The FireLoc Project: Identification, positioning and monitoring forest fires with crowdsourced data

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Athens – 13th and 14th December 2022

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ATHENS WORKSHOP

FIRELOC

WHERE'S THE FIRE?

IDENTIFICATION, POSITIONING AND MONITORING FOREST FIRES WITH CROWDSOURCED DATA

The FireLoc Project:

Identification, positioning and monitoring forest fires with crowdsourced data

2019 - 2023

Funded by:

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FCT Fundação para a Ciência e a Tecnologia

www.fireloc.org

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FIRELOC

WHERE'S THE FIRE?

Motivation

- **Severity**, **impact** and **frequency** of devastating **forest fires**
- Likelihood of aggravation due to climate changes

Develop tools to assist authorities in the **early identification and geolocation of ignitions** so that they can be tackled as fast as possible

The FireLoc project – Main aim

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WHERE'S THE FIRE?

Develop a system that enables citizens to provide georeferenced data allowing the **detection** and **geolocation** of spotted fires in real time

Observer's **geolocation**

Orientation towards the **FIRE**

Photograph

Orientation towards the **SHADOW**

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LOCATE THE FIRE

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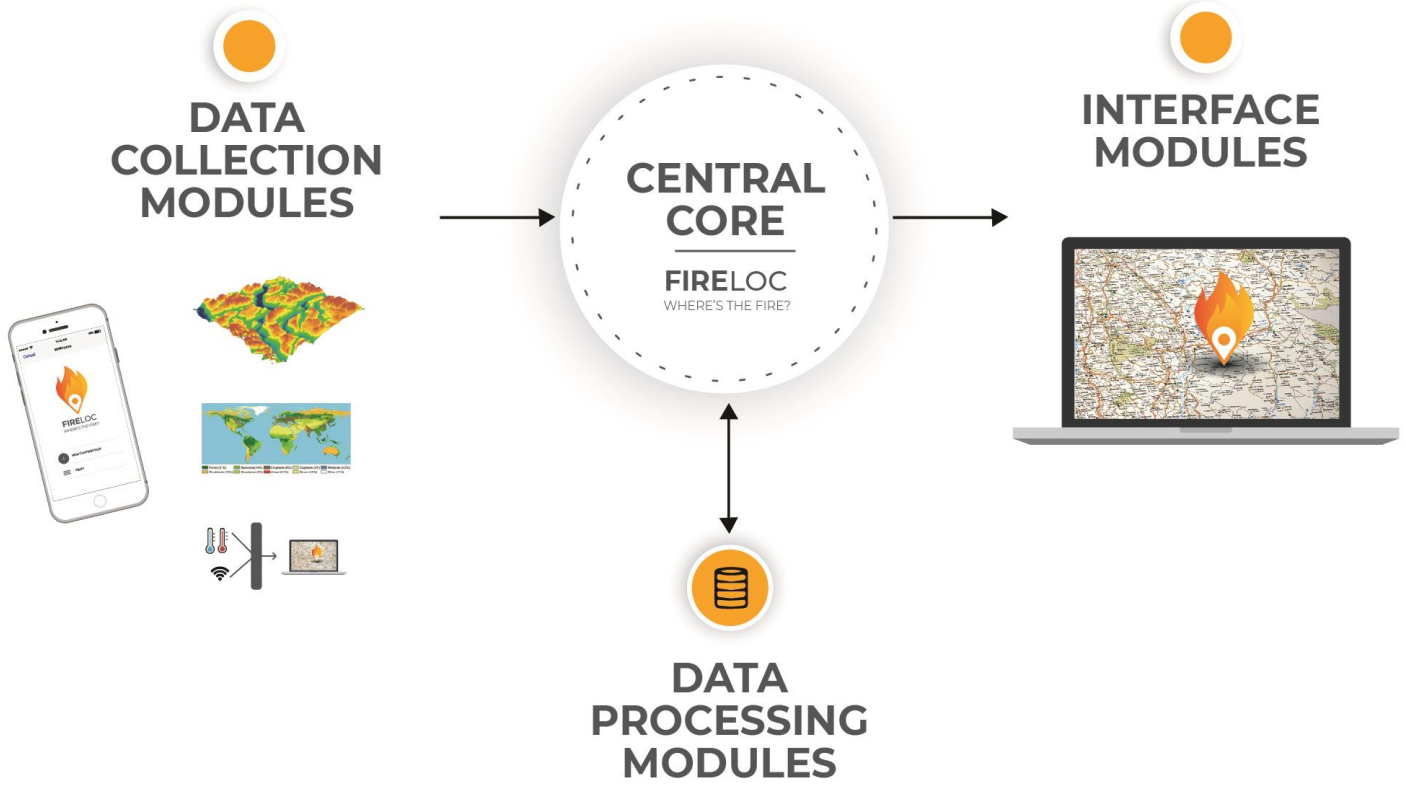
The FireLoc System



