D9.1 - Report on organisational readiness of the pilot setup

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101037247

Horizon 2020
European Union Funding
for Research & Innovation

Project Acronym	SILVANUS
Grant Agreement number	101037247 (H2020-LC-GD-2020-3)
Project Full Title	Integrated Technological and Information Platform for Wildfire Management
Funding Scheme	IA – Innovation action

DELIVERABLE INFORMATION

Deliverable Number:	D9.1
Deliverable Name:	SILVANUS Report on organisational readiness of the pilot setup
Dissemination level:	CO (confidential)
Type of Document:	R
Contractual date of delivery:	31/03/2023 (M18)
Date of submission:	31/03/2023
Deliverable Leader:	ASFOR
Status:	Final
Version number:	0.7
WP Leader/ Task Leader:	WP9 – ASFOR
Keywords:	Operational readiness, pilot setup, deployment, resources, permits, trials, process, procedures, timeline
Abstract:	The aim of D9.1 is to ensure that all pilots are ready from an operational point of view and report on the administrative approvals received from organisational management team to ensure the pilot activities as planned within WP9 will be carried out. Additionally, this entails that each pilot has also been able to identify and plan for relevant activities to be implemented (for Phase A, B and C) of the SILVANUS outcomes. Furthermore, the deliverable provides a general overview of their planning and sequence, including, as much as possible the future integration of technologies with the SILVANUS platform, and thus, the technical requirements.

Lead Author(s):	Mircea Segarceanu, Ciprian Musca (ASFOR)

Reviewers:	VTG, PEGASO, KEMEA

Disclaimer

All information in this document is provided “as is" and no guarantee or warranty is given that the information is fit for any particular purpose.

The user there of uses the information at its sole risk and liability. For the avoidance of all doubts, the European Commission has no liability in respect of this document, which is merely representing the authors’ view.

Document History			
Version	**Date**	**Contributor(s)**	**Description**
V0.1	12.10.2022	ASFOR	D9.1 Structure
V0.2	02.11.2022	ASFOR	Restructuring and integration of partners' contributions
V0.3	25.02.2023	ASFOR	D9.1 Draft circulated to partners
V0.4	09.03.2023	ALL task 8.1 partners	Round of contributions to all chapters added
V0.5	17.03.2023	ASFOR	D9.1 Circulated for internal review
V0.6	28.03.2023	ASFOR	Integrated feedback from internal review and finalised the deliverable for submission
V0.7	26.09.2023	ASFOR	Reviewed D9.1 integrating feedback received from PO and external reviewers

List of beneficiaries

No	Partner Name	Short name	Country
1	UNIVERSITA TELEMATICA PEGASO	PEGASO	Italy
2	ZANASI ALESSANDRO SRL	Z&P	Italy
3	INTRASOFT INTERNATIONAL SA	INTRA	Luxembourg
4	THALES	TRT	France
5	FINCONS SPA	FINC	Italy
6	ATOS IT SOLUTIONS AND SERVICES IBERIA SL	ATOS IT	Spain
6.1	ATOS SPAIN SA	ATOS SA	Spain
7	EMC INFORMATION SYSTEMS INTERNATIONAL	DELL	Ireland
8	SOFTWARE IMAGINATION & VISION SRL	SIMAVI	Romania
9	CNET CENTRE FOR NEW ENERGY TECHNOLOGIES SA	EDP	Portugal
10	ADP VALOR SERVICOS AMBIENTAIS SA	ADP	Portugal
11	TERRAPRIMA - SERVICOS AMBIENTAIS SOCIEDADE UNIPESSOAL LDA	TP	Portugal
12	3MON, s. r. o.	3MON	Slovakia
13	CATALINK LIMITED	CTL	Cyprus
14	SYNTHESIS CENTER FOR RESEARCH AND EDUCATION LIMITED	SYNC	Cyprus
15	EXPERT SYSTEM SPA	EAI	Italy
16	ITTI SP ZOO	ITTI	Poland
17	Venaka Treleaf GbR	VTG	Germany
18	MASSIVE DYNAMIC SWEDEN AB	MDS	Sweden
19	FONDAZIONE CENTRO EURO-MEDITERRANEOSUI CAMBIAMENTI CLIMATICI	CMCC F	Italy
20	EXUS SOFTWARE MONOPROSOPI ETAIRIA PERIORISMENIS EVTHINIS	EXUS	Greece
21	RINIGARD DOO ZA USLUGE	RINI	Croatia
22	Micro Digital d.o.o.	MD	Croatia
23	POLITECHNIKA WARSZAWSKA	WUT	Poland
24	HOEGSKOLAN I BORAS	HB	Sweden
25	GEOPONIKO PANEPISTIMION ATHINON	AUA	Greece

No	Partner Name	Short name	Country
26	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	Greece
27	PANEPISTIMIO THESSALIAS	UTH	Greece
28	ASSOCIACAO DO INSTITUTO SUPERIOR TECNICO PARA A INVESTIGACAO E DESENVOLVIMENTO	IST	Portugal
29	VELEUCILISTE VELIKA GORICA	UASVG	Croatia
30	USTAV INFORMATIKY, SLOVENSKA AKADEMIA VIED	UISAV	Slovakia
31	POMPIERS DE L'URGENCE INTERNATIONALE	PUI	France
32	THE MAIN SCHOOL OF FIRE SERVICE	SGPS	Poland
33	ASSET - Agenzia regionale Strategica per lo Sviluppo Ecosostenibile del Territorio	ASSET	Italy
34	LETS ITALIA srls	LETS	Italy
35	Parco Naturale Regionale di Tepilora	PNRT	Italy
36	FUNDATIA PENTRU SMURD	SMURD	Romania
37	Romanian Forestry Association - ASFOR	ASFOR	Romania
38	KENTRO MELETON ASFALEIAS	KEMEA	Greece
39	ELLINIKI OMADA DIASOSIS SOMATEIO	HRT	Greece
40	ARISTOTELIO PANEPISTIMIO THESSALONIKIS	AHEPA	Greece
41	Ospedale Israelitico	OIR	Italy
42	PERIFEREIA STEREAS ELLADAS	PSTE	Greece
43	HASICSKY ZACHRANNY SBOR MORAVSKOSLEZSKEHO KRAJE	FRB MSR	Czechia
44	Hrvatska vatrogasna zajednica	HVZ	Croatia
45	TECHNICKA UNIVERZITA VO ZVOLENE	TUZVO	Slovakia
46	Obcianske zdruzenie Plamen Badin	PLAMEN	Slovakia
47	Yayasan AMIKOM Yogyakarta	AMIKOM	Indonesia
48	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION	CSIRO	Australia
50	FUNDACAO COORDENACAO DE PROJETOS PESQUISAS E ESTUDOS TECNOLOGICOS COPPETEC	COPPETEC	Brazil

Table of Contents

Index of figures

Index of tables

List of acronyms and abbreviations

ACRONYM	Description
AP	Action Point
CA	Consortium Agreement
DoA	Description of Action
DX.Y	Deliverable X. Y (X refers to the WP and Y to the deliverable in the WP)
EAB	External Advisory Board
EC	European Commission
ECAS	European Commission Authentication Service
EU	European Union
EIM	Exploitation and IP Manager
GA	General Assembly
IPRs	Intellectual Property Rights
KoM	Kick-off Meeting
KPI	Key Performance Indicators
PAC	Project Administrative Coordinator
PM	Project Manager
PQP	Project Quality Plan
RP	Reporting Period
SC	Steering Committee
QAC	Quality Assurance Coordinator
QAM	Quality Assurance Manager
QAP	Quality Assurance Plan
SIC	Scientific and Innovation Coordinator
TL	Team Leader
ToC	Table of Contents

WP	Work Package
WPL	Work Package Leader

EXECUTIVE SUMMARY

The objective of WP9 is to facilitate the continuous evaluation of the SILVANUS scenarios across eight (8) pilot demonstration sites from EU member states and three (3) international regions. As part of Task 9.1, the deliverable 9.1 *reports on the organisational readiness of the pilots' setup,* which represents a summary of the deployment of the pilot demonstration of every country involved in this task.

The role of the report is to ensure that all pilots are ready from an operational point of view, each pilot has defined and planned the activities that are to be implemented and has a general overview of their sequence, including, as much as possible, the future integration of technologies with the SILVANUS platform, and thus, the technical requirements. Every pilot demonstration in the countries involved in this task includes a common structure with information about: the *Silvanus platform inputs* (the description of the pilot location, the objectives of the pilot demonstration, and the phases dedicated for each location), the *operational scenario* (the objectives of every phase of the pilot and the activities that will be done), and the *logistical considerations* (a detailed description of the planning of the pilot demonstration).

The pilot demonstrations aim to test, validate, and evaluate the SILVANUS technological platform and its components in different contexts (scenarios, climate, weather conditions and so on). Below there are some exemplifications for some of the pilots:

- **France** will deploy a pilot demonstration of a forest fire due to an industrial accident in a plant.
- **Italy** will test fire and hydrogeological risks.
- **Romania** will approach fire ignition caused by human negligence in a National Park.
- **Greece** pilot demonstrates the impact of wildfires on agricultural sector.
- **Portugal** will test powerline disruptions resulting in accidental fires.
- **Czech** pilot will test preparedness and response coordination in countering wildfires in one of the most visited tourist resorts in the Czech Republic.
- **Slovakia** pilot will consider policy recommendations on restoration of forest landscape.

Some challenges were identified because different fires require a combination of different resources, and deciding where to deploy them involves careful analysis of fire behaviour, accessibility, and logistical considerations. Interventions require prioritisation, with limited resources going to the most critical needs as homes, infrastructure, or sensitive ecosystems. Fighting forest fires often requires the coordination of multiple agencies, including federal, state, and local authorities, as well as private entities and the coordination between agencies can be challenging due to differences in resources, priorities, and procedures.

D9.1 integrates the complexity of the SILVANUS project into a structured general overview that can then be implemented through the different activities. Operational readiness sets a common baseline for all pilot sites and facilitates a first-round integration between technology providers, pilot sites and the design of the SILVANUS platform.

1. INTRODUCTION

SILVANUS is envisaged to develop an innovative platform for an environmentally sustainable and climate resilient forest management that aims to provide technological and decision-making support in the preparedness (Phase A), response (Phase B) and recovery (Phase C) phases (Figure 1) of wildfire management cycle and increase the human, environment and economy resilience to wildfires.

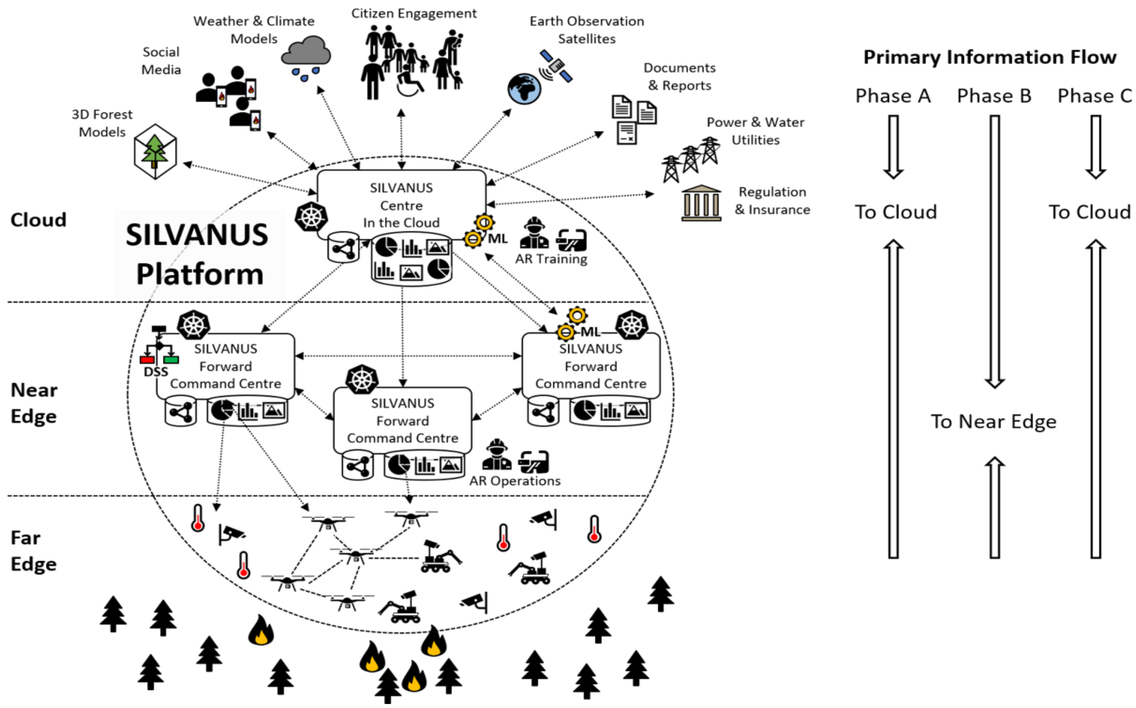

Figure 1. SILVANUS project approach

The project outcomes are systematically categorised into outputs which will be integrated and demonstrated within the platform across each of the pilot scenarios. The results will form the basis for the development of formal assessment methodology for the evaluation of effectiveness of the platform. Each of the project outcomes are categorised into different phases in combating against the spread of wildfires. The approach will undertake interdisciplinary technical and scientific innovation activities that caters to the needs of key stakeholders including environmentalists, conservationists, technology providers, forest administration authorities and local communities. The platform is envisaged to be designed to support the knowledge base of interdisciplinary teams, with the integration of linguistic toolkit based on semantic technologies.

The project innovation carried out will be systematically demonstrated across eight (8) EU and three (3) non-EU sites. An overview of the locations in which the pilot activities are to take place is presented in Figure 2. The six (6) common causes of fire ignitions will be assessed, and dedicated scenarios will be identified for the organisation of technological intervention.

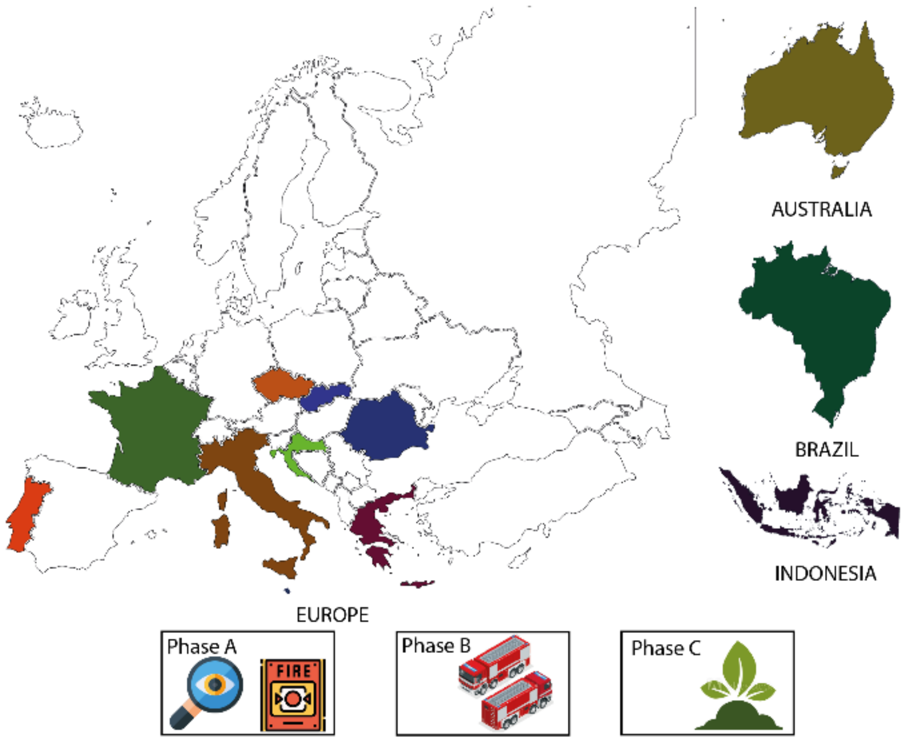

Figure 2. SILVANUS pilot demonstration sites

Each pilot demonstration is divided into three main phases, namely (i) preparation and organisation; (ii) demonstration; and (iii) assessment evaluation. To achieve the demonstration, the consortium has identified two organisation deployment to be carried out within the consortium. An organisation deployment refers to the base installation of the SILVANUS platform within the trial organizer premises or the provision of dedicated access to the cloud installation of the specific user.

The deliverable *D9.1 – Report on organisational readiness of the pilot setup* reports on the activities carried out by pilot demonstration organisations with platform installation. Such activities include gaining permissions for the pilot demonstrations, IT resources, in-situ sensors, relevant data collected from earth observation and others. The deliverable is based on the ongoing interaction between pilot leaders and their local stakeholders and as well as exchange of best practices among pilot leaders regarding the tackling of similar challenges.

1.1 Scope of the deliverable

D9.1 is part of WP 9 - Large-scale demonstration activities of project outcomes. The objective of this WP is to facilitate continuous evaluation of the SILVANUS scenarios across eight (8) pilot demonstration sites from EU member states and three (3) international regions (Figure 2). The following specific objectives are 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.

D9.1 is the first outcome of Task 9.1 - Organisational readiness for pilot demonstration. The two objectives of this task are (i) to ensure the transfer of SILVANUS platform deployment within the first responder premises and (ii) to continuously monitor the data management policies across pilot sites. The task will be responsible for obtaining organizational permissions, identification of resources to perform the Phase A, B and C trials. The processes and procedures adopted for modelling the interdependencies will be documented and will act as a ground truth for the validation of field exercise outcomes. Additionally, the task will map all relevant data protection laws and formal regulations and at the time create a comprehensive overview of relevant ethical principles for information aggregated from demonstration regions.

The aim of the process that D9.1 is based on was to ensure that all pilots are ready from an operational point of view. This entails that each pilot has defined and planned the activities that are to be implemented and has a general overview of their planning and sequence, including, as much as possible the future integration of technologies with the SILVANUS platform, and thus, the technical requirements.

Based on the above structure, and the methodology that is presented below, the goal was set to be ready with all necessary logistical and organizational permits and to identify access to the relevant resources in order to effectively perform Phases A, B and C – given the fact that some pilots are set in remote areas, enabling access to electricity and internet especially was of importance; also some locations (e.g. natural parks) have strict regulations regarding the setting of technical infrastructure and intervention procedures.

1.2 Relation with other WPs

WP9, together with WP8 – Platform design specification, interfaces and integration, constitute the Integration and Demonstration part of the SILVANUS project. WP8 and WP9 are interdependent and feed information to one another. They provide output to WP2 and WP10 and also integrate changes from the other WPs. In this context, D9.1 is the main green flag that signals the readiness for the implementation of pilot activities related to Phases A, B and C.

1.3 Overview of the working methodology

1.3.1 Need of operational readiness in the context of pilot operationalisation

SILVANUS has an innovative approach based on the engagement of all relevant stakeholders, including environmental scientists, forest conservationists, regional councils, fire fighters, first responders and technology providers, agricultural scientists, and citizens. This adds a strong layer of complexity with regard to integration of information from all stakeholders into a coherent set of activities, associated to each Phase.

Part of the role of Task 9.1 is to integrate this complexity into a structured general overview that can then be implemented through the different activities. Operational readiness sets a common baseline for all pilot sites and facilitates a first-round integration between technology providers, pilot sites and the design of the SILVANUS platform.

The main challenge to be addressed is matching technology providers and pilot sites into an implementable and congruent operational scenario. The initial expectation was that this would be achieved uniformly across all pilot sites. In addition, integration of technologies with SILVANUS platform was to also be explored.

D9.1 rationale is to integrate and synthetize a methodology for reaching green operational readiness across pilot sites. Successful implementation of activities for Phases A, B and C depends on clear planning and availability of necessary resources.

The main structure of the organizational readiness indicators is presented below.

- Permissions
  - ✓ Bureaucratical process awareness
  - ✓ Clear timeline and pilot process
  - ✓ Obtaining necessary permits
- Recruitment of stakeholders
  - ✓ Recruitment of relevant stakeholders
  - ✓ Setting up procedural framework
  - ✓ Signature of MoUs and/or collaboration agreements
- Requirements on the activities to be performed
  - ✓ Logistical requirements
  - ✓ Human resource
  - ✓ Available infrastructure
- Data sets to be analysed
  - ✓ Process framework

1.3.2 Methodology and timeline

In order to reach the desired outcome, a working methodology was developed. It included regular structured meetings, exchanges and development of an input collection tool, in the form of a questionnaire for the assessment of the operational readiness of each pilot.

The methodology followed the structure presented below.

1. Background and purpose of the pilot
2. Pilot Objectives
3. Pilot KPI's
4. Activities in the pilot according to objectives and KPI's
5. Technology used in the planned activities. Description, tools, utility
6. Identify partners, stakeholders and end users involved in the pilot
7. Timeline detailed based on the planned activities
8. Plan for data collection and analysis on each activity
9. Details regarding other features of the pilot important for permits and consent of participants
10. Assign partner responsible for each activity of the pilot. Describe responsibility and impact within the planned activities

The timeline for the deliverable was as follows:

- Establishment of bi-weekly meetings for WP9
- October 2022: development of operational readiness questionnaire based on common discussions
- November 2022: Identification of operational requirements for each pilot and establishment of timeline for each pilot
- December 2022: Update of the process
- January 2023: Input collection from partners
- February 2023: First draft of D9.1 available and input collection from partners on the draft
- 17 March 2023: D9.1 submitted to CO for internal review

At the start of Task 9.1 (M12), a WP 9 Kick-off meeting (KoM) was hosted with all involved partners. In that meeting, a decision was taken to have biweekly WP 9 meetings (until D9.1 submission) focused on Task 9.1, and more specifically, on D9.1. At the same KoM, a timeline for the implementation of activities was agreed upon and the general structure of D 9.1 was presented.

In subsequent meetings the following aspects were discussed:

- Best practices from the Italian pilot;
- Development of operational readiness questionnaire and clarifications;
- Encountered challenges and best practices in addressing them;
- Integration into SILVANUS platform;
- Interaction with stakeholders;
- Follow-up on needed permits;
- Beginning of matching between technology providers and pilots;
- Future visit to Croatian and Slovak pilots.

The management team also provided support in filling in the questionnaire for different partners and also held a meeting with WP8 management with the aim to best align with the Integration part of the project.

All meetings' recordings are saved on the project share web together with all relevant documents and collected input from partners.

Data collection from partners was followed up and all needed support was given in order to receive the questionnaires in a timely manner. In addition, the overall objective of a green operational light for pilot's activities was followed and always put into perspective.

The overall structure of the operational readiness questionnaire is presented below, and the detailed template is presented in Annex 1:

- Strategic and operational challenges
- Roles and activities of stakeholders and partners
- Operational scenario
- User stories
- Organisational requirements and permits
- Field visit planning

2. OPERATIONAL READINESS OF PILOT SITES

This section presents the detailed reports regarding the operational readiness of pilot sites, based on the interaction with pilot leaders and questionnaires.

2.1 France Pilot – Forest fire with industrial accident in highly explosive plant

2.1.1 Silvanus platform inputs

Background and context of the Pilot

The geographical context: Haute-Vienne is a region that can be classified as wooded but not densely forested. Tree coverage is relatively high in area, although large continuous forests are rare. The territory of Haute-Vienne presents fragmented afforestation. Total forest area nevertheless represents nearly 150,000 hectares (27% of the region).

The forests of Haute-Vienne are populated essentially with oaks, chestnuts and beeches. La Châtaigneraie Limousine, extends over a major part of the region, essentially over half the South part.

Softwood reforestation, associated with strong meadow precipitations, allows for productive forests. These softwood forests are found mainly in the region of Eymoutiers and in the Monts de Blond and Ambazac. In Basse Marche, towards Saint-Sulpice-les-Feuilles, the mild climate is favourable to the Charm that accompanies frequently the Oak.

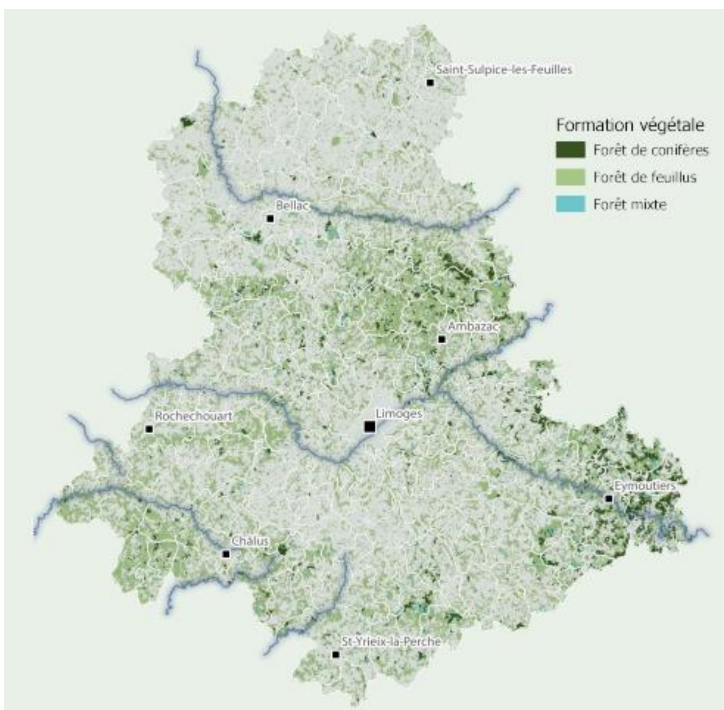

Figure 3. Map of the Haute-Vienne region, France

Map of the pilot area:

Location: St Sylvestre – Near EPC site
Pilot location (latitude, longitude) : site of fire : 46° 1' 9" N 1° 22' 30" E
For the site SEVESO : 46° 1' 18" N 1° 22' 40" E

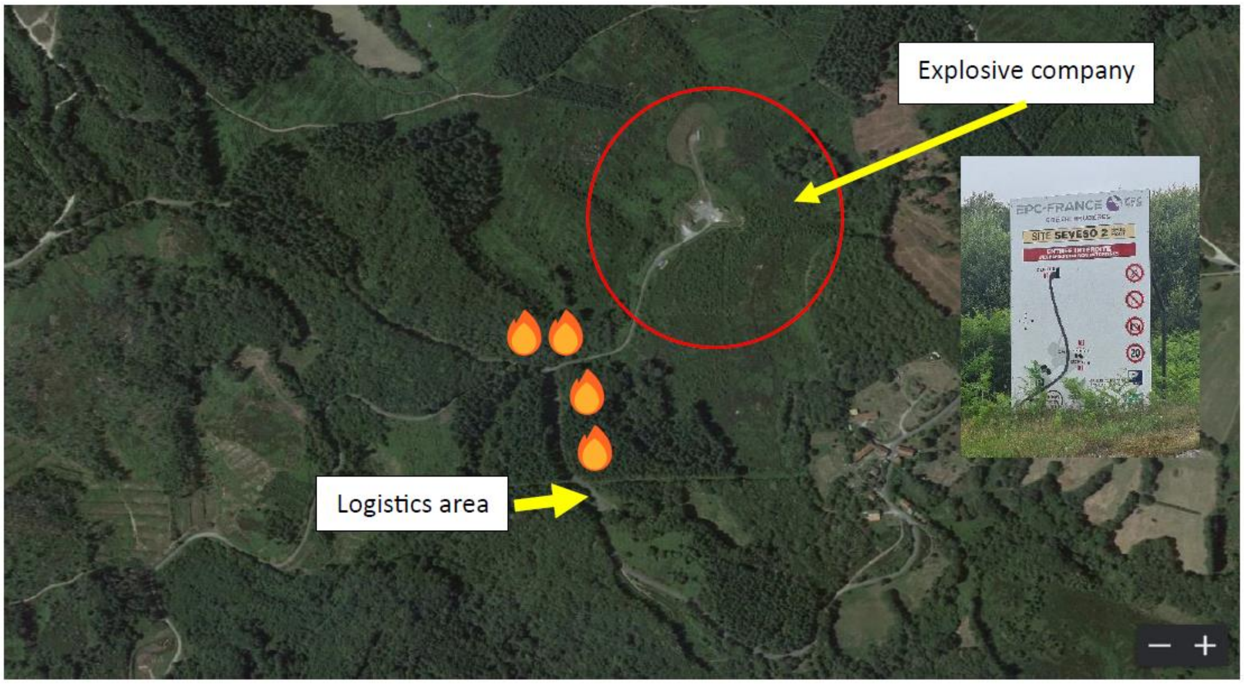

Figure 4. Map of the pilot area, France

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

- deployment of the different technologies and ease of use;
- rapid mapping of the area and the access road;
- anticipation of the spread of the fire in relation to the vulnerability of the explosive company;
- deployment of the robot and drones to monitor the situation and analyze 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)

Use Case. Motivation and Rationale

Many industries with high risk of human factor are situated near residential or rural areas. Managing a major accident in a delicate situation of forest fire is a challenge, and with the production of smoke cloud and explosive, it is always important to minimize further risks. In the scenario of the pilot, we consider the fire spread to the direction of a SEVESO2 company with explosives storage, detonator and one truck with Ammonitrate in the car park of the company.

Figure 5. Height and species of trees in the pilot area

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.

2.1.2 STAKEHOLDERS AND PARTNERS. ROLES AND ACTIVITIES

Table 1 - Stakeholders and partners, French pilot

Stakeholder	*Activity Engaged*	*Role*
SIMAVI	Training FR in VR/AR, simulation of real fire,	Scientifical and technical partner
MASSIVE DYNAMIC	Test on the field with people, school children, municipality	Technical partner
CTL	Detection of the fire	Technical partner
3MON/UISAV	Reconnaissance, analysis of the air, mapping, detection	Technical partner
EXUS	Anticipation of the spread, information to the command post	Technical partner
ITTI	Interface of users	Technical partner
PUI France	Firefighters	First responder firefighters

2.1.3 Operational scenario

Scenario description

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:

- mapping of the area;
- identification of access paths;
- 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.

Kinetics and chain of events

The previous stages of the scenario will permit, by identifying the possible outbreaks of fire, the elements and human actions that may have an impact on the fire, to identify the possible components of the fire scenarios which will lead to a threat.

→ **Fire start**: proximity to a traffic lane, mapping;
→ **Nature of vegetation**: mixture of deciduous and coniferous trees varying the speed of propagation, use of different sensors;
→ **Propagation**: high speed given a strong wind, of the order of 70 to 80 km / hour;
→ **Direction**: the fire is developing towards a production unit for explosive products;
→ **Anticipation:**

- calculation by the command post of propagation cones, mapping;
- identification of threatened targets, nature and quantities;
- possible chronological sequence, anticipation scenario;
- anticipation of the escape of the people that are present in the area regarding the propagation of the fire.

Expected outcomes

Table 2 - Expected outcomes, French pilot

Phase	*Expected outcome*
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 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 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)

Table 3 - User products, French pilot

Phase (A,B,C)	***User product (UP..)***	***Description***
A, B	AR/VR Toolkit	Training FR in VR/AR, simulation of real fire
A	Citizen engagement mobile application	Test on the field with people, school children, municipality
A	Fire detection	Detection of the fire
B	UAV/UGV	Reconnaissance, analysis of the air, mapping, detection
B	Fire spread forecast	Anticipation of the spread, information to the command post
B	User interface	Interface of users
B	UAV to complete the action of UGV Command post on the field Extinguishing the fire with high pression Security and safety Presentation of new equipment and trucks	Firefighters

Objectives and KPIs:

- Training fire fighters in VR/AR, simulation of real fire
- Testing on the field
- Detection of the fire
- Reconnaissance, analysis of the air, mapping, detection
- Anticipation of the spread, information to the command post

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

Table 4 - Objectives and KPIs, French Pilot

Phase	*Objective*	*Activity*	*KPI's*
A1. Prevention and preparation	OA1.1 To contribute to project innovation development and to improve the prevention phase through the introduction of innovative technological solutions (installation of sensors)	**Monitoring tools**	KPIA1.1 At least 1 new innovative technology or other system / tool / instrument for fire prevention adopted (gateway + sensor/s) - monitoring station
	OA1.2 To increase public/citizen awareness alerting system via a Citizen engagement toolkit (mobile application) for signalling accidental fires and activate mitigation strategies		KPIA1.2 Citizen engagement activities promoted and citizen-engagement-toolkit used through the involvement of 5 local authorities (municipalities) and 3 local schools. We foresee 40 people using the app.
A2. Prevention and preparation	OA2 To increase awareness of young generation on forest management and risks, sensitization campaign	**Stakeholders and school involvement**	KPIA2 Organization of a short course (3 hours of lessons) in 3 local schools (40 participants of 12-14 age) in 5 different municipalities about biodiversity and forest management, in cooperation with main stakeholders (Prefecture, Firefighters, NGO)

B. Detection and Response	OB1.1 To contribute to project innovation development and to improve the detection and response phase through the introduction of innovative technological solutions (installation of sensors)	**Monitoring tools**	KPIB1.1 At least 1 new innovative technology or other system / tool / instrument for early detection adopted (gateway + sensor/s) - monitoring station
	OB1.2 To facilitate the identification of fire ignition through the active collaboration of citizens		KPIB1.2 At least 50 citizens informed about the importance of their active collaboration in the fire detection phase through social media identified in the framework of SILVANUS
B. Detection and Response	OB2 Instant communication through direct and digital systems	**Control and evaluation**	KPIB2 1 test of communication among direct observer, mobile application results and innovative technologies monitoring and timing of the communication
C. Restoration and Adaptation	OC1 To contribute to build knowledge base to intervene after fire event it will be improved a restoration document on the adoption of different strategies	**Public engagement**	KPIC1 Observations to restoration document contained in AIB Plan by all the stakeholders involved in the previous phases (municipalities, external experts, public authorities, private landowners)

C. Restoration and Adaptation	OC2 In order to define best restoration strategies and vegetation, different kinds of vegetation will be planted in one already burnt area	**Test in burnt area**	KPIC2 Involvement of main stakeholders (Firefighters, forest expert, prefecture) in order to test and monitor 3 species of restoration trees

2.1.4 Receiving requirements & permits

Safety and security : we have an official decree from the mayor of St. Sylvestre : the road will be closed during the pilot and controlled by police.
A meeting was organized with the military police to present the pilot and the participants.

