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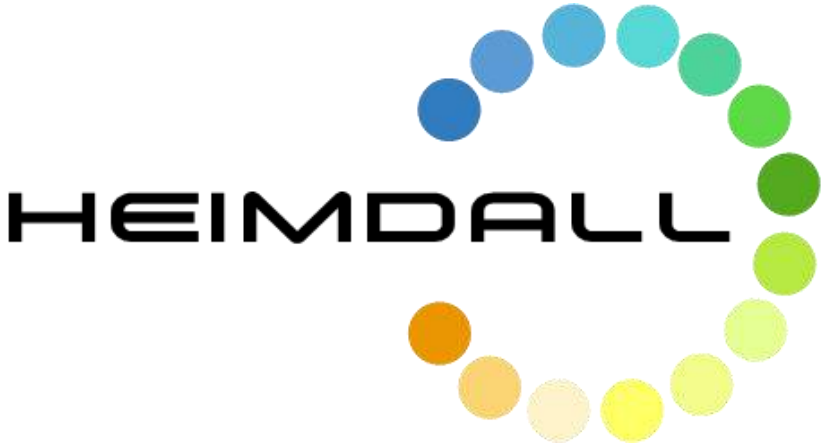


Introducing the HEIMDALL Project and Solutions

Monika Friedemann (German Aerospace Center, DLR)

4th September, I4CM, Warsaw, Poland

Multi-Hazard Cooperative Management Tool for Data Exchange, Response Planning and Scenario Building

H2020 Security Project
Research & Innovation (RIA)

05/2017 – 10/2020

14 EU Partners
incl. 5 End User Partners

Project Lead

http://heimdall-h2020.eu/

R&D

Collaborative Design

END USERS

Medical Emergency Units

Croce Rossa Italiana

Civil Protection

FREDERIKSBORG BRAND & REDNING

Police & Firefighting Units

Generalitat de Catalunya
Departament d'Interior

Command and Control Centers

SCOTTISH FIRE AND RESCUE SERVICE

ELSI

EBERHARD KARLS UNIVERSITÄT TÜBINGEN ELSI Experts

Collaborative

Development and Management of

complex, cross-jurisdiction/-country

Disaster Scenarios,

Data Exchange and Response Planning

Decision Making

Command and Control Centers

First responders in the field

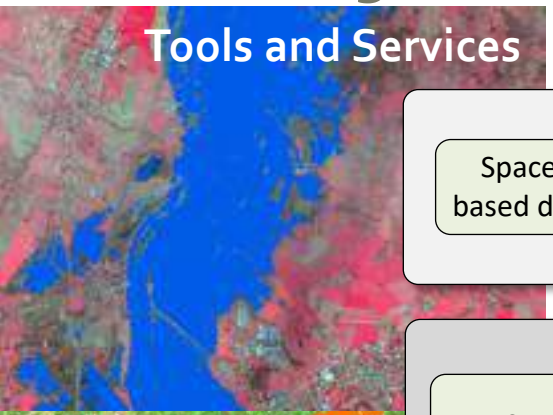
Population and Society

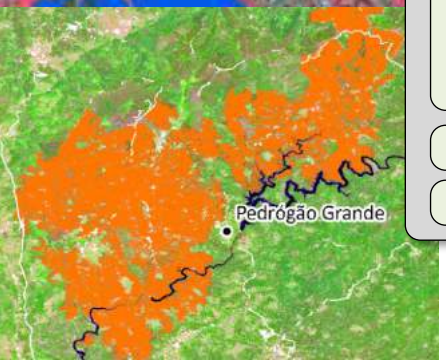
HEIMDALL

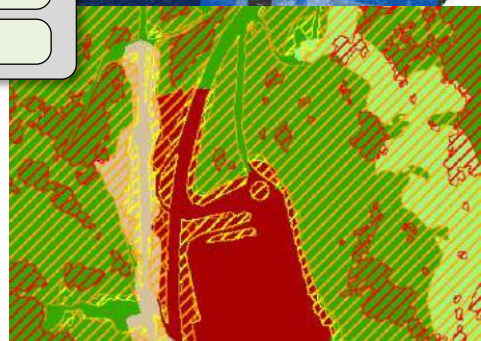
Multi-hazard Co… …ool for Data Exchange, Response Planning and Scenario Building

Solutions for Multi-Hazard Scenario Building, Response Planning and Information Exchange

Tools and Services







Data Sources

- Space-based data
- Ground-based data
- Aerial sensors

External Systems

- Data Sources
- Services

Integrated Service Platform (Local Unit)

- Scenario Management
- Modelling and Simulation
- Risk and vulnerability assessment
- Situation Assessment and DSS
- Data Sharing and Communication
- Graphical User Interfaces

Control Centre

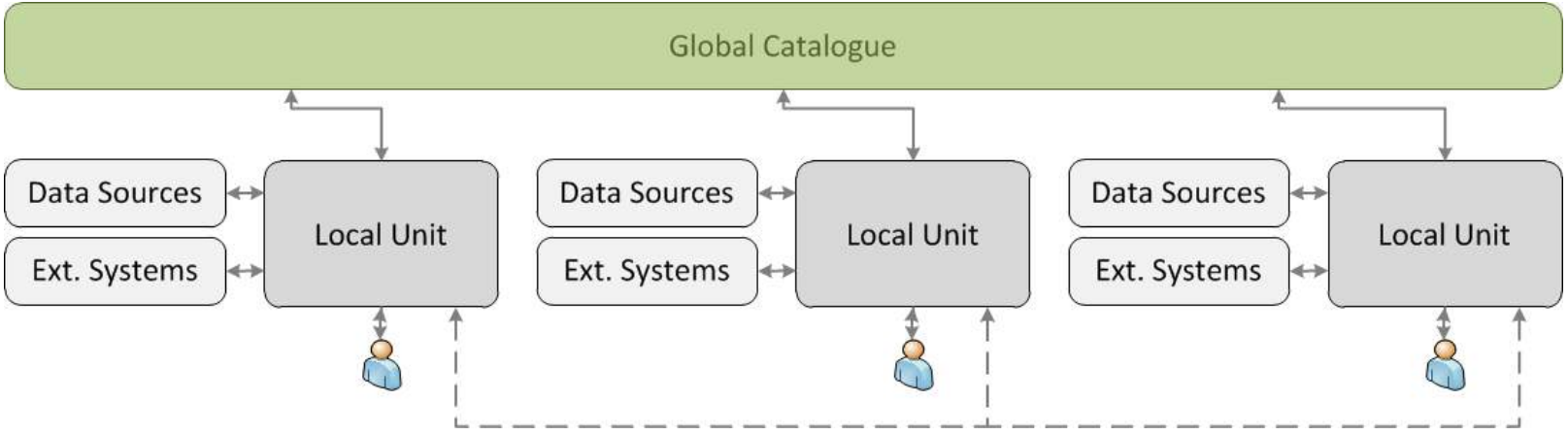
First responders on the field

Population

HEIMDALL

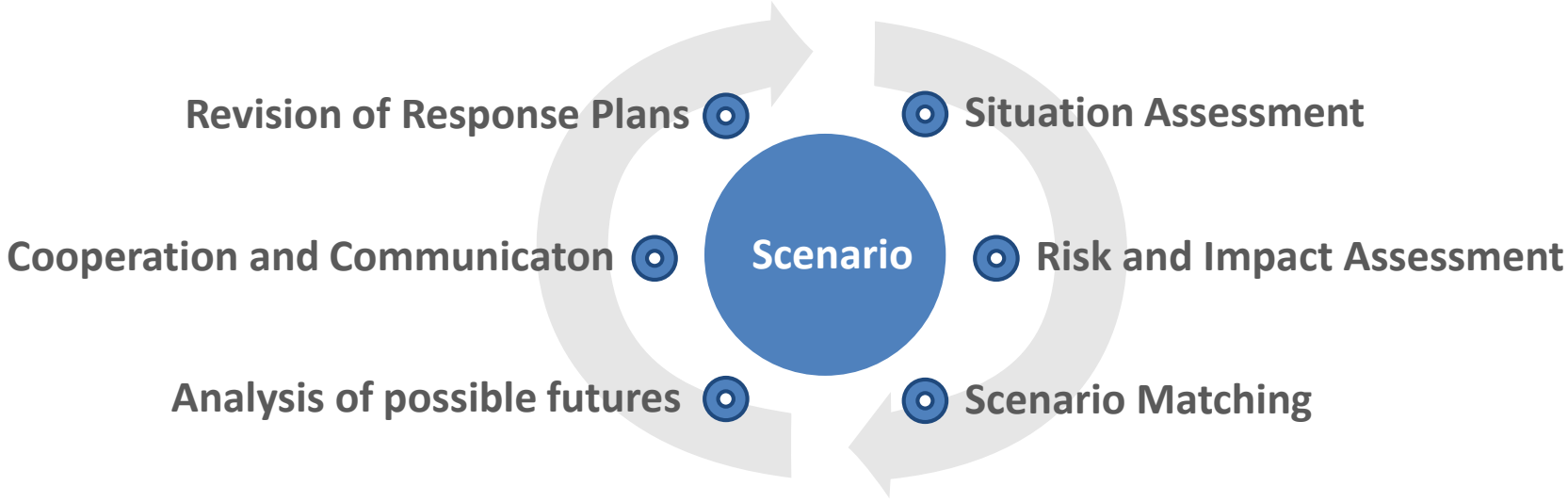
Solutions for Multi-Hazard Scenario Building, Response Planning and Information Exchange

Inter-Agency Communication between HEIMDALL Units



Supporting Management of Multi-disciplinary Disaster Scenarios

- **Scenario-based cooperative response planning activities** (immediate & long-term)*:



*Friedemann, M., Barth, B., Vendrell, J., Muehlbauer, M., Riedlinger, T.: **Conceptual scenario model for collaborative disaster response planning** (to be shortly published in proceedings of EnviroInfo 2018)

Towards Standardisation

- We align the system processes to the **decision making process**, directives and best-practices used by the end user organizations
- We build a **glossary** and **data models** around established standards and taxonomies (e.g. EXDL-CAP Event Terms List, Sendai Framework, ISO 31000 and other DRR terminologies, ICS)
- We use **OGC** and **INSPIRE** standards for geospatial information
- We implement standardized **Web services** and **REST APIs**
- We use **standard message formats** for the exchange of situation reports and response plans (e.g. EDXL-SitRep)
- We implement a **data and service catalogue** for data and service discovery and interconnection of HEIMDALL units

Desired Degree of Decision Support

- **Ethical, legal and social issues** (ELSI): discussions between the project lead, the ELSI research partners and the end-users regarding the appropriate and desired degree of decision support by technology in HEIMDALL, e.g.:
  - The system does not propose decisions or routes of actions. Instead, decision support is provided in the form of **relevant goal-oriented information which users can base their decisions on**
  - Users always have the possibility to add and modify information according to their individual knowledge, and their individual and organizational needs and goals
  - Criteria and thresholds are configurable for users according to their individual knowledge, and their individual and organizational needs and goals

Workshop Scope

- **Decision making in uncertain, complex wildfire situations**
- Held by Catalan Fire and Rescue Service

Generalitat de Catalunya
Departament d'Interior

- Objectives:
  - Discuss **factors** and **values** to be considered in decision making
  - Identify (further) **gaps**
  - Consider HEIMDALL tools and services

Generalitat de Catalunya

bombers

Polygons methodology exercice

Polygons decision-making methodology

- Campbell prediction system > how wildfire spreads through surface
- Fire types > how they can spread through landscape
- Suppression capacity limitations

Polygons decision-making methodology

Objective: build a certain and safety emergency scenario to know where and how wildfire will burn

Incident Commander needs to decide:

- what the wildfire want to burn? > Campbell Prediction System (CPS), Fire Types description and historical fire analysis

- what the wildfire can burn (today)? > weather current conditions, real fire behaviour, fuel availability

- what would I do? > strategic decisions, common values

- what can I do? > tactical organization, suppression capacity limitations

Campbell Prediction System (CPS)

Principles:

- **INFORMATION** only the one that will change something
- Communication using **LOGIC**
- **LANGUAGE** in order to explain potential.
- **PREDICTIONS** of change
- **TACTICS**

Campbell Prediction System (CPS)

Information:

- Wind, slope and pre-heating are main causes on changes in fire behavior.
- Fire types: Wind or slope are, usually, dominant forces in topographic fires. Changes in wind with topography dominates wind driven fires

Logic:

- Changes in this forces causes changes in fire intensity
- Interaction with the own fire burning causes changes on different scales

Campbell Prediction System (CPS)

Language: Alignment of factors:

