



Increasing Resilience

Decision Support Systems for the Management and Increasing Resilience of REN's Gas and Electricity Infrastructure Facing the Risk of Forest Wildfire

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Co-financiado por:

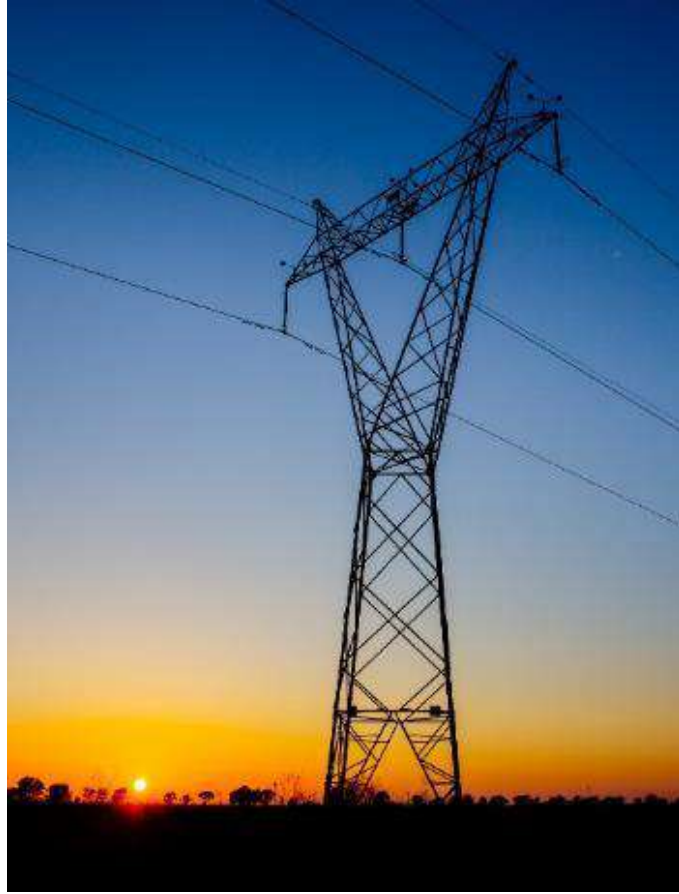


Integrated Transmission System Operator

Energy Transmission networks in Portugal

ELECTRICITY- TRANSMISSION LINES

Length of Lines: more than 9300km



More than 35000ha of Right-of-Way

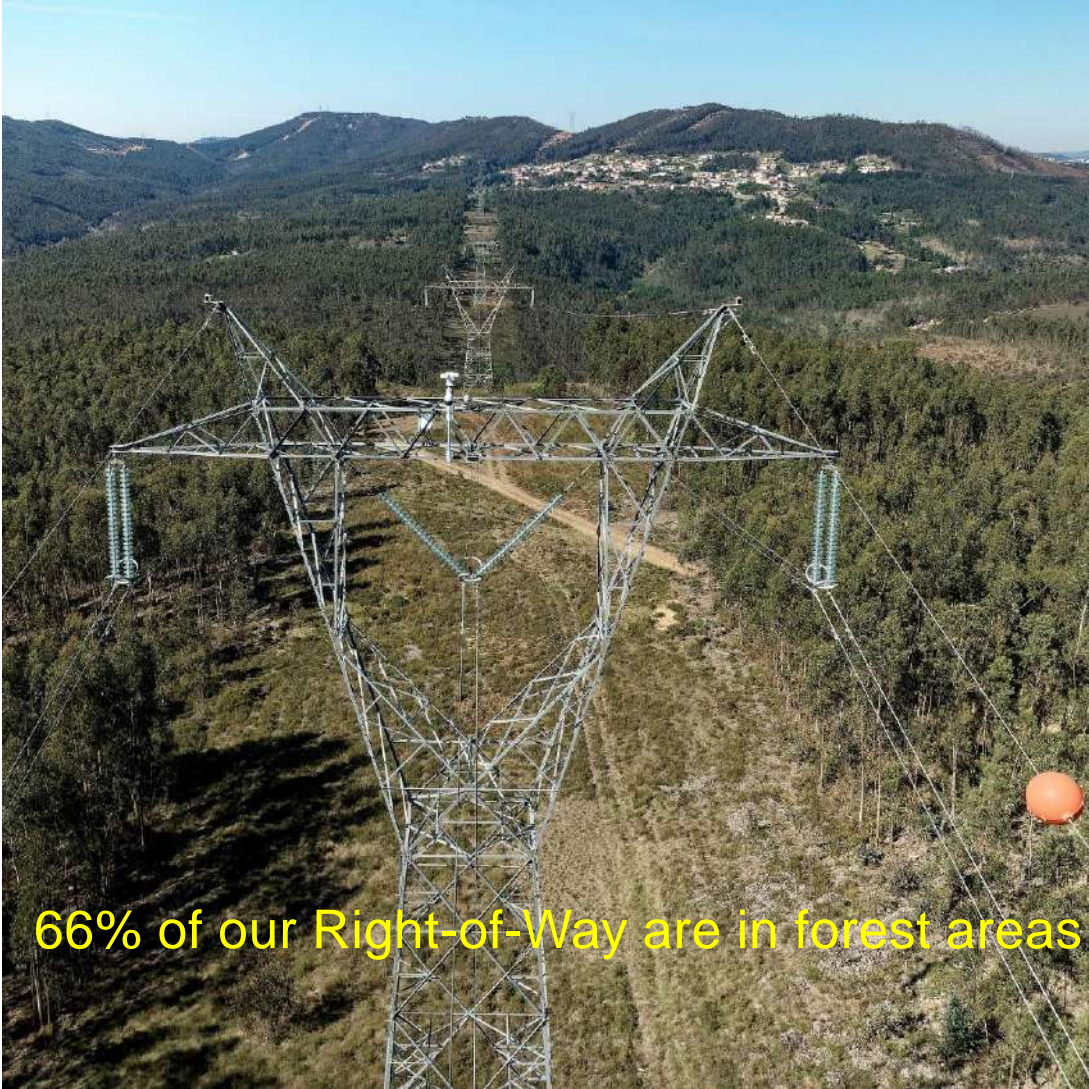
NATURAL GAS PIPELINES

Pipeline Length: almost 1400km



Wildfires impact on REN infrastructures

Why use existing REN infrastructure for forest monitoring?

