Fire Management and Advanced Analytics

ISCI

Advanced Analytics tools for the Protection of Wildland-Urban Interface Against Wildfires

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Madrid

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UNIVERSIDAD DE CHILE

fcfm

Agenda

1. Our Approach for wildfire management
   a. Key tools
   b. Active Users
   c. Team
2. Fire-analytics QGIS toolbox
3. Use cases
   a. Fuel treatment localization for landscape protection
   b. Hazard and risk assessment for electric facilities
   c. Emissions mitigation through preventive sylviculture
4. How we manage to make impact in real world
5. Potential New Projects
   a. Smart Landscapes Design
   b. Combat Resources Allocation

Our approach
Wildfire Management and Advanced Analytics (Fire2A)

Advanced analytics tools for wildfire management before and wildfire events.

We combine:

- **Stochastic wildfire simulations**

- **Operations Research** techniques for optimization and decision support.

- **Remote Sensing**, spatial data analysis, etc.

- **Artificial Intelligence**: machine learning, deep learning, reinforcement learning.

Our Team
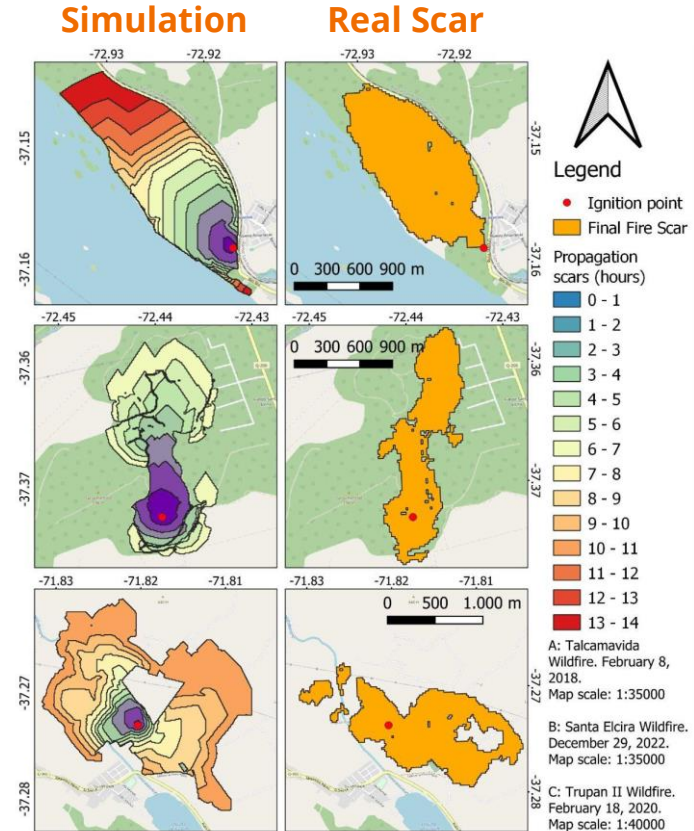## Wildfire Management and Advanced Analytics (Fire2A)

C2F-W
Open source stochastic wildfire simulator

An updated version of Cell2Fire[1].

Adapted to several fuel systems:

- KITRAL (Chile) [2]
- FBP (Canada) [1]
- Scott & Burgan (EU, USA) [3]
- Portugal (in progress)

