscape Area Beskydy is 1.160 km2. with the highest mountain Lysá Hora with an altitude of 1.323 meters, lowest areas have an average altitude of approximately 400 meters. The pilot area will be placed at the territory of the Krásná municipality.

Approximately 2/3 of the PLAB are covered by forests (Figure 92), and a significant part presents old growth deciduous and coniferous forests. The reason for declaring the Beskydy Protected Landscape Area was its exceptional natural values, especially the remnants of the original primeval forests with the occurrence of rare Carpathian animals and plants. The Beskydy Mountains are famous for their highland meadows and occurrence of rare Carpathians plants and animals. Also noteworthy are the species-diverse meadows and pastures, unique surface and underground pseudo-karst phenomena. The Beskydy landscape still has an extraordinary aesthetic value, which was created by the historical coexistence of man with the mountains.

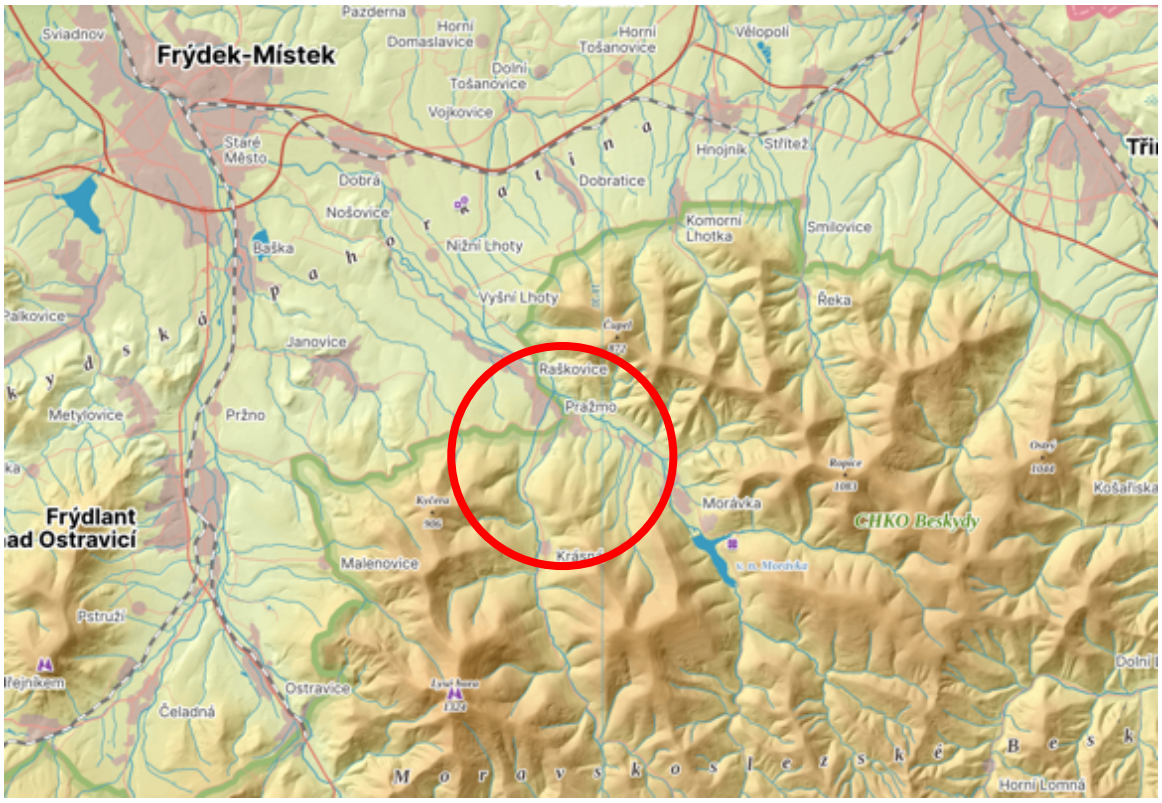

Figure 91 - Krásná municipality, location of the Pilot Case in Czechia, source: Mapy.cz

Figure 92 - Krásná municipality, the location of the pilot area, source: Mapy.cz

The climate of the Beskyds Mountains (Figure 93) is influenced by their location in the central part of Europe. The influences of the oceanic and continental climate meet here. The oceanic air masses bring weather with mild winters, colder summers, heavy clouds and heavy rainfall. Continental air is characterized by daily and annual temperature fluctuations, less precipitation and clouds. The fragmentation of the relief also has a great influence on the climate. As the altitude rises, the temperature and atmospheric pressure decrease and other climatic factors are also influenced. According to the climatic division of the Czech Republic, the Beskyds Mountains region belongs to the category of cold areas.

Figure 93 - Beskds Mountains, source: Gigaplaces.com

Territory of Moravian-Silesian Beskyds Mountains (MSBM) belongs to 26 municipalities, which dispose its own Volunteer Fire Brigade. This fire brigades are situated directly at the territory of MSBM or close to its borders. The Volunteer Fire Brigades dispose the basic resources for forest firefighting. Area of MSBM is also covered by four professional fire stations of FRB-MSR. FRB-MSR disposes of well-trained personnel, appliances, facilities and is fully equipped to provide service in all scales of emergencies. FRB-MSR manages with 22 full time fire stations and operationally controls approximately 356 part-time and volunteer stations. Airborne firefighting vehicles (helicopters), UAV for monitoring and assessment and high-capacity pumping equipment to treat forest fires are at disposal too.

3.5.2 Participating stakeholders

The stakeholders involved in the Czech pilot of the SILVANUS project represent a diverse array of typologies, each contributing with unique perspectives and expertise to the initiative. The network encompasses entities fulfilling roles such as project members, pilot demonstration owners, technology partners, researchers, observers, and end users. These stakeholders span emergency services, research institutions, technology providers, forest owners, municipal authorities, and various associations related to firefighting and emergency response. Their participation includes activities like conducting pilot demonstrations, providing emergency services, contributing research insights, and offering observations. This collaborative network showcases a holistic approach, ensuring the integration of diverse expertise to enhance the success and effectiveness of the SILVANUS project in the Czech Republic.

The stakeholders are detailed in Table 17 and Table 18, according to their particular activity and role.

Table 17 - SILVANUS project partners' roles and activities, Czech pilot

Stakeholder	*Activity Engaged*	*Role*
Fire Rescue Brigade of Moravian-Silesian Region	SILVANUS project member pilot demonstration owner	end user emergency service
UI SAV	SILVANUS project member technology partner	researcher
3MON	SILVANUS project member technology partner	technology partner
KEMEA	SILVANUS project member technology partner	researcher
TUZVO	SILVANUS project member technology partner	researcher
VTG	SILVANUS project member technology partner	Scientific and technical coordinator of SILVANUS

Table 18 - Stakeholders' roles and activities, Czech pilot

Stakeholder	*Activity Engaged*	*Role*
VSB – Technical University Ostrava	pilot demonstration partner observer	researcher
České lesy s.p. (Czech Forests)	pilot demonstration partner observer	end user forest owner
Firefighting College Frýdek-Místek	pilot demonstration partner demonstration participants	end user emergency service
Záchranný útvar HZS ČR (Rescue Brigade)	pilot demonstration partner demonstration participants	end user emergency service
Volunteer Firefighter Unit of Krásná municipality	pilot demonstration partner demonstration participants	end user emergency service
Volunteer Firefighter Unit of Raškovice municipality	pilot demonstration partner demonstration participants	end user emergency service
Volunteer Firefighter Unit of Pražmo municipality	pilot demonstration partner demonstration participants	end user emergency service
Krásná Municipality	observer	end user municipal authority
Povodí Odry, s.p. (Odra River Basin)	observer	end user river basin authority
Borsod-Abaúj-Zemplén County Firefighter Association	observer	end user firefighter association
Horská služba s.p. (Mountain Rescue)	observer	end user emergency service
Policie ČR (Police of Czech Republic)	observer	end user emergency service

3.5.3 Objectives

The demonstration activities planned for the Czech pilot will contribute to the following objectives of the SILVANUS project.

- PA1: Environmental and ecological mapping and assessment of forest regions within project demonstrations.
- PA4: Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcements.
- DO1: Creation of demonstration scenarios and establishment of real-world drills for the evaluation of SILVANUS project outcomes.
- DO2: Engagement of stakeholders at periodic intervals to evaluate the outcomes adopting agile methodologies.

3.5.4 Description of performed activities

Czech Pilot Demonstration (CPD) was held as two days event on 3rd and 4th October 2023.

First day consisted of three separate activities - pre-demonstration workshop, user-product showroom and in-field inspection.

Pre-demonstration workshop was held at the VSB – Technical University Ostrava property, Faculty of Safety Engineering in Ostrava. The main goal was to brief all the participants on in-field exercise contents and activities, the SILVANUS project user products introduction and validation goals, safety and security, logistic and organizational issues. Moreover, the CPD participants took an opportunity to visit special laboratories and workplaces of the Faculty of Safety Engineering (Figure 94).

Figure 94 - SILVANUS stakeholder engagement

The user product showroom took place at the Headquarter of Fire Rescue Brigade of Moravian-Silesian Region in Ostrava. The SILVANUS user products and other cutting-edge equipment and appliances of Fire Rescue Service of the Czech Republic were promoted at the showroom (Figure 95).

Figure 95 - Field exercise activities coordinated by FRS MB

The in-field inspection, the last activity of the first day, was held in the territory of pilot location in Krásná Municipality. The CPD participant took the opportunity to acquaint with the CPD territory (Figure 96).

Figure 96 - In-field inspection of the activity

The second day of the CPD was primary dedicated to in-field exercise – demonstration. The exercise scenario was purposefully tailored to test and validate the SILVANUS project user products and to test and assess their effectiveness and utilization with existing fire-fighting techniques and procedures and their complementarity with cutting-edge equipment and appliances of firefighters in the Czech Republic.

The exercise activities were carried out at four separate workplaces/sectors (Figure 97):

- command post (no. 2)
- water-pumping post (no. 5),
- firefighting sector Alfa (no. 3),
- firefighting sector Beta (no. 4).

Figure 97 - Map of the pilot site visit

Water-Pumping Post – Various techniques of water-pumping and firefighting water supply were tested and promoted (Figure 98).

Figure 98 - Water pumping post and water resupplying process demonstrated

Figure 99 - Firefighting capacity being demonstrated

Fire-fighting Sector Alfa – Fire-fighting techniques and procedures using the portable high-capacity water tanks and special forest firefighting appliances and their cooperation with UAV surveillance was assessed (Figure 99).

Command Post – The Command Post was dedicated workplace for the incident commander to manage all firefighting activities. The SILVANUS project user products were used to carry out various specific tasks to provide inevitable information support to coordinate all activities (Figure 100).

Figure 100 - Pilot preparation being carried out

The equipment for detection of forest fires was tested to detect fictious forest fires (Figure 101).

Figure 101 - Fire detection equipment being tested

UAV was used to carry out on-line surveillance to provide real-time information of affected areas, and to detect possible other fire-affected areas (Figure 102).

Figure 102 - Drone surveillance being demonstrated

The SILVANUS project mobile application was used for community engagement and sharing information about the real time situation and the forest fire spreading (Figure 103).

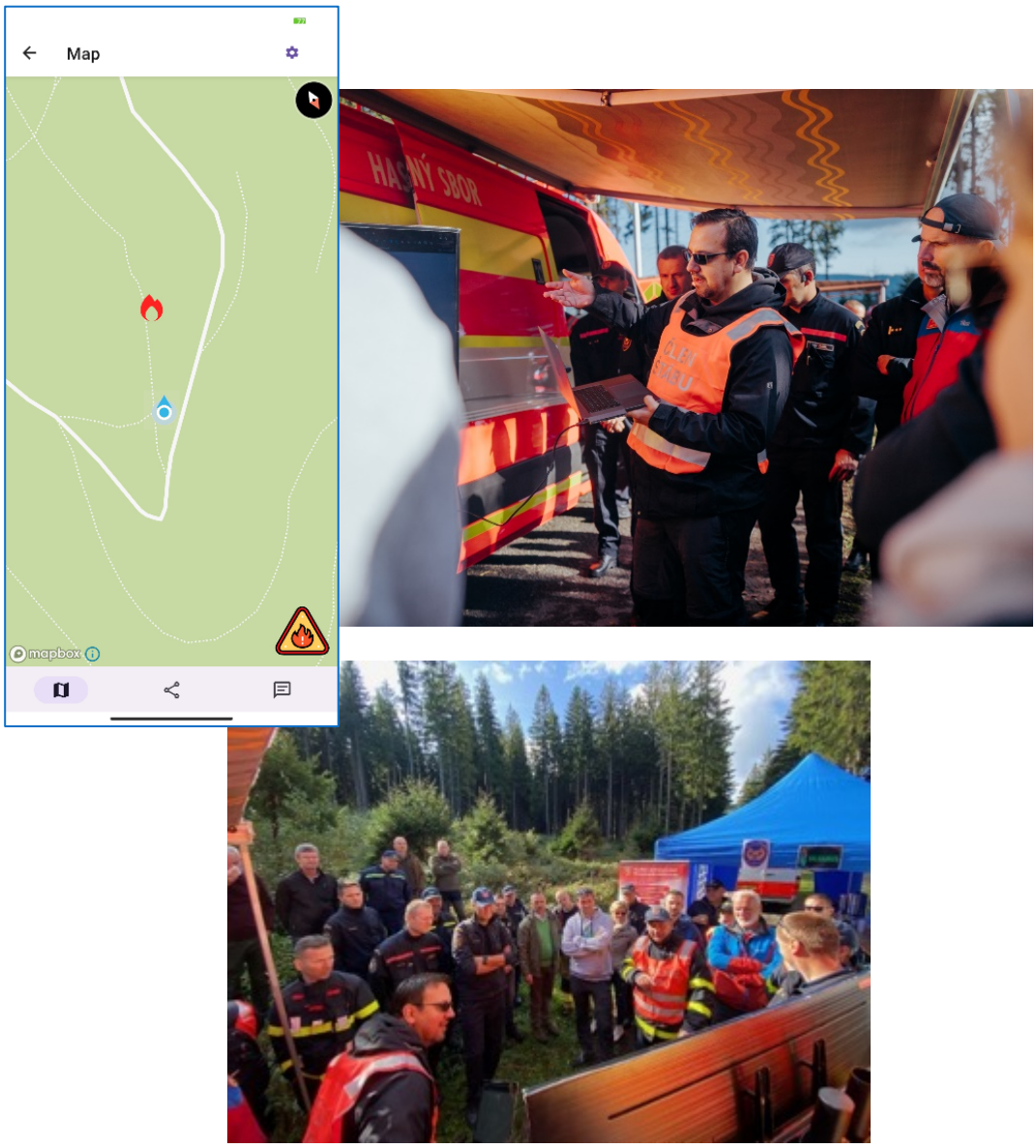

Figure 103 - Citizen engagement application being presented

Fire-fighting Sector Bravo – The portable high-capacity water tanks, special forest firefighting appliances, D-house system and other special fire-fighting equipment and procedures were tested with cooperation with UGV. UGV appliance was used to carry out specific activities related to fire-fighting, transportation, logistic, search and rescue activities (Figure 104).

Exercise evaluation and lessons learned were held again in Ostrava City, at the VSB - Technical University Ostrava. This final session of the CPD provided room to discuss the exercise and all user project performances. The session provided necessary feedback from exercise participants to SILVANUS project technology partners for further development of their user products and integration in SILVANUS project platform.

Figure 104 - Ground robots under demonstration for fire suppression

3.5.5 User product validation

Table 19 presents the UPs that has been tested during the execution of the Czech pilot, providing a short description of each one and their outcome from the tests.

Table 19 – User product, Czech pilot

Phase (A,B,C)	*Tested user product*	*Description*	*Outcome*
Phase B	UP5 UAV	UAV was used and assessed in various roles during the exercise – wildfire detection and survey.	UAV successfully accomplished all assigned tasks related to forest fire detection and reconnaissance
Phase B	UP6 UGV	UGV was used and assessed in various roles during the exercise – wildfire detection and survey, firefighting, rescue and logistic activities	UGV was able accomplish all successfully fulfill assigned task related to accomplish all defined tasks related to forest fire detection and reconnaissance
Phase B	Optic detection system	optic detection system was tested to detect forest fire and to transfer data to emergency command pot	optic detection system successfully accomplished all defined tasks
Phase A,B,C	UP8 MobileApp	this citizen engagement toll was tested to be used as a	MobileApp and Integrated Dashboard were successfully used to announce

		tool for forest fires detection	the forest fire to fire brigade command post
Phase A,B,C	Integration Dashboard	the dashboard platform was used and assessed for wildfire detection	
Phase A	UP7 Woode App	Capturing of biodiversity information from the pilot site	Successful testing of the first release of the mobile application.

3.5.5.1 UP9 MobileApp

Volunteers assumed the roles of random tourists exploring the demonstration area and observed smoke. They employed the Fire Reporting module of the CEA mobile application to complete and submit a form containing an estimated location, a picture from the scene and a brief description (Figure 105) to the EmerPoll dashboard.

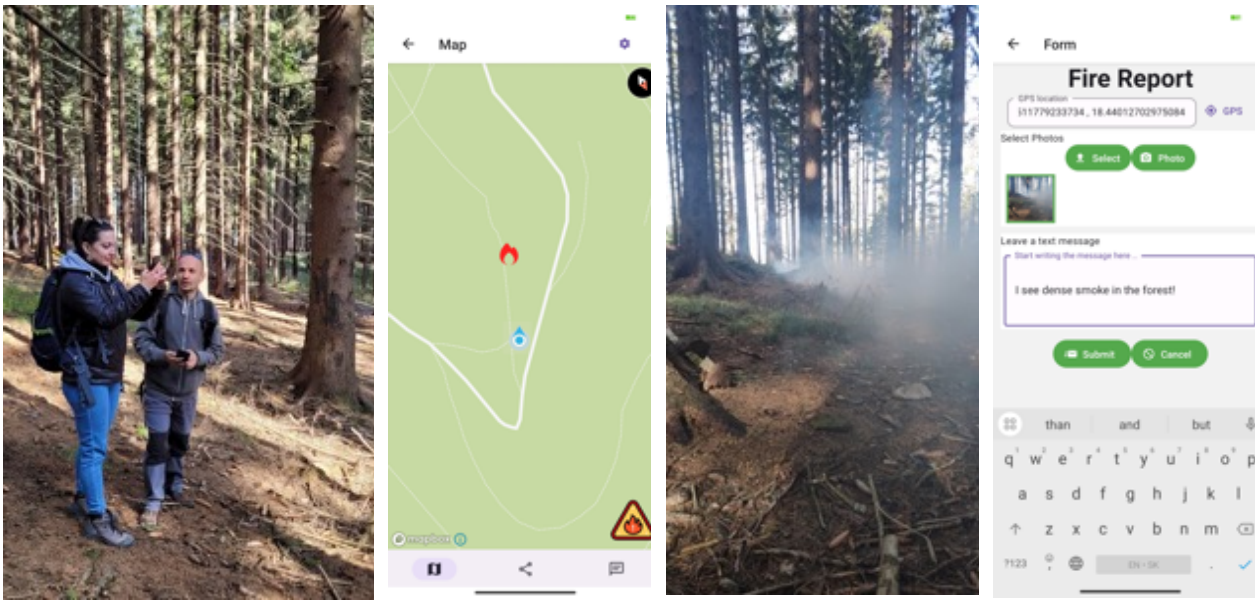

Figure 105 - Steps for fire repoting in CEA mobile application: a) user marks approximate location of the spotted fire/smoke; b) take the picture(s); and c) write short description if needed

This dashboard was integrated as one of the screens in the mobile command and control space (Figure 106). In the fire detection phase of the demonstration, a total of two fire reports were sent to the EmerPoll dashboard.

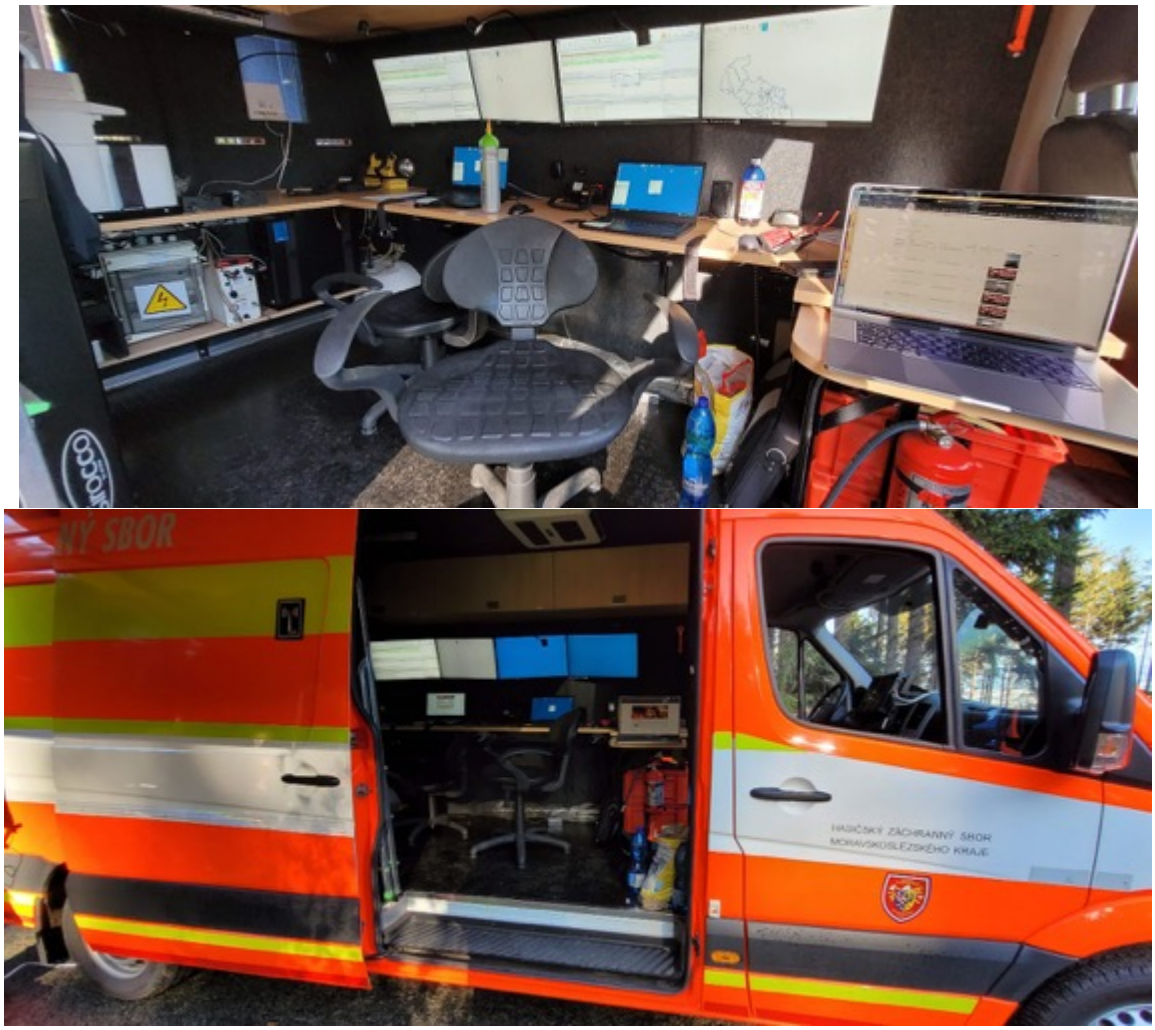

Figure 106 – The EmerPoll dashboard integrated into the Mobile Command Center

3.5.5.2 UP5 UAV

The Czech pilot, the successful deployment and assessment of various user products, including UAVs, UGVs, optic detection systems, mobile apps, and an integrated dashboard, demonstrated their commendable efficacy in tasks ranging from wildfire detection and reconnaissance to firefighting and citizen engagement. The primary goals of the CPD weren´t data gathering but validation and assessment of SILVANUS user products and technologies to deal with forest fires and to test their effectiveness and benefits in combination with up-to-date equipment and existing firefighting SOPs.

The overall deployment and assessment of the UPs highlight their effectiveness in wildfire management scenarios, showcasing their reliability and functionality across different roles and phases of the Czech pilot.

3.5.6 Strategic and operational challenges

To organize the CPD, the pilot owner had to face some challenges.

The strategic challenges for the pilot owner included communication gaps among project partners, leading to delays in organizing the CPD. Operationally, some encountered challenges involved adapting to weather conditions in the Krásná municipality territory and coordinating timber extraction activities, which required adjustments to workplaces and extraction plans for the successful execution of the CPD in the intended location and scale.

These challenges highlighted the need for improved collaboration and information-sharing within the SILVANUS project consortium and especially between pilot demonstration holders and technology partners in order to define the pilot validation requests in advance, that in turn will provide pilot owner sufficient time to arrange the demonstration. Furthermore, organizational measures have been defined and adopted to avoid challenges occurring in CPD in 2023.

Logistics requirements to hold the CPD were covered by pilot owner (FRB MSR) and CPD partners. Namely VSB Technical University Ostrava (facility to hold the workshops and lessons learned activities on 1st and 2nd day), volunteer fire fighting units (the exercise participants), Rescue Brigade of FRS CR (the exercise and showcase participant), Lesy ČR (facilitation of CPD location). FRB MSR established a CPD team of various experts to organize the exercise, facilities to hold the showcase activity, equipment and resources to organize the exercise (power supplies, appliances and equipment, petrol, data network connection etc.).

3.5.7 Planning of 2024 pilot activities

Lessons learned from organizing of CPD in 2023 have been identified by the pilot owner and will be considered for the organization of CPD in 2024 has already begun organizing.

The tentative date to organize CPD in 2024 has been set for the first half of June 2024. The pilot owner is in touch with all key stakeholders, internal (SILVANUS project coordinator, WP 9 leader, technical partners etc.) and external (forest owner, Krásná municipality, exercise participants etc.) too. CPD in 2024 will be held in the frame of CPD in 2023, but in a bigger scale. The exercise scenario will be on forest fire-fighting topic, tailored to user product validation requests and promotion of SILVANUS project.

3.5.8 Conclusions

The Czech pilot provided a comprehensive showcase of the SILVANUS project's capabilities through the successful deployment of various user products. In particular, the Unmanned Aerial Vehicle (UAV), Unmanned Ground Vehicle (UGV), optic detection system, Mobile App, and Integrated Dashboard demonstrated commendable efficacy across tasks ranging from wildfire detection and reconnaissance to firefighting and citizen engagement.

During the two-day Czech Pilot Demonstration (CPD) in October 2023, the pre-demonstration workshop on the first day facilitated an in-depth introduction to the SILVANUS project, its User Products (UPs), and various stakeholders. The second day of the CPD was dedicated to in-field demonstrations and exercises, featuring four distinct workplaces: the water-pumping post, command post and firefighting sectors. The in-field scenario forest-fire firefighting, aiming to promote modern equipment, procedures, and assess the SILVANUS project's user products.

However, the pilot did not come without challenges. Strategic challenges included communication gaps among project partners, leading to delays in organizing the CPD. Operationally, challenges involved adapting to weather conditions in the Krásná municipality and coordinating timber extraction activities. These challenges necessitated adjustments to workplaces and extraction plans for the successful execution of the CPD in the intended location and scale.