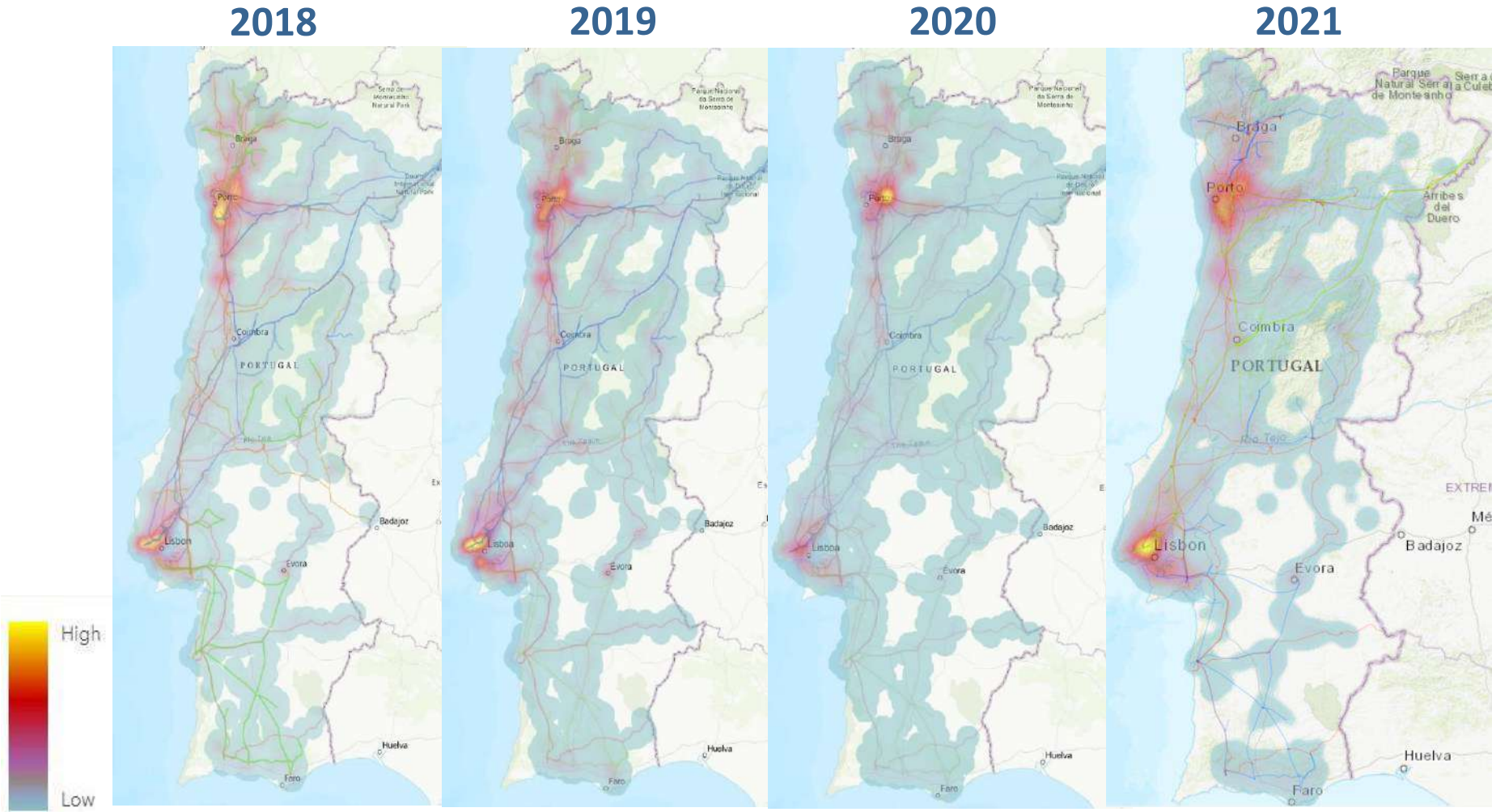


66% of our Right-of-Way are in forest areas



REN and the forest wildfires

Heatmap of rural fire occurrences inside a 5 km buffer of REN infrastructures

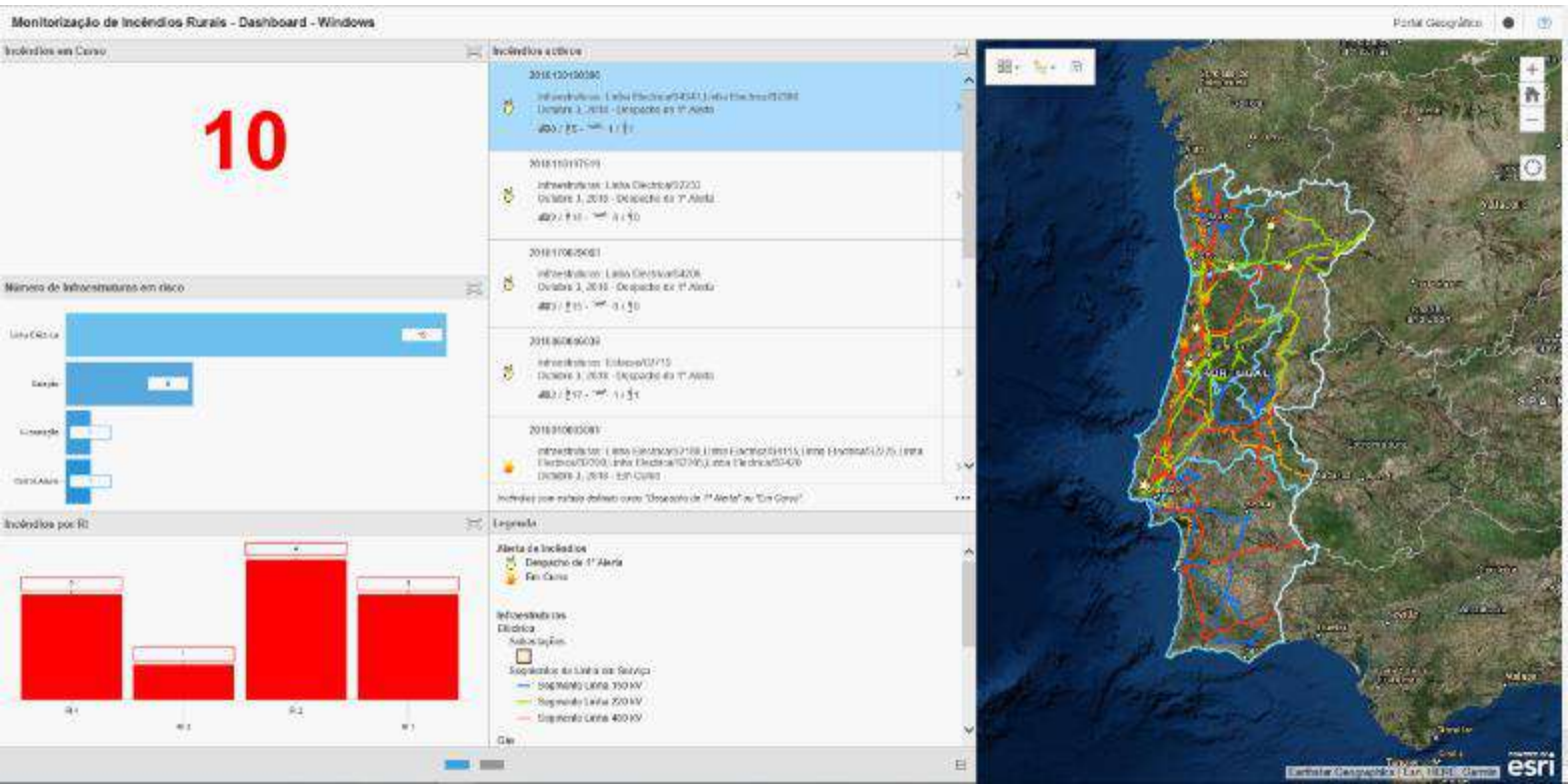


Average of 5000 occurrences each year.

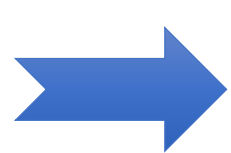
In one day (13 July 2022) we had more than 195 occurrences near REN infrastructures!

REN and the forest wildfires

Forest Fire Alert System – Develop in 2017 with ESRI tools



Forest wildfires dashboard < 5 km critical infrastructures

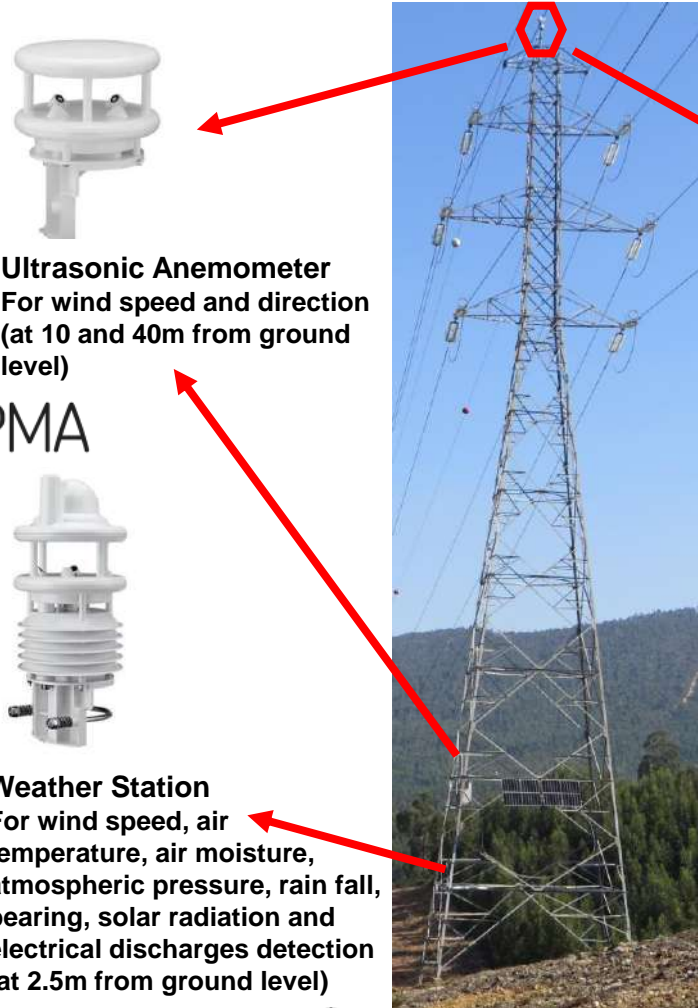


Incoming SMS (text message) when at less than 2km

Innovative ways: Infrastructures Monitoring

Hardware and demonstration zones

As part of this project, REN is installing **eight (8)** infrastructure monitoring systems...



Ultrasonic Anemometer
For wind speed and direction
(at 10 and 40m from ground level)



Weather Station
For wind speed, air temperature, air moisture, atmospheric pressure, rain fall, bearing, solar radiation and electrical discharges detection
(at 2.5m from ground level)



Main Camera
Ignitions and smoke columns detection based on IR and visible cameras

Secondary Camera
Tracking events based on visible camera



... in three demonstration zones, which represent three different types of territories, but all subject to the pressure of rural wildfires.