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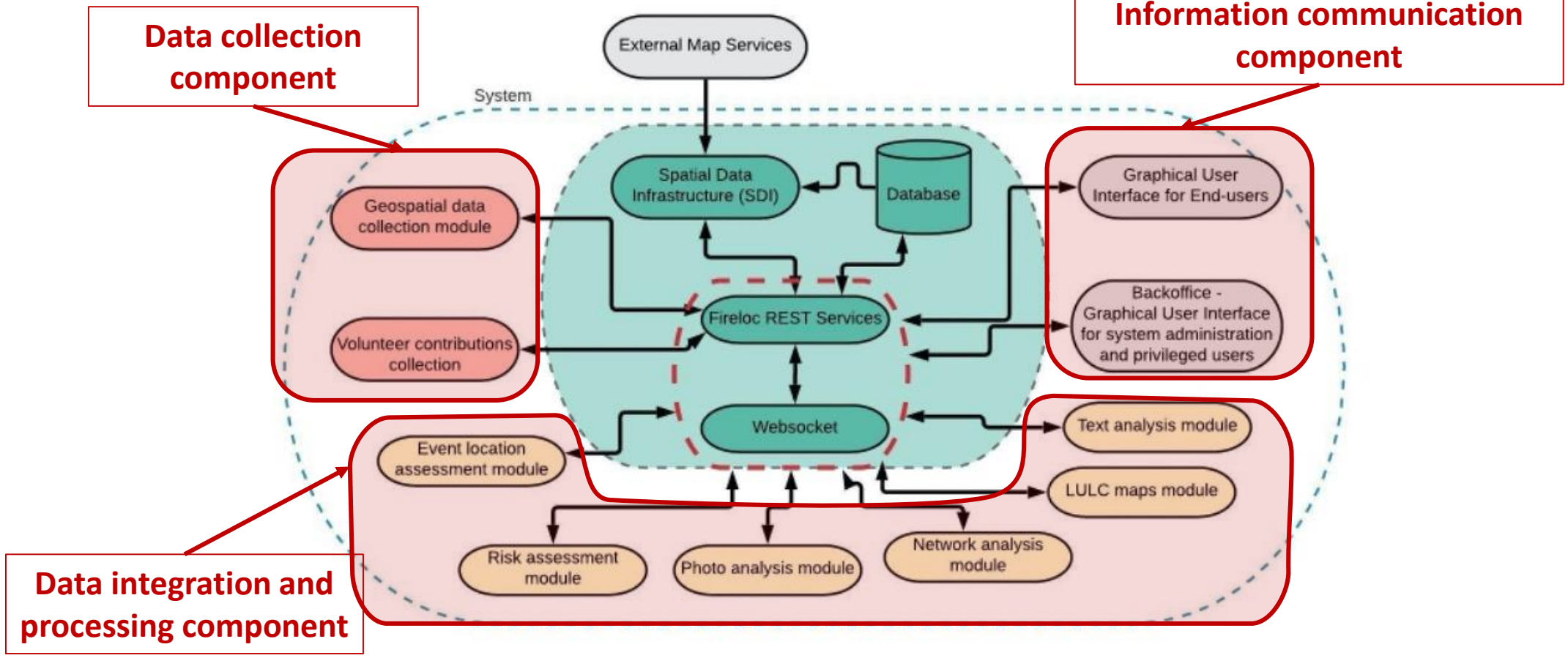
WHERE'S THE FIRE?

The FireLoc System



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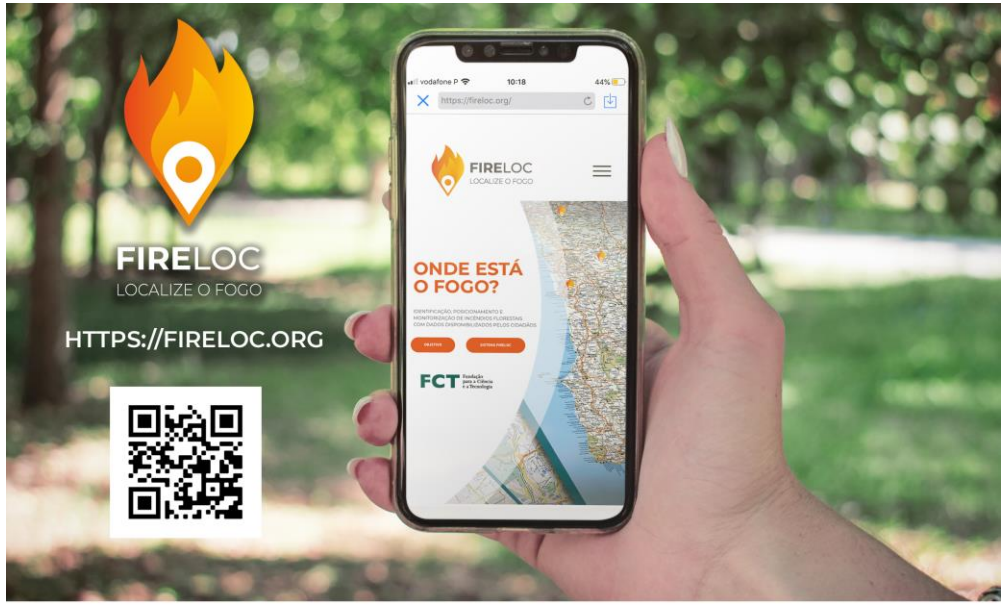
WHERE'S THE FIRE?

The FireLoc app

- Developed to collect the data contributed by the **citizens**
- So far it is only available in **Portuguese**



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WHERE'S THE FIRE?

