Institute for
Sustainability and
Innovation in Structural
Engineering

Improving Wildfire Simulation Accuracy Using Satellite Active Fire Data Interval Reinitialization and Rate of Spread Adjustment

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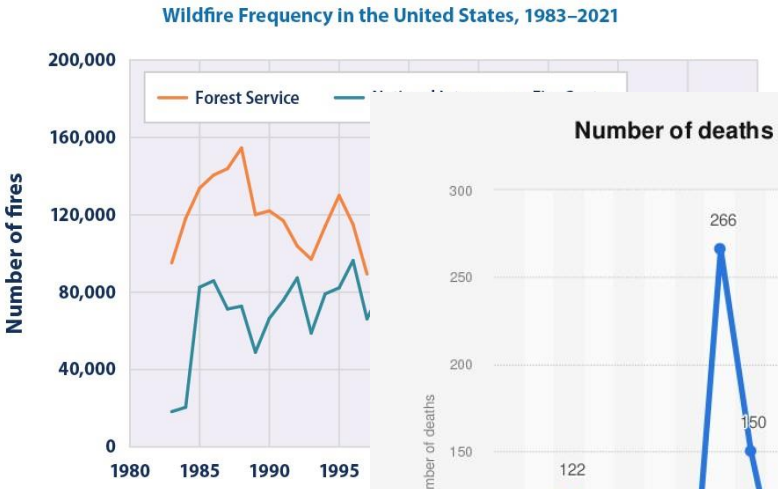
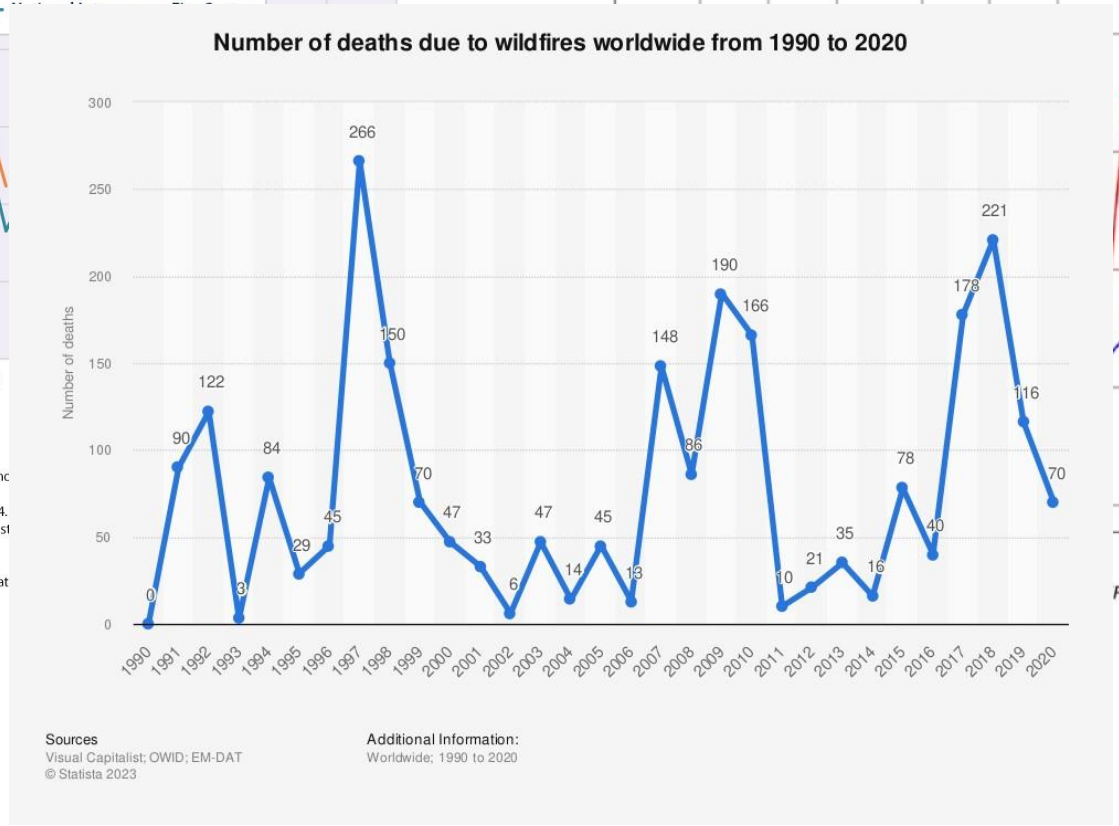
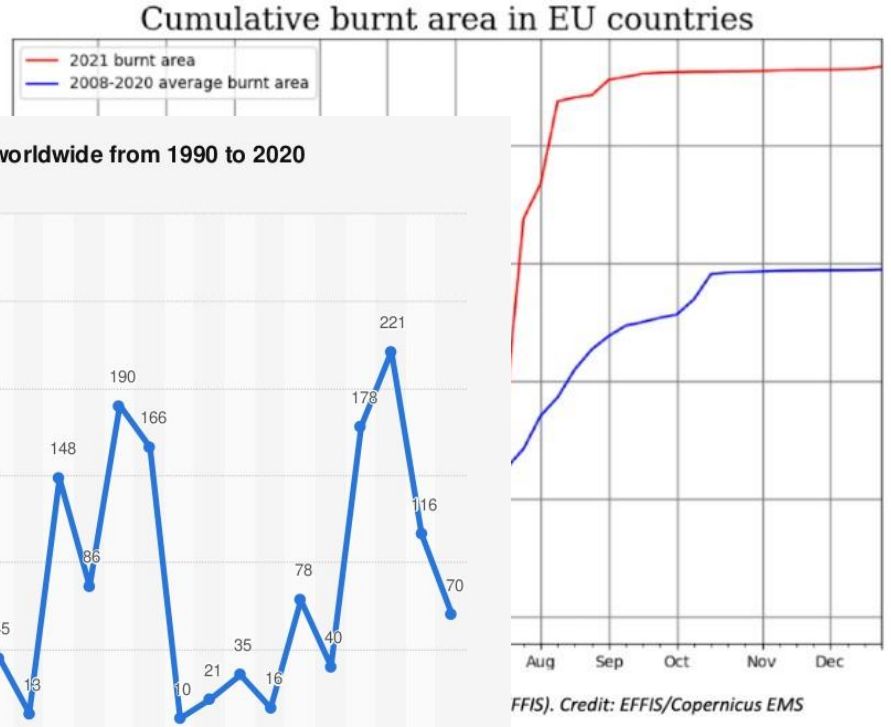
Wildfires