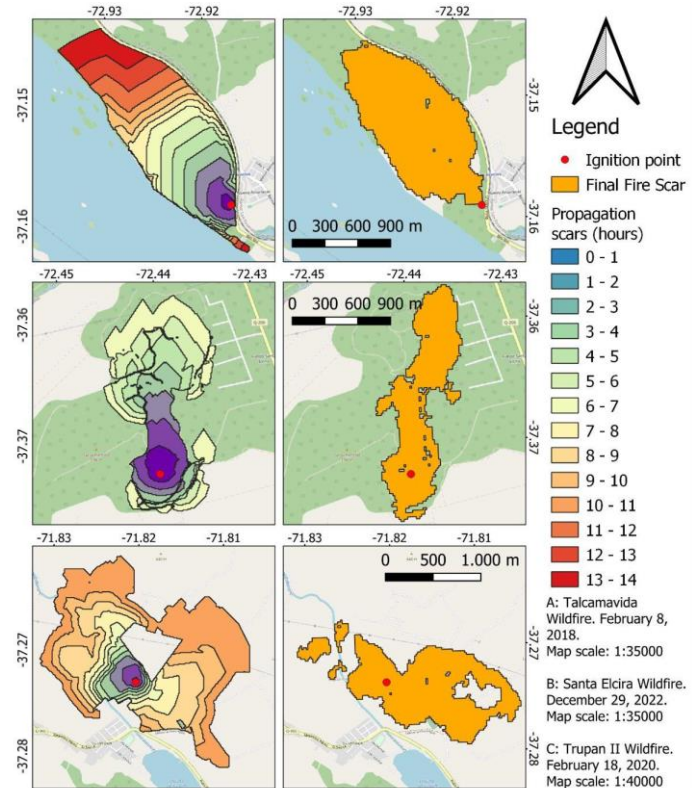# C2F-W
Open source stochastic wildfire simulator

Used by:

Simulation   **Real Scar**

Legend
- • Ignition point
- ▮ Final Fire Scar

Propagation
scars (hours)
- ▮ 0 - 1
- ▮ 1 - 2
- ▮ 2 - 3
- ▮ 3 - 4
- ▮ 4 - 5
- ▮ 5 - 6
- ▮ 6 - 7
- ▮ 7 - 8
- ▮ 8 - 9
- ▮ 9 - 10
- ▮ 10 - 11
- ▮ 11 - 12
- ▮ 12 - 13
- ▮ 13 - 14