The FireLoc app - Collected data

Data	Collection mode
Temporal data: Date and time (hour and minute) of the contribution	Mandatory / Automatic
The **geolocation of the observer**: The coordinates of the observation point obtained with the smartphone's Global Navigation Satellite System (GNSS) receiver imbedded in the device	Mandatory / Automatic
Orientation: The orientation of the smartphone is collected when the contributor is oriented towards the fire. It corresponds to the bearing relative to the magnetic North pole, extracted from the compass imbedded in the device	Mandatory / Automatic
Photograph: A photograph taken by the contributor of the observed event. This photograph will be used to validate if the contributor is in fact observing a fire or smoke with an automated approach and will enable the visualization of the spotted event within the system	Mandatory / Manual
The **orientation** (bearing) of the smartphone when the volunteer orients himself/herself towards his/her **shadow**.	Optional / Automatic
The **geolocation** of the observer after the volunteer moves **10 steps forwards of backwards** in the direction of the fire	Optional / Automatic
Distance: The approximate distance between the observer and the spotted fire	Optional / Manual
Short **text messages**	Optional / Manual

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WHERE'S THE FIRE?

The FireLoc app

- **Mandatory data**
  - **Date** and **time** of observation

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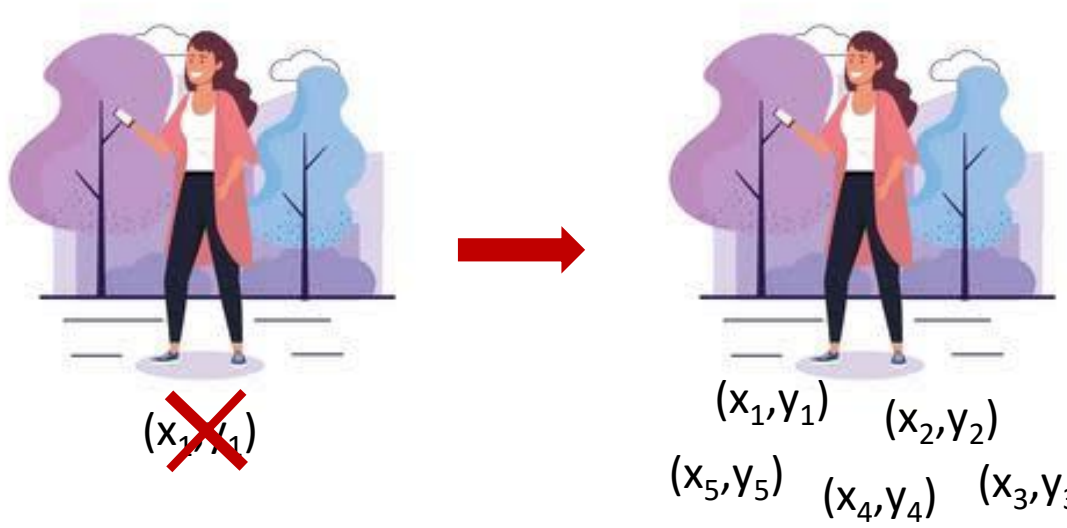
WHERE'S THE FIRE?

The FireLoc app

- **Mandatory data**

Observer's **geolocation** → **Errors** → **Measured continuously** – enables a statistical analysis



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WHERE'S THE FIRE?

The FireLoc app

- **Mandatory data**

Photograph

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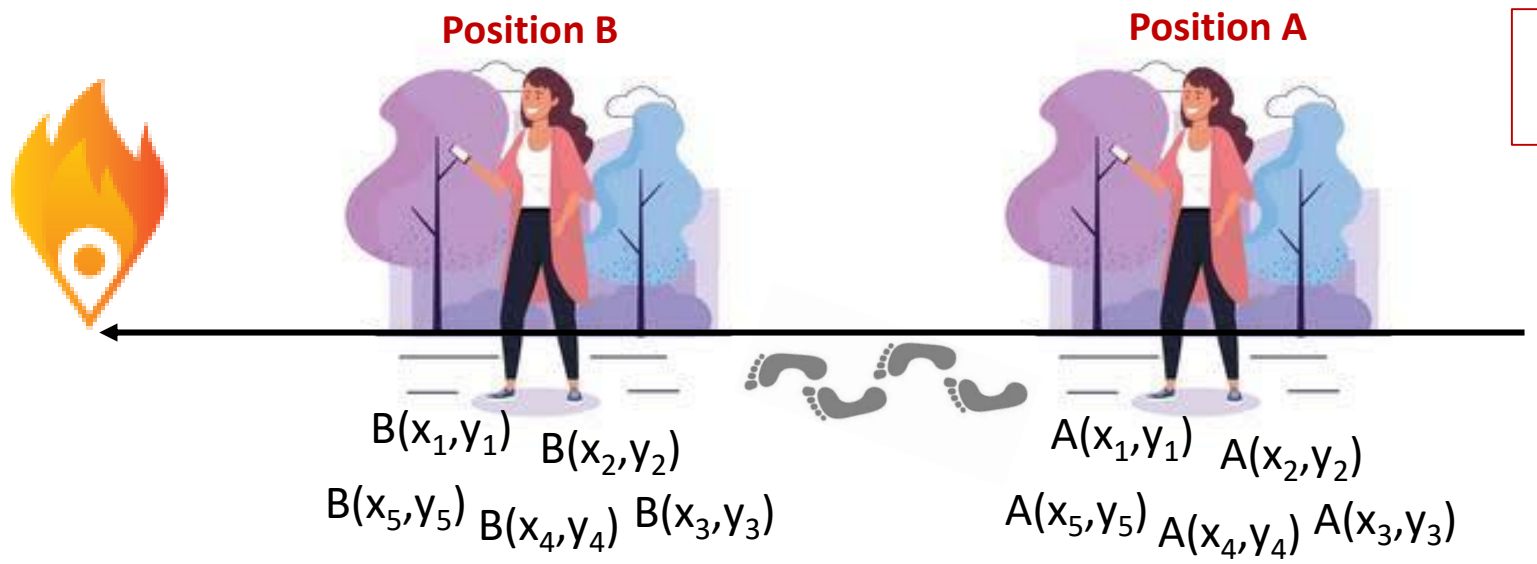
WHERE'S THE FIRE?