- A FORCE in or out of alignment causes changes in intensity

  0 / 3 out of alignment
  1 / 3 small alignment
  2 / 3 medium alignment
  3 / 3 full alignment

Predictions

- When the change is from fewer to more forces are aligned, fire is getting worse
  When the change is from more to less forces aligned, fire is getting better

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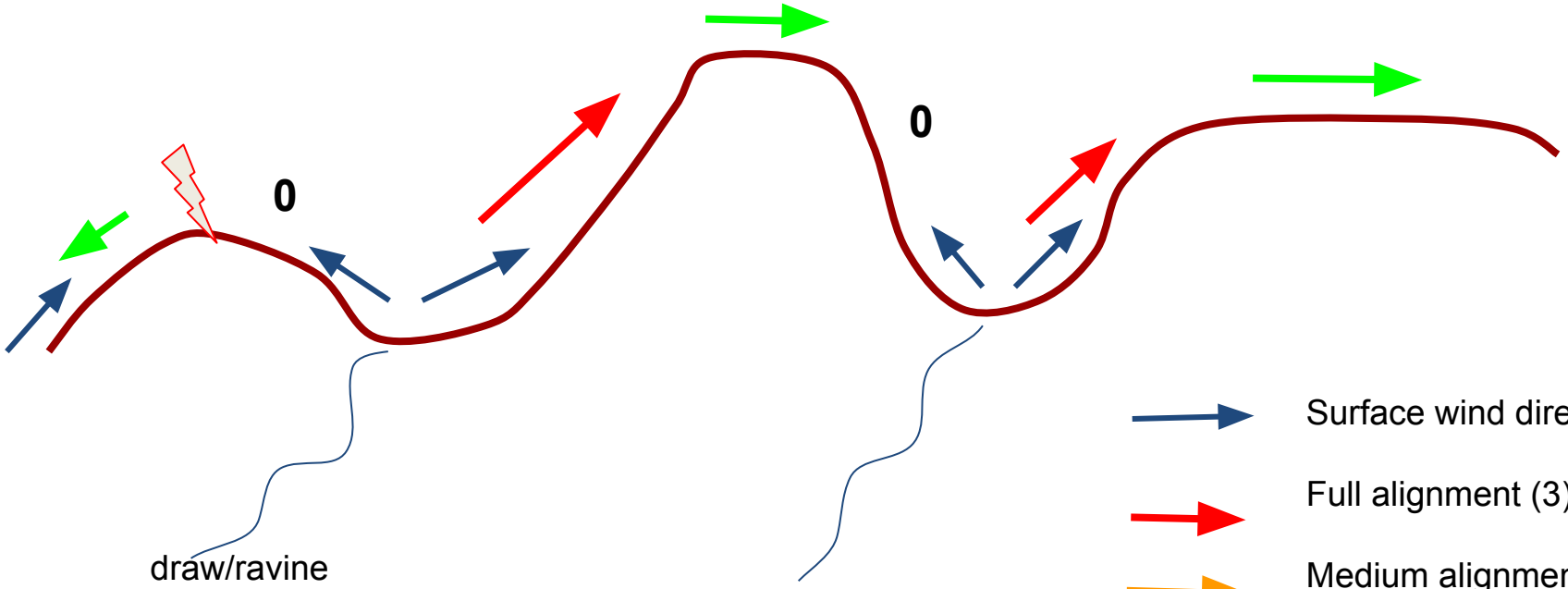
Campbell Prediction System (CPS)

Topographical fire type

- Slope
- Wind
- Pre-heating fuels (aspect)



Surface wind direction

Full alignment (3)

Medium alignment (2)

Small alignment (1)

0 Out of alignment (0)

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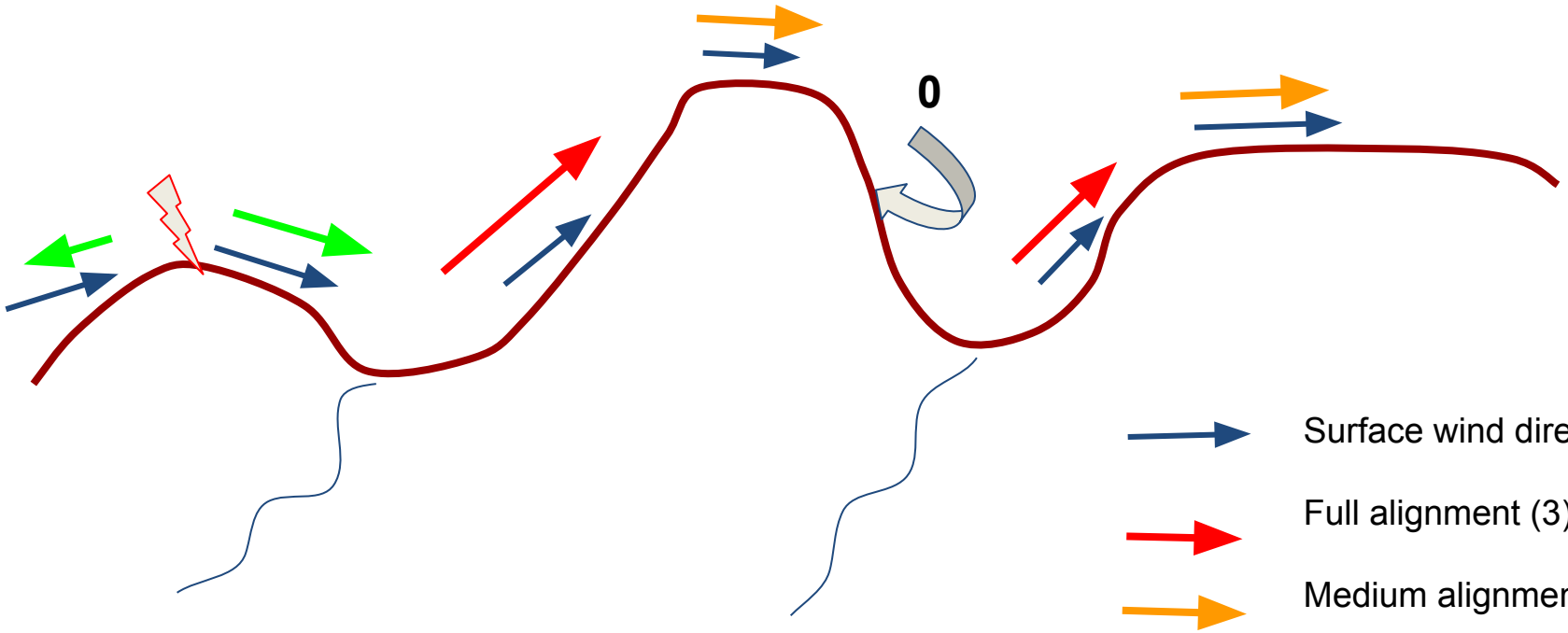
Campbell Prediction System (CPS)

Wind-driven fire type

- Slope
- Wind
- Pre-heating fuels (aspect)



Surface wind direction

Full alignment (3)

Medium alignment (2)

Small alignment (1)

0 Out of alignment (0)

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Campbell Prediction System (CPS)

Tactics

- How to attack the situation?

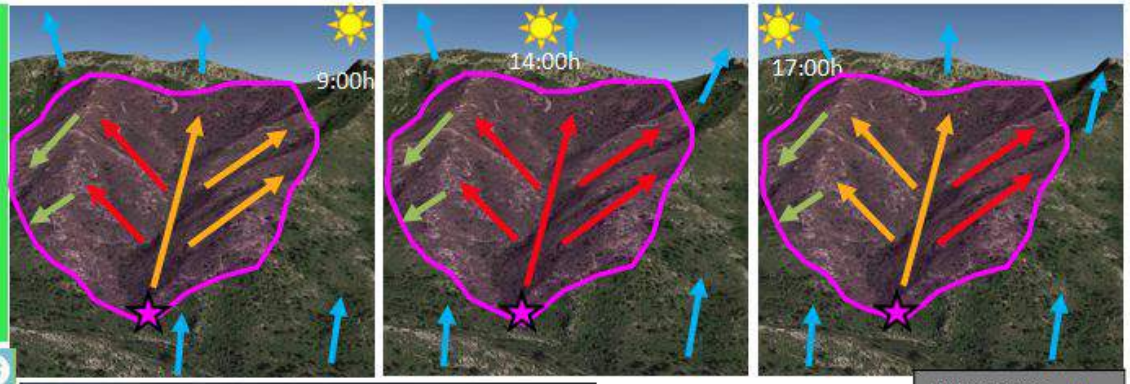
  Is this tactic safe and effective?

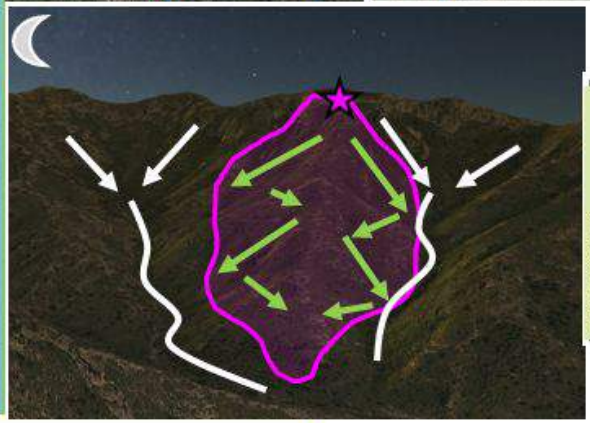
  Do we apply the professional ethic?

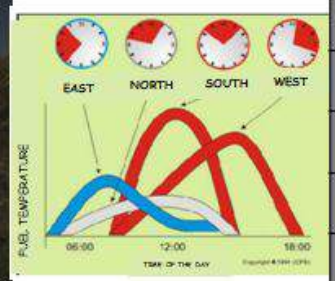
  Can we explain Why this will work?

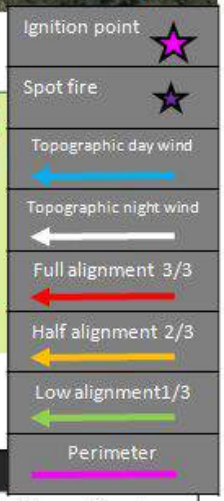
Fire Types description

TOPOGRAPHIC STANDARD







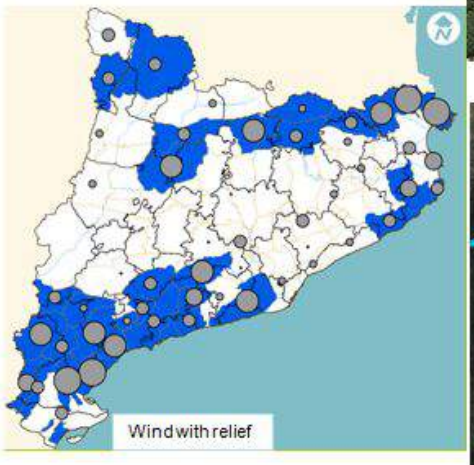


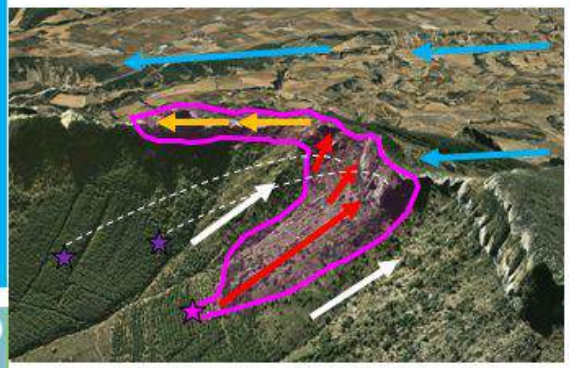
	Day				Nigth							
Fire Behavior	Follow maximu slope and insolate slopes helped by topographic winds				Follow descendent slopes. Can advance over descendent ridges driven by topographic night winds. It's said That fire goes down climbing.							
Critical Points	Ravines, ravine nodes				Saddle							
Opportunities	descendent slopes and/or without insolation				Fire going down							
Time of Maximum intensity	**14:00 h**		**20:00 h**		**1:00 h**			**5:00 h**				
Time of the year	**Gen**	**Feb**	**Mar**	**Apr**	**Mai**	**Jun**	**Jul**	**Aug**	**Set**	**Oct**	**Nov**	**Dec**

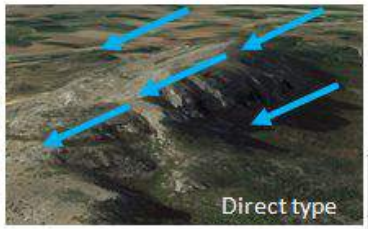
Watch out for the position of the fire on the topography | **Day night dynamics of topographic winds**

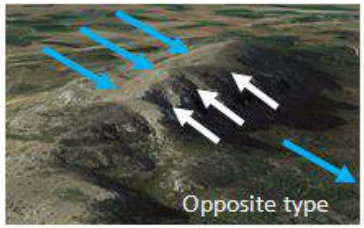
Fire Types description

WIND WITH RELIEF









	Day	Night
Fire Behavior	Follow the crest axes. The more parallel is the ridge to the wind the more direct fire runs. The more perpendicular is the ridge to the wind the more leewind fire runs. At Indirect type there is a flank that goes opening.	
Critical Points	Parallel ridges to wind, ridges knots, saddles, exits from leewind areas to direct wind areas.	
Opportunities	Ends of ridges, leewind areas	
Time of Maximum Intensity	**While wind conditions don't change**	

Time of the year	Gen	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Set	Oct	Nov	Dec
Watch out for ridge knots, saddles, limit areas wind-leewind and began, end and changing direction of ridges										Take in the cone		

Suppression capacity limitation

Fire spread speed higher than fire supression (0,5-2 km/h)

Fire intensity (flame lenght) > 3-6 m

Fire spread by points rather than continuously

Crown fire

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Exercice

Wildfire incident

Wildfire paths through landscape

Agreement in values/Goods

Availability of resources

Priorities and incident action plan

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Exercice

Availability of resources

1st time

2nd time

3rd time

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www.gencat.cat

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Previous introduction

Emergency management: interagency coordination

Who commands the incident?

