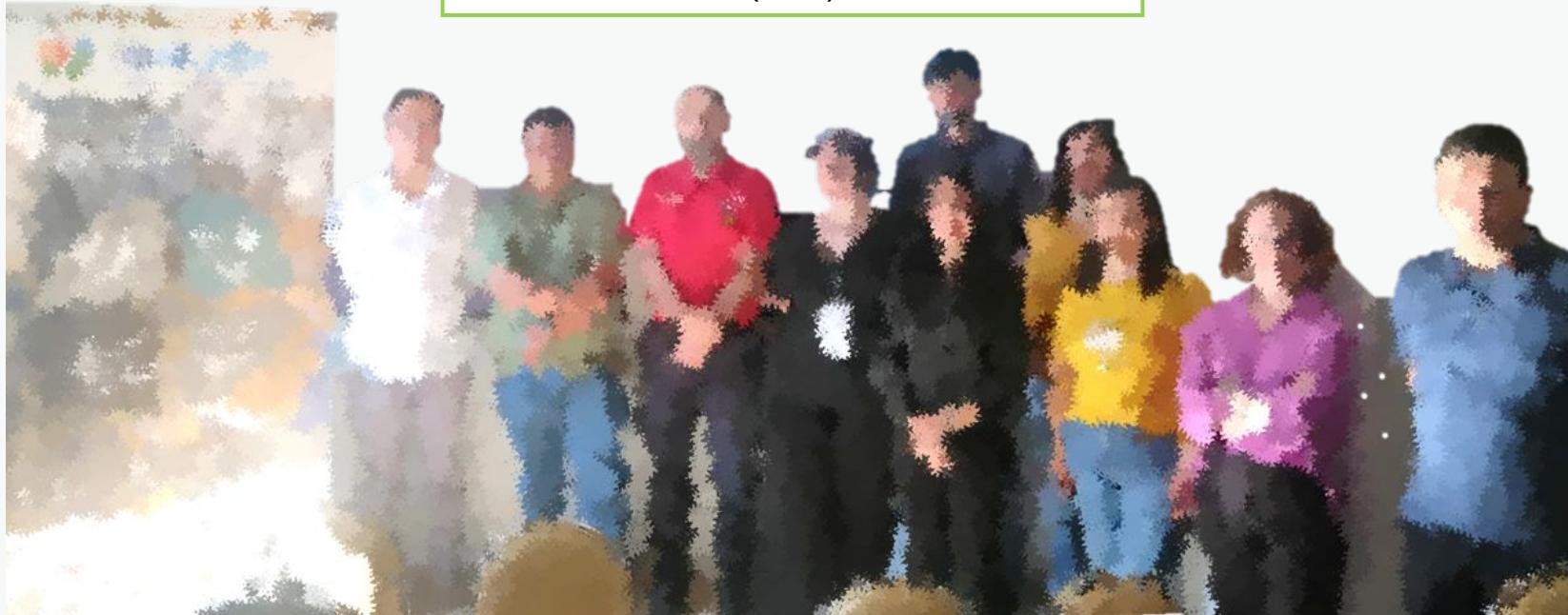


Integrating Stakeholder Preferences into Multi-Criteria Decision Analysis for Strategic Forest Management

Sergio Rodríguez Fernández
(ISA)



DecisionES
Decision Support for the Supply of Ecosystem Services under Global Change



FIRE-RES



**INSTITUTO
SUPERIOR D
AGRONOMIA**
Universidade de Lisboa

Context

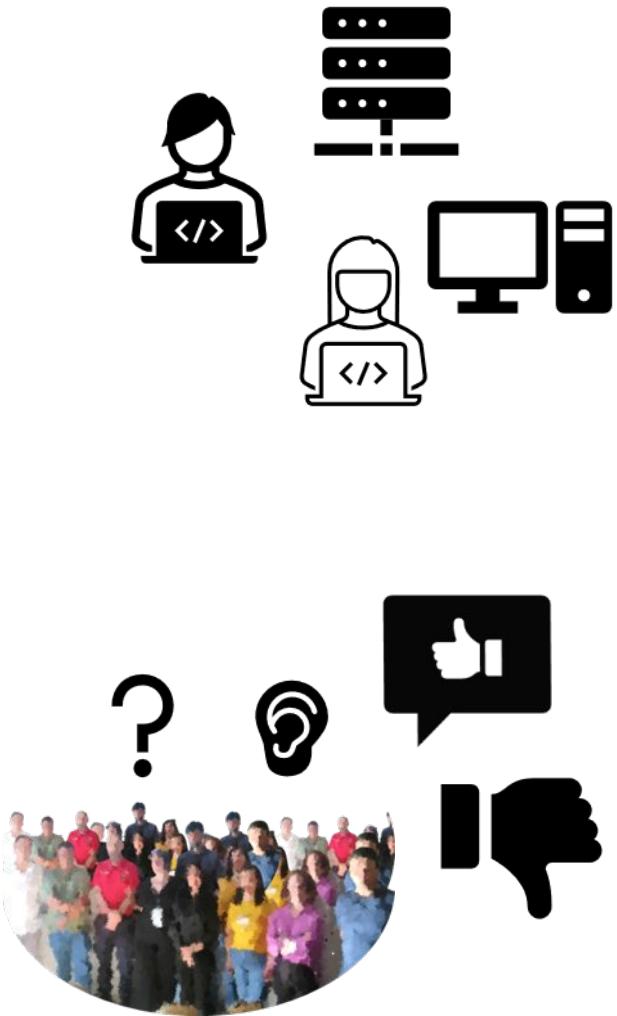
Fire prone areas in the Mediterranean region

Recurrent **extreme** wildfire events

Inefficacy in **resource allocation**

Fuel treatments can **improve efficiency** and **safety** of suppression operations

What to do?



Context-specific participatory MCDA

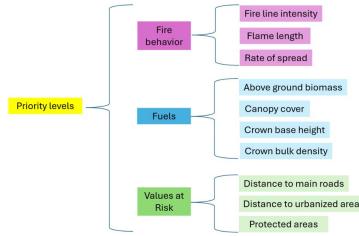


What to do?