These strategic and operational challenges emphasized the importance of improved collaboration and information-sharing within the SILVANUS project consortium. Lessons learned from the CPD in 2023 are being considered for the organization of the CPD in 2024, reflecting the project's commitment to continuous improvement and addressing challenges for future successful pilot activities.

The CPD was promoted with media through press release distributed by FRB MSR (https://www.hzscr.cz/clanek/projekt-silvanus-a-problematika-haseni-lesnich-pozaru.aspx) and the shared on firefighting and common web portals and media (Figure 107).

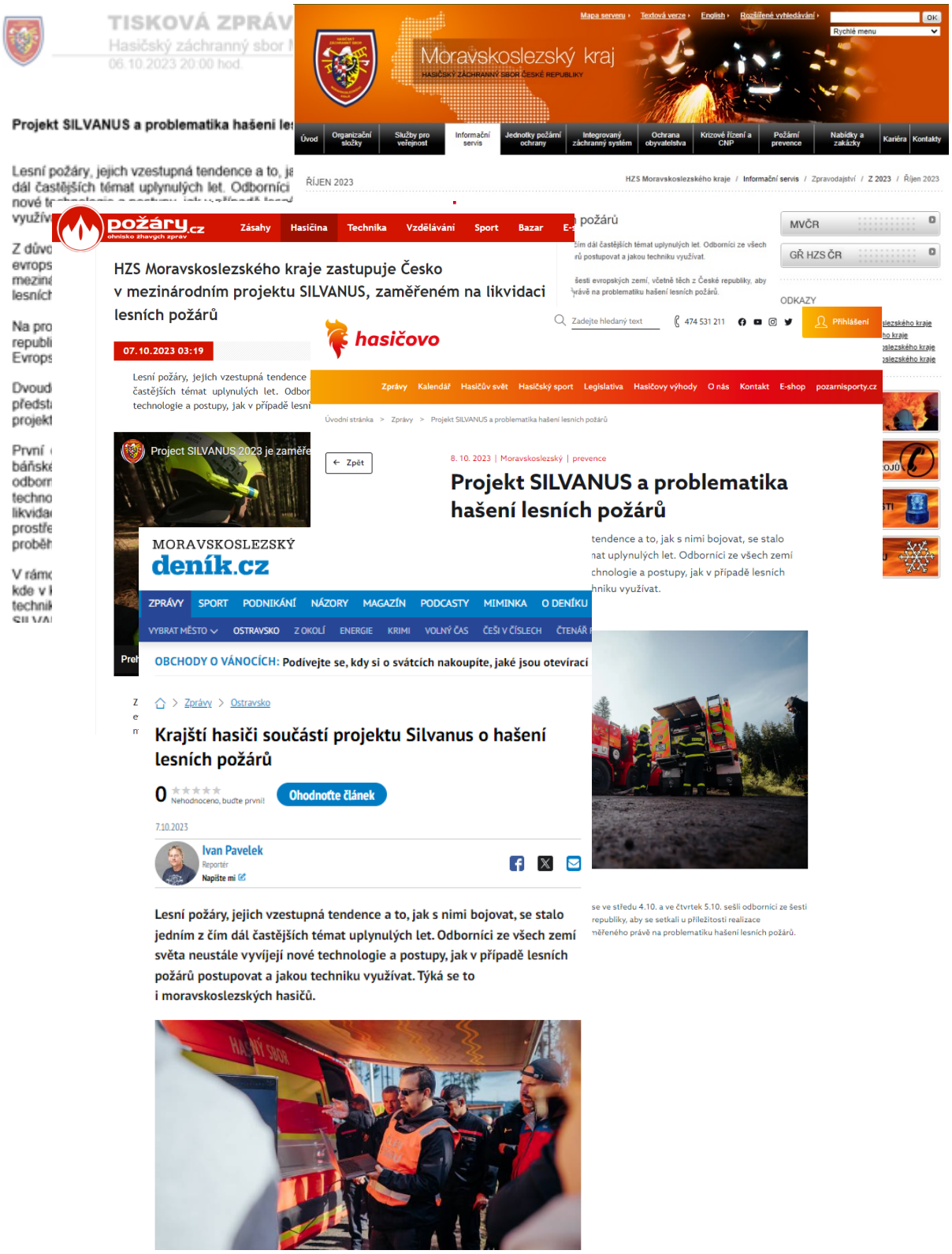

Figure 107 - Media coverage of the Czechia pilot

3.6 Italy (Puglia) pilot

The Italian tabletop exercise was carried out on 13/10/2023 which was preceded by a visit to the pilot site on 06/10/2023. The agenda for the pilot activity is presented below in Table 20. The organisation of the event was carried out as hybrid presentation. The details of the demonstration activities and the dataset collected during the field visit is reported in the rest of the Chapter.

Table 20 - The agenda for the tabletop exercise

13/10/2023, Friday			
No.	**Time**	**Topic**	**Responsible(s)**
1	09.00 – 09.30	Institutional welcome • Elio Sannicandro – General Director of Regional Strategic Agency for the Eco-sustainable Development of the Territory – ASSET – Puglia Region • Marcello Scipioni – Project Manager, FINCONS • Nicola Lopane – Director of Department of Civil Protection and Emergency Management – Puglia Region	ASSET – Marino Spilotros
2	09.30 – 10:00	• Silvanus project – opening session (VTG) Gargano: pilot site description and phase A - B - C use cases – *Sergio Colecchia, Letizia Musaio Somma (ASSET)*	ASSET – Marino Spilotros
3	10:00 – 11:00	Operational scenarios: forest resilience and biodiversity under the climate change • Cooperation on woods protection *Francesco Ronco (Civil Protection)* • Management of fires in Puglia region *Lucio Pirone (Civil Protection)* • The role of ARIF in Puglia region *Giorgio Bucci (Regional Agency for Irrigation and Forestry* - ARIF*)*	ASSET – Marino Spilotros
	11.00 – 11.15	Coffee Break	
4	11.15 – 13.00	SILVANUS technologies demonstrations • Technological Demonstrations Overview (FINC) • Technology demonstrations: data collected in the Gargano Pilot - *ing. Mirko Saponaro (ASSET)* • Technological Demonstrators Integration (FINC) • T8.2 - T8.3 integrated demo: Citizen Engagement App (UP8), Emerpoll, East-West API (UISAV, FINC) • UP3 - Social Media Sensing (CERTH) • UP5 - UAV Monitoring for Wildfire Behaviour (TRT)	FINCONS – Marcello Scipioni

		• UP6 - Fire Spread Model (EXUS)	
	13.00 – 14.00	Networking lunch	
5	14.00 – 14.40	SILVANUS integrated platform • UP2 - Fire Danger Index (CMCC) • UP4 - Fire Detection from IoT Devices (CATALINK)	FINCONS – Marcello Scipioni
6	14.40 – 15.30	Dissemination activities • Citizen's engagement programme - schools *Giovanna Mangialardi (ASSET)* • Firefighters Volunteers training - presentation *Letizia Musaio Somma (ASSET)*	ASSET – Marino Spilotros
7	15.30 – 16.00	Discussion	ASSET - FINCONS
	16.00	End of the meeting	

3.6.1 Location

Gargano is a historical and geographical sub-region in the province of Foggia, Apulia, southeast Italy, consisting of a wide isolated mountain massif made of highland and several peaks and forming the backbone of the Gargano Promontory projecting into the Adriatic Sea (Figure 108). The Gargano National Park is a regional park established in 1991 (according to Regional Law 394/91) and includes, totally or partially, 18 municipalities, covers an area of about 120.000 hectares and it is affected from fire and hydrogeological risks. The territory is divided into zone 1 and zone 2; zone 1 is the area of significant natural, landscape and cultural interest with limited or no anthropization. The zone 2 is the area of naturalistic, landscape and cultural value with a greater degree of anthropization. There are 35 land-use classes. In particular, ignoring the case of artificial surfaces (Class 1), which in any case amount to only 1.09% of the surface of the Park (testifying to its high environmental value), it is possible to notice that the used agricultural surfaces (Class 2) are equal to 24.03%, while the % of surface related to wooded and semi-natural areas is the most consistent, being equal to 66.15%. Finally, with very small values (0.87%), the areas invested in wetlands are followed by water bodies amounting to 7.85% of the Park's territory due to the presence of the two large lakes of Lesina and Varano. Concerning the % of homogeneous groups of land use classes, it can be noted that the greater % is the 3.1 Wooded areas with 29.78%, followed by that of 2 Agricultural areas used (24.09%) and 3.2.4 Areas with evolving woody and Areas with evolving woody and shrubby vegetation (15.05%). There is a set of wooded areas, areas with evolving woody and shrubby vegetation, and areas of Mediterranean scrub (scrubland vegetation). Mediterranean scrub (sclerophyllous vegetation) includes a surface area of more than 60.000 hectares, i.e., almost 50% of the Park territory (Figure 108).

The Pilot Case in Italy (Gargano National Park) is considered for all the **three phases (A, B, C)** of SILVANUS project activities. Specifically, part of the demonstration activities is carried out in Vico del Gargano, in an area near an agricultural company, which provided the required utilities to run the experiments (i.e., electric energy and internet connection). The area located on a hill superseding the Gargano Park, represents a relevant case study, as it presents a dense forest and some remains of a previous fire, currently in restoration (Figure 109).

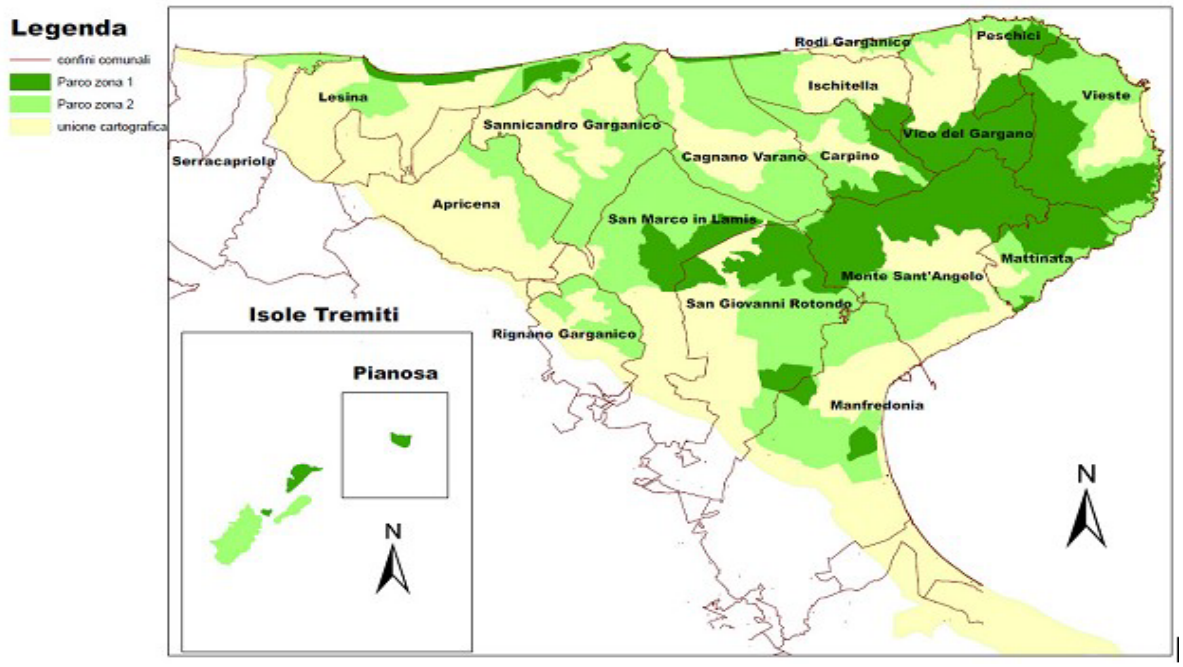

Figure 108 – Map of the Gargano National Park area, Italy

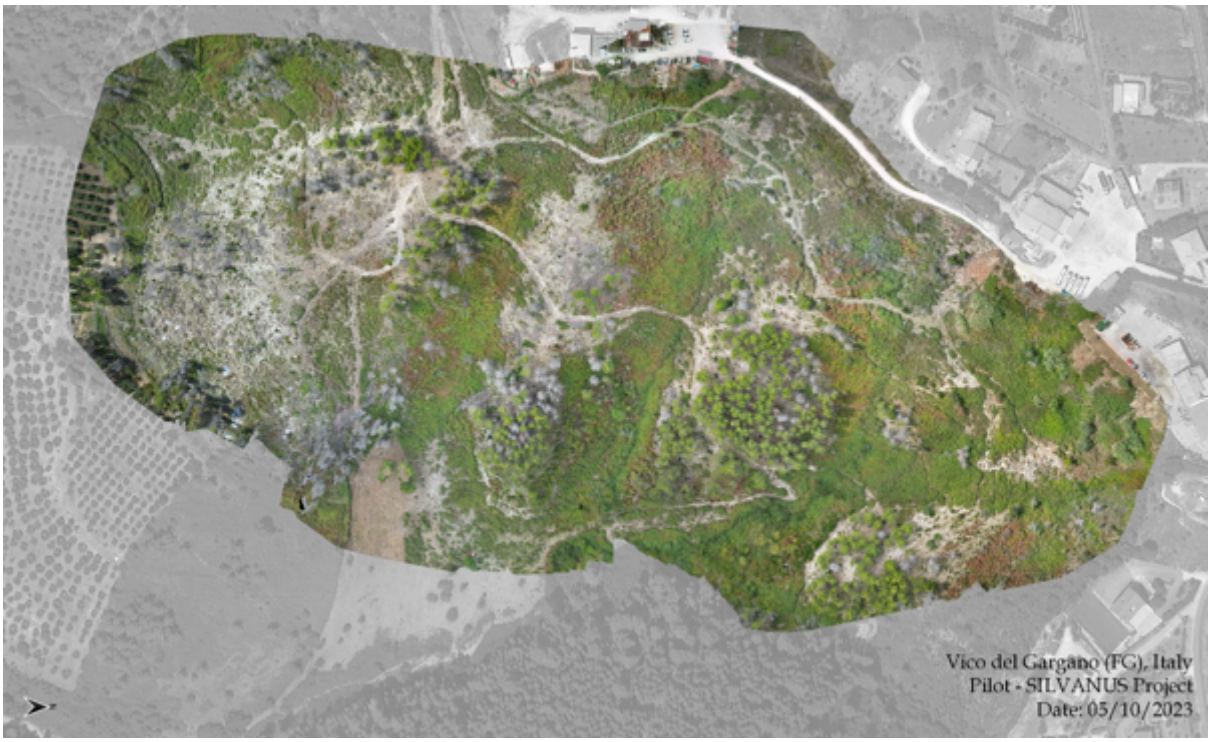

Figure 109 – Location of the first pilot (Pilot Area)

3.6.2 Participating stakeholders

During the field operations of the **tabletop exercise organised on 5th October 2023**, a series of practical tests in relation to aerial mapping with drones and detection of smoke and fire as well as the demonstration of some SILVANUS UPs was performed. This exercise has been organized by ASSET and FINCONS, in collaboration with the Civil Protection, as presented in Table 21.

Table 21 - Stakeholders and partners, Italian pilot 2 field operations

Stakeholder	*Activity Engaged*	*Role*
ASSET	Visit and mapping by drone of burnt and unburnt areas of the Gargano pilot. Logistic support to the installation of the IoT devices provided by technology providers	Pilot owner
Civil Protection	Supervision and control of the simulated smoke and fire tests in the park and of the rescue of a person with drone	Active Fire Fighting
FINCONS	Integration of SILVANUS UPs in dashboard, configuration and deployment of the IoT Gateway	Technology provider, pilot coordinator

During this field operation, ASSET, in its role as Pilot Owner, closely collaborated with technology providers, overseeing drone-based mapping and facilitating IoT device installations. Civil Protection actively engaged in simulated tests and drone-assisted rescues, demonstrating a collaborative approach to active firefighting. Concurrently, FINCONS, acting as both a technology provider and pilot coordinator, fostered seamless integration of SILVANUS User Products into the dashboard and orchestrated the deployment of the IoT Gateway, showcasing strong stakeholder relations and collective engagement in the success of the field operations.

The results of the tabletop exercise organised on 5th October 2023 were presented during the Consortium meeting, held on **13th October 2023 in the Gargano Park**, in the conference room of the Apulia Region. The event highlighted the collaboration between various stakeholder (i.e., Civil Protection and ARIF-Regional Agency for Irrigation and Forestry), focusing on their specific responsibilities and current projects, in order to highlight synergies and discuss the integrated fire management approach in SILVANUS, as specified in Table 22. In addition, a significant contribution was provided by ASSET, reporting the activities carried out on training and engagement in schools as well as the activities performed with the drones. Civil protection explained their responsibilities in the management of disasters that it tries to contain, such as hydrogeological, seismic and forest fires and its role at EU level (i.e., European Civil Protection Mechanism).

Table 22 - Stakeholders and partners, Italian pilot 2 consortium meeting

Stakeholder	*Activity Engaged*	*Role*
	In person	
ASSET	Host, Speaker ASSET presented the content captured from the Gargano pilot in which the EMDC IoT gateway, the video camera and the drone were used. Furthermore, ASSET presented the citizen's engagement program in schools and the firefighters volunteers training course related to the dissemination activities.	Consortium meeting host, pilot owner
FINCONS	Speaker	Consortium meeting attendee, technical pilot coordinator

	FINCONS presented the backend architecture of using geo-GIS support	
VTG	Chairman, Speaker VTG presented the scientific overview of the project	Consortium meeting attendee
ARIF Regional Agency for Irrigation and Forestry	Speaker	Active Fire Fighting
Civil Protection Regione Puglia	Speaker	Active Fire Fighting
Remotely		
EXUS	Speaker EXUS presented the topic regarding the fire spread forecast (UP6), suggesting using a global map and then zooming in on a particular area to allow civil authorities to understand the context. Different fire forecasts could be mapped against the severity scale could help establish a storyline and show the 'continuity' in the UPs and how the different components are 'integrated'.	Consortium meeting attendee
CERTH	Speaker CERTH presented the social media sensing technology (UP3) to facilitate the identification of fire ignition origin using multi-modal data analytics with simulated localization in the Gargano area	Consortium meeting attendee
UISAV	Speaker UISAV presented the citizen engagement app (UP8) with the backend and the Emerpoll system	Consortium meeting attendee
ATOS	Speaker ATOS presented the demo of the fire and smoke detection deployed on the cloud. This module is part of UP4 using images taken from UAVs. Life demo using a video was shown	Consortium meeting attendee (remote)
CTL	Speaker CTL presented the results of the fire and smoke detection (UP4) on the data captured from Gargano Park	Consortium meeting attendee
TRT	Speaker	Consortium meeting attendee

	TRT presented the technology on trajectory models developed for UAV (UP5b) piloting and demo with Google Earth	
CMCC	Speaker CMCC presented the fire danger index demonstration (UP2)	Consortium meeting attendee
PNRT	Auditor	Consortium meeting attendee
EAI	Auditor	Consortium meeting attendee
FINCONS	Auditor	Consortium meeting attendee
HRT	Auditor	Consortium meeting attendee
Government of Canary Islands	Auditor	External stakeholder

3.6.3 Objectives

The trial phase of the Gargano pilot was designed to demonstrate the enhancement of fire management across the prevention and preparedness, active response, and restoration phases by implementing the innovative technologies and practices identified in SILVANUS.

The objectives underlying the organization of the Italian tabletop exercise were connected to each of the three phases (A, B and C). According to each phase, the main objectives encompass the following:

Phase A (Prevention and Preparedness)

- Evaluation of monitoring tools and techniques (including SILVANUS UPs) in addition to the standard direct observation;
- Improvement of awareness related to fire events, engagement of young population involving schools, app to be used to indicate fire events.

Phase B (Detection and Response)

- Use of monitoring devices and techniques, such as sensors to be installed in the area and satellite data, to reduce intervention times after fire detection (the mapping of the pilot area using drones, the detection of a fire using drones and the IoT Gateway);
- Direct and computerized control and evaluation, in real time, of the intervention (the detection of a person in the forest using drones);
- Integration and assessment of SILVANUS UPs in a relevant environment.

Phase C (Restoration and Adaptation)

- Engagement of different stakeholders such as municipalities, external experts, public authorities, private landowners, to raise awareness and knowledge of post fire restoration actions in terms of regulatory processes and good practices;

- Analysis of three types of restoration (planting new trees in a burned area and monitoring their growth).

Therefore, the activities conducted by Gargano pilot during Periods #1 to #3 represent a comprehensive and strategic approach to advancing fire management across multiple dimensions, from Prevention and Preparedness (Phase A), Detection and Response (Phase B) to Restoration and Adaptation (Phase C). Some objectives were focused on soft aspects, such as awareness raising (Phase A) or stakeholders' involvement (Phase C), while others were dealing with the deployment of monitoring devices such as sensors and satellite data, coupled with advanced technologies like drone mapping and real-time intervention control using the IoT Gateway (Phase B).

The execution of the first trial period activities underscores the pilot's commitment to addressing fire management comprehensively, from prevention and preparedness through to detection, response, and eventual restoration. By engaging various stakeholders, utilizing cutting-edge technologies, and implementing adaptive strategies, the Gargano pilot demonstrates an effective model for resilient fire management systems. The success of these activities not only showcases the potential of SILVANUS technologies, but also sets a valuable precedent for future initiatives in the field.

3.6.4 Description of performed activities

In the week preceding the planned initiatives in the Gargano Park, Fincons set up the Dell EMC Edge AGateway 5200, hardware provided by Dell, at the ASSET offices (Figure 110).

Figure 110 – IoT Gateway at ASSET's offices

The necessary software for the Gargano Park test was installed and configured, the remote connection through the Silvanus VPN network and via TeamViewer was tested, and various test clips were recorded using FFMPEG. Finally, a final test simulating the installation of the Gateway in Gargano Park was performed.

Pilot activities in Gargano Park – 5th October 2023

On 5th October 2023, ASSET and FINCONS supported by the Civil Protection organized a day in Gargano to perform a series of practical tests in relation to aerial mapping with drones and detection of smoke and fire as well as the demonstration of SILVANUS UPs (i.e., UP4 and UP5). During the first trial period activities, the following steps have been completed:

1) Arrival and Setup
2) Area Mapping with UAV

3) Fire Detection with IoT Gateway and UAV (Lightning Torch and Smoke Grenade)
4) People detection with UAV

(1) Arrival and Setup

Arriving at the pilot area , it was decided to perform the tests in a specific zone a little more distant to the building providing the electrical power and internet connectivity to avoid any real risk of fire. However, this change of position of a few meters has presented new challenges. The building Wi-Fi signal was insufficient at the new location; thus, a cell phone hotspot was used to ensure a stable connection during operations (Figure 111).

Figure 111 – IoT Gateway setup during the Gargano Pilot

(2) Area Mapping with UAV

The mapping of the area was carried out with the help of the DJI Mavic Mini 3 drone, providing a detailed and comprehensive view of the area and its surroundings (Figure 112).

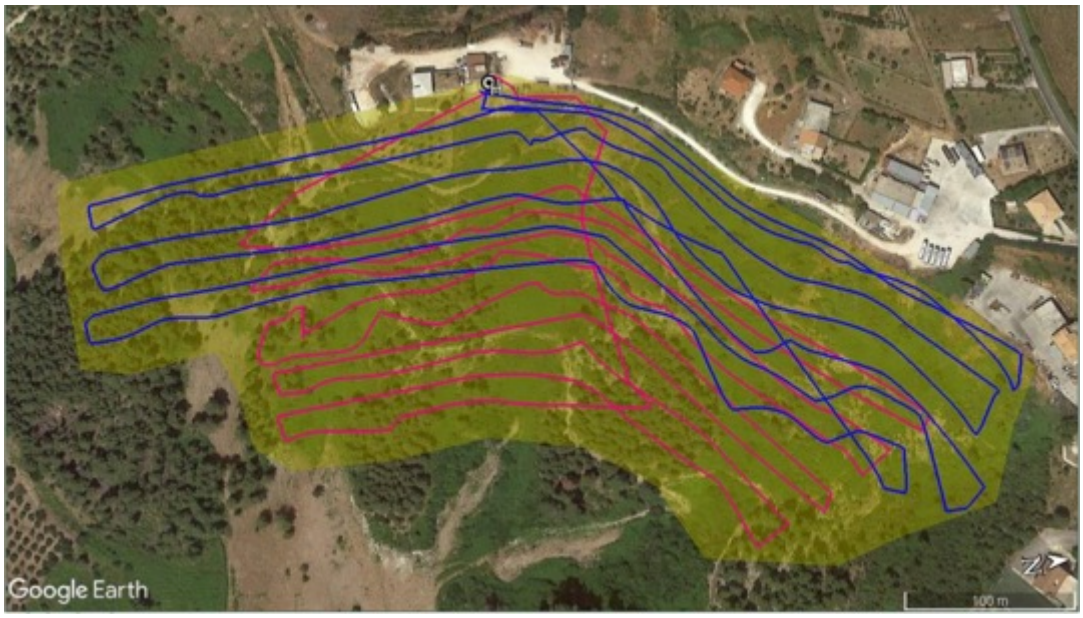

Figure 112 – Image of the trajectory used by the micro-drone to map the area

Subsequently, the extracted data were processed to create a 3D Point Cloud (Figure 113).