Innovative ways: Infrastructures Monitoring

Main Camera - Fire detection AI and Timelapse

The screenshot displays the 3EE FIRE DETECTION monitoring interface. At the top, there is a navigation bar with options: Monitorização, Videovigilância, Alertas, Terreno, and Pesquisa. The main content area shows an alert for "Incêndio (Novo) Replant Recarei (T01)" with a detection date of 13/05/2022 at 16:41:54. A table below the alert provides details: Data de Detecção (13/05/2022 16:41:54), Nº Ocorrência (0013/2022), Perigosidade (---), and Coordenadas (--- / ---). A large blue arrow points to a red-bordered frame in the timelapse video, highlighting a fire event. The interface also includes a weather station section on the left with data for humidity (0.0%), precipitation (--- mm), temperature (--- °C), and wind speed (1.2 m/s W (280.8 ft)). A map at the bottom shows the location of the fire event in the Paços de Ferreira area, with a red circle indicating the fire's location. The interface also features a "Falso" (False) button and a "Confirmar" (Confirm) button, as well as an "Análise" (Analysis) button and a "Câmara Óptica" (Optical Camera) dropdown menu.

Innovative ways: Infrastructures Monitoring

Secondary Camera - Real-time data

REN Intranet - Home | NetworX | WhatsApp | Detecção Bee2Fire

https://replant.bee2firedetection.com/b2f/web/surveillance/284

Qlik Sense | GeoREN | RENLAND | LandWeek | OneDrive | Outlook Web | REN | @udit | HelpDesk | Fluxo | NetworX | ZAPT | Tasker

BEE FIRE DETECTION | Monitorização | Videovigilância | Alertas | Terreno | Pesquisa

2000-03-12 19:46:13 Sun | 81.67/-0.89/4.9x E

- Incêndio (Novo) | 23/03/2023 11:24:50 | T06 - LPNLTABP91 | 210° 84°
- Incêndio (Novo) | 23/03/2023 10:22:50 | T06 - LPNLTABP91 | 210° 78°
- Incêndio (Novo) | 23/03/2023 09:47:34 | T08 - LFTFRP19

LTRRRP42 ... | 0,6 m/s N (0 °) | Velocidade Vento | Perigosidade

Solution: Decision Support System

GIS (frontend) and Fire Propagation Simulator (isochronous lines)

The screenshot shows a web browser window with the URL <https://georen-intra.ren.pt/portal/home/>. The browser tabs include 'REN Intranet - Home', 'NetworX', 'WhatsApp', 'Portal Geográfico', and 'Simulação de Propagação'. The page header features navigation links: 'Início', 'Galeria', 'Mapa', 'Cena 3D', 'Grupos', 'Conteúdo', and 'Organização'. A user profile for 'João Gaspar' (E401433@REN) is visible in the top right. The main content area displays the 'GEOREN' logo and a 'Mapas' section with four interactive tiles: 'Simulador Incêndios (em teste)', 'Histórico Risco de Incêndio - Dashboard', 'Dados Gerais Ambiente', and 'Monitorização das Classes de Risco - Dashboard'.

The screenshot shows the mobile application interface for 'rePLANT Simulação de Pr'. It features a map with various colored overlays and a 'Lista de Ocorrências' (Incident List) section. The list contains three entries:

ID	Data	Origem
99659	2022-11-11 16:20	Utilizador
99761	2022-11-11 16:19	Utilizador
99382	2022-11-11 16:22	Utilizador

Infrastructures Monitoring and Decision Support System



Increased security in other infrastructures such as energy, roads, rails, and industrial areas

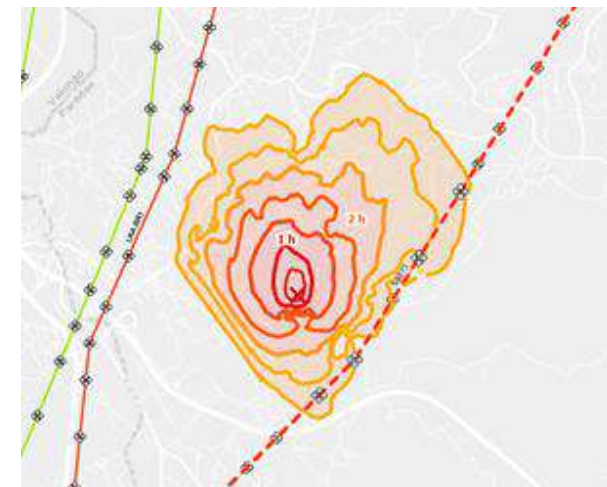
Infrastructures Monitoring and Decision Support System

Increasing resilience of REN's Infrastructure

- No longer **focus** on the wildfire ignition point, but on the **time and place** where it will likely **impact** the gas and electricity transmission network.
- Knowing which forest wildfires can really impact our network we can have a **reduction of alerts**.
- Is possible to monitor forest wildfires that start **outside the 5 km buffer** and from there, **make new simulations**.
- **Have a better efficiency** in activating prevention and surveillance teams and other support staff, in dispatch and operation rooms.
- **Providing services to other entities, helping companies and communities.**