Fire and Rescue Service

- Structurural Fires
- Vegetation Fires
- Search and Rescue
- Other incidents: traffic accidents, gas leak, electrical fires,...

Police Department

- Criminal acts
- Terrorism

Medical Emergency System

- Medical Emergency

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Previous introduction

Wildfire incident management: interagency coordination

Wildfire IC

Operations	Security	Medical	Logistics
			
•Fire and Rescue Dept •Forest Defense Associations •Forest guards	•Police Dept. •Local Police •Forest guards	•Medical Emergency System •Red Cross	•Civil Defense •Municipalities •Companies
			

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Decision-making process in wildfire incidents

Fire suppression paradox

95% of wildfires burn less than 1ha, but
5% of wildfires burn over 90% of surface

Decision-making process weakness

80% incidents are responded by **maneuver** concept
15% incidents are solved by **tactical** decisions
5% incidents are managed from **strategic** point of view

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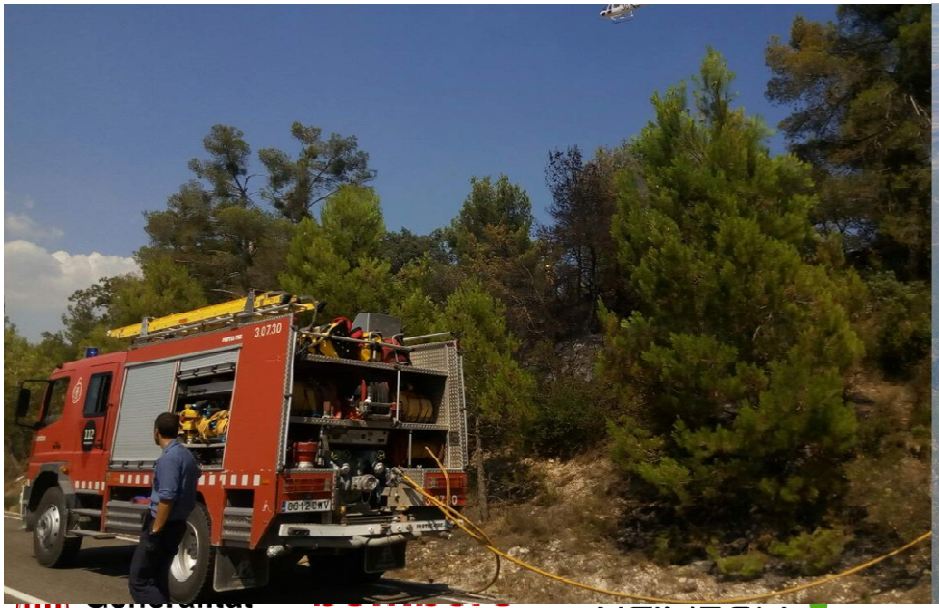
Decision-making process in wildfire incidents

Maneuver actions - 1st operation (what): reaction and more resources

Tactic decisions - opportunity (when, where and how): analysis and anticipation

Strategic plan - emergency scenario (why, what I want / don't want): safety and certainty



Emergency organization main commitment

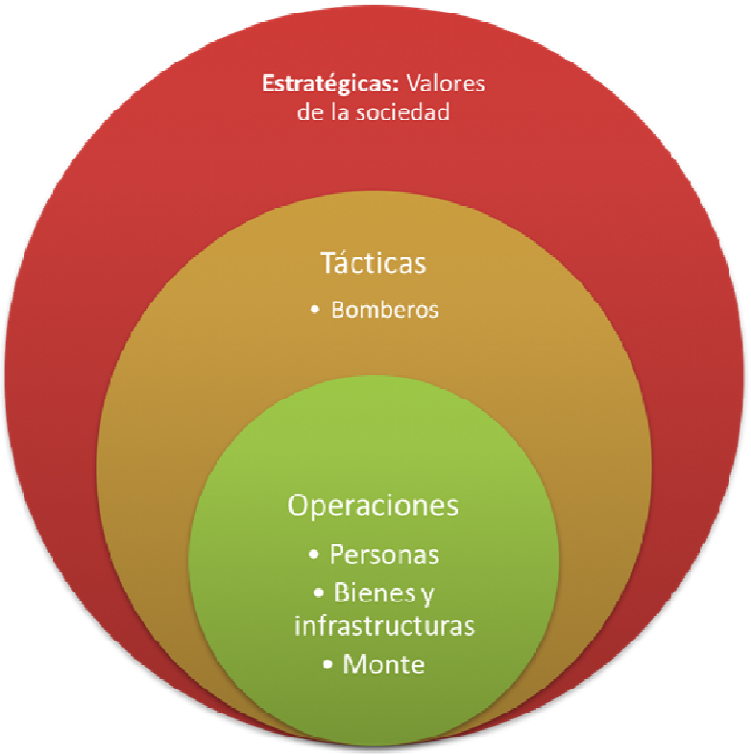
don't collapse, neither for simultaneously incidents nor complex scenarios

Constraints:

- priorities of the goods at risk
- unknown emergency scenario

Emergency organization main commitment

From the property and persons culture to the common goods culture



People

Property

Forest

Fire Service

Collapse

Common Goods

Maneuvers - single operations

Tactical decisions

Strategical decisions

Emergency organization main commitment

Building a known (certain) and safety emergency scenario: wildfire paths and polygons of potential decision-making methodology

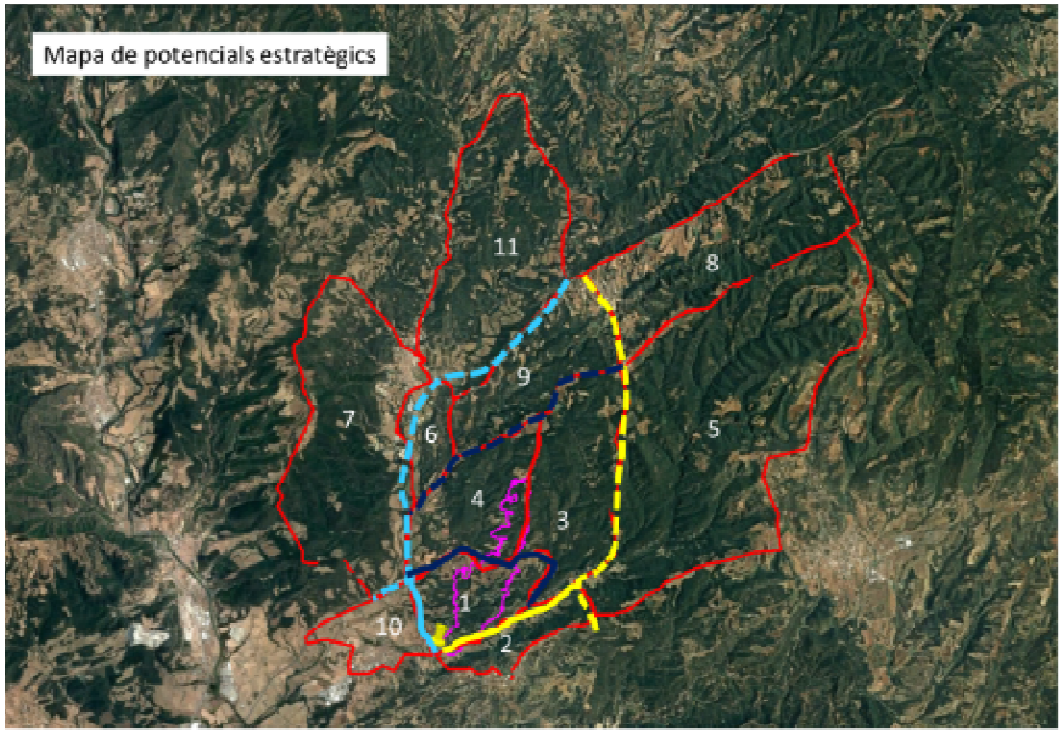
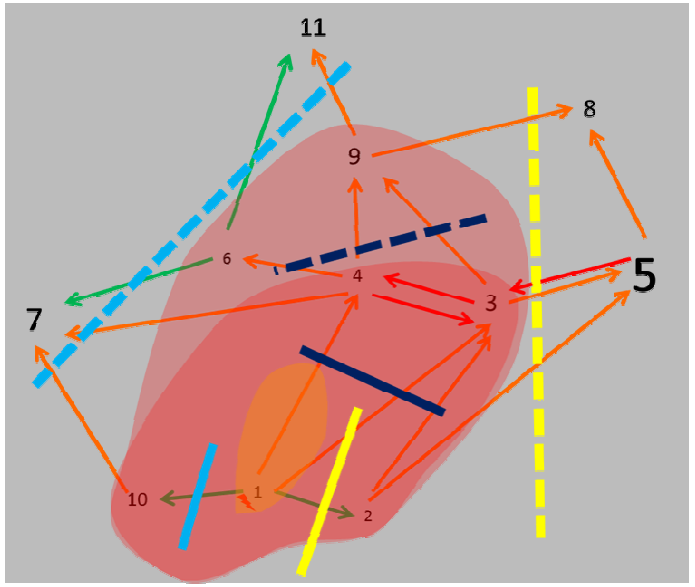


Figura 1. Polígons potencials, perímetre final i eixos de confinament primaris i secundaris