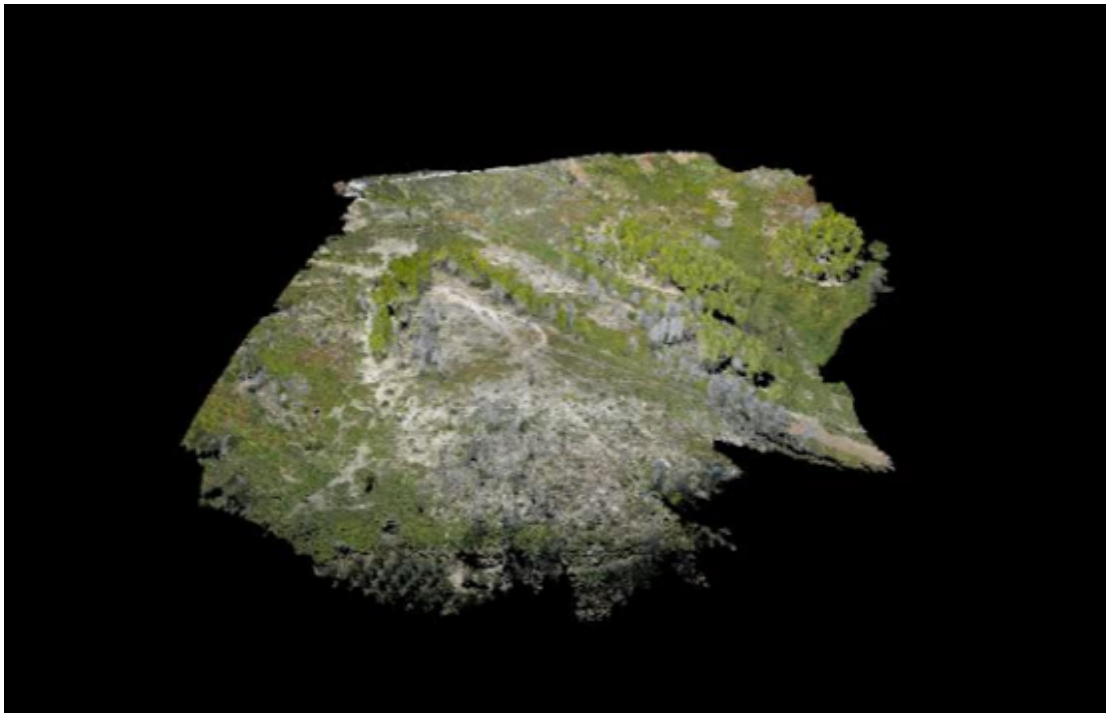

Figure 113 – 3D Point Cloud exported from the mapping

In the flight mission performed with the DJI Mini 3 Pro aircraft for the purpose of mapping the study area, 1127 images with 8064×6048 effective pixel resolution were acquired in about 40 min, covering an area of 11 hectares. The images were subsequently processed in Pix4DMapper in the 3D Maps - Rapid/Low Res mode in order to test the efficiency of the processes by simulating an emergency scenario. 98% of the images were calibrated and enabled for photogrammetric processing, returning a Mean Reprojection Error of 0.103 pixels. In terms of geometric accuracy, although no Ground Control Points (GCPs) were used for the purpose of direct georeferencing, the three-dimensional model was returned with an RMS Error (X,Y,Z) of (0.35, 0.51, 0.51) m based solely on the positioning inherited from the geo-tags of the processed images. A dense cloud of 3,926,853 points and a 3D Textured Mesh were returned in about 13 min, used as the

basis in order to process a Digital Elevation Model (DEM) and then the orthomosaic with Ground Sample Distance (GSD) equal to 2.66 cm/pixel in 17 min.

(3) Fire Detection with IoT Gateway and UAV

The 1080p camera (model ELP-USBGHD05MT-DL36), mounted on a tree (Figure 114), was placed at a height of 5 meters above the ground and was about 40 meters away from the area where the simulation was done.

Two simulations were conducted, namely Lightning Torch and Smoke Grenade. For each of them, the IoT Gateway was used to record video footage and the thermal camera drone (DJI Matrice 300 RTK + Zenmuse H20T) was used to identify the fire through temperature differences.

Figure 114 – The IoT Gateway webcam mounted on a tree

First test: Lightning Torch

The first test involved a lightning torch (Figure 115). Both the IoT Gateway and the drone recorded videos. However, the drone, equipped with a thermal sensor, recorded the ignition of the fire as a thermal variation.

Figure 115 – Torch Test recorded by the IoT Gateway

Second test: Smoke Grenade

The second test involved a smoke grenade (Figure 116). Like the first test, both the IoT Gateway and the drone recorded videos. The drone, equipped with a thermal sensor, was not able to observe thermal variations around the smoke.

Figure 116 – Smoke Grenade recorded by the IoT Gateway

(4) People detection with UAV

After these tests, the team moved to a nearby wooded area. Using the DJI Matrix 300 RTK equipped with a thermal camera (Zenmuse H20T), the area was mapped (Figure 24). Then a test was performed to verify if the drone was able to identify the presence of people in an area particularly dense with trees. Indeed, the drone was able to detect the thermal difference between the vegetation and the human body, thus demonstrating the effectiveness of the instruments in detecting people inside the forest.

Several images were acquired in the thermal band and in the visible range. The images are resulting georeferenced with accuracy <1 cm since they were acquired in Real Time Kinematic (RTK) mode based on

the permanent stations of the National Dynamic Network (RDN2008). Therefore, the resolution and quality of the acquisitions in the thermal and visible band are found to be directly dependent on the features of the sensor used and the flight height.

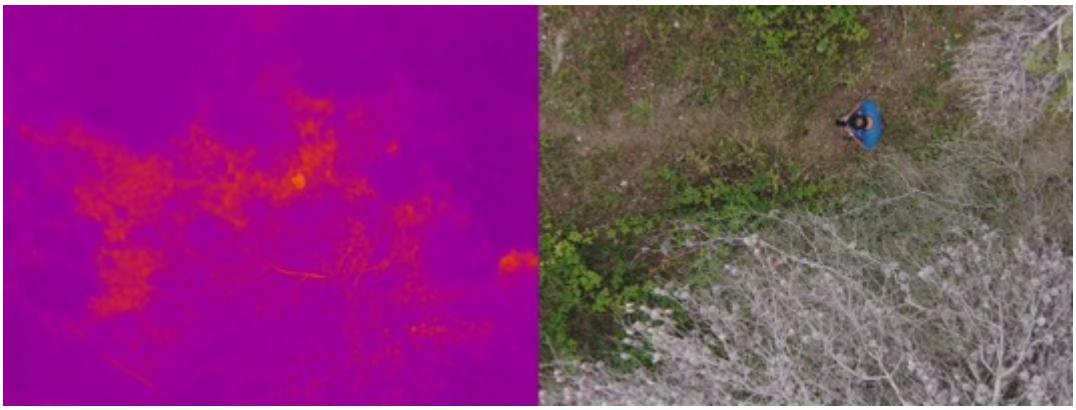

Figure 117 – Screenshot showing the footage taken by the drone with thermal camera (at left) and RGB camera (at right)

The inaugural trial period on October 5, 2023, marked a significant milestone for Gargano Pilot. Despite challenges such as connectivity issues and strategic adjustments, the team successfully executed a series of practical tests, showcasing the real-world application of innovative technologies. From aerial mapping using drones to simulated fire and smoke scenarios, as well as the demonstration of SILVANUS UPs, the activities exemplified the efficacy of the instruments in fire management. Notably, the tests involving IoT Gateways, thermal cameras, and UAVs highlighted the potential for quick and efficient fire detection and people identification within challenging environments. This successful demonstration sets a promising foundation for the continued evolution and implementation of advanced technologies in fire prevention and response strategies. The lessons learned from this initial trial period pave the way for further refinement and optimization of the systems, emphasizing the pilot commitment to enhancing overall fire management capabilities.

Italian pilot demonstration day – 13th October 2023

On 13th October 2023, a presentation of the results of the Gargano Pilot, held on 5th October 2023 in the Gargano Park, was held in the conference room of the Apulia Region. The event highlighted the collaboration between various stakeholder (i.e., Civil Protection and ARIF- Regional Agency for Irrigation and Forestry), focusing on their specific responsibilities and current projects, in order to highlight synergies and discuss the integrated fire management approach in SILVANUS. In addition, a significant contribution was provided by ASSET, reporting the activities carried out on training and engagement in schools as well as the activities performed with the drones. Specifically, the DJI Mavic Mini 3 was used to map the territory. That mapping was then processed to visualise the surface in 3D. Additionally, GPS data was collected to extrapolate the trajectory taken by the drone pilot. While a DJI Matrice 300 RTK was used to detect fires and people. This drone, equipped with a dual camera (RGB + Thermal), allowed the operator to record a video and, at the same time, detect the presence of a person in the forest. The data collected was shared across the project, allowing other partners to conduct tests and refine their software.

Civil protection explained their responsibilities in the management of disasters that it tries to contain, such as hydrogeological, seismic and forest fires and its role at EU level (i.e., European Civil Protection Mechanism). Different projects with possible synergies with SILVANUS were also presented. The possibility of a tabletop exercise in Croatia was discussed, as well as the possibility of accessing the data from the SINAPSI (Civil Protection) platform and to the data provided by the Carabinieri Forestali and the Police which, however, can only be partial due to legal reasons and possibly undergoing investigation (e.g., in the case of malicious fires).

Finally, each user product leader explained their contribution, detailing specific results achieved for the Gargano Pilot, as reported in the following section.

3.6.5 User product validation

The complete list of user products tested in Gargano Pilot is presented in Table 23, highlighting the UP description, as well as the outcome.

Table 23 - User products, Gargano National Park area, Italian pilot

Phase (A,B,C)	*Tested user product*	*Description*	*Outcome*
Phase A	**UP2 - Fire Danger Risk**	UP2 offers an accurate cartographic representation of the region under consideration, organized in a grid 2x2. Each grid cell reflects the level of fire risk through a specific staining.	UP2 has been integrated into the first Silvanus Dashboard from Fincons. The platform displays the detailed cartographic information provided by UP.2, organized in a 2x2 grid. The reference data, from the CMCC displayed on the map, with the appropriate shades as defined by the legend.
Phase B	**UP3 - Fire detection based on social media sensing**	UP3 represents a significant advance in fire management, leveraging social media readiness to gather information in real time. At the heart of this system is the analysis of X's (tweets), through which you identify reports or clues of possible fires.	UP3 has been integrated in the first Silvanus Dashboard from Fincons. UP3 in collaboration with the PUC leader produced 26 synthetic X's (Tweets) representing fire-related scenarios and generated two corresponding fire events. Those X's were used and uploaded to a X account to simulate fire reports in Gargano. The UP successfully crawled the X's and identified the location of the fire (GPS coordinates), the contents of the X's and the attached photos, and aggregated them in a detailed fire event report.

Phase B	**UP4 - Fire detection from IoT devices**	UP4 uses machine learning algorithms for real-time video analysis, automatically identifying and reporting fires. This solution uses state-of-the-art neural networks to detect patterns and thermal anomalies that indicate the presence of fire.	IoT Gateway was successfully deployed on site and tested the software for Fire and Smoke detection.
Phase B	**UP5 – Fire Detection from UAV**	UP5 provides a system for the planning of flight paths optimized for drones allowing full scanning of the area of interest, generating paths that ensure complete coverage of the surface.	The drone successfully executed the trajectory created on site by the pilot to completely map the surface.
Phase A, B	**UP6 – Fire Spread Model**	UP6 offers a solution to understand and monitor in detail the spread of fires.	UP6 has been integrated into the first Silvanus Dashboard from Fincons. The simulation was generated from the selected coordinates at the area of the Gargano National Park.
Phase A, B	**UP8a - Citizen's engagement programme and mobile App**	UP8 allows users to report fires in real time. With automatic geolocation, the app records the exact coordinates of the user and location of the fire. Users can enrich the report with photos and an alert message.	UP8 product has been integrated into the first Silvanus Dashboard from Fincons. The fire reports, sent by users using the Citizen Engagement app, were successfully collected and displayed in real time on the Silvanus Dashboard.
Phase A	**UP8b - Citizen's engagement mobile application/ Situational Awareness and Information Sharing**	Public awareness campaign through knowledge diffusion	UP8 has been carried out by ASSET organizing short courses in 3 schools in May 2023 in collaboration with Civil Protection, one 16-hour training course addressed to Civil Protection volunteers will take place in November 2023

Briefly, the user products tested in the Gargano National Park area during Phases A, B, and C of the Silvanus project have demonstrated substantial advancements in fire management capabilities. In detail the following results were achieved and presented during the Gargano Tabletop exercise.

UP2 – Fire Danger

The user product "UP2 – Fire Danger" reports data from CMCC about the Fire Danger Index. The grid has a size of 2 km x 2km and is coloured to reflect the level of Fire Danger Risk: Extreme, Very High, High, Moderate, Low and Very Low. With the data of the Gargano National Park, CMCC will be able to reduce the scale of the grid to squares of 500m x 500m.

The data was integrated into the first Silvanus Dashboard from Fincons. This dynamic map (Figure 118) allows users to activate or deactivate information layers based on time intervals, facilitating the analysis of risk trends over time.

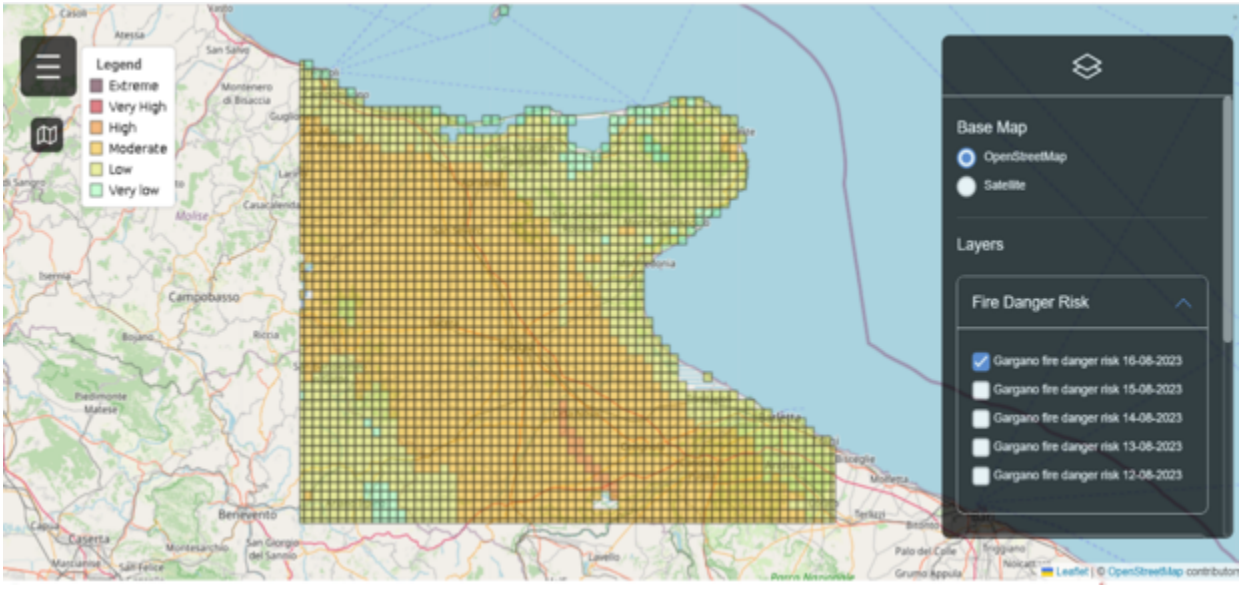

Figure 118 – Fire Danger Risk page on Fincons WEB-GIS Dashboard

UP3 – Social Media Sensing

CERTH demonstrated the pipeline used for capturing, aggregating, and displaying tweets reporting a fire. The system crawls X's API (or posts on a Facebook group, or a particular website). If it detects potential reports, based on certain keywords, they are captured and unpacked (date, location, tweet text). Once this is done, the reports are aggregated and analysed. Those marked as real are then forwarded to the SILVANUS Cloud, which allows the WEB-GIS to display them on the map (Figure 119).

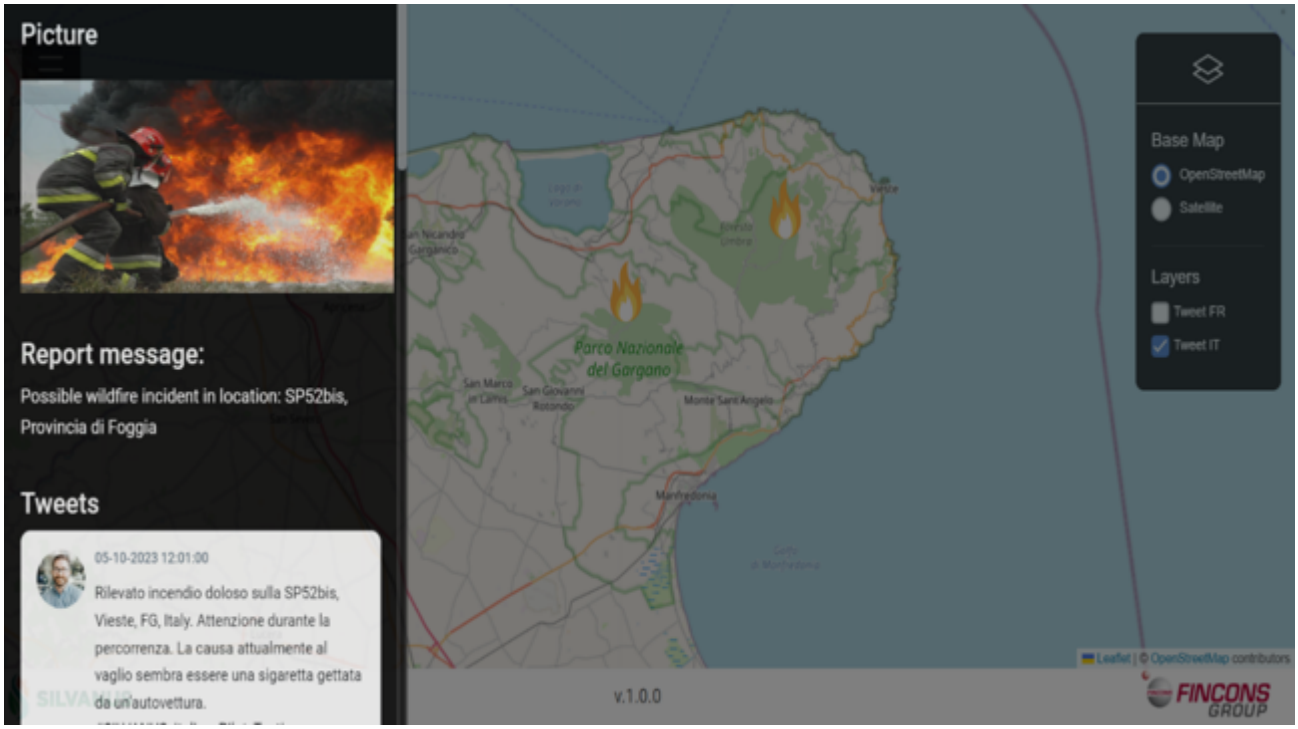

Figure 119 – Social Media Sensing page on Fincons WEB-GIS Dashboard

UP4 – Fire Detection from IoT Devices

The on-site recordings taken by the IoT Gateway were analysed by the Machine Learning algorithm developed by CATALINK. The analysis of the video correctly detected the smoke in both tests (lightning torch and smoke bomb) done in the park (Figure 120 and Figure 121).

Figure 120 – Frame extracted from the lightning torch test video analysed by CATALINK algorithm

Figure 121 – Frame extracted from the video of the test with the smoke bomb analysed by CATALINK algorithm

The algorithm can also be run on machines that are less powerful than DELL's EMC 5200. For example, CATALINK has built a small Gateway using a Raspberry Pi equipped with a GPS antenna, an RGB Camera and a smoke sensor (Figure 122). The whole set is fitted inside a 3D printed case that can be mounted on a tree. The CATALINK's setup with the Raspberry Pi will be tested in future pilots.

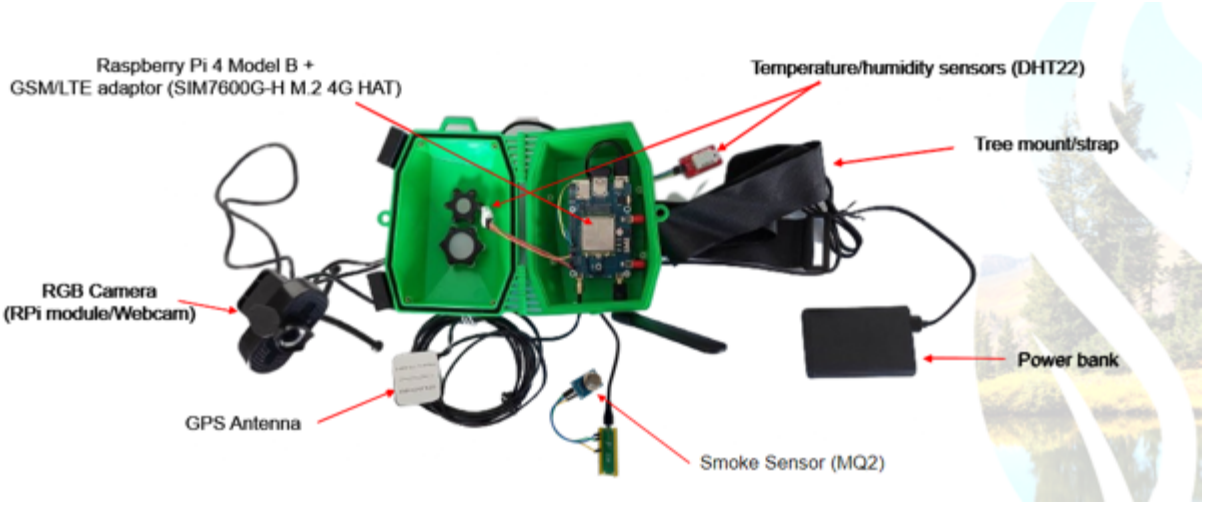

Figure 122 – IoT Gateway made by CATALINK with a Raspberry Pi

UP5 – Fire Detection from UAV/UAG

THALES demonstrated its software that, given an area to be scanned, returns one or more trajectories that the drones can make to map the surface completely and efficiently. These trajectories can be exported in a file that has the same characteristics as the files exported by DJI drones.

UP6 – Fire Spread Model

The Fire Spread Model developed by EXUS was evaluated over an area agreed by ASSET and Fincons. That area was selected because it is relevant in terms of nature, landscape, and culture with a limited or non-existent degree of urbanisation.

The simulation results obtained by the model were subsequently integrated into the first Silvanus Dashboard from Fincons (Figure 123).

From the interface, it is possible to select one of the available layers and, for each of them, it is possible to visualise how the fire will propagate over time using the time dimension bar in the bottom left corner.

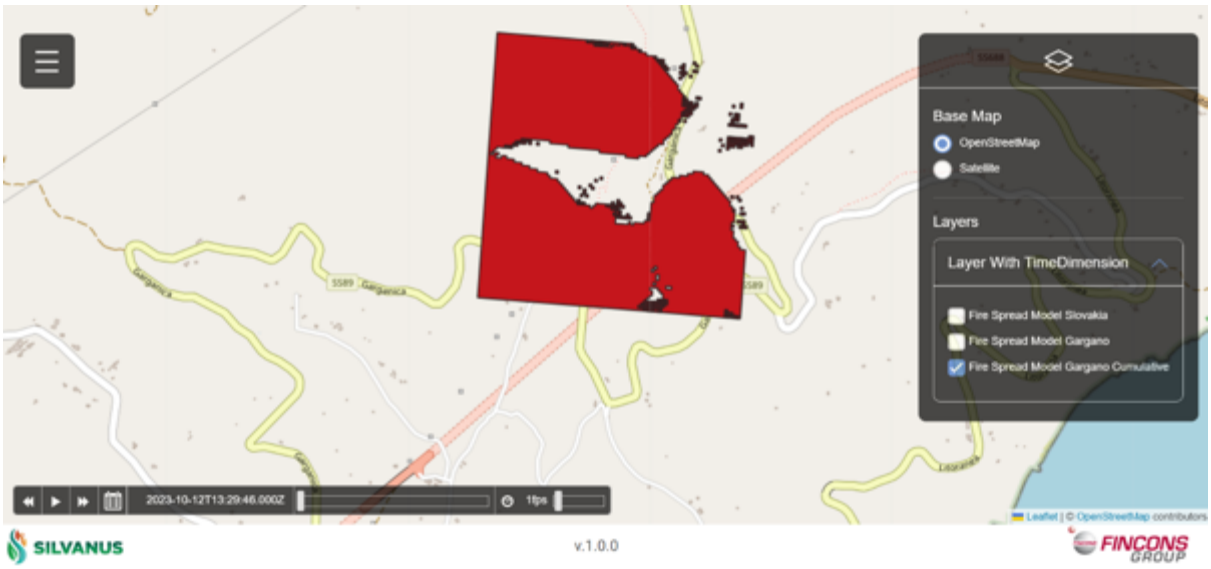

Figure 123 – Fire Spread Model page on Fincons WEB-GIS Dashboard

UP8 – Citizen's engagement programme and mobile app

The UP8 User Product provides citizen involvement through mobile apps. Fire reports made by users through the mobile application developed by UISAV are forwarded to EMERPOLL, a framework that manages and aggregates reports. We have verified that the generated report of the mobile application is sent to the Silvanus cloud, which allows you to view it on the map of the Dashboard (Figure 124).

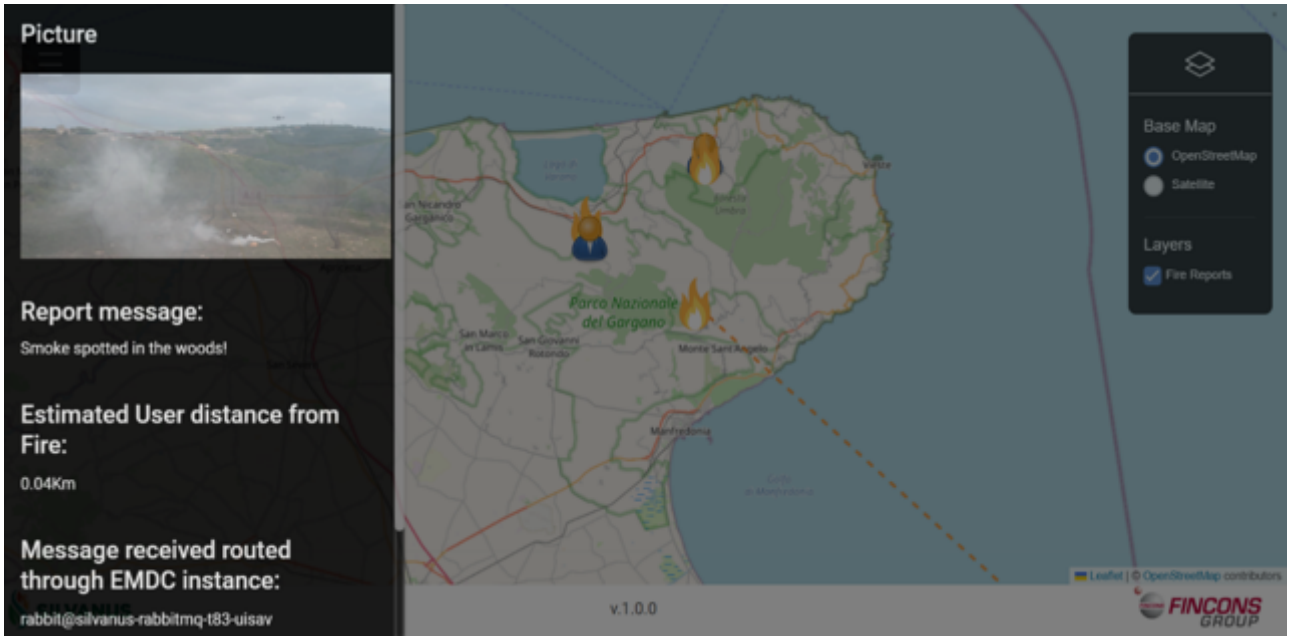

Figure 124 – Fire Reports page on Fincons WEB-GIS Dashboard

3.6.6 Strategic and operational challenges

During the tabletop exercise held on 5th October 2023, the main challenges encountered were rather operational. The first challenge was related to the deployment of the EMC IoT Gateway on field:

- The EMC 5200 is not Waterproof/Dust proof/Moisture proof so the location of the EMC 5200 must be in a dry place, protected from rain and weather.
- The power supply may be away from the final location of the Gateway.