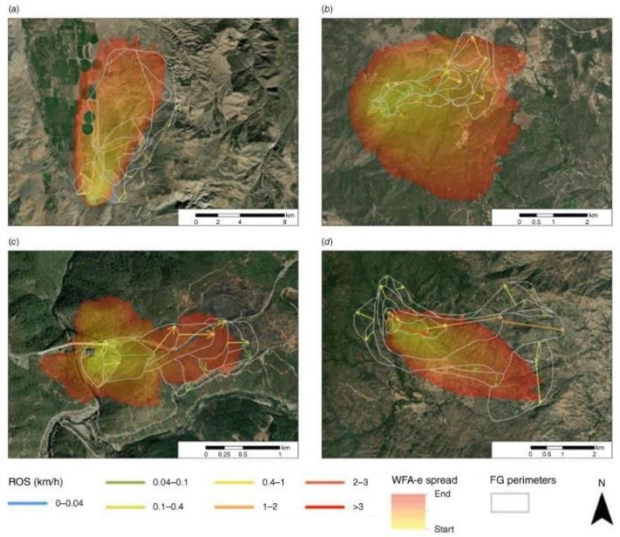
FFIS). Credit: EFFIS/Copernicus EMS

Wildfire Simulation

- Effective method for comprehending how fire spreads and evolves under different circumstances.

- Used by fire management agencies and decision-makers to analyze real-time fire behavior to:
  - develop effective suppression strategies.
  - evaluate the effectiveness of suppression efforts.
  - whether to evacuate a certain region or not.
  - wildfire prevention efforts such as c… d fuel management.

But…



The Accuracy of models depends on:

- **Their limitations,**
- **assumptions,**
- **accuracy of input data**

Simulation Accuracy

- ROS accuracy of five fuel-type specific fire spread models in Australia over 49 case studies (Cruz et al., 2018):
  - MAPE of 42% up to 124%

- ROS accuracy of the Rothermel model for 4 types over 29 case studies:
  - MAPE of 49% up to 76%

- Cardil et al., (2023) assessed the performance of operational fire spread models in California over 1853 fires:
  - MAPE of 26% up 67%

Gaps & Challenges

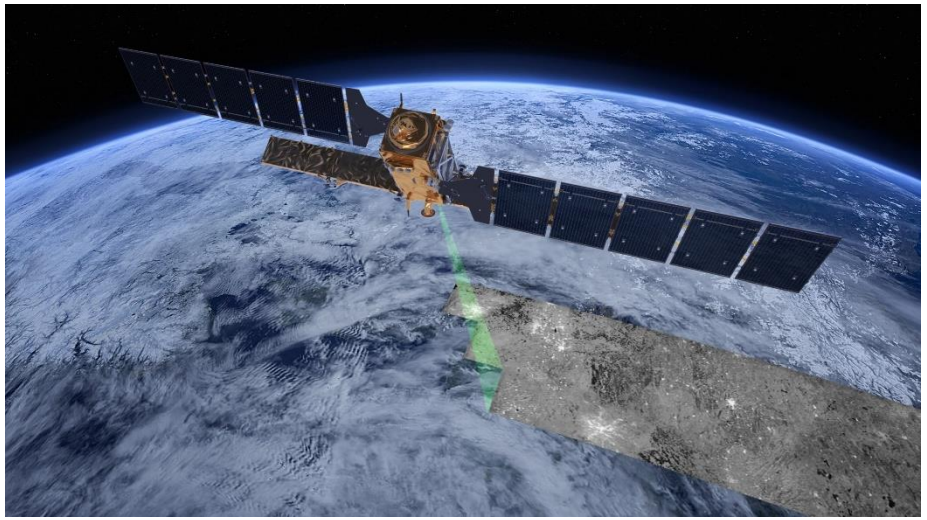
- Accumulation of Errors

- Rate of Spread adjustment:

  - Rothermel and Rinehart (1983) and then by Finney (1998)
  - match the simulated ROS with the actual fire.
  - Evaluating manually, search for the optimal adjustments iteratively.
  - **However, manual work, error-prone, time-intensive**
  - **Require control points where the fire arrival time is known.**

Earth Observations

- Offer an invaluable resource to remotely monitor and characterize wildfire temporal and spatial evolution.
- Evaluate the discrepancies between fire simulations and actual fire spread cost-effectively.
- widely accessible and reliable resource.
- global coverage.
- readily and freely available through various online platforms.
- providing both historical records and near-real-time information.

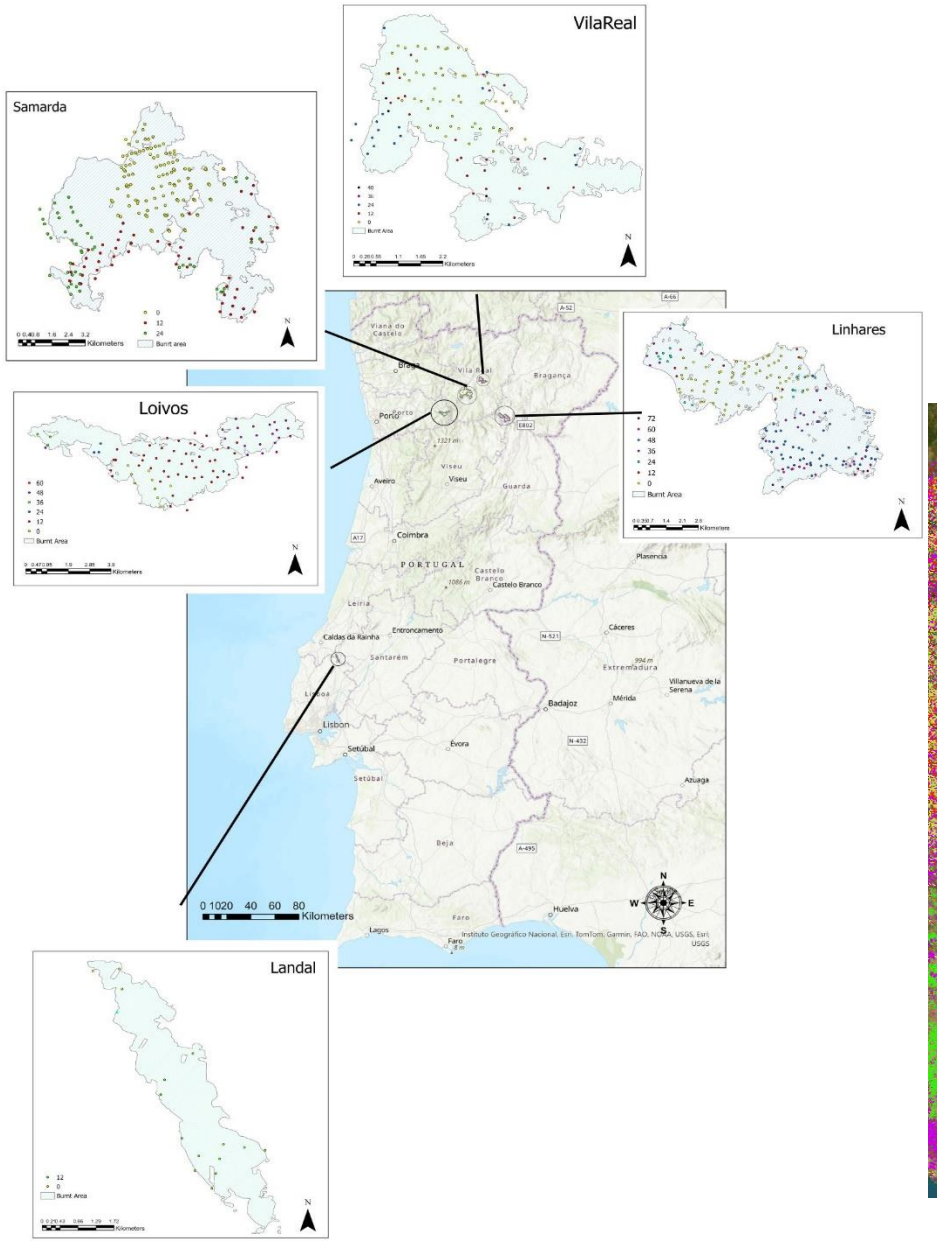


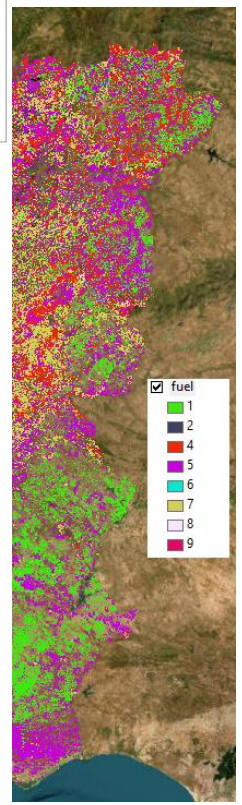
Method

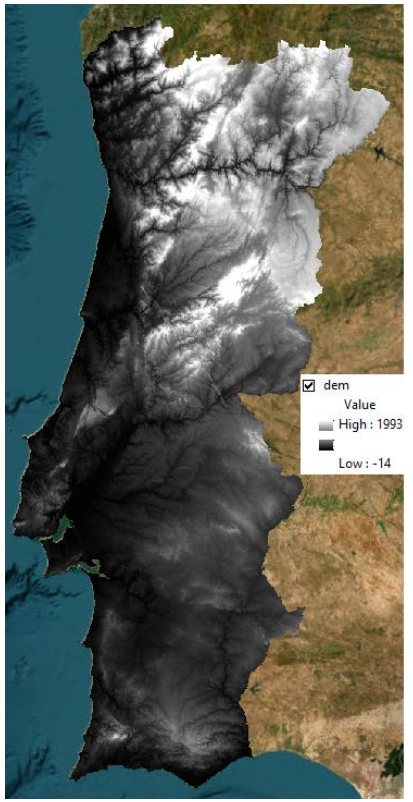
- Divide the total fire period into specific segments.
- Use an automatic algorithm for ROS adjustment.
- Use satellite active fire data for control points.
- Reinitialize the simulation each 12 hours aligned with satellite data.
- Adjust ROS of each segment and apply to the next interval.

Wildfire Simulation

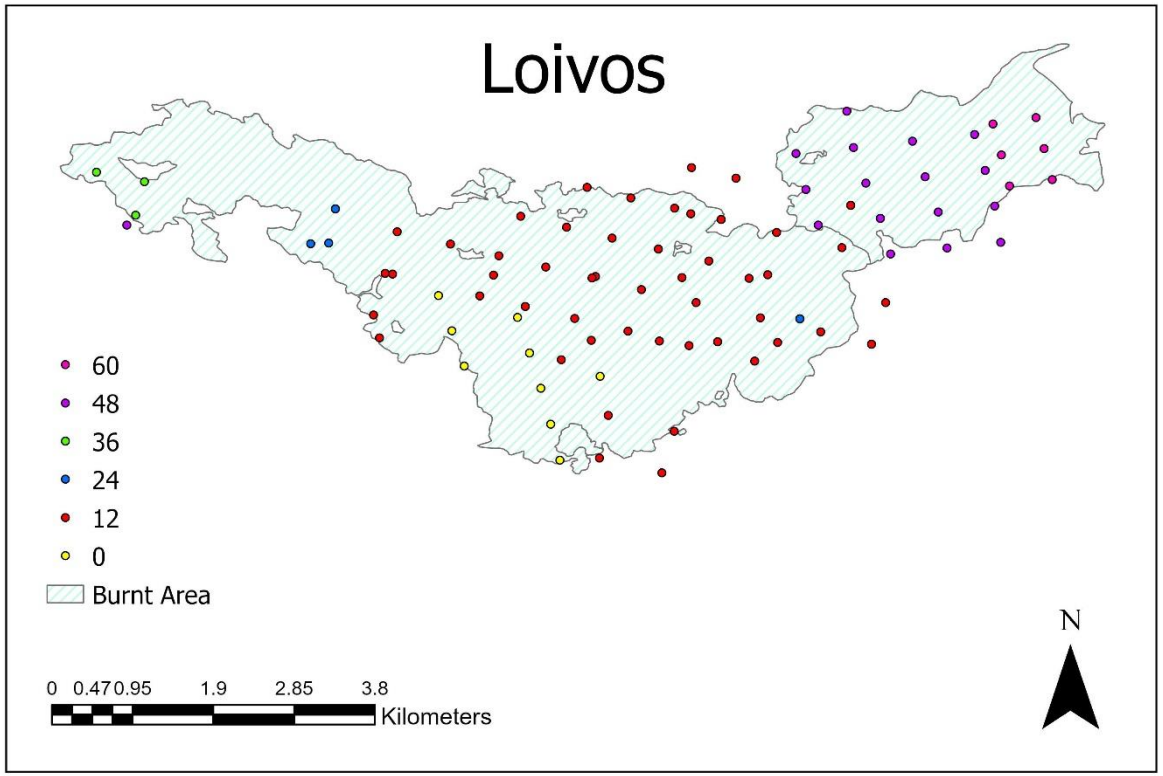
- Rothermel spread model
- Nelson's equation for dea
- Inputs:
  - **Fuel Cover:** COS20
  - **Fuel Model:** Rotherr
  - **Digital Elevation Mo**
  - **Weather** (Instituto Portugu
  - **Satellite Hotspots** (F