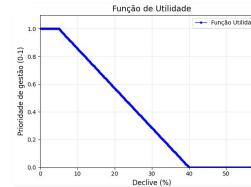


Four main steps

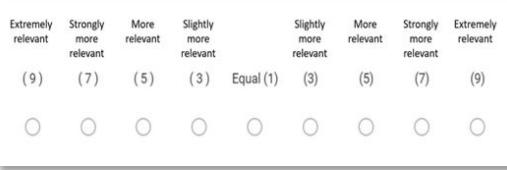
1. Define criteria and sub-criteria



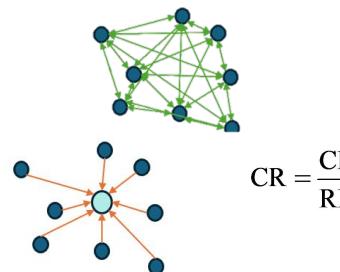
2. Scale parameters for utility functions



3. Weights of importance



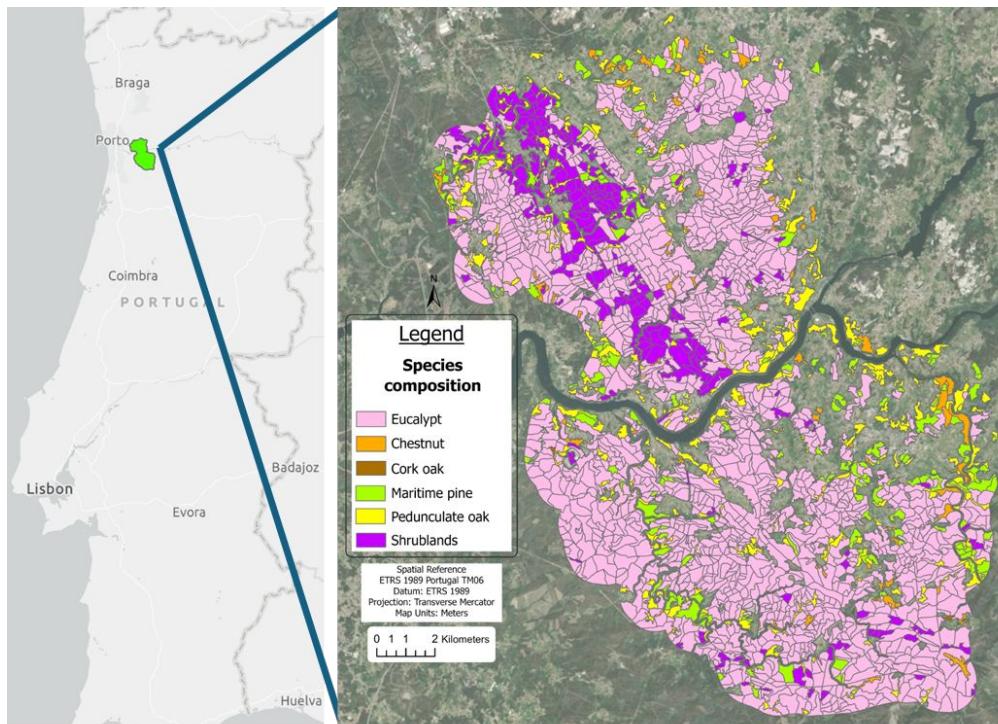
4. Weights to stakeholders' contributions



Where?

1

Vale do Sousa - Portugal



2

Iberian peninsula



Definition of criteria and sub-criteria

survey 1 vid 1

1. Do you consider **Fire Behavior** a relevant criteria for the purpose of this study? *

YES

NO (Skip to question 2)

1a. Which sub-criteria do you consider are relevant for the criteria '**Fire behavior**'?

Rate of spread

Flame lenght

Otro: _____

2. Do you consider **Vulnerability** a relevant criteria for the purpose of this study? *

By vulnerability we refer to areas that require special protection, mainly for social security, environmental or cultural reasons.

YES

NO (Skip to question 3)

2a. Which sub-criteria do you consider are relevant for the criteria '**Vulnerability**'?

Buffer around urbanized areas



Sección 1 de 2

Designing strategic networks of managed areas to improve suppression efforts against Extreme Wildfire Events - Criteria identification

The purpose of this survey is to carry out a preliminary identification of the stakeholders' preferences on the useful criteria and sub-criteria to prioritize areas to be managed for the creation of a network to contribute with the fire suppression efforts in Vale do Sousa - Portugal (case study area).

This first survey is an evaluation of the opinions of the selected actors and will be followed by a Focus Group to discuss the relevance of each criterion and sub-criterion as well as the metrics to be established for each of them.

The objective of making this study a participatory work is to make it as realistic and applicable as possible in the criteria for decision making and, by involving those professionals working in the field (in this case in the fire suppression efforts). The selection of criteria and sub-criteria, although participatory, will eventually have to be adapted to the availability of spatial data (inventory data, infrastructure information, etc.).

Correo *

Correo válido

Este formulario registra los correos. [Cambiar configuración](#)



Online surveys and Focus Group Discussion

Weights of importance (AHP online survey)