- The length of the USB Webcam cable may not be sufficient to cover the distance from the Gateway to the camera location, as the USB 2.0 specification states that the maximum theoretical length is 30 meters. In the event of a longer length, you could opt for an IP Webcam powered via Power Over Ethernet, with a cable length of up to 100m.
- Internet connection: Although the EMC has several Wi-Fi antennas, a wired connection should be considered, as the wireless connection can be affected by atmospheric conditions such as rain or intense heat.

The second challenge was related to the integration of the different technologies and their use. Wireless sensors for early detection of fires were replaced by a USB camera connected to the gateway. The software was not running onboard the gateway to perform stream analytics using edge computation and it does not provide awareness about eventual limited processing power.

The third challenge was coordination between partners. The trajectory map to be executed during the pilot was awaited by TRT. Due to a lack of communication, the previously simulated navigation route maps were not used. However, some route maps were created on site with the drone pilot.

The fourth challenge is related to the timing of the project. The restoration activity of the chosen trees needs to be carried out at an appropriate time of the year (autumn) for it to be effective. This clashes with the execution priorities of the pilot's other tasks.

In conclusion, the main operational obstacles were related to:

- Deployment of EMC IoT Gateway, such as Waterproof/Dustproof/Moisture proof limitations, Power Supply Distance, USB Webcam Cable Length, Internet Connection Reliability.
- Integration of Technologies, such as replacement of Wireless Sensors.
- Coordination Between Partners reflected into Trajectory Map Delays.
- Timing of Project Activities regarding the optimal timing for the restoration activity, which clashed with the execution priorities of other pilot tasks.

However, despite some operational challenges, the first trial period highlights the relevancy of implementing cutting-edge technologies in real-world scenarios, emphasizing the importance of adaptability, coordination, and strategic planning to address potential challenges effectively.

3.6.7 Planning of 2024 pilot activities

In 2024 it is envisaged to organise and execute a large-scale pilot in Gargano, which will include a second round of demonstration of the UPs already demonstrated in 2023, and a selection of new UPs that has not been tested in this first round (e.g., UP7, which will be tested during the field exercises to be carried out) as well as new UPs that may be developed, enriching the UPs offering of the SILVANUS platform.

Figure 125 presents the scheduled timeline of the planned activities.

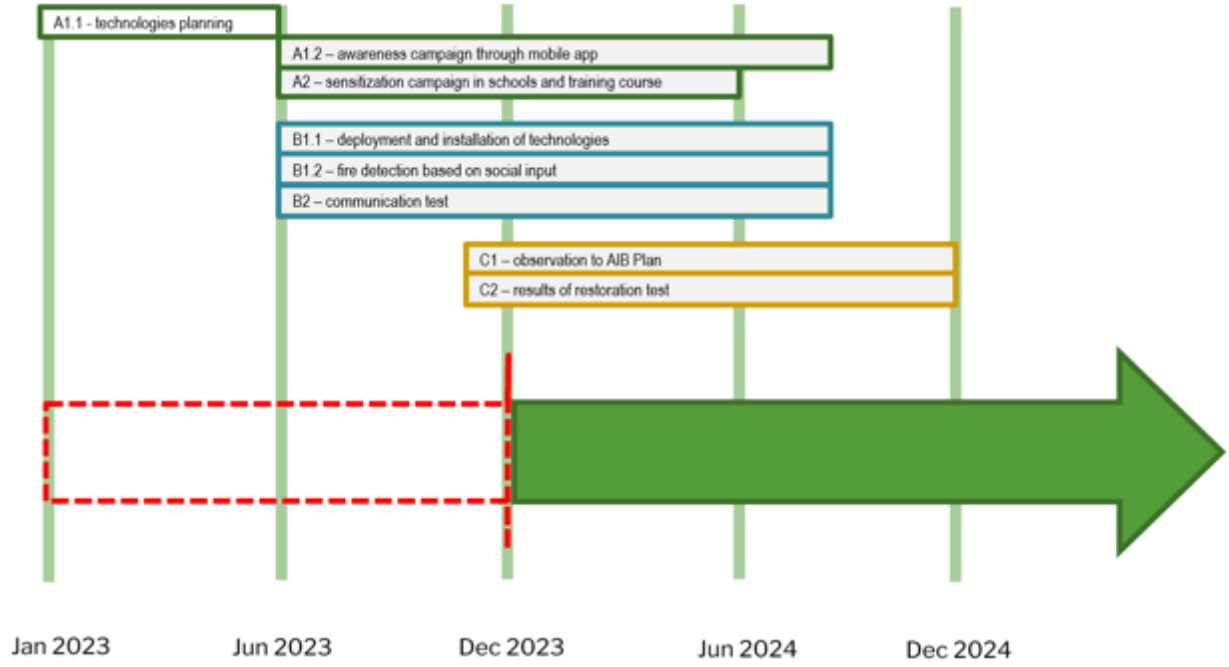

Figure 125 – Scheduled timeline of planned activities for 2024 in Italian pilot 2

Specifically, the following activities are planned:

- **November 2023** (M26) – planting among three different typologies of trees in an already identified burnt area, in order to monitor resilience parameters.
- **December 2023** (M27) – organisation of one 16-hour training course addressed to Civil Protection volunteers.
- **December 2023 (**M27) – starting of tree planting and definition of the observations at the restoration phase to be included in the AIB Plan.
- **April 2024** (M31) – setting up and installing the HW/SW equipment for the final pilot demonstrator in real-world scenario, in coordination with FINC and the other technology providers.
- **April 2024** (M31) – delivery of no.2 courses in schools in collaboration with Civil Protection for citizen involvement in the use of mobile applications for situational awareness and information sharing.
- **October 2024** (M37) – organisation of a one-day inspection with the Consorzio di Bonifica Montana del Gargano to verify the growth of the plants that were planted.

3.6.8 Conclusions

During this first round of pilot in Gargano the integration of different SILVANUS UPs was successfully tested and the effectiveness of different technologies (e.g., drones and IoT Gateway) on site was demonstrated.

The results were presented to the project partners and local stakeholders such as Civil Protection and the Regional Agency for Irrigation and Forestry. Details can be found on the Silvanus project LinkedIn channel (www.linkedin.com/feed/update/urn:li:activity:7140017431749578752) and in the October News section of the institutional website http://asset.regione.puglia.it

Moreover, different activities were carried out with respect to training of Civil Protection volunteers and seminars and serious games have been held in schools to engage students and raise awareness on wildfires. From a technical point of view, the expectation was having a near real-time detection of fire events, from ignition (i.e., light smoke) to flame burning (i.e., fire) by using embedded vision on the edge. After the first test, useful images to train the AI algorithms offline were collected. The results obtained by the different

algorithms range from the identification of fire and smoke with a lower accuracy (Fincons PoC) to a higher accuracy (CTL).

During the pilot and specifically in evaluating the deployment of the IoT Gateway some key improvements areas were identified, that will be considered during next year activities:

- **Hardware protection**: It was noticed that the EMC 5200 requires additional protection against moisture and dust. It should be considered installing a cabin with an adequate level of protection.
- **Power supply**: It is important that the power source is located near the Gateway. It may be useful to consider using longer power cables or remote power solutions.
- **Webcam Cable Length**: It is essential to determine the precise distance between the webcam and the Gateway. If it exceeds 30 meters, it is recommended to consider alternatives such as an IP webcam with Power over Ethernet (PoE) to overcome the USB cable length limit.
- I**nternet connection**: We found inadequate Wi-Fi reception. To ensure stable connectivity, especially in adverse weather conditions that may affect the wireless signal, a wired connection should be considered.

Furthermore, the coordination among the technology providers and the provision of a unified SILVANUS platform are envisaged.

The plan for mitigating the potential challenges concerns the following activities:

- To schedule in advance back-up plans related to field operation that may be partially simulated (e.g., ignition and extinguishing of fire).

In what concerns the changes regarding 2024 pilot activities (comparative with the initial plan), Italian pilot 2 only includes the (partial) simulation of some fire fighting activities on the field.

3.7 Greece Pilot

During Phase-1 of the SILVANUS pilots (trial periods M19 to M26) in Greece two main different activities took place. HRT organized a Citizen Engagement workshop in Thessaloniki (Northern Greece) on 28 June 2023 and PSTE, the Greek pilot leader, organized one Table-Top exercise (TTX) in the main pilot area in Chalkida (capital of Evia island) on 30 October 2023.

The TTX is considered to be the main pilot event in Greece, although the citizens workshop is also of great importance in raisins citizens' awareness of wildfires.

3.7.1 Citizen Engagement workshop in Thessaloniki, Greece – 28th June 2023

A few months before the planned TTX of the Greek pilot, a workshop was organised by HRT as part of Phase A.

The workshop was held in the Municipal Hall of Thessaloniki (Greece), was attended by 95 participants (Figure 126) and served as a hub for discussion on forest fire prevention. Key participants included representatives from the Fire and Forestry Services, who enriched the discussions with expert insights. Representatives from civil protection, voluntary groups and the 383 Aerial Firefighting Squadron also attended, demonstrating a unified commitment to protecting the region. Their diverse expertise and collaborative spirit emphasised a multi-agency approach and laid the foundations for a stronger, integrated forest fire prevention strategy in Northern Greece.

Figure 126. Citizen engagement workshop in Thessaloniki – June 2023

The main objectives of the Thessaloniki activity are summarised below:

- To inform participants about the causes and consequences of forest fires.

- To provide knowledge on strategies and techniques to prevent forest fires, including good land management practices, fire-resistant landscaping, controlled burns, early detection systems and community involvement.
- Encourage community involvement and foster a sense of responsibility among residents, landowners and stakeholders.
- To showcase advances in SILVANUS technologies and innovations that assist in the early detection, monitoring and suppression of forest fires.

The workshop agenda (Table 24) included presentations by invited speakers and an interactive workshop, which was the result of collaboration between Boras University, MDS and HRT.

Table 24. Agenda of the Thessaloniki citizen engagement workshop.

Time	Topic	Presenter
18:00-18:15	Welcome and Introduction	Iosif Vourvachis, HRT Vasilis Moisidis, Civil Protection of Thessaloniki
18:15-18:45	Forest fire prevention projects in the peri-urban forest of Thessaloniki	Dr Peri Kourakli, Thessaloniki Forestry Department
18:45-19:05	Silvanus Project in a nutshell	Mr Iosif Vourvachis, HRT
19:05-19:20	Social Media Sensing	Aris Bozas, CERTH
19:20-19:30	Break	
19:30-19:50	Citizen Engagement Program and App	Eleni Kotali, MDS
19:50-20.30	Open discussion – Citizen Engagement Workshop	Eleni Kotali, MDS
20.30-21:00	Ways of preventing and responding to forest fires and pilot activities	Christos Papachristos, Fire Service

During the interactive workshop, the audience was presented with three realistic scenarios drawn from previous operations and asked to respond via Slido to measure emergency response strategies. All data collected was translated by HRT and sent to Boras University for in-depth analysis, contributing significantly to the understanding of citizen engagement.

Key questions for discussion were:

- How can citizens be effectively informed about the risks and possible fire incidents?
- What methods can be used to raise awareness and ensure that the information reaching citizens is timely and accurate?
- What kind of training programmes and educational materials would be useful to provide citizens with the necessary skills and knowledge to prevent and respond to fires?
- What do you think could increase citizens interest in the environment and forests?

These sessions were followed by a presentation from the Hellenic Fire Service, focusing on advanced forest fire prevention strategies.

The workshop demonstrated how the SILVANUS project can increase community participation and improve fire management strategies. Workshop participants were very enthusiastic about both the workshop and the SILVANUS project, recognising significant value in the user products and citizen engagement discussions facilitated through Slido. Through Slido, participants contributed diverse viewpoints, fostering an inclusive conversation among stakeholders on important aspects of forest fire management.

Several key conclusions emerged from the in-depth discussions at the workshop:

- Digital applications and social media platforms offer innovative ways for citizens to actively participate in forest fire management, transforming them from passive spectators to active contributors.

- Social media has become a powerful tool for disseminating real-time information on fire incidents, evacuation procedures and emergency response, enabling faster and more effective action.

- While technology helps with early detection, preparedness remains a critical aspect. Educating citizens about fire safety measures and developing clear protocols for action during fire emergencies were highlighted as essential.

However, several challenges were identified during the Thessaloniki workshop:

- The workshop highlighted the need for mechanisms to verify and validate information shared on social media platforms during fire incidents to avoid misinformation and panic.

- According to the participants, ensuring seamless coordination between citizens, authorities and the different actors involved in fire management remains a challenge that requires structured protocols and communication channels.

In conclusion, by addressing these challenges and harnessing the power of collaboration, communities can play a key role in minimising the impact of wildfires.

The event was covered and promoted by national media.

3.7.2 TTX - Impact of wildfires across Sterea Ellada

3.7.2.1 Pilot area description

The SILVANUS pilot area for Greece is the island of Evia, and more specifically its northern part and parts from the center of the island due to its characteristic mountainous area of Dirfy, which is the highest peak (1743m) of the island (Figure 127).

Evia is the second largest island in Greece and is located in central Greece. Administratively it belongs to the Region of Sterea Ellada. It stretches along the northeastern coast of Attica, separated to the north and south by the Gulf of Evia, which is narrowest at the central part of the island. Here the island is connected to the continent by a paramental bridge that leads directly to the town of Chalkida. The eastern coasts of the island are in the Aegean Sea, while the western coasts are in the Gulf of Evia.

In terms of administrative boundaries, there are three municipalities in the pilot area: the municipality of Istiaia-Aidipsos, the municipality of Limni-Mantoudi-Ayia Anna and the municipality of Dirfys-Messapion. The core of Northern Evia is the area belonging to the municipalities of Istiaia-Aidipsos and Mantoudiou-Limnis-Ayias Annas. Due to the fact that within the boundaries of the municipality of Dirfys-Messapion is the mountain of Dirfys, which has a significant ecological value for the whole island of Evia (protected forest area with dense forest and local species of flora and fauna) and the fact that it is still unburned, the GR partners decided to extend the pilot area of Northern Evia to include the municipality of Dirfys-Messapion, in particular the part of the mountain of Dirfy.

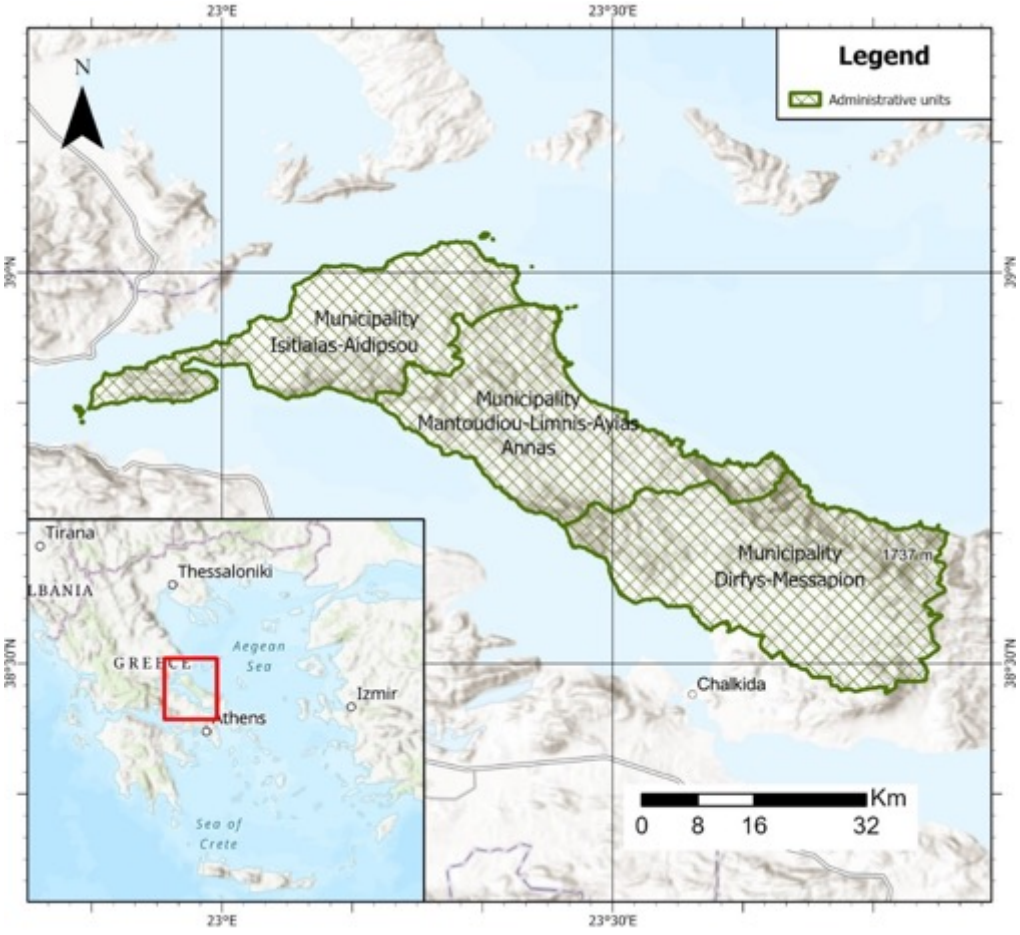

Figure 127. Administrative boundaries of the SILVANUS Hellenic pilot area (North Evia)

The typical fire season lasts from the beginning of May to the end of October each year. The prevailing winds, especially in summer, are N-NE, while summers are typically Mediterranean, with maximum temperatures that can exceed 40° C. At lower altitudes, the vegetation in Evia is mostly coniferous, with *Pinus halepensis* being the dominant species. Above 500 m there is a mixture of coniferous and deciduous trees. More information on the fire regime can be found in SILVANUS deliverable D2.1.

The pilot as it was planned to be a Table-Top exercise with the code name "Pilot- Evia 1" it was conducted in the capital of Evia, in the premises of the Region of Sterea Ellada, easily accessible to all local stakeholders as well as to the SILVANUS partners, especially to those travelling from abroad.

3.7.2.2 Participating stakeholders

During the TTX in Chalkida several partners of SILVANUS as well as external stakeholders, mainly local ones, participated. The SILVANUS partners were either the organizers and supporting partners to TTX or the technology providers as well as the main evaluators. These are presented in Table 25 along with their respective roles. The external stakeholders were divided into players and observers and are presented in Table 26.

The **players** or trainees are the representatives of the following services/agencies: The players of the exercise are defined as the staff/representatives of the participating services involved in the emergency situation described in the scenario (local Hellenic Fire Service, Hellenic Police, Civil Protection, local Municipalities, Forest Agencies, local critical infrastructure, antiquity agencies, volunteer teams). The players should inform the participants, according to the flow of information and according to their competence, in order to deal with the situations presented to them in the scenario as realistically as possible, as they would do if the presented situation were real. The players should be familiar with the structure of the civil protection system and the emergency plan of their agency.

Observers are the representatives of the following services/agencies: Observers are defined as persons who follow the progress of the exercise. They have been invited by the service organising the exercise, either for training purposes, to disseminate the exercise or to supervise the trainees. They are nominated by the participating services.

Table 25. SILVANUS partners participated in the TTX and their role.

Stakeholder	*Activity Engaged*	*Role*
PSTE	TTX in Evia (2023)	Host & trial owner. Organizer & participation in CEP activities.
VTG	TTX in Evia (2023)	Technology provider, development & evaluation of UP7 Biodiversity profile mobile application
KEMEA	TTX in Evia (2023) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Participation in CEP activities, UP3, UP4, UP6, evacuation module and system modules.
AUA	TTX in Evia (2023) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP6. Estimate soil erosion and run-off related to restoration phase.	Evaluator of system modules Evaluation of NDVI and other forest restoration and resilience metrics Soil rehabilitation monitoring
HRT	TTX in Evia (2023) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of evacuation module	Participation in CEP activities
CERTH	Development & testing of UP3	Technology provider, development & evaluation of UP3
AMIKOM	Development & testing of UP6	Technology provider, development & evaluation of UP6 PHACE C OPEN FOREST MAP
EXUS	Development & testing of UP6	Technology provider, development & evaluation of UP6

UTH	Development & testing of health assessment and evacuation modules	Technology provider, development & evaluation of health assessment and evacuation modules
CATALINK	Development & testing of UP4	Technology provider, development & evaluation of UP4 Fire detection from IoT devices
EVIDEN	Development & testing of UP4	Technology provider, development & evaluation of UP4 Fire detection from IoT devices
UISAV MASIVE DYNAMIC SWEDEN	Development & testing of UP8	Technology provider, development & evaluation of UP8 Citizen's engagement programme and mobile app
TRT	Development & testing of UP5	Technology provider, development & evaluation of UP5 Fire detection from UAV/UGV
SGSP	First reposnder of SILVANUS	Responsible for the evaluation schema and the evaluation of the pilots with the contribution of all partners.

Table 26. External stakeholders participated in the TTX and their respective role.

Stakeholder	***Activity Engaged***	***Role***
Local Firefighters ***(Hellenic Fire Service)*** ***Administration of the Fire Department of Evia*** ***Fire Department of Istiea***	TTX in Evia (2023)	*Players, contribution to the evaluation of SILVANUS*
General Police Directorate of Central Greece	TTX in Evia (2023)	Players, contribution to the evaluation of SILVANUS
Directorate of Forests of Evia & Viotia	TTX in Evia (2023)	Players, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation module, health module and additional modules)
Municipality of Istiaia - Edipsos	TTX in Evia (2023)	Players**,** contribution to the evaluation of SILVANUS
Voluntary Groups **Volunteer Group O.E.D.D. "CATRACE"**	TTX in Evia (2023)	Players, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation

O.E.D.D. "AM. ARTEMIS" OH F.E.T.E.S. (ERETRIAS		module, health module and additional modules)
Istiaea Forestry	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Lake Forest Department	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Aliveri Forestry	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Forestry Department of Thebes	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Infantry School	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
National Emergency Center of Evia	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Public Electricity Company - Chalkida Region	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Municipality of Chalkida	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Municipality of Eretria	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Municipality of Distomo - Arachova - Antikyra	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Municipality of Thebes	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Chalkida Port Authority	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Edipsos Port Authority	TTX in Evia (2023)	Players, contribution to the evaluation of SILVANUS
Kymi Port Authority	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Ephorate of Antiquities of Evia	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
Ephorate of Antiquities of Boeotia	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS

Regional Civil Protection authorities **Civil Protection of Evia** **Civil Protection of Fthiotida** **Civil Protection of Fokida** **Civil Protection of Boeotia** **Civil Protection of Evrytania**	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS
E.D.D. SHARE **SEDDE LIMNIS** **Prokopio Volunteer Group** **Rescue Team of N. Evia**	TTX in Evia (2023)	Observers, contribution to the evaluation of SILVANUS

Prior to the implementation of the exercise, PSTE shared a guide for the upcoming TTX providing information to the participants, about the logistics of the exercise (place, agenda, administrative issues) as well as information of the area and the phenomenon of wildfires in Evia, the objectives of the exercises, the planning, conduct and evaluation team.

3.7.2.3 Objectives

The main and overall goal of the Greek pilot entitled with the code name "Pilot – Evia 1" was to bring the SILVANUS platform in an operational environment pointing out the technological and operational challenges, and consequently to be tested, validated, evaluated and improved under an operational framework by the end users (firefighters, civil protection, foresters, etc.). Exercises, in general, are a great tool to examine processes, guidelines, tools, and other functions of emergency services and of the whole disaster management system. As a first step, the TTX offers many opportunities to test a system that is under development.

Thus, the TTX was designed in a way to test all phases (Phase A-Prevention, Phase B-Response, and Phase C-Restoration) through a realistic scenario with the participation of all the services involved in a case of a wildfire (pre-, during and post-fire).

In particular, the specific objectives are:

- To test and demonstrate the SILVANUS platform as an operational tool in real-life situations.
- To test and demonstrate individual modules of SILVANUS and specifically the following:
  - The social media sensing (UP3) as an early warning fire detection tool and monitoring of the evolution of the fire.
  - The detection from IoT devices (UP4).
  - The use of UAVs/UGVs (UP5) for detecting wildfires and planning of response measures.
  - The use of fire spread forecast (UP6).
  - The Biodiversity application (UP7) as a tool for prevention and monitoring of restoration.
  - The use of citizen mobile application (UP8) and training program as a whole.

- To showcase the SILVANUS Decision Support System (DSS) and get relevant feedback from first responders.
- To build the SILVANUS platform in the way that conforms to integrated fire management approach by requiring specific feedback from the end users.
- To support the process of a cultural shift towards tolerance, resilience and risk mitigation.
- To examine the acceptance level of SILVANUS from a community that has been significantly affected by wildfires.
- To identify areas of improvement.
- To enhance training of local stakeholders through SILVANUS activities.

3.7.2.4 Activities and execution

A brief overview of the activities performed is provided in the agenda of the TTX, which had been with the participants prior to the exercise (Table 27).

Table 27. Agenda of the TTX held in Chalkida on 31 October 2023.

AGENDA OF GREEK PILOT «EVIA 1» ***Tuesday 31/10/2023***	
TIME	***ACTIVITY***
09:30 a.m - 10:00 a.m	***Arrival – Welcome coffee - Arrangement of participants***
10:00 a.m. - 10:10 a.m.	***Greetings***
10:10 a.m. - 10:30 a.m.	***Introduction*** ***- Ms. Roula KECHRI*** ***Regional Advisor for European Programs & International Relations*** ***- Mr. Konstantinos MELETIS*** ***Head of the Environment Department of Perifereia Stereas Elladas*** ***- Mr. Krishna CHANDRAMOULI*** ***Technical manager of the European Horizon SILVANUS Program***
10:30 a.m.	***TABLE-TOP EXERCISE****
10:30 a.m. - 11:55 am.	***Part I: Phase I (Prevention) - Phase II (Response) -Scenario Analysis*** ***Introduction & Coordinator: Mr. Polyzos ZOIS, Head of the Civil Protection Department***
11:55a.m. - 12:00a.m.	***BREAK (coffee etc available all-day long within the hall)***
12:00 a.m. - 1:30 p.m.	***Part II: Continuation of Phase II (Response)***

	Scenario Analysis ***Phase C (Rehabilitation)***
1:30 p.m.-2:00 p.m	***LIGHT LUNCH BREAK***
2:00 p.m - 3:00 p.m	***Table-top Exercise Concluded remarks - Discussion & Evaluation **** ***Interventions-presentations of the digital applications developed under the SILVANUS program to the potential users***

A realistic scenario was used as a basis for the discussion for SILVANUS platform and its products (Table 28). The scenario of the exercise is based on the "Scenario Evia-1" which was presented in deliverable D9.1 with some simplifications and adaptations to the time of the TTX and data related specifically to the pilot area. SILVANUS capabilities were demonstrated to the players to showcase the support that SILVANUS can offer and the improvement in prevention and firefighting. Soil protection and forest restoration measures was also be discussed. In addition, technology owners, either live or remotely, demonstrated the technological tools offered by SILVANUS.

The exercise manager gave room for discussions between the participants and the various incidents. Specific questions related to operational challenges for response phase, but also for prevention and restoration activities were discussed. During the narration of the scenario, the exercise manager (PSTE) asked questions to the players about their reaction to each phase of the wildfire event. In parallel, there was also a dialogue between the authorities regarding the coordination between them (Figure 128 and Figure 129). The UPs that have been demonstrated during the execution of the TTX are presented in Table 28, providing a short description of each one and their outcome from the tests.