Drones : as first responder and member of the civil protection, we have an authorization to use the drones of PUI during the pilot in St Sylvestre. The prefecture will be informed and present for the pilot.

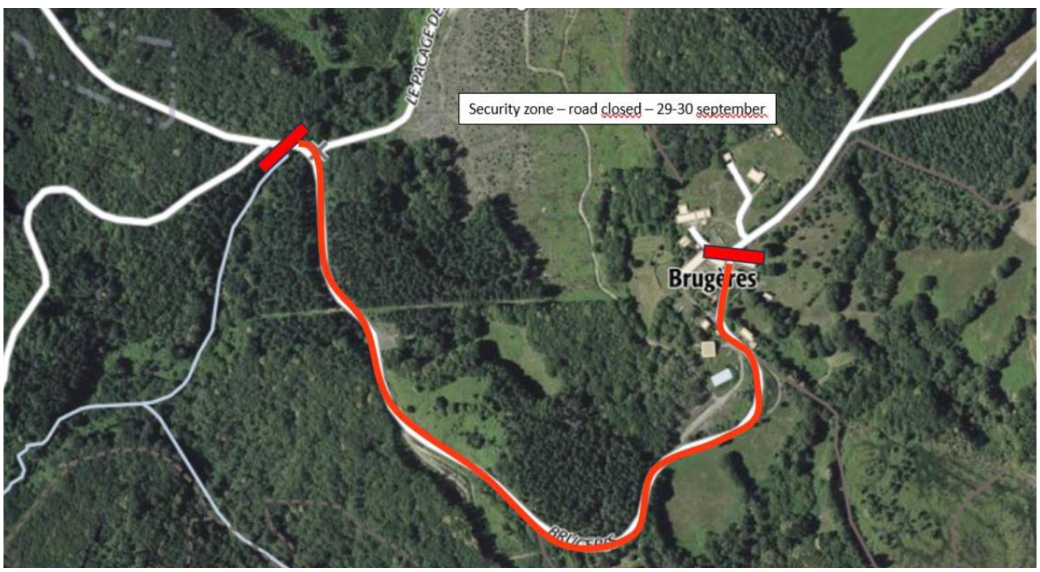

Figure 6 - Map of closed road during pilot activities

2.2 Italy Pilot 1 – Parco Naturale Regionale di Tepilora

2.2.1 Silvanus platform inputs

Background and context of the Pilot

Figure 7 - Map of Sardinia with the indication, in green, of the Tepilora Regional Natural Park

Parco Naturale Regionale di Tepilora is a 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 challenges 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.

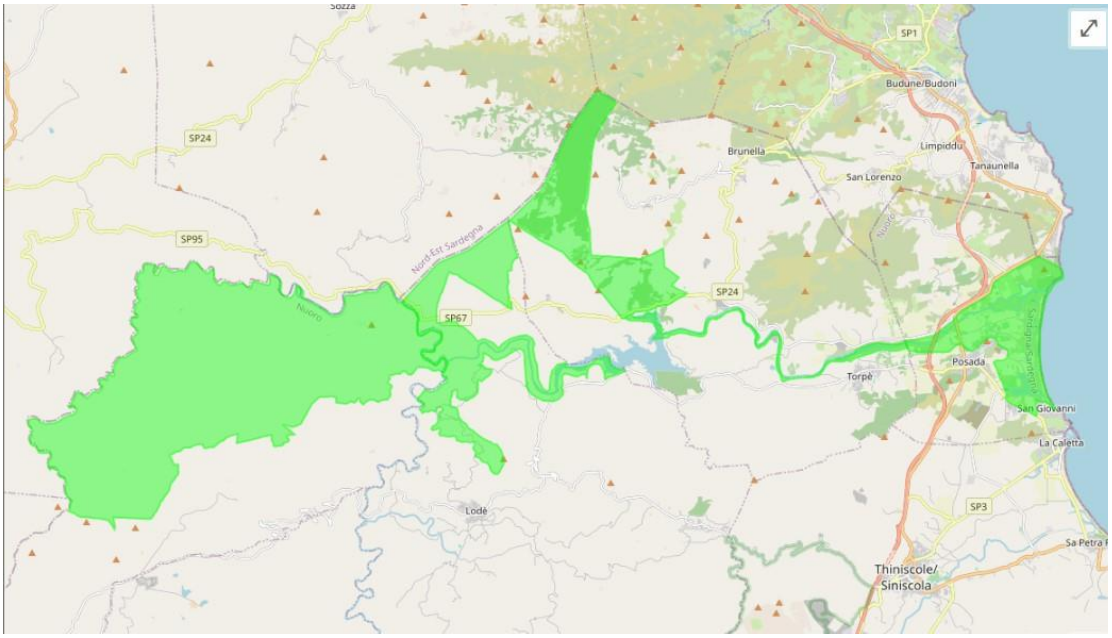

Figure 8 - Detail of the previous map, representing the Tepilora Regional Natural Park

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, with a little luck 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.

Fire regime

Analyzing the fires of the past, we can deduce that fires on the Park area and in neighboring areas occur almost exclusively in summer (in June, July, August, September).

Processing the data under consideration in Sardinia, the main cause of fire was found to be 60% of arson, 35% of involuntary origin and 5% of accidental origin.

As for fires of involuntary and accidental origin, they are mainly due to cigarette butts or the removal of plant remains (burning stubble).

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

- Protection of human lives, health and environment

- (A) Necessity of improving the environmental and ecological mapping and assessment of the Park aimed at fire prevention and risk assessment;
- (A) Scarce use of technologies for fire prevention
- (A) Weak culture of risk prevention among local stakeholders
- (B) Early detection of wildfires
- (B) Persisting difficulties in the identification of fire ignition through the active collaboration of citizens and tourists
- (B) Scarce use of technologies for early fire detection
- (C) Absence of a resilience strategy

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**
  - Planning prevention for the most vulnerable and the most subject to fire risk sites
  - Provision of the necessary tools / equipment / know how
  - Citizen engagement and wildfire risk awareness
- **Phase B: Detection and Response**
  - Early detection of wildfires
  - Planning operational intervention measures in case of fire: gathering points for rescuers, identification of areas where water is present, safe places, population gathering points, evacuation assembly points/areas and evacuation processes
  - Cultural change of the local stakeholders
  - Provision of the necessary tools / equipment / know how. All the processes are currently human-based. In the Park there are three fire lookout posts, they are masonry buildings, in good condition and regularly used. Furthermore, in the neighboring municipalities there are watch towers. This implies more difficulties in the timely management of concurrent and/or distant fire events
  - Gap in the communication and coordination during response between the various stakeholders.
  - Overall organization/coordination during the fire between all stakeholders
- **Phase C: Restoration**
  - Conservation of the species and habitats of the park
  - Restoration issues in accordance with the legislation in force and its constraints

2.2.2 Stakeholders and partners. Roles and activities

Table 5 - Stakeholders and partners, Italian pilot 1

Stakeholder	*Activity Engaged*	*Role*
Civil protection	Drafting of the Plan and in the awareness raising process	Coordinates the civil protection activities of the regional bodies, the provinces, the municipalities and voluntary organizations
Forestry guards	Drafting of the Plan and in the awareness raising process	Coordinates operations on the ground and air fleets for fire suppression
Forests agency	Drafting of the Plan and in the awareness raising process	Manages fire prevention activities in its forest compendiums and contributes to alerting and fire suppression operations on the ground
Voluntary organizations	Drafting of the Plan and in the awareness raising process	Risk awareness, discussions, citizen engagement, observers
Municipalities	Drafting of the Plan and in the awareness raising process	Player, contribution to the evaluation of SILVANUS, Risk awareness, discussions, citizen engagement, observers
Local Environmental education canters	Awareness raising campaign	Risk awareness, discussions, citizen engagement, observers
FINCONS, CMCC	Identification of the best activities to be implemented in the framework of the SILVANUS Project	System Integrator and Technology provider
Other SILVANUS technological partners	Providing the technology technologies and tools to be tested as described at paragraph n.4	System Integrator and Technology provider

The identified end-users that will benefit of project results are: schools, citizens, tourists and environmental education centres.

2.2.3 Operational scenario

The objective of the demonstration is to test, validate and evaluate the SILVANUS technological platform and its components, as well as the additional programs inside SILVANUS, such as awareness raising activities.

In order to understand the activities proposed in the framework of SILVANUS it is important to shortly introduce the ordinary activities carried out by PNRT to which the new ones are related:

Phase A:

- Preventive information to visitors and residents on the danger of forest fires, and on the correct behaviour to be adopted to avoid fires (in particular accidental fires)
- Prevention campaign on websites and social networks, not very effective yet
- Fire ban in force from June 15 to September 15 to reduce unintentional fires

Phase B:

PNRT ordinary activities about detection and Response include:

- Involvement of the lookout points of the Fo.Re.S.T.A.S. Regional Agency located within the Tepilora Park
- The involvement of citizens of the Park Municipalities and tourists that can send an alert through the toll-free number dedicated to environmental emergencies

In this context:

- UAV and UGV technology are not deployed
- Remote Sensing Technology, Sensors and IoT Tools and Instruments are not used
- Alerting/ Fire Detection Systems are not deployed

Phase:C

There is not any regional plan for restoration and adaptation but, after a wildfire, there are some rules to be respected:

- For 5 years after the wildfire: neither reforestation nor other environmental engineering works are permitted
- For 10 years after the wildfire: in wooded areas the construction of buildings is not permitted. Grazing and hunting are prohibited as well.

For 15 years after the wildfire: in wooded areas where a fire occurred, the change in the use of the land it is not allowed. For example, a forest must remain a forest and cannot become a pasture or something else.

Concerning the activities to be carried out in the framework of SILVANUS, during the Phase A and C, PNRT will work in the constitution of a working group represented by key stakeholders. Through several consultation meetings - where a review of the current situation, challenges and changes will be made - the WG will be able to identify a common strategy and a roadmap that will bring to the preparation of one plan containing key information about:

- activities for planning prevention and operational intervention measures in case of fire (Phase A)
- guidelines for a correct restoration in accordance with the legislation in force (Phase C)

A relevant component of the entire process is represented by citizens / tourists' engagement activities aimed at creating risk awareness, understanding and active engagement but also informing about the SILVANUS technological application for citizens.

The deployment of technologies / systems / tools / instruments for fire prevention and early detection – as described in detail in the paragraph n.4 - will show how the innovative technologies and practices identified in SILVANUS can improve fire management in each of the three phases of prevention and preparedness, active response, and restoration.

Expected outcomes

1. Improvement of the environmental and ecological mapping and assessment of the park, aimed at fire prevention and risk assessment;
2. Raise of awareness activities on fire prevention and active involvement of citizens and tourists in the alerting system;
3. Validation and assessment of SILVANUS project technologies through their deployment in the PNRT Pilot Site for prevention and early detection.

Table 6 - User products, Italian pilot 1

Phase (A,B,C)	*User product (UP..)*	*Description*
A.1		**Drafting of one plan that contains key information about***:* activities for planning prevention and operational intervention measures in case of fire, guidelines for a correct restoration in accordance with the legislation in force.
A.2	**UP7** **UP8**	**Preparation of a public awareness campaign.** PNRT actively collaborate with 4 Environmental

		Education Centres in the involvement of Schools and Local Authorities
A.3	**UP8**	**Dissemination and promotion of the citizen engagement application (UC8).** PNRT and the 4 local municipalities will promote the APP through their institutional web sites.
A.4	**UP2, UP4**	**Deployment of technologies / systems / tools for fire prevention such as satellite monitoring.** PNRT and Project Partners will implement this activity.
B.1	**UP4, UP6**	**In the framework of SILVANUS phases, A and B, PNRT would like to implement activities that have not been carried out yet and that are related to the use of new tools / technologies / systems for fire prevention and detection (UC4).**
B.2	**UP3**	**Awareness raising about the importance of fire detection based on social sensing will be implemented**
C.1		**Drafting of a programme concerning the adoption of a resilience strategy to be included in the Plan for fire prevention and risk assessment containing some guidelines for a correct restoration in accordance with the legislation in force.**

Objectives and KPI's

The main technologies that will be used in the pilot are related to the following Silvanus User Products (UP):

1. UP2 (Fire danger risk assessment): assesses the fire danger risk of a specific area over a certain forecasting period. This UP will be responsible of the production of fire danger risk maps by adopting Data-driven (i.e., ML Models) and empirical approaches

(i.e. FWI, …), as well as the prediction of the probability of fire threat in a certain area for the next day;

2. UP3 (Fire detection based on social sensing): provides warning of possible active fires or indication that could lead to a fire incident through crowdsourced information. Specifically, by means of real time collection, classification, and visualization of tweets and extraction of posts' geotag and images this UP will support the detection of possible fire events in the pilot area.
3. UP4 (Fire detection from IoT devices): supports the detection of fires in remote areas by providing an IoT kit that will be used to monitor the designated area 24/7 and raise an alarm when a fire event is identified. The IoT devices will mainly collect and analyse data from RGB cameras as well as other sensors (e.g., temperature and humidity) that will be installed in an area overseeing the Park.
4. UP8 (Citizen's engagement program and mobile app): the citizen engagement mobile application serves an important role in disseminating information related to the awareness of wildfire prevention and response and collecting information about events hazardous to the forests, processing and extracting high level information, and spreading awareness regarding forest fire prevention and restoration.

Specifically, the demonstration activities planned for the Tepilora 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
- PC4: Restoration roadmap for natural resources
- DO2: Engagement of stakeholders at periodic intervals to evaluate the outcomes adopting agile methodologies
- DO3: Organisation of at least three large-scale pilots for the systematic evaluation of the project outcomes

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

Table 7 - Objectives and KPIs, Italian Pilot 1

Phase	***Objective***	***Activity***	***KPI's***
Phase A	O.A.1: To improve the environmental	A.1. Drafting of one plan that contains	KPI.A.1. One Plan for fire prevention and

	and ecological mapping and assessment of the park aimed at fire prevention and risk assessment.	key information about: • activities for planning prevention and operational intervention measures in case of fire (Phase A) • guidelines for a correct restoration in accordance with the legislation in force (Phase C)	risk assessment adopted.
	O.A.2. To implement a culture of risk prevention among project stakeholders and preparedness of a campaign on fire danger.	A.2. Preparation of a public awareness campaign	KPI.A.2. At least 3 workshops and visits to the park with local schools for children from 6 to 16 years old during which awareness raising material is developed and disseminated. At least 1000 members involved in the campaign through different channels.
	O.A.3. To increase public/citizen awareness alerting system via a Citizen engagement toolkit (mobile application) for signalling accidental fires and activate mitigation strategies.	A.3. Dissemination and promotion of the citizen engagement application (UC8) UP8 Citizen engagement mobile application	KPI.A.3. Citizen engagement activities promoted and citizen-engagement-toolkit used through the involvement of 4 local authorities and 4 local schools.

	O.A.4. To contribute to project innovation development and to improve the prevention phase in the park through the introduction of innovative technological solutions.	A.4. Deployment of technologies for fire prevention UP4: Fire detection from IoT devices	KPI.A.4. At least 1 new innovative technology or other system / tool / instrument for fire prevention adopted.
Phase B	O.B.1. To contribute to project innovation development and to improve the detection and response phase in the park through the introduction of innovative technological solutions	B.1 Deployment of technologies / systems / tools / instruments for fire early detection (UC4) UP4: Fire detection from IoT devices	KPI.B.1 At least 1 new innovative technology or other system / tool / instrument for early detection adopted
	O.B.2 To facilitate the identification of fire ignition through the active collaboration of citizens and tourists	B.2 Awareness raising about the importance of fire detection based on social sensing UP3: Fire detection based on social sensing	KPI.B.2 At least 1000 citizens and tourist informed about the importance of their active collaboration in the fire detection phase through Twitter or other social media identified in the framework of SILVANUS
Phase C	O.C.1. To contribute to build knowledge base about Tepilora	C.1 Drafting of a programme concerning the	KPI.C.1 Guidelines for a correct restoration drafted

	Park containing the geographical data, national forest inventory data, and other relevant information for: the development of the SILVANUS platform, the evaluation of the forest resilience to fires and the adoption of a resilience strategy	adoption of a resilience programme strategy to be included in the Plan for fire prevention and risk assessment containing some guidelines for a correct restoration in accordance with the legislation in force	

2.2.4 Preparing user stories

- **Phase A: Prevention and Preparedness**

PHASE A – Activity A 1	
What	**A.1. Drafting of one plan that contains key information about:** 1. activities for planning prevention and operational intervention measures in case of fire **(Phase A)** 2. guidelines for a correct restoration in accordance with the legislation in force **(Phase C)**
How	*A.1.1.1 Creation of a Working Group* Involvement of the main actors: 1. those who will be implementing the plan (e.g., management, staff, volunteers) 2. those who will be affected (e.g., members, users, etc) 3. those who will monitor implementation (e.g., Management Committee) 4. others who can contribute to its development through: ✓ a series of consultation meetings ✓ questionnaires ✓ a steering group made up of a range of stakeholders A.*1.1.2 Review of the current situation, challenges and changes which will affect the plan future development* *A.1.1.3. Identification of a strategy*

A. *1.1.4. Creation of a roadmap* for:

1. Setting objectives
2. Agreeing or approving operational/work plans
3. Ensuring appropriate systems and structures are in place (e.g. how staff, volunteers and management are organized; what kind of equipment, premises are needed; training requirements; measurement of outcomes)

A.1.1.5. Writing and delivering the plan

Who

For the drafting of the Plan, PNRT is supported by:

1. Civil Protection Forestry and Environmental Surveillance Corps (CFVA)
2. FoReSTAS Agency
3. Regional Agency for the Protection of the Environment for Sardinia (for monitoring and data collection)
4. Regional Fire Department Sardinia
5. Park Municipalities (n.4)

When

See graph below

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		01/10/2021	01/11/2021	01/12/2021	01/01/2022	01/02/2022	01/03/2022	01/04/2022	01/05/2022	01/06/2022	01/07/2022	01/08/2022	01/09/2022	01/10/2022	01/11/2022	01/12/2022	01/01/2023	01/02/2023	01/03/2023	01/04/2023	01/05/2023	01/06/2023	01/07/2023	01/08/2023	01/09/2023	01/10/2023	01/11/2023	01/12/2023	01/01/2024	01/02/2024	01/03/2024
A.1. Drafting of one plan that contains key information about: activities for planning prevention and operational intervention measures in case of fire, guidelines for a correct restoration in accordance with the legislation in force	A.1.1.1 Creation of a Working Group																														
	A.1.1.2 Review of the current situation, challenges and changes																														
	A.1.1.3. Identification of a strategy																														
	A.1.1.4. Creation of a roadmap																														
	A.1.1.5. Writing and Delivering the plan																														

PHASE A – Activity A 2

What

A.2. Preparation of a public awareness campaign

How

*A.2.1.1 Involvement of the Environmental Education Centres (*EECs)

The local 4 EECs are informed about the project contents and its aims and actively involved through an agreement. The strategy of the awareness raising path to be implemented is shared in order to jointly define the main key steps of the campaign: objectives, targets, contents, tools, timeline, etc.

A.2.1.2 Involvement of municipalities and other institutional actors

The local 4 municipalities of Bitti, Posada, Torpè, Lodè are involved in the active dissemination of project activities and in the promotion of the *Citizen engagement application* through their institutional website.

	Population and tourists are the main target to be reached with the support of the municipalities, also through public meetings. *A.2.1.3 Involvement of schools and workshops* The EECs support PNRT in the organization of at least 3 workshops that are part of the awareness raising path through which the students can learn more about project topics, the Citizen engagement application and the importance of fire detection based on social sensing *A.2.1.4 Organisation of social media and institutional website dissemination activities* All the activities and contents will be disseminated through different channels
Who	PNRT is supported by: Environmental Education Centres; 4 municipalities of Bitti, Posada, Torpè, Lodè; schools; tourists; citizens.
When	See table below
PHASE A – Activity A 3	
What	**A.3. Dissemination and promotion of the citizen engagement application (UC8)**
How	*A.3.1.1* As described above, this important channel for citizens to increase their awareness regarding wildfires and their impact as well as engage them in fire-prevention and rehabilitation actions will be disseminated during the awareness raising campaign
Who	For the promotion and dissemination of the APP, PNRT is supported by: Environmental Education Centres; 4 municipalities of Bitti, Posada, Torpè, Lodè. Realization of the APP: MDS and UISAV
When	Once the APP will be ready, it will be disseminated during the campaign described above.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
		01/10/2021	01/11/2021	01/12/2021	01/01/2022	01/02/2022	01/03/2022	01/04/2022	01/05/2022	01/06/2022	01/07/2022	01/08/2022	01/09/2022	01/10/2022	01/11/2022	01/12/2022	01/01/2023	01/02/2023	01/03/2023	01/04/2023	01/05/2023	01/06/2023	01/07/2023	01/08/2023	01/09/2023	01/10/2023	01/11/2023	01/12/2023	01/01/2024	01/02/2024	01/03/2024	01/04/2024	01/05/2024	01/06/2024	01/07/2024	01/08/2024	01/09/2024	01/10/2024	01/11/2024	01/12/2024	01/01/2025	01/02/2025	01/03/2025
A.2. Preparation of a public awareness campaign	A.2.1.1 Involvement of the local 4 Environmental Education Centers																																										
	A.2.1.2 Involvement of municipalities and other institutional actors																																										
	A.2.1.3 Involvement of schools and workshops (with X)																					X												X							X		
	A.2.1.4 Social Media and institutional website Dissemination Activities																																										
A.3. Dissemination citizen engagement APP	A.3.1.1 Dissemination and promotion of the citizen engagement APP																																										

PHASE A – Activity A 4	
What	**A.4. Deployment of technologies for fire prevention**

How	*A.4.1.1* Provision of info about weather, vegetation, historical data about burnt areas for the Fire Danger Risk Assessment in order to forecast the probability of fire threat in the area *A.4.1.2* Silvanus Fipas Mobile App: fire prevention and awareness support Support in gathering of biodiversity and location data for fire prevention and citizen awareness Support in gathering of biodiversity and location data for fire prevention and citizen awareness augmented data suitable for deep learning training
Who	A.4.1.1 PNRT is supported by the Autonomous Region of Sardinia – ARPA Sardegna and CMCC A.4.1.2 PNRT supports VTG in the provision of data
When	See table below

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
		01/10/2021	01/11/2021	01/12/2021	01/01/2022	01/02/2022	01/03/2022	01/04/2022	01/05/2022	01/06/2022	01/07/2022	01/08/2022	01/09/2022	01/10/2022	01/11/2022	01/12/2022	01/01/2023	01/02/2023	01/03/2023	01/04/2023	01/05/2023	01/06/2023	01/07/2023	01/08/2023	01/09/2023	01/10/2023	01/11/2023	01/12/2023	01/01/2024	01/02/2024	01/03/2024	01/04/2024	01/05/2024	01/06/2024	01/07/2024	01/08/2024	01/09/2024	01/10/2024	01/11/2024	01/12/2024	01/01/2025	01/02/2025	01/03/2025
A.4. Deployment of technologies for fire prevention	A.4.1.1 Provision of info for the Fire Danger Risk Assessment																																										
	A.4.1.2 Provision of data for the Fipas Mobile APP																																										

- **Phase B: Detection and Response**

PHASE B – Activity B 1	
What	**B.1 Deployment of technologies / systems / tools / instruments for fire early detection (UC4)**
How	*B.1.1.1* Collaboration with TRT for the use of drones for visual inspection and with THALES for the use of their system and algorithm to provide optimal trajectories and task allocation for a given area and fleet of drones equipped with sensors (M6 to M36) *B.1.1.2* Provision of data (Location, tree-type/fuel model, canopy cover) for the development of the Fire Spread Model to be used for preparedness (A) and operational phases (B) *B.1.1.3* Use of IoT devices for fire detection through the collection of images and sensor data of the area (Real-time potential fire/smoke detection on the edge; Use

	lightweight ML algorithms; Power independency; Server connectivity in remote areas (no cellular connection); Visualization of captured events.
Who	B.1.1.1 - An external supplier provides to PNRT the drones to be used during the demonstration period. It has to be selected by May 2023 at the latest by PNRT. TRT B.1.1.2 - PNRT provides data to EXUS. B.1.1.3 - CTL
When	See table below
PHASE B – Activity B 2	
What	**B.2 Awareness raising about the importance of fire detection based on social sensing**
How	B.2.1.1 Organization of a campaign as described in detail in phase A, where citizens will be informed, among all, about the importance of their contribution in the early-stage detection of wildfires through social media.
Who	B.2.1.1 PNRT is supported by: Environmental Education Centres, 4 municipalities of Bitti, Posada, Torpè, Lodè; schools; tourists; citizens; CERTH
When	See table below

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
		01/10/2021	01/11/2021	01/12/2021	01/01/2022	01/02/2022	01/03/2022	01/04/2022	01/05/2022	01/06/2022	01/07/2022	01/08/2022	01/09/2022	01/10/2022	01/11/2022	01/12/2022	01/01/2023	01/02/2023	01/03/2023	01/04/2023	01/05/2023	01/06/2023	01/07/2023	01/08/2023	01/09/2023	01/10/2023	01/11/2023	01/12/2023	01/01/2024	01/02/2024	01/03/2024	01/04/2024	01/05/2024	01/06/2024	01/07/2024	01/08/2024	01/09/2024	01/10/2024	01/11/2024	01/12/2024	01/01/2025	01/02/2025	01/03/2025
B.1 Deployment of technologies / systems / instruments for fire early detection	B.1.1.1 Use of drones for visual inspection (Demonstration)																					X																					
	B.1.1.2 Provision of data for the Fire Spread Model																																										
	B.1.1.3 Use of IoT devices for fire detection (Demonstration)																					X																					
B.2 Awareness raising about the importance of fire detection based on social sensing	B.2.1.1 Organization and implementation of the campaign																																										

- **Phase C: Restoration**

Table 8 - Timeline of activities, Italian pilot 1

PHASE C – Activity C 1	
What	**C.1 Drafting of a programme concerning the adoption of a resilience programme strategy to be included in the Plan for fire prevention and risk assessment containing some guidelines for a correct restoration in accordance with the legislation in force**
How	See the description reported for A.1
Who	See the description reported for A.1
When	See the description and timeline reported for A.1

2.2.5 Receiving requirements & permits

The pilot owner PNRT will have the overall supervision and make the proper arrangements.
No specific permit and requirements are needed.
For the implementation of all activities, the following rules apply:

- Information sheets and consent forms will be distributed to all participants.
- GDPR rules will be closely followed and monitored during the implementation of the activities.
- All participants will be invited. No external member without a prior notice or invitation will participate.
- Video recording or photo shooting of people or students is permitted only with their written consent, otherwise no videos or photos will be taken/recorded. This material can be used for educational, training and promotional purposes based always on the signed consent forms.

2.2.6 Testing the pilots

For the demonstration activities where the technology providers can perform field visits for testing/ validation, the different following alternatives are proposed:

- April 2024
- May 2024

During 2023 PNRT is involving the regional and local stakeholders in the creation of a working group able to support the management in the:

- review of the current situation, challenges and changes
- identification of a strategy
- creation of a roadmap
- writing and delivering of a Plan about necessary activities for planning prevention and operational intervention measures in case of fire, guidelines for a correct restoration in accordance with the legislation in force.

2.3 Italy Pilot 2 – Parco del Gargano

2.3.1 Silvanus platform inputs

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. The Gargano National Park, one of the Italian project pilots jointly with the Park of Tepilora in Sardinia, is a National Park **established in 1991** (according to art. 19 of Law 394/91) and is located on the promontory of the same name, in the province of Foggia, in the **Puglia Region**, Italy. It is managed by the Gargano National Park Authority, covering nearly the entire promontory, and extends over an **area of about 120,000 hectares**, including totally or partially, **18 municipalities**, including the Tremiti Islands.

The location of the park on the Mediterranean Sea lends to a climate of high temperatures and moist conditions with precipitation during every season. The temperature change throughout the year is gradual and moderate, with the warmest month of the year being July with an average high of 88.9 degrees Fahrenheit, and the coldest month being January with an average high of 52.9 degrees Fahrenheit. *(Source: AIB Plan of Gargano National Park)*

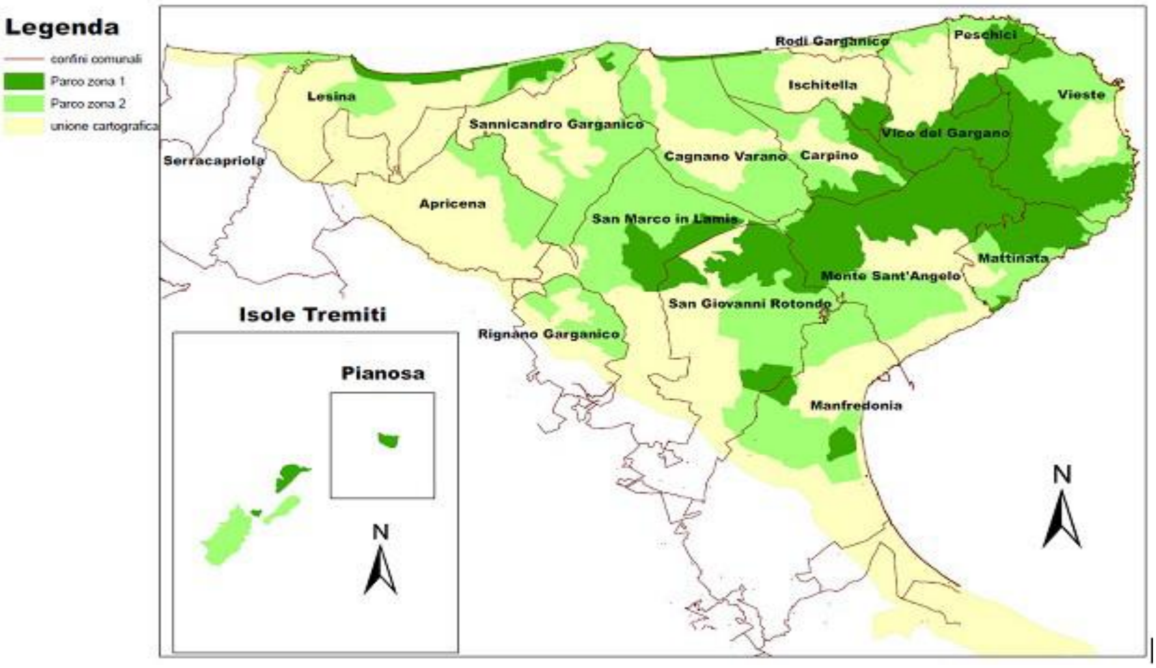

Figure 9 - Gargano National Park area, Italian pilot 2

The Pilot Case in Italy (Gargano National Park) is considered for all the **three phases (A, B, C)** of SILVANUS project activities.

Fire Regime: The Gargano area is Mediterranean and wildfires are concentrated in summer months (from June to September, and in particular in July and August), but these phenomena can sometimes happen in autumn and winter, during drought periods.

The AIB plan of Gargano National Park highlights how areas at greatest risk are concentrated along the southern slope of the Gargano, which is characterized by steppe vegetation or Maquis shrubland , with some exceptions along the northern slope corresponding to coniferous forest, pine forests or the Maquis shrubland overlooking the sea, as well as some internal areas falling above all in the municipalities of Peschici and Vieste.

The size and frequency of wildfires are extremely variable: in the period 2003-2012 there was a minimum of 13 events (2009) and a maximum of 72 events (2007), while the mean areal extension of a single event had a range from 7 hectares (2009) to 80 hectares (2007); in the same period the forested burned areas were the 63% of the total burned areas, the remaining 37% was made of grazing and uncultivated lands.

The causes of wildfires in the Gargano area (based on data for the 2003-2012 period) are:

- Intentional: wildfire caused intentionally to destroy a forested area for different purposes (e.g. creation of new grazing lands, disputes between people), 70% of wildfires are in this category;
- Negligence or incidental: 30% of wildfires are in this category, e.g. burning of plant residues related to agricultural activities, wildfire caused by cigarette butts.
- No wildfire was caused by natural events (e.g. lightening).

The forest fire risk within the Gargano National park is high in the coastal areas and in zones close to them located to the east and south-east of the Gargano (areas with greater severity), while in inland areas the impact has a value that is entirely relative (low/ medium) as in these areas the fires registered are decidedly reduced, both in terms of numbers and territorial extension. The fires considered also include particular surfaces such as pastures and prairies which, however, do not fall within the classic categories established for "forest fires" from the point of view of classification (these are not forest habitats).

However, it was considered that the inclusion of such data in the context of the plan was useful for evaluating the phenomenon in its complexity and above all in consideration of the ecological value of these environments (grasslands and bushy areas) which certainly have a role of primary importance in a conservation perspective of the species and habitats of the Gargano, also considering that the territory of the Park is affected for 63% of the territory by Sites of Community Interest (Siti di Interesse Comunitario “SIC”) and for 68% by Special Protection Areas (Zone di Protezione Speciale “ZPS”).