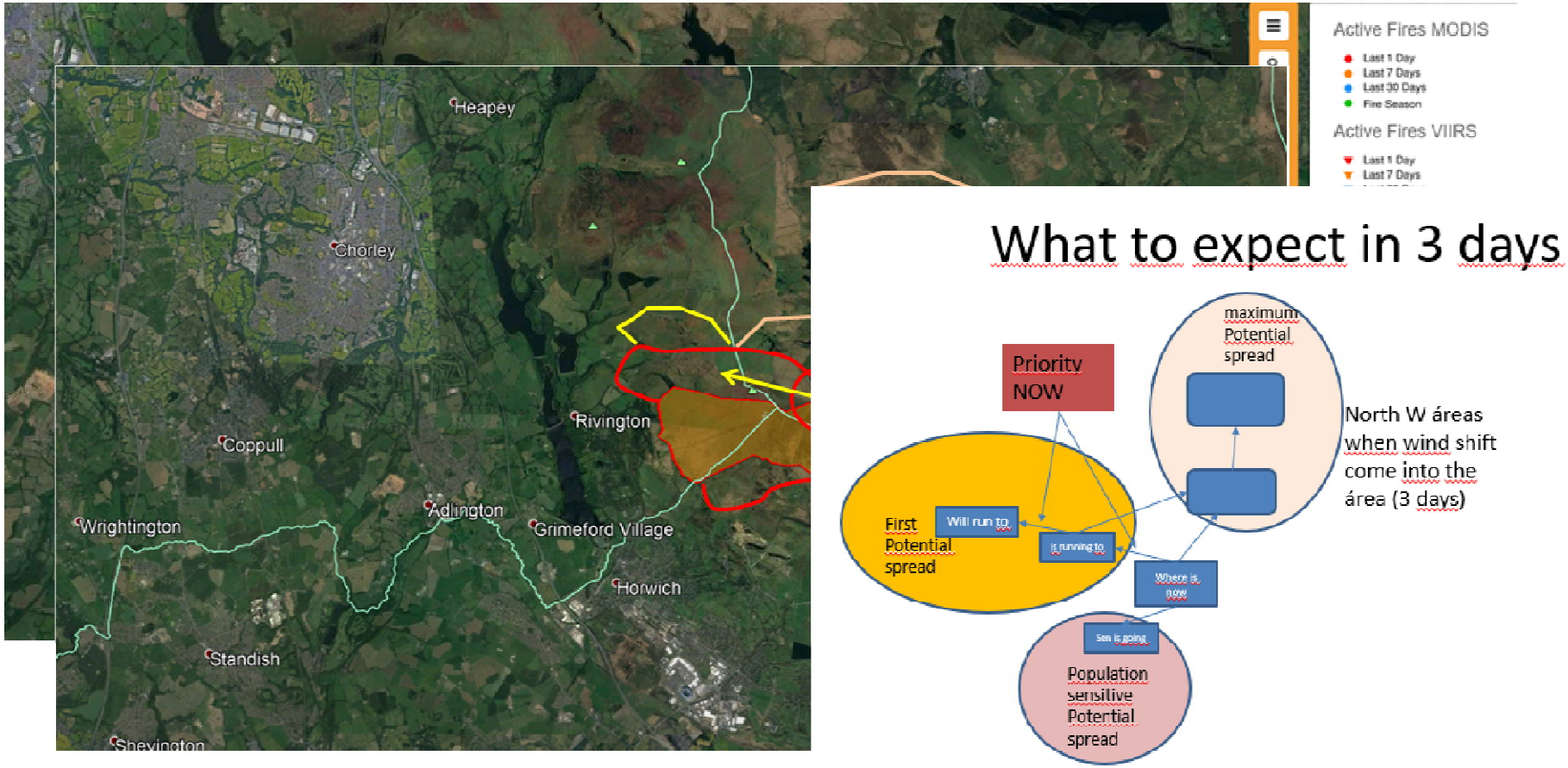
Eix contenció primari FD
Eix contenció primari FE
Eix contenció primari Cap
Eix contenció secundari FD
Eix contenció secundari FE
Eix contenció secundari Cap

Artés fire 2017



Emergency organization main commitment

Manchester Fire 2018



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Emergency organization main commitment

Silent Valley Reservoir (Northern Ireland)

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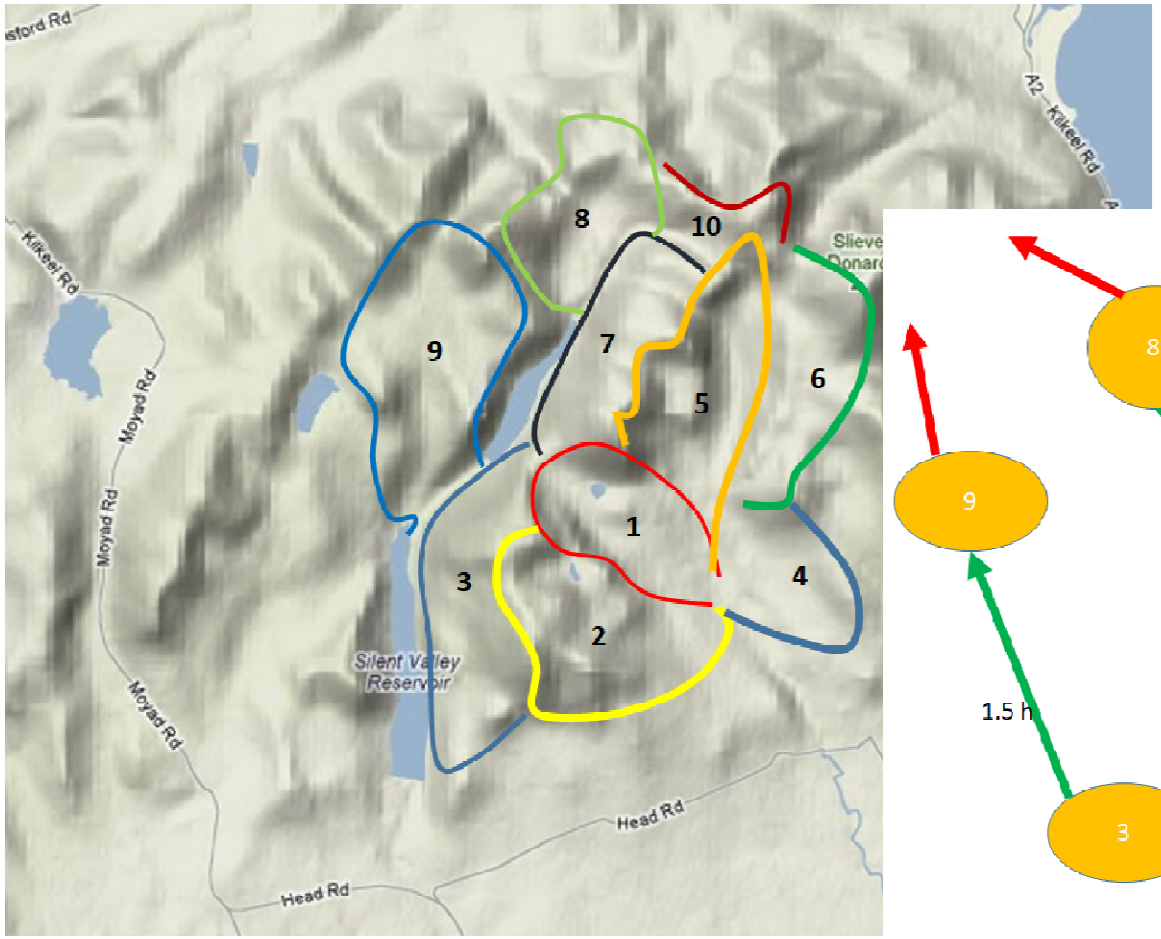
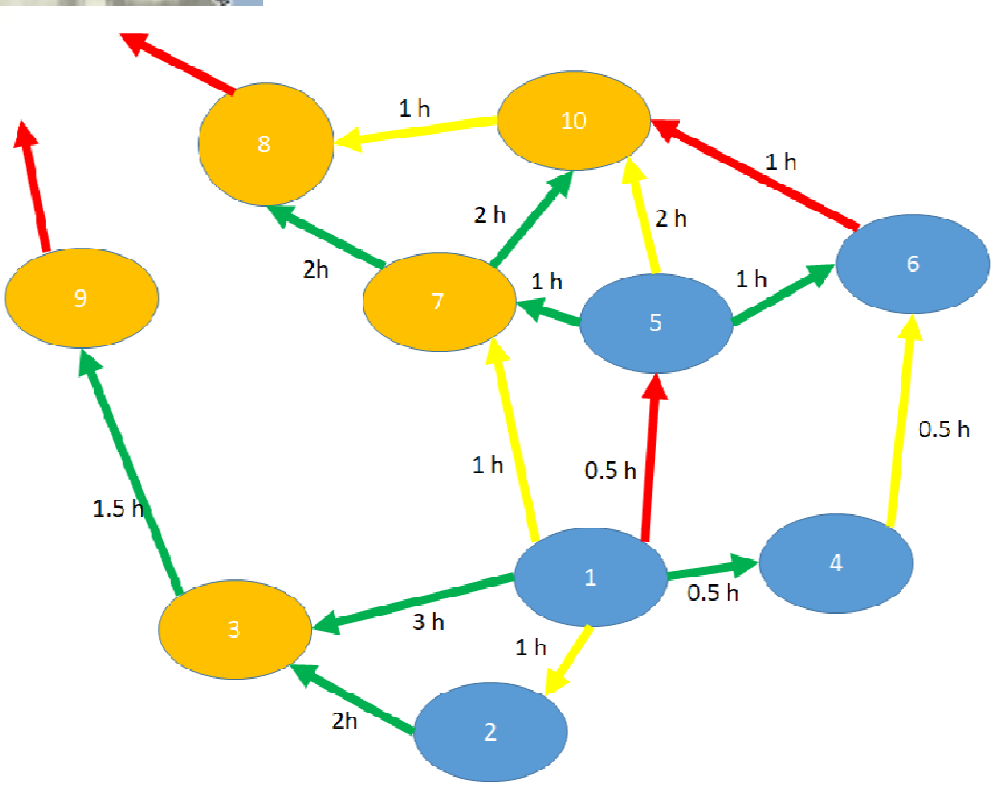
Emergency organization main commitment

Silent Valley Reservoir (Northern Ireland)





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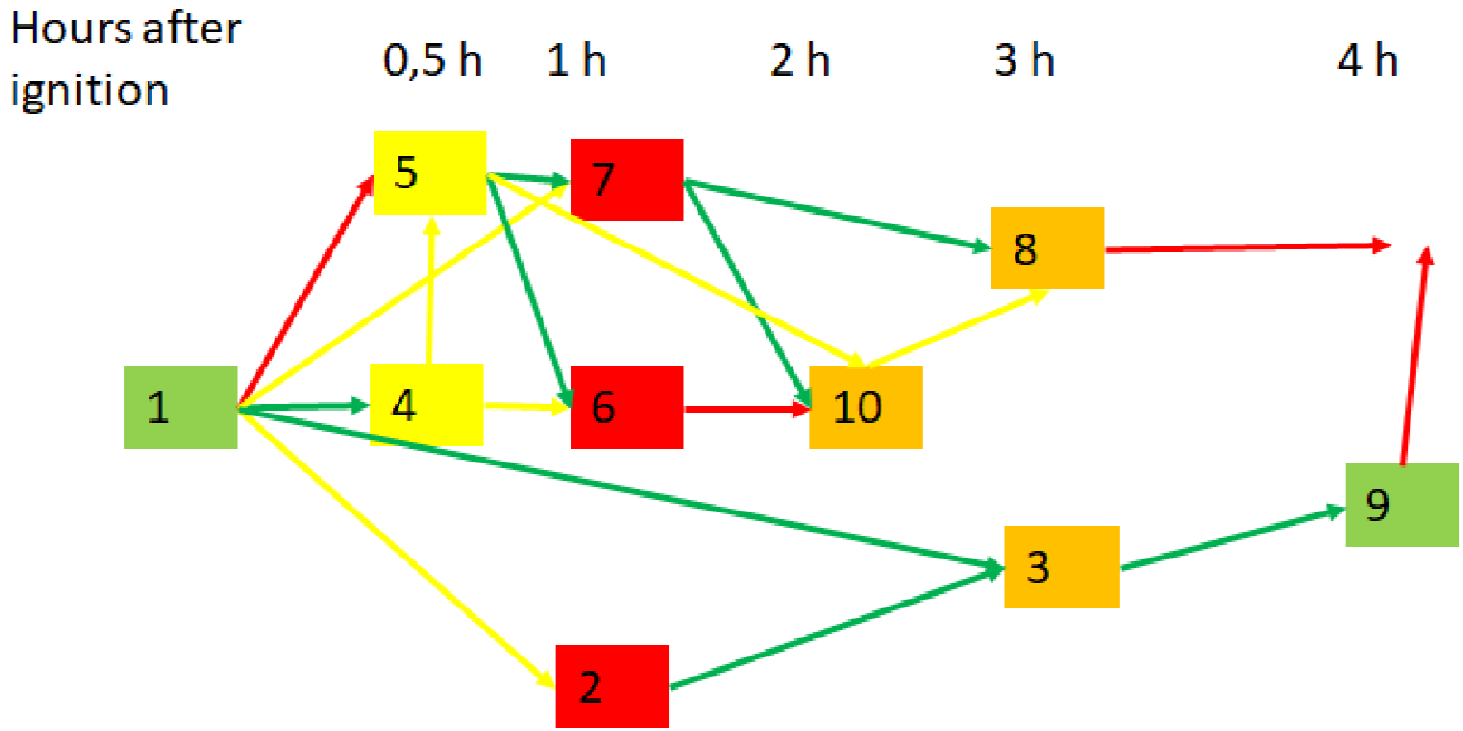
Emergency organization main commitment

Silent Valley Reservoir (Northern Ireland)



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Polygons decision-making methodology

Objective: build a certain and safety emergency scenario to know where and how wildfire will burn

Incident Commander needs to decide:

- what the wildfire want to burn? > Campbell Prediction System (CPS), Fire Types description and historical fire analysis

- what the wildfire can burn (today)? > weather current conditions, real fire behaviour, fuel availability

- what would I do? > strategic decisions, common values

- what can I do? > tactical organization, suppression capacity limitations

Suppression capacity limitation

Each agency has their own suppression capacity, depending on their resources, methodologies, proceeds and tools.