Table 28. Scenario description used for the TTX in Chalkida.

Time steps	Scenario description
Background information - Phase A Prevention	It is the year 2023 with a hot summer prevailing in Greece. May and June 2023 were characterized by normal temperatures and a typical summer situation in Greece. However, July is a hot month with many days of above average temperatures and the average temperature is +1.5 above average across the country
	[discussion]: Preventative measures taken before the fire season by local authorities and the Greek fire brigade
	As a consequence of the heatwave, a fire broke out in the southern Peloponnese on August 3. On Saturday, August 5, at 12:30 p.m., the General Secretary of Civil Protection issues and sends to the relevant Services the daily fire risk forecast map for August 6, where areas of Attica, Eastern Central Greece and the Peloponnese are classified in category (4) (i.e., very high fire risk). Also, areas of the Eastern Aegean are classified in category (5) i.e., in a state of alert.
	[discussion]: Preparedness phase. How do local authorities and the Hellenic fire brigade operate under these conditions? Are there specific measures taken under the Greek legislation?
Phase B Detection and Response	It is Sunday, August 6 at 12:00 pm when a tourist calls the European Emergency Number 112 and reports in English that he spots smoke over a dense forest area in the mountains of Edipsos.

	[discussion]: What are the actions taken? How the Greek fire brigade was informed about the incident (from Central to local fire brigade station) and what are the first steps in the organisation of the hole operation.
	At 12:01 p.m. the 100 call center of the Hellenic Police receives a call from a citizen near the community "Kastaniotissa" of the Municipality of Istiea - Edipsos, who sees black smoke in the forest. At the same time, the Fire brigade Command Center is notified by the local fire station that smoke is observed in the same area south of the community "Taxiarchis" of the Municipality of Istiea - Edipsos.
	At 12:05 p.m., at the number 199 of the Fire Department receives a call from a citizen of the community "Galatsades" of the Municipality of Istiea - Edipsos who works in the forest (just south of the village) stating that he smells strongly burnt wood.
	[discussion]: Actions from emergency units and civil protection
	Due to the very high degree of fire risk, the aerial patrol of the Fire Service has been activated, which supervises the area of Pagasitikos Gulf and northern Evia. Crews are detecting smoke south of Istiea and east of Edipsos, indicating that there is an active fire front which due to the topography is in its initial stage. The leader is instructed to attempt a drop which is successful. However due to the terrain it has not been possible to contain the expansion of the fire. At this point it is not clear whether one or more fire fronts are active and how big they are.
	At 12:45 p.m. local residents, municipal officials of Istiea - Edipsos and local emergency services arrive at the site. Airborne firefighting means will not arrive soon due to the difficult situation that continues to develop in the Southern Peloponnese. Two minutes later it is clear that two independent fire fronts are active in their initial stage.
	[discussion] Who is responsible for distributing and organising the resources? Could resources be transferred from one incident to another? Is it easy, usual?
	The forest fire in the area of the Municipality of Istiea - Edipsos in Evia is ongoing. The National Weather Service at 14:00 p.m. issues an Extraordinary Stormy Winds Bulletin effective from the afternoon hours of August 6. Evia will be affected by strong winds of 8Bf in the south and 6Bf to 7Bf in the northern parts of the island. The winds will last until midday on August 7th. Temperatures will drop and will not exceed 32° Celsius.
	[discussion]: Change of planning? Can this be monitored through SILVANUS?
	In the evening of 6th of August and the early morning of 7th of August the fire is visible from Edipsos and is heading towards the NE side, driven by the strong winds in the area and the morphology and topography of the area. During the night, the Fire Service forces have been reinforced, with the assistance of firefighters from other regions of the country, residents and volunteers of the area.
	Early in the morning of August 7th the fire appears to be partially controlled, but at 7:00 am the intensity increases and the fire is reinforced by wind gusts of higher intensity. The direction and intensity of the winds are constantly changing, and the fire is heading towards the northern Gulf of Euboea.
	[discussion]: Can this be monitored through SILVANUS? Evacuation actions? Suppression actions?
	At 11:30 a.m. the wind intensity decreases and the firefighting planes still operating at the site manage to control the fire at the points delineated by the ground forces.
	In the afternoon of August 7th, the fire has no active front, but has burned a significant portion of the mountain, and has been brought under partial control.

	The weather forecast, with lower winds and lower temperatures, favors the firefighting operation.
	In the evening hours of August 7th small fire outbreaks are still burning in scattered parts of the burnt area. The hiking sections of Fire Service are operating in order to be fully extinguished and bring the forest fire under full control.
	On Monday, August 8th, the forest fire has been brought under full control, but strong forces of Fire Service remained stand by in the field for surveillance and prevention of outbreaks.
	[discussion]: end of response phase. Evaluation of actions. How SILVANUS can support all the actions taken?
Phase C Restoration	Due to the forest fire, the impact on the natural environment, the economy of the region and tourism was significant affected, but the lives and property of citizens were preserved
	[discussion]: Restoration issues. How is restoration being made? What are the short- and long-term measures for the restoration of the forest and society? How SILVANUS approaches this issue?

Figure 128. Image during the TTX conduct in Chalkida.

Figure 129. Image depicting the TTX's participants.

3.7.2.5 User products tested

Table 29. SILVANUS User Products (Ups) demonstrated and focused on during the Greek pilot (Chalkida TTX).

Phase (A,B,C)	*Tested user product*	*Description*	*Outcome*
Phase A, C	UP7: Biodiversity profile mobile application	To test the biodiversity application in post and pre-fire event status	In the TTX, the user products were presented and analyzed to the participants. The test will be done in the field exercise
Phase A, C	UP8: Mobile App - Citizen Engagement and Fire Report Module, EMDC Integration	To test the Citizen Engagement Program and relevant Mobile Application in Greece with its application not only to the pilot area (North Evia) but other areas of Sterea Ellada and Northern Greece (Thessaloniki) testing it in different type of population and environments.	In the TTX, the user products were presented and analyzed to the participants. The test will be done in the field exercise.
Phase B	UP3: Fire detection based on social sensing	Testing the functionality of the early detection of wildfires and its usefulness for the evolution of a fire incident using real time collection of citizen observations from social media (X).	UP3 in collaboration with the PUC leader produced seven synthetic X's (Tweets) representing fire-related scenarios and generated a corresponding fire event. Subsequently, successfully posted these X's on X (Twitter) and meticulously crawled the data through the dedicated X crawler. The evaluation of this data was conducted through the user interface of SILVANUS via the Media Sensing layer.
Phase B	UP4: Fire detection from IoT device	To test the functionality of detecting fire events from IoT devices.	In the TTX, the user products were presented and analyzed to the participants. The test will be done in the field exercise.
Phase B	UP5 Fire detection from UAV/UGV	To test and demonstrate the functionality of detecting fire events from UAV/UGV devices.	In the TTX, the user products were presented and demonstrated to the participants using mock-up images (synthetic).
Phase B	UP6: Fire spread forecast	To test the algorithm in real-time environment.	In the TTX, the user products were presented and analyzed to the

			participants. The test will be done in the field exercise.

UP3 – Social Media Sensing

CERTH demonstrated the pipeline used for capturing, aggregating, and displaying X's reporting a fire. The system crawls X's API (or posts on a Facebook group, or a particular website). If the system detects potential reports, based on certain keywords, these are captured and unpacked (date, location, X text). Once this is done, the reports are aggregated and analysed. Those marked as real are then forwarded to the SILVANUS Cloud, which allows the dashboard to display them on the map (Figure 130).

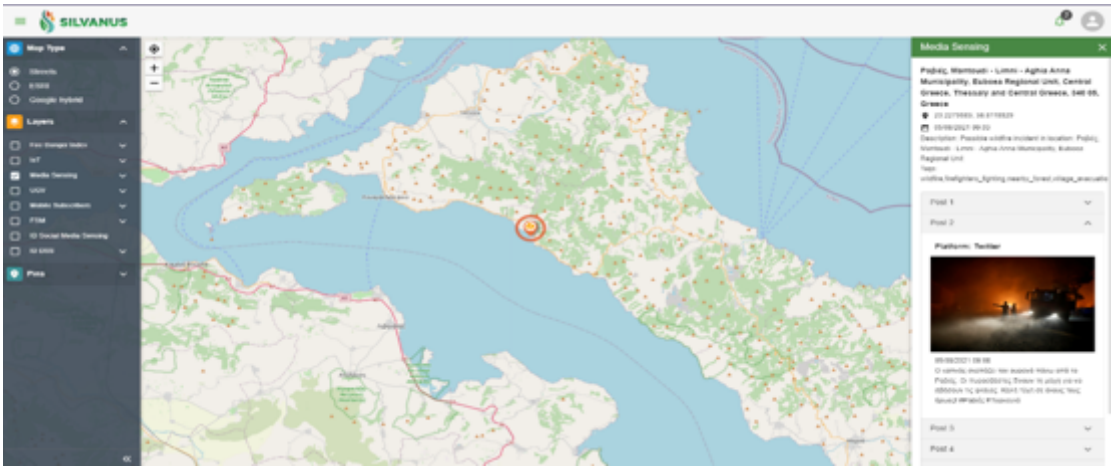

Figure 130. Social Media Sending layer on SILVANUS Dashboard

Evacuation and Health modules - UTH

During the Greek Pilot, UTH showcased two components: the health impact component (DSS - BS10/UP6) and the evacuation route planning component (DSS - BS9/UP6). The former facilitated an in-depth analysis of firefighters' exposure to forest fires, modelling both short and long-term effects. Meanwhile, the latter enabled the development of effective evacuation strategies to assist responders in coordinating their efforts. These components were deployed on a web server, demonstrating the servers' integrated features and functionalities.

UTH demonstrated a comprehensive air quality monitoring system, comprising a Raspberry Pi, a 4G antenna, a SIM module, a power bank, and a GPS antenna. Attached to the Raspberry Pi were emission sensors detecting Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), Ozone (O3), and particulates PM2.5 and PM10.0. Regarding the evacuation route planning component, UTH outlined its architecture and illustrated an incident scenario in the northern part of Evia Island, where smoke was directed eastward. Evacuation routes generated from this scenario were displayed on a map interface. For both components, UTH presented eight different endpoints, allowing partners to access health impact and evacuation route planning data through simple HTTP GET/POST requests.

Fire and Smoke detection (UP4 part) – ATOS (EVIDEN)

During the pilot, Atos (now named Eviden) demonstrated the fire & smoke detection module of computer vision. This module is part of the user product 4 (UP4). For the demonstration, we used synthetic images of fire and smoke in forests (part of the annotated dataset generated for Silvanus).

We demonstrated the complete integrated process from the data “ingestion” of the images in the SAL, to the images analysed:

· Ingestion of images (as taken from AUVs) in the SAL

· Consumption of the queue of images using Rabbit MQ by our detection module

· Analysis of the images in “soft” real time

· Output of the images, via JSON in Rabbit MQ

This almost complete this section of UP4. Being the only part still pending to show the images with the detection of fire and smoke overlaid in the common final user interface.

UP4 as a complete system

During the TTX the IoT device’s components were showcased, along with its functionalities and potential benefits from its use. Lastly, results from previous pilots were presented to the participating stakeholders to emphasise the effectiveness of the ML algorithms for fire/smoke detection in different scenarios/landscapes.

UP6 Fire spread forecast - EXUS

During the pilot, the Fire Spread Model was demonstrated to the TTX participants, with the objectives of validating some of the assumptions and variables required for the model. The software was evaluated on a specific region of interest to the pilot owners, to also test its performance on local conditions. The results were demonstrated to the stakeholders for evaluation and feedback, as integrated into the first version of the Silvanus Dashboard.

3.7.2.6 Key outcomes

Feedback of the end user related to the user products that were demonstrated is provided below:

- With regard to the health device: The easy to use and portability of the health device was appreciated by the end users and their instalment to vehicles was also considered. The equipment's capability to monitor air quality within safe areas, like schools or hospitals, was acknowledged.
- The evacuation module was a good point for discussion between the players and the observers. A better understanding was gained regarding the criteria defining a safe area for evacuation route planning; for instance, a region with a school or hospital might be considered a safe destination.
- The use of social media for alerts and monitoring during a fire event is not only interesting, but also highly valuable in gaining situational awareness. By analyzing information shared on social media, we can quickly gather insights and updates about the fire's progression. However, it is important to note that false positives and the verification of incoming information can pose challenges. Despite these potential issues, social media remains an effective tool for obtaining real-time information and enhancing overall situational awareness during a fire incident.
- Users have shown great interest in IoT devices designed for smoke and fire detection. These devices have proven to be highly accurate in detecting potential hazards, as evidenced by successful pilot projects. However, there are several challenges that need to be addressed for widespread adoption. The installation process, the quantity of devices required, the establishment of a network of sensors, and ensuring hardware security are all concerns that have been raised. These potential barriers must be carefully considered and resolved to enable the practical and effective use of IoT devices for smoke and fire detection in the future.

- The fire spread forecast tool, UP6, has emerged as a critical tool for firefighters and civil protection agencies. Its ability to provide rapid results, in minutes or even seconds, holds immense value for the overall response mechanism. However, the accuracy of these forecasts is a crucial concern for ensuring reliable simulations. Furthermore, the challenge of accurately predicting fire propagation in varying weather conditions has been a significant issue. Nevertheless, the tool's integration with the SILVANUS Decision Support System (DSS) proves to be extremely helpful, enhancing the overall effectiveness and efficiency of fire response efforts.
- The Citizen mobile application and Citizen Engagement Program were highly captivating aspects of the Greek pilot. The importance of educating and training the population for wildfire events cannot be overstated, as it plays a significant role in increasing awareness, preparedness, response, and restoration efforts. The program, along with the mobile application, was regarded as extremely interesting and beneficial. The mobile application not only supports the detection and monitoring of fire incidents, but also empowers citizens to become active responders. Additionally, the application proves to be an effective means of reaching out to and engaging with young people, surpassing the limitations of traditional methods.
- The biodiversity application offers a unique and engaging opportunity for young people to connect with nature and forests. It serves as an excellent platform for them to familiarize themselves with different species and habitats. The application also highlights the importance of restoration and prevention efforts in maintaining biodiversity. In particular, foresters can effectively utilize the application in conjunction with other tools to monitor burnt areas and assess the level of regeneration taking place. This integration of technology and ecological monitoring enhances our understanding of forest ecosystems and supports informed decision-making for their conservation and management.
- By integrating these products into a comprehensive platform, decision-makers can gain access to real-time data, advanced analytics, and decision support tools that are crucial for managing wildfires. This integration enhances preparedness, response, and recovery efforts, while also increasing resilience in terms of human safety, environmental protection, and economic stability. The embedding of these products into a Decision Support System (DSS) within the platform further amplifies their functionalities and augments the data processing, analysis, and decision-making support capabilities of the DSS. This comprehensive approach to wildfire management provides valuable insights and assistance throughout all phases, from preparedness to response and recovery.

  Through the SILVANUS integrated DSS, decision-makers can leverage real-time data and tactical recommendations to drive firefighters to adopt different tactics and strategies. The platform can offer support in resource allocation, collaboration, and communication, as well as assistance in restoration planning based on historical data analysis. This collective information empowers firefighters and land managers to make more informed decisions, adapt their approaches, and effectively address the challenges of wildfire prevention, response, and restoration. Ultimately, the platform helps increase resilience by equipping decision-makers with the tools and information needed to manage wildfires more effectively and mitigate their impacts.
- In addition to the comprehensive platform and Decision Support System (DSS), an interoperability approach is crucial when integrating these products into an existing system within a country. Interoperability ensures seamless communication and data exchange between different systems, enabling effective collaboration and coordination among various stakeholders involved in wildfire management.

  By adopting an interoperability approach, decision-makers can integrate the platform and its products with the existing system in the country. This integration allows for the sharing of real-time

data, analytics, and decision support tools, enhancing the overall capabilities of the system. Interoperability ensures that information from different sources, such as weather data, fire spread forecasts, and citizen reports, can be seamlessly integrated into the existing system. This enables decision-makers to have a comprehensive and unified view of the wildfire situation, facilitating more informed decision-making and coordinated response efforts.

Last but not least, interoperability enables the exchange of data and information with external systems, such as regional or international fire management platforms. This collaboration ensures that decision-makers can leverage a broader range of resources, expertise, and data sources, enhancing the effectiveness of wildfire management at a larger scale.

The first trial period activities in the Greece pilot highlights the participation of many local authorities in the TTX, which illustrated a high interest for the topic among local and national SILVANUS members and stakeholders. One of the main achievements during this phase is represented by the fact that the stakeholders of Evia island and Sterea Ellada agree that there is a potential use of Silvanus technology in the future. Many firefighters pointed out that the technological tools, when used, will help them a lot in their work and will have a significant contribution to extinguishing the fire.

3.7.3 Future outlook for 2024

The TTX served as a valuable precursor to the upcoming field exercise in mid-2024 in Evia. It provided an opportunity to identify and address any potential challenges that may arise on a strategic and operational level. The preparatory efforts, meticulous design, and efficient implementation of the TTX ensured a high level of cooperation, communication, and understanding among the participating stakeholders. This facilitated a productive exchange of expertise, knowledge, and insights.

Although the TTX itself presented significant challenges, it is important to acknowledge that real-life situations may introduce complexities. The involvement of multiple stakeholders with diverse backgrounds, different jurisdictions, and areas of authority can introduce challenges. Additionally, regulatory or bureaucratic elements may further complicate the decision-making process.

To mitigate and manage these challenges effectively, steps will be taken ahead of the field exercise. These steps will involve proactive measures to address anticipated obstacles and ensure smooth coordination among all stakeholders. By fostering effective communication channels, promoting collaboration, and streamlining processes, the field exercise can overcome any potential hurdles and maximize its effectiveness in testing the capabilities of the wildfire management system.

Overall, the TTX served as a valuable learning experience and an opportunity to fine-tune the preparations for the field exercise. It highlighted the importance of addressing potential challenges and implementing strategies to effectively manage them. By doing so, the field exercise can be executed successfully, allowing for a comprehensive evaluation of the system's capabilities, and enhancing the overall readiness to respond to wildfires.

Additionally, during 2024, the Hellenic Rescue Team (HRT) will organize at least 2 Phase A initiatives dedicated to forest fire prevention. The plan is to fortify early detection systems, intensify community engagement, and enhance fire prevention strategies. Also, the primary objective is to carry out a variety of educational initiatives aimed at providing citizens with practical knowledge and skills.

3.7.4 Media activities

After the completion of the TTX that was conducted in Chalkida, PSTE (the pilot leader) issued a Press Release on the website of Region of Sterea Ellada (https://pste.gov.gr/deltio-typou-megali-symmetochi-stin-askisi-tis-perifereias-stereas-elladas-gia-ti-diacheirisi-agrodasikon-pyrkagion/).

Also, additional social media posts were made on LinkedIn:

- https://www.linkedin.com/posts/silvanus-project_silvanusproject-pilot-activity-7125069676270804994-Jqs0?utm_source=share&utm_medium=member_desktop

- https://www.linkedin.com/posts/dr-nikolaos-g-kalapodis-a776a082_i-am-thrilled-to-announce-that-on-october-activity-7125459504590110721-X-xT?utm_source=share&utm_medium=member_desktop

Finally, a brief presentation of the TTX was included in the Vol. 6 Newsletter of SILVANUS.

3.8 Indonesia pilot

The Silvanus Indonesia Pilot Visit activity was carried out for 6 days on 6-11 November 2023. Activities were carried out in two (2) cities, namely Palangka Raya and Yogyakarta.

3.8.1 Location

The Silvanus Indonesia Pilot Visit activity was carried out for 6 days on 6-11 November 2023. Activities were carried out in 2 cities, namely Palangka Raya and Yogyakarta. However, because there are no direct flight connections to these 2 cities, participants also pass through 2 or 3 other cities, namely Banjarmasin, Bali and/or Jakarta. The visualization of the pilot location is shown in the Figure 131 - Pilot Visit Location.

Figure 131 - Pilot Visit Location

In Palangkaraya pilot visit did in the Sebangau National Park. Sebangau National Park (latitude, longitude: -2.5973765,113.6712027) is the largest tropical peat forest conservation area in Indonesia. It is administratively in Central Kalimantan Province, Indonesia (Figure 132 - Pilot site location in Indonesia: Sebangau National Park Position in Central Kalimantan Province, Borneo Island, Indonesia (left) and Sebangau National Park Administrative (right)- left). It was formally declared as a national park on October 19, 2004, by Minister of Forestry Decree No. 423/Menhut/II/2004, covering a total area of 568,700 hectares. Sebangau National Park is located across three districts/municipalities in Central Kalimantan Province, which includes Katingan Regency, Pulang Pisau Regency, and Palangkaraya City (Figure 132-right).

According to Indonesia Law Number 5 of 1990, the main function of national park is Conservation of Biological Natural Resources and Their Ecosystems. Sebangau National Park area is an essential habitat for orangutans, proboscis monkeys, and hornbills. Sebangau National Park also has a diversity of flora, a mixture of lowland riparian vegetation with typical peat swamp vegetation.

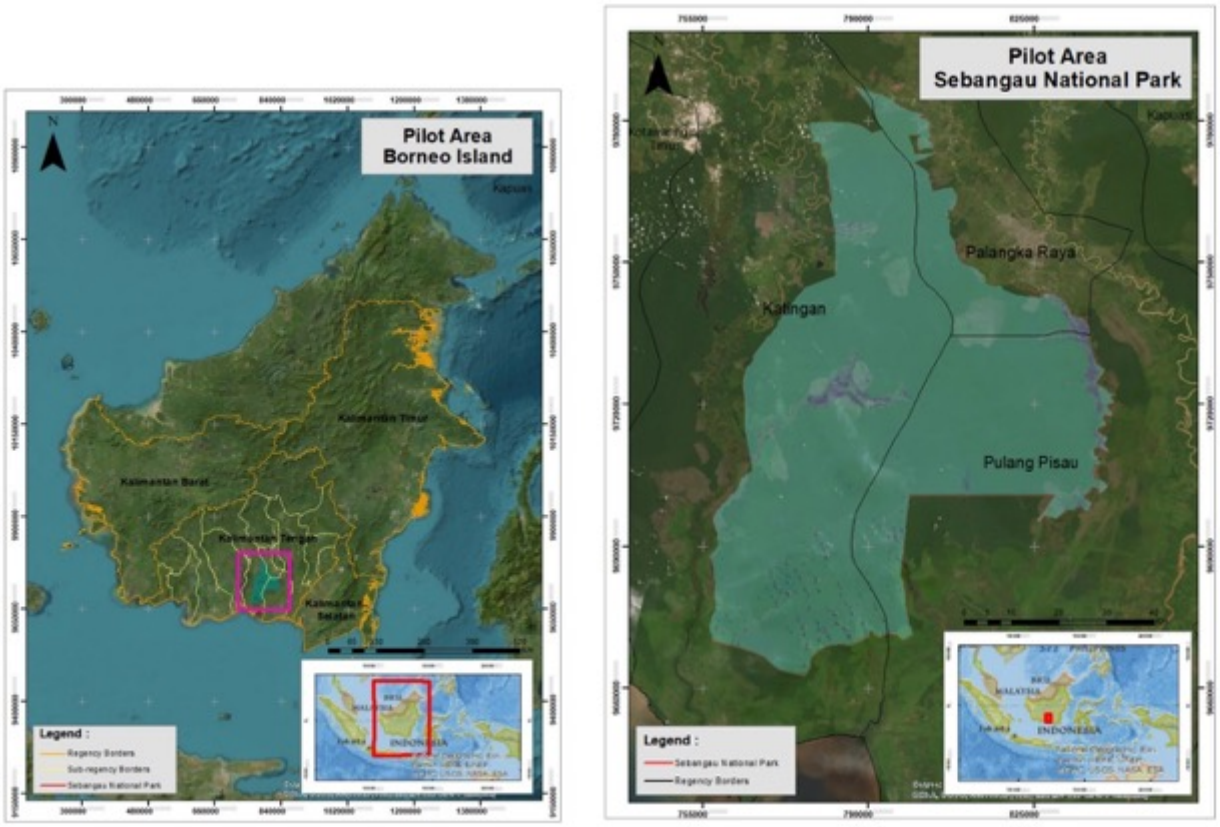

Figure 132 - Pilot site location in Indonesia: Sebangau National Park Position in Central Kalimantan Province, Borneo Island, Indonesia (left) and Sebangau National Park Administrative (right)

Besides Sebangau National Park, other places were visited are Disaster Management Office, Penda Barania. In Yogyakarta, the Indonesia Pilot Visit is done in The Sahid Jaya Hotel and Convention Center (Latitude, Langitude: -7.7797612,110.4113919).

The detail agenda of the Pilot Visit is Shown in the Table 30

Table 30 - The Indonesia Pilot Visit Agenda

Day	Local Time	Activity
Day 1, Mon 6th Nov		Arrive at Palangkaraya
	… - 18.30	Checkin Aquarius Hotel
	18.30 - 21.00	Welcome Dinner at Hotel
Day 2, Tue 7th Nov	06.30 - 08.30	Breakfast
	08.30 - 12.00	Visiting Local Disaster Management and continue doing observation the burned location
	12.00 - 13.00	Lunch
	13.00 - 13.30	Travel Hotel - Dermaga Kereng Bengkirai National Sebangau Park
	13.30 - 16.30	River trip in Sungai Koran and observation in the Pristine Jungle
	16.30 - 17.00	Travel to Local Restaurant

	17.00 - 19.00	Dinner at Local Restaurant
	19.00 - 19.30	Travel to Hotel
Day 3, Wed 8th Nov	06.30 - 08.00	Breakfast
	08.00 - 12.30	Sharing Session with Sebangau National Park management, local government, local community, local expert
	12.30 - 14.00	Lunch and Checkout
	14.00 - 21.00	Travel to Banjarmasin
	21.00 - 22.00	Dinner at local restaurant
	22.00 - 22.30	Travel to Hotel
Day 4, Thu 9th Nov		Transit from Banjarmasin to Yogyakarta
Day 5, Fri 10th Nov	06.30 - 08.30	Breakfast
	08.30 - 16.00	The 6th International Conference on Information and Communications Technology 2023 (6th ICOIACT 2023)
	16.00 - 16.45	Travel to AMIKOM
	16.45 - 20.00	Social Dinner at AMIKOM
	20.00 - 20.45	Travel to Hotel
Day 6, Sat 11th Nov		Transit Yogyakarta to Denpasar/Jakarta

The stakeholders in the Indonesian pilot exhibit a diverse range of typologies, each contributing with distinct activities and roles to the SILVANUS project. In the Indonesian pilot, stakeholders actively engaged in various activities, showcasing their commitment to the success of the Silvanus project. There are 16 people from 9 Silvanus partners as shown in Table 31**Error! Reference source not found.**.