Criteria weighting

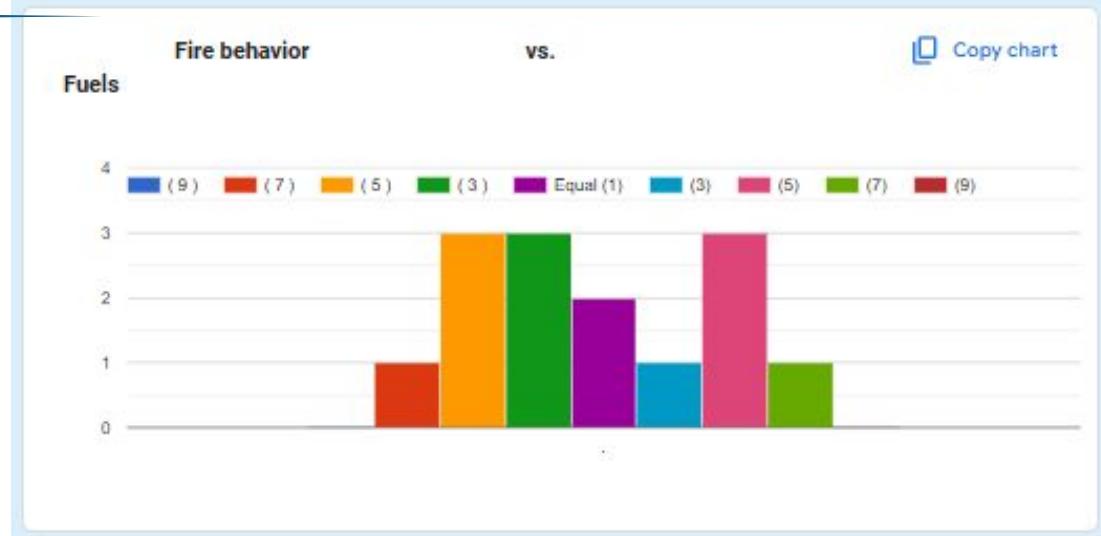
	Extremely relevant	Strongly more relevant	More relevant	Slightly more relevant	Slightly more relevant	More relevant	Strongly more relevant	Extremely relevant
(9)	(7)	(5)	(3)	Equal (1)	(3)	(5)	(7)	(9)
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Fuels vs. **Vulnerability**

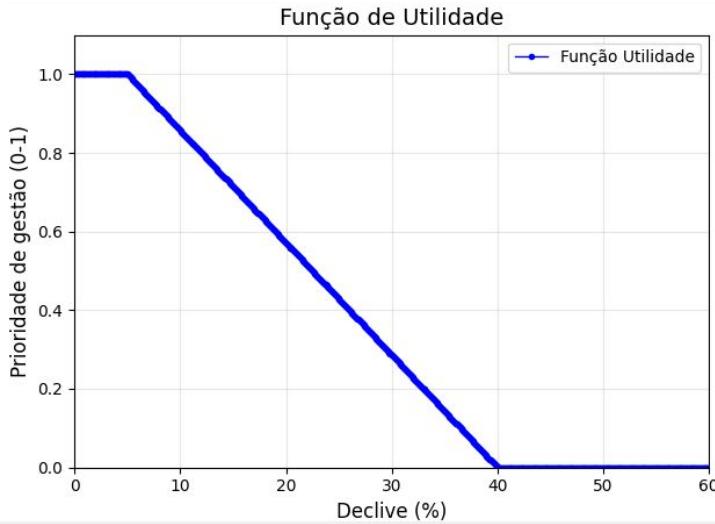
	(9)	(7)	(5)	(3)	Equal (1)	(3)	(5)	(7)	(9)
<input type="radio"/>									

Hazard ignition areas vs. **Suppression drivers**

	(9)	(7)	(5)	(3)	Equal (1)	(3)	(5)	(7)	(9)
<input type="radio"/>									



Scale parameters for utility functions



Maximum
priority

<5%

Slope (%)



Minimum
priority

>40%

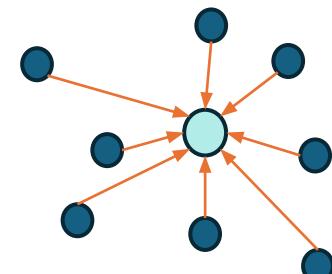
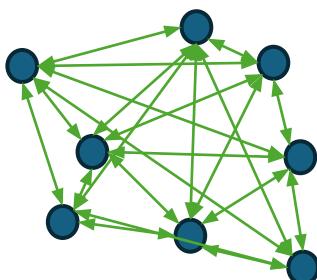
Participants' contributions