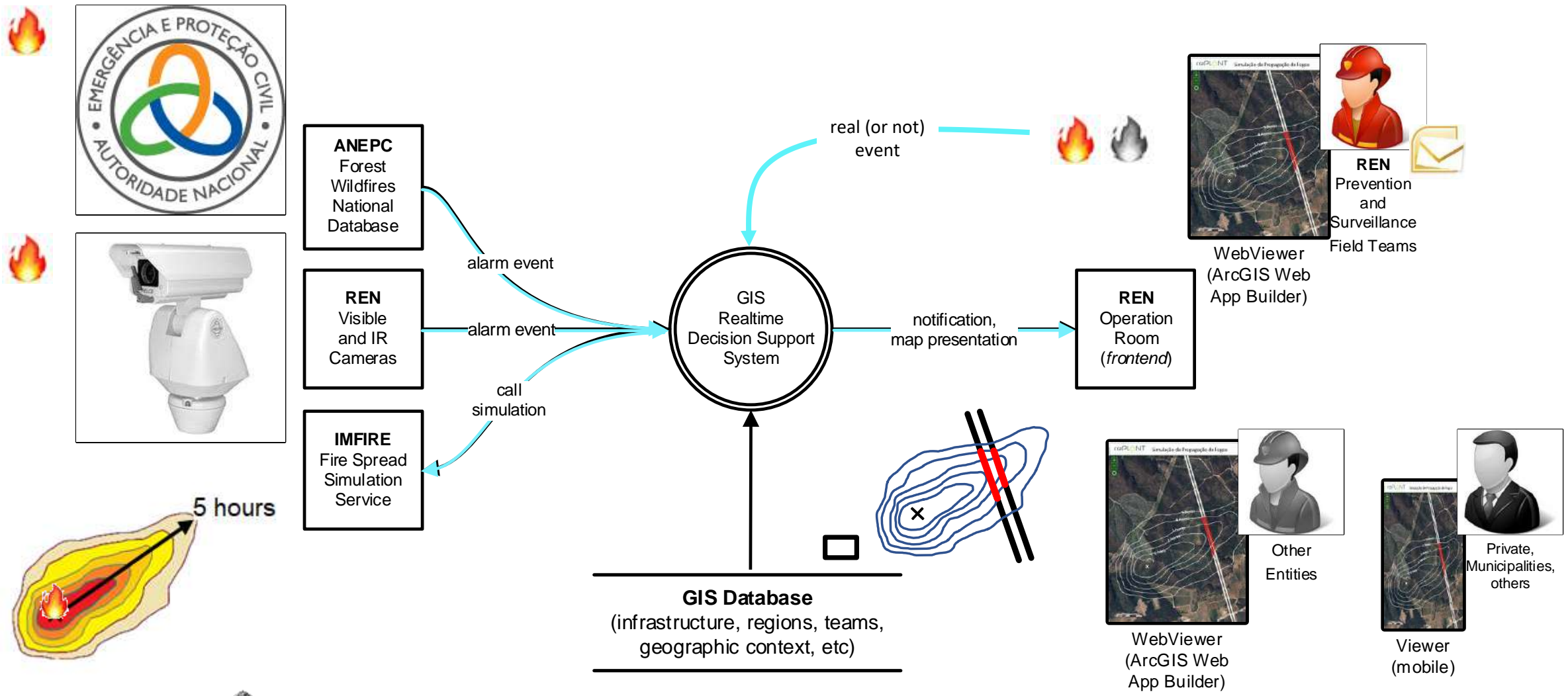
Infrastructures Monitoring



Decision Support System

A Decision Support System

Solution Use Workflow



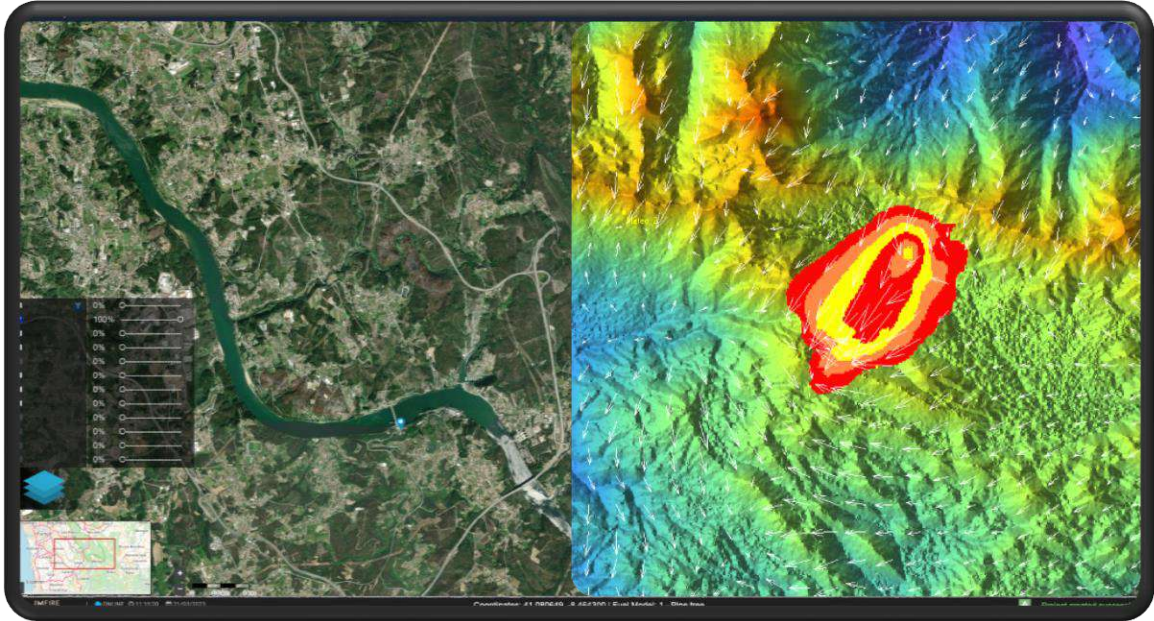
A Decision Support System

GIS frontend

rePLANT Simulação de Propagação de Fogos

Lista De Ocorrências		
Efectuar simulação:		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="button" value="Criar"/>
<input checked="" type="radio"/> todas <input type="radio"/> reais <input type="radio"/> simuladas		
99299	Data: 2021-06-24 12:30 Origem: Utilizador	
99608	Data: 2021-06-24 12:27 Origem: Utilizador	
99608	Data: 2021-06-24 12:27 Origem: Utilizador	
99224	Data: 2021-06-22 16:03 Origem: Utilizador	
99563	Data: 2021-06-22 16:02 Origem: Utilizador	
99657	Data: 2021-06-22 16:02 Origem: Utilizador	

Fire Propagation Simulation



Based on advanced Wildfire, Smoke and Weather models, coupled with AI.