Table 31- Stakeholders' roles and activities, Indonesian pilot

Stakeholder	***Activity Engaged***	***Role***
Kusrini (AMIKOM)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	PIC
Gardyas Bidari Adninda (AMIKOM)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Moderator of sharing session with external session 1 Moderator of International Conference
Arief Setyanto (AMIKOM)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference	Moderator of sharing session with external session 2

	Visit AMIKOM campus	
Paweł Gromek (SGSP)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Prepare and collect questionnaire from pilot visit participant and external stakeholder
Krishna Chandramouli (VTG)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Present the Silvanus Project and Woode Application in the sharing session and international conference
Marcin Przybyszewski (ITTI)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Present Silvanus dashboard
Emil Gatial (UISAV)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Present citizen engagement application and EmerPoll
Zoltan Balogh (UISAV)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Present citizen engagement application and EmerPoll
Despina Anastasopoulos (INTRA)	Visit Disaster Management Office Visit forest fire location (Penda Barania) Visit pristine jungle (National Sebangau Park) Following international conference Visit AMIKOM campus	Present Decision Support System application
Alexandre Lazarou (Z&P) **Domenica Casciano (Z&P)** **Alessandro Zanasi (Z&P)** **Inês Ribeiro (IST)**	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Participants

Sergio Colecchia (ASSET) **Daniela Di Carne (ASSET)**		
Lovorko Maric (MD)	Visit Disaster Management Office Visit forest fire location Visit pristine jungle Following international conference Visit AMIKOM campus	Disseminate the Silvanus project

External stakeholders involved in this visit in difference activity and role as shown in the Table 32.

Table 32- External Stakeholders' roles and activities, Indonesian pilot

Stakeholder	***Activity Engaged***	***Role***
Head of Disaster Management Office	Sharing Session on The Existing Technology and Challenge for Forest Fire Management in The Center of Kalimantan Province	Presenter
3 Staffs of Borneo National Faundation	Sharing Session on The Existing Technology and Challenge for Forest Fire Management in The Center of Kalimantan Province	Give explanation about the existing technology
10 Staffs of Disaster Management Offife	Sharing Session on The Existing Technology and Challenge for Forest Fire Management in The Center of Kalimantan Province	Give explanation about the existing technology
3 Staffs of Borneo National Faundation	Obsevation in Penda Barania (Burned location)	Give explanation about condition of forest fire
Expert from Center Calimantan Environmental Service (Mangrove Peat Restoration Agency) - Merty	Sharing Session in The Best Western Hotel Palangkaraya	Present on peat restoration management
Expert from National Sebangau Park – Noviyanti Nugraheni	Sharing Session in The Best Western Hotel Palangkaraya	Present on Forest fire management "A shifting paradigm" Journey to Unlearn and Relearn the Conservation, National Sebangau Park
22 staffs from: **Borneo National Foundation** **WWF Indonesia** **Central Kalimantan Environmental Service**	Sharing Session in The Best Western Hotel Palangkaraya	Following Sharing Sessin and giving feedback

Palangka Raya Environmental Service **Fire Fighter** **Climate Change Control Center** **Fire Care Society** **Universitas Palangkaraya** **Universitas Muhammadiyah Palangkaraya**		
Former Head of National Sebangau Park (Now Head of Bukit Baka National Park) – Andi M Khadafi	International Conference ICOIACT at Sahid Jaya Hotel and Convention Center Yogyakarta	Keynote Speaker in The Conference: Peat Swam Ecosystem and Its Potential Development of Artificial Intelligence
Prof. Naoyuki Kubota (online), Professor from Tokyo Metropolitan University	International Conference ICOIACT at Sahid Jaya Hotel and Convention Center Yogyakarta	Keynote Speaker in The Conference: Topological Intelligence for Cognitive Robotics
More than 40 onsite participants	International Conference ICOIACT at Sahid Jaya Hotel and Convention Center Yogyakarta	Participants
More than 80 online participants	International Conference ICOIACT at Sahid Jaya Hotel and Convention Center Yogyakarta	Participants

3.8.2 Objectives

Sebangau national park, Indonesia pilot activities was mainly designed to demonstrate the support of technology innovation on phase C restoration and adaptation. However, due to the nature of forest managements have interconnected each other from phase A, prevention, and preparedness, as well as phase B detection and response. Indonesian pilot also involved some demonstration of the solution for phase A and B.

The objectives underlying the organization of the Indonesian tabletop exercise were connected mainly to phases C, but for some extent phases (A and B). According to each phase, the main objectives encompass the following:

Phase C (Restoration and Adaptation)

- Demonstrate, test, early user adoption of the biodiversity tagging mobile application (*woode*)
- Data collection of leaf images and its tree species in tropical forest.
- Demonstrate the technological support to the ecological resilience long term forest monitoring and evaluation of forest restoration using “open forest map” application

- Observe current implementation of “manual” biodiversity tagging in real tropical forest
- Learn current forest restoration policy and programs in peat forest.
- Gathering user feedback and further user requirements from forest management stake holder such as Sebangau national park managements, the disaster management office (BPPD), local government, and related parties.
- Drone image and video data collection over the pilot area.

Phase A (Prevention and Preparedness)

- Evaluation of satellite image monitoring tools (integrated in OFM) and silvanus dashboard.
- Present Silvanus wildfire awareness campaign materials to related stake holders

Phase B (Detection and Response)

- Demonstrate the decision support systems in supporting the fire spread simulation
- Present the forward command centre and exploring further user requirements
- Observe the current technology, tools, and organization of disaster management office (BPBD)
- Observing the real peat forest and collecting the visual information in order to improve the fire detection application in underground fire incident.

In order to achieves these objectives Indonesian pilot activities was design in the pilot location to collect the data such as images, video of the tropical peat forest. A field survey inside the forest area in many statuses such as pristine forest, naturally regenerated forest, on-going forest fire and canal blocking infrastructures. The tree biodiversity image data collection also carried out inside the forest to partially capture the vegetation diversity in peat forest.

To engage the local stake holder to actively participates become early application adopter, provides their feedback and further requirements a tabletop demonstration and focus group discussion carried out. Forest rehabilitation expert is also invited to deliver their views on local peat land management challenges.

3.8.3 Execution

Pilot activities was held in **Palangka Raya and Yogyakarta, starting from November 7 to 10, 2023**.

First Day, November 7th, 2023

The first activity carried out was to visit Badan Penanggulangan Bencana Daerah (BPBD) / Disaster Management Authority of Central Kalimantan. Discussion between consortium member and the BPBD employees was held to discuss about forest and land fire management in Central Kalimantan. After the discussion, Consortium member observed the tools for firefighting, including the fire trucks (Figure 133 to Figure 135).

Figure 133 - Stakeholder engagement being carried out at disaster management office

Figure 134 Site visit at disaster management for inspecting the infrastructure

Figure 135 – Images from the demonstration: Visitation to the Local Disaster Management

After visiting BPBD, Consortium members moved to the ex-fire area. Here the underground fire that had occurred at that moment was observed. Here, we learn about the invisible fire where can only be anticipated by visual clues of smoke instead of fire that can be a valuable input for the fire detection application (Figure 137).

Figure 136 - SILVANUS partners visiting a burnt area affected by peat fire

Figure 137 - Images from the demonstration: Observation the Burned Area

Afterwards, the Sebangau National Park was visited. The peat forest was reached from Consortium members by riding small boat (Figure 138). Then, Consortium members walked into the forest to observed canal blocking, one of the projects that is used in Sebangau National Park to keep watter in the peat land in order to avoid forest wildfire (Figure 139) In that occasion we take some leaf photo sample of many vegetations in the peat forest, and observing current manual biodiversity tagging techniques currently used (Figure 145Figure 142).

Figure 138 – Images from the demonstration: Travelling Across the Koran River to Reach the Pristine Peat Forest

Figure 139 – Images from the demonstration: Observation of the Pristine Peat Forest

Second Day, November 8th, 2023

In the second day, the pilot activity was conducted via focus group discussion and UP demonstration. Focus group discussion participant consisted of Silvanus Consortium members and local stakeholders; in total 31 participants joined the event (Figure 140).

Figure 140 – Images from the demonstration: Explanation from the PIC in The Sharing Session

There were 2 speakers from local stakeholder; the first speaker, from Environmental Authority, explained how peat restoration is carried out in Central Kalimantan. the second speaker, from Sebangau National Park, informed how the management in Sebangau National Park is conducted, including the forest rehabilitation and restoration strategies (Figure 141).

Figure 141 – Images from the demonstration: Sharing Session from 2 Local Experts

The following activities is the demonstration and presentation of Silvanus user product to get the user input from the local stake holder such as the Sebangau national park, disaster management officer, fire brigade, expert from university mainly on forest management (Figure 142). The demonstration of “Woode” mobile application for biodiversity Tagging and Analysis for Improved Awareness and Support attract many stakeholders' attention. “Open forest map”, a forest rehabilitation mapping tools is also presented, and prospective user expect the usability for them and give input to the consortium mainly on data compatibility and accessibility. Citizen engagement application, forward command centre and its mechanism is also presented. Decision support systems application for fire spread calculation is presented. Finally, Silvanus dashboard is presented to local stake holder. Some interesting discussion and insight have been raised up by the stake holder such as the possibility to consider underground fire and society involvement in forest management in social forestry issue.

Figure 142 – Images from the demonstration: Session Sharing from Silvanus Partners

Fourth Day, November 10th, 2023

In the last day of the Indonesia pilot visit the Consortium member participated in the 6th International Conference on Information and Communications Technology 2023 (ICOIACT 2023). The conference was

held in hybrid system, both online and offline in Yogyakarta, where SILVANUS was presented by Krishna Chandramouli (VTG) to a wide audience of local participants (Figure 143). Related speakers delivered the discussion and panel presentation also conducted at that time. In this conference a speaker from former head of Sebangau national park has explained the rehabilitation strategy that has been carried out and its key success factor and challenges. The opportunity to implement information technology-based solution is also elaborated by the speaker and also his expectation to Silvanus user product in the futures.

Figure 143 – Images from the demonstration: International Conference ICOIACT 2023

3.8.4 User products tested

Table 33 presents the UPs that has been tested during the execution of the Indonesian pilot, providing a short description of each one and their outcome from the tests.

Table 33 – User product, Indonesian pilot

Phase (A,B,C)	***Tested user product***	***Description***	***Outcome***
Phase A/C	Silvanus WOODE mobile app	Biodiversity Tagging and Analysis for Improved Awareness and Support VTG provided the beta version of the Woodee mobile application to be installed. Participants went into the tropical forest and took some pictures of vegetation inside the forest. On the second day, VTG introduced the application to the wider audience and let them be the external users.	Tropical forest vegetation pictures already collected. New users already successfully registered and inputed data to the mobile apps

Phase A,C	Open Forest Map User Interface	A web-based application to monitor forest rehabilitation, and forest resiliency The operational scenario : Amikom demonstrated the beta version of the open forest map application based on cases of historical forest fires – in 2015 and 2019 in Sebangau National Park. Sebangau National Park Officer verified the output of the Open forest map with their forest fire historical data. External audience gave feedback on additional necessary requirements.	The forest continuous monitoring graph has a proper behaviour to represent the historical condition of a location that experienced forest fire Some data showed in the demo was inaccurate due to the quality of satellite images (affected by high level of cloud cover). Prospective users already aware of the potential of the application and some missing requirements needed by expert users were identified.
Phase B	Fire spread Forecast	An application to simulate the spread of the fire and allocate the resources based on the simulation. Intrasoft demonstrated the fire spread model to the external stakeholders. External stakeholders gave a feedback on the simulation. Silvanus participants also visited the undergoing pit fire site to see the requirements that needed to be taken into account if the model would be implemented real life.	Prospective users are already aware of the potential of the application, some variables of fire spread model need to be adapted for pit land wildfire.
Phase A, B, C	Citizen Engagement - Mobile App and Fire Report Module, EMDC Integration	Citizen Engagement mobile application demonstrate by UISAV, they shows the application and let a number of external participant to use the apps with the installed mobile apps in the demo. UISAV also demonstrate the result of the mobile apps on the dashboard and its	Prospective users understand the forward command centre ability and mobile application engagement.

		connection with the forward command center with independent network and mobile application for community engagement	
Phase A, B, C	Silvanus Dashboard User Interface	User interface for integrated Silvanus project. ITTI demonstrated the dashboard to external users using local data in Sebangau National Park	Prospective users understand the high-level feature of the Silvanus dashboard such as the map of fire risk
Phase B	UP3 Fire detection based on social sensing	UP3 represents a significant advance in fire management, leveraging social media readiness to gather information in real time. At the heart of this system is the analysis of X's (tweets), through which you identify reports or clues of possible fires. Amikom demonstrated the application and received 26 synthetics tweets in Bahasa related to forest fire.	For the Indonesian pilot, UP3 in collaboration with the PUC leader produced 26 synthetic X's (Tweets) representing fire-related scenarios and generated three corresponding fire events. Subsequently, successfully posted these X's on X (Twitter) and meticulously crawled the data through the dedicated X crawler. The evaluation of this data was conducted through the user interface of SILVANUS via the Media Sensing layer. The social media sensing successfully identified the forest fire related tweets and showed them in the dashboard

UP3 – Social Media Sensing

CERTH demonstrated the pipeline used for capturing, aggregating, and displaying X's reporting a fire. The system crawls X's API (or posts on a Facebook group, or a particular website). If it detects potential reports, based on certain keywords, they are captured and unpacked (date, location, X text). Once this is done, the reports are aggregated and analysed. Those marked as real are then forwarded to the SILVANUS Cloud, which allows the dashboard to display them on the map (Figure 144).

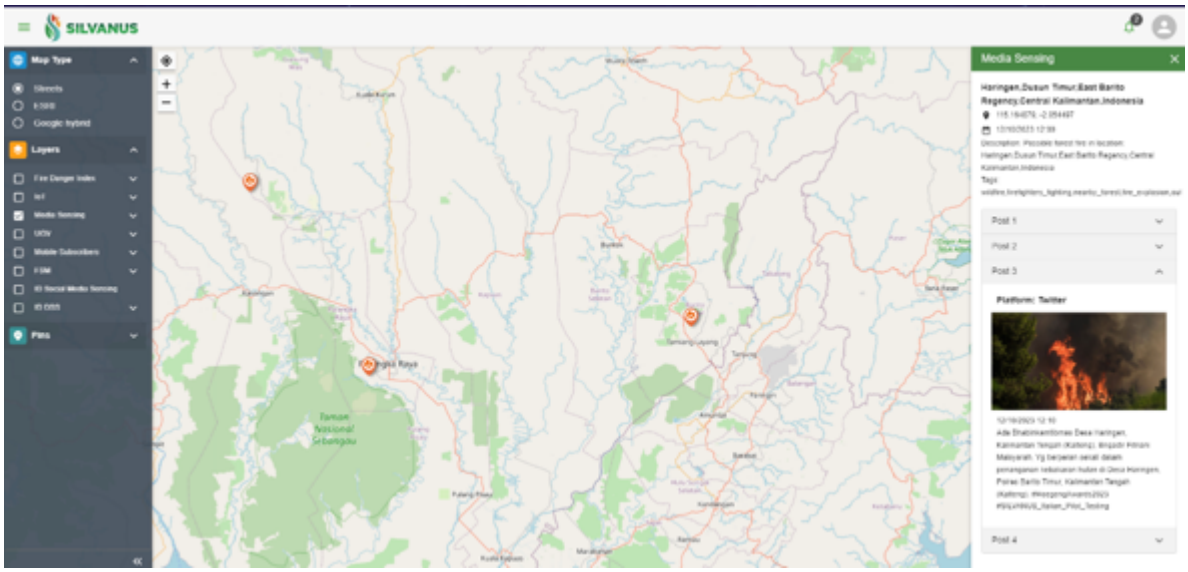

Figure 144 – Social Media Sensing layer on SILVANUS Dashboard

Silvanus technology offer further enhancement of technology intervention towards biodiversity tagging and rehabilitation monitoring. Since the pilot area are very rich of biodiversity, Wodee applications can potentially help stakeholders to tag the location and vegetation species in the long run.

The current technique for biodiversity tagging in the Sebangau National Park is (Indonesian pilot area) showed in Figure 145.

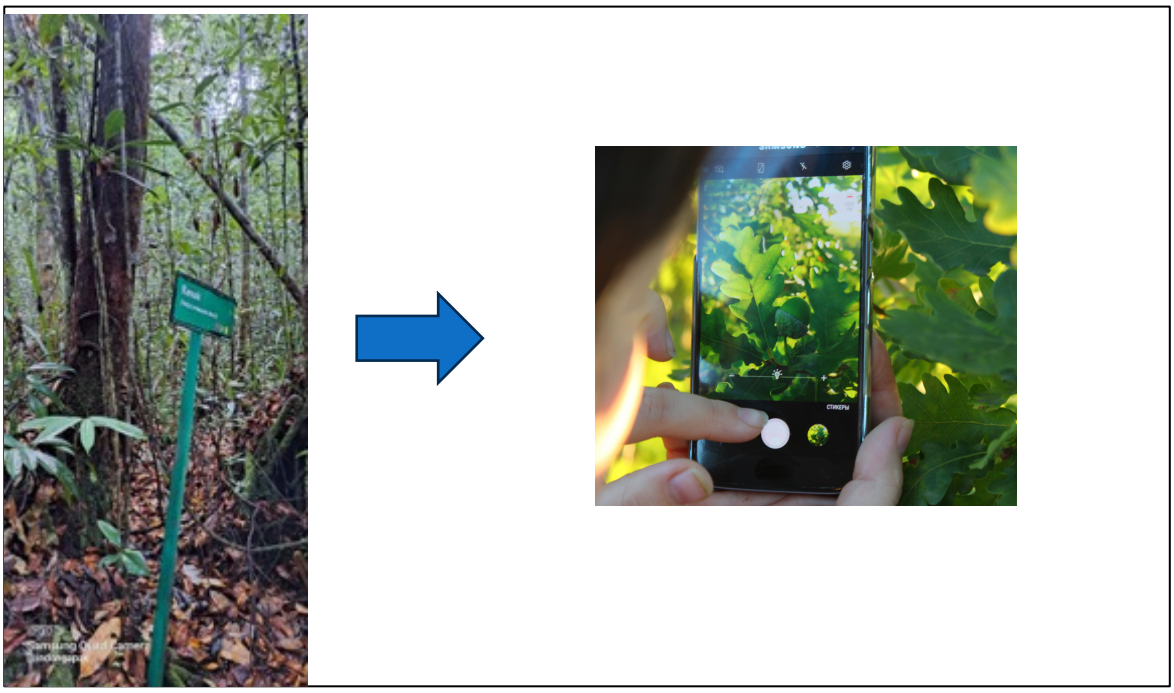

Figure 145 – Images from the demonstration: Observation in The Pristine Peat Forest

In terms of rehabilitation and restoration monitoring, systematic continued monitoring is unavailable. According to the stakeholder the data is available in many applications provided by stakeholders, such as the Meteorological Climatological and Geophysical Agency, the Ministry of Forest and Environmental, the Disaster management services and many more. The lack of integrated information due to separated application island hindering stakeholder to take good decision. Open Forest map potentially provides integrated monitoring services to serve the need of stakeholders to observe the success of their rehabilitation program as well as mapping potential environmental threats in the future. The request from the stakeholder is data openness since they expect to integrate the application with current tools.

Challenges in organizing Indonesian pilot visit were faced by Amikom regarding the pilot visit preparation and on-site problems. The first problem was regarding the preparation before the agenda. One of them was about the legal challenges that allow Consortium members to visit the Sebangau National Park regarding the situation before the visitation. Burning was still happening in some areas and smoke was still everywhere. The second challenge was caused by the unstable weather. In order to reach the pristine forest, a certain height of the water level of the peat should be reached. The pilot visit was conducted in November, and at that time the rainy season was just starting, so the water level was not sufficient. Because of that, Consortium members were only able to reach the canal blocking area in Sungai Koran.

Furthermore, a problem faced on the site was the location of the forest itself. The location of pristine forest is deep inside the Sebangau National Park. Small boats are required to transport the Consortium members from the nearest Kereng Bengkirai Dock to the location. One of the agenda points was to observe canal blocking as one of the rehabilitation and restoration strategies conducted by Sebangau National Park Authority. Reaching the canal-blocking area requires 2 hours back and forth while walking with extreme humidity and temperature. The road to canal blocking area is also challenging, because of the peat soil that has many holes (Figure 146).

Figure 146 – Images from the demonstration: Observation in The Canal-Blocking

Another problem was the high density of the forest that makes it challenging to assess biodiversity, in relation to species richness and abundance. The presence of endemic animals, such as orangutans, is also hard to detect, only their nest was witnessed on the way to the pristine forest.

Indonesia has an area of 13.43 million hectares of peat (FAO & Wetland Data, 2008), including the 542.171,1 ha area of Sebangau National Park. Peat is a naturally formed organic material resulting from the halted decomposition of plants perpetually inundated and accumulated in wetlands. The peat ecosystem is an arrangement of peat elements with unique and fragile characteristics. It is a comprehensive whole within the peat hydrological unit that influences each other to form balance, stability, and productivity. The peat ecosystem cannot stand alone but has a close reciprocal relationship with living creatures such as plants, wildlife, and humans. Peat in Indonesia have been formed approximately 6800 – 4200 years ago. The accumulation of peat layers can reach a depth of 10-15 meters or more. The peat layer in Indonesia grows on average 1 cm in 10 years or 1 meter in 500 years.

The peat area of Sebangau National Park is prone to fire, especially the border area close to the community. When a fire occurs, Sebangau National Park staff, firefighters, the fire care community, and related authorities first protect the fire from spreading underground fire. The underground fire is a substantial threat because when it happens, it is hard to monitor the depth and the spread areas compared to the crown of surface fire. In the case of Sebangau National Park, the firefighters usually take several days or weeks until the fire stops.

The challenge in extinguishing fires on peatlands is that fires in the soil cannot be seen from above. Usually, all that is visible is only the smoke, even though the fire has spread underground. Firefighters always facing difficulty in extinguishing fires on peatlands. Often, the fire stops after a few days or even weeks. The method firefighters use is to insert a water hose into the ground and continuously pour water into the ground, hoping to make the ground watery so that it can extinguish the underground fire.

3.8.5 Media activities

The activities in Indonesia is published in a local media that can be accessed at http://republika.co.id/r/s43yue291 (Figure 147) and https://jogja.tribunnews.com/2023/11/10/ambil-bagian-dalam-proyek-silvanus-amikom-buat-berbagai-aplikasi-untuk-pengelolaan-kebakaran-hutan (Figure 148).

3.8.6 Future Outlook for 2024

Amikom has been using the allocation for Indonesia pilot visit in November 2023. For the meantime, there is no further plan for second pilot visit in Sebangau National Park. Regarding the application of Open Forest Map, the demo will be conducted around March-June 2024. The current plan is to conduct the demo of running the Open Forest Map in Sebangau National Park Map area that will be led by AMIKOM.

During the first trial period activities, stakeholders around the Pilot area agree that there is a potential use of Silvanus technology in the future. There are some improvements required for the technology to adapts the complexity of forest fire problems mainly in peat land area.

The user product expects to be implemented in the Indonesia Pilot area. However, based on the focus group discussion, some participants inform that it would be hard for some user product to be implemented in Sebangau National Park. This is due to the condition of the citizen that live near the forest as well as for the condition of the peat swamp forest.

Regarding potential improvements, the Indonesian pilot considers that the following aspects should be taken into account:

- Consideration of under soil fire as happened in the peat forest area.
- Consideration of remote forest area with lack of infrastructure access.

For this reason, the proposal for mitigating the potential challenges involves two main activities:

- Discuss the user product with related person who are expected to be the end users.
- Improve the UPs so that they can be easily explained and used by local Indonesian users, and that they are able to operate in conditions with limited access to a connection (GMS).

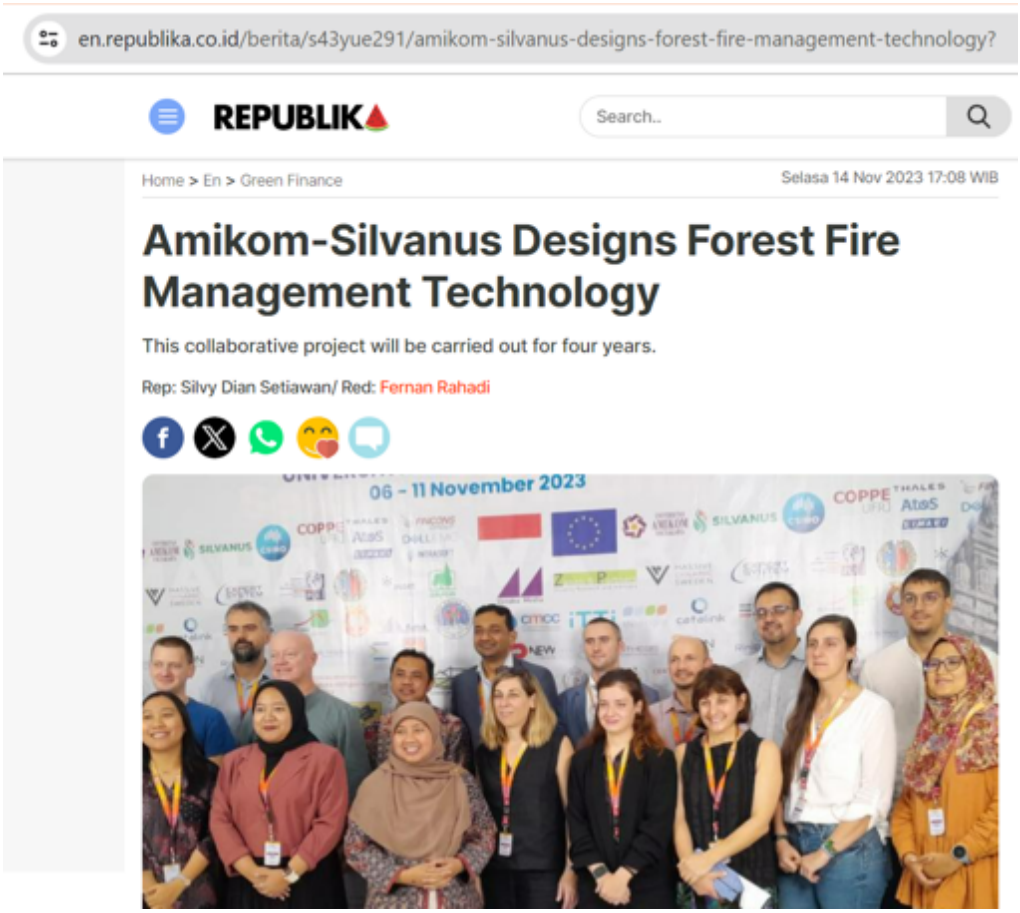

Figure 147 – Republika Publication

Figure 148 – Tribun Jogja Publication

We also published the activities information through https://silvanus-project.eu/news/ (8th November 2023, (10th November 2023) and

https://www.linkedin.com/feed/update/urn:li:activity:7127693293978595328/ and https://www.linkedin.com/posts/silvanus-project_silvanusproject-activity-7128633564954341376-dVo7?utm_source=share&utm_medium=member_desktop.

3.8.7 Conclusions

During the first trial period activities, stakeholders around the Pilot area agree that there is a potential use of Silvanus technology in the future. There are some improvements required for the technology to adapts the complexity of forest fire problems mainly in peat land area.