A: Talcamavida Wildfire. February 8, 2018.
Map scale: 1:35000

B: Santa Elcira Wildfire. December 29, 2022.
Map scale: 1:35000

C: Trupan II Wildfire. February 18, 2020.
Map scale: 1:40000

Workflow
Simulation, hazard and risk analysis, and optimization
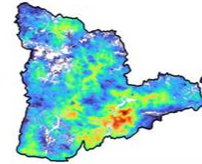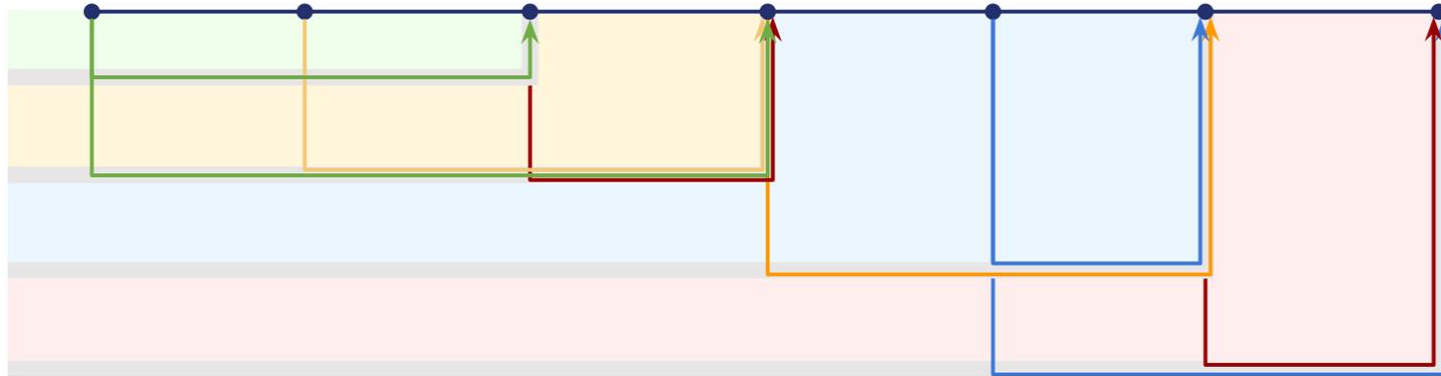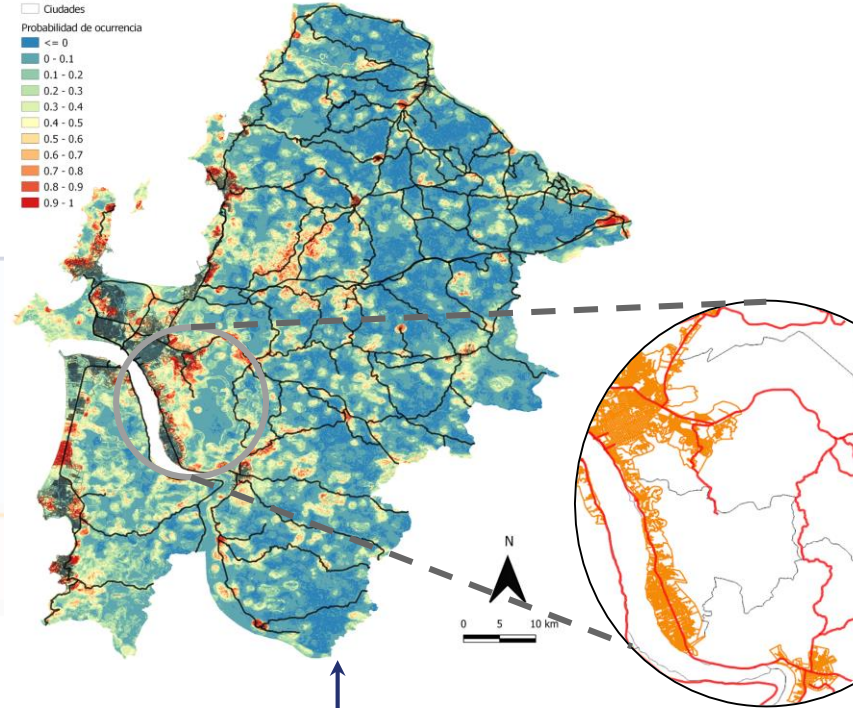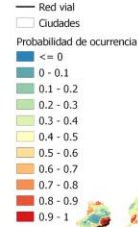
Ignitions could be:

- Random
- Ignition Probability Map (raster layer)
- Spatial Points

Fire-analytics QGIS toolbox
Simulation, hazard and risk analysis and optimization

National administrator for forestry policy and wildfire fighting.

We developed an interactive tool for:

- Wildfire simulation
- Optimization for fuel treatment allocation under technical and budget constraints.
- Wildfire hazard and risk assessment.

Processing Toolbox

Search...

- Fire Analytics
  - Cell2 Fire Simulator
  - Instance Downloader
  - Decision Optimization
    - Multi Objective Raster Knapsack
    - Polygon Knapsack
    - Polygon Treatment
    - Raster Knapsack
    - Raster Treatment
    - Raster Treatment Team
  - Simulator Post Processing
    - Bundle
    - Fire Scar
    - Ignition Points
    - Propagation DiGraph
    - Spatial Statistic
  - Simulator Risk Metrics
    - Betweenness Centrality Propagation Metric
    - Burn Probability Propagation Metric
    - Downstream Protection Value Propagation Metric
  - Utils
    - Match All Grids
    - Meteo Kitral
    - Polygonize Multiple Rasters