1

Vale do Sousa case

$$CI = \frac{(\lambda_{\max} - N)}{(N-1)}$$

$$CR = \frac{CI}{RI}$$



Three measures
based on AHP output

Consistency ratios

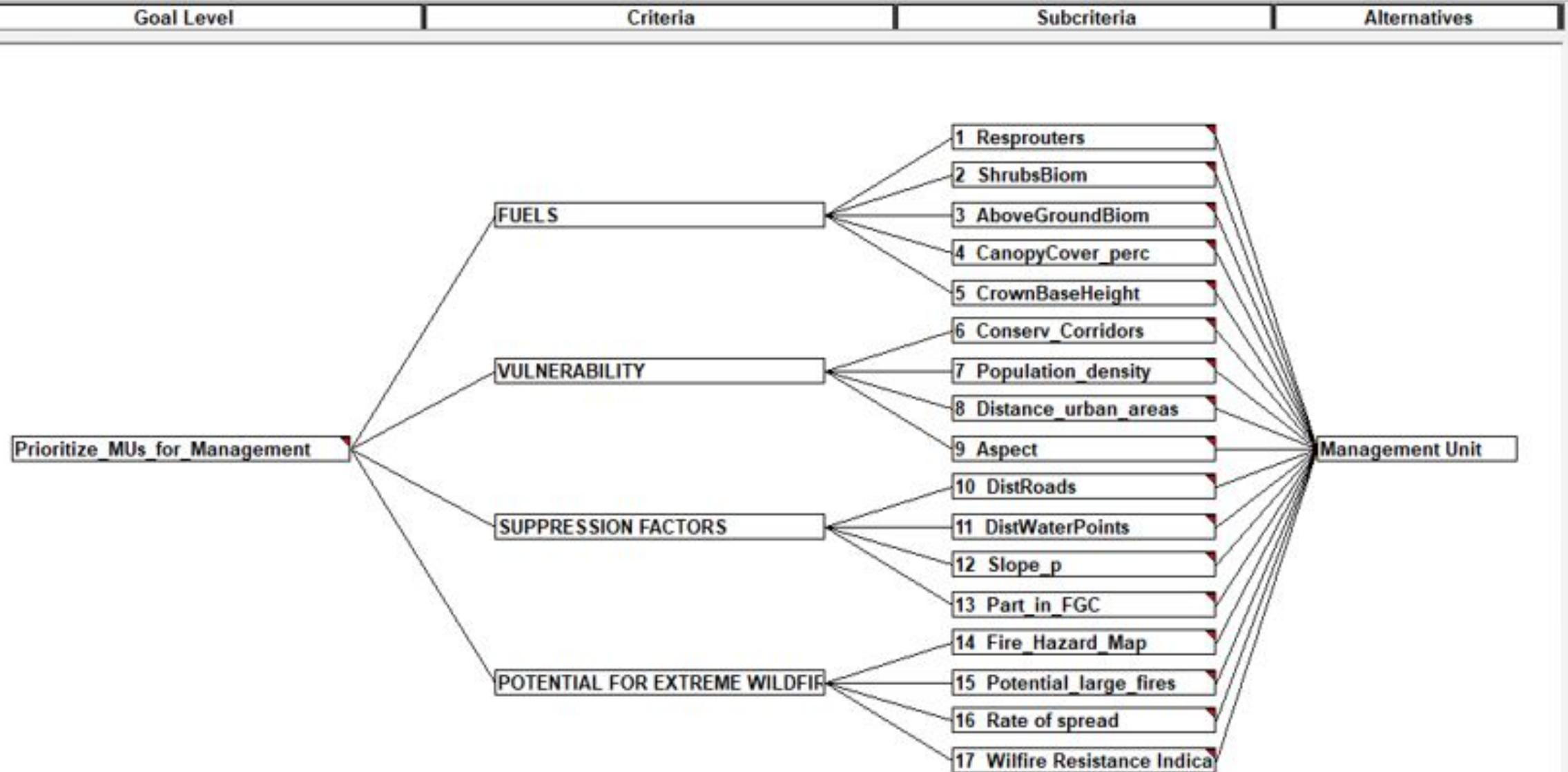
Euclidean Distances

Spearman Rank Correlation

Different weights for each
stakeholder

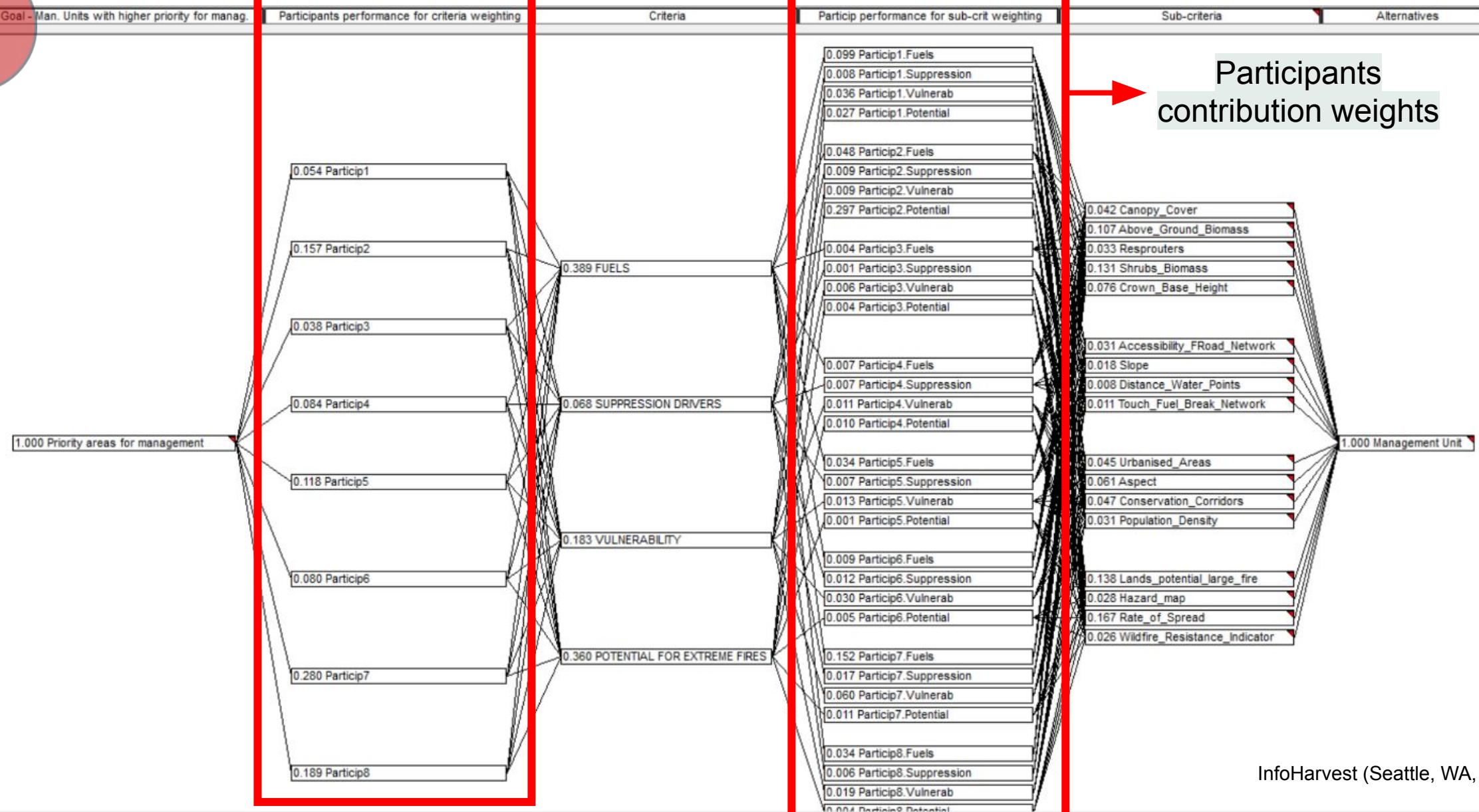
Hierarchical model (CDP)

1



Hierarchical model (CDP)