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3.9 Italy (Sardinia) Pilot

The Italian pilot exercise was held as a tabletop activity that was scheduled on 10/11/2023, during which the external stakeholders were invited to participate and provide comments and feedback on the SILVANUS platform development. The programme for the tabletop exercise is presented below (Figure 149).

10/11/2023			
No.	**Time**	**Topic**	**Responsible(s)**
1	10.30 - 10.45	Institutional welcome • PNRT Director, Marianna Mossa • Italian pilot sites coordinator within the SILVANUS project (FINCONS)	PNRT – Marianna Mossa
2	10.45 - 11.15	• Silvanus project presentation – opening session (FINCONS) • Tepilora: pilot site description - Marianna Mossa (PNRT)	PNRT – Marianna Mossa
3	11.15 - 11.45	SILVANUS technologies overview (FINCONS)	FINCONS
	11:45 - 12:00	Break	
4	12.00 – 12.10	The importance of stakeholders' engagement Krishna Chandramouli – Scientific Coordinator (VENAKA)	PNRT – Marianna Mossa
5	12:10 – 12:45	Wildfires and the active role of the local stakeholders: • CORPO FORESTALE • CIVIL PROTECTION • FORESTAS	PNRT – Marianna Mossa
6	12.45 – 14.00	Round table with the participation of regional stakeholders and project partners	FINCONS
	14.00	End of the Meeting	

Figure 149 - Programme for the Italian (Sardinia) pilot

3.9.1 Location

The Italy (Sardinia) pilot is located in the Parco Naturale Regionale di Tepilora (Figure 150). Parco Naturale Regionale di Tepilora is a Sardinian regional park established in 2014 (according to Regional Law 21/14). The park includes, totally or partially, the **four municipalities** of Torpè, Posada, Lodè and Bitti and it covers an **area of about 8.000 hectares** and 10.000 inhabitants. The park's main problems are fire and hydrogeological risks.

Located in the north-west of **Sardinia**, the Tepilora Regional Natural Park includes a vast territory that insists on four municipalities: Torpè, Posada, Lodè and Bitti. The park extends from the tepilora forest to the mouth

of the Rio Posada; its fulcrum is Mount Tepilora (m.528 s.l.m.), a rocky tip with a triangular profile that stands out in the densely wooded area of Littos and Crastazza and looks towards Lake Posada. Once intended for grazing and cutting wood, in the 1980s the area was afforested for 16% of the total and was equipped for hiking and fire protection, becoming a nature reserve.

In the territory of the municipality of Bitti fall the state forests of Crastazza-Tepilora and Sos Littos-sas tumbas owned by the Autonomous Region of Sardinia and managed by the regional agency FORESTAS. In the territory of the municipality of Lodè falls the territory bordered by the forest yard of Sant'anna, owned by the municipality of Lodè and managed by the regional agency FORESTAS. In the territory of the municipality of Torpè falls the territory bordered by the forest yard of Usinavà state-owned and managed by the regional agency FORESTAS.

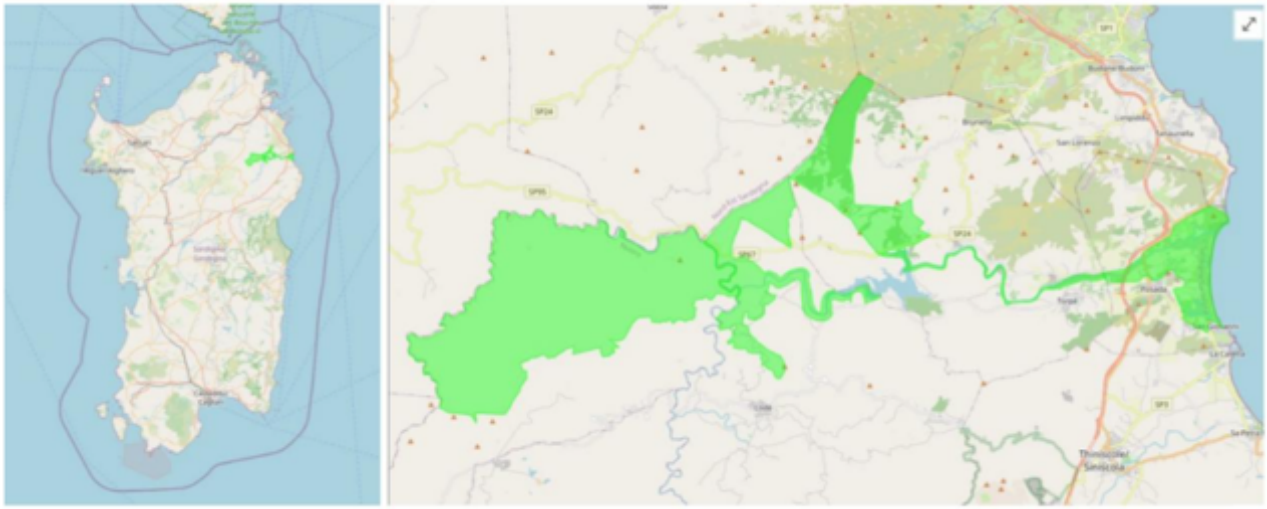

Figure 150 - Map of the Parco Naturale Regionale di Tepilora, Italy

The establishment of the Park was started in 2005 at the impulse of the Municipality of Bitti, in agreement with the Sardinia Region, the Forestry Authority of Sardinia and the Province of Nuoro with the aim of protecting the natural resources of the area and encouraging the sustainable development of the territory. Today the Park, entirely passable, also thanks to its mild winters is an ideal destination for tourism in contact with nature even in low season, between breathtaking views, fresh spring waters and florofaunistic typicality: vigorous lyceums, strawberry trees, junipers, corks are the habitat of animal species typical of the Mediterranean scrub, such as the Sardinian hare, wild boar, fox; there are also donkeys and mouflons and, near the Tepilora tip, it is possible to spot specimens of golden eagle. There is no shortage of cultural attractions, linked to a rich historical-archaeological heritage, ancient traditions, crafts and food and wine.

3.9.2 Participating stakeholders

The tabletop exercise was well participated by experts from interdisciplinary background representing the first respondres, fire fighters, civil protection agencies, foresteres, environmental protection organisations and regional education centres.

Table 34 - Stakeholders and partners, Italian (Sardinia) pilot

Stakeholder	*Activity Engaged*	*Role*
Civil protection	Presentation of their work and planning of the activities to be jointly carried out within SILVANUS: i.e. participation to the Pilot Visit in 2024, drafting of the Plan for fire prevention and operational intervention measures in case of fire, involvement in the awareness raising process	coordinates the civil protection activities of the regional bodies, the provinces, the municipalities and voluntary organizations

Forestry guards	Presentation of their work and planning of the activities to be jointly carried out within SILVANUS: i.e. participation to the Pilot Visit in 2024, drafting of the Plan for fire prevention and operational intervention measures in case of fire, involvement in the awareness raising process	coordinates operations on the ground and air fleets for fire suppression
Forestas agency	Presentation of their work and planning of the activities to be jointly carried out within SILVANUS: i.e. participation to the Pilot Visit in 2024, drafting of the Plan for fire prevention and operational intervention measures in case of fire, involvement in the awareness raising process	manages fire prevention activities in its forest compendiums and contributes to alerting and fire suppression operations on the ground
Local environmental education centers	Involvement in the awareness raising campaign	Risk awareness, discussions, citizen engagement, observers
FINCONS	Presentation of Silvanus UPs	System Integrator and Technology provider

The synergistic collaboration among the diverse stakeholders in the Italian Pilot 1 (presented in Table 34) forms an ideal alliance for effective fire management. The cohesive efforts of Civil Protection, Forestry Guards, Foresta Agency, Local Environmental Education Centres, and FINCONS create a powerful and cohesive network dedicated to the fire prevention in the Italian pilot 1. This group not only ensures strategic planning and operational efficiency but also underscores a shared commitment to community awareness and preparedness, especially due to the participation of the Local Environmental Education Centres. Finally, this collaborative network showcases the integration of expertise from civil protection, forestry management, environmental education, and technology, emphasizing a comprehensive approach to fire management in the Italian Pilot 1 of the SILVANUS project.

3.9.3 Objectives

The goal was to collaborate with local stakeholders in order to share current SILVANUS achievements in terms of UPs and technical offering, but also to discuss and understand the operational modalities for the implementation of the pilot activities to be held in May 2024.

Description of performed activities

The event was held in **Bitti (Sardinia – Italy) with a remote connection for project partners on November 10th**, 2023. Activities started at 10.30, as presented in the agenda detailed in Table 6.

After the institutional greetings, activities began with a brief presentation of the SILVANUS project, as a reminder to local stakeholders, and the presentation of the pilot area.

FINCONS presented the following SILVANUS user products, describing, for each of them the involved partners, the main features, the components, the purpose through examples of actual applications in other sites such as Gargano:

- UP.1 - AR/VR Training Toolkit for Trainers
- UP.2 - Fire Danger Risk Assessment
- UP.3 - Fire Detection Based on Social Sensing
- UP.4 - Fire Detection from IOT Devices
- UP.5 - UGV Monitoring for Wildfire Behaviour
- UP.6 - Fire Spread Forecast
- UP.7 - Biodiversity Profile Mobile Application

- UP.8 - Citizen Engagement Mobile Application

The second part of the meeting was devoted to the Local Stakeholders that introduced their activities in relation to what was presented by the SILVANUS project.

Forestry and Environmental Surveillance Corps (CFVA). It was illustrated the role of CFVA in the Prevention, Detection, and Management of Forest Fires, explaining that a structure spread across the entire regional territory, operating through a general direction, 3 central services, 7 territorial services, 80 forest stations, 10 naval bases. Their general direction carries out organizational, directive, coordinating, and supervisory tasks regarding the technical and policing interventions of the entire structure

The Departmental Inspectorate Services, also known as Territorial Services, are seven, each carrying out the same functions within their territorial area of competence (jurisdiction). Specifically, they coordinate and support the activities of the Forest Stations which are operational structures with jurisdiction beyond individual municipalities and have on the territory technical, control and surveillance functions.

The territorial departmental inspectorate service of CFVA in Nuoro is organized into a central headquarters and a peripheral operational structure. The central headquarters is divided into four organizational units (sectors) and 6 operational units. The peripheral operational structure consists of 15 forest stations and 1 Operational Logistic Naval Base (in La Caletta - Siniscola). The Forestry and Environmental Surveillance Corps of the Sardinia Region was established by regional law on November 5, 1985, no. 26. The establishing law granted new institutional responsibilities to the CFVA by strengthening its organizational structure and distribution across the territory through the establishment of new operational facilities (forest stations).

The new organizational framework allowed the forestry administration to expand its control and surveillance not only in protected areas under hydrogeological constraints but also in those protected areas based on environmental and landscape regulations

Among the functions attributed to CFVA by Regional Law No. 26/85 is the surveillance, prevention, and repression regarding forest fires and, according to annual regional intervention programs, in suburban areas

The Regional Fire Prevention Plan also assigns to the Forestry Corps:

- Coordination of ground operations and aerial means
- Management of extinguishing functions at the Unified Operating Room
- Management of COPs (Firefighting Operations Centers) and Helicopter Bases
- Identification of areas affected by fire
- Investigative activities
- Preventive policing
- Training and information provision

There are four levels of coordination of CFVA-led firefighting operations:

- D.O.S. (Director of Extinguishing Operations)
- U.O.C. (Operational Units by Sector)
- C.O.P. (Provincial Operational Centers)
- S.O.U.P. (Permanent Unified Operating Room - Extinguishing and Fire Census Function)

The Corps is entrusted with the prevention and repression of illegal behaviors and activities related to authorized fire use and arson offenses. The increased investigative competence has led to the identification of an increasing number of perpetrators of these offenses, classified by our penal code as crimes against public safety and the environment.

It is referred that out of a total of 1200 arson incidents investigated over the last 20 years, the main causes are attributed to:

- Conflicts and vendettas

- Agricultural practices (elimination of vegetative cover)
- Faulty fire prevention systems
- Pathology related to pyromania

This information is extremely useful in order to implement a specific awareness raising campaign.

Furthermore, out of a total of 1673 negligent fires investigated over the last 20 years, the main causes are attributed to:

- Failure to assess the danger derived from the use of flame or electrical machinery
- Failure to extinguish fires
- Agricultural practices
- Neglect in maintaining electrical lines

Civil Protection. The activities of the Civil Protection can be summarized as follows:

- PLANNING: the drafting of the PRAI (Regional Plan for Forecasting, Prevention, and Fighting Forest Fires);
- FORECASTING: the issuing of a forest fire risk forecast bulletin;
- EMERGENCY MANAGEMENT: active firefighting with the support of volunteers;
- PREVENTION: the use of new technological frontier of Unmanned Aerial Systems (UAS).

With Deliberation No. 24/29 dated July 13, 2023, the Regional Council approved the Regional Plan for Forecasting, Prevention, and Fighting against Forest Fires for the triennium 2023-2025, was drafted with the contribution of the following entities:

- Directorate General of Civil Protection;
- Forestry and Environmental Surveillance Corps;
- FoReSTAS Agency;
- Regional Agency for the Protection of the Environment for Sardinia;
- Regional Directorate of the Fire Brigade for Sardinia.

The PRAI aims to plan and coordinate fire-fighting activities among all institutional components and contains the framework of thematic knowledge specifically developed to properly plan activities related to:

- Forecasting
- Prevention
- Active firefighting based on an organizational model consisting of a plurality of institutional and non-institutional entities that contribute, in various forms and areas, to achieving the objectives of the Plan itself.

Another objective of the document is to define emergency procedures, territory monitoring activities and assistance to the population, in addition to coordinating, in a harmonized and synergistic manner, the complex of operational activities for a coordinated and synergistic intervention in prevention and emergency assistance for the territory and populations exposed to calamitous events. In this regard, coordination with Municipal Civil Protection Plans is fundamental. During the summer period, when there is a high risk of forest fires, the Decentralized Functional Center analyzes the daily level of fire danger, issuing the Forest Fire Risk Forecast Bulletin. Through the fire danger forecast activity, the possibility is evaluated on a daily basis: whether potential fires might spread more or less rapidly in a specific territory due to specific meteorological conditions inferred from the forecast. The forecast of forest fire hazard thus expresses the likelihood of such events occurring along with the difficulty of extinguishing them in a given portion of the territory exposed to calamitous events, categorizing it with a color code: green for low danger, yellow for medium danger, orange for high danger, red for extreme danger.

Concerning the emergency management, active firefighting is supported by voluntary organizations representing the core and operational arm of the national Civil Protection system while prevention activities

involve implementing targeted actions to reduce the causes and potential ignition of fires, along with interventions aimed at mitigating the resulting damages. Preventive activities concern:

- actions focused on forests, involving proper management of available resources;
- actions targeted at individuals, including educational and informative activities aimed at preventing improper behaviors, promoting risk awareness, and encouraging the adoption of correct behavioral norms

In order to reduce the causes, potential ignition of fires, and mitigate resulting damages, all systems and means of monitoring and surveillance of at-risk areas, as well as general technologies for monitoring the territory, are utilized. In this regard, currently, the Directorate General of Civil Protection is qualified as an aeronautical operator at ENAC (Italian Civil Aviation Authority), employing 45 pilots and has acquired a fleet of Unmanned Aircraft Systems (drones). Certification activities for the use of aircraft in specific scenarios are underway. Drones are used for (Figure 151):

- Human/drone support for territory monitoring;
- Georeferencing the point of fire outbreak;
- 24-hour control with a 7 km radius;
- Preparation of predefined flight missions;
- Verification of area accessibility for ground vehicles;
- Support for firefighting and prevention of reignitions;
- Perimeter delineation of fire-affected areas.

Figure 151 - Example of emergency mapping for drones

The conclusion of the intervention highlighted that the experimentation with drones for fighting forest fires is only at the beginning and synergies with the SILVANUS project are expected.

Forestas. It is a regional entity established by the regional law n.8 of 2016 and operates with a territorial structure comprising 7 territorial services and forest complexes within the provincial areas. Tepilora is one of the two regional parks where Forestas covers 80% of the territory and intervenes to simplify and standardize firefighting operations, with 68 teams present in the Nuoro province, which includes Tepilora. The 36 observation towers are crucial for early fire detection. Forestas teams engage in firefighting using vehicles carrying up to 600 liters of water. Higher-capacity vehicles are used for more effective interventions. Timely intervention within the first 10 minutes is crucial, but challenges arise during high-risk days when red alerts are activated, potentially compromising statistics such as the fire in Posada which involved 600 hectares, encompassing both forested and urban areas.

Forestas' interventions continue even after the wildfires. Reference is made to national law no. 353 of 1998, emphasizing the need for immediate action without waiting for new growth: activities involving removal of burnt vegetation, allowing subsequent growth, require derogations granted by the forestry department. Furthermore, it is highlighted that the nature in Sardinia has evolved to withstand fires: cork oaks, cistus, maritime pines, and Canary Island pines have developed defense mechanisms.

Concerning the prevention phase, Forestas' efforts are devoted to the creation of firebreaks and environmental awareness campaigns. An environmental education project is presented by Forestas, fostering synergies with SILVANUS.

Furthermore, concerning the use of the drones Forestas underline the need of providing them to public entities – i.e. judicial police - capable of rapid repressive action

Round table. It was interesting to note that everyone agreed on the need to work on awareness activites, and in this regard, of particular interest were the UP3 and UP8 that can be easily used during the awareness raising campaign.

All regional stakeholders expressed their interest in participating in the drafting of a plan for PNRT containing key information about activities for planning prevention and operational intervention measures in case of fire and guidelines for a correct restoration in accordance with the legislation in force. CFVA has also underlined the need of including this document in the Regional Fire Protection Plan.

Images from the event organized by the Italian Pilot 1 are presented in Figure 152, Figure 153 and Figure 154.

Figure 152 - Image during event: Marianna Mossa, PNRT Director, explaining Italian (Sardinia) pilot

Figure 153 - Image during event: Marco Saltarella (FINCONS) illustrates project results

Figure 154 - Image during event: The Director of the CFVA illustrates their active role in fighting wildfires

3.9.4 User product validation

No user product was tested nor validated during the first trial period activities in the Italian Pilot 1, however each user product was presented to the local stakeholder to gather feedback and to understand mutual interest in deploying and evaluating specific technologies for the 2024 pilot.

3.9.5 Strategic and operational challenges

The main challenges that emerged during the meeting are mainly related to three needs:

- strengthening communication and awareness raising activities with reference to the reasons explained by CFVA;
- strengthening the exchange of experiences and best practices between local stakeholders and the SILVANUS project since, in some ways, it seems that the Region of Sardinia is well equipped with cutting-edge technologies that could also be of interest to project partners.
- customizing technologies that are planned to be deployed in SILVANUS pilots on individual territories and the specific needs of each site/ pilot.

3.9.6 Planning of 2024 pilot activities

PNRT has already agreed with local stakeholders to take the following steps:

- December 2023: coordination meetings with FORESTAS and the 4 Local Environmental education centres (CEAS) for starting the joint communication campaign and the creation of synergies with

other EU projects in the Region with similar topics. The campaign will last until the end of the project.

- December 2023 – April 2024: meetings with CORPO FORESTALE, FORESTAS and PROTEZIONE CIVILE to concretely explore ways of collaboration in the frame of SILVANUS, also in view of the demonstration phase. In order to reach the objectives, the active collaboration of project partners is important, the presence of UP leaders especially will allow to explain all the details about the technologies (UPs) toward which local actors may show interest.
- May 2024: pilot visit with the involvement of regional, local and international actors. This activity is subject to positive feedback on the amendment request.

3.9.7 Conclusions

The pilot has given the possibility to discuss with local stakeholders and lay the basis for further interaction in anticipation of the pilot activities in Tepilora Park in 2024.

It is essential to improve the coordination of the activities and the need to raise awareness among technology partners about the importance of dealing with pilot territories, especially in situations where, as with PNRT, there is a lack of technical expertise capable of fully understanding the potential of each technology and its application in the territory.

Furthermore, it is necessary that all pilot activities are scheduled far apart to allow everyone to participate, especially the technology partners. In order to reach this objective PNRT suggest that:

- all pilot visits to be done in 2024 are planned by December 2023
- from December 2023 to May 2024 (pilot visit to Sardinia) a series of coordination meetings between pilot site owners, technology partners, WP9 and scientific coordinators are scheduled.

In order to raise awareness about the project activities and goals, the results of the meeting held in Bitti were disseminated through the PNRT official website (https://www.parcoditepilora.it/news-dettaglio.php?id=76756), PNRT Facebook page and La Nuova Sardegna regional newspaper as shown Figure 155 and Figure 156.

The event has also given the opportunity to build regional synergies between PNRT and FORESTAS – stakeholder of Silvanus but also partner of the ResAlliance e FireRes Projects (H2020) - about fire Fighting and Land Resilience in Sardinia. In this regard, PNRT participated to a Workshop organized by FORESTAS on December 1, 2023, where SILVANUS was presented. About a hundred people attended from Forestas and Civil Protection, volunteers, environmental associations, NGOs, Local environmental education centres and regional parks. Interesting proposals and conclusions emerged and will be relaunched in territorial laboratories for the transfer of good practices.

34 Giovedì 23 Novembre 2023 LA NUOVA Nuova Sardegna

OGLIASTRA ▸ BARONIA

Bitti Droni e robot per proteggere il parco dai roghi

Presentato il progetto Silvanus per il Tepilora

di Sergio Secci

Marianna Mossa è la direttrice del parco regionale di Tepilora

BITTI Un incontro all'insegna della condivisione e dell'ascolto sulle buone pratiche utilizzate in Sardegna da importare da altre realtà dell'Unione europea e un primo bilancio del progetto Silvanus dedicato alla prevenzione e alla gestione degli incendi nei territori del Parco di Tepilora. A partecipare ai lavori la direttrice del parco Marianna Mossa e la responsabile del progetto Loredana Mulas, Protezione civile regionale, vertici provinciali dell'agenzia Forestas, Corpo Forestale, i quattro Ceas dell'area protetta (Posada, Torpè, Lodè, Bitti) e i partner nazionali e internazionali.

Il progetto Silvanus, finanziato dal programma Europeo Horizon 2020 Green Deal, ha l'obiettivo di realizzare una piattaforma di gestione forestale ecosostenibile e resiliente per combattere gli incendi boschivi, soddisfare l'utilizzo efficiente delle risorse e rigenerare il paesaggio, fornendo protezione contro le minacce di incendi. Le attività si articolano in tre fasi: prevenzione, rilevamento incendi e risanamento delle aree boschive colpite. Le relazioni hanno messo in evidenza quanto sia importante costruire dei progetti di prevenzione che coinvolgano i portatori di interesse in un gioco di squadra indispensabile per mettere in sicurezza boschi, pascoli e paesaggi. Un'azione che deve coinvolgere anche i volontari gestiti dai comuni e dalla protezione civile, compagnie barracellari e agricoltori che più di tutti conoscono i territori.

Nel rilevamento operano soprattutto Forestas e Civa, con monitoraggio e segnalazione incendi attraverso le vedette nei territori. Silvanus cercherà di contribuire alla lotta agli incendi attraverso l'integrazione di una struttura di elaborazione in grado di analizzare varie fonti come modelli climatici, dati meteorologici e strumenti di osservazione della terra, portando allo sviluppo di modelli intelligenti sull'accensione degli incendi attraverso tecnologie di sensori wireless e il coordinamento di droni e robot terrestri automatizzati per coordinare la risposta dei primi soccorritori. Il ruolo dei droni può essere uno strumento nonvolmente innovativo nell'integrare le attività di segnalazione perché se ben coordinati con le centrali operative, possono garantire una costante osservazione di enormi superfici, coprendo luoghi difficilmente raggiungibili dalle squadre a terra. I lavori hanno studiato anche i roghi estivi di Posada e Siniscola con oltre 700 ettari percorsi dalle fiamme anche all'interno del Parco nelle zone umide del Rio Posada. Nell'area protetta circa il 60% degli incendi, segnalati da quando è nato il Parco, sono di origine dolosa, il 5% accidentale e il 35% involontaria e accidentale (inosizioni di sigaretta, rimozione di resti vegetali, stoppie bruciate). Ultimo passaggio ha riguardato il risanamento e la rigenerazione delle aree incendiate dove un lavoro importante nelle terre pubbliche, svolge il personale dei cantieri di Forestas in collaborazione con i Centri di educazione ambientale.

> Forestas, corpo forestale, protezione civile ed ente parco insieme per tutelare l'ambiente

Figure 155 - Image of an article from La Nuova Sardegna, regional newspaper, about the results of the event

Figure 156 - Image during the workshop: the PNRT Director illustrates SILVANUS during one of the working groups

3.10 Australia Pilot

The Australian field exercise was scheduled from 14th November to 16th November of 2023 with the programme shown in Figure 157, Figure 158 and Figure 159.

time	event	location
9:00 – 9:30 am	Sign in	Reception
9:30 – 10:00 am	Welcome to country, safety announcements, summary of visit, welcome packs	Executive Boardroom
10:00 – 10:30 am	Site tour: - IAEA robot - Max - Hexapod	RIC (K Block)
10:30 – 11:00 am	Morning tea	RIC (K Block)
11:00 – 11:30 am	- Spot - Titan	R4 Robot room
11:30 – 12:00 pm	- Lunar testbed - Tunnels - 3D Vision Lab	Hill
12:00 – 12:30 pm		
Lunch 12:30 – 1:30 pm		
1:30 – 2:00 pm	Overview of Robotic Perception & Autonomy group	Lecture Theatre
2:00 – 2:30 pm	Overview of Robotic Design & Interaction group	Lecture Theatre
2:30 – 3:00 pm	Overview of Distributed Sensor Systems group	Lecture Theatre
3:00 – 3:30 pm	Afternoon tea	Outside Lecture Theatre
3:30 – 4:00 pm	3:30-3:40pm Petra Kuhnert – CSIRO fire spread 3:45-3:55pm Claire Krauss- Geoscience Australia: Fire hotspots	Lecture Theatre
4:00 – 4:30 pm	4:00-4:10pm John Atkinson: Qld Parks and Wildlife Fire 4:15-4:25pm Mark Walding QFES	Lecture Theatre
4:30 – 5:00 pm	4:30-4:40pm Dr Philip Stewart- Wildland Fire Ecologist 4:45-4:55pm Dr Annabel Smith	Lecture Theatre

Figure 157 - Day 1 agenda programme for the pilot

time	event	who	location
9:00 – 9:30 am	Autonomous navigation to/from sim fire	Tom	orchard
9:30 – 10:00 am	Tree analytics in thin/thick coverage – data to cloud	Tom	orchard
10:00 – 10:30 am	Smoke detection at different ranges	Maria	orchard
10:30 – 11:00 am	Morning tea		
11:00 – 11:30 am	Humidity tests then move to hill	Tirtha	orchard
11:30 – 12:00 pm	2nd robot mid-run map sharing 3rd robot start-of-run map sharing	Milad	hill
12:00 – 12:30 pm	Waypoint control of 3 robots simultaneously Return-to-start, with dynamic obstacle	Milad	hill
Lunch 12:30 – 1:30 pm			
1:30 – 2:00 pm	1:30-1:45pm Overview of the demonstrations 1:45-2:15pm CSIRO UGV platform technologies	CSIRO team	Lecture theatre
2:00 – 2:30 pm	2:00-2:15pm CSIRO UGV R&D 2:15-2:25pm Smoke detector IoT technology	CSIRO CTL	Lecture theatre
2:30 – 3:00 pm	2:30-2:40pm CEA Mob. App./EmerPoll demo 2:45-2:55pm Dashboard demonstration/presentation	UI SAV ITTI	Lecture theatre
3:00 – 3:30 pm	Afternoon tea		Outside Lecture theatre
3:30 – 4:00 pm	3:30-3:40pm policies on wildfires 3:45-3:55pm Italian pilot results	KEMEA ASSET	Lecture theatre
4:00 – 4:30 pm	Wildlife tour of QCAT		
4:30 – 5:00 pm	Wildlife tour of QCAT		

7:00 pm	Southbank Beer Garden	30ba Stanley St Plaza, South Brisbane

Figure 158 - Day 2 agenda for the visit

time	event	location
9:00 – 9:30 am	Meet at 9:00am, bus leaves at 9:10am.	Outside reception
9:30 – 10:00 am	Arrive 10:00am at Mt Nebo	
10:00 – 10:30 am	Walk to strangler fig, optional longer walk	Mt Nebo
10:30 – 11:00 am	Note historic site on way back, get on bus at 11 am	
11:00 – 11:30 am	Drive to Walkabout Creek	
11:30 – 12:00 pm	Arrive at Walkabout Creek	Walkabout Creek
12:00 – 12:30 pm	Unguided walk / explore / talk at cafe	
Lunch 12:30 – 1:30 pm	Lunch at café. Get on bus at 1:30pm	Cafe
1:30 – 2:00 pm	Bus leaves 1:30pm, arrives at QCAT 2:00pm	
2:00 – 2:30 pm	Collaboration tests in Robot Room R4	Workshop:
2:30 – 3:00 pm	Trial technologies on robot, trial technologies on-site	*How to use a robot in bush fires*
3:00 – 3:30 pm	Afternoon tea	
3:30 – 4:00 pm	Concluding remarks from Program Leader Navinda Kottege	
4:00 – 4:30 pm		
4:30 – 5:00 pm		

Figure 159 - Day 3 agenda for the visit

3.10.1 Location

The pilot takes place at Queensland Centre for Advanced Technology (Figure 160), which includes a robotics centre and is a 24-hectare site of mixed land, from industrial to forest, creek and pasture.