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

- The Gargano Park spans multiple municipalities (18) that are difficult to coordinate, across the different phases of fire prevention, suppression, and restoration and for sharing information, resources and expertise;
- The areas at greatest risk are in between the coastal and the natural areas, where an increased effort must be employed to preserve the ecosystem and biodiversity;

- Conservation of the species and habitats of the park area, as different habitats require different fire management strategies to maintain their ecological functions;
- Management and restoration of burned areas with public financial resources, as the Italian law forbids reforestation and environmental engineering interventions for five years inside burned areas.

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. It has to be highlighted, however, that the different challenges are only reported under the phase in which they are considered more crucial, but they have repercussions, even to a small degree, in all phases.

- **Phase A: Prevention and Preparedness**
  - The accumulation of forest fuel in time, increasing the fire risk and complicating the planning and implementation of forest management and fire prevention strategies as different fuel types requires different approaches and/or treatments.
- **Phase B: Detection and Response**
  - All the processes are currently human based. This implies more difficulties in the timely management of concurrent and/or distant fire events. In the Park there are fire lookout posts. There is a central station that coordinates all the operations in Puglia region and it is located in Bari. This implies more difficulties in the timely management of concurrent and/or distant fire events. SILVANUS project actions aim to improve fire detection and to reduce time of intervention.
  - Coordination between the different municipalities spanning the area.
  - The areas at greatest risk are difficult to reach by ground vehicle
- **Phase C: Restoration**
  - Conservation of the species and habitats of the park

2.3.2 Stakeholders and partners

Table 9 - Stakeholders and partners, Italian pilot 2

Stakeholder	*Activity Engaged*	*Role*
Project partners	Identification of activities and technologies to be implemented in the framework of SILVANUS	System Integration and Technology provider
ARIF (Agenzia Regionale Attività Irrigue e Forestali - Regional Agency for Irrigation and Forestry Activities)	Support for preparation of pilot site visit (June 2022), overview of fire management approach in Gargano National Park	Regional Agency

Civil protection	Preparation of training material and participation in short courses for schools, Requirements elicitation from a technological point of view Identification of the area for the installation of SILVANUS tech	Regional body
Gargano National Park	Requirements elicitation Support for preparation of pilot site visit Data provision	End-Users
Schools	Educational activities and serious games on biodiversity and fire safety Dissemination of SILVANUS apps	Citizens

2.3.3 Operational scenario

The Gargano pilot aims at showcasing how the innovative technologies and practices identified in SILVANUS can improve fire management in each of the three phases of prevention and preparedness, active response, and restoration. To this end different activities have been identified and will be carried out to contribute to the achievement of the overall projects objectives and KPIs, by exploiting the results of the different WPs and the SILVANUS User Products.

With respect to ***Phase A*** (Prevention and Preparedness), the main activities involve the collaboration with Civil Protection for the preparation of training materials both for schools and volunteers with small fire-fighting demonstration, as well as the dissemination of SILVANUS first outcomes and mobile applications to different events on mobility, sustainability and biodiversity. The main objective in this phase is to raise awareness and educate the public, especially students and teachers, as well as provide preliminary training to civil protection volunteers. This phase also includes the identification and adoption monitoring tools and techniques UPs for fire risk assessment.

Phase B involves the installation of the Fire detection from IoT devices UP in a designated area overseeing Gargano Park. At an early stage RGB cameras will be connected to DELL's IoT Gateway to run the fire detection algorithms implemented in UP4 and the solution will be assessed to ensure reliable and accurate performance. The implementation of this system will represent a first step towards a technical empowerment of the human-based approaches which are the only one in place to date, as stated in the challenge section.

Finally, ***Phase C*** will mainly involve the collaboration with the local restoration agency (Consorzio di bonifica) that will plant three different species of native plants in a selected burned area to increase vegetation cover, diversity and resilience. The growth and survival of the plants will be closely monitored to contribute to the SILVANUS framework with best practices and lesson learned. Moreover, drones will be used to monitor a designated burnt area to support the planning of an integrated restoration activity, and the optimal flight path to cover the area will be computed by using UP5.b. Any other recorded drone footage of the Gargano Park will be stored for archival purposes and eventually employed for supporting other phases (e.g., for assessing fire damage and supporting the biodiversity restoration).

Expected outcomes

Table 10 - Expected outcomes, Gargano National Park area, Italian pilot 2

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

Table 11 - User products, Gargano National Park area, Italian pilot 2

Phase (A,B,C)	*User product (UP)*	*Description*
Phase A1	UP2: Fire Risk Assessment, UP4: Fire detection from IoT devices	Monitoring tools and techniques in addition to the ongoing direct observation
Phase A2	UP7: Fire Prevention and Awareness Support mobile application UP8: Citizen engagement mobile application	Improvement of awareness related to fire events, engagement of young population involving schools, app to be used to indicate fire event
Phase B1	UP3: Fire detection based on social sensing, UP4: Fire detection from IoT devices UP6: Fire spread forecast	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 C1		Engagement of different stakeholders such as municipalities, external experts, public authorities, private landowners
Phase C2		Analysis of three kinds of rehabilitation (through planting new trees and monitoring them)
Phase C3	UP5: Wildfire Behaviour inspection based on UAVs' deployment	Optimal flight path evaluation for monitoring an area designated for restoration

Objectives and KPI's

The main technologies that will be used in the pilot are related to the following Silvanus User Products (UP):

1. UP2 (Fire danger risk assessment): assesses the fire danger risk of a specific area over a certain forecasting period. This UP will be responsible of the production of fire danger risk maps by adopting Data-driven (i.e., ML Models) and empirical approaches (i.e. FWI), as well as the prediction of the probability of fire threat in a certain area for the next day;
2. UP3 (Fire detection based on social sensing): provides warning of possible active fires or indication that could lead to a fire incident through crowdsourced information. Specifically, by means of real time collection, classification, and visualization of tweets and extraction of posts geotag and images this UP will support the detection of possible fire events in the pilot area.
3. UP4 (Fire detection from IoT devices): supports the detection of fires in remote areas by providing an IoT kit that will be used to monitor the designated area 24/7 and raise an alarm when a fire event is identified. The IoT devices will mainly collect and analyze data from RGB cameras as well as other sensors (e.g., temperature and humidity) that will be installed in an area overseeing the Park.
4. UP5.b (UAV Monitoring for Wildfire Behavior): provides an algorithm for the optimized use of Unmanned Aerial Vehicles fleets to inspect pilot areas. This UP will be employed to monitor the restoration phase in a specific area burnt by a fire (Phase C)
5. UP7 (Fire Prevention and Awareness Support mobile application): supports the collection of data on forests biodiversity through crowdsourcing, by processing and extracting valuable information from images of trees and leaves to assess the biodiversity of the area and the forest fuel.

6. UP8 (Citizen’s engagement program and mobile app): the citizen engagement mobile application serves an important role in disseminating information related to the awareness of wildfire prevention and response and collecting information about events hazardous to the forests, processing and extracting high level information, and spreading awareness regarding forest fire prevention and restoration. Both UP7 and UP8 will be showcased and disseminated during different events.

Specifically, the demonstration activities planned for the Gargano 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
- PC4: Restoration roadmap for natural resources
- DO2: Engagement of stakeholders at periodic intervals to evaluate the outcomes adopting agile methodologies
- DO3: Organisation of at least three large-scale pilots for the systematic evaluation of the project outcomes

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

Table 12 - Objectives and KPIs, Gargano National Park area, Italian Pilot 2

Phase	***Objective***	***Activity***	***KPI’s***
A1. Prevention and preparation	OA1.1 To contribute to project innovation development and to improve the prevention phase in the park through the introduction of innovative technological solutions (installation of sensors)	**Monitoring tools UP4: Fire detection from IoT devices**	KPIA1.1 At least 1 new innovative technology or other system / tool / instrument for fire prevention adopted (gateway + sensor/s) - monitoring station
	OA1.2 To increase public/citizen awareness alerting system via a Citizen engagement toolkit	**Monitoring tools UP8: Citizen engagement mobile application / Situational**	KPIA1.2 Citizen engagement activities promoted and citizen-engagement-toolkit

	(mobile application) for signalling accidental fires and activate mitigation strategies	**Awareness and Information Sharing**	used through the involvement of 5 local authorities (municipalities) and 5 local schools. We foresee 50 people using the app.
A2. Prevention and preparation	OA2 To increase awareness of young generation on forest management and risks, sensitization campaign	**Stakeholders and school involvement**	KPIA2 Organization of a short course (3 hours of lessons) in 5 local schools (40 participants of 12-14 age) in 5 different municipalities about biodiversity and forest management, in cooperation with main stakeholders (Gargano National Park, Civil Protection, ARIF, Consorzio di Bonifica Montana del Gargano)
B. Detection and Response	OB1.1 To contribute to project innovation development and to improve the detection and response phase in the park through the introduction of innovative technological solutions (installation of sensors)	**Monitoring tools UP4: Fire detection from IoT devices UP6: Fire spread forecast**	KPIB1.1 At least 1 new innovative technology or other system / tool / instrument for early detection adopted (gateway + sensor/s) - monitoring station
	OB1.2 To facilitate the identification of fire ignition through the active	**Monitoring tools UP3: Fire detection based on social sensing**	KPIB1.2 At least 100 citizens and tourist informed about the importance of their

	collaboration of citizens		active collaboration in the fire detection phase through social media identified in the framework of SILVANUS
B. Detection and Response	OB2 Instant communication through direct and digital systems	**Control and evaluation**	KPIB2 1 test of communication among direct observer, mobile application results and innovative technologies monitoring and timing of the communication
C. Restoration and Adaptation	OC1 To contribute to build knowledge base to intervene in Gargano Park after fire event. A restoration document will be improved on the adoption of different strategies	**Public engagement**	KPIC1 Observations to restoration document contained in AIB Plan by all the stakeholders involved in the previous phases (municipalities, external experts, public authorities, private landowners)
C. Restoration and Adaptation	OC2 In order to define best restoration strategies and vegetation, different kinds of vegetation will be planted in one already burnt area	**Test in burnt area**	KPIC2 Involvement of main stakeholders (Gargano National Park, Civil Protection, ARIF, Consorzio di Bonifica Montana del Gargano) in order to test and monitor 3 species of restoration trees

2.3.4 Preparing user stories

For phase A, the planning and design of technologies and systems to be demonstrated are foreseen. Tools for fire prevention will be identified, such as satellite monitoring (e.g., UP4). Moreover, a public awareness campaign will be conducted, using the awareness mobile application foreseen by UP.8.A.

The information and sensitization campaign will be conducted in three schools before summer 2023 in collaboration with the local stakeholders (Civil Protection, ARIF, Consorzio di Bonifica Montana del Gargano)

For Phase B, the deployment of technologies and systems for active fire detection to be demonstrated will be conducted; in particular, the installation of a monitoring station is foreseen (UP4).

An activity will be conducted for fire detection based on social input collection, employing social media posts geotagged in the relevant area of the Gargano Park (UP3) to ascertain the correctness of the automated tools employed. Moreover, tests on communication during the fire simulated event among the involved personnel from different stakeholders on site will be conducted.

For phase C, observations for the restoration phase will be conducted and documented for the AIB Plan (piano Anti Incendio Boschivo, fire prevention plan), and documentation about the results of restoration tests will be produced.

- **Phase A: Prevention and Preparedness**

Table 13 - Timeline of activities, Gargano National Park area, Italian pilot 2

Phase	Activity timeline	Activity content
Phase A	**A1.1** **01.2023 – 06.2023**	Planning of technologies / systems / tools for fire prevention such as satellite monitoring (UP.4)
	A1.2 **06.2023 – 09.2024**	Public awareness campaign through mobile app knowledge diffusion (UP.8.A)
	A2 **04.2023 - 05.2023**	The information and sensitization campaign will be conducted in 5 schools before summer 2023 in collaboration with the local stakeholders (Civil Protection, ARIF, Consorzio di Bonifica Montana del Gargano) (UP.8.B)

- **Phase B: Detection and Response**

Phase	Activity timeline	Activity content
Phase B	**B1.1** **06.2023-09.2024**	Deployment of technologies / systems / tools / instruments for fire detection (installation on a monitoring station) (UP4, UP6)

Phase	Activity timeline	Activity content
	B1.2 **06.2023 – 09.2024**	Fire detection based on social input collection (UP3)
	B2 **06.2023 – 09.2024**	Test on communication during the fire simulated event

- **Phase C: Restoration**

Phase	Activity timeline	Activity content
Phase C	**C1** **10.2023 – 12.2024**	Defining observations to restoration phase in AIB Plan
	C2 **10.2023 – 12.2024**	Document about results of restoration test (new plants)

2.3.5 Receiving requirements & permits

The considered pilot area where sensors will be installed is outside the perimeter of the Gargano National Park and is on the top of a hill, so it is suitable to observe the park area. The ownership is private, so it is not necessary to require any kind of permit to install sensors.

2.3.6 Testing the pilots

The activities foreseen in Phase A will be carried out between January 2023 and June 2023 for planning activities, from June 2023 to September 2024 for the public awareness campaign and from April 2023 to May 2023 for the sensitization campaign in schools. Activities foreseen in Phase B will be carried out between June 2023 and September 2024, while activities foreseen in Phase C will be conducted between October 2023 and December 2024.

2.4 Romania Pilot – Rodna Mountains

2.4.1 Silvanus platform inputs

Wildfires are becoming a serious problem for Europe but also for Romania. Thus, in recent years Europe and Romania have faced both fires and forest fires. In 2020, more than 4,700 hectares were destroyed, the second largest area in the last 34 years. The wildfires caused the most damage in eight years and the second highest loss in 34 years. More than 5,150 hectares burned, the estimated value of the damage reaching more than 206,000 euros. Most of the fires started because farmers clean up their land by burning it. Also, another 43 fires burned 416 hectares of forested land, located outside the forests. They burned 195.7 thousand plantations with saplings and about 3,000 cubic meters of wood.

In a statistic between 1986 and 2022, the most fires occurred in 2012 when 900 fires caused the destruction of 7,000 ha.

On average, in Romania there are 297 fires per year leading to the destruction of 1,800 hectares of forest. Based on the form of ownership, almost half of the forests affected by the fires, 2,714 hectares, belong to the state, through local public administrations or directly through the National Forestry Agency. 57 forest fires were extinguished after more than 24 hours, one of them being extinguished after 10 days. Also, 570 hectares were destroyed in a single fire.

The most numerous fires broke out in the spring (444 fires between March 17 and April 24, which destroyed 4,300 hectares) following the burning of pastures in windy conditions and high temperatures. 2020 was even worse than 2019 in Romania.

In total, 64,554 burned hectares belong to Natura 2000, 1.52% of the total area of Natura 2000.

In 2022, seven times more wildfires were recorded than in 2021. Extreme temperatures and prolonged drought fuel wildfires. In the first six months, seven times more forests burned than in the same period last year. There are more than 10,000 hectares burned.

In 2022, a forest vegetation fire occurred in the Rodnei Mountains National Park. They burned 3 hectares of forest in the Natural Park, in an area close to that of where the Romanian Pilot is.

In Romania, the forest is considered a national asset with a huge importance in ensuring security through the benefits for the environment, public and economic health being included in the national security law. In these conditions, special importance is given to the method of prevention as well as intervention in the event of fires.

Forest fires have a negative impact on:

- the forest ecosystem (especially flora and fauna) and environmental factors (air, water, soil);
- the population, as well as its movable and immovable assets;

- economic activities (tourism, exploitation and wood processing, shepherding, electricity transport, road and rail transport, telecommunications relays, etc.);
- cultural values (objects of worship, with related movable heritage, historical objects, etc.);
- protected areas as nature reserves.

In 2018 Romania developed and approved at governmental level the action plan targeting "National concept of response in case of forest fires", which is based on the concepts of single command, and which delegated responsibilities between authorities, institutions and citizens and monitors, through the responsible authorities, the elaboration of operational plans and documents at the national, zonal, county and local level.

The “Rodna” Mountains National Park is the second largest national park in the country, with an area of 47.177 ha. 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.

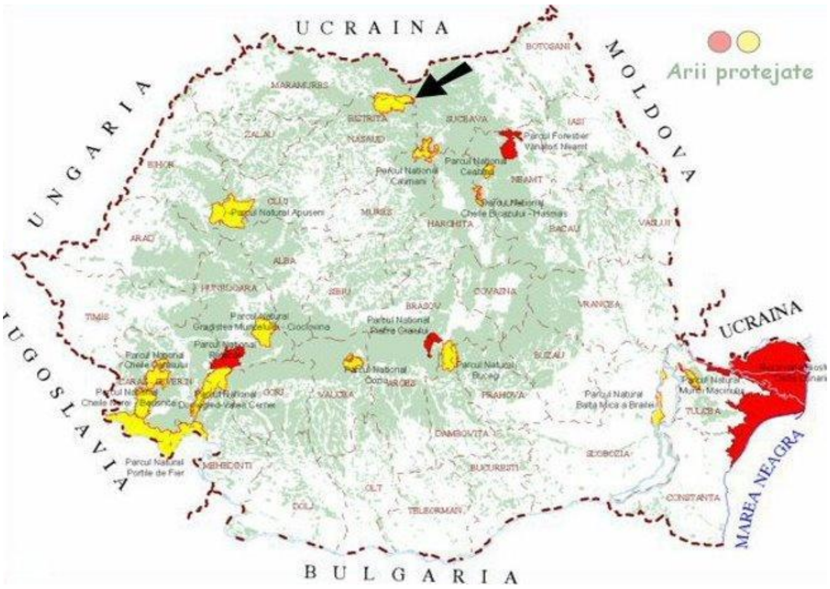

Figure 10 - Location of the Rodna Mountains National Park, Romania pilot

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

- Utilizing preventive measures for reducing human negligence forest fire incidence;
- Improving firefighter response time and operational capacity by using modern sensor and imaging technologies;
- Implementing regular monitoring activities at the pilot site;
- Utilizing AR-VR technology in training exercises for firefighters;

- Integrating the particularities of protected natural areas in the preventive measures and intervention scenarios by a joint ongoing effort between firefighter department and natural park curators;

In line with the existing methodology, the Romanian use case will tackle Phases A and B from the **SILVANUS** methodology. 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**
    - identification of risks and vulnerabilities that have a negative impact on the forest;
    - the implementation of preventive measures to prevent the occurrence of fires in the forest or in the adjacent areas;
    - ensuring coherent public communication and information;
    - the use of AR/VR programs for the training of firefighters, foresters and those interested in carrying out firefighting missions.
- **Phase B: Detection and Response**
    - establishment of decision-making, coordination and control institutions in case of forest fires;
    - the efficient use of available informational, human, financial and material resources;
    - realization of equipment/arrangement projects in support of response actions.
    - the use of drones to locate fires, or areas prone to fires;
    - the use of modern satellite monitoring techniques;

2.4.2 Stakeholders and partners. Roles and activities

Table 14 - 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

2.4.3 Operational scenario

The objective of the demonstration is to test, train on, validate and evaluate the SILVANUS technological platform and its components, as well as the additional programs inside SILVANUS, such as training, that aim to create fire resilient societies.

Table 15 - Operational scenario, Romania pilot

<table>
<tr><th>Phase (A,B,C)</th><th>Description</th><th>User product</th></tr>
<tr><td rowspan="4">Phase A
Prevention and Preparedness activities</td><td rowspan="4">• Development of AR/VR training module and training of firefighters and forest rangers for intervention scenario;
• Installation of monitoring system
- identifying relevant areas for mounting sensors;
- mounting the sensors in the designated areas in accordance with natural park area restrictions;
- identifying relevant location for a forward outpost with access to electricity;
- ensuring uninterrupted connectivity of IoT devices to the internet;
- development of monitoring procedures;
- ensuring connectivity to relevant databases.
• Testing and validation of monitoring system
• Organization of awareness campaigns</td><td>UP1: AR/VR training toolkit: data collection and development of training module</td></tr>
<tr><td>UP1: AR/VR training toolkit: testing and validation</td></tr>
<tr><td>UP4: Fire detection from IoT devices: installation and integration of sensors</td></tr>
<tr><td>UP4: Fire detection from IoT devices: testing and validation</td></tr>
<tr><td>Phase B
Detection and Response activities</td><td>• Simulation of intervention to a forest fire at the pilot site
• Testing and validation of SILVANUS technologies:</td><td>UP1: AR/VR training toolkit: assessment of training sessions</td></tr>
</table>

	- analysis of opening-up of territory for purposes of deployment of fire trucks in case of fire; - mapping of suitable water sources; - ensuring continuous monitoring activities and uninterrupted flow of data/ communication; - information (image, text, and coordinates of fire site) transfer to Operational Command Centre of Fire and Rescue Service.	UP4: Fire detection from IoT devices: continuous monitoring and information gathering UP6: Fire spread forecast

Objectives and KPI's:

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

- PA1 - Environmental and ecological mapping and assessment of forest regions within project demonstrations.
- PA3 - Development of fire danger index profile management system based on environmental, ecological and biodiversity models.
- PA4 - Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcement.
- PA5 - Define training activities designed to improve safety and preparedness of firefighters in combating wildfire.
- PB9 - Development of Crisis management tool.

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

Table 16 - Objectives and KPIs, Romania pilot

Phase	Objective	Activity	KPIs
Phase A	Implementing regular surveillance activities at the pilot site	UP4: Fire detection from IoT devices	• False alarm rate < 15% • True positives > 70% • Missing rate < 5%
	Utilizing AR-VR technology in training exercises for firefighters	UP1: AR/VR training toolkit	• N° of training scenarios created >= 3 • Implement multi- player support for at least 3 users • No of firefighters trained >17 • N° of training environments created >= 3
	Utilizing preventive measures for reducing	Awareness campaigns	• Reach: min 30.000 persons on social media

	human negligence forest fire incidence		• Min 1 workshop/ conference with stakeholders
Phase B	Improving firefighter response time and operational capacity by using modern sensor and imaging technologies	UP4: Fire detection from IoT devices	• False alarm rate < 15% • Time to action – reduced by 50% • Event detection (from ignition to detection and event generation) < 10 minutes

2.4.4 Preparing user stories.

Phase A. Prevention and Preparedness

At a certain moment, based on the data available, the SILVANUS platform issues a potential fire hazard alert. Following this, a drone is sent for monitoring and at the same time the patrol team of the Forest District is alerted, for investigation.

All of available information (some gathered on the ground, and some extracted from available databases) is sent to the cloud in the SILVANUS platform to be processed and it issues an alert regarding the fire danger index and necessity of complementary measures for investigation and assessment.

Phase B. Detection and Response activities

Several mountain hikers, who were in the pilot area lit a campfire to prepare their food. The fire went unattended and spread to the dry vegetation in the area.

Alerted by the SILVANUS monitoring system for fire hazard, the employees of the Forest District, who were patrolling the area, discover a fire of dry vegetation at the forest fund in the pilot area, which quickly spreads to the forest litter, on an area of approx. 200 sqm, with the possibility of spreading to the forest due to the existence of permanent air currents specific to the area.

The event was detected by the Forest District patrol (following the alert issued by the monitoring system), but calls were also made to 112 by locals in the area, who noticed large smoke emissions in the area. Forest rangers inform the Dispatch Office of the Inspectorate for Emergency Situations of Bistrița County (ISU Bistrița) and sent the approximate coordinates of the event, the latter also having access to the available data collected by the monitoring system.

With support from the SILVANUS monitoring system, ISU Bistrița begins procedures to extinguish the fire in the pilot area.

2.4.5 Receiving requirements & permits

For the implementation of all activities, the following rules apply:

- All participants will be invited. No external member without a prior notice or invitation will participate.

- Video recording or photo shooting of people or students is permitted only with their written consent, otherwise no videos or photos will be taken/ recorded. This material can be used for educational, training and promotional purposes based always on the signed consent forms.
- The pilot owner (ASFOR) will have the overall supervision and make the proper arrangements.
- No prescribed fires or lighting a fire will take place for demonstration purposes.
- For the SILVANUS modules that detect smoke or fire, the use friendly to environment smoke generators will be a priority.
- In case fire flames need to be detected or high rise of temperatures, lighting of fire inside metal barrels and in a controlled environment may take place taking the necessary permissions.
- In case drones or other flighting equipment need to be deployed, the necessary permissions must be granted.
- In case a SILVANUS partner needs a specialized equipment then he/she must take care to purchase it or be in contact with the pilot owner for further details.
- During the field exercise the local stakeholders will participate with their usual equipment to increase the realism for the simulations.

2.4.6 Testing the pilots.

Technology providers are free to make field visits any time of the year considering the following:

- Exact dates of the exercises and demonstrations will be provided in the next months.
- Prior notice to ASFOR and other RO partners is mandatory.
- Prior notice will involve a brief description of the scope of the visit, the places that will be visited and the time plan. This is necessary in order to organize a visit in the best possible way. ASFOR or other Romanian partners may help you to select the proper locations and accompany you during the visit.
- For the participation of the partners in the exercises a prior notice, the latest, one month before is mandatory. Romanian will be the official language of the exercise. Nevertheless, guidelines and logistics will also be provided in English (for partners of SILVANUS and deliverable purposes).
- It is advised for the SILVANUS partners to take the visits close to the dates of the exercises for managerial purposes.

- SILVANUS partners must take into account that travels are in the responsibility of the partner and not any other Romanian partner or the pilot owner unless other and specific instructions are given.
- Try to avoid visits during late autumn or winter as severe weather phenomena may occur.

2.5 Greece Pilot – Impact of wildfires across Sterea Ellada and evaluation of SILVANUS platform for Phase A, B and C

2.5.1 Silvanus platform inputs

Greece is one of the European countries that suffer most from forest and landscape fires. According to the most recent National Risk Assessment study (NRA Greece – Eftychidis et al., 2019), forest fires is one of the major hazards for the country. Every year, the fire season extends from May to October (Xanthopoulos et al., 2022, Ntinopoulos et al., 2022).

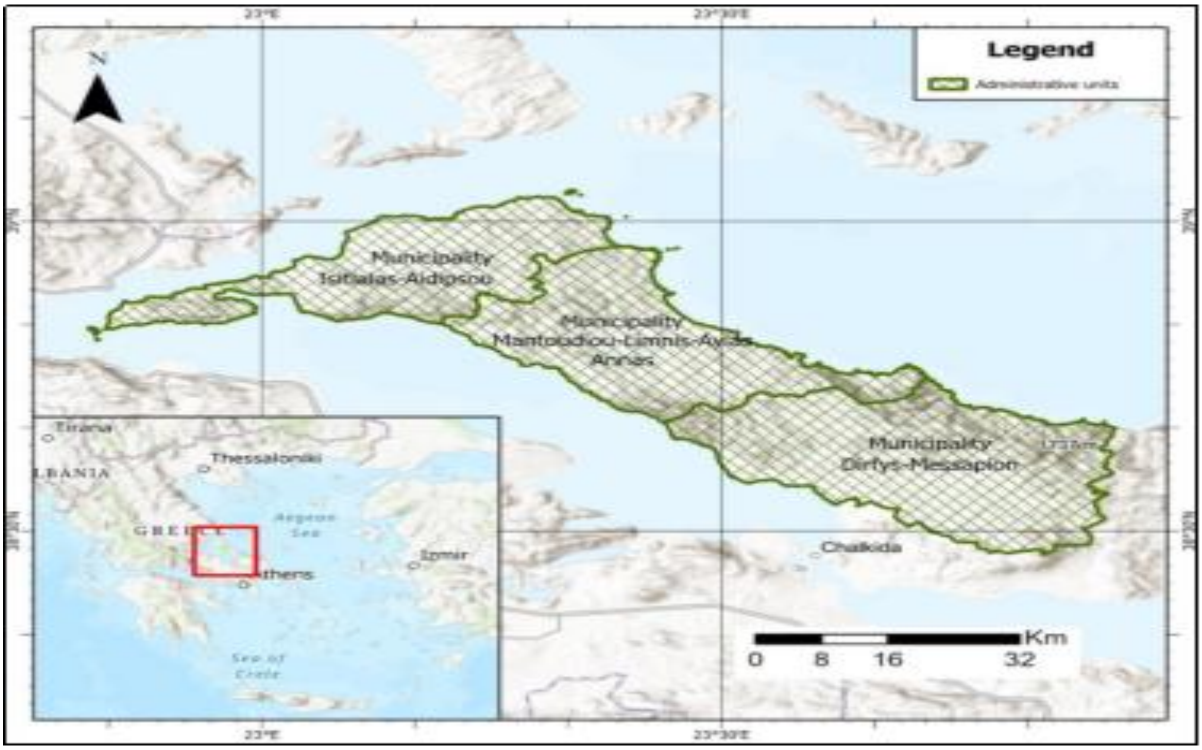

Figure 11 - Administrative boundaries of the SILVANUS Hellenic pilot area (North Evia) and SILVANUS pilot interest area.

In addition, in recent years, three major wildfire events made clear that significant measures have to be taken to reduce the impacts of wildfires to the environment, health, society, culture and economy. The wildfire of 2018 at the NE suburbs of Athens metropolitan area, at Mati (Wildland Urban Interface area), caused the death of 101 people. In August 2021, two severe wildfires events occurred: one in the NNW of Athens suburbs (Varympompi, Thrakomakedones, Parnitha), which destroyed 6.747 hectares of thick forest and houses (WUI area) and had also significant impact on the society (e.g., Efthimiou et al., 2020; Vallianou et al., 2020), and one in North Evia (SILVANUS pilot area), which burned 46.582 hectares, being one of the largest wildfires in the history of Greece, destroying thick forests, local settlements, houses, agricultural areas and businesses, luckily without human losses but affecting significantly the local economy and society (Varela et al., 2022).

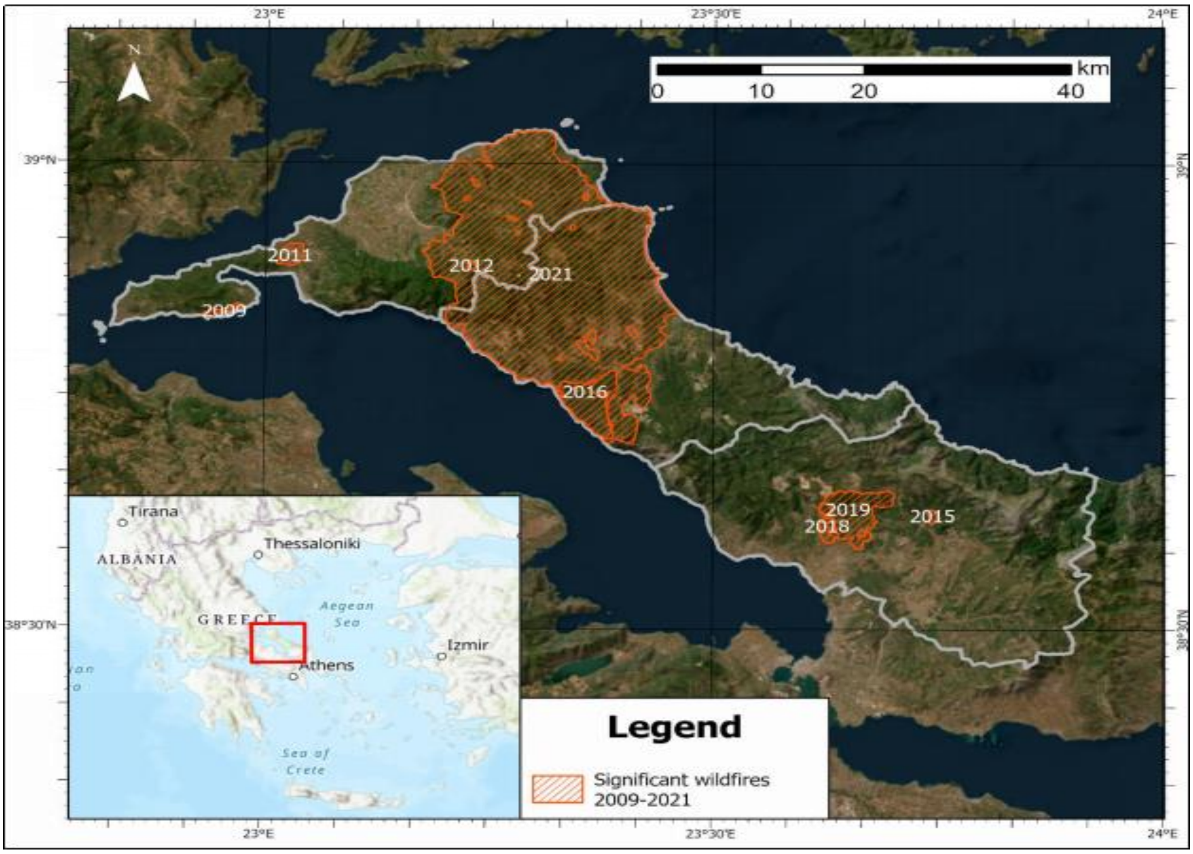

Figure 12 - Significant wildfires in the pilot area for the period 2009-2021

(Source: polygons from EFFIS).

Wildfires such as the ones presented above, and more specifically extreme wildfire events, are increasing, having significant impacts both to the environment and society and consequently require new ways, means and knowledge to confront with. The severity, intensity, speed, and extension of new, extreme events is unprecedent (Duane et al., 2021). The aim of SILVANUS is to provide the technological, theoretical, and strategic tools to support the process of building resilient and sustainable forests and societies, especially against wildfires.

The challenges of security practitioners and first responders, the operational gaps, and in general the difficulties that they face in their daily work, have been documented by various studies under the framework of recent EU projects, such as the FIRE-IN project (Miralles et al., 2021) and the MEDEA project (MEDEA consortium, 2020). Possible solutions are also documented. But the gap remains, as fragmentation is a key problem of the European security market. SILVANUS targets to support practitioners, citizens and policy makers providing a holistic platform.