There are several possibilities how fire behaviour can overcome suppression capacity:

- growth rate perimeter length is greater than the capacity of the containing operations due to the continuity of the landscape
- rate of spread is greater than suppression progress. Resource deployment along the perimeter is slower than the rate of perimeter growth
- the high intensity of fire or crown fire activity exceeds suppression capacity and no ground force nor aerial resources can carry out effective operations

Polygons decision-making methodology

It allows Incident Commander establish order and priorities in the incident response plan

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Garós Pirinees Fire 2017

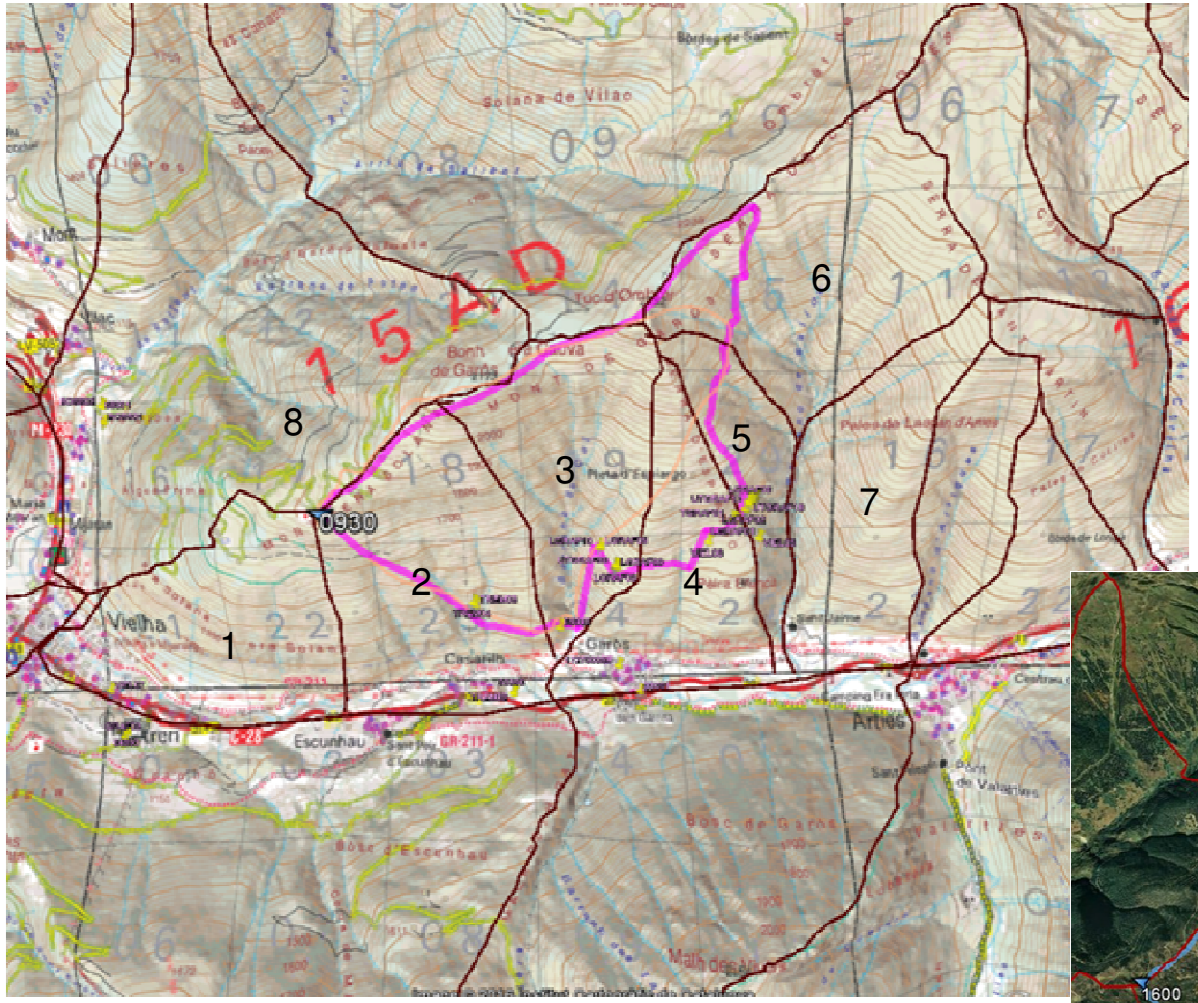
Goods:

- landscape
- grasslands
- woods
- wildfauna (brown bear and endemic lizard,)

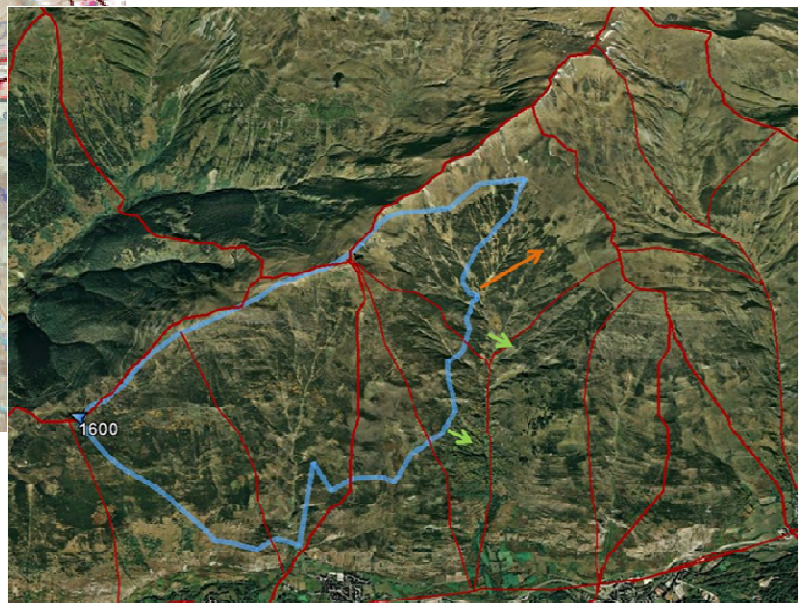
Emergency strategy: 1st contain, then from fire management to fire suppression

At the beginning of the incident there was an agreement land values with landowners and forest managers

Polygons decision-making methodology



Polygon values:
1 woods+landscape
2 grasslands
3 grasslands+landscape
4 landscape+grasslands
5 wildfauna
6 grasslands
7 wildfauna+landscape
8 woods+wildfauna



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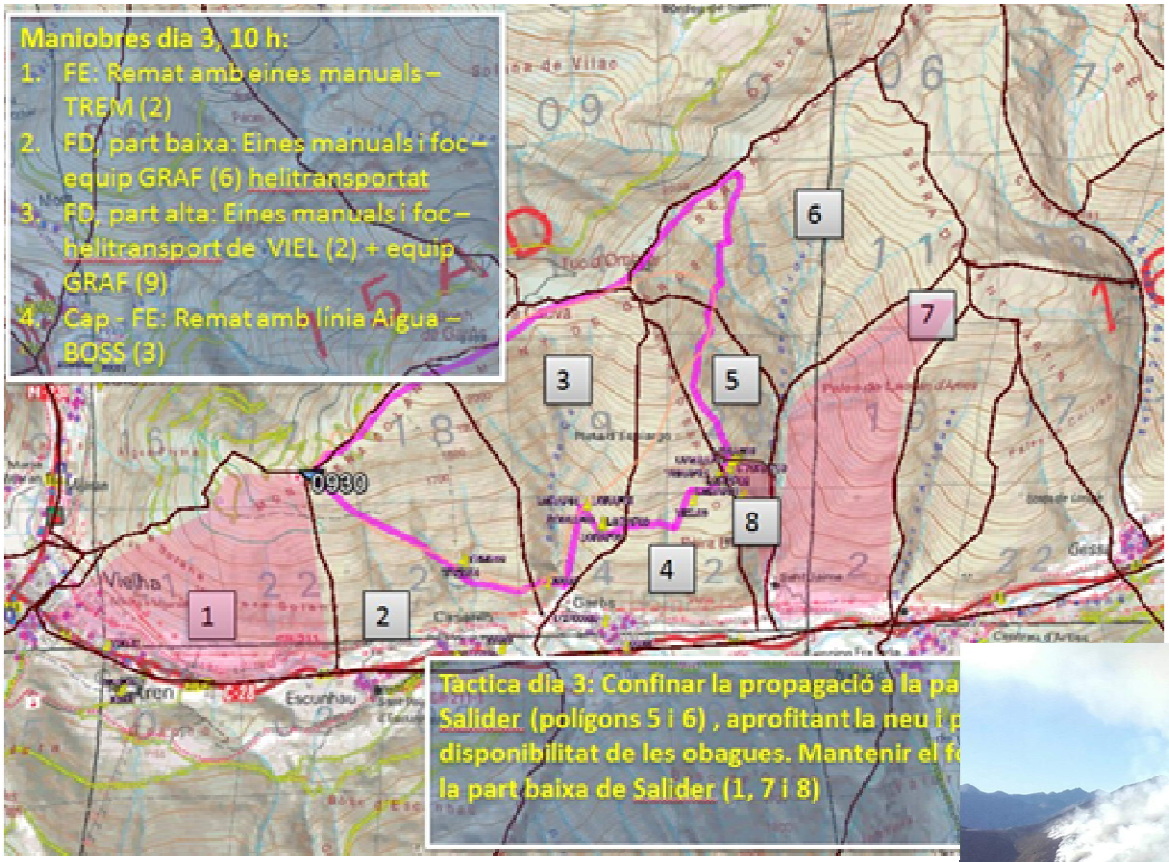
Polygons decision-making methodology



Order and priorities:

1. stop from 2 and 3 to 1 and 8
2. stop from 5 to 8 > 7 > 6
3. contain into 2 and 3
4. contain into 6

Because there was no many resources availables

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Polygons decision-making methodology

Ódena fire 2015

13:41h fire ignition
14:00h smoke plume
14:32h head fire jumping main roads
17:15h left flank
17:50h head fire
18:22h right flank

Fire behaviour:
1st 5h hours: convective fire pattern 3-5km/h
Average speed 1,6km/h
Massive Spots: 500m

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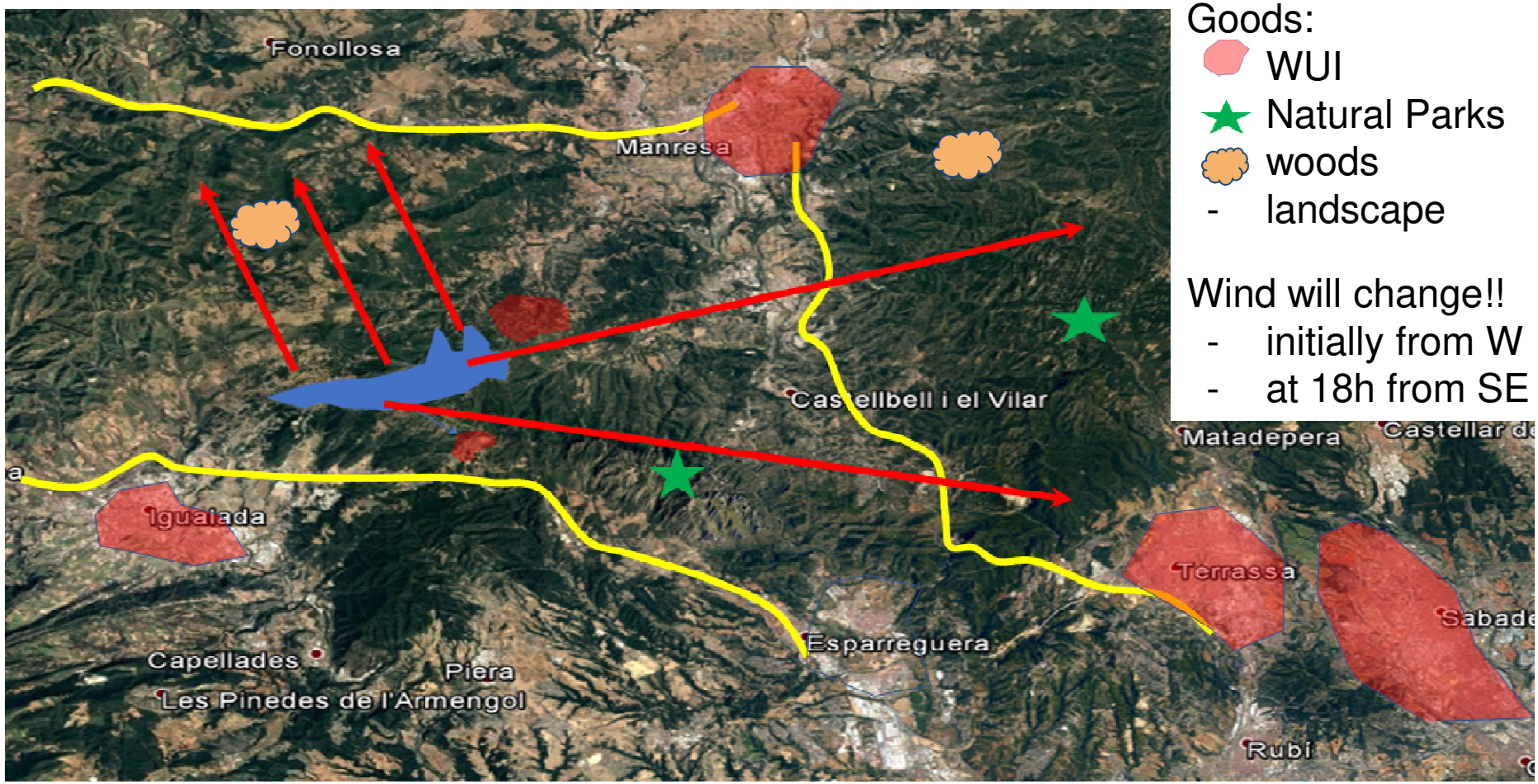
Polygons decision-making methodology