- ✓ Simulation of the fire spread and behavior, coupled with atmospheric changes, for a local set of parameters, including topography, vegetation (fuel) and weather.
- ✓ Available as stand-alone web-based platform or API.
- ✓ Simulation time below 2 minutes, for predictions up to 5 hours in the future.

IMFIRE
INTELLIGENT MANAGEMENT FOR WILDFIRES
Project Ref. PCIF/SSI/0151/2018

DA | ISR INSTITUTO DE SISTEMAS E ROBÓTICA | CFisUC | THALES

<https://adai.pt/imfire/>



fct Fundação para a Ciência e a Tecnologia

Simulation Process - Overview

Input data

From user:

- Fire ignition (time and coordinates)
- Local wind speed and direction (optional)

From database:

- Terrain (slope/aspect/DEM)
- Fuel Models and Maps (fuel load, depth, physical and chemical properties, ...)

Automatic data fetching from online sources:

- Fuel moisture content
- Local wind speed and direction



Models

- Fire 1 - [Rothermel](#) (1972) surface fire spread model
- Fire 2 - [Van Wagner](#) (1977) and [Cruz, Alexander, Wakimoto](#) (2005) crown fire models.
- Fire 3 - [Albini](#) (1979) spot fire model
- Wind 1 - [Nuatmos](#) Kinematic model; smooth topography; no thermal effects; numerically stable and low computational times;
- Wind 2 - [Canyon](#) Full 3D Navier-Stokes solver; complex topography; thermal and turbulence effects; terrain roughness or vegetation effects modelled; long computational times
- Smoke 1 - [Disperfire](#) (2007) 3D Smoke concentration model
- FMC 1 - [Lopes](#) (2014) Equilibrium moisture content and timelag model

Results

- Fire rate of spread
- Fire line intensity
- Flame height
- Wind map
- Smoke generation
- Smoke dispersion and concentration

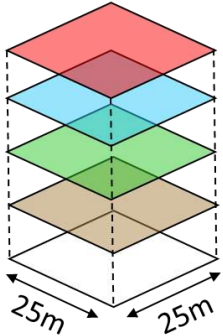
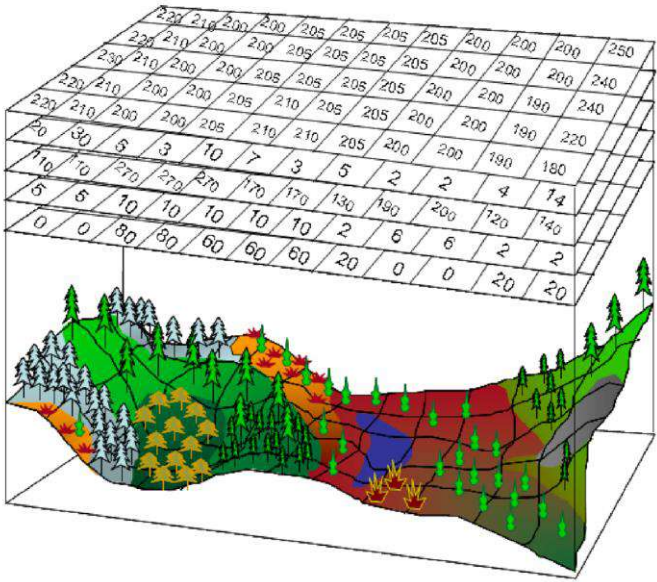


GA Algorithms

Simulation Process - Input data



Worldwide coverage capable



Maps:

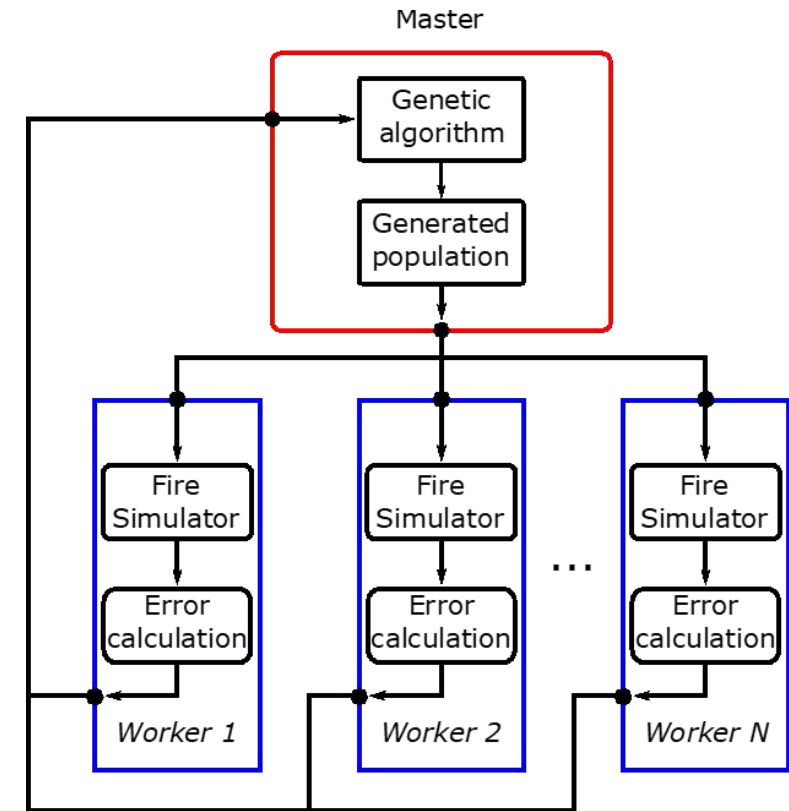
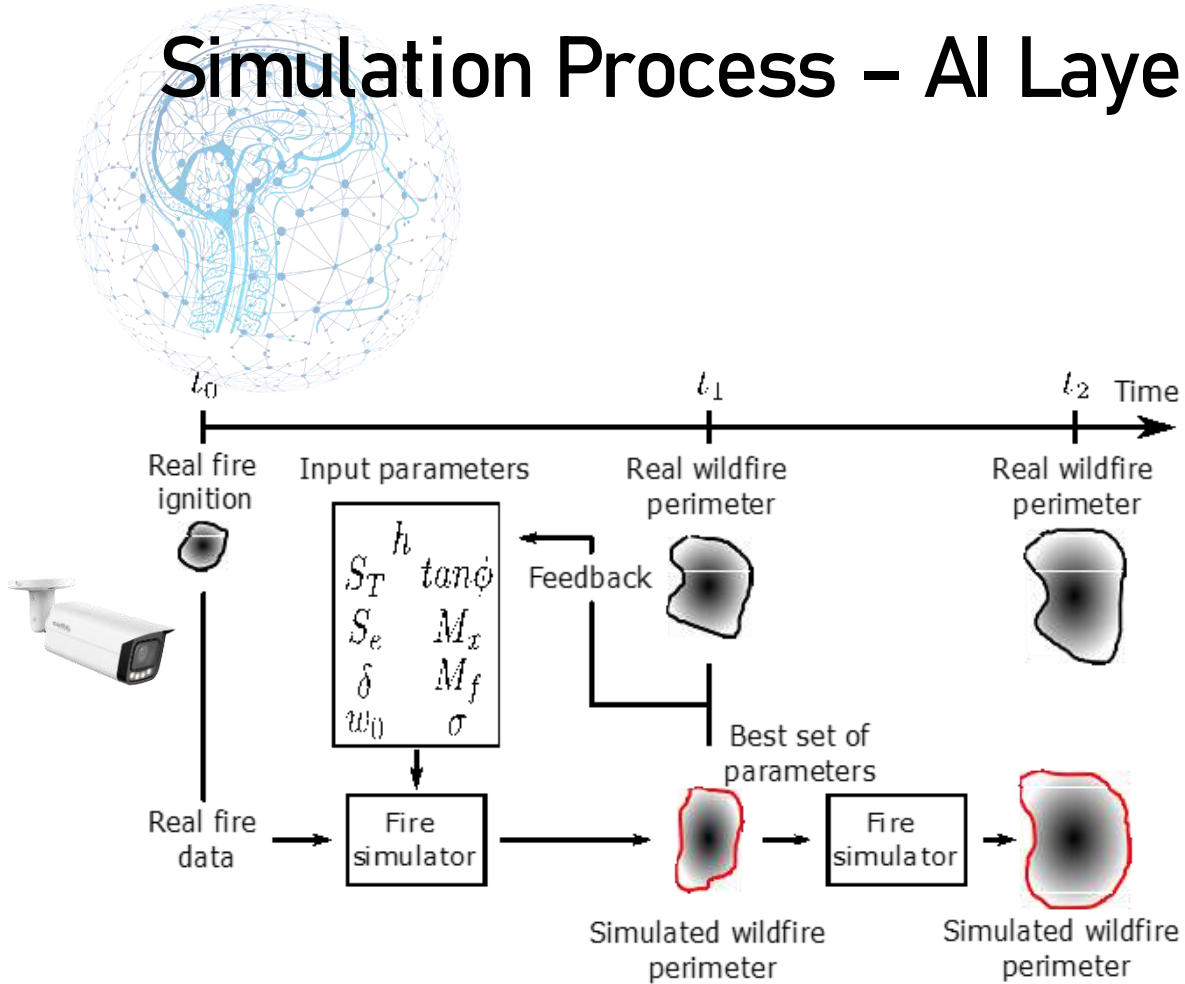
1. Ignitions – burning cells
2. Wind – wind speed U (x and y direction)
3. Fuels – fuel model
4. Slope – slope Φ
5. Coordinates – scale