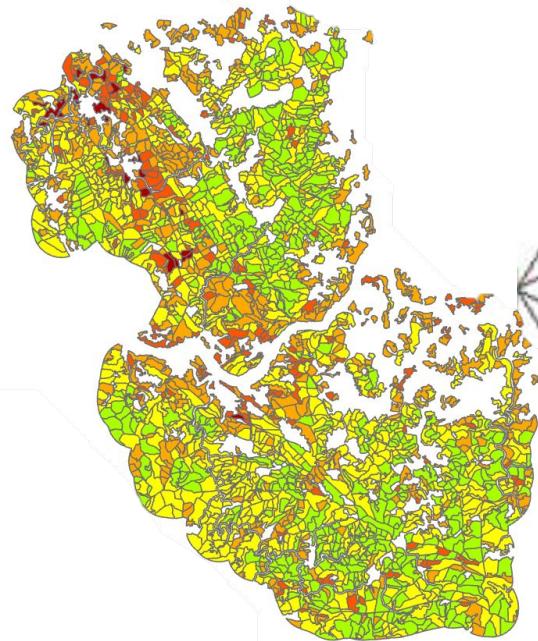
1



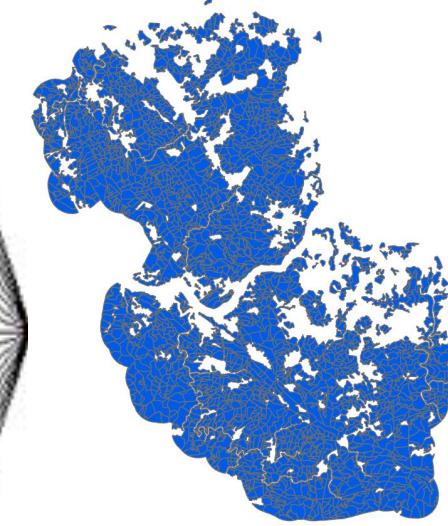
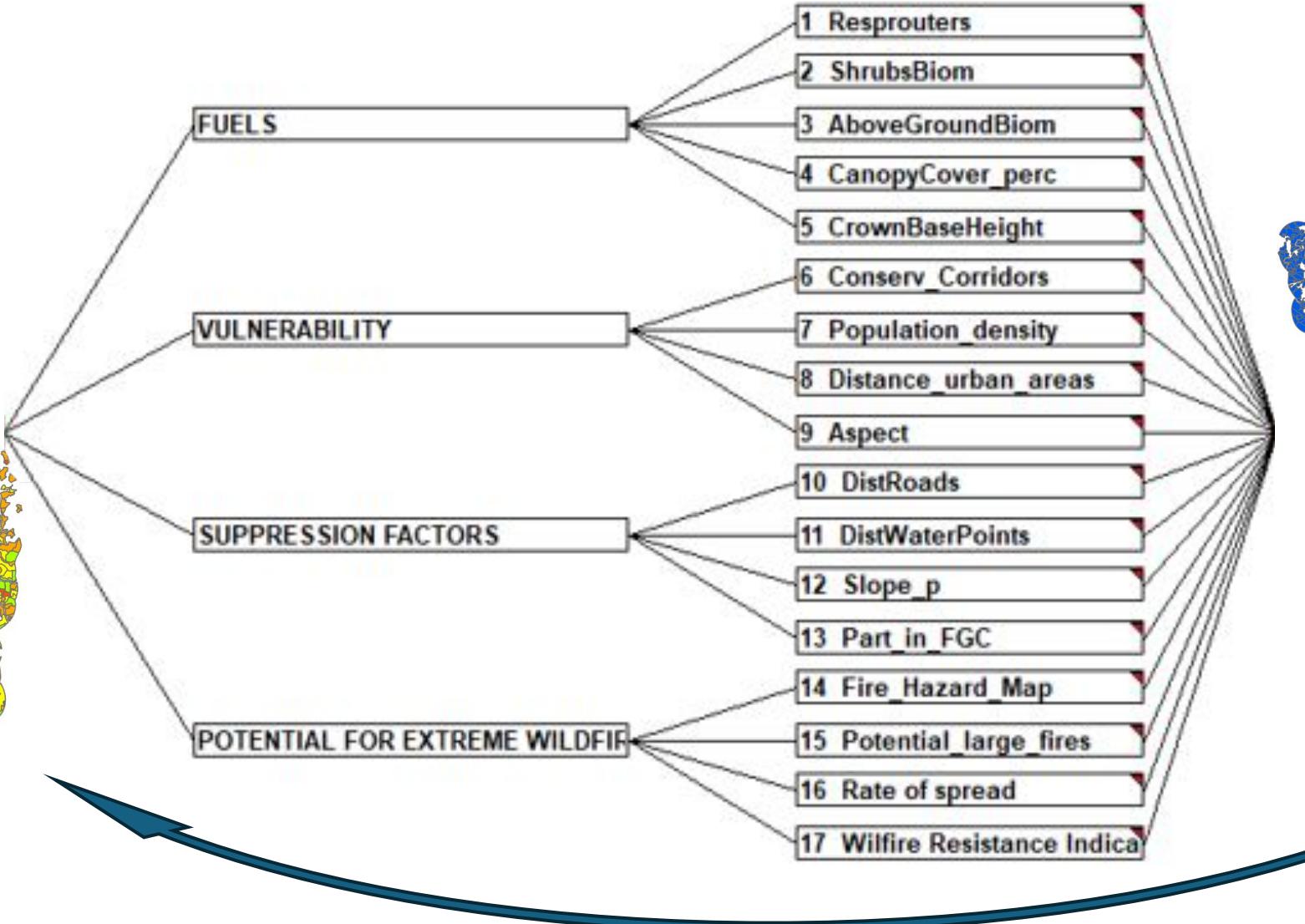
Integration in GIS through EMDS

(Reynolds et al., 2023)