Goods:
- WUI
- Natural Parks
- woods
- landscape

Wind will change!!
- initially from W
- at 18h from SE

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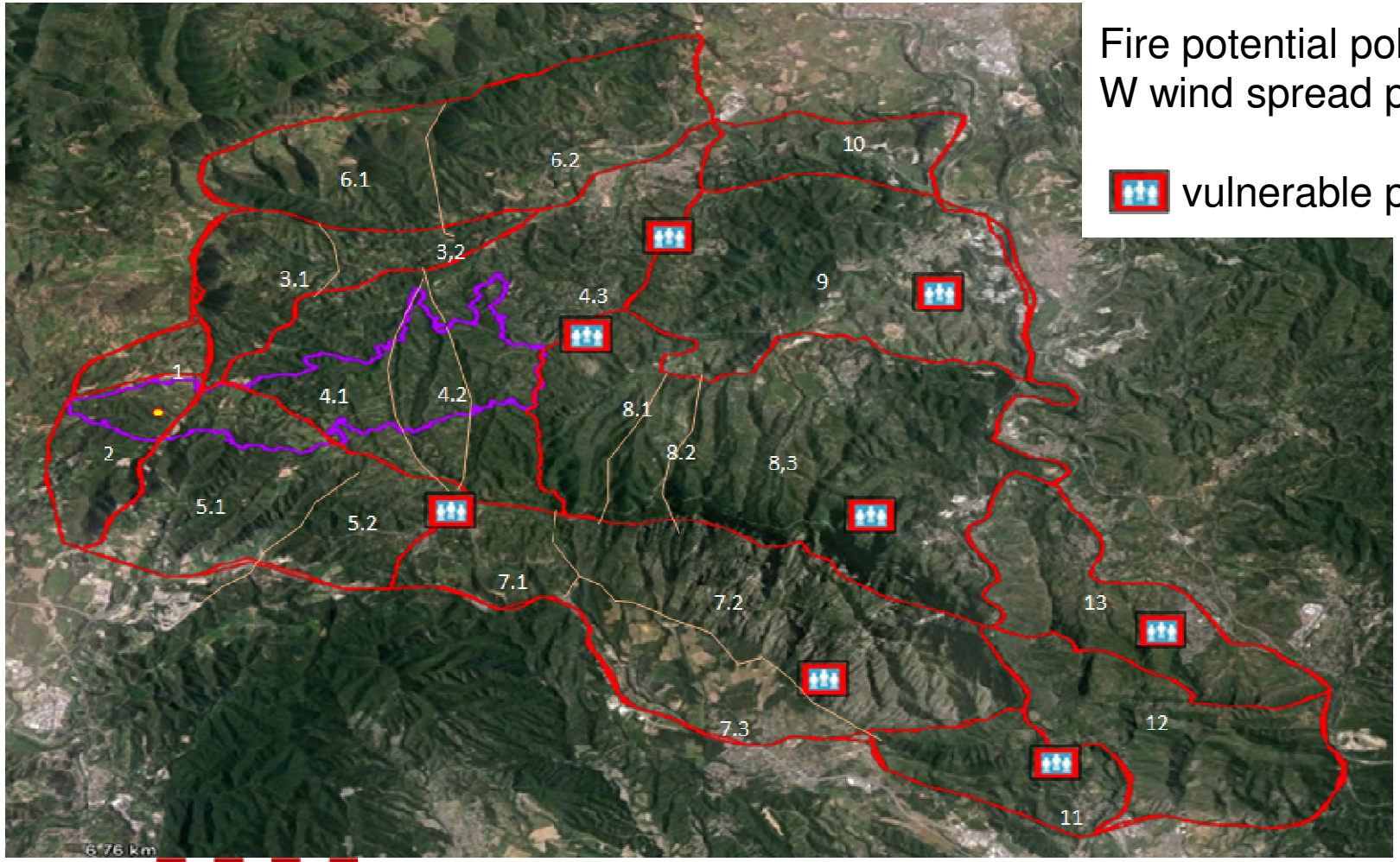
Polygons decision-making methodology



Fire potential polygons for W wind spread pattern

vulnerable points (WUI)

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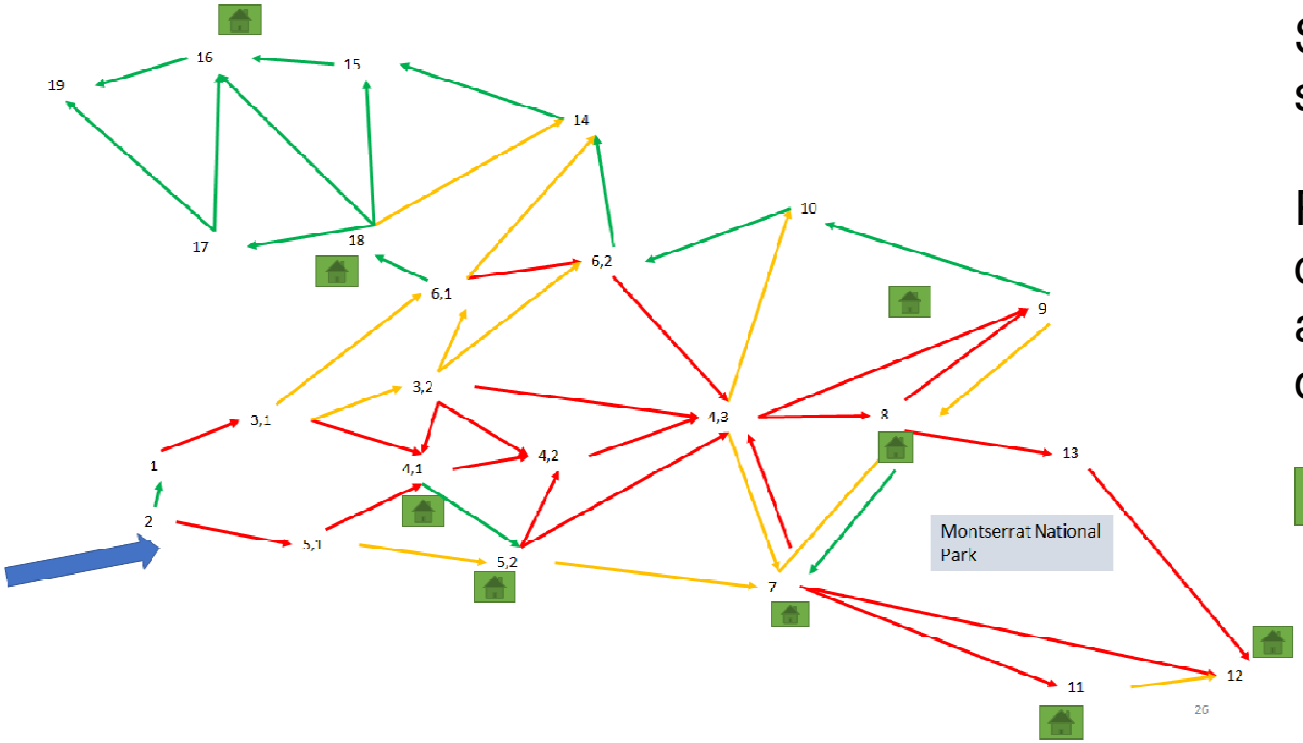
Polygons decision-making methodology



Schematic tree where spread chances are shown

Red is over threshold of control, yellow is at the limit and green is under threshold of control

vulnerable points (WUI)

Priorities ordered: 5.1 (avoid 5.2), 4.1 (avoid 5.2) and 4.3 (avoid 7, 8, 9 and 10), and then 3.1 (avoid 6.1 and 3.2)

Analysis done by fire behavior observation on the field the same day of the fire and assuming that with same aspect, wind and fuel fire will show approximately same fire behavior

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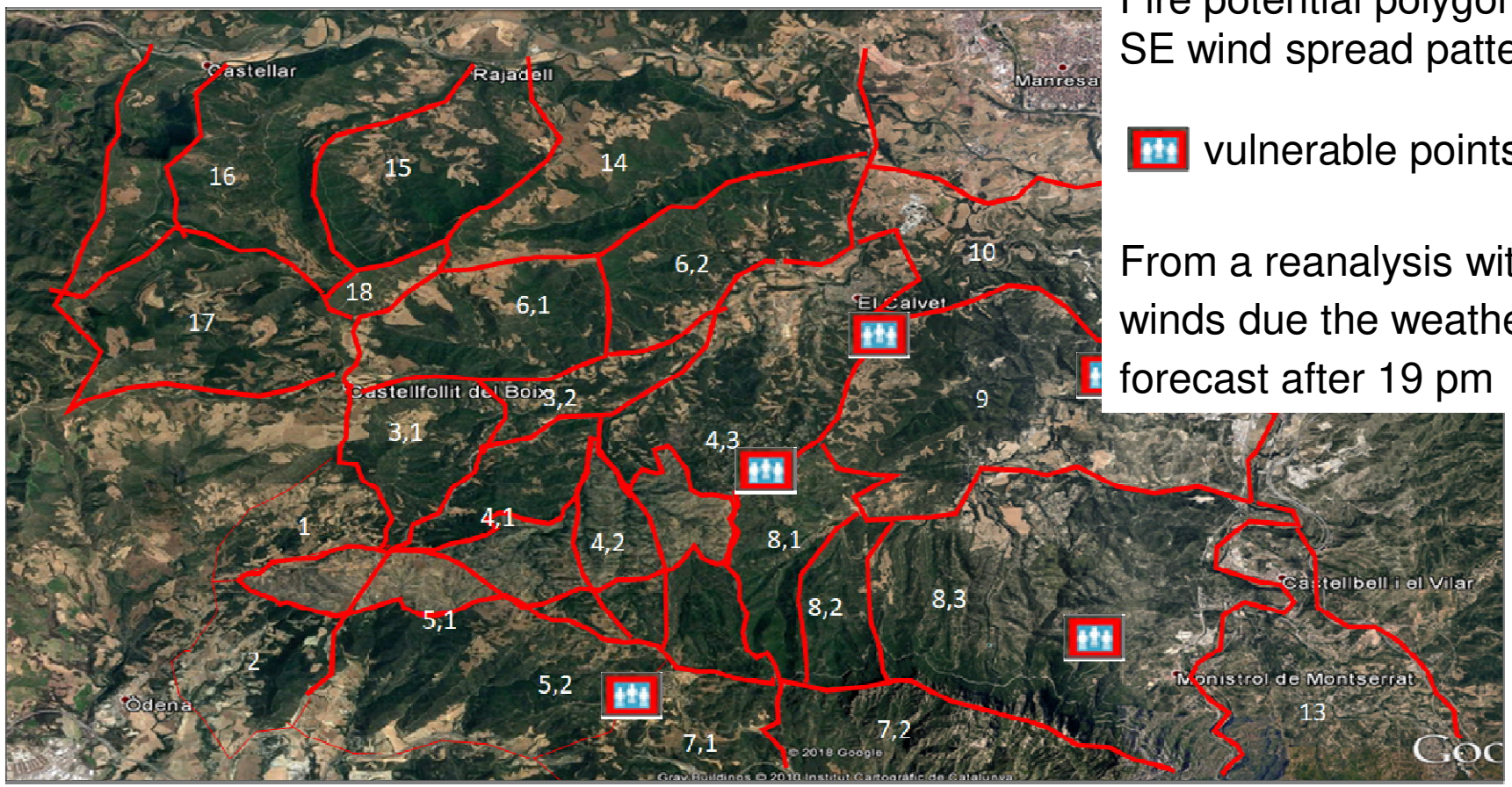
Polygons decision-making methodology