Fire-analytics QGIS toolbox
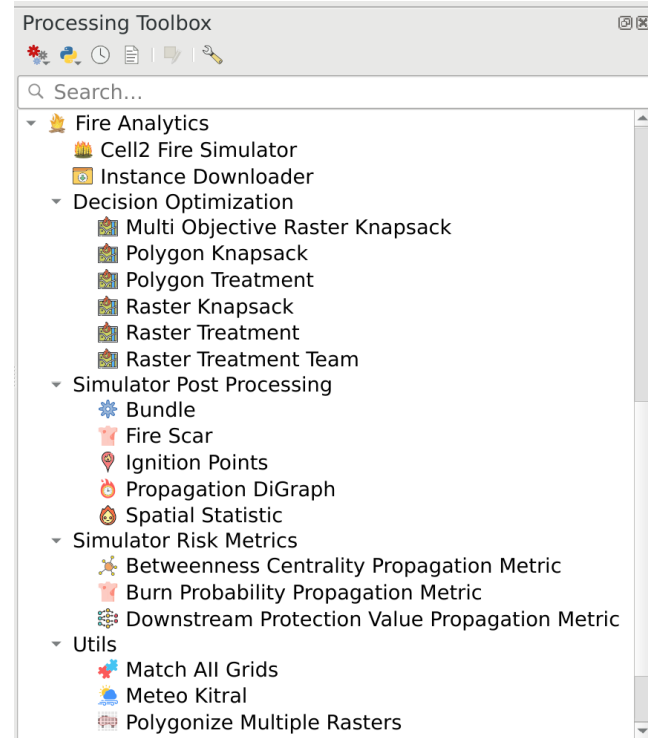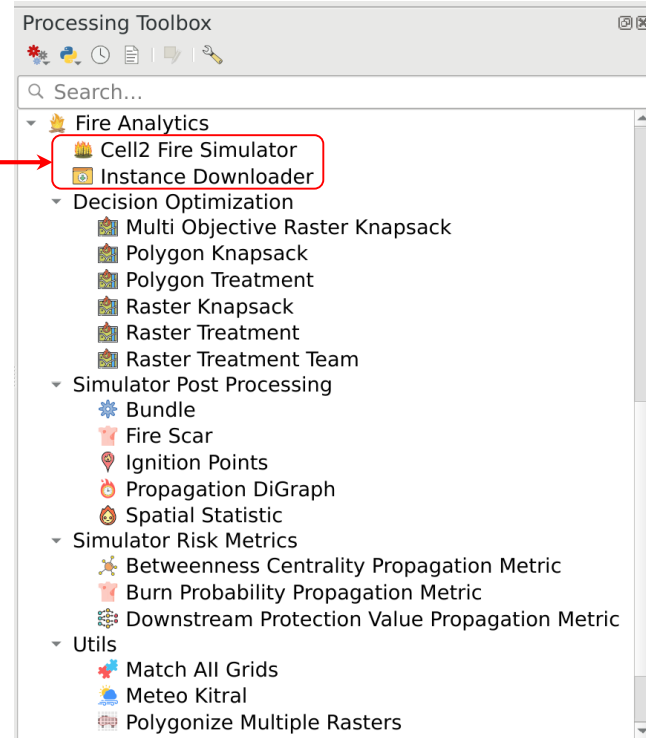## Simulation, hazard and risk analysis and optimization