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

- To develop a technological, scientific, environmental, societal and innovative framework for wildfires and sustainable forest development.
- To develop a technological infrastructure that can support decision-making for all phases of the wildfire management cycle (preparedness, response, recovery).

- To increase wildfire risk awareness and the protection and sustainability of forests.
- To support the process of a cultural change towards risk tolerance, resilience and risk mitigation.
- To increase certainty and (common and shared) situation awareness for wildfire emergencies.
- To increase the resilience of the pilot area at all levels (environmental, economic, social).
- To enable the collection of data from various sources, in real or near-real time, for valid and early detection and warning indicators.
- To assess algorithms, data and risk indicators for fire ignition, fire propagation and evacuation models.
- To setup communication infrastructures for new technologies such as drone surveillance.
- To reduce the impacts in the rural and urban environment.
- To protect human lives and health.

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:

Table 17 - Main challenges and gaps for the pilot in Greece

Phase A: Prevention and Preparedness	• Citizen engagement and wildfire risk awareness. • Landscape management. • Legal and regulatory framework related to wildfire prevention. • Creation of wildfire protection zones around settlements (Wildfire Defensible Buffer Zones). • Funding to local administration
Phase B: Detection and Response	• Early detection of wildfires. • Safe places, population gathering points, evacuation assembly points/areas and evacuation processes. • Cultural change of the local stakeholders. • Provision of necessary human resources and equipment. • Gap in the communication and coordination during response between the various stakeholders. • Problematic Evacuation. • Overall organization/coordination during the fire between all stakeholders

Phase C: Restoration issues	• Restoration issues (time). • Maintenance and sustainability of forests. • Engaging stakeholders that can directly or indirectly affect or be affected by a forest and landscape restoration initiative (involvement in the participatory restoration planning). • Raise awareness related to restoration and regeneration (natural and artificial). • Training for restoration issues. • Overall communication of the restoration.

2.5.2 Stakeholders and partners. Roles and activities

Table 18 - Relation of the various stakeholder's groups with planned activities and their role

Stakeholder	Activity Engaged	Role
Local Firefighters (Hellenic Fire Service)	TTX in Evia (2023) TTX or field exercise in Evia (2024) Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Player, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation module, health module and additional modules)
Other first responders	TTX in Evia (2023) TTX or field exercise in Evia (2024) Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Player, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation module, health module and additional modules)
Local Civil Protection authorities	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Player, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation module, health module and additional modules)
Regional Civil Protection authorities	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Player, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation module, health module and additional modules)
National Civil Protection Authorities	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2	Player, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation

	Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	module, health module and additional modules)
Volunteers	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Player, contribution to the evaluation of SILVANUS (UP3, UP4, UP6, UP7, evacuation module, health module and additional modules)
Local professionals (including farmers and agrotourism professionals)	UP8: CEP & App Round 1 UP8: CEP & App Round 2	Risk awareness, discussions, citizen engagement, observers
Local citizens (including students)	UP8: CEP & App Round 1 UP8: CEP & App Round 2 UP7: Biodiversity App	Risk awareness, discussions, citizen engagement, observers
Other invitees (local forest offices)	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 UP7: Biodiversity App Use of UP3, UP4, UP6, evacuation module & health module.	Observers, contribution to the evaluation of SILVANUS
PSTE	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Host & trial owner. Player in the TTX & FSX. Organizer & participation in CEP activities.
KEMEA	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP4, UP6, evacuation module & health module. Training FRs protocols.	Lead evaluator in all exercises. Participation in CEP activities, UP3, UP4, UP6, evacuation module and system modules.
AUA	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of UP3, UP6.	Evaluator in the exercise and of system modules Evaluation of NDVI and other forest restoration and resilience metrics Soil rehabilitation monitoring

	Estimate soil erosion and run-off related to restoration phase.	
HRT	TTX in Evia (2023) TTX or field exercise in Evia (2024) UP8: CEP & App Round 1 UP8: CEP & App Round 2 Use of evacuation module	Player & evaluator in exercises. Participation in CEP activities.
CERTH	Development & testing of UP3	Technology provider, development & evaluation of UP3
EXUS	Development & testing of UP6	Technology provider, development & evaluation of UP6
AHEPA	Testing of health module	Technology provider, Evaluation of health module
UTH	Development & testing of health assessment and evacuation modules	Technology provider, development & evaluation of health assessment and evacuation modules
HB	Development & testing of UP8: CEP & App Round 1 Development & testing of UP8: CEP & App Round 2	Technology provider, development & evaluation of CEP
MDS	Development & testing of UP8: CEP & App Round 1 Development & testing of UP8: CEP & App Round 2	Technology provider, development & evaluation of CEP mobile app
CTL	Development & testing of UP4, entailing the detection of smoke and fire particles in surveilled region with the use of edge device (IoT).	Technology provider, development & evaluation of UP4

2.5.3 Operational scenario

The objective of the demonstration is to test, train on, validate and evaluate the SILVANUS technological platform and its components, as well as the additional programs inside SILVANUS, such as training and restoration, that aim to create fire resilient societies.
Especially for the Greek pilot demonstration, the following modules, technical and non-technical, are aimed to be demonstrated, tested, discussed, validated and evaluated form the SILVANUS partners and local stakeholders:

- Cluster 1: Probabilistic models and regression analysis for the quantification of fire index and fire ignition forecasting models

- Cluster 3: Citizen engagement toolkit as a training and education program for creating risk awareness, understanding and active engagement but also as a technological application for citizens.
- Cluster 4: Environmental threat assessment from wildfires on forests, climate and societies and humans
- Cluster 6: Predictive analytics based on weather and climate patterns.
- Cluster 7: Topics related to response coordination and mitigation.
- Cluster 8: Quality assessment of natural resources and habitats.
- Cluster 10: Restoration processes (including vegetation recovery, soil stabilization, flood protection, with inputs from cluster 9 – testing protocols for evaluating burnt area impacts).

The research questions are:

- Can a technological platform that operates 24/7/365, receives input data from various sources, provides estimations based on widely accepted scientific methodologies and hosts existing knowledge and training/education programs be the decision-support system or tool that will contribute to a fire resistant and resilient area and promote innovative forest management and governance models?
- Is this system accepted by local and national stakeholders? Are they going to support its operation?
- Is the system interoperable with other existing systems?
- Is it easy to use? Does it require extensive training?
- Can the system be widely accepted by relevant stakeholders outside Greece?
- Does the system consider local peculiarities/specificities, or can it be configured to do so?
- Does SILVANUS provide a holistic approach considering all the phases of the disaster management cycle?
- Can citizen engagement be enhanced through training in a way that increases risk awareness, understanding and active support?

Data collection – Analysis - Evaluation approaches & plan (KPIs) - Reporting

Data will be collected from various sources such as the players, evaluators and observers, discussions in the demos, videos, photos, system log files and system output files. More specifically:

- Questionnaires distributed to the participants (evaluators, observers, players). Questionnaires may be similar or different regarding the category of the participant.
- Input, in the form of key notes, from the discussions and exercises during the demonstrations.
- Videos and photos that will be taken during the demonstrations.
- Data sent by sensors and the platform.
- Log files or other similar input data.
- Output data of the platform and its dashboard modules (maps, alerts, etc.).

Specific people will be assigned to collect the gathered data.

Selection of solution/ SILVANUS components

For the Greek pilot trials and demonstrations, the following modules (Minimum Viable Products - MVPs and other modules) of SILVANUS will be tested:

- The SILVANUS User Interface Dashboard.
- UP3: Fire detection based on social sensing.
- UP4: Fire and smoke detection from IoT device
- UP6: Fire spread forecast.
- UP7: Biodiversity profile mobile application.
- UP8: Citizen engagement programme and relevant mobile application.

Additional modules:

- Evacuation models and algorithms in relation to the fire spread forecast.
- Health module in relation to the fire spread forecast.
- Restoration programs and techniques that contribute to Sustainable Forest Management.

Moreover, the other MVPs such as the UP2 and UP5, as well as additional modules can be used and tested until the end of the trials in Greece, as soon as they become available.

Time plan / structure of the demonstrations

The activities for the Greek pilot focus not only on the demonstration of the SILVANUS platform and its modules but also on the operational challenges faced in Greece in relation to preventing, suppressing and restoring from wildfires. In deliverable D2.1 (Majlingova et al., 2022), specific steps have been identified, which are related to each phase.

Thus, the activities that are described below are either individual demonstrations/tests with a focus on specific modules, technologies and programs or demonstrations directly related to the 24/7/365 operational use of the platform.

The activities for the demonstrations in SILVANUS will take place during 2023 and 2024 in scope of the integrated SILVANUS platform, its independent modules, as well as relevant standalone tools. The various activities will examine all aspects of the disaster management cycle from prevention to response and restoration. The activities can be fed with synthetic (dummy) or real data. Especially for the activities that will take place during 2023, synthetic data will be fed into the system. These are presented in the table below.

Table 19 - Activities and UPs of the Greek pilot

Phase A	User Product 6 (UP6: Fire spread forecast module) in relation with evacuation and health modules for pre-planning issues.
	User Product 8 (UP8: Citizen's engagement programme and mobile app) - Thessaloniki Round 1

	User Product 8 (UP8: Citizen's engagement programme and mobile app) - Thessaloniki Round 2
	User Product 7 (UP7: Biodiversity profile mobile application)
	Discussion-based exercise / trial in Evia (2023)
	Trial / TTX or field exercise in Evia (2024)
	User Product 8 (UP8: Citizen's engagement programme and mobile app) – Evia/Sterea Ellada Round 1
	User Product 8 (UP8: Citizen's engagement programme and mobile app) - Evia/Sterea Ellada Round 2
Phase B	User Product 3 (UP3: Fire detection based on social sensing)
	User Product 4 (UP4: Fire detection from IoT device)
	Discussion-based exercise / trial in Evia (2023)
	Trial / TTX or field exercise in Evia (2024)
	User Product 6 (UP6: Fire spread module) in relation with the evacuation and health modules for response purposes.
	Evacuation module
	Health module
Phase C	Discussion-based exercise / trial in Evia (2023)
	Trial / TTX or field exercise in Evia (2024)
	User Product 8 (UP8: Citizen's engagement programme and mobile app) - Thessaloniki Round 1
	User Product 8 (UP8: Citizen's engagement programme and mobile app) - Thessaloniki Round 2
	User Product 8 (UP8: Citizen's engagement programme and mobile app) – Evia/Sterea Ellada Round 1
	User Product 8 (UP8: Citizen's engagement programme and mobile app) – Evia/Sterea Ellada Round 2
	Forest resilience and restoration metrics (such as NDVI-based)
	Soil rehabilitation monitoring

Activities, as mentioned previously, target all phases of the disaster management cycle. In the following table these activities are placed in chronological order per phase as a preliminary plan for the next two years, considering the GR targeted products. The goal is to test as many as possible of the Minimum Viable Products (MVPs) of SILVANUS during 2023 and in 2024 to test improved modules of the MVPs as well as additional SILVANUS platform modules. The SILVANUS User Interface Dashboard will also be used and tested as the main for visualizing inputs from the various sources. In any case, year 2024 will be the milestone of the completion of the tests and demonstrations of SILVANUS platform for the Greek pilot. During the exercises, all the individual modules presented in the tables above as well as additional modules of SILVANUS will be used for the implementation of the exercises in order to simulate the real situation to the maximum possible extent and use SILVANUS as an operational (24/7/365) tool. The first one, discussion-based exercise, will take place on October 31, 2023 while the second one, operations-based exercise, will take place during spring of the year 2024.

Objectives and KPI's:

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

- PA1 - Environmental and ecological mapping and assessment of forest regions within project demonstrations.
- PA3 - Development of fire danger/risk? index profile management system based on environmental, ecological and biodiversity models.
- PA4 - Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcement.
- PA5 - Define training activities designed to improve safety and preparedness of firefighters in combating wildfire.
- PA6 - Provide modelling methodologies of wildfire impact on regional areas.
- PB4 - Use and evaluate micro-predictive analytics for modelling granular changes fire pattern.
- PB8 - Apply and evaluate intelligent data modelling to estimate impact on environment, effects on human and disruption to critical infrastructure services for response coordination.
- PB9 - Development of Crisis management tool.
- PC1 - Development of biodiversity index for monitoring the effectiveness of restoration and adaptation process.
- PC2 - Implement continuous report on natural forest inventory during rehabilitation.
- PC3 - Implement soil rehabilitation strategy through advanced data analytics.
- PC4 - Restoration roadmap for natural resources.

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

Table 20 - Activities in relation to the specific objectives and KPIs. KPIs are based on those presented already in deliverable D2.3 (Lazarou and Casciano, 2022).

Phase	Objective	Activity	KPIs
Phase A	To test the fire spread algorithm based on predefined deterministic scenarios for wildfires.	UP6: Fire spread	Initial fire front and fire front after 1 hour accuracy 80% compared to other state-of-the-art software and historical cases.
	To test the Citizen Engagement Program and relevant Mobile Application in Greece with its application	UP8: Citizen Engagement Program and App	N° of citizens engaged > 250 N° of citizen engagement toolkit assessment provided > 200

	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.		N° of members consulted through public forum for the evaluation of public campaign > 100 N° of evaluation surveys gathered > 50 Number of modules in the CEP mobile App >= 3
	To test the biodiversity application in post and pre-fire event status	UP7: Biodiversity profile mobile application	N° of training samples in the database > 100 N° of species in the database >= 5 Minimum number of photos required for the identification of the species >= 2 Correctly identified > 90% No identification < 5%
	To test the algorithm in relation to UP6 to improve risk assessment and response planning	Evacuation models	Accuracy of optimum exit, destination point and route > 80% compared to the knowledge from historical use cases. Acceptance from first responders and civil protection > 50%.
Phase B	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 (Twitter).	UP3: Fire detection on social sensing	Accuracy of fire detection in images > 75%. Precision of fire events detection (% correctly identified) > 80%. Retrieval time (from publication to collection) < 5 minutes. Analysis time (from collection to enhancement and storage) < 2 minutes. Event detection time (from publication to event (warning) generation) < 10 minutes.
	To test the functionality of detecting fire events from IoT devices.	UP4: Fire detection from IoT device	Classification accuracy of detecting fire incidents in the captured image > 70%. Accuracy of detecting fire/smoke particles within the video frame/images, denoting the location of the fire > 60%. Analysis time (from capturing to transmission) < 5 minutes.

			Event detection (from ignition to detection and event generation) < 10 minutes. Trustworthiness from firefighters and first responders should be more than 70%
	To test the algorithm in real-time environment	UP6: Fire spread	Change of operational tactics based on the results of the algorithm compared to real historical scenario. Initial fire front and fire front after 1 hour accuracy 80% compared to other state-of-the-art software and historical cases.
	To test the algorithm in real-time environment and in relation to the UP6.	Evacuation models	Accuracy of optimum exit, destination point and route > 80% compared to the knowledge from historical use cases. Acceptance from first responders and civil protection > 50%.
	To apply and test the Implemented algorithms in relation to UP6	Health impact	- Time to conclude the assessment minutes
Phase C	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.	UP8: Citizen Engagement Program and App	N° of citizens engaged > 250 N° of citizen engagement toolkit assessment provided > 200 N° of members consulted through public forum for the evaluation of public campaign > 100 N° of evaluation surveys gathered > 50 Number of modules in the CEP mobile App >= 3
	To test the applicability of NDVI and/or other metrics as a useful index for restoration in North Evia and Greece	NDVI monitoring	Acceptance from Forest Services of local municipalities to include it in the permanent monitoring measures and indicators.
	To study soil pollution and to simulate soil erosion and run-off	Soil rehabilitation monitoring	- Degree of soil pollution (changes over time) - Measurements of soil erosion and run-off (changes tracked according to vegetation recovery)

It has to be noted that the KPIs of the two exercises are the ones of the modules of SILVANUS that will be used during the exercises. An additional KPI for the exercises is the participation of representative local stakeholders in the process. The agreement for the continuation of future exercises will be an additional KPI, as a measure for an improved collaboration in the

2.5.4 Preparing user stories

Phase A. The Prevention and Preparedness activities

In WP2, deliverable D2.1 (Majlingova et al., 2022), specific steps have been mentioned as relevant to the Greek pilot. These steps include potential data and technologies that are of interest for the Greek case and are briefly mentioned below (these are described in detail in D2.1):

- The use of fire risk daily map published every day during the fire season in Greece, by the General Secretariat for Civil Protection.
- Use of static data and layers, such fuel maps, exposure elements, weather data.
- Use of real-time weather data for the pilot area.
- Soil moisture related data and maps.
- Fire ignition probabilities and fire propagation modelling in GIS environment
- Training, especially of citizens, but also of first responders.
- Other preventive measures, not technological, that could support prevention, early detection and mitigation of impacts of wildfires.

Activities to be carried out:

<u>User Product 6 (UP6: Fire spread forecast module)</u>: This module will be tested against past forest fire events that have occurred in Evia, especially in North Evia, and other regions of Sterea Ellada. New events will also be tested. The activities will be online and based on synthetic data until the full operation of the SILVANUS platform. The module will also be used during the two exercises offline and online. Besides the propagation forecast for wildfires, the tool will be estimated for risk assessment and risk awareness purposes.

<u>User Product 8 (UP8: Citizen's engagement program and mobile app)</u>:

The citizen awareness program of SILVANUS will be tested in at least two cycles in two areas in Greece. The first cycle will take place in 2023 in North & central Evia and in Thessaloniki and the second cycle in North Evia and Thessaloniki.

In Thessaloniki with the main contribution of HRT, and the support of AHEPA, UTH, KEMEA, AUA, MDS and potentially other Greek partners the following events are planned to take place:

- Conduct info days to educate/train citizens on behaviour modification approaches to safety in the forest, train them on how to use the developed mobile application and how they can support prevention efforts through its use.

- Create info-points that will distribute dissemination material promoting both the scope of the project and the use of its mobile application for the overall objective of preventing a forest fire to break out.
- Info days on the health effects of forest fires on rescuers. Collaboration with AHEPA.
- Learning about active fire protection systems through demonstration.
- At the same time, we intend to conduct research based on the HB study protocols and share them with local stakeholders (Civil Protection, Forest Service, etc.)

In Evia Island, as well as other areas in Sterea Ellada, with the main contribution of PSTE (as pilot owner and final end user) and the contribution of HRT, KEMEA, AHEPA, UTH, AUA and potentially other Greek partners a similar citizen engagement will take place. The CEP in Sterea Ellada will be implemented in two rounds, while specific education events in schools will take place at various time through the school year until the end of SILVANUS project.

- A one-day event will take place in the municipality of Dirfys-Messapion for citizen awareness prior or after the TTX (back-to-back).
- A citizen engagement educational and training program is planned to take place at the schools of Sterea Ellada. This program will start at the same day with the event in the municipality of Dirfys-Messapion but due to the high interest of local stakeholders, it will be expanded in the North Evia as well as other areas of Sterea Ellada such as Chalkida, Thiva, Lamia, and other cities. The aim is to make as broad as possible and engage/train/educate as many students (all ages) as possible.

<u>User Product 7 (UP7: Biodiversity profile mobile application)</u>:

In relation with the CEP module, the biodiversity will also be demonstrated and used for gathering of biodiversity and location data for fire prevention and ecological awareness. The focus is put on images of tree leaves in order to determine the type of forest/trees and other related information that can enhance forest landscape models for wildfire threat assessment. The data derived from the collection and analysis will enable deeper understanding of the relation between the biodiversity of forests and fire related aspects such as forest fuel detection, landscape management, and fire fuel threat assessment.

<u>Discussion-based exercise / Trial in Evia 2023</u>:

This exercise aims to gather all involved emergency services, professionals and volunteers, public and private, in order to discuss the various issues in case of two wildfire events in Evia and surrounding areas. The trial/exercise will be implemented in a way that will cover all phases of the disaster management cycle. The scenario will contain incidents and discussion topics for all phases. During the exercise, all available modules/tools at the time will be used, even in an offline, not fully operational, version, with or without the use of SILVANUS User Interface Dashboard. For phase A, focus will be given to the tools that are enhancing prevention against wildfires.

Trial / TTX or field exercise Evia 2024:

The preliminary plan is to carry out a second field exercise, approximately in mid-2024 at North Evia engaging once again all involved emergency services, professionals and volunteers, public and private. The aim is to use the SILVANUS platform as a pilot operational tool and simulate with real and synthetic data the exercise scenario. This will be the final large-scale test of SILVANUS platform in Greece. During the exercise the incidents will focus on all phases with specific discussion topics.

Phase B. Detection and Response activities

The interest for the Greek pilot in this phase focuses on early detection and warning through social media, drones, mobile applications, a decision support system, use of mobile command centers, equipment that can be used by firefighters during the suppression and firefighting, organization of citizens and authorities from fast and efficient evacuation, fire propagation models in real-time, evacuation models in real-time/near real-time, and use of health metrics both for firefighters and citizens.

Activities to be carried out:

User Product (UP3: Fire detection based on social sensing):

Collection of citizen observations from social media, in particular Twitter, about possible fire incidents, in order to contribute to early-stage detection of wildfires.

- Extraction of concepts from textual as well as visual contents from Twitter. Detection of location-related concepts and geotag the corresponding social media posts.
- Extraction of visual concepts, such as flames, smoke, etc., to indicate potential fire events in user photos.
- Automatic classification of social media posts as relevant or irrelevant to fire disasters.

The tool will be tested throughout 2023 and 2024, especially during the fire season. It will also be fed with synthetic data for the TTX in 2023, and real or synthetic for the exercise in 2024.

User Product 4 (UP4: Fire detection from IoT device):

Initially the IoT devices are expected to collect data from RGB and infrared cameras, while several other sensors, such as thermometer, wind and humidity sensors are investigated in order to be included for future integration. Pre-processing will take place on the edge device, to prepare the data for feature extraction, representation in a lightweight environment and further analysis. Pre-processed data will then be analysed from lightweight computer vision and machine learning algorithms to detect fire and smoked incidents in the region. Only detected events will be transmitted through the network and notify the SILVANUS platform. Edge analysis results including the detection of fire and smoke incidents will be represented on SILVANUS dashboard.

User Product 6 (UP6: fire spread forecast module): UP6 will be used in the TTX and field exercises as one of the main tools for the planning of the response to the scenarios that will be simulated. It will also be used as a training for the first responders either online or offline. Also, the propagation forecast will feed the evacuation module in order to assist the response and the evacuation of citizens. In addition, it can be used as a first input for the health module.

Evacuation module:

Fed by the fire spread forecast tool (UP6), the health module and the appropriate population and geospatial data, the evacuation tool will provide the necessary information for safe evacuation routes and concentration points to the coordination team and support decision-making. Each route will be determined using the OpenRouteService API and be plotted using OpenStreetMaps. The final form of each safe route will be a GeoJSON feature collection of distance and time, as well as a geometry of multiple latitude-longitude points that represent the actual evacuation path. The inferred routes will be represented on the SILVANUS dashboard. The module will be tested throughout 2023 and 2024.

Health module:

Fed by the fire spread forecast tool (UP6), the health module reflects the potential impact of wildfire emissions in human health. The proposed module can process data delivered by multiple independent sources (e.g., IoT devices and Silvanus modules) while exploiting the medical knowledge provided by experts to derive the appropriate reasoning. The target is to detect the safe areas and avoid negative consequences on first response teams, nearby citizens and distant populations located in the same direction in which the wind is blowing. Health module generate real data using a Raspberry Pi and five pollutant sensors (Sulfur Dioxide - SO_2, Nitrogen Dioxide - NO_2, Carbon Monoxide - CO, Ozone - O_3 and Fine Particulate Matter - $PM_{2.5}$). All the above information is used to calculate the European Air Quality Index (EAQI) by the Raspberry Pi itself. Next, a JSON object that contains information about the health status will be stored in a local database. The JSON object contains is a Circle with latitude-longitude coordinates for the centre, a float value in meters for the radius and also an indication about the air quality of the area inside the circle (e.g., good, poor). The health module can be consumed by any other module by calling the appropriate endpoint. The module will be tested throughout 2023 and 2024.

Discussion-based exercise / Trial in Evia 2023:

This exercise aims to gather all involved emergency services, professionals and volunteers, public and private, in order to discuss the various issues in case of two (wild)fire events in Evia and surrounding areas. The TTX will be implemented in a way that will cover all phases of the disaster management cycle. The scenario will contain incidents and discussion topics for all phases. During the exercise all available modules/tools at the time will be used, even in an offline, not operational, version. For phase B, the focus will be given on the tools of SILVANUS, such as UP6, evacuation module and health monitoring of first responders and citizens that can provide valuable input during response.

Trial / TTX or field exercise Evia 2024:

Most probably a second field exercise will be carried out, approximately in mid-2024 at North Evia engaging once again all involved emergency services, professionals and volunteers, public and private. The aim here is to use the SILVANUS platform as an operational tool and simulate with real and synthetic data the exercise scenario. This will be the final large-scale test of SILVANUS platform in Greece. The tools UP6, evacuation and health monitoring will be used through the SILVANUS platform in real-time and the User Interface Dashboard.

Phase C: Restoration and Adaptation activities

The interest on the restoration for the Greek pilot is extremely significant given the fact that area was significantly affected by the 2021. Already actions that are of interest have been described in deliverable D2.1, such as soil and ground water protection /conservation measures in order to minimize erosion water pollution, and floods, soil restoration and water remediation measures, restoration of burnt forest areas either through natural or artificial regeneration, reforestation, biodiversity issues, socio-cultural and economic issues. Already in Greece, due to the 2021 megafire, a large restoration and re-development strategic plan of the area has been approved and is under further discussions.

Activities to be carried out:

Discussion-based exercise / Trial in Evia 2023:

This exercise aims to gather all involved emergency services, professionals and volunteers, public and private, in order to discuss the various issues in case of two wildfire events in Evia and surrounding areas. The TTX will be implemented in a way that will cover all phases of the disaster management cycle. The scenario will contain incidents and discussion topics for all phases. During the exercise all available modules/tools at the time will be used, even in an offline, not operational, version. For phase C, focus will be given on the short-term and long-term restoration actions currently in place in Greece (and the pilot area) and suggestions for the future.

Trial / TTX or field exercise Evia 2024:

A second exercise (field exercise) will be carried out, approximately in mid-2024 at North Evia engaging once again all involved emergency services, professionals and volunteers, public and private. The aim here is to use the SILVANUS platform as an operational tool and simulate with real and synthetic data the exercise scenario. This will be the final large-scale test of SILVANUS platform in Greece. For phase C, focus will be given on the short-term and long-term restoration actions currently in place in Greece (and the pilot area) and suggestions for the future. SILVANUS platform will be used as a tool for monitoring restoration and potentially organizing further actions.

User Product 8 (UP8: Citizen's engagement program and mobile app):

The citizen awareness program of SILVANUS will be tested in at least two cycles in two areas in Greece. The first cycle will take place in 2023 in North & central Evia and in Thessaloniki and the second cycle in North Evia and Thessaloniki.

The time-plan of the CEP will follow the one presented in the first phase. In the education and training sessions, especially those in schools, a section will also focus on phase C, for restoration actions and in a new approach of close-to-nature for children.

Forest resilience and restoration metrics

This activity will produce a timeline of vegetation recovery using NDVI and other relevant metrics.

Soil rehabilitation monitoring:

This activity will study soil rehabilitation in the pilot territory, focusing on measuring soil pollution. This activity will also study and simulate soil erosion and run-off change, in conjunction with vegetation recovery, in selected sampled areas of the pilot territory.
The rationale, for the Greek pilot, behind the selection of the activities, the various steps that have been mentioned previously, as well as in other deliverables (e.g., D2.1 - Majlingova et al., 2022), and the scenarios described below, is that in Greece and more specifically in the pilot area Evia Island and surroundings, the aim is to test and demonstrate SILVANUS capabilities in all the phases of the disaster management cycle. Thus, two preliminary scenarios are described that will be the basis for the detailed scenarios that will be discussed during the discussion-based and operations-based (field demonstrations) exercises in Evia. The detailed scenarios will be provided in other deliverables after the implementation of the exercises and other activities (i.e., D9.2, D9.4).

The main pillars of the scenarios are presented below. The date and time of both scenarios are considered to be simulated during the exercises. During the breaks for discussion, the exercise manager will ask specific questions to the players and allow a discussion between them. SILVANUS capabilities will be shown to the players in order to demonstrate to them, the support that SILVANUS offers and the improvement in prevention and firefighting. Soil protection and forest restoration measures will also be discussed.

Scenario Evia -1:
It is the year 2023 with a hot summer prevailing in Greece. May and June of 2023 were characterized by usual temperatures and a typical summer condition in Greece, slightly more humid than usual as many rains occurred, especially during the first 15 days of June. Nevertheless, July is a hot month with many days with above average temperatures and the average temperature is +1.5 above mean values across the country. In the central and southern part many extreme heat events were observed. In addition, air humidity is very low and in some meteorological stations of southern Greece, and of Attica, soil moisture is also extremely low. The atmospheric prognostic models of the Hellenic National Meteorological Agency of Greece and other meteorological research institutes predict that the high temperatures will continue, although with slightly lower values due to strong NE winds that will start to prevail by the end of July and August in the Aegean Sea. Greece has mobilized its rescEU AFFF capacities to France and Italy respectively due to the

high number of active wildfires which led these countries to activate the Union Civil Protection Mechanism.

[Short break for discussion from the exercise manager]

As a consequence of the hot weather, a wildfire has occurred in Southern Peloponnese during the last day of July (31st of July). The map of the General Secretariat of Civil Protection of Greece (GSRT-GR) had issued a warning through the daily map for that day, especially for South-Western Peloponnese.

[Short break for discussion from the exercise manager]

The wildfire in the Peloponnese is active for many days. On the 5th of August, the GSRT-GR publishes the daily fire danger map and the regions of Attica and Eastern Sterea Ellada are coloured in orange (Very High level of hazard), as well as all islands of the Aegean Sea. Some of them are in red colour (Alert situation).

[Short break for discussion and map provision from the exercise manager]

It is the 6th of August 12:00 when a tourist calls 112 and in plain English reports that smoke is observed over a densely wooded area in the mountains NNE of Aidipsos. The 112-command centre asks him for more details and also asks to acknowledge his position through his mobile phone.

One minute later the 100 Hellenic Police number receives a call from a citizen close to the village “Kastaniotissa” seeing black smoke in the woods. At the same time, the Hellenic Fire Service command centre is notified by the local fire watch station that smoke in the same area south of the village “Taxiarchis” is observed. The Fire Service command centre immediately mobilizes the nearest fire engines that are geographically distributed in the area according to the operational plan for the fire season. The fire brigades of Evia are on general alert. The head of the firefighting forces at the site of the fire makes a request for more fire engines and aerial means. The General Emergency Response Plan for Forest Fires, code-named 'IOLAOS', is activated. Therefore, the armed forces, the police and the local government are assisting under the plan.

A couple of minutes later, a third call at the 199 Hellenic Fire Service number is received by a citizen of the village “Galatsades” who is working in the woods (a bit south of the village) reporting that he intensely smells burned wood. At this point it is not clear if one or more fire spots are active and how big the fire front is.

[Short break for discussion from the exercise manager]

The air patrol of the Hellenic Fire Service arrives from the northern part of the country at Volos, flying towards Evia and reports that the crew is able to see very clearly smoke South of Istiaia and East of Aidipsos indicating that the fire front has not evolved, being at an initial stage. The plane makes an attempt to put out the fire by dropping the water that is carried into its tank. However, due to the difficult terrain the attempt was unsuccessful.

The weather conditions are approximately 37˚C regarding temperature, and 4 Bf NNE winds. Nevertheless, it is expected that temperature will fall to 33˚C but the winds will be stronger up to 5Bf, locally 6Bf of varying direction from NNW to NE.

[Short break for discussion from the exercise manager]

Local residents, local municipalities and local emergency services are reaching the spot. Air firefighting means will not arrive soon due to the difficult situation that still evolves in the Southern Peloponnese. A couple of minutes later it is clear that two independent fire spots are active at their initial stage.

[Short break for discussion from the exercise manager]

The fire in Evia evolves. A new meteo alarm is issued for the afternoon of the 6th of August. The meteo alarm is the following: "Strong winds are expected in the regions of Eastern Sterea Ellada, Attica and the Aegean Sea. Winds will reach up to 8Bf in the Aegean Sea but gusts will reach 10 Bf. Evia will also suffer from strong winds of 8Bf to the south, and 6Bf up to 7Bf in the northern parts of the island. The winds will last up to the noon of the 7th of August.". Temperatures will drop and will not exceed 32oC.

[Short break for discussion from the exercise manager]

By the night of the 6th of August, the fire reaches the highest altitudes of the mountain, and starts to descend towards Aidipsos.

[Short break for discussion from the exercise manager]

During the night the forces of the Hellenic Fire Service have been reinforced with the help from many parts of the country, and of local residents and volunteers. Early in the morning of the 7th the wildfire seems to be partly controlled, but at 7 o'clock stronger winds start to prevail. The direction of the winds is not constant, and the fire takes a route towards the northern Evoikos gulf.

At 11:30 in the morning, winds are less violent, and the few airplanes still operating at the spot manage to control the fire on the "barricades" setup by land forces.

In the afternoon of the 7th of August, the fire burned a considerable part of the mountain, but now it is under control. The weather forecast is good, with lower winds and similar temperatures. By the night of the 7th of August small fires are still burning close to some villages but the situation is under control.

On the 8th of August the fire was put out. There are some cases where the fire did reach the northern Evoikos gulf burning thick forest, but the villages are safe.