The FireLoc app

- **Additional optional data**

  Allow the volunteer to **collect data again a few steps forward or backwards**



Enables a statistical analysis

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WHERE'S THE FIRE?

The FireLoc app

- **Additional optional data**
  - The indication of the approximate **distance** to the fire;
  - A short **text message** with information the volunteer may consider useful.

Examples of text messages:

- The fire is close to houses
- Next to a gas station
- Close to a factory
- The fire is just starting
- I only see a smoke column
- The fire is very far away
- The fire is spreading very fast
- It is close to the river
- There are lots of parked cars

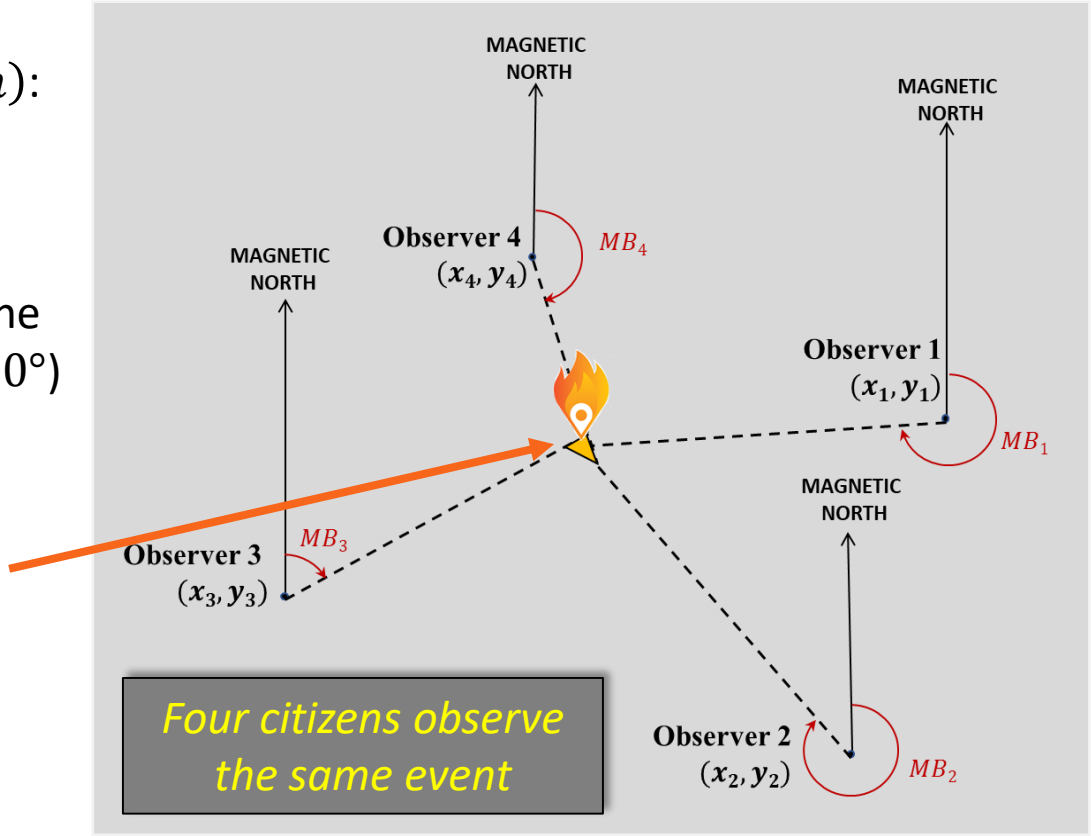
The FireLoc system – Main functionality

- Positioning with the **intersection** of at least **two contributions**

Measured quantities for each observer $(i = 1, \dots, n)$:

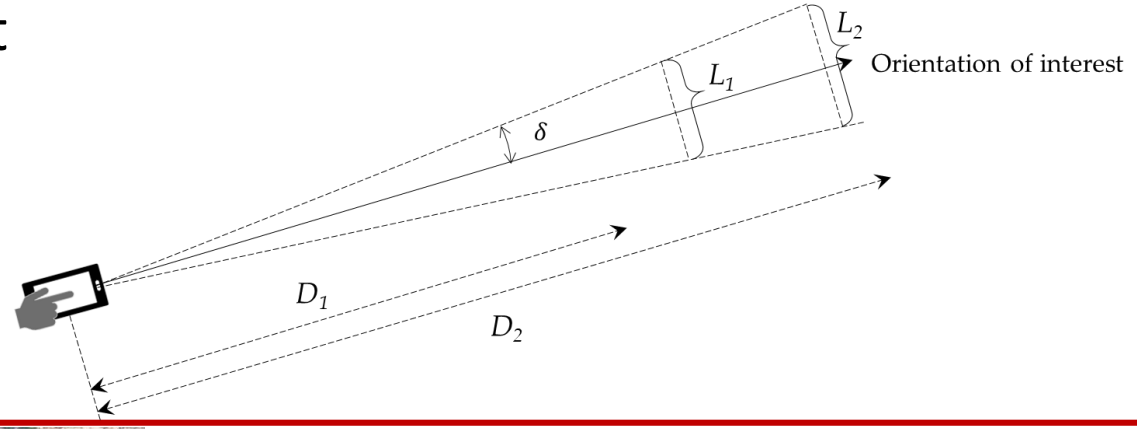
- **Geolocation**: (x_i, y_i)
- **Magnetic bearing** measured with the smartphone oriented towards the fire: MB_i $(0° < MB_i < 360°)$