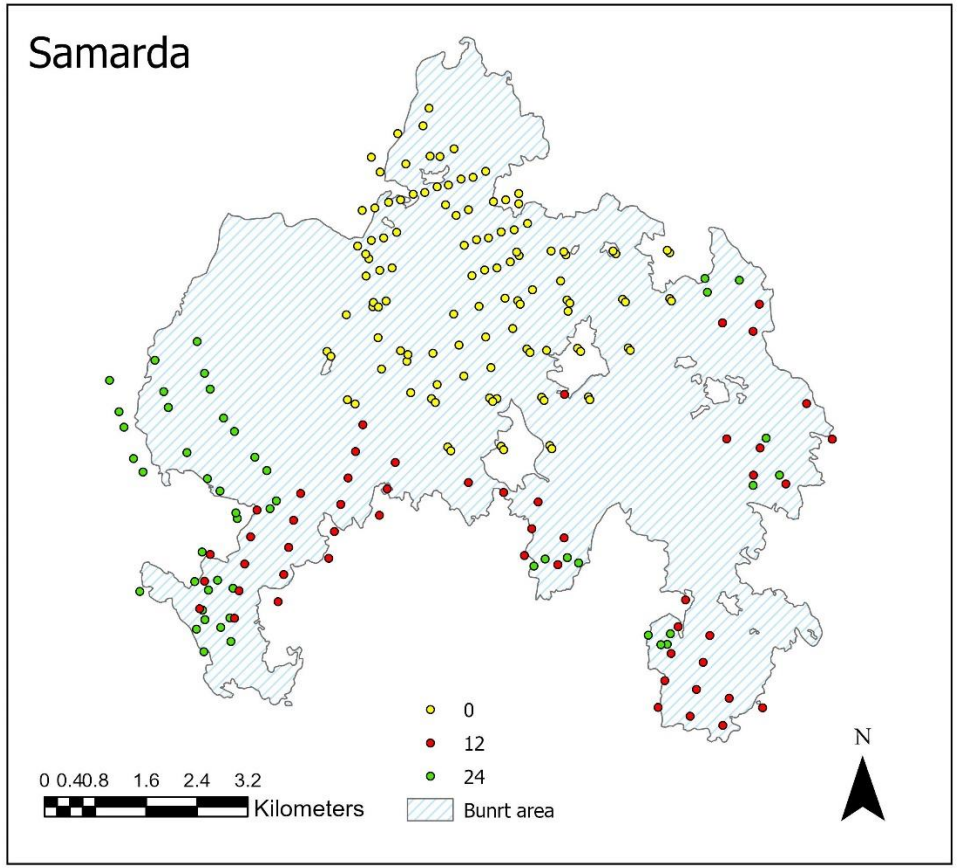




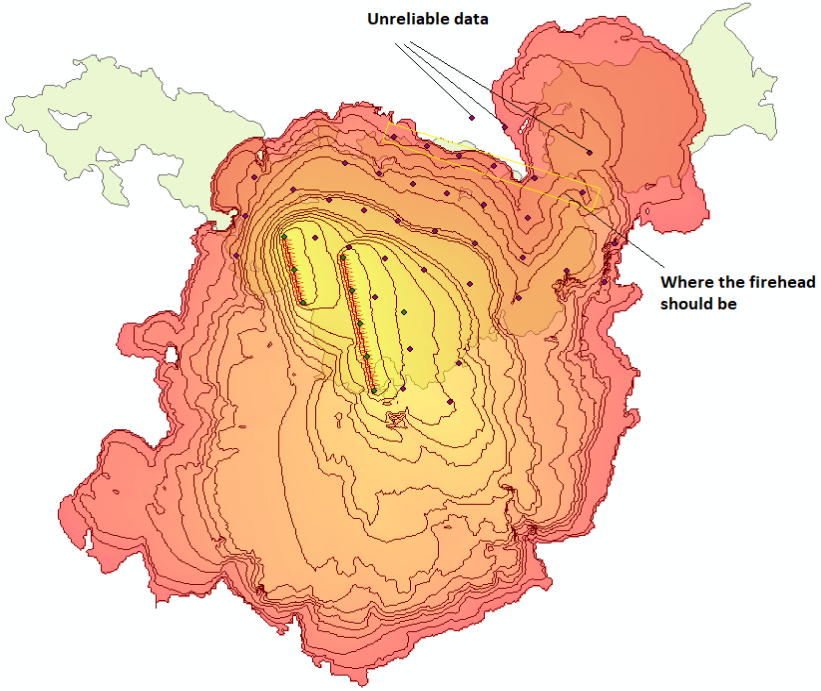


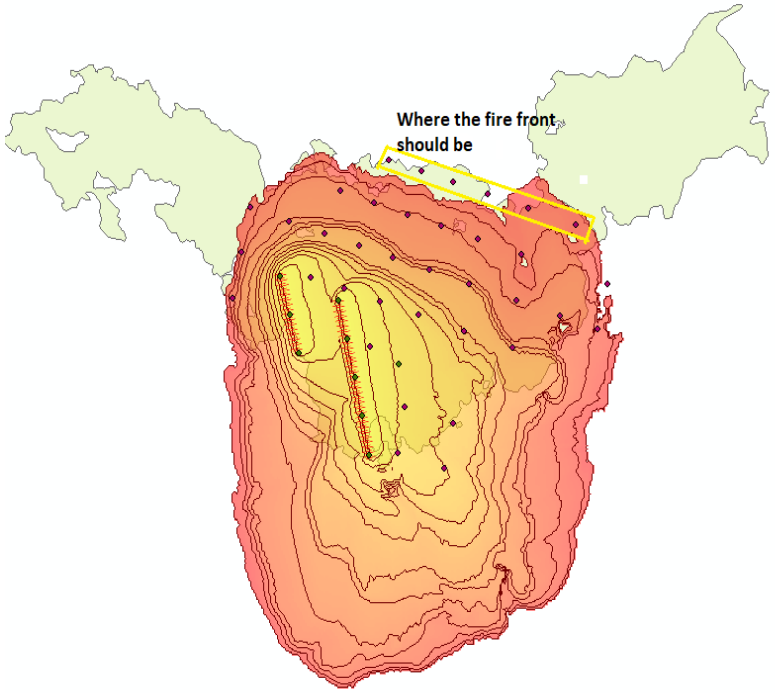