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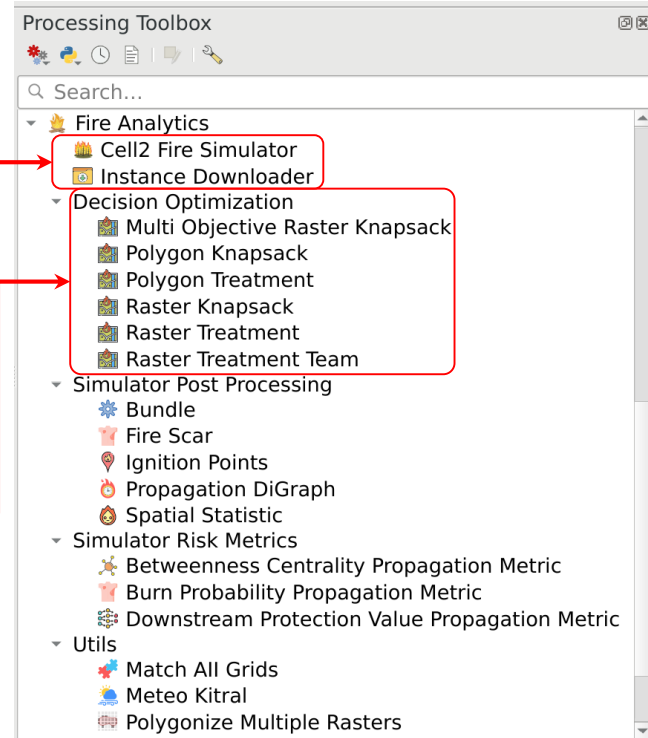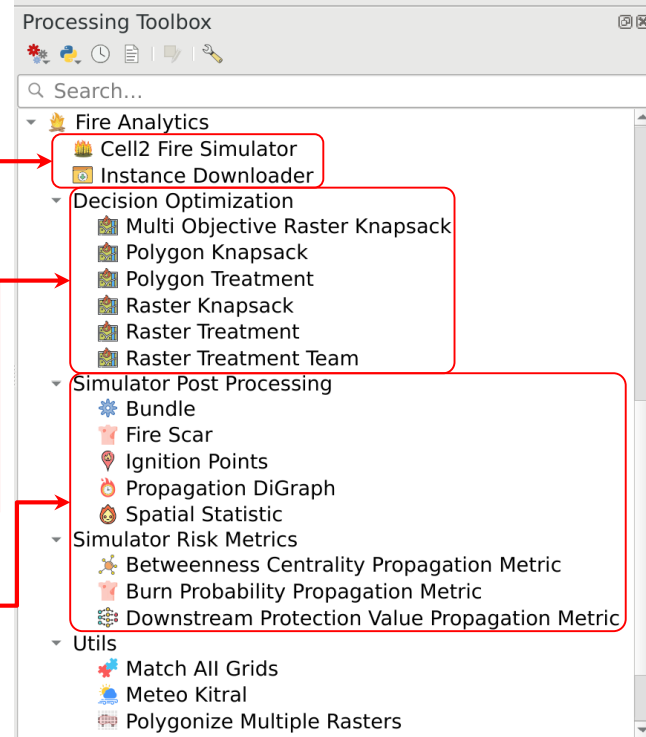## Simulation, hazard and risk analysis and optimization

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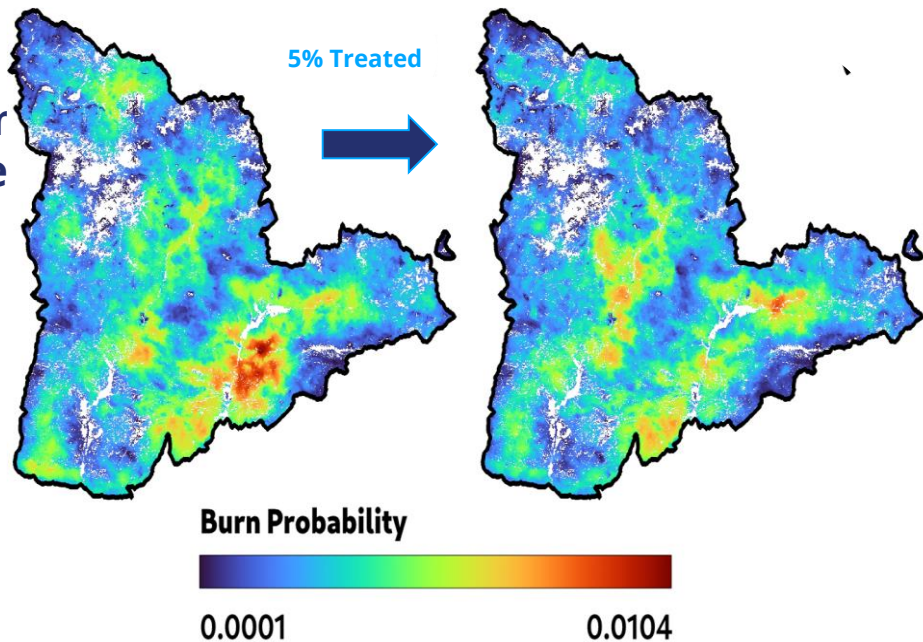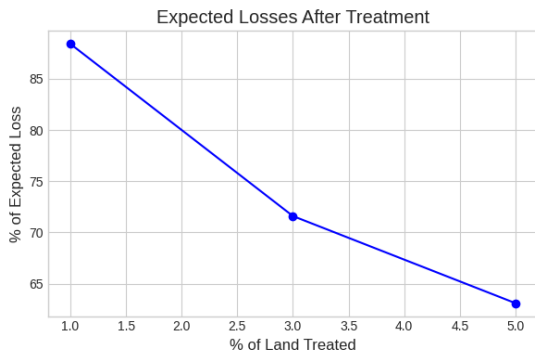- Wildfire hazard and risk assessment.