1



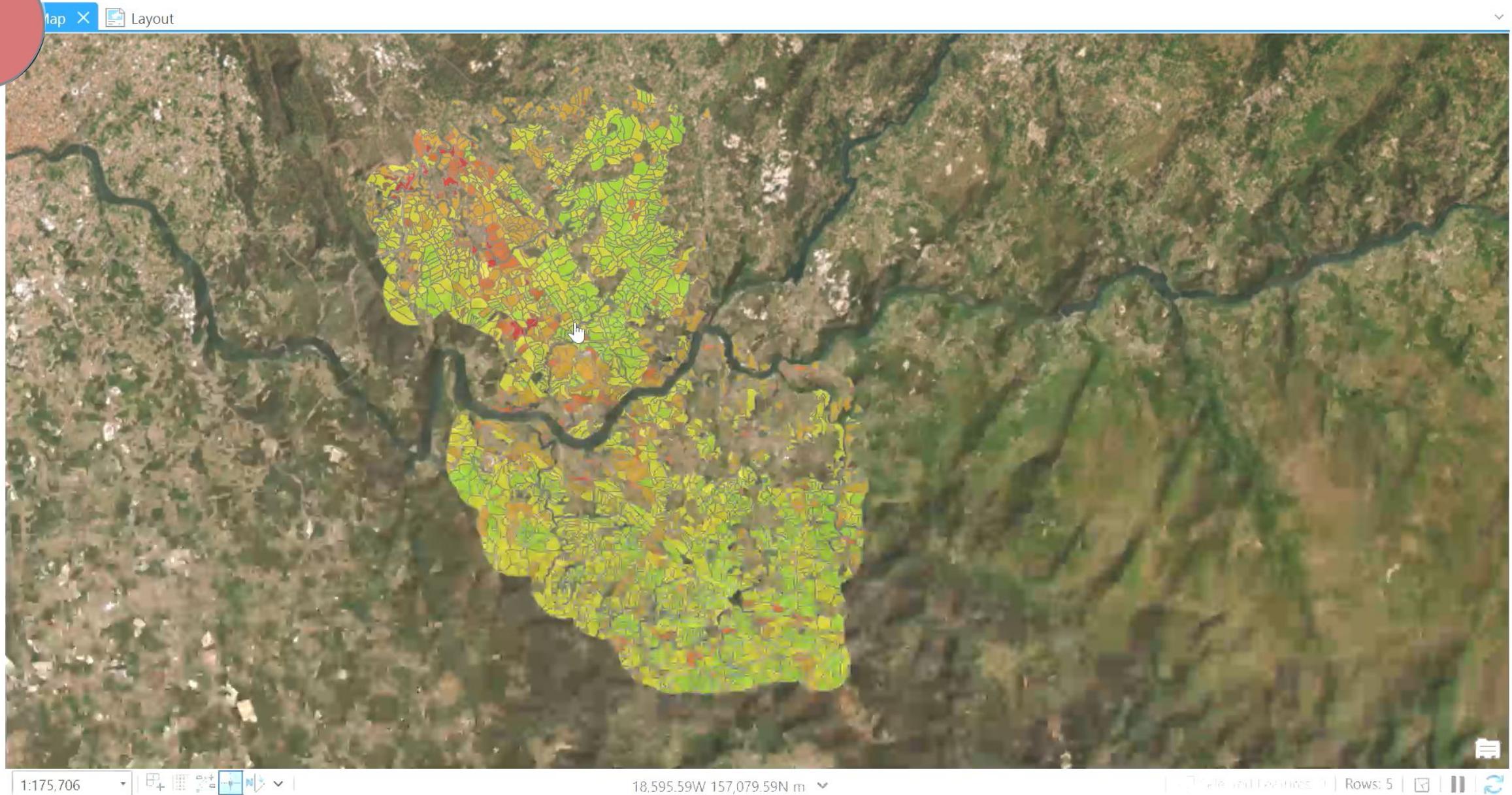
Resulting priorities



Dataset with
spatial info
for each MU

Validation and Stakeholders' approval

1



Iberian peninsula case study

2

- * From local to **regional**

- * **Harmonized dataset:** Pan-European Fuel Map Server & Wildfire Behavior Metrics (FireSim- Technosylva)

- * From shapefile MU level info, to **raster** 100x100m pixel

- * From context-specific issues, to focus on **policy making**

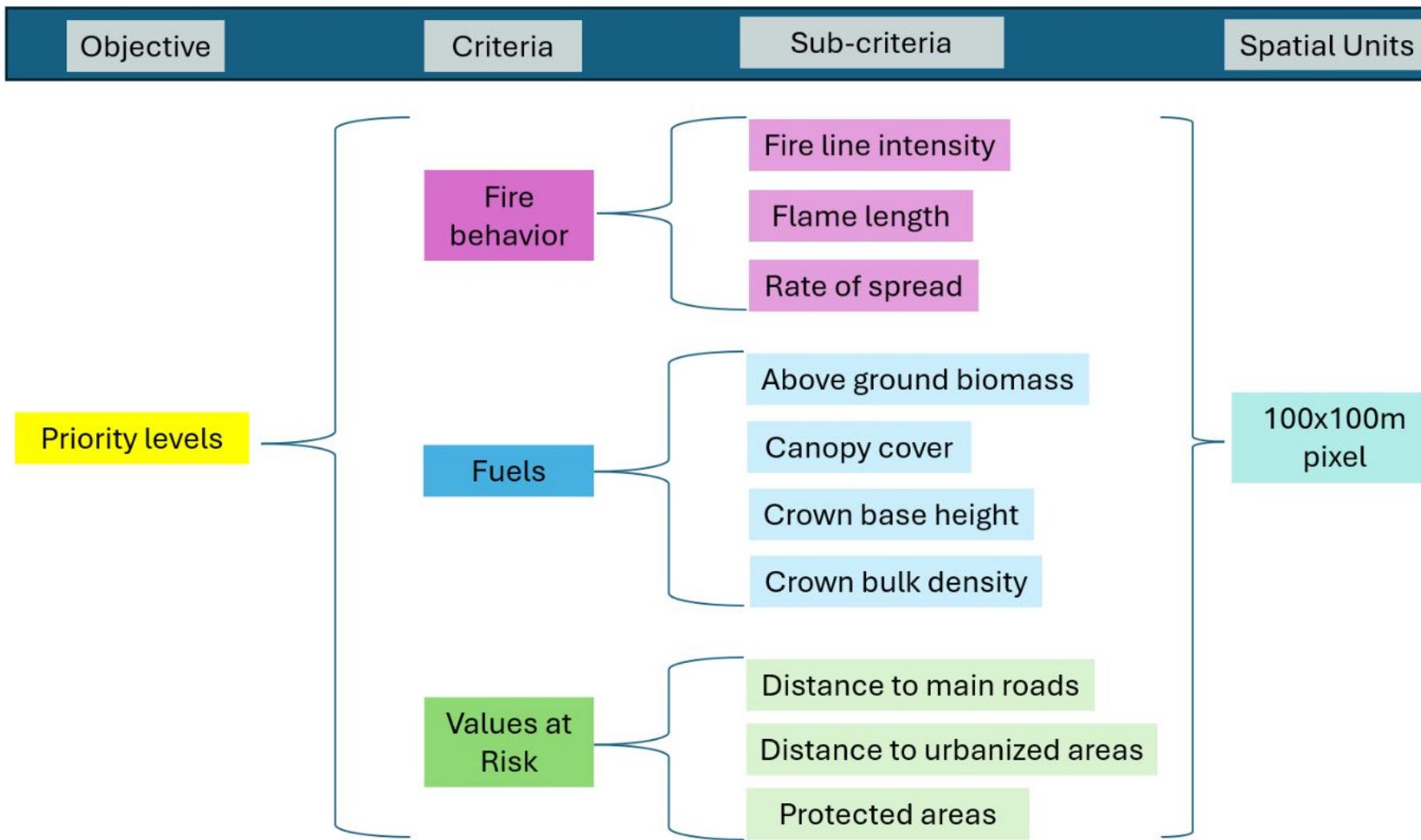
- * **Pan-European plugin** (F2A-ISCI-Chile)