Wildfire Simulation Using Satellite Data



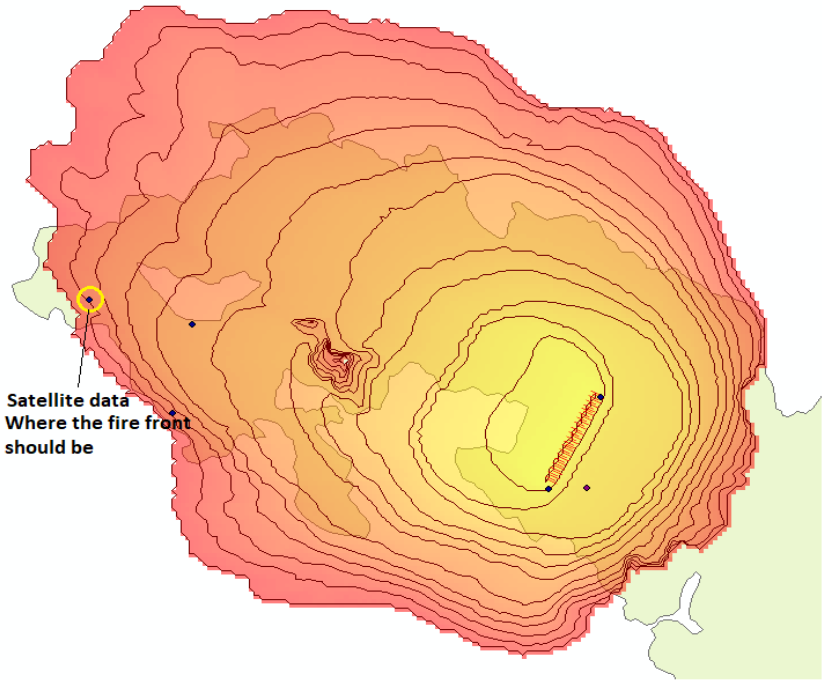


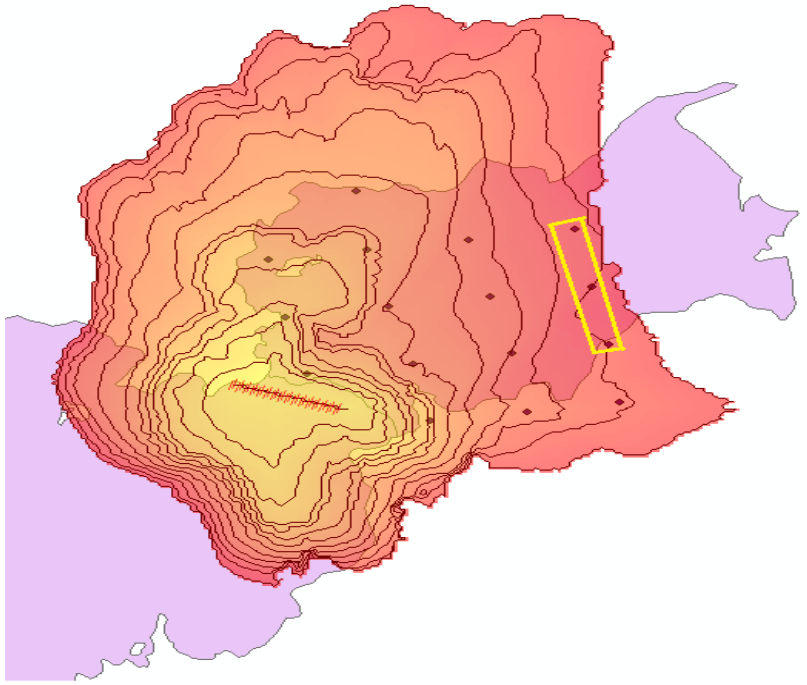
Wildfire Simulation Using Satellite Data