Fire potential polygons for SE wind spread pattern

vulnerable points (WUI)

From a reanalysis with SE winds due the weather forecast after 19 pm

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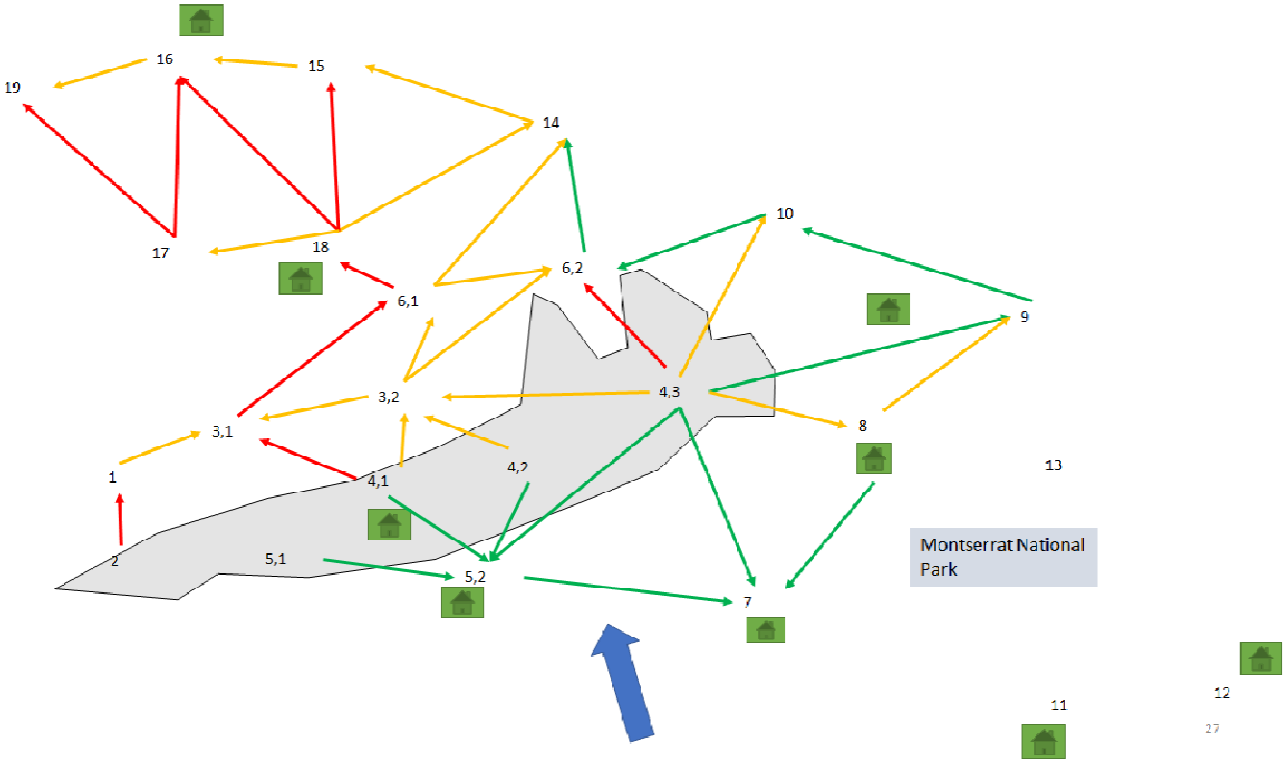
Polygons decision-making methodology



Schematic tree where NEW spread chances are shown

Red is over threshold of control, yellow is at the limit and green is under threshold of control

vulnerable points (WUI)

Priorities ordered: 1 (avoid 3.1), 4.1 (avoid 3.1, 3.2), 4.2 (avoid 3.2 and 5.2) and 4.3 (avoid 6.2, 10 , 9, 8, 7 and 5.2)

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Polygons decision-making methodology

So…

- if IC wants to do all… will fail, first on the left and then on the right
- if IC put all efforts on right flank before wind change… could lose the left wooded area
- if IC keep efforts for left flank before wind change and let resources in stand-by waiting the new scenario...everyone will kill him
- if IC distributes efforts on right and left flank could save something… or lose almost the whole surface and houses

How can he explain and show clear the timing of each action and its consequence?

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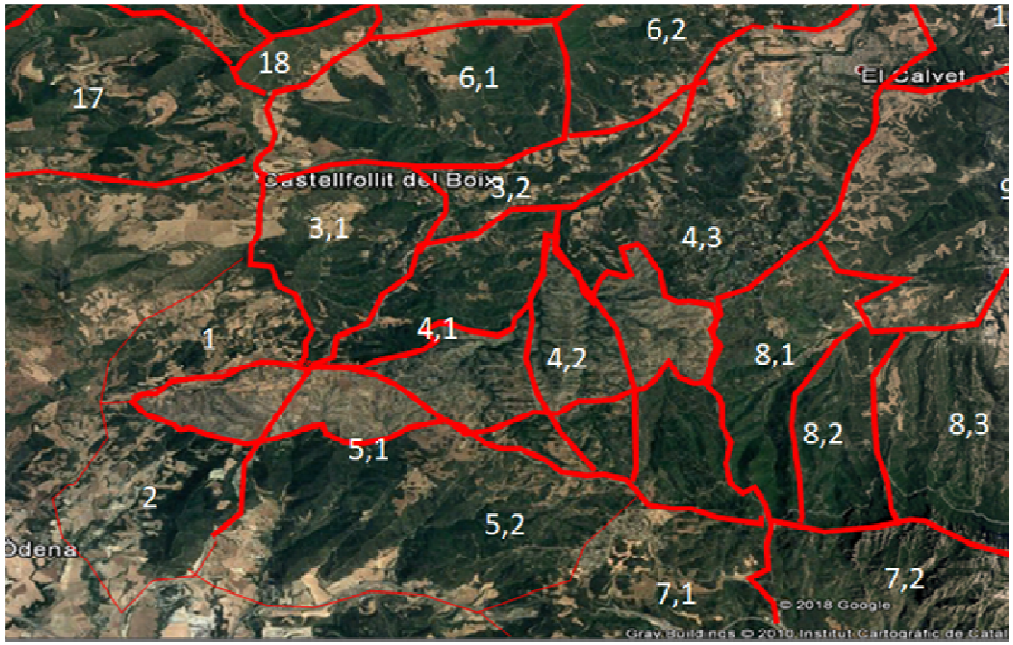
Polygons decision-making methodology

IC solution plan:

Before wind change:
1rst left flank: stop in 1 and 4.1
2nd right flank: stop in 5.1
3rd head: indirect attack in 4.2-4.3

After wind change:
1st head-new right flank stop 4.3
2nd stop new (little) head 4.2



From operational and incident response perspective it's a good methodology to order several priorities and explain why to all commanders and external experts, land managers and advisors staff

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Polygons decision-making methodology

But could be two constraints to considerer:

1. due to looking for total safety in risky operations

High pressure hose line direct attack model

We must build a **certain and safety scenario** where work, if not we could fall in a defensive model of emergency response

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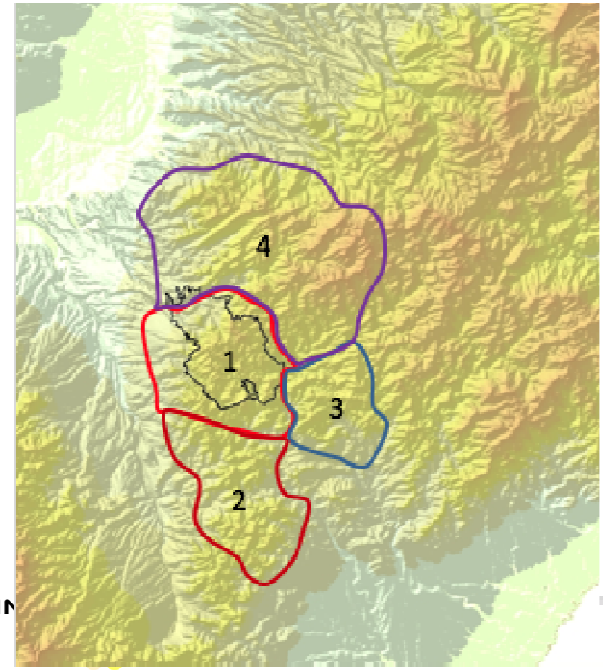
Polygons decision-making methodology

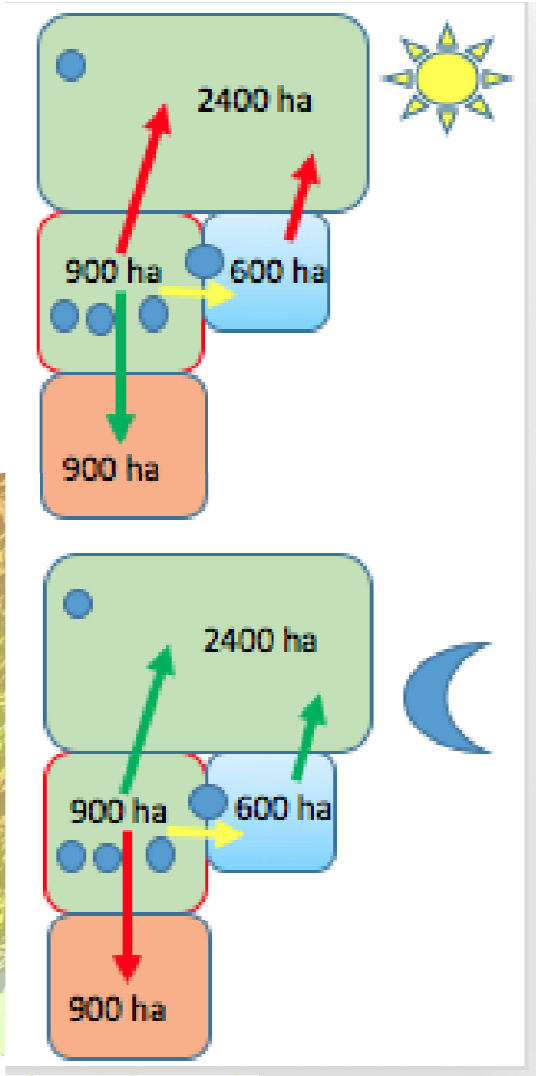
Could be two constraints to considerer:

1. Due to looking for total safety in risky operations

2. Our results are judged (by our society) according to what has been burned

We must change this criteria according **what has been saved**, using potential polygons schema





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Polygons decision-making methodology

Better than plan during the incident is do it before:

1. Fire Analyst can describe polygons according different scenarios

2. Values of each polygon can be fixed by an agreement with all interested agencies and stakeholders (key agents)

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Co-designed participatory processes: assignment of values

- Montseny:
  - Natural Park: It's a singular space protected by government
  - With related economic activities.

- CFRS:
  - Knowledge about fire behavior and strategic decision-making methodology.

- Humbolt University (Berlin)/ICR.
  - Expert professionals in the design of participatory processes
  - Identification of actors, meetings...

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Co-designed participatory processes: assignment of values

- Co-design
  - Identification of key actors. Who has interests or responsibilities.

    - To share the knowledge and values that each key group has about territory.
    - All the key agents of the study area are involved on design of the participatory process, in which everybody will be able to give their opinion about the study area according to the explained values.
    - Key agents create the support tools and materials for the public participation process.