MCDA hierarchy

2

MCDA



Participants' contributions and consensus

2

Consistency ratio and modified Consensus Convergence Algorithm

Consistency ratios

$$CI = \frac{(\lambda_{\max} - N)}{(N-1)}$$

$$CR = \frac{CI}{RI}$$

Consensus Convergence Algorithm

$$w_{ij} = \frac{1/d_{ij}}{\sum_k 1/d_{ik}}$$

$$c_i = 1 - CR_i \quad w_{ij} = \frac{c_j/d_{ij}}{\sum_{k \neq i} c_k/d_{ik}}$$

Modified respect weights

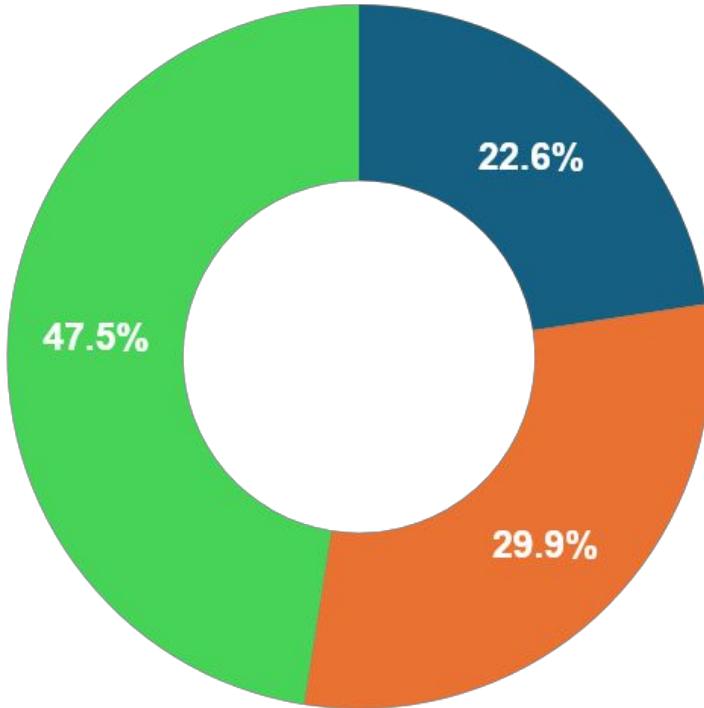
Consensus

Consensus weights

2

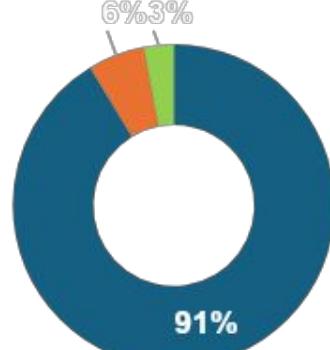
Main criteria weights

■ Fire Behavior ■ Fuels ■ Values at Risk



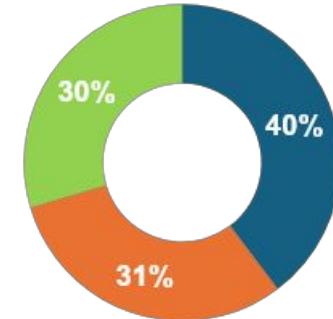
Values at risk

■ Distance to urbanized areas
■ Distance to Primary Roads
■ Presence of Protected Areas