[discussion between the participants, focusing on a short aftermath of the wildfire and the next steps, short and long term].

[End of exercise and debriefing.]

Scenario Evia-2:

It is the year 2023 with a hot summer prevailing in Greece. May and June of 2023 were characterized by usual temperatures and a typical summer condition in Greece, slightly more humid than usual as many rains occurred, especially during the first 15 days of June. Nevertheless, July is a hot month with many days with above average temperatures and the average temperature is +1.5 above mean values across the country. In the central and southern part many extreme heat events were observed. In addition, air humidity is very low and in some meteorological stations of southern Greece, and of Attica, soil moisture is also extremely low. The atmospheric prognostic models of the Hellenic National Meteorological Agency of Greece and other meteorological research institutes predict that the high temperatures will continue, although with slightly lower values due to strong NE winds that will start to prevail by the end of July and August in the Aegean Sea. Greece has mobilized its rescEU AFFF capacities to France and Italy respectively due to the high number of active wildfires which led these countries to activate the Union Civil Protection Mechanism.

[Short break for discussion from the exercise manager]

At around 14:00 of the 14th of August the fire spot monitoring station close to Drymonas and Skepasti village reports to the Hellenic Fire Service and at the municipality of Limnis-Ayias Annas-Mantoudiou light smoke coming from an area in Xero Vouno up in the mountains.

[Short break for discussion from the exercise manager]

The area belongs to the big part of Evia Island that burned in 2021. The specific area has not been burned totally in 2021. After 10 minutes the fire spot monitoring station reports that the smoke has intensified. Local conditions are about 35˚C with about 3-4 Bf of N-NE winds.

10 minutes later local forces started to gather and move towards the area that is burning.

Approximately 35 to 45 minutes after the fire ignition the first residents start to approach the area.

A Hellenic Fire Service helicopter arrives in order to provide the first estimation.

[Short break for discussion from the exercise manager]

The situation is not considered very difficult as the areas have been burned again. The wildfire burns black pines, firs and low vegetation.

[Short break for discussion from the exercise manager]

At 15:00 in the afternoon the Hellenic Fire Service receives a call for a fire close to the industrial area of Schimatari and Oinofyta.

At 15:10, the ignition point is located at the south of the village "Kalochori" at the high areas above Schimatari.

[Short break for discussion from the exercise manager]

At 15:30, the fire moves towards Schimatari. Weather conditions are similar to the ones in Evia.

[Short break for discussion from the exercise manager]

Around 16:00 the fire is close to the top of the hills of Schimatari.

Around 16:30 in the afternoon, the wildfire in Evia has not expanded significantly, and it seems to be under control. At around 17:00 the winds are getting a bit stronger, and the fire front expands with higher rhythms.

At 17:30, the fire front expands significantly, and it seems to be out of control. Nevertheless, the fire expands in low grass land and unfortunately burns small pines that have been naturally regenerated.

[Short break for discussion from the exercise manager]

At 18:00 the fire in Schimatari was put out due to the use of air fighting means and land forces.

At 20:30 the air firefighting means stopped due to the coming night. The fire is now under control. Grassland and small vegetation are burning.

By the next morning the fire had been totally suppressed. A small part of the burned area has been burned again including naturally reforested areas.

[discussion between the participants, focusing on a short aftermath of the wildfire and the next steps, short and long term].
[End of exercise and debriefing.]

2.5.5 Receiving requirements & permits

For the implementation of all activities, the following rules apply:

- Information sheets and consent forms will be distributed to all participants.
- GDPR rules will be closely followed and monitored during the implementation of the activities.
- All participants will be invited. No external member without a prior notice or invitation will participate. An exemption is made for the citizen engagement program application which targets local citizens, and in some cases may be implemented in open public spaces while in other cases in schools.
- Video recording or photo shooting of people or students is permitted only with their written consent, otherwise no videos or photos will be taken/recorded. This material can be used for educational, training and promotional purposes based always on the signed consent forms.
- The pilot owner (PSTE) will have the overall supervision and make the proper arrangements.
- No prescribed fires or lighting a fire will take place for demonstration purposes.
- For the SILVANUS modules that detect smoke or fire, the use friendly to environment smoke generators will be a priority.
- In case fire flames need to be detected or high rise of temperatures, lighting of fire inside metal barrels and in a controlled environment may take place taking the necessary permissions.
- In case drones or other flighting equipment need to be deployed, the necessary flight plan has to be submitted to the Hellenic Civil Aviation Authority prior to the flight, and necessary permissions must be granted. It is noted that flights near airports or military facilities or other critical infrastructures is not allowed. If a SILVANUS partner will deploy drones or other means in a "sensitive" facility, PSTE must be aware prior to the action in order to get the necessary permissions. Any partner that wishes to acquire a permission for the flight plan will do so by its own, with a prior notification to PSTE.

Important notice: Drone flight plans are being submitted to the following registry: https://dagr.hcaa.gr/. In order to be approved, flight plans must be submitted by a certified drone pilot from Greece or other European country. European certifications are accepted but an additional procedure must be followed. In any case, the certification number must also be declared. Drones must be insured. In case you want to fly your drone based on your EU certification, please consider that the permission may require more than one month to be accepted.

- Drone flights can be performed by Greek partners, but a prior notification and planning is mandatory.
- In case a SILVANUS partner needs a specialized equipment then he/she must take care to purchase it or be in contact with the pilot owner for further details.
- During the table-top exercise no specialized equipment is foreseen.
- During the field exercise the local stakeholders will participate with their usual equipment to increase the realism for the simulations. PSTE will communicate that to the interested stakeholders (inside or outside of SILVANUS project).

2.5.6 Testing the pilots

Technology providers are free to make field visits any time of the year considering the following:

- Exact dates of the exercises and demonstrations will be provided in the next months.
- Prior notice to PSTE and other GR partners is mandatory.
- Prior notice will involve a brief description of the scope of the visit, the places that will be visited and the time plan. This is necessary in order to organize a visit in the best possible way. PSTE or other Greek partners may help you to select the proper locations and accompany you during the visit.
- For the participation of the partners in the exercises a prior notice, the latest, one month before is mandatory. Greek will be the official language of the exercise. Nevertheless, guidelines and logistics will also be provided in English (for partners of SILVANUS and deliverable purposes).
- In some cases, escort may be necessary, especially during summer and days that is forbidden to walk in the forests due to weather that favors fire ignition and propagation.
- Weather during summer in Greece is always hot with the exception of summer rains especially in the afternoons of early June or late August and September.
- It is advised for the SILVANUS partners to take the visits close to the dates of the exercises for managerial purposes.
- SILVANUS partners must take into account that travels are in the responsibility of the partner and not any other Greek partner or the pilot owner unless other and specific instructions are given.
- Avoid visits during late autumn or winter as severe weather phenomena may occur.

2.6 Portugal Pilot – Powerline disruptions resulting in accidental fires

2.6.1 Silvanus platform inputs

The Portuguese Pilot focuses on the demonstration of operational scenarios in **Phase A** (Preparedness and Preventions) and **Phase C** (Restoration and Adaptation).

The pilot is about **Safeguarding Critical Infrastructure**, namely power lines, power generation infrastructure, and water supply and treatment stations - and in this context, the pilot focuses on testing and implementation of prevention (Phase A) and restoration measures (Phase C), with emphasis on the use of **grazing** to **regulate biomass** and **restore habitats degraded by fire**, and the use of **monitoring data** – local IoTs, remote satellite imagery and driven products, drones, etc. - for prevention and restoration management.

The pilot site is in an agroforestry farm named Quinta da França (QF), with a total area of 500 ha, where the monitoring measures take place, and the SILVANUS user products can be tested, more precisely, within an oak forest area with 200 ha, where forest fire prevention and restoration activities are focused. QF encompasses a diversity of land cover and uses, which are representative of the existing vegetation mosaic in the study pilot region - Cova da Beira. In the pilot region, within a 30km radius from the Quinta da França pilot site, there are several critical infrastructures owned by AdP and EDP, namely two water treatment plants, a water reservoir, hydric power generation infrastructure and power lines, some of which could be used during the demonstration activities.

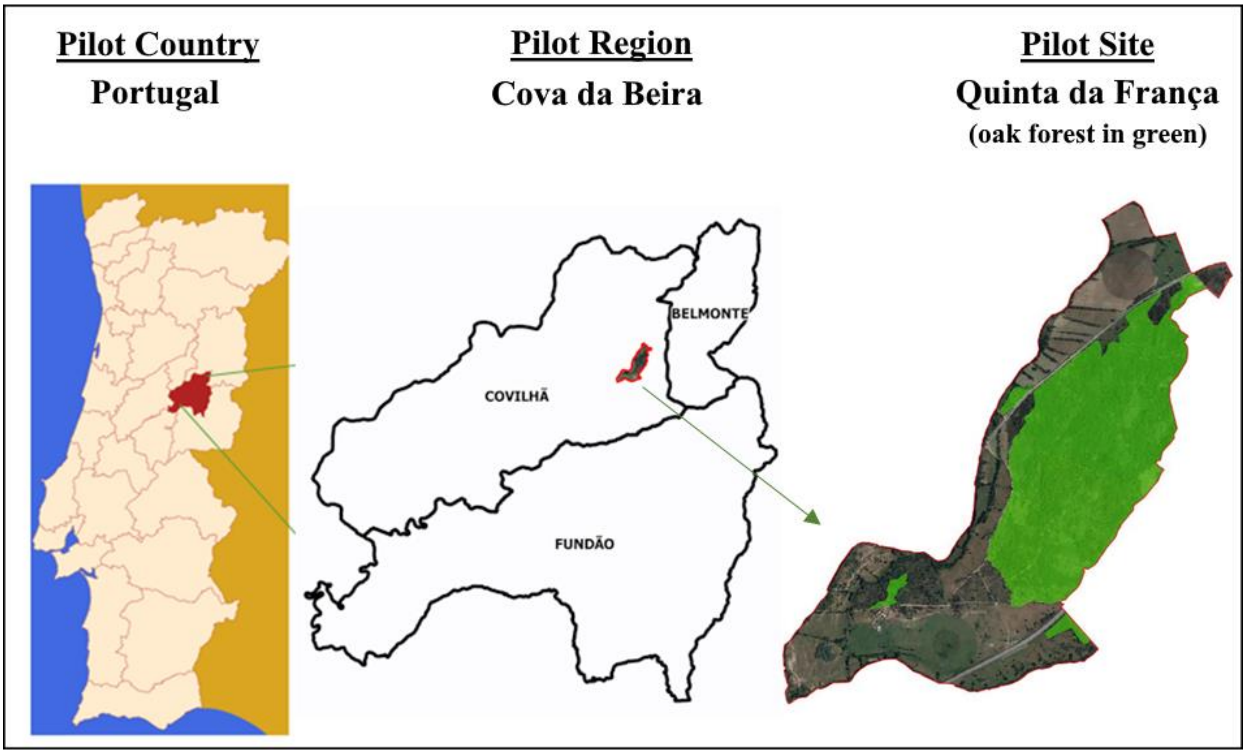

Figure 13 - Portuguese pilot site location

The Cova da Beira region is located in the east of Portugal and borders on the north with the Natural Park of Serra da Estrela, an important orographic accident, that along with the Açor and Lousã mountains, forms the western end of the Iberian Central Cordillera. Serra da Estrela is the highest point of Portugal mainland, and an important part of three hydrographic basins (Douro, Tejo and Mondego). The Serra da Estrela region and Natural Park, presents a unique and diverse landscape with a varied mosaic of habitats, combining representative elements of various biogeographic regions. It is one of the most emblematic areas in Portugal for natural values associated with altitude, many of them exclusive.

Cova da Beira region includes 3 municipalities: Belmonte; Covilhã and Fundão, with a total area of approximately 137 500 ha. It is widely known for its top-quality agriculture products. Besides some industry, the region has strong agriculture and forestry activities. Cova da Beira combines a strong implantation of the industry in an area with a strong rural influence, resulting in a rural region of high population density.

Quinta da França (QF) is a 500-ha agroforestry farmland, owned by Terraprima (TP) partner (more details about QF can be found in the Deliverable D6.2 -. QF is located in Covilhã municipality and in the parishes of Peraboa and Teixoso. The main activities in QF are agricultural exploitation, forestry activities, research and development activities in the physical and natural sciences. The main agricultural activities in QF are production of beef cattle and dairy sheep production. QF has approximately 200 ha of mixed woods forest, most area being occupied by Pyrenean oak (*Quercus pyrenaica*, 9230 Natura Network Habitat), which is the dominant forest type, but there are also conifer and other hardwood groves, riparian corridors and strips of maritime pine and eucalyptus, which contribute to the diversity of landscape. The forest at QF is essentially managed for conservation and for the provision of ecosystem services.

Figure 14 - Autochthonous Pyrenean oak forest in Quinta da França farm -pilot site

The fire regime in the pilot site is generally characterized by a typical Mediterranean fire season, that is, most of the forest and rural fires, happen in the hot and dry season (May to September). This is related with the regional Cova da Beira climatological characterization, namely, by two important predominant factors: i) hot and dry Summers, and ii) wet and humid Falls and Winters seasons, but also, combined with the typical vegetation phenology, *i.e*. growing peak in the Spring, with longer daylights and rising temperatures, followed by a senescence dry biomass period in the Summer, thus, contributing for the fire hazard increase.

This fire regime is also characterized by the occurrence of intense and big summer fires (some very severe like the ones that append in 2003, 2005 and 2022 in the pilot region), with very large areas affected, mostly form shrubland and forestland. The terrain topology, with high slopes, difficult terrain access for fire fighters, the summer climacteric adverse characteristics, and large areas of monoculture forest production regime, namely Maritime Pine (*Pinus pinaster*) and Eucalyptus (*Eucalyptus sp.*) are causes that significantly contribute for this intense forest fires. Nevertheless, the agricultural mosaic, combined with the autochthonous oak Pyrenean forests in the pilot region, largely contributes for a bigger resilience of the territory against forest fires. In contrast, the agricultural practices such as bushfires for pasture areas, burning ended annual crops for new seeding season, and the mechanical agriculture operations are pointed as some factors that contribute for unintentional and negligent fire ignitions.

To contribute for the fire prevention phases A, the SILVANUS Portuguese pilot will integrate agroforestry nature-based management solutions, with modern digital technologies, focused on remote and proximal sensing, including satellite imagery, UAV imagery and IoT sensors.

The Portuguese pilot includes both the Portuguese main electrical utility (EDP) and the main water utility (Águas de Portugal, AdP), also, one of the most reputed academic institutions (IST-ID, Instituto Superior Técnico) and a private farming company (Terraprima), which is a front runner in the implementation of 4.0 farming.

EDP's main activity involves all the energy vertical from generation to commercialization in exception of the High Voltage transport, which is managed by other company. EDP has many assets – lines, generation plants, transformers, buildings – which by being dispersed in the territory are exposed to fire risk and extreme weather natural disasters. In the project subregion, EDP has many assets which perform critical services and are often located in remote areas, such as the supply of electrical energy to isolated villages or houses

Figure 15 - EDP energy infrastructure example - medium voltage power lines crossing a forest area

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

- Attaining cost-efficient fire prevention in forest sites and next to critical infrastructures by:

a) prioritizing areas of intervention for fuel management. The identification of priority areas could be based on the condition of vegetation, considering its composition, cover, height, and water content, and will be monitored using remote sensing approaches and early warning models of fire hazard.
b) testing and implementing the use of livestock grazing as a nature-based solution (NBS) for the regulation of biomass content and distribution (horizontal and vertical continuity). This approach is expected to contribute to mitigate fire hazard, and promote forest biodiversity levels and restoration (in disturbed areas)

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**
    - Frequent remote monitoring of fire hazard and timely deployment on the terrain of different technologies to further assess the ground conditions in detail.
    - Safe and affordable deployment of measures (such as mechanical clearing of vegetation) to mitigate the fire risk.
    - Reduce management cost through early planning of clearing activities supported by Silvanus products.

- Coordination with livestock owners for the implementation of nature-based solutions based on grazing.
- Citizens and landowner’s uptake of awareness campaign.

- **Phase C: Restoration**
  - Mitigation of trade-offs by the use of grazing for biomass management, aiming at avoiding impacts on soil, biodiversity, tree regeneration and reducing GHG emissions.
  - Selecting the right set of variables to assess the performance restoration efforts.

2.6.2 Stakeholders and partners. Roles and activities

The Portuguese Pilot Cluster is composed by four partners, namely: EDP (Pilot leader), AdP, IST-ID, and TP. They are engaged with several different stakeholders in their scope of action and expertise, that are all align with the SILVANUS project objectives.

Thereby, the involved Portuguese Pilot stakeholders are very much committed in enhancing the research and development of new scientific and technological approaches, for the increasing of forest resilience to wildfires, for the prevention and protection of critical infrastructure (energy and water) against wildfires, alongside with agroforestry management and natural based solution for the forest preparedness and restauration, respectively, in phases A and C of SILVANUS project.

In the categorization of the stakeholder’s contacts, a list of 14 possible organization types were defined, where the Portuguese Pilot partners are also included.

Table 21 - Organizational type stakeholders, Portugal

List of Organization Type	Portuguese Partner
A - Firefighting association	-
B - Forest and/or landowner	TP
C - Forest governance association	-
D - Industry	-
D1 - Timber industry	-
D2 - Energy and construction industry	EDP; AdP
E - Infrastructure, traffic, and road network	-
F - Local residents and communities affected by wildfire	-
G - Civil society organisations	-

H - Research organisations (Universities, think tanks)	IST-ID
I - Software and technology developers on wildfire prevention	-
J - Policy makers	-
K - Health sector	-
L - Other	-

The stakeholders will contribute for the Portuguese Pilot site, and they will be involved in different phases (A and C) during the Pilot demonstration, and it´s expected that different stakeholders will have different roles and activities.

Table 22 - Stakeholders and partners, Portugal pilot

Stakeholder	***Activity Engaged***	***Role***
EDP	Leader of the Portuguese Cluster; Electrical infrastructures demonstration provider (linear - power lines, and nonlinear – buildings); UAVs - drone flights for remote	Pilot coordinator; Energy Infrastructures
AdP	Water infrastructure demonstration provider (nonlinear - buildings). Has a vast experience in weekly monitoring and reporting as well as managing the vegetation control activities in the vicinity of its thousands of critical infrastructures. Based on it, has a deep knowledge of legal requirements and common procedures required to interact with the national main stakeholders, to whom, as critical infrastructures´ manager, has the responsible to report the fire risk.	Water Infrastructures
IST-ID	Ecosystem and biodiversity monitoring. Development of vegetation mapping product. Nature	Researcher

	Based Solutions – Grazing management.	
TP	Demo site (Quinta da França); Local stakeholder network; IoT sensors and network; Drone imagery processing; Earth Observation data collection and data processing; Agroforestry management.	Landowner; Technical IT
Local firefighters	Controlled fire during Pilot demo exercises (to be confirm).	Safety
Local government	Workshop attendees and expert feedback contributions.	Dissemination
Local agroforest associations and landowners	Workshop attendees and expert feedback contributions.	Dissemination
Grazing activity promoters	Workshop attendees and expert feedback contributions.	Dissemination
Consortium and other projects' representatives	User product setup and demonstration.	Technical partners

2.6.3 Operational scenario

The pilot takes place in Cova da Beira in Portugal, in a farm called Quinta da França. It is dedicated to Phases A and C. Cova da Beira region demo will provide the conditions to demonstrate SILVANUS Phases A and C ambition focus on applied to two essential resources: water and energy, by forest fire prevention and recovery through the use and integration of nature-based solutions with digital technologies focused on remote detection, including satellite imagery and fully-autonomous devices helping to implement all the processes to assure that safety boundaries between Nature and Human critical infrastructure are respected. Some of these fully autonomous devices are drones and robots with recharging bases.

Phase A. The Prevention and Preparedness activities

1) ***Dynamically evaluate fire risk at regional and plot level***

Activity conducted at plot level, on the surroundings of critical assets (water treatment plants, electrical lines, electrical transformers)

- High resolution land cover mapping for wildfire risk assessment at the landscape scale
- Development of high-resolution maps of fractional land cover for the region and/or selected landscapes.

- Develop a machine learning model informed by Sentinel satellite data (10m pixel) and trained by a high-resolution land cover map developed for Quinta da França (200 ha, 20 cm-pixel).
- Test indicator value of Sentinel bands and vegetation indexes (and time-series data)
- For model evaluation drone images from Quinta da França in different dates/years and from other areas in Beira Interior can be used.
- Final product – High resolution maps of fractional land cover produced from Sentinel imagery.

2) *Remotely sensed vegetation monitoring in critical infrastructures for cost-effective planning of management interventions [two complementary studies]*

Development of monitoring protocols and models to monitor biomass growth using in-situ, (UAV, Lidar) and satellite data

- Test and develop protocols to monitor the growth of different types of vegetation cover in critical infrastructures.
- Use Quinta da França as a test site, selecting monitoring plots that are representative of the vegetation types and land cover configuration in critical infrastructures (e.g., shrubland, grassland, riparian strips, safety corridors)
- Test new approaches to vegetation monitoring using IoT (cameras, sensors, etc.) – and supported by field measurements – and develop cost-effective monitoring schemes supported by models.

Development of models, trained with long time-series, to guide the planning of biomass control interventions in critical infrastructures and for early-warning of increased wildfire risk

- Use long-time- series of satellite data covering critical infrastructures, calibrate an early-warning model [use past-interventions to train the model to identify and signal the need for intervention].
- Apply the models developed in the previous Use Case to areas of critical infrastructures of AdP and EDP [using satellite data].
- Evaluate the models against in-situ data [monitor vegetation in critical infrastructures].

3) *Evaluation of preventive measures for the regulation of biomass growth and wildfire prevention*

- Comparative assessment of livestock grazing and mechanized shrub control for biomass regulation.
- Biomass growth, vegetation structure and plant composition will be monitored in areas under livestock grazing and in areas after mechanized shrub control.

- Study area: Quinta da França, oak forest. Grazing in south sector since 2018, reference data from 2021 (year 0 of the study, prior to shrub cutting), mechanical control in 2022 (2023?), monitoring in 2023 (2024?) and 2025.

Phase C: Restoration and Adaptation activities

- EU and PT review on regulation on fire prevention, preparedness, detection and response and Restoration and adaptation activities
- Review of the main regulation concerning fires at EU and local level. To be developed by the partners with legal expertise

Table 23 - User products, Portugal pilot

Phase (A,B,C)	User product (UP..)	Description
A	UP2 – Fire risk assessment	Assessment of the fire risk on areas of interest.
A	UP4 – IoT devices	Monitoring of conditions, detection.
A	UP5 – UGV/UAV	Deploying and route planning of UAVs; Data collection, mapping.
A, C	Up7 – Fire Prevention and Awareness Support (Biodiversity profile mobile application)	Collection of data and testing/demonstration of the mobile application.
A	UP8 – Citizen's engagement programme and mobile apps	Testing/demonstration of the mobile applications; Dissemination.
A, C	Silvanus Platform User Interface	Demonstration of Silvanus product through the user interface.

Objectives and KPI's

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

Table 24 - Objectives and KPIs, Portugal pilot

Phase	Objective	Activity	KPI's
Phase A	PA1: Environmental and ecological mapping and	Development of high-resolution land cover mapping to	• > 100 ha of area analysed and mapped.

	assessment of forest regions within project demonstrations.	inform forest management	• > 1 forest models' adaptations to be studied and reviewed for ecological impact assessment.
	PA2: Development of a semantic framework to formalise the stakeholder involvement in sustainable forest management.	Development of mapping products and monitoring tools to be included in a decision-making platform to promote stakeholder engagement in sustainable forest management. Publication of the results in peer-reviewed scientific journals.	• At least two publications to promote the extension of Agriculture and Forestry Ontology to model wildfire events resulting from common causes. • At least two common actions with two different stakeholders, regarding prevention of wildfires.
	PA3: Development of fire danger index profile management system based on environmental, ecological and biodiversity models.	Modelling of seasonal weather forecast models Establishment of interfaces with external earth observation data repository and global climate repositories. Development of maps of fire hazard based on pyrophyte	• Modelling of seasonal weather forecast models for at least three (3) transitional. • Interfaces established with at least 1 external earth observation data repository and global climate repositories. • Development of fire danger index to be customised for the polygon of

		vegetation cover for the forest pilot site	Quinta da França, Cova da Beira, Portugal, with spatio-temporal distribution of vegetation and biodiversity constraints.
	PA4: Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcements.	Publication of project results and recommendations in the social media, in a campaign directed to main stakeholder classes. In-person workshops with stakeholders.	• Social media engagement for forest management authorities, landowners, public authorities. • Extend invitations to external stakeholder by at least 50 engaged organizations.
Phase C	PC1: Development of biodiversity index for monitoring the effectiveness of restoration and adaptation process.	Forest biodiversity monitoring at the forest pilot site, collection of data to calculate the biodiversity index	• Biodiversity index development in all demonstrator area. • Self-assessment survey of the demonstrator to model the natural habitat of forest environment.
	PC2: Implement continuous report on natural forest inventory during rehabilitation.	Regular monitoring of forest structure and composition	• Continuous survey recorded at least on a half-yearly cycle.

2.6.4 Preparing user stories.

Scenario 1: *Longer periods of dry weather coupled with warmer summer months will increase the risk of severe fires and may be aggravated by unregulated vegetation growth and shrub* *encroachment in areas with low human use, namely areas that are more remote from urban centres. This may put at risk critical infrastructures, including power lines and water treatment stations. Fire can spread fast across the landscape and fire projections make difficult to predict where fires may start (virtually everywhere), hence prevention and preparedness is an essential stage to address fire risk. Developing early warning products to support landscape management and planning and using nature-based solutions, such as grazing to regulate vegetation growth, are part of the proposed prevention strategy.*

Phase A: Prevention and Preparedness

A1. Produce satellite-based map products to support the regular assessment of fire risk in the landscape and identify areas of priority intervention to enhance the cost-effectiveness of wildfire prevention. Fire risk assessment will be based on land cover structure and composition, considering fire-prone shrub cover and connectivity, terrain features and proximity to sensitive areas (high ecological, social and economic value). Maps will be produced by algorithms trained with high resolution land cover maps from drone imagery and fed by satellite data.

A2. Drone flights will be used to characterize and monitor the landscape in different seasons and improve the performance of the models used to produce the map products.

A3. Local sensors (IoT sensors) will be installed in the pilot area to collect and deliver data on soil moisture and temperature and provide more detailed information on fire risk at the local level.

A4. Maps of fire risk will be produced for landscapes with critical infrastructures to inform the stakeholders responsible for their safety and management.

A5. Test new approaches to remotely monitor vegetation growth around multiple critical infrastructures, using IoT (cameras, sensors, etc.) and field measurements, with the goal of reducing in situ monitoring costs and enhancing the planning of local interventions to control vegetation.

A6. Evaluate preventive measures for the regulation of biomass growth and wildfire prevention, including the comparative assessment of livestock grazing and mechanized shrub control for biomass regulation.

Phase C: Restoration and Adaptation

C1. Evaluate the use of livestock grazing for ecosystem and biodiversity restoration, consider potential benefits and impacts on species composition, vegetation structure and soil condition. In addition, discuss the potential of herbivory – performed by domestic herbivores - to mitigate fire risk and its role in restoration strategies that rely on natural processes and contribute to the development of more resilient ecosystems.

Scenario 2: *Natural grazing is an almost fossil fuel free activity. Its use for limiting vegetation grow can be cost-effective, especially in areas more remote or of difficult access. So, using it for cleaning of safety areas around critical infra-structures, both reduces the risk of igniting fires and prevents fire propagation. The limits, rate and costs of moving the herds around the areas may be optimized* *by modelling the planning using Machine Learning over features as herds eating rate, moving speed, vegetation grow, working area, etc. From the optimization models one can extract the service cost, CO2 avoided and global savings.*

Phase A: Prevention and Preparedness

A1. Produce a Machine Learning model for graze planning.

A2. Evaluate the quality of the models based in resulting confusion matrix.

A3. Estimate the costs of the various options for grazing routes. Rank them.

A4. Estimate avoided CO_2 emission compared to the alternative use of combustion machinery in the process (tractors, chainsaws, extruders, etc.).

A5. Create a suitable business model to support the eco-purpose and economic viability of the scenario.

2.6.5 Receiving requirements & permits

For the implementation of all activities in the Portuguese Pilot demonstration site in Quinta da França, the following rules will be applied:

- A previous schedule agenda for all activities will be needed, at least with two months in advance, along with a previous meeting (online) also should take place.
- All the participant and stakeholders involved at the demonstration site, should be informed of all the activities, and give their consent of presence.
- All video, imagery and sound recording of participants, will be permitted only under previous written individual authorization. The captured video/image/sound can be used for educations, training, promotional, dissemination proposes based on the consent forms.
- GDPR rules will be applied for all participants.
- All UAVs and UGVs activities will need previous permission form landowners and competent authorities. For UAVs (drones) the National and European legislations should be applied.
- Drone flights National regulation and authorization, please visit the Portuguese Civil Aviation Authority site (ANAC).
- Drone flights should only occur when all the safety conditions (weather and low fire risk) are verified.
- Drone flights can be performed by SILVANUS partners, only with previous notification, authorization and planning.
- For possible local fire demonstration (if needed, for example, IoT smoke detector and thermal cameras), will only be possible to execute in the low fire risk season, in a confined

area in the farm agricultural zone (border to the forest), indicated by the landowners. The presence of firefighters will be mandatory.

- Visitors in the forest should not be possible in a “Very high” or “Highest” scale of fire risk, followed by the daily recommendation of the Portuguese Meteorological Institute site (IPMA)
- All the mechanical actions/equipment that need to take place in the forest (e.g., vegetation control), should only occur in the low fire risk season and conditions, and will be performed by the Quinta da França´s staff.
- All IoT sensors deployed in Quinta da França, will need a previous authorization from the landowner, and its characteristics should be identified in a sheet form and with a known location (georef).
- All experiments in the demonstration site should not interfere with the farm agricultural activities and practices, nor with the animal’s wellbeing.
- All participants accept to respect the forest and the nature wildlife, and not to leave waste or damage the environment.

2.6.6 Testing the pilots. Field visits availability for technology providers

For the technological providers in the Pilot site Quinta da França, SILVANUS partners can visit the farm site any time of the year, as long as the Requirements & Permits above mentioned, are ensured and permission has been given by the landowner. Please enter with contact with the pilot owners (EDP, Terraprima, IST-ID and AdP) to check the availability for a visit.

2.7 Czech Pilot – Preparedness and response coordination in countering wildfires

2.7.1 Silvanus platform inputs

A long-time high temperature period, adjoined by no-precipitation session, in Beskydy mountains highly increases the risk of wildfires at the territory. These unfavourable conditions have caused a wildfire, which occurs at the mountain territory of the Krásná municipality. Because of windy conditions the wildfire extends rapidly in neighbour forest landscape.

Fire Regime

The progress and tactics of extinguishing forest fires are influenced by:

- Climatic conditions (Relative air humidity, amount of rainfall (longlasting drought), Direction, strength and speed of wind, Duration and intensity of sunlight, temperature)
- Flammability of forest vegetation according to the type of the type of wood and age of the wood
- Soil cover and terrain configuration including natural barriers
- Availability for fire equipment (trucks, pumps) and distance of water sources for extinguishing

Forest fires can be divided into:

- Underground – fires of peat or layer of deep hummus manifesting itself as hidden burning under the layer of forest litter
- Ground – fire of ground cover (forest litter, grass, moss)
- Tree crown (high) – fire in the crown of the tree, in the branches, which occurs as a result of the ransition from a ground fire, then the fire reaches the branches and ignites them. This type of fire is the most dangerous one, especially for conifers. This type of fire has the highest rate of spread

Forest fires are characterized by the rapid fire spread over large areas, which can lead to the surrounding of forest visitor or used fire department forces and resources (fire department units). Fire extinguishing is lengthy, reignition from hidden places of fire cannot be completely excluded and re-ignition supervision must be ensured.