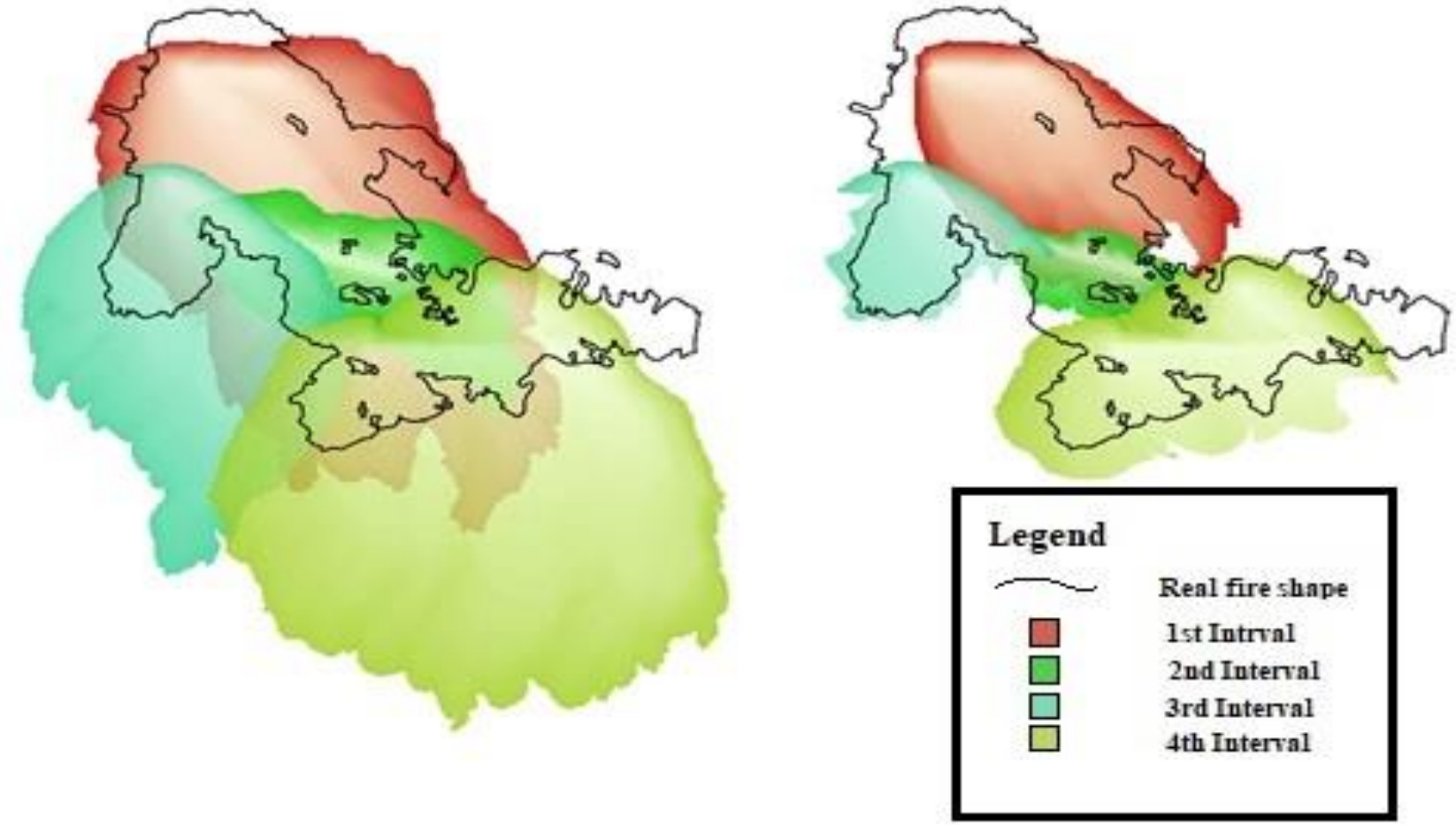


Wildfire Simulation Using Satellite Data

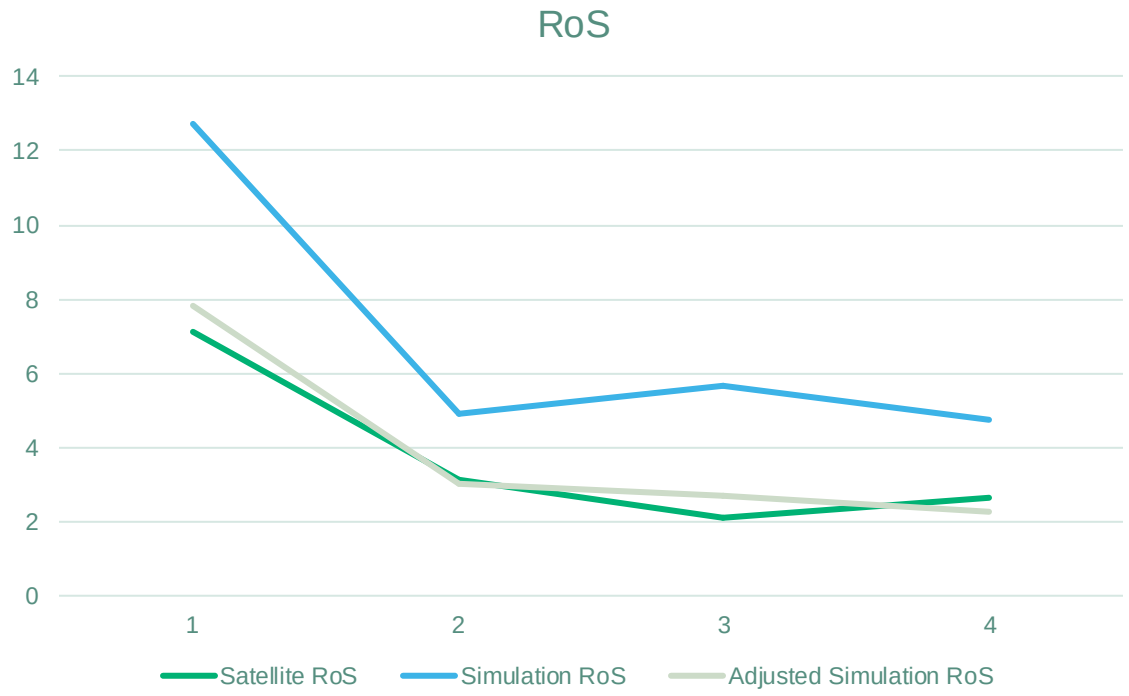