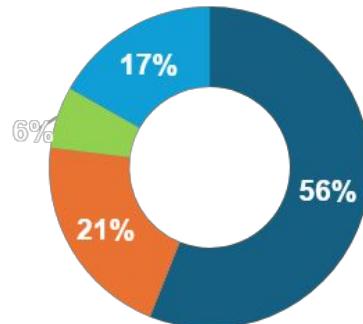
Fire behavior

■ Flame Length ■ Fireline Intensity ■ Rate of Spread

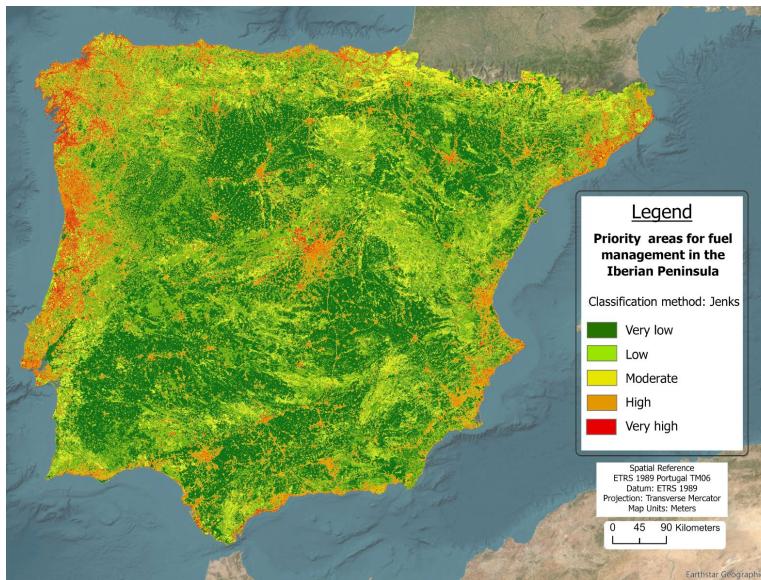
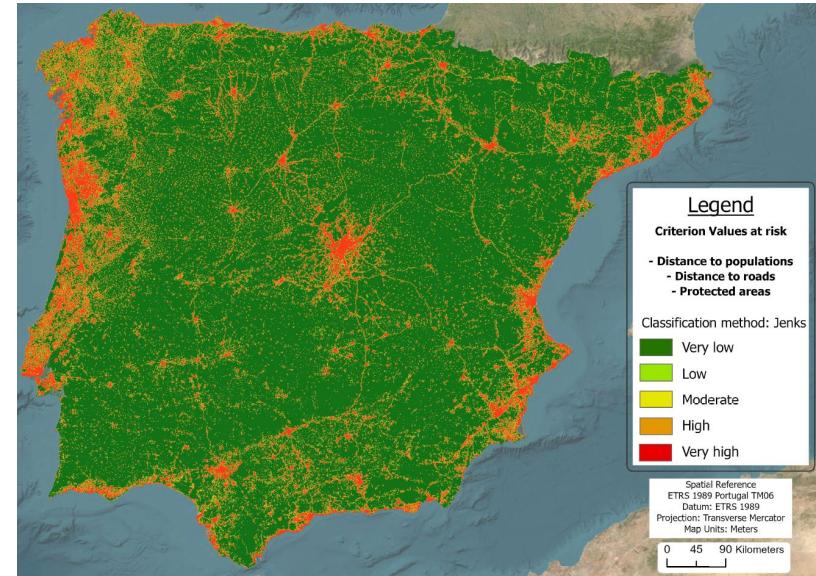
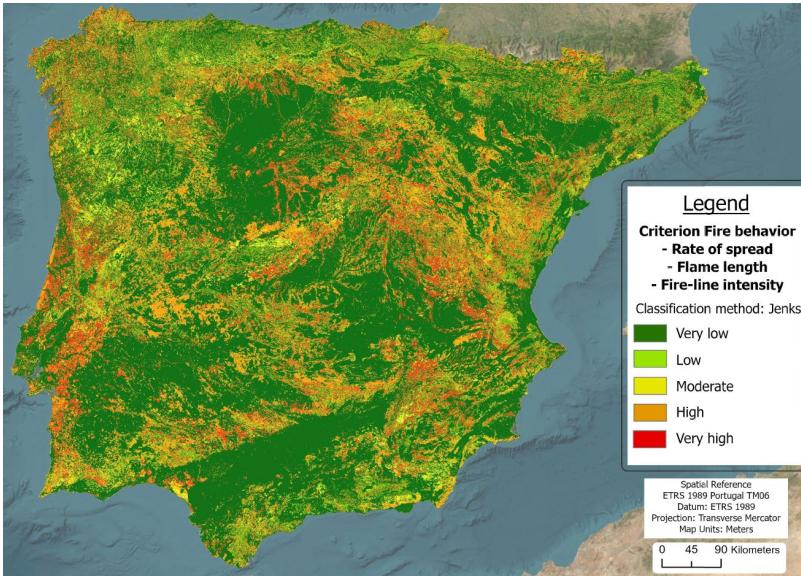
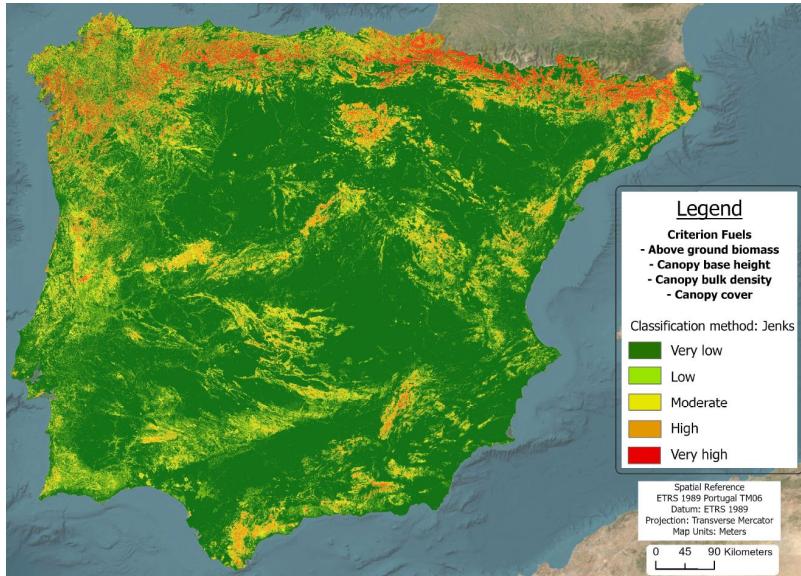


Fuels

■ Above Ground Biomass
■ Crown Bulk Density
■ Crown Base Height
■ Canopy Cover



Criteria maps and priorities map



Conclusions and outlook

Why Stakeholder Weighting Matters

- » Achieve a shared understanding or acceptable compromise
 - » Down-weighting outliers = enhances stability
 - » Fairness ≠ Equality of Influence (quality of contributions)

Tools and Data Suitability

Tool selection depends on data type and scale:

- **CDP-EMDS**: Best for vector-based local unit planning (e.g., shapefiles)
- **Pan-European plugin**: Supports large-scale MCDA with raster maps

Scale: Local vs. Regional Prioritization

Large-scale prioritization supports policy making and strategic resource allocation

Local-level exercises:

- Require refined, context-specific data
- Use different criteria; some indicators may be irrelevant locally

Muito obrigado Gracias Thank you



Acknowledgments:

To all the stakeholders of Vale do Sousa who participated in this work

To all the members of the FIRE-RES Project who are participating in the participatory prioritization processes

Funded by:

Project "Innovation technologies & socio-ecological-economic solutions for fire resilient territories in Europe - FIRE-RES" Nº101007950.

DecisionES Mobility Project of the Marie-Curie Marie Skłodowska-Curie grant agreement No 101007950.

Sergio Rodríguez Fernández
sergiorf@isa.ulisboa.pt
sergiorf4@gmail.com