Map of the area:

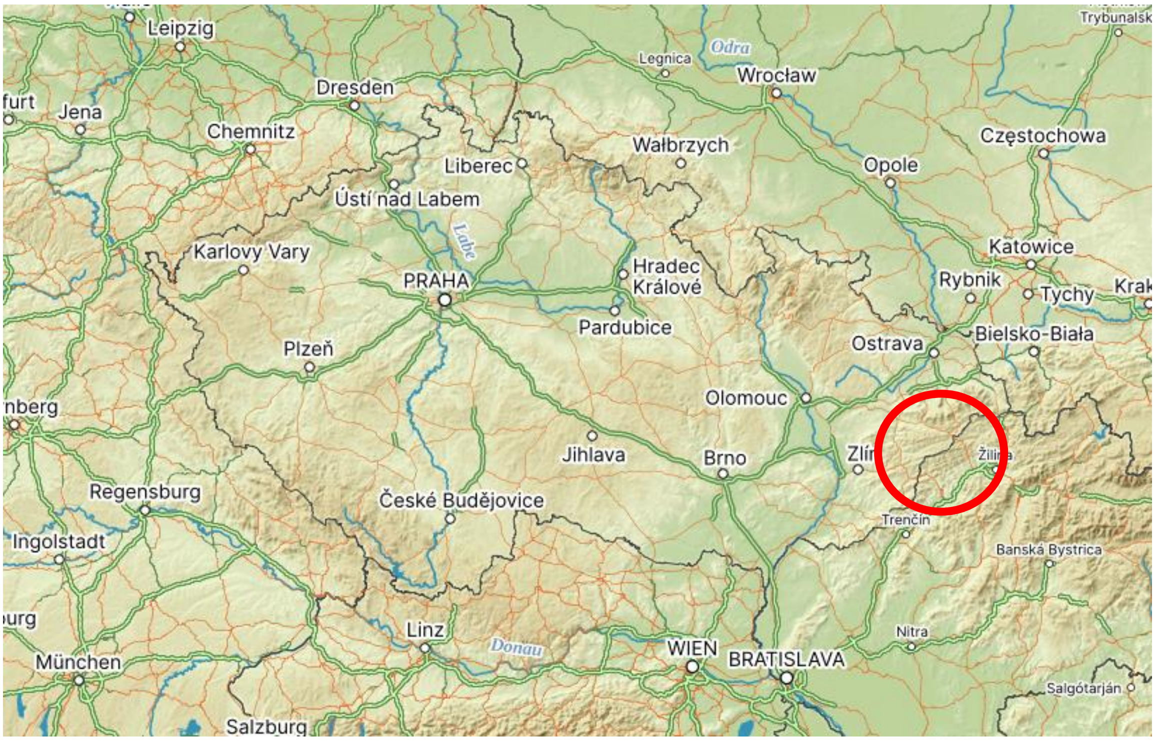

Figure 16 - Czech Republic, location of the Pilot Case in Czechia, source: Mapy.cz

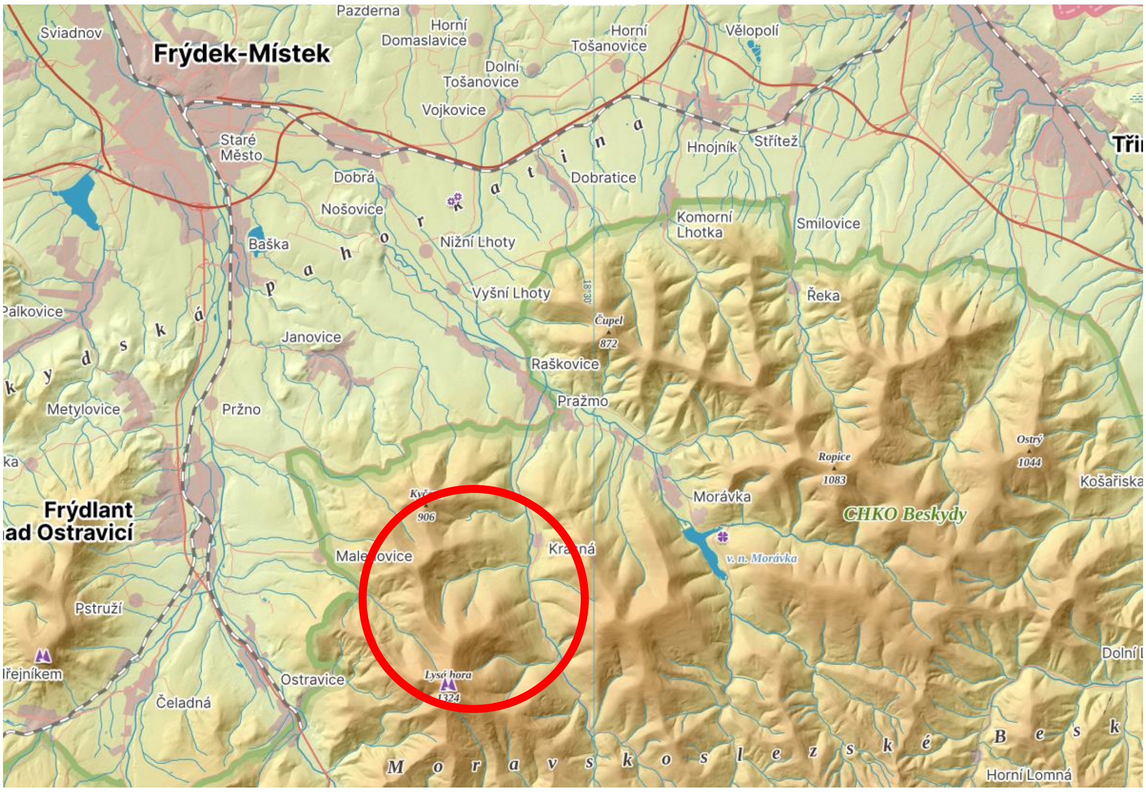

Figure 17 - Territory of the Krásná municipality, location of the Pilot Case in Czechia, source: Mapy.cz

Location: 49.5812039N, 18.4768839E, Krásná municipality, Protected Landscape Area Beskydy Authority, Moravian-Silesian Region, Czechia.

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

- increasing the human, environment and economy resilience to wildfires by training,
- gathers technology and scientific innovation, environment and human factors.
- include the setup of wireless communication infrastructure, and the use of drones to perform surveillance and undertake mitigation actions,
- deployment of mechanical platform (including Unmanned Aerial Vehicles (UAVs), Unmanned Ground Vehicles (UGVs)) for continuous surveillance and early-stage situational awareness,
- decision support system for resource deployment and management.

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**
  - **Pilot Activity A – Mid-term environmental data gathering** - The main goal of this activity is to gather basic information/data related to the forest environment behavior. The collected data will be used by the project partners to develop the project outcomes.
- **Phase B: Detection and Response**
  - **Pilot Activity B – In-field exercise** – validate and assess project technologies, technology solution and to provide the room and the feedback for the project partners to better understand the first responders' requests and needs

2.7.2 Stakeholders and partners. Roles and activities

Table 25 - Stakeholders' roles and activities, Czech pilot

Stakeholder	*Activity Engaged*	*Role*
Fire Rescue Brigade of Moravian-Silesian Region	Pilot Case exercise (PCE, Activity B) holder, engaged in all exercise activities, UAV team provider (user product to be tested and assessed)	Emergency service
Municipality of Krásná	Public warning, active players in in-field wildfire emergency management	Municipality
Forests of the Czech Republic (FCR)	In-field environmental data gathering, in-field wildfire emergency management	Forest owner and management institution
Rescue Brigade of the Fire Rescue Service of the Czech Republic	Emergency service engaged in various firefighting and logistic activities	Emergency service

Volunteering Firefighting Brigades	Emergency service engaged in various firefighting and logistic activities	Emergency service
3MON	UGV and wildfires detection technology provider (user products to be tested and assessed)	Technology partner
UISAV	MobileApp and Integration Dashboard provider (user products to be tested and assessed)	Researcher
Police of the Czech Republic (PCR)	Participant – observer	Emergency service
Mountain Rescue Service Beskydy	Participant – observer	Emergency service
Czech Association of Fire Officers (CAFO)	Participant – observer	Association
VSB – Technical University Ostrava	Participant – observer	University

2.7.3 Operational scenario

A long-time high temperature period, adjoined by no-precipitation session, in Beskydy mountains highly increases the risk of wildfires at the territory. These unfavourable conditions have caused a wildfire, which occurs at the mountain territory of the Krásná municipality. Because of windy conditions the wildfire extends rapidly in neighbour forest landscape.

Wildfire will be simultaneously detected by fire-detection technology and by citizen-engagement MobileApp. The fire detection alarms/notification will be delivered at the Control Room of Fire Rescue Brigade. Wildfire emergency state will be shared with other emergency services and firefighting unis will be deployed.

Once the firefighting units will be deployed at the scene of fire, the fire survey activities (UAV) will be commenced. The wildfire affected area will be divided into two firefighting sectors and, depended on the fire regime, various firefighting technologies and tactics will be applied (mobile and stationary water tanks, D-house programme, UGV, firefighting appliances).

The Command Post for the firefighting management will be established. All actors and stakeholders will be involved into firefighting management acting in CP. Outcomes from UAV and UGV survey will be available there too.

Table 26 - User products, Czech pilot

Phase (A,B,C)	*User product (UP)*	*Description*
Phase B	**UAV**	UAV will be used and assessed in various roles during the exercise – wildfire detection and survey
	UGV **Fire spread forecast**	These will be used and assessed in various roles during the exercise – wildfire detection and survey, firefighting, rescue and logistic activities
	MobileApp	citizen engagement toll will be tested and assessed during the PCE – wildfire detection, awareness rising
	Integration Dashboard	The dashboard platform will be used and assessed for wildfire detection and awareness rising

Objectives and KPI's:

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

In the table below, the specific objectives for the Czech pilot are presented with the related activities and Key Performance Indicators (KPI_{PR}):

Table 27 - Specific objectives and KPIs, Czech pilot

Phase	*Objective*	*Activity*	*KPI's*
Phase A	PA1: Environmental and ecological mapping and assessment of	Pilot Activity A Three places of overall area 0,225 km^2 will be mapped by UAV	(**KPI_{PA1-1}**): 47,504x104 sq. meters of area analysed and mapped.

	forest regions within project demonstrations		
Phase B	PA1: Environmental and ecological mapping and assessment of forest regions within project demonstrations	Pilot Activity B 1 regional demonstration 4 EU countries	(**KPI_{PA1-2}**): At least 15 regional demonstration sites to be analysed within the project from eight (8) EU and three (3) non-EU countries.
	PA4: Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcements	Pilot Activity B MobileApp will be used and demonstrated at PCE, citizens will announce forest fire using MobileApp and Dashboard developed by SILVANUS project.	(**KPI_{PA4-1}**): Social media engagement for forest management authorities, landowners, public authorities and visitors of eight (8) pilot sites (as outlined in Section 1.3.3) through at least three (3) platforms.
	DO1: Creation of demonstration scenarios and establishment of real-world drills for the evaluation of SILVANUS project outcomes.	Pilot Activity B See the scenario description in chapter No 3.	(**KPI_{DO1}**): Formalisation of at least 6 complementary scenarios to reflect upon different causes of wildfires
	DO2: Engagement of stakeholders at periodic intervals to evaluate the outcomes adopting agile methodologies	Pilot Activity B At least 5 experts from universities, professional associations or forest industry will attend the PCE	(**KPI_{DO2}**): At least 20 external experts to be invited to oversee the pilot demonstration activities as outlined in Section 1.3.3.

Apart from the SILVANUS project KPIs (KPI_{PR}), the pilot owner defined his own Pilot Owner KPIs (KPI_{PO}):

KPI 01 - The advanced technologies to be used for geolocation of wildfire (MobileApp, fire-detection technologies).
KPI 02 - Digital data sharing between emergency services of Integrated Rescue System to speed up mutual cooperation and make it more effective.
KPI 03 - Using of digital environment and remotely controlled applications and tools for more effective deployment of rescue units.
KPI 04 - Deployed professional and volunteer firefighting unit will be navigated at the scene of emergency by navigation technology facilitated on appliances.
KPI 05 - GPS location and GIS tools to locate deployed emergency units and appliances.
KPI 06 - Continuous data and information sharing between Command Post and Control Room.
KPI 07 - Setting up effective procedural management at the scene of wildfire for cooperation between all involved emergency services.
KPI 08 - Involvement of key stakeholders (local authorities, forest owners etc.) into wildfire management.
KPI 09 - To use of high-capacity equipment and appliances to ensure sufficient water supply for wildfire firefighting.
KPI 10 - UAV and UGV appliances will be used for aerial monitoring and assessment of real-time situations.
KPI 11 - UAV appliance will be facilitated by the camera and the infra-red thermo camera for detection of fire affected areas.
KPI 12 - The video signal from UAV and UGV will be transmitted to the emergency service command post.
KPI 13 - UAV tracking tools will be used for continuous real-time surveillance.
KPI 14 - UGV appliance will be used for ground monitoring and assessment,
KPI 15 - UGV will be used for logistic support, firefighting and rescue activities,
KPI 18 - Set up communication procedures between Command Post, subordinated Sectorial Command Posts and First Line Commanders.

2.7.4 Preparing user stories

Phase B. Detection and Response activities

Activity 1 (the in-field exercise) scenario

A long-time high temperature period, adjoined by no-precipitation session, in Beskydy mountains highly increases the risk of wildfires at the territory. These unfavourable conditions have caused a wildfire, which occurs at the mountain territory of the Krásná municipality. Because of windy conditions the wildfire extends rapidly in neighbouring forest landscape.

The extending wildfire will be spotted by several persons situated at the territory of Krásná municipality. Wildfires will be announced at public safety answering point (ISC MSR). Advanced

Mobile Location technology will be used to localize the place of emergency calls at the ISC MSR. ISC MSR will handle emergency calls and deploy firefighting units to treat the wildfire.

The officer in charge at the scene of wildfire will manage all activities related to treating of wildfire, will be responsible for continuous assessment, real-time monitoring and evaluation, deployment of firefighting units, equipment and appliances and for cooperation with the emergency services, municipality and all stakeholders. Decision support system will be utilized to for wildfire emergency management.

UAV appliance will be used for aerial monitoring and assessment of real-time situation. UAV appliance will be facilitated by the camera and the infra-red thermos-camera for detection of fire affected areas. The video signal from UAV will be transmitted to the emergency service command post.

UGV appliance will be used for ground related assistance and support the firefighting activities.

High-capacity pumping equipment and long-distance hose lines will be used for supplying of deployed firefighters by water. Pendular transport of firefighting water by firefighting tank appliances will be deployed to supply adequate water resources to suppress the wildfire.

Both, UAV and UGV devices, must face and be able to operate at the rugged topographical territory with steep and uneven slopes, heavy vegetation or jagged rocks. They must face this challenge and sustain their functionalities like data sharing, remote control, operational endurance etc.

The lesson learned session after the wildfire will be held, good and bad practice will be shared through all stakeholders, deployed technologies will be evaluated.

Activity 2 (environmental data gathering) scenario:

The activity will be carried out by FRS MSR, using its own UAV team to gather data related to the pre-set points of interest. The data (pictures or video records from the common and the infrared cameras) will by gathered by UAV in regular periods using the pre-set trajectories.

Moreover, other additional data, if requested from the SILVANUS project partners (such as temperature, or humidity), may be gathered from the pre-set locations.

The data collection will be carried out in mid-term period (from 2 to 4 months) in dependence on weather and environmental conditions.

2.7.5 Receiving requirements & permits

All activities at the PCC will be carried out with the approval of FCR, the pilot case forest owner and authority. FCR will be also indispensable partner for implementing bot activities at the PCC (Activity 1 and Activity 2).
UAV devices and operators will be provided FRB MSR, which disposes its own UAV team. The UAV operators own requested pilot licenses. All UAV activities must be announced and permitted by the operators at Frýdnant Airport, that located 4 km from the PCC.

2.7.6 Testing the pilots

The SILVANUS project coordinator, WP leaders, technology partner and other project partners are welcome to visit the PCC location in May or June 2023.

Activity 1 will be carried out in October 2023.

Activity 2 will be carried out in the period between April and September 2023.

All the terms of PCC vit must be confirmed and approved by FRB MSR and FCR.

2.8 Croatia Pilot - Integrated next generation forest fires management systems

2.8.1 Silvanus platform inputs

The following aspects stand at the core of the Croatia pilot in the framework of the SILVANUS project:

- → increasing the human, environment and economy resilience to wildfires by training;
- → development of an integrated technological and information collaborative platform providing technological decision-making support in preparedness, response and recovery phase of wildfire management cycle;
- → assessment of fire risk indicators based on continuous surveys of forest regions;
- → gathers technology and scientific innovation, environment and human factors;
- → developing infrastructure to connect platform to very early and early warning indicators;
- → generating a database within collecting globally data, using big-data software, correlations and algorithms to prevent ignition and the spread of fire forest;
- → include the setup of wireless communication infrastructure, and the use of drones to perform surveillance and undertake mitigation actions;
- → use of onboard data analytics with low-cost computational components capable of performing video stream analytics at the edge will extend the longevity of the drone flight time;
- → the multistakeholder project platform is conceived to deliver the high-impact intervention in addressing the challenges outlined in Phase A, B and C.

In spring on the pilot site Šapjane there has been a longer period without precipitations (January, February, March), before plants started to green. The fine fuel moisture content reached the critical moisture content values which indicated a very high risk of wildfire. As the fire cause was human activity (negligence during prescribed burning) – the fire started in a rural, inaccessible area and under influence of wind and spread towards training facilities on pilot site Šapjane, where critical infrastructure was endangered, and fire-fighting technical equipment and forces had to be engaged in prevention, surveillance and suppression.

Fire regime: The fire has spread from the first sector towards the second sector.

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. 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.

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.

Map of the area:

Location: Šapjane, County Primorsko-goranska

Pilot location (latitude, longitude): 45.4739540, 14.2419480

Figure 18 - Location of the Pilot in Croatia

The relevant challenges, 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.

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	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

2.8.2 Stakeholders and partners. Roles and activities

Table 28 - 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

2.8.3 Operational scenario

The demonstration is planned for April 18-19, 2023. The Pilot Site is situated in Šapjane, Primorsko-goranska County where a Firefighter Training Centre is located.

Table 29 - Operational scenario, Croatia pilot

PHASE	ACTIVITIES
Phase A. The Prevention and Preparedness activities	• Seasonal integrated public awareness campaign will be provided to citizens and possible tourists • A susceptibility of territory to wildfire will be provided from risk assessment plan • Prevention, education and suppression activities will be based on a national plan of education and prevention • County fire-fighting plan will be made • Mapping of site will be through satellite and camera images • Maps of fire danger will be provided • Preparedness of robotic systems • An integrated national surveillance system of cameras will be used for surveillance. • IoT sensors will be distributed to gather microclimate data.
Phase B. Detection and Response activities	• An integrated national video-surveillance system of cameras will alert when fire or smoke is detected • Observation of fire by citizens will be used by firefighters to precise the position of fire site • After arrival of first fire brigade to fire site, deployment of further fire-fighting forces and resources will be needed • After initial alerting of firefighters, deployment of further fire-fighting forces • For modelling wildfire behaviour, a simulator will be used • A mobile fire-fighting operational centre will be used to monitor and lead all activities • Monitoring and fire extinguishing activities will be achieved by providing terrain pictures that will be transferred to the mobile fire-fighting command centre • Transferring monitored data from the sensors deployed on drones will be provided if all other communication fails • IoT sensor will be used for monitoring the microclimate situation and getting information for real time modelling of fire behaviour • For ground monitoring of the fire site area UGV (robots) will be used • Advanced education programs will be elaborated for fighting wildfires, using the technology deployed in the pilot

	• New guidelines for conducting training of firefighters and use of new technologies in coping with wildfires will be elaborated

Table 30 - User products, Croatia pilot

Phase (A,B)	***User product***	***Description***
A, B	UAV	Reconnaissance, mapping
A	Fire detection	Detection of the fire
B	UGV	Fire suppression
B	Mesh in the Sky	Communication between drones
B	Fire detect camera	Detection of smoke and fire
B	Fire spread forecast	Prediction of fire spread

Objectives and KPI's:

- At least 100 people will be informed about forest fires this way;
- 15,700 sq. meters of area of demonstration site will be analyzed and mapped;
- At least 20 wildfire surveillance cameras will be integrated in national GIS system;
- Microclimate data will be collected, stored, and processed on 1 site;
- At least 5 firefighting organizations will be alerted and monitored through 1 integrated national fire-fighting management system;
- At least 3 firefighting operational centers will be engaged.

At least 1 UAV and 1 UGV systems will be used for transmitting data and for 2 extinguishing activities.

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

Table 31 - Objectives and KPIs, Croatia pilot

Phase	***Objective***	***Innovation/***	***KPI***
A	PA1: Seasonal integrated public awareness campaign with info billboards	Billboards with QR codes that lead to Silvanus website	**Outcome**: At least 100 people informed about forest fires this way

	PA2: Environmental and ecological mapping and assessment of exercise ground within project demonstration	Mapping done with orthophotos, satellite images and images collected by cameras from UAV (drone)	**Outcome**: 15,700 sq. meters of area of demonstration site analysed and mapped
	PA3: Surveillance of demonstration site	An integration of national surveillance system of cameras and national GIS system	**Outcome**: At least 20 wildfire surveillance cameras integrated in national GIS system
	PA4: Gathering of microclimate data at the demonstration site	Gathering achieved through IoT sensors	**Outcome**: Microclimate data collected, stored, and processed on 1 site **Output**: – interdisciplinary simulation models for global impact on climate
B	PB1: Coordination of activities through fire-fighting management system	A unique integrated national fire-fighting management system used to provide surveillance and recording of activities on site, alarming of fire-fighting forces, navigating them to the site and providing necessary data for coordination and extinguishing activities	**Outcome**: At least 5 firefighting organizations alerted and monitored through 1 integrated national fire-fighting management system **Output**: – environmental threat assessment -assessment of adherence to safety protocols -response coordination and mitigation

	PB2: Monitoring of onsite activities through fire-fighting operational centres	Integration of national, regional and mobile fire-fighting operational centres.	**Outcome**: At least 3 firefighting operational centres engaged **Output**: – environmental threat assessment -assessment of adherence to safety protocols -response coordination and mitigation
	PB3: Usage of UAV and UGV systems	Use of UAV systems for monitoring and UGV systems for monitoring and fire extinguishing activities	**Outcome**: At least 1 UAV and 1 UGV systems used for transmitting data and for 2 extinguishing activities **Output**: – environmental threat assessment -assessment of adherence to safety protocols

2.8.4 Preparing user stories

The demonstration is planned for April 18-19, 2023. The Pilot Site is situated in Šapjane, Primorsko-goranska County where a Firefighter Training Centre is located.

There will be a longer period without precipitations (January, February, March), before plants start to green. The fine fuel moisture content will reach the critical moisture content values = very high risk of wildfire. Maps of fire danger will inform about this danger. As the fire initiator will be human activity (negligence during prescribed burning) – the fire will start in a rural inaccessible area and under influence of wind and spread towards training facilities on pilot site Šapjane, where critical infrastructure will be endangered, and all fire-fighting technical equipment and forces have to be engaged in prevention, surveillance and suppression.

The first day will be dedicated to the familiarization of the participants with the detailed plan of the demonstration, equipment checks and various educational activities.

On the second day, the demonstration will take place, including Phase A and Phase B activities.

Phase A: Prevention and Preparedness

A1. **Seasonal integrated public awareness campaign** will be provided to citizens and possible tourists through TV and radio spots, billboards, leaflets, exhibition of burnt areas.

A2. **A susceptibility of territory to wildfire** will be provided from risk assessment plan provided by Croatian Forestry Service using data on terrain (elevation, terrain slope, aspect), fuel (vegetation type, quantity, and quality). Additional data from GIS-CLOUD from HVZ will be provided like public utilities (power lines, hydrant network and fire brakes).

A3. Prevention, education and suppression activities will be based on the **National Program of Activities in the implementation of special fire protection measures of interest to the Republic of Croatia for 2023.**

A4. **County Fire-fighting plan** will be prepared on an HVZ platform as a base of engagement of fire-fighting forces and communication with other stakeholders.

A5. **Mapping of site** will be done through orthophotos, satellite images and images collected by cameras from UAV (drone).

A6. The **moisture content** of fine fuel will be calculated and compared with moisture content critical value (moisture of extinction) under which limit any of fire initiators is capable to start the fire. The output of comparing the actual and critical fine fuel moisture content values will be assignment of an area (forest stand) to one of 4 degrees of fire danger. This will be provided on daily basis. Maps of fire danger are published at the public portal of Croatian Forrest. Information (map) is sent to involved stakeholders daily.

A7. **Robotic systems** are constantly in the state of preparedness in county Civil Protection facilities, provided by HVZ, 3MON and DOK-ING.

A8. An **integrated national surveillance system of cameras** will be used for video surveillance of site.

A9. There will be installed **IoT sensors** (distributed on the vehicles) continuously gathering the microclimate data (temperature, precipitations, relative air humidity, wind speed, wind direction). The data from IoT will be collected, stored, and processed by 3MON and sent to GIS cloud.

Phase B: Detection and Monitoring

B1. An **integrated national video-surveillance system of cameras** provides the county and national firefighting headquarter with information from all parts of the country. Automatic alerts will be provided for fire and smoke detection. Additionally, if fire (smoke) will be detected by cameras on site, national firefighting headquarters will automatically collect information from other 96 cameras (image, coordinates and distance of fire source) deployed on national level for immediate risk assessment and redeployment of firefighting forces.

B2. The fire will also be observed by citizens and tourists by calling the fire-fighting **alert number 193**. This information will be used by firefighters to precise the position of fire site.

B3. An **integrated national Fire-fighting Management system** (GIS cloud based HVZ system) will provide alarming of fire-fighting forces, navigating them to the site, additional mapping of suitable water sources for extinguishing activities, critical infrastructure on sites, tracking and recording of fire-fighting events. Basically, it will provide overall situation of the scene. Additionally, we will in parallel deploy tracking devices, mobiles with command aps and GINA central system as a different tool to manage the resources on the ground, or in the air provided by 3MON.

B4. After arrival of first fire brigade to fire site, the fire will be fully developed, and **deployment of further fire-fighting forces** and resources will be needed. Except professional firefighters from Rijeka and Opatija, 10 volunteer Fire Brigades will be deployed. Mapping of position of fire fighters in terrain is ensured by GIS cloud. In parallel, GINA system from 3MON will also be used for sharing communication and images/videos from GINA users on the fire line to the command post.

B5. For **modelling wildfire behaviour** on site GIS based FESB wildland fire spreading simulator using data on terrain (elevation, terrain slope, aspect), fuel (vegetation type, quantity, and quality) and estimation of wind will be used.

B6. A **mobile fire-fighting Operational Centre** will be used to monitor and lead all activities on the endangered site, estimating possibility of coordination of several mobile fire-fighting operational centres and separate command post of HVZ with the county and national operative centres. Alternative communication means (5G etc.) will be used. The mobile unit will be provided by the Fire-fighting Association of Primorsko-goranska County. In parallel, the GINA central will be in mobile operational centre or near it. Depending on the space of the operational centre, the GINA central can communicate with another mobile apps GINA. Tracking system will be used with the trackers that will be deployed before the scenario on chosen assets (planes, helicopters, fire engines, individuals...)

B7. **Aerial forces** of MORH will be included in monitoring and fire extinguishing activities, providing terrain pictures that will be transferred to the mobile fire-fighting command centre. Additionally, fire site area will be monitored (image, coordinates and distance of fire source) with the UAV (drones) providing data that will be transferred to the mobile fire-fighting command centre. We will try to install small tracking device on a firefighting helicopter or the firefighting plane so we can see the position of the aerial assets in real time on the GINA central and onto the mobile apps GINA. Also, GINA drone will communicate with the GINA software and can create a real time map of the fire.

B8. A RINI **Mesh in the Sky system** will be used for transferring monitored data from the sensors deployed on drones if all other communication systems fail.

B9**. IoT sensor** will be used for monitoring the microclimate situation and getting information for real time modelling of fire behaviour.

B10. For ground monitoring of the fire site area **UGV (robots)** will be used. Those will be used for fire monitoring, transport of firefighting resources and fire extinguishing purposes. Data from UGVs will be transmitted to the mobile fire-fighting Operational Centre.

B11. **Advanced education programs** will be elaborated for fighting wildfires, using the technology deployed in the pilot.

B12. **New guidelines** for conducting training of firefighters and use of new technologies in coping with wildfires will be elaborated.

After the demonstration, there will be organized debriefing with different stakeholders. The pros and cons of applied procedures, technology deployed, fire tactics used, will be discussed.

2.8.5 Receiving requirements & permits

- → Registration for an UAS Operator in Croatia – 3x
- → Human participation – legal ethics consent forms

2.8.6 Testing the pilots.

The demonstration is planned for 18th - 19th April 2023. Testing/ validation on site for technology providers will be available from 11th - 18th April 2023.

2.9 Slovakia Pilot - Policy recommendations on restoration of forest landscape

2.9.1 Silvanus platform inputs

The aim of Slovak Pilot Study is to demonstrate as holistic as integrated approach to wildfire management. The holistic approach is based on the risk assessment of the territory of Biospheric Reserve Polana / Podpolanie region. There were prepared the outputs of fire susceptibility, fire danger, opening up analysis focusing the pass ability of the territory for fire trucks (phase A). Those data were provided by the TUZVO as well as outcomes of fire spread modelling. Crowdsourcing application for citizens engagement which is under development of UISAV is going to be demonstrated too.

Further, the data from UAVs (foresters, firefighters), CCTV camera smoke detection system Optix (3MON) are going to integrated with results of risk assessment analyses and provided for the decision support system of incident commander. Drones are provided by several providers. Those are also used for GSM mesh creation in localities without GSM signal, after completing them with Starlink Satellite Internet. This solution is provided by UISAV. UISAV will demonstrate the SWARM of drones to create ortho photo map of the area in real time. Colossus UGV is going to be used for monitoring of the area under the tree crown closure and for fire suppression purposes. This technology is provided by 3 MON. Another product of 3MON which is going to be demonstrated is GINA application based on GIS and allowing the integration of data from drones and its visualization in the Mobile Command Centre.

The integrated approach is based on data integration coming from different sources and technologies provided by different stakeholders (foresters, firefighters, & SMEs). For successful wildfire fighting the integration of all relevant stakeholders is required. This integration and cooperation is going to be demonstrated.

According to phase C, the simulation in biodynamic simulator SIBYLA and visualization of its outcomes in 3D cave using VR technology is going to be demonstrated for the Pilot Site area. A workshop for relevant stakeholders is going to be organized to discuss the pros and cons of deployed data and technology as well as needs for increasing the resilience of forests under climate change conditions.

Surface/ground fire which continues to crown fire is going to be demonstrated, as it surfaces fire is the most common regime of fire in Slovakia and its transition to crown fire is considered to be the worst scenario which requires deployment of nor only fire trucks but also helicopters for fire localization and suppression. There is also the Mobile Command Staff is going to be established due to the wildfire severity and intensity.

The following aspects stand at the core of the Slovak pilot in the framework of the SILVANUS project:

- increasing the human, environment and economy resilience to wildfires by training;
- development of an integrated technological and information collaborative platform providing technological decision-making support in preparedness, response and recovery phase of wildfire management cycle;
- assessment of fire risk indicators based on continuous surveys of forest regions;
- gathers technology and scientific innovation, environment and human factors;
- developing infrastructure to connect platform to very early and early warning indicators;
- generating a database within collecting globally data, using big-data software, correlations and algorithms to prevent ignition and the spread of fire forest;
- include the setup of wireless communication infrastructure, and the use of drones to perform surveillance and undertake mitigation actions;
- use of onboard data analytics with low-cost computational components capable of performing video stream analytics at the edge will extend the longevity of the drone flight time;
- the multistakeholder project platform is conceived to deliver the high-impact intervention in addressing the challenges outlined in Phase A, B and C.

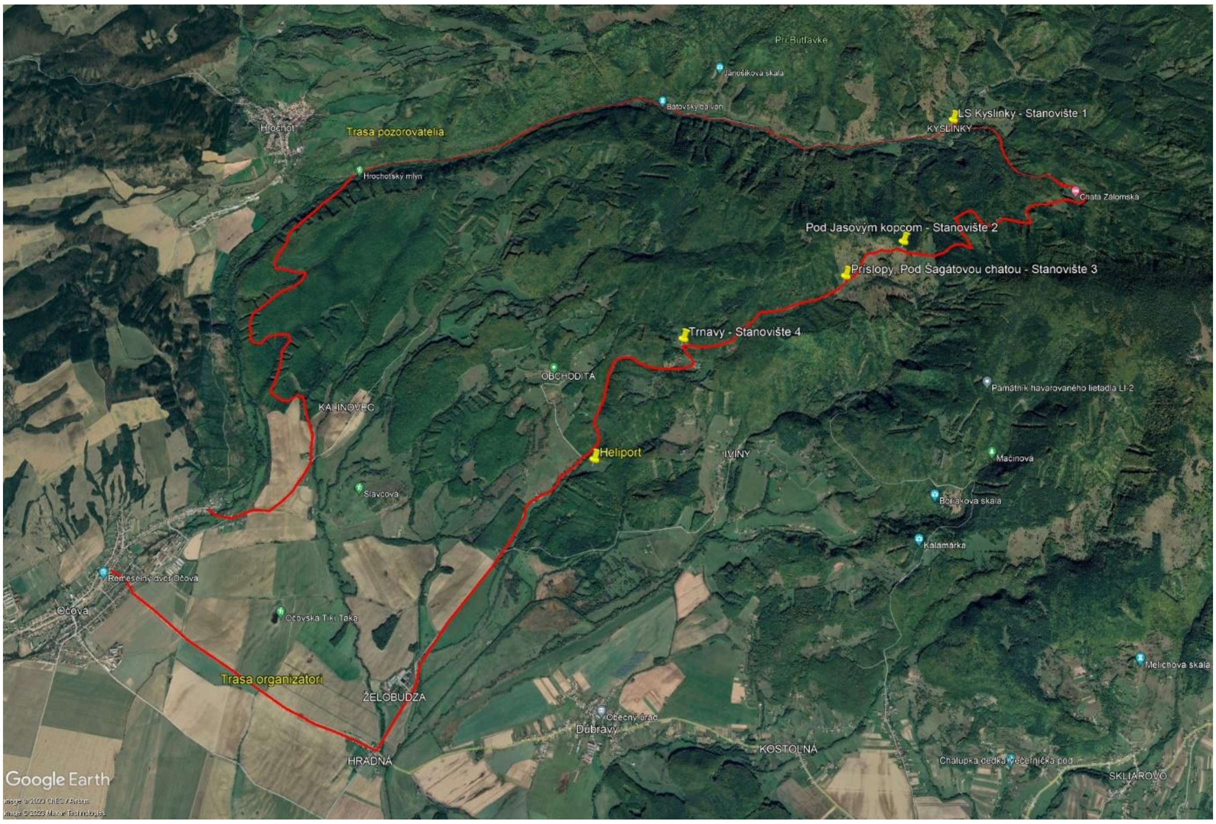

Figure 19 - Location of the Pilot in Slovakia

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

- Data support of management staff: GIS data for the territory

- Fire risk data: Risk assessment based on GIS technology
- Real time data from the incident site: CCTV smoke detection systems, UAVs
- Monitoring of the area with high fire danger degree (UAV, CCTV smoke detection system)
- Having GSM connection to transfer the data from Far Edge to near Edge and from near Edge to Cloud

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**
    - GIS data support
    - Information on fire susceptibility
    - Information on fire danger index
    - Information on opening-up of the area to deploy the fire trucks
    - Preventive fire monitoring in areas with higher/high fire danger
- **Phase B: Detection and Response**
    - Continuous monitoring of incident site using UAVs/drone
    - Fire spread modelling
    - GIS data support
- **Phase C: Restoration**
    - Forest management alternatives
    - Modelling the forest management alternatives - SIBYLA
    - Consensus about forest ecosystem services among stakeholders

Networking and strengthening cooperation among stakeholders.