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Fire-analytics QGIS toolbox
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Use Case: protection of WUI
Optimization to protect values at risk by fuel treatment [6]
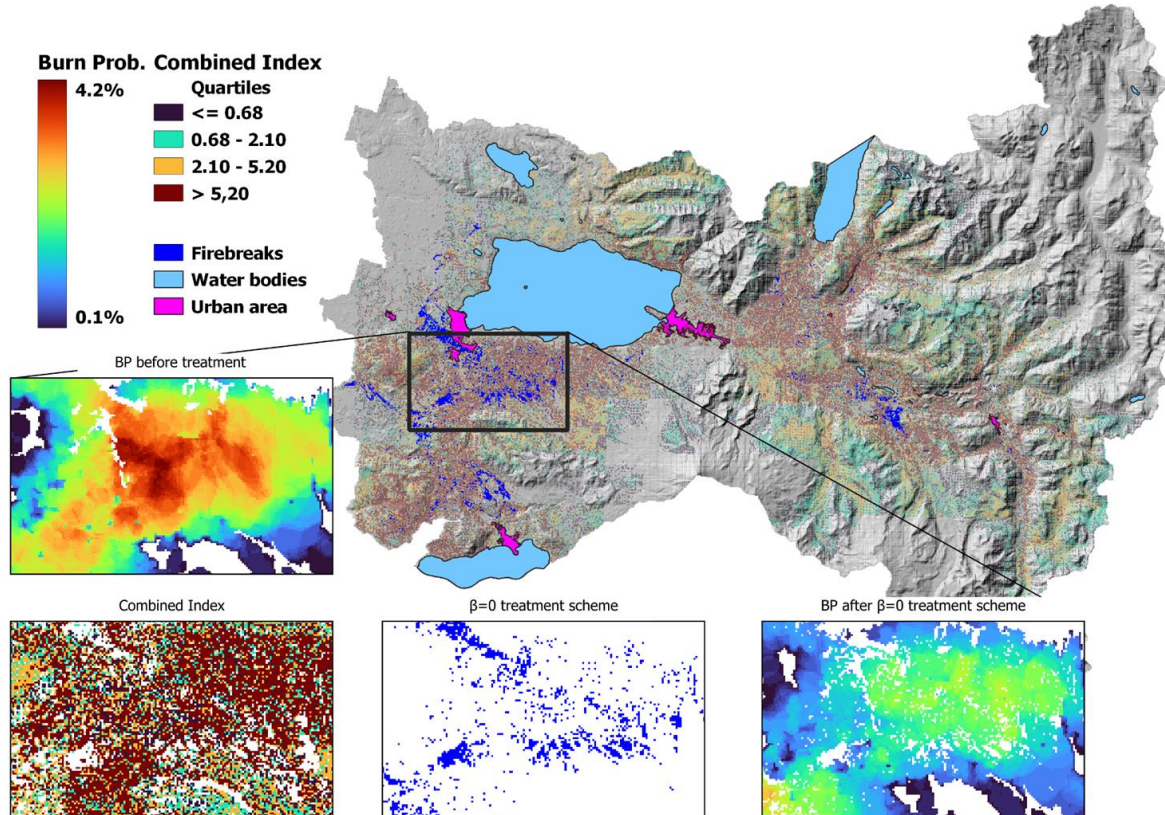
FIRE-RES