The **fire** should be in the **convex area** containing the points obtained with all intersections (orange polygon)



The FireLoc system – Main functionality

- **Geolocation errors**
  - Smaller impact over the geolocation of the event as they propagate with the same order of magnitude
- **Errors** associated with the **orientation** measurement
  - May have large magnitudes (tens of degrees)
  - Their effect over the geolocation of the event increases with the distance to the event



The FireLoc system – Main functionality

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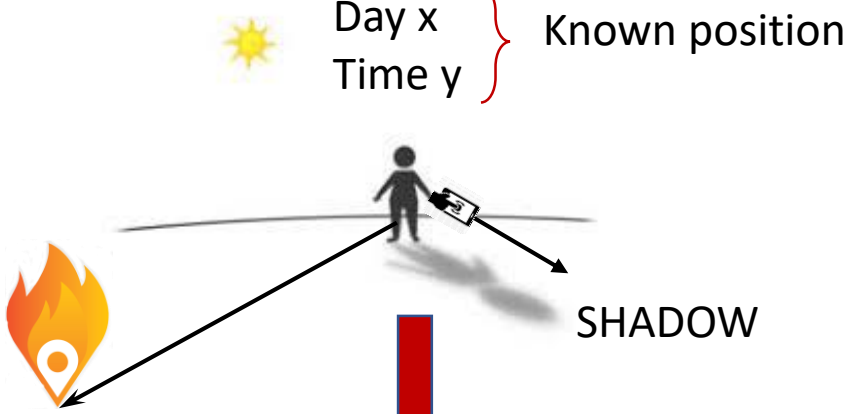
WHERE'S THE FIRE?

- **Mandatory data**

Orientation towards the **FIRE**

May have very large errors!



- **Optional data**

Orientation towards the **SHADOW**

Assess the magnitude of the orientation errors

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WHERE'S THE FIRE?

The FireLoc system – Main functionality

- Computation of:
  - The **estimated error ε** in the measured magnetic bearing
  - The **corrected magnetic bearing** towards the fire (MB_{Fire})

$$MB_{SHADOW} = AZ_{Sun} \mp \delta \mp 180°$$

$$\varepsilon = MB_{SHADOW} - MB_{SHADOW}^{MEASURED}$$

$$MB_{Fire} = MB_{FIRE}^{MEASURED} + \varepsilon$$

MB_{Fire} → Corrected magnetic bearing towards the fire

$MB_{FIRE}^{MEASURED}$ → MEASURED magnetic bearing towards the fire

MB_{SHADOW} → Shadow's KNOWN magnetic bearing

$MB_{SHADOW}^{MEASURED}$ → Shadow's MEASURED magnetic bearing

The FireLoc system – Main functionality

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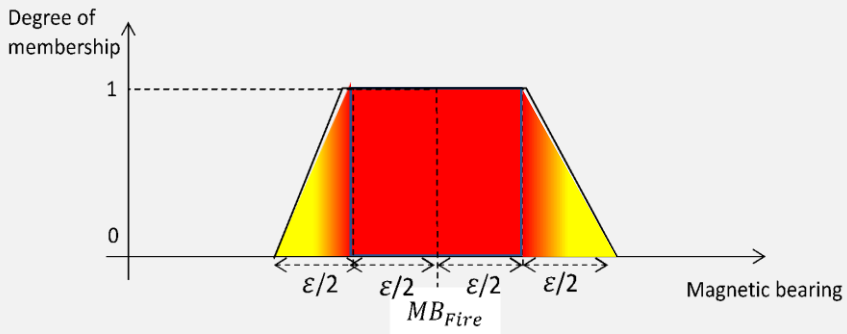
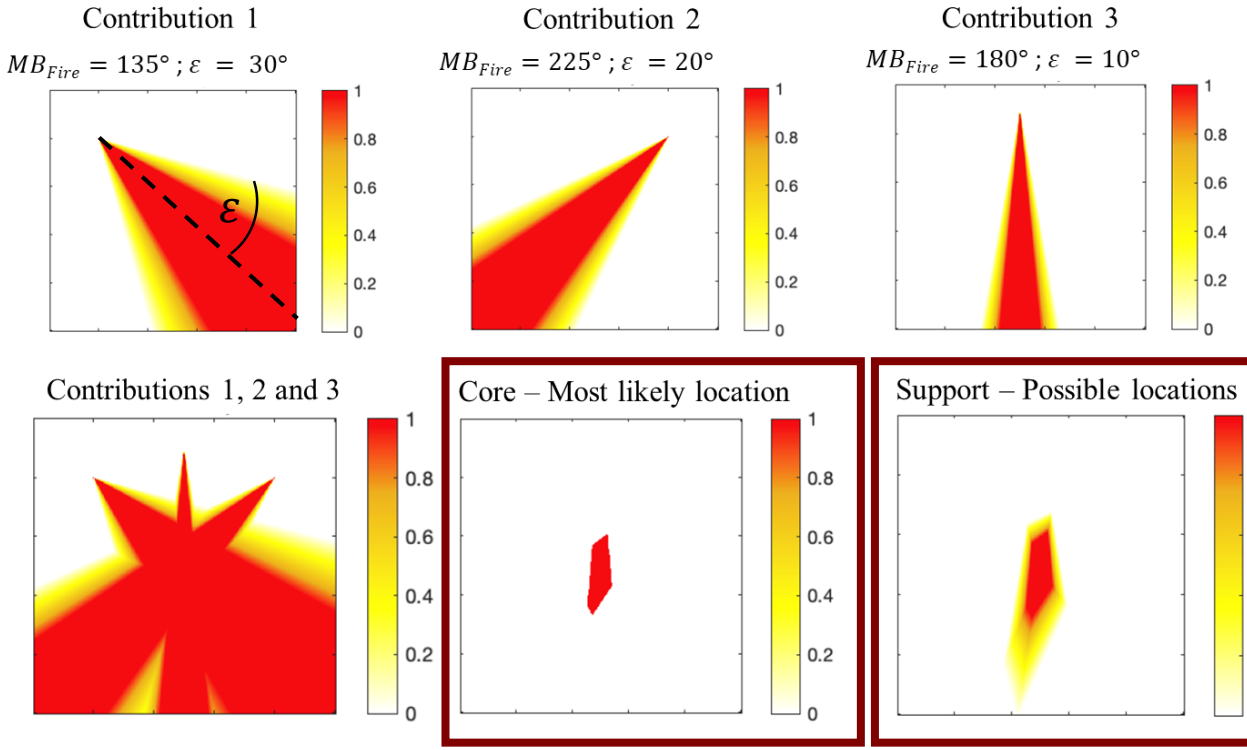
WHERE'S THE FIRE?