2.9.2 Stakeholders and partners. Roles and activities

Table 32 - Stakeholder roles and activities, Slovakia pilot

Stakeholder	*Activity Engaged*	*Role*
Self-governing region Banská Bystrica	Passive	Observer
Municipality Očová	Passive	Observer
Municipality Lieskovec	Passive	Observer
Municipality Hrochoť	Passive	Observer
Municipality Detvianska Huta	Passive	Observer
Slovak Environment Agency	Passive	Observer
State Forest Enterprise	Passive	Observer

Ministry of Agriculture and Rural Development of SR	Passive	Observer
Ministry of the Environment of SR	Passive	Observer
Ministry of Interior SR	Passive	Observer
Fire and Rescue Service	Active	Demonstrator
Fire and Rescue Service Presidium	Active	Demonstrator
Fire and Rescue Service Regional Headquarters Banská Bystrica	Active	Demonstrator
Fire and Rescue Service Regional Headquarters - Trnava	Active	Demonstrator
YMS, a.s.	Passive	Observer
Fire Prevention Officers	Active	Demonstrator
Municipality Zvolen	Passive	Observer
State Forest Enterprise, management unit of Kriváň	Passive	Observer
Voluntary Fire Brigades	Active	Demonstrator
Fire Brigades of Armed Forces	Active	Demonstrator
TUZVO students	Passive	Observer
RTVS	Passive	Media
JOJ	Passive	Media
Les & letokruhy	Passive	Media
Denník N	Passive	Media
TA3	Passive	Media
TASR	Passive	Media
Markíza	Passive	Media

Civil Association Červený anjel	Passive	Media
SITA	Passive	Media
3MON	Active	Demonstrator
Slovak Academy of Sciences	Active	Demonstrator
TUZVO	Active	Organiser/Demonstrator
TUZVO CASD	Active	Organiser
VTG	Passive	Observer
ASFOR	Passive	Observer
EDP	Passive	Observer
Thales Research and Technology	Passive	Observer
University of Patras	Passive	Observer
SGSP	Passive	Observer
Fire Brigade of the Moravian-Silesian Region	Passive	Observer
Dronmedia	Active	Demonstrator
Aliter	Active	Demonstrator
Optix	Active	Demonstrator
Biosphere reservation of Poľana	Active	Permit issuer/Observer
Association of Owners of Community and Private Forests of the Banská Bystrica Region	Passive	Observer
State Nature Conservancy	Passive	Observer

2.9.3 Operational scenario

Operational scenario. Specific steps for each phase. Technology providers challenges / issues for each pilot and activity

The demonstration is planned for **April 24-26, 2023**. The Pilot Site is situated in Polana Mts. Region (Central part of Slovakia), specifically in locality called Kyslinky.

The first day will be dedicated to the familiarization of the participants with the detailed plan of the demonstration/ tactical training of fire and rescue services, the pilot site location, as well as networking with each other.

On the second day, the demonstration will take place, including Phase A and Phase B activities.

On the third day, there will be the debriefing, presentation of the demonstration results and findings. Also Phase C activities will be provided – restoration and adaptation activities in the forest, introduction of forest management alternatives suitable for the territory and their negotiation with other stakeholders (representatives of firefighters, foresters, State Nature Conservancy, municipalities, citizens, and experts from TUZVO, PLAMEN, UISAV and 3MON.

Phase A. The Prevention and Preparedness activities

Spatial analyses are going to be developed, informing about fire danger in the territory using the weather data from IOT sensor situated in the forest under the tree crown closure. Also, an opening up analyses for deployment of fire trucks will be available to support the fire brigades (squad) commanders when fire. Drones will be used for the mapping the area. Fuel models for the territory will be available. Results of the analyses will be presented during the briefing on the first day (April 24, 2023).

Phase B. Detection and Response activities

The demonstration (April 25, 2023) is divided to 6 stations. Those are:

1) ***Station No.1 – Fire Detection***
   a. Detection of the fire will take place at the spot by means of the CCTV fire detection system.
   b. After detection, a "reconnaissance" drone will be dispatched to verify the actual fire detection – confirm or not confirm the fire. Smoke (barrels with smouldering fuel) will be used for this purpose.
   c. A fire alarm will be raised - data transmission. Communication: Control centre of the camera system (Forests SR) – Operational Centre of the Regional Directorate of the Fire and Rescue Service in Banska Bystrica – Fire Station of the District Directorate of the Fire and Rescue Service in Zvolen and Detva + Volunteer Fire Brigades + Firefighters from the Military Airport in Sliač
   d. The firefighting group will ensure the simulation of fire spread
2) ***Station No.2 – Arrival of the fire brigade, survey will be carried out in different ways***
   a. On foot / by Polaris® Firefighting and Rescue Vehicle
   b. by UAV reconnaissance drone or drones
   c. by Robot

3) ***Station 3 – Tactics, the station will demonstrate possible uses of ICT and technological equipment in conjunction with firefighting systems used in the intervention***

a. Robot

b. UAVs - how they are used: infrared cameras, RGB cameras

c. Intervention using helicopters and ground firefighting methods will also be demonstrated at the spot.

4) ***Station 4 – Data collection for information support***

a. UAV equipment - data collection and interpretation - orthophoto maps in RGB as well as in IR

5) ***Station 5 – Control Staff – demonstration of the use of collected data in the Control Staff***

a. Decision making support by the means of spatial analyses results: fire danger, fire spread modelling results and transfer of knowledge to management and coordination of forces and resources and selection of fire tactics

6) ***Station 6 – Completion of intervention + Collection of tertiary UAV data***

a. Monitoring of smouldering local fires, post-fire damage

b. Extent of the fire site

c. Other (to be defined)

Phase C: Restoration and Adaptation activities

On the third day, there will be a debriefing organized. This will have the form of a workshop, where all the relevant stakeholders' representatives will be invited. Demonstration results and findings are going to pre presented and discussed.

Also, Phase C activities are going to be provided: presentation of forest management activities in the territory, presentation of suitable forest management alternatives to keep the biodiversity and increase the resilience of forests, negotiations on those alternatives.

Table 33 - User products, Slovakia pilot

Phase (A,B,C)	***User product***	***Description***
A	GIS	A1 Assessment of susceptibility of the territory to wildfire
	IoT	A2 Microclimate data gathering via IoT sensors
	GIS, Weather and fuel data	A3 Fire danger assessment
	GIS	A4 Territory opening-up analyses to deploy the fire trucks

	GIS	A5 Suitable water sources to be used for extinguishing activities
	GIS	A6 Mapping of sites to be used as heliports
	CCTV smoke detection system	A7 Monitoring the forested area by CCTV
	UAV	A8 Monitoring the forested area by UAV
B	CCTV smoke detection system	B1 Fire detection by CCTV detection system Optix
	Crowdsourcing application	B2 Crowdsourcing application
	GINA	B3 Navigation to fire site
	GINA/DSS	B4 Decision support for incident management
	Fire spread prognosis	B5 Fire behaviour modelling
		B6 Input information to modelling
		B7 Mapping firefighters' position in the field and health state
	UAV	B8 UAV technology deployment
	UGV	B9 UGV technology deployment
		B10 Helicopters deployment
C		C1 SIBYLA forest biodynamics simulator
	VR	C2 VR and 3D cave

Objectives and KPI's

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

- PA1: Environmental and ecological mapping and assessment of forest regions within project demonstrations
- PA3: Development of fire danger index profile management system based on environmental, ecological and biodiversity models
- PA4: Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcements
- PB1: Define the conditions for Unmanned aerial vehicles use for fire risk assessment and payload capacity for early response
- PB5: Assess the use of robotic ground vehicles to gather situational intelligence of wildfire behaviour
- PB9: Development of Crisis management tool
- PC1: Development of biodiversity index for monitoring the effectiveness of restoration and adaptation process

- PC2: Implement continuous report on natural forest inventory during rehabilitation

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

Table 34 - Objectives and KPIs, Slovakia pilot

Phase	***Objective***	***Activity***	***KPI's***
Phase A	PA1: Environmental and ecological mapping and assessment of forest regions within project demonstrations	Addressing these challenges, the SILVANUS project will develop an intuitive visualisation toolkit in consultation with the ecologists [TUZVO, AUA, ASFOR, ASSET] to accurately map the natural resources observed within the forest to the project platform. The toolkit will be modelled to capture the wide-spread geographic profile of SILVANUS consortium partners [PUI, LETS, KEMEA, HVZ, PLAMEN, EDP] from across eight (8) EU and three (3) non-EU countries. The environmental and ecological assessment toolkit will consider different forms of vegetation including agriculture land. HB will design the consultation methodology to engage with the stakeholders, while AMIKOM will contribute to the development of processing satellite imagery of monitoring forests. UASVG will contribute to the development of environmental threat levels.	• 47,504x104 sq. meters of area analysed and mapped • At least 15 regional demonstration sites to be analysed within the project from eight (8) EU and three (3) non-EU countries. • > than 4 forest models' adaptations to be studied and reviewed for ecological impact assessment
	PA3: Development of fire danger index profile management	The project will undertake investigations on the development of new methodologies for the	• Modelling of seasonal weather forecast models for at least three (3)

	system based on environmental, ecological and biodiversity models	computation of fire danger index, following the deployment of distributed environmental sensors [SGSP, CTL, UASVG, TUZVO] and the use of data from weather models. The dynamic variation of chemical composition and the nutrients in the soil structure will be taken into consideration for the development of a fire danger index. The project outcomes will extend the reported measure such as, ECMWF Probabilistic model provides four fire danger indices: (1) FWI Extreme Forecast Index (FWI EFI), (2) FWI Shift of Tails (FWI SOT), (3) Fine Fuel Moisture Content Extreme Forecast Index (FFMC EFI) and (4) Fine Fuel Moisture Content Shift of Tails (FFMC SOT). CMCC will exploit the expertise on modelling environmental data to build a fire danger risk index.	transitional seasons from eight (8) EU and three (3) non-EU regions. • Interfaces established with at least four (4) external earth observation data repositories and global climate repositories • Development of fire danger index to be customised for at least 3 forest model categories based on spatio-temporal distribution of vegetation and biodiversity constraints.
	PA4: Implement Culture of risk prevention among project stakeholders and preparedness campaign on fire danger index and preparedness announcements	Addressing the critical need to develop and promote the culture of safety and prevention among the stakeholders, the project will launch a public campaign in collaboration with the practitioners [HB, ATOS, SGSP, AMIKOM] paving the way for project results dissemination. The campaign will be aligned with the demonstration activities planned within the project to showcase the effectiveness of the solution. The project will strive to achieve high visibility among the relevant stakeholders in promoting safety	• Social media engagement for forest management authorities, landowners, public authorities and visitors of eight (8) pilot sites (as outlined in Section 1.3.3) through at least three (3) platforms. • Promotion of citizen engagement activities and use of citizen-engagement-toolkit through 500 local authorities.

		regulations as recommended by national authorities. The communication toolkit will adopt the use of citizen science programme to ensure broad awareness and active public engagement. FINC will contribute with the linguistic toolkit that offers intelligent communication to the relevant stakeholder on the threat of fire and risk assessment of specific geographic regions. UASVG in collaboration with TUZVO and PLAMEN will launch public campaign toolkit with support from HB and ATOS on promoting awareness about the risk of wildfire and prevention strategies. KEMEA will contribute through its collaboration and close connection with several Greek municipalities. MDS will contribute to the development and release of a mobile application for regional utilisation by EU citizens. UISAV will integrate its crowd sourcing EmerPoll platform as a part of the citizen engagement toolkit. FRB, will promote the project outcomes through organisation of community events in crisis management and fire rescue actions, along with activities focussed on capacity building, education to stakeholders.	• Extend invitations to external stakeholder advisory group from the list of past projects (refer to Table 3) • Citizen-engagement-tool-kit assessment by at least 200 engaged users. • At least 2000 members consulted through public forum for the evaluation of public campaign
Phase B	PB1: Define the conditions for Unmanned aerial vehicles use for fire	Addressing the demands of the spread of wildfire, the SILVANUS project will bring forward indigenous	• > 15% increase in the flight time compared to the current market standards based on low-cost on-board data

	risk assessment and payload capacity for early response	development of drone solutions that are deemed safe, equipped with advanced sensing capabilities including the use of multi-spectral imaging system, signal processors and wireless communication infrastructure (PB6). The aerial platforms will be equipped with onboard data analytics (PB2) and establish coordination with autonomous ground robots (PB5) to enable accurate aggregation of situational awareness modelling the spread of wildfires. TRT, will lead the activity on autonomous flight path management to be controlled and monitored by the command centre. Additionally, the computational processing of information collected from the UAVs will be addressed by the technical solutions from ATOS, UISAV, 3MON to be evaluated in demonstration activities by PUI, FRBMSR and SGSP. UISAV will apply its multi-robot swarm coverage and coordination approach. HB and KEMEA will provide guidance for ethical compliance on the use of UAVs in surveillance and response missions.	analytics integrated within the platform • At least 5 additional sensor technologies (based on multi-spectral sensing) integrated within the aerial platform in complement with current market standards
	PB5: Assess the use of robotic ground vehicles to gather situational intelligence of wildfire behaviour	Addressing these challenges, SILVANUS will build upon existing products within consortium (COLOSSUS robot from 3MON) high-grade unmanned remotely controlled robots which will be	• > 80% reduction in the deployment of firefighter personnel to the forefront of wildfire

		demonstrated to navigate complex terrains. The remotely controlled ground vehicles will provide higher resilience against smoke and fog, and higher coordination of data streams with the data collected from the aerial platform. As for the aerial platform, the robots will be equipped with sensors for mapping terrain and environment along with additional sensing capabilities that include the use of multispectral imaging systems. A communication link will assure coordinated information exchange with the other SILVANUS system components. DELL and CTL will contribute to the development of IoT processing gateway supported by FRB-MSR, SGSP and UISAV. 3MON will adapt the COLOSSUS multi-purpose support vehicle robot for interventions in places with a high risk of danger, with versatile use in forest fires context.	• > 80% resilience in navigating natural terrain • A reduction of more than 15% computational complexity in processing information stream.
	PB9: Development of Crisis management tool	Our objective is to develop a Crisis Management Tool which considers information from various sources during a forest fire, provides a graphical interface for situation assessment, helps to coordinate task assignment, and provides optimal suggestions for actions (e.g., firefighters and vehicles to allocate). The Crisis Management Tool will be based on the tool developed in the frame of the INGENIOUS project and will be adapted to the tasks required for	• Monitoring of field resources deployed within a 5km distance • At least 10 forms of alert levels for Phase A, Phase B and Phase C criteria as defined in the requirements • Legacy system interface with at least four (4) different modalities (such as APIs, file systems, process integration).

		the extinction of forest fires. In particular, the tool aims at improving first responder's daily deployment through machine learning and optimization algorithms. It will be a tool based on AI to prepare stakeholders to cope with crises which are complex, unpredictable, and which need fast tactical and operational decision making under uncertainty and stress. Stochastic modelling, multi-criteria decision analysis and evolutionary optimization algorithms will be used to construct such a toolbox by simultaneously taking advantage of efficient simulation scenarios (e.g., baseline, optimistic and pessimistic scenarios) and efficient data mining techniques for finding hidden patterns and correlations in multi-dimensional datasets. Furthermore, fuzzy rule-based inference approaches combining expert knowledge with data science practices will support the tasks of gathering and organizing knowledge about emergency management situations, as well as generating conceptual models, related to fragments of crisis/emergency scenarios. Based on cooperation of large-scale, high-resolution, numerical simulations and observation quantitative and qualitative data, the crisis management tool aims at providing proactive measures to	

		support disaster operations immediately after a disaster/crisis occurrence. TUZVO in collaboration with PLAMEN and 3MON will evaluate the functional specification for the end-users and operational requirements. TRT along with ITTI will lead the activity on crisis management toolkit development, supported by EXUS through the extraction of actionable insights from the data analysis. The situational awareness component complemented with the predictive analysis and the information fusion solution will deliver the end-users the required real-time alert levels on estimated spread of wildfire to optimise resource deployment in safe and effective manner. 3MON will leverage and integrate the resource monitoring and dispatch features of its GINA framework.	
Phase C	PC1: Development of biodiversity index for monitoring the effectiveness of restoration and adaptation process	Addressing these requirements, the SILVANUS sustainable forest management platform will integrate components to monitor the growth of forest regions in compliance with the biodiversity index and the ecological balance assessment. The measurements collected will be analysed by the consortium partners for each individual region demonstrated in the project across eight (8) EU and three (3) non-EU countries. The rehabilitation activity will be led by ASSET with the support for pilot	• Biodiversity index development of six (6) EU member state regions • Self-assessment survey of at least 20 pilot sites from the six (6) member states to model the natural habitat of forest environment

		demonstrators AdP, ASFOR, LETS, PNRT, HRT, TUZVO.	
	PC2: Implement continuous report on natural forest inventory during rehabilitation	Addressing these requirements, the SILVANUS sustainable forest management platform will integrate components to monitor the growth of forest regions in compliance with the biodiversity index and the ecological balance assessment. The measurements collected will be analysed by the consortium partners for each individual region demonstrated in the project across eight (8) EU member states and three (3) International countries. The rehabilitation activity will be led by ASSET with the support for pilot demonstrators AdP, ASFOR, LETS, PNRT, HRT, TUZVO	• Continuous survey recorded on a half-yearly cycle. • Reports on the natural forest inventory published to advisory board members.

2.9.4 Preparing user stories.

Region: Podpolanie, Central part of Slovakia
Scenario: There is a longer period of hot weather without precipitations (July, August). The fine fuel moisture content reaches the critical moisture content values = very high risk of wildfire. Maps of fire danger inform about this danger. As the fire initiator is human activity (negligence) – fire starts from an open area near forest covered by tall grass and will continue to forest (broadleaves).

- **Phase A: Prevention and Preparedness**
- A1. There will be produced an *GIS* based assessment of the **susceptibility of the territory to wildfire** using data on terrain (elevation, terrain slope, aspect), fuel (vegetation type, quantity, and quality) and potential occurrence of human in forest (using forestry data on timber logging and forest cultivation activities – planned for each stand for period of 10 years, also considering the distance from nearest road or settlement in form of buffer zone).
- A2. There will be installed *IoT sensors* (distributed in the territory) continuously gathering the microclimate data (temperature, precipitations, relative air humidity, wind speed, wind direction). The data from IoT will be collected, stored, and processed by TUZVO.
- A3. The moisture content of fine fuel will be calculated and compared with moisture content critical value (moisture of extinction) under which limit any of fire initiators is

capable to start the fire. The output of comparing the actual and critical fine fuel moisture content values will be assignment of an area (forest stand) to one of 5 degrees of **fire danger**. This will be provided on daily basis. Maps of fire danger are published at the TUZVO website. Information (map) is sent to involved stakeholders daily.

- A4. For purposes of deployment of fire trucks in case of fire an analysis of opening-up of territory will be provided in GIS.
- A5. Mapping of suitable water sources for extinguishing activities will be provided (in GIS and in the field).
- A6. Mapping of sites to be used as heliports will be provided in GIS. Helicopters are used for firefighting purposes in Slovakia.
- Orthophotos, satellite images and drones will be used for those purposes.
- A7. The area is under the fire monitoring using the CCTV fire detection system (Optix). The cameras are operated by a person in Operational Centre. Automatic alerts are provided when smoke detected. Totally 3 cameras are deployed.
- A8. Drones (UAV) will be used by **foresters** to monitor the forested area in days (time during the day will be specified) with high fire danger degree in the field. The drone operators communicate with Optix Operational Centre.

- **Phase B: Detection and Response**
- B1. Fire (smoke) will be detected by the Optix system and information (image, text, and coordinates of fire site) will be sent from Optix Operational Centre to the Coordination Centre of the Integrated Rescue System and will be registered as an emergency in the CoordCom SW used for management of sources and resources of the Fire and Rescue Service.
- B2. Fire will also be observed by **tourists** and announced via crowdsourcing application send to social networks. Fire site coordinates will be sent, too. This information will be used by firefighters to precise the position of fire site.
- B3. Gina application will be used for navigation of professional fire brigade (first responder) to the fire site and for support of spatial decision-making process (GIS layers, CoordCom SW) of incident commander as well as Command Staff.
- B4. After arrival of first fire brigade to fire site, the fire will be fully developed, and deployment of further forces and resources will be needed. Except professional **firefighters** from Zvolen and Detva and Banska Bystrica Fire Stations, also 6 Volunteer Fire Brigades will be deployed and military fire brigade from Airport Sliac. Forest workers will be involved in firefighting activities, too. For better coordination of those forces and resources a Command Staff (at incident area) will be established, which will coordinated by the director of the Regional Directorate of the Fire and Rescue Service in Banska Bystrica. The incident commanders of the deployed fire services and representative of forest administration body will be involved in the Command Staff. As a SDSS tool they will use the maps included in GINA application and real time data from UAV and UGV.
- B5. For modelling wildfire behaviour FARSITE environment will be applied. TUZVO will provide in its specialized workplace and online provide to Command Staff.

- B6. IoT sensor will be used for monitoring the microclimate situation and getting information for real time modelling of fire behaviour.
- B7. To map the position of fire fighters in terrain and their health will be used. Output will be visualized in GINA which will be used by Command Staff.
- B8. For aerial monitoring of the fire site area the UAV technology will be used. Information from UAV will be transmitted to the Command Staff.
- B9. For ground monitoring of the fire site area UGV (robots) will be used. Those will be used for fire monitoring, transport of firefighting resources and fire extinguishing purposes, too. Information (video) from UGV will be transmitted to the Command Staff.
- B10. Helicopters will be deployed for fire localisation and extinguishing purposes.

Phase C: Restoration and Adaptation

After the demonstration, there will be organized workshop with different stakeholders. The pros and cons of applied procedures, technology deployed, fire tactics used, will be discussed. Besides, there will be introduced possible strategies for forest and soil restoration after the fire as well as strategies for increasing the resilience of forest to wildfire facing the expected climate change consequences.

The SIBYLA forest biodynamics simulator will be introduced to stakeholders and modelling outcomes will be visualised in 3D cave (at TUZVO) using the VR tools.

2.9.5 Receiving requirements & permits

- To provide the demonstration in the Pilot Site, i.e. in the Biospheric Reserve Polana, we had to receive permission from the Ministry of Environment of the Slovak Republic which was supported by the employees of the Biospheric Reserve Polana, who are the employees of the State Nature Conservancy of the Slovak Republic at the same time.
- The permission for demonstration of the Pilot site was also obtained from the foresters, i.e. Polana Forests of the Slovak Republic (S.E.) Management Unit, that is responsible for forest management activities in this territory.
- To deploy the professional, i.e. Fire and Rescue Service, fire brigades (from Fire stations in Banska Bystrica, Zvolen, Detva) the permission was obtained from the director of the Regional Directorate of the Fire and Rescue Service in Banska Bystrica who got it from the Presidium of Fire and Rescue Service.
- To deploy the fire brigades of the Armed Forces of the Slovak Republic as well as to deploy the helicopter used for demonstration of firefighting, the permission from the Ministry of Defence of the Slovak Republic.
- To use the UAVs technology in the field, there was necessary to get permission for each drone and drone operator from the Airport Sliač (Control tower).

2.10 Indonesia Pilot

2.10.1 Silvanus platform inputs

Sebangau National Park as one of Pilot Area located in Indonesia aims to demonstrate operational scenarios in Phase C. However, several demonstrations in Phase A and B might be possible to be done during the pilot visit.

Amikom will arrange series of activities in the pilot visit:

1. Pilot observations in Sebangau National Park, Kalimantan, Indonesia.
2. Discussion session and demonstration with local stakeholders in Sebangau National Park, Kalimantan, Indonesia.
3. International Conference of ***International Conference on Information and Communications Technology (6th ICOIACT)*** in Universitas Amikom, Daerah Istimewa Yogyakarta (DIY), Indonesia.

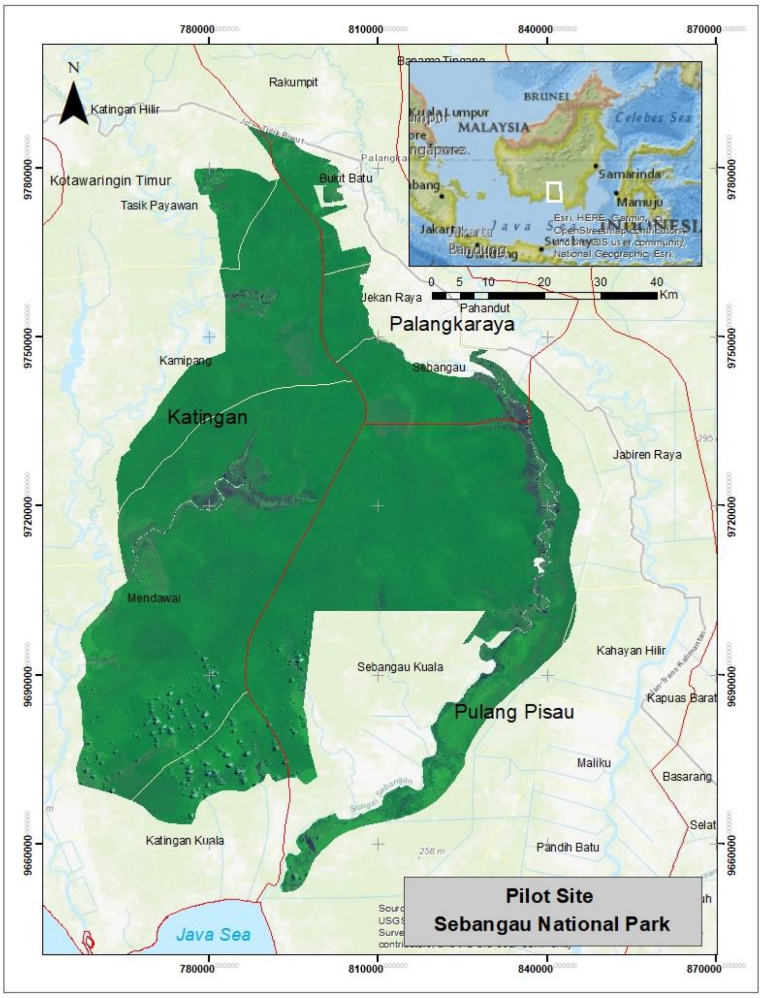

Figure 20 - Location of the Pilot in Indonesia

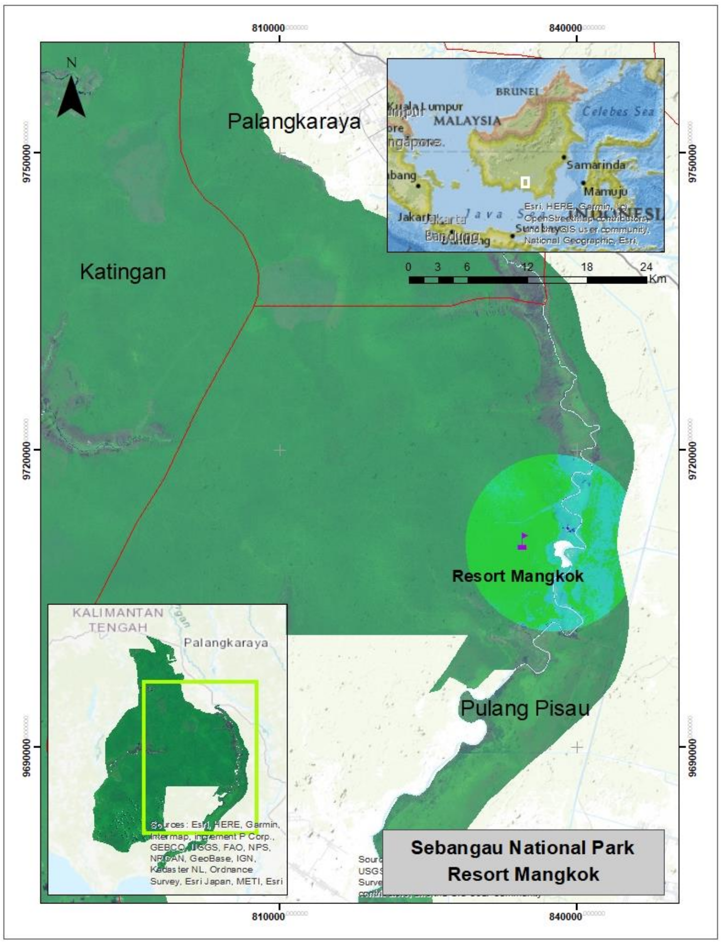

Figure 21 - Rehabilitation Area in Resort Mangkok, Sebangau National Park

Sebangau National Park, located in Central Kalimantan Province. It is located across three regencies: Katingan Regency, Pulang Pisau Regency, and Palangka Raya City. The area of Sebangau National Park is ± 542,141 ha; meanwhile, the forest land area in Central Kalimantan Province is ± 12,561,867.57 ha. Regarding the management, Sebangau National Park is divided into 3 (three) areas of the National Park Management Section (SPTN), namely SPTN I in Palangka Raya, Region II SPTN in Pulang Pisau, and Region III SPTN in Kasongan. The whole area is included in a national park, managed by the government, Sebangau National Park Bureau.

2.10.2 Stakeholders and partners. Roles and activities

Table 35 - Stakeholders and partners, Indonesia pilot

Stakeholder	***Activity Engaged***	***Role***
AMIKOM (3)	Conducting the whole activities; demonstration of data fusion	Scientifical and Technical partner
VTG (1)	Demonstration of Fipass and speaker in the conference	Technical partner
ITTI (1)	Demonstration of User Interface	Technical partner

UISAV (2)	Demonstration of Citizen Engagement	Technical partner
SGSP (1)	Pilot observation and discussion; Conference	WP9 representative
INTRA (1)	Pilot observation and discussion; Conference	Pilot observant and participant
Z&P (3)	Pilot observation and discussion; Conference	Pilot observant and participant
MD (1)	Pilot observation and discussion; Conference	Pilot observant and participant
IST (1)	Pilot observation and discussion; Conference	Pilot observant and participant
ASSET (2)	Pilot observation and discussion; Conference	Pilot observant and participant
Sebangau National Park Bureau (5)	Discussion and assist the activities inside the forest	Speaker and Participant
Local Stakeholder (15)	Discussion and demonstration participant	Speaker and Participant

2.10.3 Operational scenario

Table 36 - User products, Indonesia pilot

Phase (A,B,C)	***User product***	***Description***
A/B/C	Citizen engagement mobile application	The application enables interactive two-way process that encourages participation, exchange of ideas and flow of conversation between the citizens and the government
A/B/C	User interface	Interface of Silvanus System
A/C	Silvanus WOODE Mobile App	Biodiversity tagging and analysis for improving awareness and support. This application enables users to collect biodiversity data in the app.
B	Fire spread forecast	Employing high variability of information to measure forest fire risk, the affected area, and

		allocated resources that should be provided.

Objectives and KPI's specific to each pilot

Indonesian Pilot, Sebangau National Park, mainly responsible in Phase C of forest management. The objective is to observe the rehabilitation area, have discussion with local stakeholders, and conduct International Conference with related themes. However, pilot activities can cover several KPI in Phase A and B as well.

The whole activities of pilot observation, demonstration, and conference activities that will be conducted in the Indonesian pilot will contribute to the following objectives of the SILVANUS project:

- PA1-1 : 47,504x104 sq. meters of area analysed and mapped.
- PA1-2 : At least 15 regional demonstration sites to be analysed within the project from eight (8) EU and three (3) non-EU countries.
- PA4 : At least 15 regional demonstration sites to be analysed within the project from eight (8) EU and three (3) non-EU countries.
- PB9 : Monitoring of field resources deployed within a 5 km distance.
- PC3 : Report on soil rehabilitation strategy published across six (6) EU member state locations
- DO2 : At least 20 external experts to be invited to oversee the pilot demonstration activities as outlined in Section 1.3.3.
- DO3 : Two cycles of Phase A, Phase B and Phase C pilots organised in an agile manner as outlined in Section 1.3.3.
- ODE3-1 : 12 Scientific papers to be published in peer-reviewed journals and conferences.
- ODE3-2 : Demonstrations at co-located workshops and conferences.