Strategic fuel treatment placement can **reduce expected losses by more than 35% with 5% or less of the landscape treated.**

- Theoretically tested in Catalonia, Portugal, Chile and Canary Islands

Expected Losses After Treatment

5% Treated

Burn Probability

0.0001   0.0104

saesa®

Chilean electric company. In 2022 had more than **6.600 thousand customers** around the country and a **net worth of more than 290 million USD.**

We estimate the:

- impact that fires can have on their infrastructure.
- impact that a fire that starts in their infrastructure can have on landscape values.

0   7.5   15 km   Probabilidad de quema

0.02%   6.43%
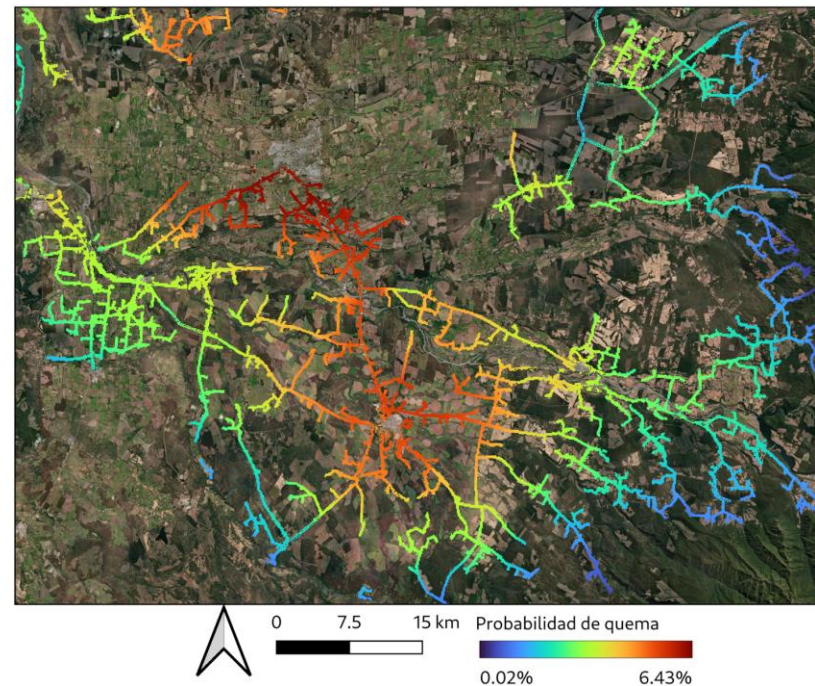
SOFOFA, 142-year old, **unite over 160 companies**.

Emission mitigation through preventive sylviculture:

- Spatial estimation of expected emissions from wildfires.
- Minimization of expected emisiones through fuel treatment allocation.