$$\varepsilon = MB_{SHADOW} - MB_{SHADOW}^{MEASURED}$$

Trapezoidal fuzzy sets perpendicular to the line of sight centered at MB_{Fire}



Fuzzy set { Support: 2ε ; Core: ε



Fire location!

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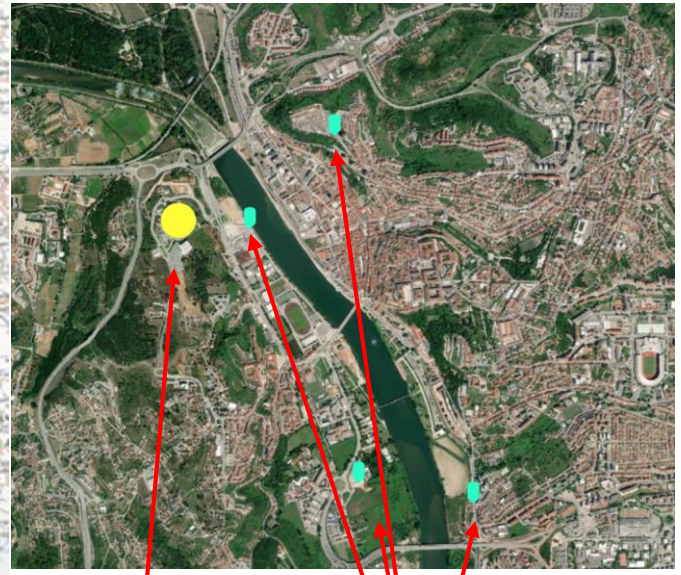
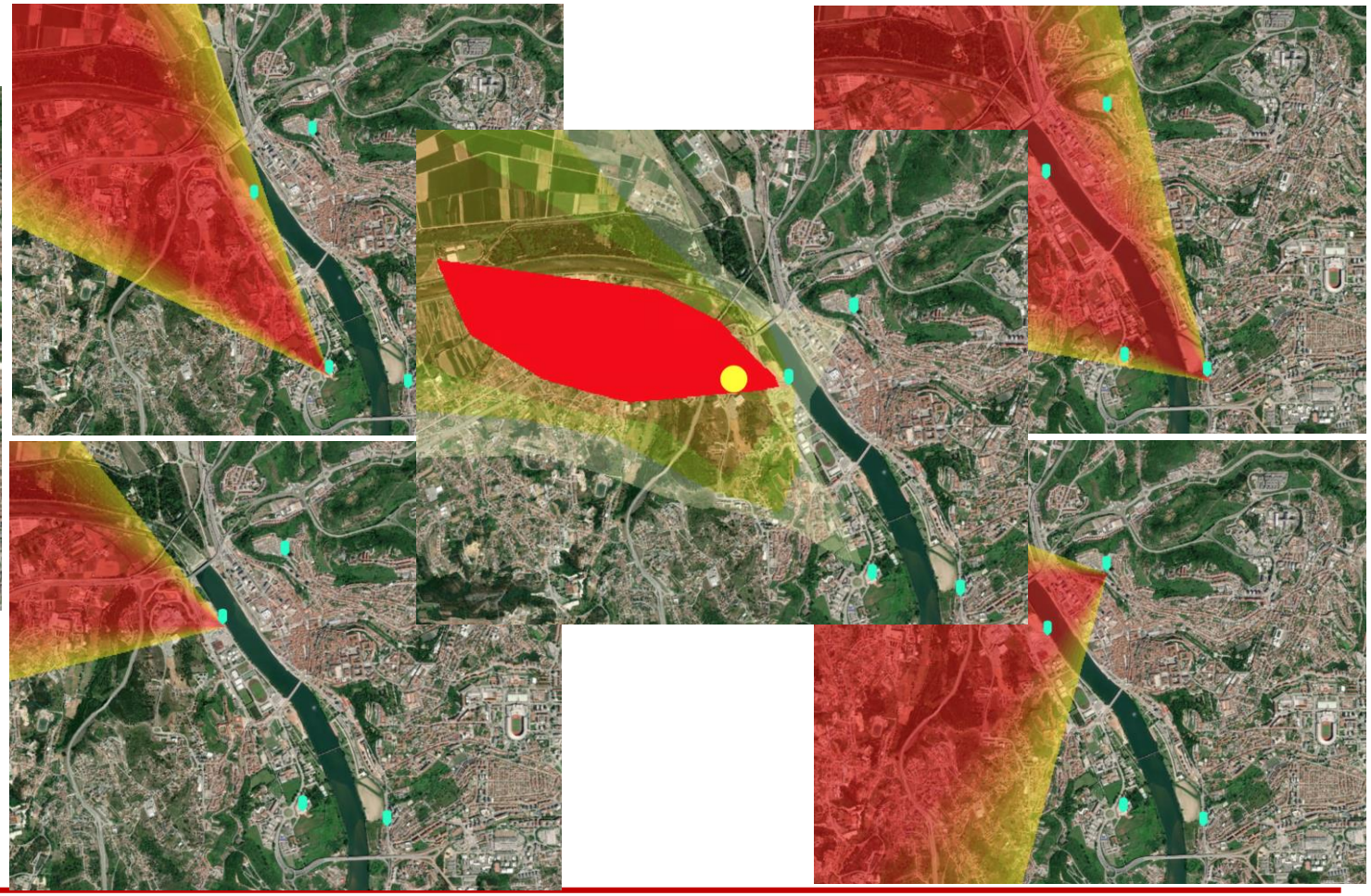
WHERE'S THE FIRE?