The primary purpose of the pilot is to test and demonstrate Unmanned Ground Robot activities for the mitigation of wildfires/bushfires (Australian terminology is bushfires). The demonstrations cover examples from pre-during and post-fire, that is phase A, B and C. Each has a role that UGVs can play, in combination with other partner technologies:

- Phase A: obtaining local ground conditions (humidity/temperature) using UGVs
- Phase B: autonomous exploration and navigation to/from fire front spread using UGVs
- Phase C: assessment of forest state and safety post-fire using UGVs

The connection of multiple partner technologies to achieve these goals was demonstrated, including smoke detection (Catalink), SILVANUS platform pipeline (Dell), and the GUI of UGV analytics (ITTI).

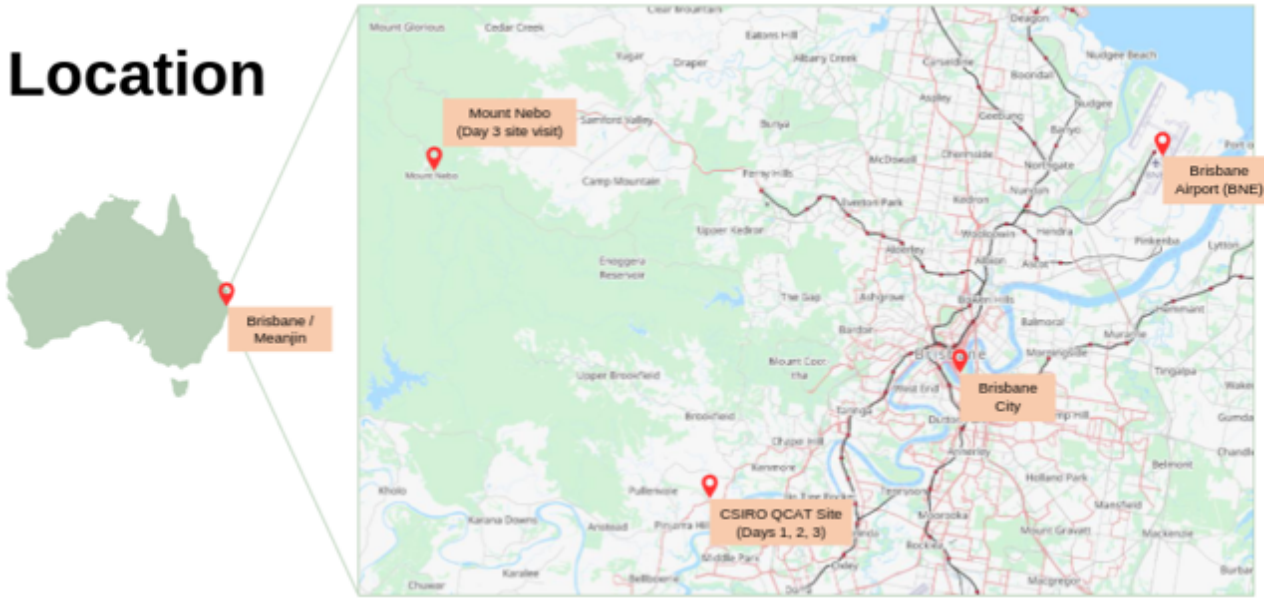

Figure 160 - Pilot site location in Australia

3.10.2 Participating stakeholders

The stakeholders in the Australian pilot exhibit a diverse range of typologies, each contributing with distinct activities and roles to the SILVANUS project as shown in Table 35.

Table 35 - Stakeholders and partners, Australian pilot

Stakeholder	*Activity Engaged*	*Role*
CSIRO	SILVANUS project member pilot demonstration owner	Pilot organisation UGV pilot demonstrations
UI SAV	SILVANUS project member technology partner	Present work on dashboards
KEMEA	SILVANUS project member observer	Presentation
VTG	SILVANUS project member technology partner	Presentation on leaf identification. Collecting data
Catalink	SILVANUS project member technology partner	Demonstration of static/dynamic smoke detection. Presentation
ASSET	SILVANUS project member observer	Presentation
ITTI	SILVANUS project member technology partner	Demonstration of UGV/smoke/social media data on map.
SGSP	SILVANUS project member, pilot observer	Support in pilot organisation. Pilot effectiveness assessment and replicability studies

Terraprima	SILVANUS project member, pilot observer	Pilot observation
Z&P	SILVANUS project member, pilot observer	Pilot observation
FRB MSR	SILVANUS project member, pilot observer	Pilot observation
Dr Sahani Hendawitharana	observer	QUT Wind and Fire Engineering Lab
Thanirosan Krishnakumar	observer	QUT Wind and Fire Engineering Lab
Dr Annabel Smith	observer/ presenter	UQ Fire management research
Dr Shane Campbell	observer	UQ Fire management research
John Atkinson	observer/ presenter	QPWS landscape fire management
Petra Kuhnert	observer/ presenter	CSIRO fire spread
Mark Walding	observer	QFES Area Commander Pullenvale
Dr Dmitry Bratanov	observer	QUT Wind and Fire Engineering Lab
Dr Anthony Ariyanayagam	observer	QUT Wind and Fire Engineering Lab
Jaye Buswell	observer	Firefighter QFES
Claire Krauss	presenter	Digital Earth Australia
Leeton Lee	presenter	Firesticks Alliance / cultural burning
Vincent Lemiale	presenter	CSIRO SPARK project

The Australian Silvanus pilot witnessed active engagement from diverse stakeholders, showcasing a collaborative effort towards the project's objectives. Key stakeholders and partners played a crucial role in the implementation of demonstration activities implemented during the first trial period activities.

3.10.3 Objectives

The demonstration activities of the Australian pilot have the following objectives:

- Show arm-on-vehicle capabilities for measuring localised ground conditions.
- Demonstrate static and dynamic (on-vehicle) smoke detection in forested environments.
- Demonstrate autonomous UGV exploration and navigation through dense forested environments, with attached smoke detector.
- Demonstrate forest analysics from UGV, sent and received from SAL.
- Demonstrate 3-robot map merging (including different robot types), allowing one officer to control multiple robots using simple point and click end points.
- Demonstrate dynamic obstacles, and the correct alignment of individual maps.

3.10.4 Description of performed activities

The Australian pilot was carried out over three days. The first day was a site tour with non-SILVANUS robot demonstrations, followed by talks from external speakers across Australia on their work related to bushfire management.

The second day was the full set of demonstrations in the morning, combining the work of four UPs. In the afternoon presentations by SILVANUS partners were held, reflecting recent work and demonstrating technologies.

The third day was an excursion to a transitional forest zone between Eucalypt and rainforest. This provided a real-world example of fire's influence on the ecology of a region. It also provided leaf input for the Woode App.

3.10.5 User product validation

Table 36 presents the UPs that has been tested during the execution of the Australian pilot, providing a short description of each one and their outcome from the tests.

Table 36 – User product, Australian pilot

Phase (A,B,C)	***Tested user product***	***Description***	***Outcome***
Phase A	UGV with arm	Robot arm on moving UGV was tested for ability to sense local humidity/ temperature and produce a map of this data.	Successfully demonstrated
Phase A	Static Smoke Detection (CTL)	Smoke detector on tree tested with smoke machine at multiple strength settings	Successfully demonstrated, showing 95-100% confidence in smoke detection.
Phase B	Dynamic smoke detection	Smoke detection from UGV in thick forest, approaching smoke.	Successfully demonstrated 97/98% confidence of detection. Results sent to SAL and data mapped from SAL.
Phase B	Autonomous UGV exploration	From no prior map, UGV explores towards specified fire point, generating map as it goes.	Mainly successful, the robot took longer than in previous tests (18 minutes rather than 10 minutes) as it explored a dead end first. This slower speed may also have been due to the field-of-view reduction due to the smoke detector.
Phase B	Autonomous UGV navigation	Robot with built map sent to/from base/fire front multiple times	Successfully demonstrated. The robot was sent to/from three times, and each took 30 minutes for approximately 60m of forest, and having the acquired map meant that the robot took no wrong turns.

Phase B	UGV forest analytics	Robot processes the local lidar data to assess the forest density using four metrics (canopy coverage, tree density, leaf area index and observation area)	Successfully demonstrated. The analytics were acquired, sent to SAL, received from SAL on a different laptop, and visualised on a map of the site.
Phase B	UP3 Fire detection based on social sensing	UP3 represents a significant advance in fire management, leveraging social media readiness to gather information in real time. At the heart of this system is the analysis of X's (tweets), through which you identify reports or clues of possible fires.	For the Australian pilot, UP3 in collaboration with the PUC leader produced 25 synthetic X's (Tweets) representing fire-related scenarios and generated a corresponding fire event. Subsequently, successfully posted these X's on X (Twitter) and meticulously crawled the data through the dedicated X crawler. The evaluation of this data was conducted through the user interface of SILVANUS via the Media Sensing layer.
Phase C	Multi-robot map sharing	Robots starting at different locations build their own maps and then match their maps in order to generate a union of all maps, for multi-robot operation	Successful demonstration. The three robots' maps were successfully aligned, the operator was able to control all three robots simultaneously through point and click operations.
Phase C	Robot dynamic obstacle avoidance	Barriers inserted after robots have passed their start point. The robots are then instructed to return to the near side of these barriers.	Successfully demonstrated. Despite the barriers not being in the initially generated map, the robots observed and avoided these barriers, before returning to the specified start position.
Phase A	UP7 Woode App	Capturing of biodiversity information from the pilot site	Successful testing of the first release of the mobile application.

UP3 – Social Media Sensing

CERTH demonstrated the pipeline used for capturing, aggregating, and displaying X's reporting a fire. The system crawls X's API (or posts on a Facebook group, or a particular website). If it detects potential reports, based on certain keywords, they are captured and unpacked (date, location, X text). Once this is done, the reports are aggregated and analysed. Those marked as real are then forwarded to the SILVANUS Cloud, which allows the dashboard to display them on the map (Figure 161).

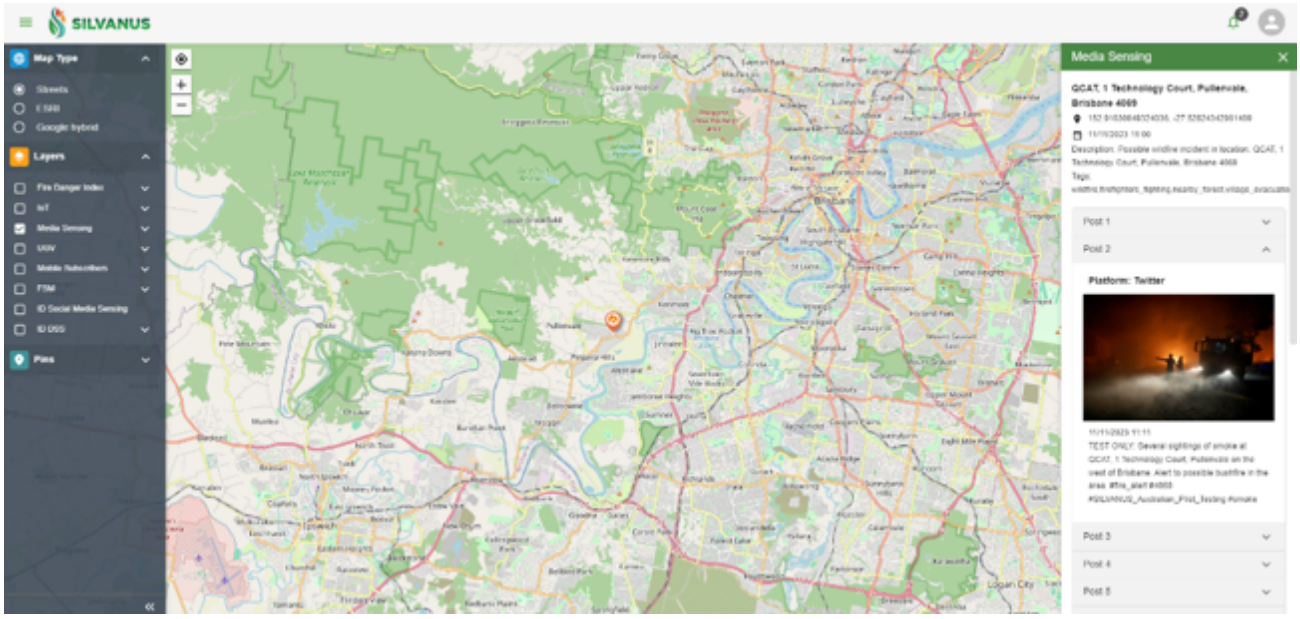

Figure 161 – Social Media Sensing layer on SILVANUS Dashboard

The presentation of SILVANUS user products to the regional and local community stakeholders were carried out and is presented in Figure 162

Figure 162 - Presentation of SILVANUS technologies to the external stakeholders

The landscape biodiversity was captured using the Woode App (UP7) and an overview of the landscape terrain is presented in Figure 166. Overall, the Australian pilot's user products exhibited consistent success in various scenarios, emphasizing their effectiveness in enhancing autonomous capabilities, environmental analytics, and multi-robot coordination (Figure 163 -Figure 166).

Figure 163 - Two different robots are being tested during operational validation

Figure 164 - Deployment of in-situ devices on the forest for smoke and fire detection

Figure 165 - SILVANUS and external stakeholders present during the pilot

Figure 166 - A visit to the national park to review the restoration and rehabilitation activities along with studying the biodiversity of the region

3.10.6 Strategic and operational challenges

The ground vehicle operation in forest environments has many challenges, such as:

- reliably sensing obstacles
- navigation in the presence of smoke
- distinguishing plants/grass (that can be driven over) from thin tree trunks (that shouldn't be driven over).
- how to align to and build on a previous map after a power cycle (e.g., the next day)
- multi-robot communication and map sharing
- semantic understanding of the scene (grass/wood/foliage/sky/road/mud)
- how to estimate foliage density, tree density and canopy coverage

3.10.7 Planning of 2024 pilot activities

Following the full-scale trial activity conducted in November 2023, CSIRO will continue its ongoing development of the robot platform. In 2024, the outcome of SILVANUS integrated platform development will be disseminated and promoted among the regional stakeholders. The results of full-scale field exercises from the European pilots will be disseminated to the stakeholders.

3.10.8 Conclusions

The Australian pilot was successfully delivered and brought together a range of different groups and technologies. Four partner technologies were utilized and demonstrated as one system (CSIRO, CTL, Dell, ITTI), along with the use of Woode App to capture the rich biodiversity of the forest (Figure 166) and the demonstrations crossed the three phases of wildfire response.

In addition, many external stakeholders were present, and presented their work. This brought in new insights into the Consortium, and new connections.

The unique aspects of Australian flora, cultural traditions and fire practices were also presented, which helped to extend the diversity of ideas on fire management.

4 Overall challenges encountered in SILVANUS 2023 pilot activities

The **common challenges of different pilots** include the following:

- Technological Deployment Challenges: Almost all pilots faced issues related to the deployment of cutting-edge technologies. From the need for waterproof and moisture-proof equipment to ensuring reliable internet connections, the pilots grappled with operational obstacles in setting up and using the required hardware and software. For instance, the France pilot faced challenges in deploying the EMC IoT Gateway due to its lack of waterproofing. This raised concerns about the device's placement in dry locations, protected from rain, and the need for a reliable power supply. The Italy pilot 2 highlighted the importance of considering a wired internet connection for the EMC IoT Gateway. This was due to potential interference in the wireless connection caused by atmospheric conditions like rain or intense heat. Italy pilot 2 encountered challenges in integrating different technologies, such as replacing wireless sensors with a USB camera connected to the gateway. The software limitations onboard the gateway also raised questions about processing power.
- Communication and Coordination: Communication emerged as a critical challenge for several pilots. Effective coordination between project partners, stakeholders, and local authorities was crucial for the success of the demonstrations. This challenge was particularly emphasized in Italy pilot 1, where coordination meetings and improved engagement with technology partners were deemed essential. For instance, the Czech pilot faced internal communication challenges leading to delays in arranging the CPD. This emphasized the importance of effective communication within the project Consortium. Italy (Sardinia) pilot experienced coordination challenges between partners, resulting in delays in receiving the trajectory map, which affected the execution of the pilot and the creation of navigation route maps on-site. Furthermore, Italy pilot 1 emphasized the need for improved coordination activities and highlighted the importance of technology partners' active engagement in pilot territories, especially in regions lacking technical expertise.
- Stakeholder Engagement and Awareness: Engaging stakeholders, raising awareness, and customizing technologies to local territories were shared challenges. Pilots highlighted the importance of involving local communities, political agents, and technology partners to address specific regional needs. Similarly, the Italy pilot 1 stressed the importance of customizing technologies based on individual territories, which involves understanding the specific needs and characteristics of each region and adapting solutions accordingly.
- Logistical Constraints: Logistics posed challenges, especially in remote areas. Accommodating participants, transporting them to demonstration sites, and ensuring the smooth movement of UPs presented hurdles that pilots needed to overcome.

These examples illustrate the concrete challenges faced by SILVANUS project pilots in deploying technologies, coordinating activities, engaging stakeholders, and managing logistics. Addressing these challenges is vital for the effective implementation of SILVANUS project’s objectives and the successful demonstration of innovative solutions for the cycle of wildfire management.

- Context-Specific Challenges: The challenges faced by each pilot often reflected the unique characteristics of their respective regions. For instance, Australia pilot faced distinct issues related to their environments, such as semantic understanding of scenes and navigating in the presence of smoke in forest environments.
- Awareness and Prevention Strategies: Italy (Sardinia) pilot emphasized improving awareness and exchange of experiences among local stakeholders. These distinct approaches highlight the context-specific nature of the challenges faced by each pilot.
- Climate and Weather-Related Challenges: Indonesia and Australia pilot faced challenges related to weather conditions, including the instability during the rainy season or the heat affecting pilot visits. Such climatic factors added complexity to on-site activities and required adaptations to the project timeline.

- Timing and Project Activity Challenges: The timing of project activities emerged as a challenge for Italy pilot 2, especially concerning the restoration activity of chosen trees. The clash with other pilot tasks emphasized the need for strategic planning to synchronize various components of the project.

As such, the comparative analysis reveals a complex landscape of challenges faced by the 12 SILVANUS pilots. Shared difficulties in technology deployment, communication, and stakeholder engagement highlight universal concerns, while context-specific challenges underscore the need for tailored solutions. Recognizing these commonalities and differences is essential for the collaborative success of the SILVANUS project, allowing for the exchange of lessons learned, best practices and the refinement of strategies for future phases.

5 Addressing challenges

Based on the challenges encountered and the mitigation actions proposed by the SILVANUS project pilots during the first trial period activities, below is list of recommendations to address and overcome these challenges. Among the most pressing challenges, strategic planning for technological deployment, robust communication and coordination among pilots and technology providers, as well as logistical planning and flexibility have been highlighted.

Ensure strategic and operational planning for technological deployment. Each technology provider and pilot owner need to check that technologies are equipped with necessary resources (power, water, Wi-Fi, etc.) for successful operation. Checking technical aspects might include addressing issues related to device specifications, such as waterproofing and power supply distance, during the planning phase, establishing a robust telecommunication system in remote areas to ensure effective communication among technologies and first responders or addressing logistical constraints in remote areas, including accommodation, transportation, and terrain planning. Furthermore, it is important to establish a feedback mechanism to collect insights from stakeholders and make necessary adjustments to logistics and other technical requirements. For example, pilots should factor in weather conditions during the planning phase and make adaptations to the project timeline accordingly and develop contingency plans for unexpected weather-related challenges.

Plan pilot visits well in advance and establish an effective communication between pilot owners and technological providers. This recommendation focused on the creation of a storytelling for future pilot, with a more structured approach (e.g., setting the date and the overall objectives for at least six months ahead, defining what UPs that will be tested in certain periods with at least six months ahead, prepare agenda to be circulated among partners with at least three months ahead). A better preparation of demonstration activities should also include continuous communication between pilots and technology providers to prepare all the technical aspects and avoid delays and misunderstandings. The WP 9 coordinator will support efficient communication between partners involved in demonstration activities and will schedule coordination meetings and pilot visits with technology partners in advance to accommodate all participants.

Establish more efficient coordination between the different pilot participants and between pilots themselves. This recommendation is focused on facilitating the exchange of experiences and best practices among local stakeholders, as highlighted by Italy (Puglia) pilot, but also among different pilots engaged in SILVANUS project.

Ensure that the Integrated Fire Management (IFM) approach is embedded in the Integrated Technology and Information Platform for Wildland Fire Management.

Ensure that all these UPs' could be integrated into a Decision Support System (DSS) embedded within the platform.

It is crucial to ensure an interoperability approach when these products are integrated into an existing system within a country (e.g. the command centre of the fire brigade in the Czech Republic)). These recommendations aim to enhance the overall effectiveness of the SILVANUS project by addressing common challenges and ensuring a collaborative, adaptive, and context-aware approach to integrated wildfire management. These results are aimed to lead the way to better plan and organise future pilot activities.

6 Conclusions and future work

In summary, during the year of 2023 from April to November a total of 10 pilots have been organised, spanning over a period of eight (8) months across seven (7) EU member states and two (2) international countries. A total of four (4) field exercises were successfully executed, in which the technology partners, stakeholders, and external participants actively engaged. Additionally, a total of four (4) tabletop exercises were carried out (which includes a pilot site visit to collect the relevant data from the field for subsequent processing). The two (2) international field exercises were also successfully conducted offering the SILVNAUS project a unique opportunity to interact with the interdisciplinary stakeholders with vast amounts of experiences in combating wildfires. It is also worth noting the visit in Indonesia allowed the participants of SILVANUS to experience and witness the challenges encountered by first responders when dealing with peat fires. The overall coordination and the logistics planning that was required to execute the 10 pilot activities was successfully achieved within SILVANUS through strong collaboration and cooperation among all the partners.

As presented in Chapter 2, in each pilot activity, a set of user products were demonstrated to the stakeholders. While the formal assessment of the pilot outcome will be published in D9.3 (due March 2024, M30), a preliminary assessment of the functionalities has been used to revise the SILVANUS architecture (D8.4) planned for the final release by M30 (March 2024). The extensive organisation of the pilots in 2023 allowed the SILVANUS partners to actively continue the utilisation of the participatory approach that was well established and reported in D2.1 (at M8). The review of case-studies during the tabletop exercises, have been instrumental in the development of the complex scenario analysis on wildfire causes and consider the failure of wildfire suppression methodologies that would be deployed resulting in worst-case scenario to be tackled by the first responders.

The pilot participation of the technical partners has offered the opportunity to identify the operational requirements of the first responders to ensure each user role interacting with the platform is offered the right amount of information to make time critical decisions. This requirement will be reflected in the release of the revised SILVANUS platform deliverable (D8.5, planned for submission in M32), that will incorporate the use of the forward command centres (also referred to as incident command posts). The adoption of AI based technologies for the development and visualisation of time-bound information will be further validated in the context of IFM based scenarios to be demonstrated in the next round of pilots planned for execution in 2024.

Deliverable 9.2 reports on the first trial period activities conducted by the 10 pilots, the results were presented as a collection of cases analysed to highlight common challenges and identify recommendation to better tailor and improve the demonstration actions.

The knowledge and experience gained from the active participation of 10 pilots in 2023 will be leveraged by SILVANUS consortium to execute IFM based field exercises that are to be scheduled in 2024. The challenges outlined in Chapter 4, will be addressed during the 2024 field exercises that are planned for execution in 2024.

ANNEX 1. Questionnaire Template on first trial period activities

1. SILVANUS PILOT DEMONSTRATION DESCRIPTION

1.1. Inputs for each pilot
1.2. Strategic and operational challenges

- *Include a clear map of the area, the location of the pilot, when it occurred, who were the Consortium members participating in the pilot and the stakeholders, representative photos (maximum 3) and provide a narrative description of the activities.*
- *What challenges did you encounter in organizing the first pilot demonstration?*

2. SPECIFIC STEPS FOR EACH PHASE. TECHNOLOGY PROVIDERS CHALLENGES / ISSUES FOR EACH PILOT AND ACTIVITY

Phase (A,B,C)	*User product (UP..)*	*Description*

Please provide a narrative description of the way SILVANUS technologies enhance the intervention capabilities in a case of a forest fire.

In the table below, the specific objectives for the ..... pilot are presented with the related activities and Key Performance Indicators (KPIs):

Phase	*Objective*	*Activity*	*KPI's*
Phase A			
Phase B			
Phase C			

3. NEXT STEPS, THE DATE AND LOCATION OF THE PILOT DEMONSTRATION

Please specify which steps you plan to take in the intermediate period before the final pilot demonstration?

4. CONCLUSIONS

- *Please include a short description of the expectations versus reality after the first trial.*
- *What can be improved?*
- *What's your plan for mitigating the potential challenges?*
- *What changes do you bring (if it's the case) comparative with the initial plan?*