ISCI
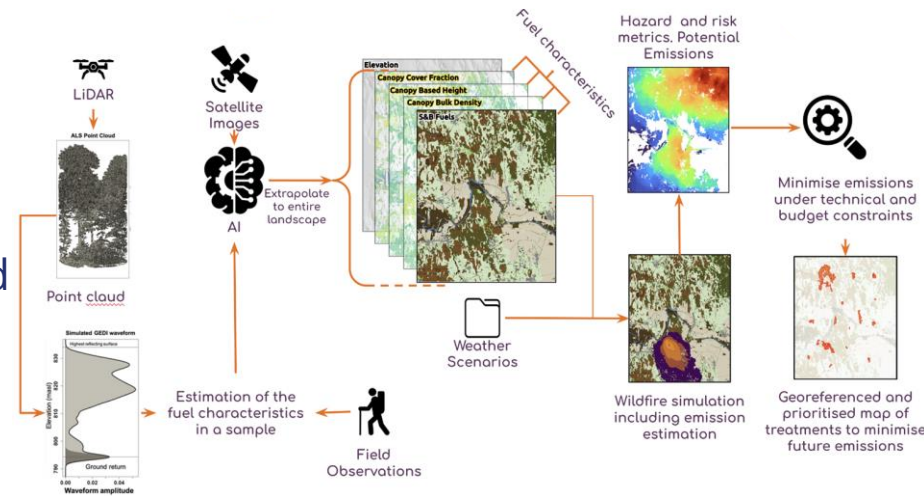
- **Solve problems,** then publish.

- **Visibility:** Official media appearances.

- **Listen not just words**, but needs and wants.

- **Joint project formulations**

- **Regular collaborations** through periodic working and discussion sessions.

- Transparency and honesty:

  - What we can really do

  - Unintuitive and unexpected results

Potential New Projects
Smart Landscape Design to maximize EESS and fire preparedness

Smart landscapes:

- Engagement of **multiple stakeholders**
- **Minimizing risks** of wildfire and floods.
- **Maximizing Ecosystem Services**
    - Water preservation,
    - Soil preservation,
    - biodiversity, etc.
- **Maximising economic and social benefits**
    - Productive activities,
    - Recreational activities, etc.

Combat resources localization:

- Operational and
- Tactical planning

References / Our Research

[1] Pais, C., **Carrasco, J.**, Martell, D. L., **Weintraub, A.**, & Woodruff, D. L. (2021). Cell2Fire: A cell-based forest fire growth model to support strategic landscape management planning. Frontiers in Forests and Global Change, 4, 692706.

[2] **Carrasco, J. and Pais, C.l and Soto, F. and Palacios, D. and Mahaluf, R. and de la Barra, F. and Gilabert, H. and Alfaro, G. and Miranda, A. and Castillo, M. and Weintraub, A.,** C2F K: An Open-Source Wildfire Simulator Based on Cell2Fire and the Chilean KITRAL System. Available at SSRN: https://ssrn.com/abstract=4384499 or http://dx.doi.org/10.2139/ssrn.438449

[3] **Gonzalez-Olabarria, J. R., Carrasco**, J., Pais, C., **Garcia-Gonzalo, J., Palacios-Meneses, D., Mahaluf-Recasens, R., ... & Weintraub, A.** (2023). A fire spread simulator to support tactical management decisions for Mediterranean landscapes. Frontiers in Forests and Global Change, 6, 1071484.

[4] **Carrasco, J.**, Acuna, M., Miranda, A., Alfaro, G., Pais, C., & **Weintraub, A.** (2021). Exploring the multidimensional effects of human activity and land cover on fire occurrence for territorial planning. Journal of environmental management, 297, 113428.

[5] **Badilla, F.; Carrasco, J.; Espinoza, C.; González, J. R.; Palacios, D.; Mahaluf, R.; Vilchez, M.; Weintraub, A.** Recommendations for improving security on WUI at multiple scales. Deliverable D2.4 FIRE-RES project. DOI: 10.5281/zenodo.14206158.

[6] **Carrasco, J., Mahaluf, R.**, Lisón, F., Pais, C., Miranda, A., **de la Barra, F., ... & Weintraub, A.** (2023). A firebreak placement model for optimizing biodiversity protection at landscape scale. Journal of Environmental Management, 342, 118087.

Acknowledgment

Sources

[1] https://www.scientificamerican.com/article/beaver-dams-help-wildfire-ravaged-ecosystems-recover-long-after-flames-subside/

[2] Scott, A. C., Bowman, D. M., Bond, W. J., Pyne, S. J., & Alexander, M. E. (2013). Fire on earth: an introduction. John Wiley & Sons. Page 6.