The FireLoc portal





Observed location

Observers

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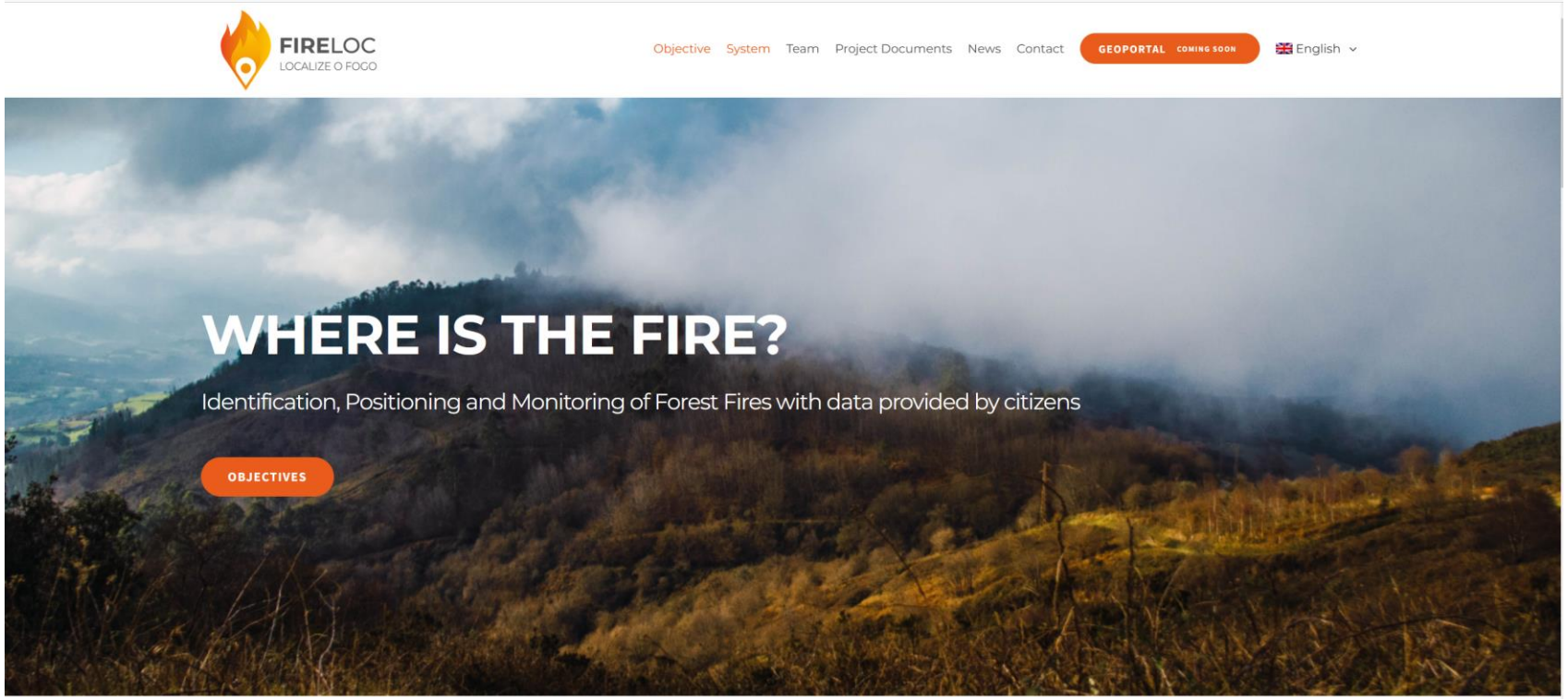