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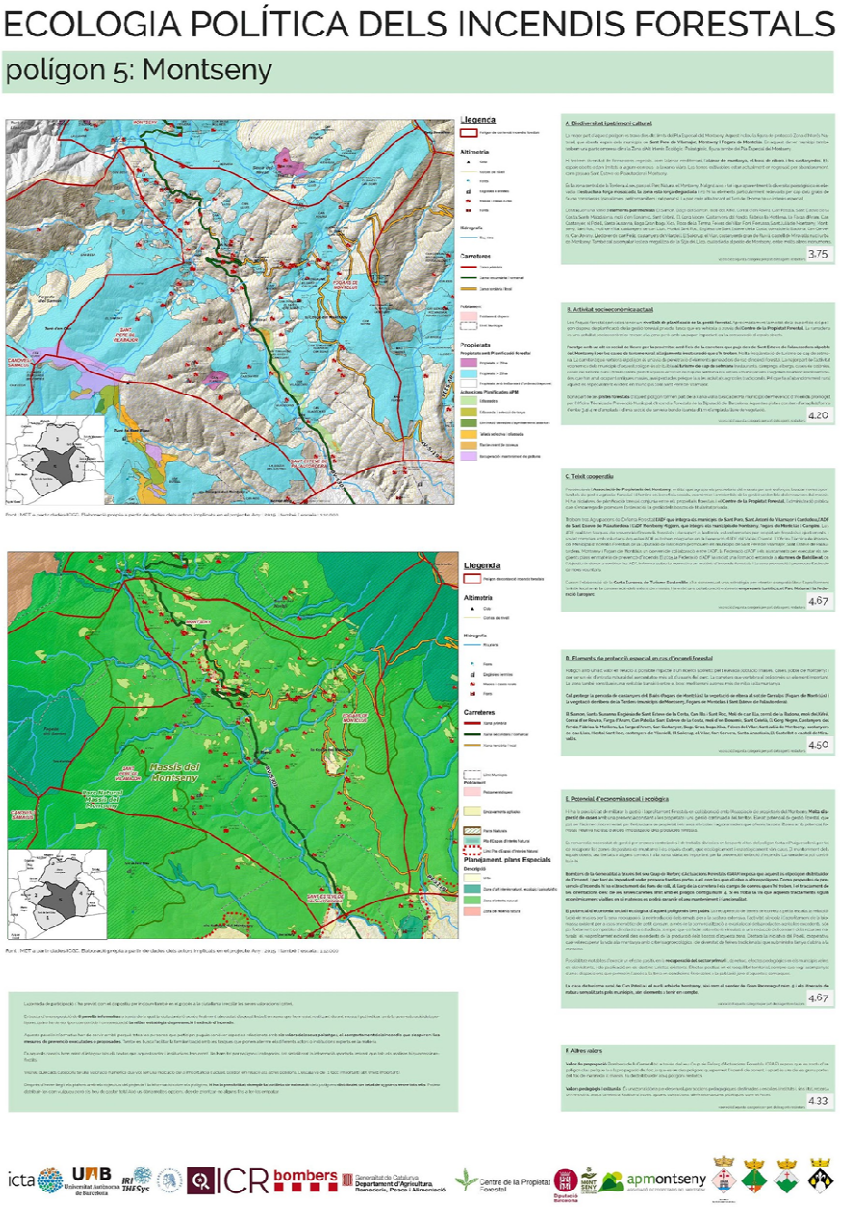
Co-designed participatory processes: assignment of values

- For each polygon used in the strategic decision-making process in forest fires in the area of study, the working group of stakeholders elaborates a description in different areas(biodiversity, cultural heritage, economy and cooperative networks, landscape, special protection elements against forest fires, social, ecological and economic potential), and explain all the goods that they shown in previous workshops.

- These support materials are the basis for the public participation process

- What is achieved with co-design?



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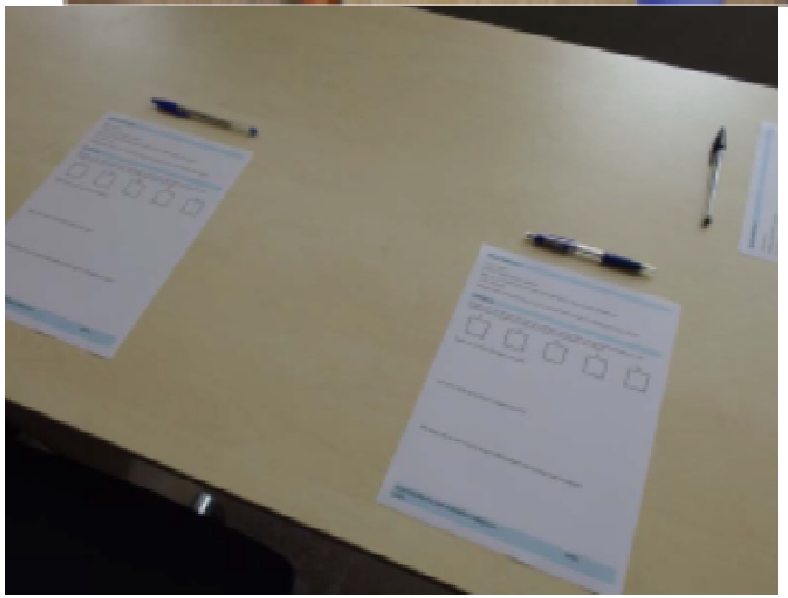
Co-designed participatory processes: assignment of values

- Public participation:
  - Process of learning and knowledge ot territory
  - Weighted opinion and responsibility in the opinion



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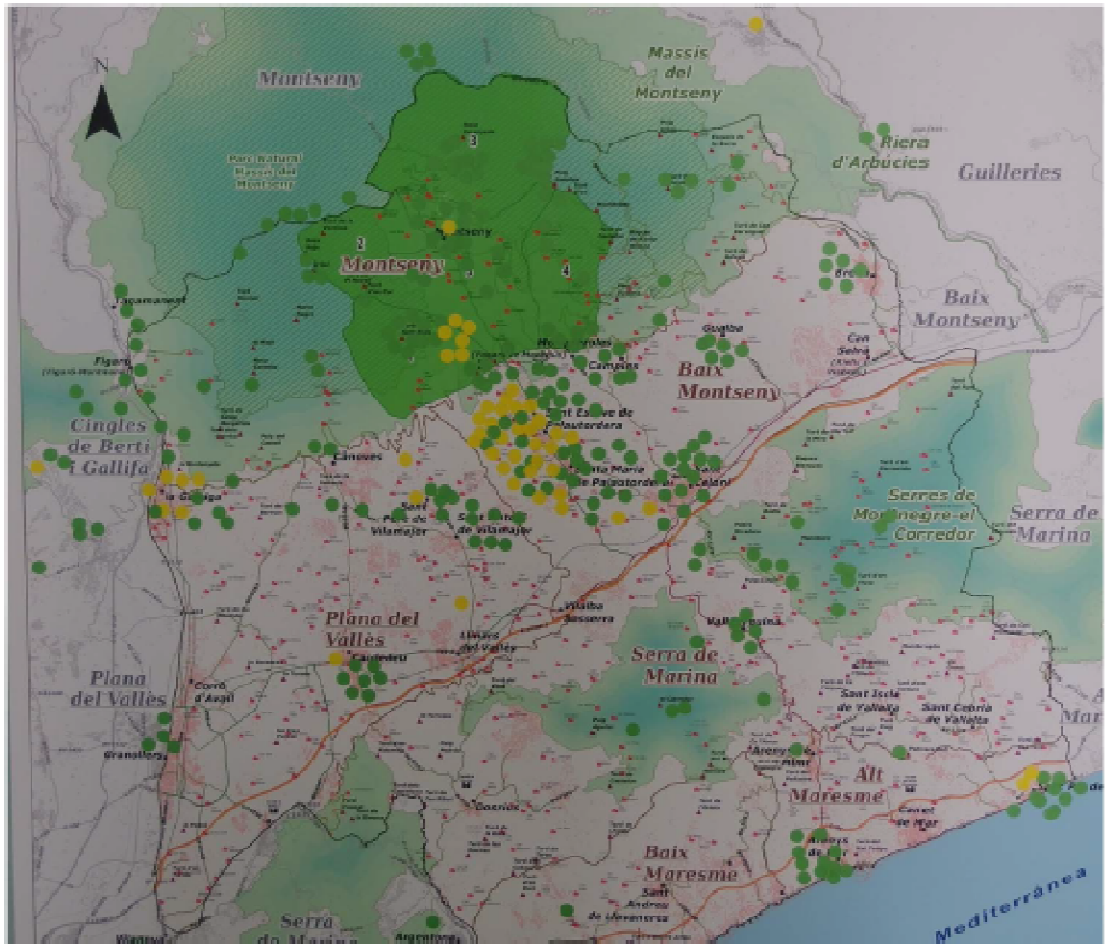
Co-designed participatory processes: assignment of values

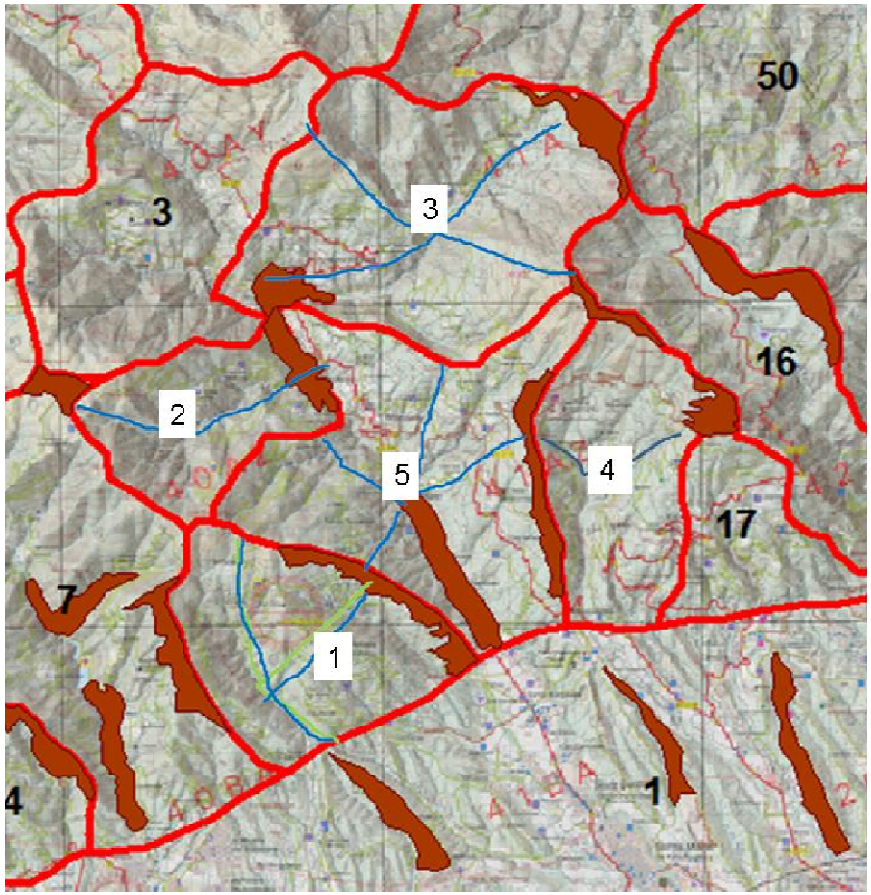
- Public participation:
  - Reproducible process
  - Knowledge of representativeness
  - Obtain socially consensuated values to ponderate each polygon

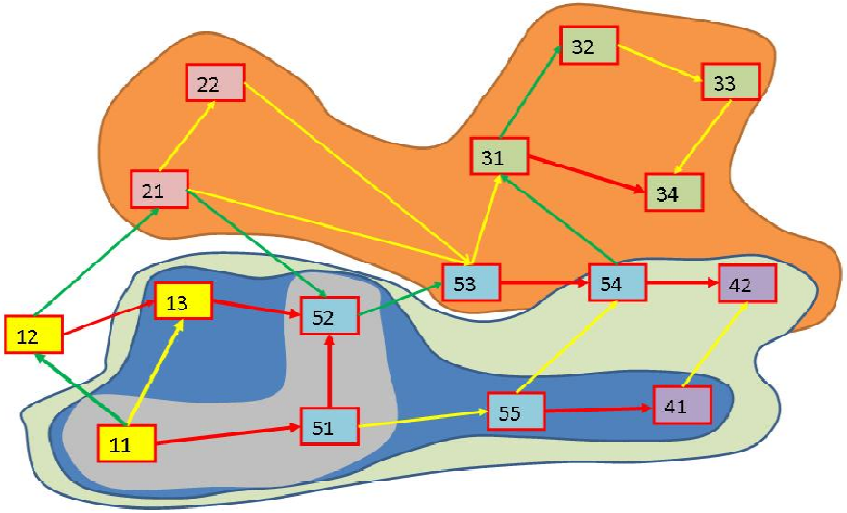


Participatory decision making

- What can we do with assigned values?
  - CFRS explain the extinction strategy including the values that society give to express its priorities.
  - CFRS explain where and why there are problems to carry on this social agreed strategy and what kind of management is needed to make it possible.
  - It's like an agreement between FRS and society.
    - Territory has said what they want and know what is necessary to do if they want that firefighters can do his accorded task.
    - When land management is done and is being maintained, CFRS explain and set up inside the different levels of structure:
      - What wants the territory.
      - Where are the infrastructures and which are the manoeuvre that can be applied on it

Participatory decision making





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Participatory decision making

Results:

- CFRS could have planned strategies according to the values and desires that society has expressed, if the land management needs had been done previously.
- This creates certainty in future scenarios for firefighters' work.
- Society become aware of and responsible of the fire suppression problem, that until now was only a firefighters' problem.

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