Simulation Process - Fire Behaviour Models



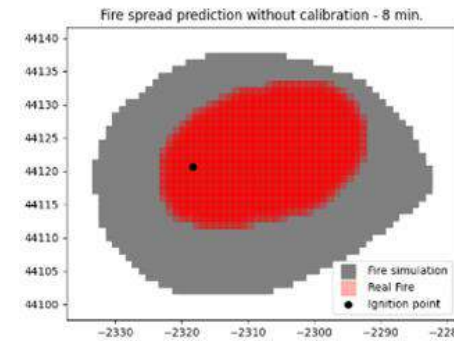
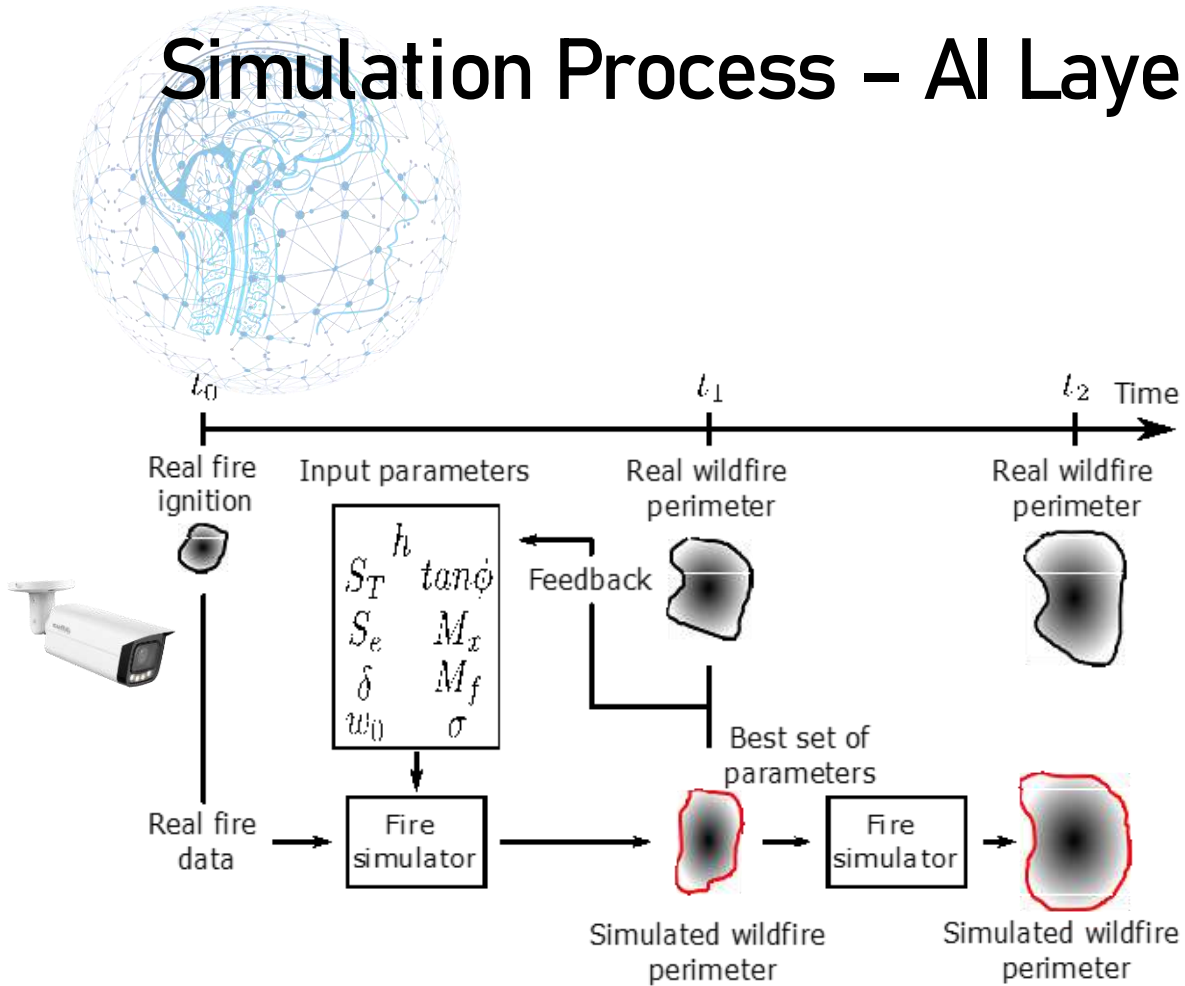
Bringing more than 30 years of expertise on **fire behavior** to aid in the decision making.

Simulation Process - AI Layer

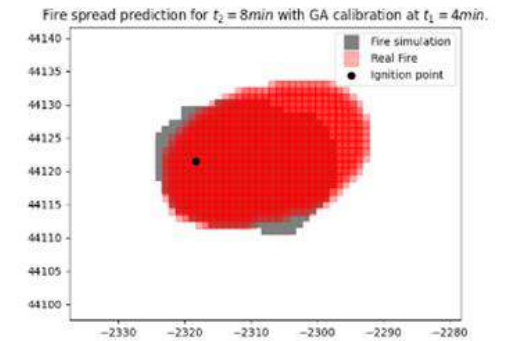


Parallel computing and Algorithm optimization for increased calculation speeds

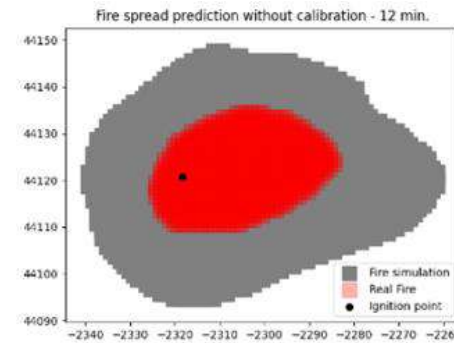
Simulation Process - AI Layer



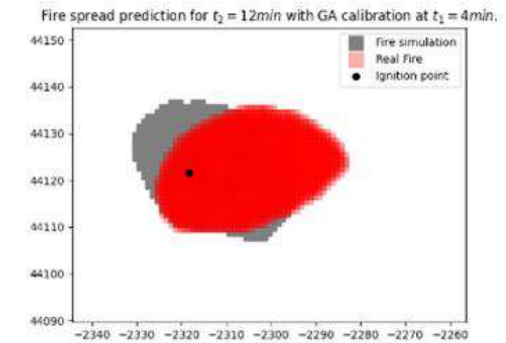
(a) Non-calibrated prediction.



(b) GA calibration.



(a) Non-calibrated prediction.

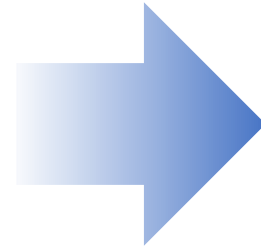


(b) GA calibration.

40% accuracy increase on fire spread results using Genetic Algorithms and parameter fine-tuning.

What's next?

From proof of concept to project scale-up



6.3M€

2023 —————> Dez/2025

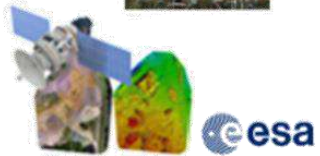
Wildfire risk —————>

Other environmental risks
and natural disasters

What's next?

Data collection

Multiple sources



Data processing

Data aggregation and analysis center



Decision-making support services and alerts



other companies and communities

Thank you!

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