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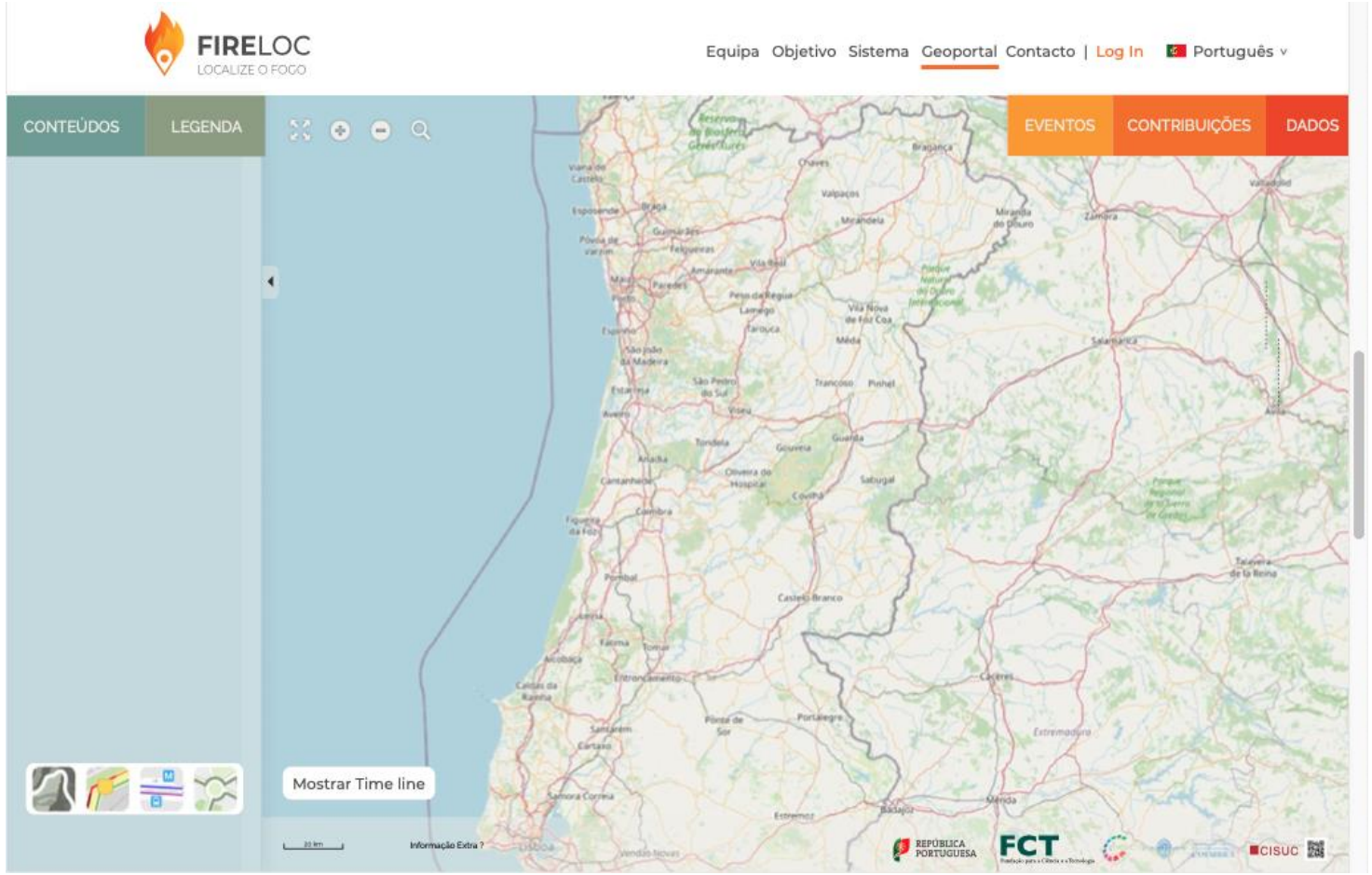

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The FireLoc portal – available data

- Citizen **contributions**
  - **Different** according to the **users profiles** (citizens in general, volunteers, authorities and administrators)
- The **events identified with the contributed data**
  - In **real time** (when the user has the required permissions)
  - **After the event** finished
- **Statistical analyses** and **graphs** about reported events and contributions;
- Several types of **geospatial data**:
  - Land-use/land-cover maps
  - Digital elevation models
  - Slope maps
  - Built-up areas
  - Maps of the burnt areas
  - …

The FireLoc system: Tecnologies used

Components	Technologies
Server	django, PostgreSQL, GeoServer
Client (app and web)	ANGULAR, Leaflet, ionic, NGRX
Data processing	GDAL, GRASS GIS, GeoPandas

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State of the project

- The interconnection of all modules is almost finished
- The app is developed for Android and in adaptation for iOS

- Main **constraint**
  - Difficulty in obtaining human resources with knowledge in the necessary technologies

Conclusions

- The FireLoc system will enable:
  - The collection of **geospatial data** provided by citizens that may assist in **fire detection** and **monitoring**
  - The uploaded **photographs** will enable the **early visualization of the event** by authorities
  - May provide **useful information**
    - Especially in cases where reported events are not spotted by observation towers or more complex systems, **but only** through a phone call to **emergency number 112** (where the geolocation of the event is only based on the **observer's oral description**).

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WHERE'S THE FIRE?

Conclusions

The automatic processing of all collected data will **provide additional information** that may be useful to:

- Monitor events in real time
- Analyse past events

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Thank you!

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