In the table below, the specific objectives for the Indonesia Pilot, Sebangau National Park, are presented with the related activities and Key Performance Indicators (KPIs):

Table 37 - Objectives and KPIs, Indonesia pilot

Phase	*Objective*	*Activity*	*KPI's*
A	4 km^2 of area of Sebangau National Park to be analysed.	Amikom can prepare this KPI limited to the part of rehabilitation area of Sebangau National Park. One of the schedules in the pilot visit is visiting the	KPI$_{PA1-1}$: 47,504x104 sq. meters of area analysed and mapped.

		rehabilitation area, where we could take some photos, site seeing, and take photos and videos through drone. Amikom already got the permit to operate the drone.	
A	Sebangau National Park (Indonesia; non-EU) will be considered as regional demonstration site	Pilot visit activities will accommodate the related matter.	KPI_{PA1-2} : At least 15 regional demonstration sites to be analysed within the project from eight (8) EU and three (3) non-EU countries.
A	Information about the pilot will be shared among forest management authorities, landowners and public authorities with the use of social media	Sharing information of Indonesian Pilot, for instance rehabilitation programs that the stakeholders did, to the public via our private social media or social media engagement application made by Silvanus partner.	KPI_{PA4-1} : Social media engagement for forest management authorities, landowners, public authorities and visitors of eight (8) pilot sites (as outlined in Section 1.3.3) through at least three (3) platforms.
B	Demonstration of User Interface of Silvanus Platform in the pilot site with stakeholder.	Silvanus Partner demonstrate User Interface of Silvanus when the discussion session with stakeholders in the pilot site.	KPI_{PB9-1} : Monitoring of field resources deployed within a 5 km distance.
C	Merit-related issues concerning soil rehabilitation strategy will be discussed during conference and demonstration.	Conference: Amikom invites speaker in the ICOIACTConference who is the former Head of the Sebangau National Park Bureau, which can explain about the soil rehabilitation strategy in	KPI_{PC3} : Report on soil rehabilitation strategy published across six (6) EU member state locations

		the Sebangau National Park. Demonstration: Amikom invites speaker from Peat and Mangrove Restoration Bureau to share the soil rehabilitation strategy in the Sebangau National Park in the discussion session.	
	Experts (stakeholders) to be invited to oversee the pilot demonstration activities.	Despite Silvanus Partners, Amikom will invites 20 external experts in the discussion session from the local stakeholders of Sebangau National Park. 5 will be the speakers and 15 will be the participants.	KPI_{DO2} : At least 20 external experts to be invited to oversee the pilot demonstration activities as outlined in Section 1.3.3.
	Conducting international conference with related theme of SFM and Technology. Conference will be held in November 2023. The international conference will gather at least 70 participants. At least 5 papers will be submitted.	Amikom will hold the **International Conference on Information and Communications Technology (6th ICOIACT).** One of the sub-themes is Policies & Technologies for Wildfire Management. More or less, there will be 70 participants in the conference. 2 papers from Silvanus already submitted.	KPI_{ODE3-1} : 12 Scientific papers to be published in peer-reviewed journals and conferences.
	Organization of the Indonesian large-scale pilot in an agile manner for the systematic evaluation of the project outcomes	Pilot visit activities will accommodate the related matter.	KPI_{DO3} : Two cycles of Phase A, Phase B and Phase C pilots organised in an agile manner as outlined in Section 1.3.3.

	Manage demonstration during the pilot visit. Demonstration will be conducted in the discussion meeting with local stakeholders (at least 20 participants following the demonstration).	Amikom will invites 20 participants in the discussion session, and we could do the demonstration at the same time.	KPI_{ODE3-2} : 3 Demonstrations at co-located workshops and conferences.
	Experts (stakeholders) to be invited to oversee the pilot demonstration activities.	Discussion session in the pilot site	KPI_{p-M2}: At least 5 external experts participating in a pilot to oversee relevant demonstration activities
	Indonesian pilot considers Phase C accordingly to Description of Action for the project and will allow for systematic evaluation of the project outcomes	Discussion session in the pilot site.	KPI_{p-M3}: Large-scale pilot fully considers phases expected in Description of Action for the project (Phase A, Phase B and/or Phase C) and allows for systematic evaluation of the project outcomes
	Information about agriculture, tourism, construction industry, insurance and financial services will be presented during the conference and discussed when conducting demonstration activities	Conference: Amikom invites speaker in the ICOIACT Conference who is the former Head of the Sebangau National Park Bureau, which can explain the related informations. Demonstration: Amikom invites speaker from Peat and Mangrove Restoration Bureau and Sebangau National Park bureau which can explain the related informations in the discussion session.	KPI_{p-M4}: Pilot gives information input to report on the economic impact assessment during the project life cycle regarding to agriculture, tourism, construction industry, insurance and financial services
	Several Ups will be demonstrated during the pilot	Demonstration allocated in the pilot activity dicussion session.	KPI_{p-M5}: Pilot allows to implement at least 1 tool developed in the project

	Pilot will implement at least 3 good practices related to wildfire management in accordance to Phase C (the phase expected in Description of Action)	3 good practices related to wildfire management already implemented by the stakeholder.	$KPI_{p\text{-}M6}$: Pilot implements at least 3 good practices related to wildfire management for each pilot phase expected (Phase A, Phase B and/or Phase C)
	At least 50% of pilot participants will be engaged in pilot activities regarding to pilot organization, presentation of UPs, and giving direct feedback to technology partners. They will fill in questionnaires prepared by T9.6 Leader for the purposes of the pilot effectiveness assessment and replicability studies	Demonstration allocated in the pilot activity dicussion session.	$KPI_{p\text{-}M7}$: At least 50% of pilot participants are engaged in pilot activities and reflect this in the pilot effectiveness assessment and replicability studies by completing relevant surveys
	At least 50% of pilot participants will report acquiring new knowledge or information from the demonstration activities by filling in questionnaires prepared by T9.6 Leader for the purposes of the pilot effectiveness assessment and replicability studies	Demonstration allocated in the pilot activity dicussion session.	$KPI_{p\text{-}M8}$: At least 50% of pilot participants report acquiring new knowledge or information from the demonstration activities
	The chosen entities considered in wildfire management plans will be involved in pilot activities.	Allocation for the chosen expert as a speaker in the ICOIACT Conference.	$KPI_{p\text{-}M9}$: All entities considered in wildfire management plans are involved in pilot activities
	Pilot Owner, Pilot Observer and Pilot Players will be indicated in person before the pilot date.	Amikom invites speaker in the ICOIACT Conference, the former Head of the Sebangau National Park Bureau, who is capable to	$KPI_{p\text{-}O1}$: Pilot Owner, Pilot Observer and Pilot Players are indicated in person

		explain the related matters.	
	Amikom ensure 80% of the objectives are achieved	All related activities that supported the objectives.	KPI_{p-O3}: Pilot organisation allows to achieve at least 80% of the pilot objectives specified in relevant Template Operational Readiness
	T9.6 Leader will prepare relevant on-line questionnaire and Pilot Owner (AMIKOM) will organize a short (15 min. long) session to ensure participants a possibility to fill in the questionnaire.	Discussion session in the pilot site.	KPI_{p-O5}: Pilot stakeholders notice at least 4.0 overall rank for satisfaction in terms of a pilot organisation process (using Likert scale, on the base of questionnaires filled by pilot stakeholders, and concerning division of tasks for pilot stakeholders, rational ascribing pilot tasks to pilot stakeholders, synergy effect related to collaboration between pilot stakeholders, information flows as well as structure of commanding the pilot)
	AMIKOM will ensure that all functionalities of User Products dedicated for a specific pilot have the necessary conditions and infrastructure to be verified during the pilot	Preparation session before the pilot visit	KPI_{p-I1}: All functionalities of User Products dedicated for a specific pilot have the necessary conditions and infrastructure to be verified during the pilot
	T9.6 Leader will prepare relevant on-line questionnaire and Pilot Owner (AMIKOM) will organize a short (15 min. long) session to ensure participants a possibility to fill in the questionnaire.	Discussion session in the pilot site.	KPI_{p-I2}: Functionalities of SILVANUS tools implemented in a pilot notice at least 4.0 rank on satisfaction of a pilot stakeholders in relation to use the tools easily and intuitively (using Likert

	There will be a one common session to consider all KPIp related to the questionnaire.		scale on the base of questionnaires filled by pilot stakeholders)
	Amikom ensure all partners engage with the pilot visit activities.	Preparation session before the pilot visit.	$KPI_{p\text{-}S3}$: Pilot Owner, Pilot Observer and Pilot Players fully express their responsibilities and tasks related to the project (including activities concerning T9.6 as well)
	T9.6 Leader will prepare relevant on-line questionnaire and Pilot Owner (AMIKOM) will organize a short (15 min. long) session to ensure participants a possibility to fill in the questionnaire. There will be a one common session to consider all KPIp related to the questionnaire.	Discussion session in the pilot site.	$KPI_{p\text{-}S5}$: Pilot stakeholders notice at least 4.0 rank for satisfaction on organisational activities carried out by Pilot Owner to prepare them for a pilot (using Likert scale on the base of questionnaires filled by pilot stakeholders)

2.10.4 Receiving requirements & permits

Amikom has contacted the forest stakeholder, Sebangau National Park bureau, and discussed the activities that will be done in the forest. We have permission to operate the drones when the pilot visit is conducted.

2.10.5 Testing the pilots

Besides the pilot visit schedule in November 2023, all Silvanus partners could come to the Sebangau National Park area for testing any technology created by Silvanus at any time. However, it may need permission letter that should be coordinated to the Sebangau National Park Bureau if the allocated time is prior or after the pilot visit schedule. Please contact Amikom if any partners would like to proceed with the extra visit.

2.11 Brasil Pilot

2.11.1 Silvanus platform inputs

We are considering hosting the Brazilian pilot in the city of Belém, which is strategically positioned at the mouth of the Amazon River, making it a gateway to the Amazon rainforest. Therefore, Belém serves as a base for researchers and conservationists to study the Amazonian biodiversity and develop strategies for its protection. Belém has actively promoted sustainable development as a means of preserving the environment while improving the quality of life for its residents. Initiatives such as the "Bosque Rodrigues Alves" and the "Mangal das Garças" showcase eco-friendly practices and serve as educational centers for locals and tourists alike. Additionally, the city has been a pioneer in promoting sustainable tourism within the Amazon, emphasizing responsible travel and eco-friendly accommodations.

Figure 22 - The Amazon (dark green) and the region of Belém (yellow ellipse)

From Alencar et al. (2015), changes in weather and land use are transforming the spatial and temporal characteristics of fire regimes in Amazonia, with important effects on the functioning of dense (i.e., closed-canopy), open-canopy, and transitional forests across the Basin. The results of the study reveal that changes in forest fire regime properties differentially affected these three forest types in terms of area burned and fire scar size, frequency, and seasonality. During the study period (1983–2007), forest fires burned 15% (0.3 million ha), 44% (1 million ha), and 46% (0.6 million ha) of dense, open, and transitional forests, respectively. Total forest area burned, and fire scar size tended to increase over time (even in years of average rainfall in open canopy and transitional forests). In dense forests, most of the temporal variability in fire regime properties was linked to El Nino Southern Oscillation (ENSO)-related droughts. Compared with dense forests, transitional and open forests experienced fires twice as frequently, with at least 20% of these forests' areas burning two or more times during the 24-year study period. Open and transitional forests also experienced higher deforestation rates than dense forests. During drier years, the end of the dry season was delayed by about a month, which resulted in larger burn scars and increases in overall area burned later in the season. These observations suggest that climate-mediated forest flammability is enhanced by landscape fragmentation caused by deforestation, as observed for open and transitional forests in the Eastern portion of the Amazon Basin.

Figure 23. Types of forests of Brazilian Amazon

Alencar, A.A., Brando, P.M., Asner, G.P. and Putz, F.E. (2015), Landscape fragmentation, severe drought, and the new Amazon Forest fire regime. Ecological Applications, 25: 1493-1505. https://doi.org/10.1890/14-1528.1

Challenges of the Brazilian pilot

Strategic level	***Operational level***
data availability	real-time monitoring
system scalability	communication and alert systems
stakeholder collaboration	infrastructure and maintenance
policy and legal considerations	

It is very hard to obtain accurate and up-to-date data related to the Amazon region, including weather patterns, vegetation density, land topography, and fire occurrence. Furthermore, a system has to be able to handle the massive scale of the Amazon area, which covers approximately

5.5 million square kilometres. In addition, the Amazon is a complex and diverse region, involving multiple stakeholders, including local communities, government agencies, environmental organizations, and researchers. Coordinating and collaborating with these stakeholders to gather inputs, validate models, and implement the computational system can be a significant challenge. Implementing a computational system in the Amazon area requires complying with relevant policies, regulations, and legal frameworks. Understanding and adhering to these local and national rules while still being effective in preventing and managing forest fires is essential.

A computational platform like SILVANUS should continuously monitor the Amazon region in real-time to detect and respond to fire incidents swiftly. This requires establishing an extensive network of sensors, satellite imagery, and other monitoring tools across the vast area and integrating them into the computational system seamlessly. Besides, developing effective communication and alert mechanisms to inform relevant stakeholders about fire incidents, potential risks, and evacuation plans is essential. Ensuring timely dissemination of accurate information to local communities and relevant authorities can save lives and minimize the impact of fires. Maintaining the necessary computational infrastructure, including servers, storage, and network capabilities, in remote areas of the Amazon can be challenging. Additionally, training personnel for ongoing system maintenance and updating the computational system to incorporate advancements in technology are crucial for long-term operational success.

Addressing these strategic and operational challenges requires a holistic and collaborative approach involving experts and stakeholders from various disciplines, including environmental science, data analytics, engineering, policy, and community engagement.

2.11.2 Stakeholders and partners. Roles and activities

At present, we are not able to fill in this section before the potential stakeholders meeting, which is planned to occur in November 2023.

2.11.3 Operational scenario

At present, we are not able to fill in this section before the potential stakeholders meeting, which is planned to occur in November 2023.

Objectives and KPI’s specific to each pilot

At present, we are not able to fill in this section before the potential stakeholders meeting, which is planned to occur November 2023. In general, for SILVANUS platform, we could cite:

1. Early detection: The system should aim to detect forest fires at the earliest possible stage to enable timely response. The objective could be to reduce the time taken to detect a fire,

and the corresponding KPI could be the average response time from detection to intervention.

2. Accuracy of fire detection: The system should have a high accuracy in identifying fires and differentiating them from other natural phenomena like haze or cloud cover. The objective could be to minimize false alarms, and the KPI could be the percentage of false positives or false negatives.
3. Localization and mapping: The system should accurately locate and map the fires to facilitate efficient firefighting efforts. The objective could be to improve the precision of fire location, and the KPI could be the percentage of correctly mapped fires.
4. Fire prediction: The system should be able to predict potential fire-prone areas and assess the risk in different parts of the Amazon. The objective could be to enhance the accuracy of fire prediction, and the corresponding KPI could be the percentage of correct predictions, or the area covered under accurate predictions.
5. Data integration and sharing: The system should have the capability to integrate data from various sources, such as satellite data, weather data, and ground-based observations. The objective could be to improve data integration, and the KPI could be the percentage of data sources integrated.
6. Stakeholder engagement: The system should involve and engage local communities, firefighters, and relevant authorities to ensure effective implementation. The objective could be to increase stakeholder engagement, and the corresponding KPI could be the number of stakeholders actively participating in the system.
7. Educational and awareness programs: The system should include educational initiatives and awareness programs to enhance local understanding of fire prevention and management. The objective could be to increase awareness levels, and the KPI could be the percentage increase in the community's knowledge about fire prevention and management.
8. System scalability and adaptability: The system should have the capability to scale up and adapt to changing environmental conditions or emerging technologies. The objective could be to improve system scalability and adaptability, and the KPI could be the percentage increase in system scalability, or the number of new technologies integrated.
9. Resource optimization: The system should optimize the allocation of resources, including firefighting personnel, equipment, and water usage, to minimize the impact of forest fires. The objective could be to reduce resource wastage, and the KPI could be the percentage improvement in resource utilization efficiency.
10. Environmental impact assessment: The system should assess the environmental impact of forest fires and provide insights into the long-term ecological consequences. The objective could be to conduct comprehensive environmental impact assessments, and the KPI could be the number of ecological variables considered in the assessment.

For now, in phase A, we are planning to disseminate the citizen engagement app. In phase C, as soon as the pilot site is defined, we are going to acquire knowledge from local stakeholders' practices. WWF Brazil has already been contacted and is going to help us. At present, it is not possible to specify which technologies will be used in the pilot.

In general, the demonstration activities planned for the Brazilian pilot contribute to the system validation, user acceptance, training, stakeholder engagement, and securing support, which are crucial for the successful implementation of the forest fire computer system in the Amazon area. In a more detailed way:

1. evaluating system effectiveness: the demonstrations will help in assessing the effectiveness of the forest fire computer system in terms of detecting and predicting forest fires accurately. It will provide an opportunity to validate the system's performance under real-world conditions, ensuring that it meets the desired objectives.
2. user acceptance testing: demonstrations can help gather feedback from end-users, such as firefighters and forest management authorities. It will provide an opportunity for them to interact with the system and provide input on its usability, functionality, and overall user experience. This feedback can then be used to further improve the system before its full implementation.
3. training and familiarization: demonstrations can be used as a platform for training and familiarizing the stakeholders with the forest fire computer system. Users can get hands-on experience with the system's interface, learn how to interpret its outputs and make informed decisions based on the information provided. This will enhance their preparedness and effectiveness in dealing with forest fire situations.
4. stakeholder engagement: demonstrations can help engage and involve various stakeholders, such as government agencies, local communities, and environmental organizations, in the forest fire management process. It provides an opportunity for them to witness the capabilities of the system firsthand, fostering collaboration and cooperation in tackling forest fires in the Amazon area.
5. garnering support and funding: successful demonstrations can help generate support and secure funding for the implementation and continued operation of the forest fire computer system. It serves as evidence of the system's capabilities and potential impact, making a compelling case for investment from relevant stakeholders.

2.11.4 Preparing user stories

At present, we are not able to fill in this section before the potential stakeholders meeting, which is planned to occur in November 2023.

2.11.5 Receiving requirements & permits

At present, we are not able to fill in this section before the potential stakeholders meeting, which is planned to occur in November 2023.

2.11.6 Testing the pilots

At present, we are not able to fill in this section before the potential stakeholders meeting, which is planned to occur in November 2023. However, the season with the lowest rainfall, known as "Amazonian Summer", runs from June to November, with October being the driest month.

2.12 Australia Pilot

2.12.1 Silvanus platform inputs

This pilot is a demonstration of the activities involved in bringing autonomous ground vehicles to wildfire environments. The challenges involved with autonomous and semi-autonomous navigation through forested regions in the presence of fire are numerous. We will demonstrate various pieces of research that aid in navigation without damaging the robot or damaging the trees. The pilot also provides a means to understand the fire regime in Australia, specifically the Eucalypt and rainforest regions of South Queensland. This region's climate is strongly influenced by the El Nino/La Nina oscillation and Indian Ocean Dipole. When the former is El Nino and the latter is positive, conditions are especially hot and dry. This will be the case during the pilot, and forest fires are common in these conditions. Eucalypt forests in particular burn hot and fast, causing intense fire scenarios.

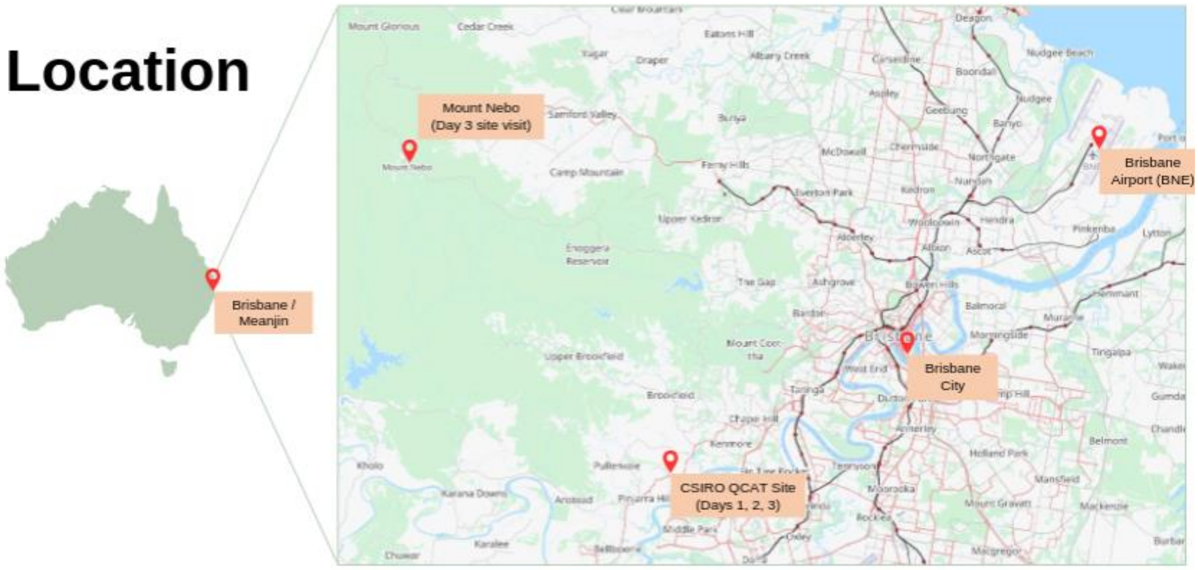

Figure 23 - Pilot site location in Australia

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

- 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

Operational challenges:

- how to allow precise vehicle control by a user, while allowing for multiple robots to explore autonomously most of the time, to minimize human resource
- how to design a base-station interface to allow operațional control of the vehicles beyond line of site, and away from the fire front danger zone
- How to communicate between the vehicles and the base station reliably even when signal can cut out

2.12.2 Stakeholders and partners. Roles and activities

Table 38 - Stakeholders and partners, Australian pilot

Stakeholder	Activity Engaged	Role
CSIRO	Autonomous ground vehicle navigation	Research and development of technologies for wildfire navigation
CTL	Testing smoke detection IoT device	Mid-pilot testing of device on moving vehicle

2.12.3 Operational scenario

Table 39 - User products, Australian pilot

Phase (A,B,C)	*User product*	*Description*
B	Ground vehicle navigation sensor payload	Integrated sensor platform for 3D mapping, localization, navigation and video for environment monitoring capabilities.
B	Ground vehicle navigation software suite	Software to support localization and mapping (SLAM), autonomous navigation, forest analytics, multi-agent communication and place recognition.

Objectives and KPI's:

Innovative technologies:

- deep-learning based place recognition for map-alignment
- cutting-edge tree reconstruction algorithms for forest analytics
- novel use of multi-return lidar for grass/plant classification
- world-leading Simultaneous Localization and Mapping technology developed at CSIRO

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

- WP4: Provide advanced capabilities for early detection of wildfires through the collection, aggregation and pre-processing of data coming from heterogeneous sources, including in-situ IoT devices and UGVs
- WP4: To implement advanced navigation systems to control the path of ground vehicles

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

Table 40 - Objectives and KPIs, Australian pilot

Phase	***Objective***	***Activity***	***KPI's***
Phase B	1. Demonstrate autonomous/semi-autonomous operation of single vehicle in simulated forest fire situation 2. Demonstrate autonomous/semi-autonomous behaviour of multiple vehicles in forested area 3. Demonstrate the integration of one or more partner technologies onto the robotic platform, to enhance detection capabilities in bushfire scenarios	1. field test with delegates and external stakeholders present. Show abilities to navigate robot to/from firefront 2. field test with delegates and external stakeholders present. Show map merging behaviour, using a prior map, and robot avoidance. 3. At present we have the CTL smoke detection device which we will attach to the vehicle and demonstrate in the forest environment	1. the vehicle navigates with minimal getting stuck and without hitting trees. Any stuck areas can be easily and safely corrected using teleoperation interface without line of site. 2. vehicle correctly acquired map of other vehicle, as evidenced on screen, and by viewing the result of motion requests in the merged map's coordinate frame. 3. CTL device performs as expected while on the autonomous vehicle. Ideally it

		while employing a smoke machine.	detects the presence of smoke and its strength.

2.12.4 Receiving requirements & permits

There will not be any permits required for our pilot activities.

2.12.5 Testing the pilots

As we are on a different continent, there will be no in-person field visits prior to the pilot. We aim to test the Catalink housing does not affect our vehicle's localisation performance prior to the pilot. We will do this with a local field test by 1st October 2023.

3. IDENTIFIED CHALLENGES

Forest fires can be devastating, and operational readiness is critical to fighting them effectively. Predicting how a fire will behave is crucial to planning an effective intervention. Determining how and where to allocate resources, including personnel, equipment, and supplies, can be challenging. Different fires require different resources, and deciding where to deploy them requires careful analysis of fire behaviour, accessibility, and logistical considerations. Interventions require prioritization, with limited resources going to the most critical needs. Identifying which areas or assets to prioritize, such as homes, infrastructure, or sensitive ecosystems, can be challenging, as it may require balancing competing demands. Fighting forest fires often requires the coordination of multiple agencies, including federal, state, and local authorities, as well as private entities. Coordinating between agencies can be challenging due to differences in resources, priorities, and procedures.

SILVANUS sets a common baseline for all pilot sites and facilitates a first-round integration between technology providers, pilot sites and the design of the SILVANUS platform. The general challenges that pilots are faced with are listed below:

- To develop a technological, scientific, environmental, societal and innovative framework for wildfires and sustainable forest development.
- To develop a technological infrastructure that can support decision-making for all phases of the wildfire management cycle (preparedness, response, recovery).
- To increase wildfire risk awareness and the protection and sustainability of forests.
- To support the process of a cultural change towards risk tolerance, resilience and risk mitigation.
- To increase certainty and (common and shared) situation awareness for wildfire emergencies.
- To increase the resilience of the pilot area at all levels (environmental, economic, social).
- To improve firefighter response time and operational capacity by using modern sensor and imaging technologies.
- To enable the collection of data from various sources, in real or near-real time, for valid and early detection and warning indicators.
- To assess algorithms, data and risk indicators for fire ignition, fire propagation and evacuation models.
- To setup communication infrastructures for new technologies such as drone surveillance.
- To reduce the impacts in the rural and urban environment.
- To protect human lives and health.
- To generate a database within collecting globally data, using big-data software, correlations and algorithms to prevent ignition and the spread of fire forest.

4. CONCLUSIONS

SILVANUS has an innovative approach based on the engagement of all relevant stakeholders, including environmental scientists, forest conservationists, regional councils, fire fighters, first responders and technology providers, agricultural scientists, and citizens. This adds a strong layer of complexity with regards to integration of information from all stakeholders into a coherent set of activities, associated to each Phase.

Part of the role of Task 9.1 is to integrate this complexity into a structured general overview that can then be implemented through the different activities. Operational readiness sets a common baseline for all pilot sites and facilitates a first-round integration between technology providers, pilot sites and the design of the SILVANUS platform.

Deliverable 9.1 integrates and synthetizes a methodology for reaching green operational readiness across pilot sites. Successful implementation of activities for Phases A, B and C depends on clear planning and availability of necessary resources. This output has been achieved for 9 pilot sites in France, Italy, Romania, Greece, Portugal, Czech Republic, Croatia and Slovakia. The general timeline and user stories are developed and the process of integration with technology providers has begun.

Task 9.1 will continue its activities and closely monitor the organizational readiness for pilot demonstrations throughout the process. The locations for the pilot demonstration varies in order to test, validate and evaluate the SILVANUS technological platform and its components in different contexts, climate, weather conditions and so on:

- **France** will deploy a pilot demonstration of a forest fire with industrial accident in highly explosive plant
- **Italy** will test fire and hydrogeological risks
- **Romania** will approach fire ignition caused by human negligence in a National Park
- **Greece** pilot demonstrates the impact of wildfires on agricultural sector
- **Portugal** will test powerline disruptions resulting in accidental fires
- **Czech** pilot will test preparedness and response coordination in countering wildfires in one of the most visited tourist resorts in the Czech Republic
- **Slovakia** pilot will consider policy recommendations on restoration of forest landscape

Each pilot follows the methodology employed in this project, including a structured approach consisting of various elements all adapted to the specific of each pilot. These include outlining the background and purpose of the pilot, defining pilot objectives and KPIs, planning activities in line with the objectives and KPIs, identifying relevant technology and tools for the activities, involving partners, stakeholders and end-users, establishing a timeline for the pilot, designing a data collection and analysis plan, providing details on important features for permits and consent of participants, and assigning partners with specific responsibilities and impact within the planned activities. This structured approach ensures a comprehensive and organized implementation of the pilot.

The pilots' reports revealed a range of challenges faced by pilots aimed at wildfire management and sustainable forest development. These challenges include, in various degrees in each pilot:

- → developing a comprehensive framework that considers technological, scientific, environmental, societal, and innovative aspects
- → establishing a technological infrastructure to support decision-making across all phases of the wildfire management cycle
- → increasing awareness of wildfire risks and protecting forests sustainably
- → fostering cultural change towards risk tolerance, resilience, and mitigation
- → improving situation awareness and response time for emergency situations
- → enhancing resilience at all levels
- → utilizing modern sensor and imaging technologies to enhance firefighting response time and operational capacity
- → enabling real-time data collection from various sources to detect and provide early warning indicators
- → evaluating algorithms, data, and risk indicators for fire ignition, propagation, and evacuation models
- → establishing communication infrastructures to support emerging technologies such as drone surveillance
- → minimizing impacts on rural and urban environments
- → protecting human life and health
- → generating a comprehensive global database by utilizing big-data software, correlations, and algorithms to prevent forest fire ignition and spread.

ANNEX 1. Operational readiness pilot – Questionnaire Template

1. **SILVANUS PLATFORM INPUTS FOR EACH PILOT. STRATEGIC AND OPERATIONAL CHALLENGES.**
    - *increasing the human, environment and economy resilience to wildfires by training;*
    - *development of an integrated technological and information collaboratory platform providing technological decision-making support in preparedness, response and recovery phase of wildfire management cycle;*
    - *assessment of fire risk indicators based on continuous surveys of forest regions;*
    - *gathers technology and scientific innovation, environment and human factors.*
    - *developing infrastructure to connect platform to very early and early warning indicators;*
    - *generating a database within collecting globally data, using big-data software, correlations and algorithms to prevent ignition and the spread of fire forest;*
    - *include the setup of wireless communication infrastructure, and the use of drones to perform surveillance and undertake mitigation actions;*
    - *use of onboard data analytics with low-cost computational components capable of performing video stream analytics at the edge will extend the longevity of the drone flight time;*
    - *the multistakeholder project platform is conceived to deliver the high-impact intervention in addressing the challenges outlined in Phase A, B and C.*

2. **STAKEHOLDERS AND PARTNERS. ROLES AND ACTIVITIES**

Our stakeholders are___________________
The role of each stakeholder __________________
Activities developed of stakeholders in the pilot______________
Same for the partners. You can use tables for each category.

3. **OPERATIONAL SCENARIO. SPECIFIC STEPS FOR EACH PHASE. TECHNOLOGY PROVIDERS CHALLENGES / ISSUES FOR EACH PILOT AND ACTIVITY**

3.1. Phase A. The Prevention and Preparedness activities
3.2. Phase B. Detection and Response activities
3.3. Phase C: Restoration and Adaptation activities
3.4. Objectives and KPI's specific to each pilot achieved.

Create a table and try to assign each objective with a pilot and a technology and other activities. It should be mentioned already but now it has to be refined, close to one year and a half during the project.

4. **PREPARING USER STORIES. SPECIFIC SCENARIOS FOR EACH PILOT. OPERATIONAL PROCESS/ PROCEDURES. DEMO DESCRIPTION.**

5. **RECEIVING REQUIREMENTS & PERMITS**

Example: This is pilot specific and most importantly scenario specific as the previous one. If we want to fly a drone, we need the permission of an authority in that area to do that. You have to indicate some details about the permits and requirements of using the chosen technology.

6. **TESTING THE PILOTS. FIELD VISITS AVAILABILITY FOR TECHNOLOGY PROVIDERS**

Example: please specify a 1-2 week interval/s between July - September 2023 when technology providers can perform field visits for testing/validation)

ANNEX 2. Operational readiness pilot – Questionnaire Template Updated

1. SILVANUS PLATFORM INPUTS FOR EACH PILOT. STRATEGIC AND OPERATIONAL CHALLENGES.

- *Context description (narrative) – **Important: mention fire regime***
- *Include a clear map of the area*

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

- ...
- ...

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 B: Detection and Response**
  - ...
  - ...
- **Phase C: Restoration**
  - ....

2. STAKEHOLDERS AND PARTNERS. ROLES AND ACTIVITIES

Stakeholder	*Activity Engaged*	*Role*

3. OPERATIONAL SCENARIO. SPECIFIC STEPS FOR EACH PHASE. TECHNOLOGY PROVIDERS CHALLENGES / ISSUES FOR EACH PILOT AND ACTIVITY

- *General objective of demonstration (narrative)*
- *Operational scenario activities for each phase (narrative that will include for each outputs and outcomes)*

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

Objectives and KPI's specific to each pilot

- *Describe innovative technologies that will be used in the pilot.*

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

- PA… – *description*
- PA… – *description*

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			

4. PREPARING USER STORIES. SPECIFIC SCENARIOS FOR EACH PILOT. OPERATIONAL PROCESS/ PROCEDURES. DEMO DESCRIPTION.

- **Phase A: Prevention and Preparedness**
- **Phase B: Detection and Response**
- **Phase C: Restoration**

5. RECEIVING REQUIREMENTS & PERMITS

Example: This is pilot specific and most importantly scenario specific as the previous one. If we want to fly a drone, we need the permission of an authority in that area to do that. You have to indicate some details about the permits and requirements of using the chosen technology.

6. TESTING THE PILOTS. FIELD VISITS AVAILABILITY FOR TECHNOLOGY PROVIDERS

Example: please specify a 1-2 week interval/s between July - September 2023 when technology providers can perform field visits for testing/validation)