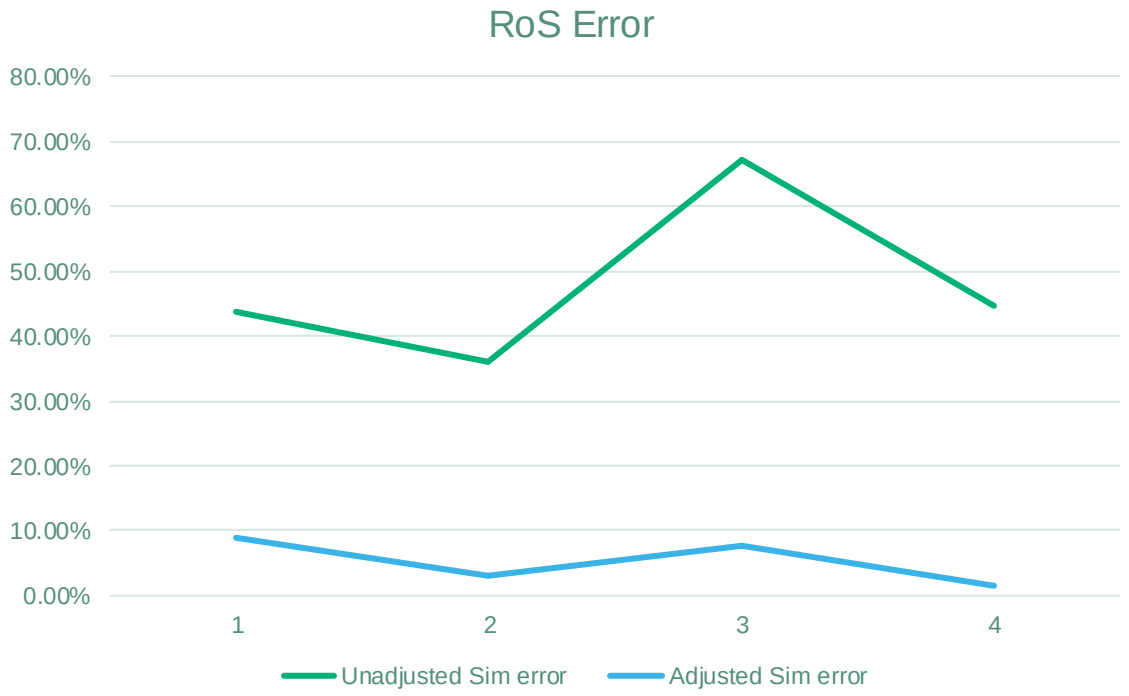


Results

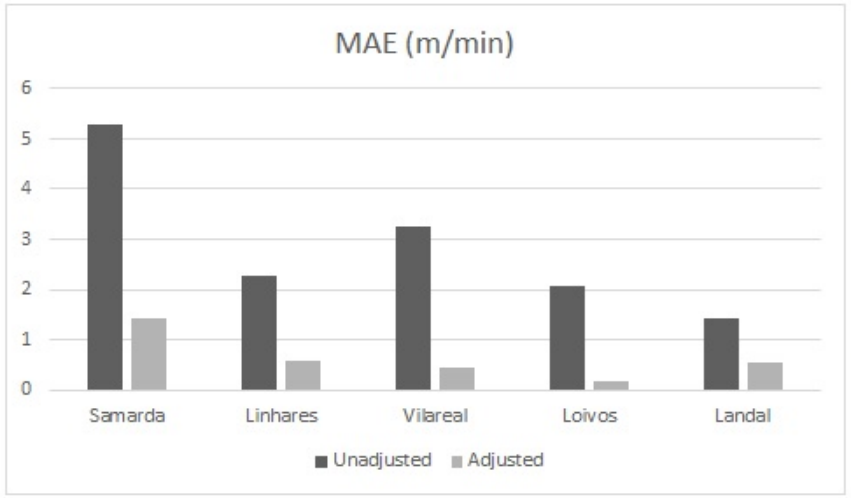

Legend
Real fire shape
1st Intrval
2nd Interval
3rd Interval
4th Interval

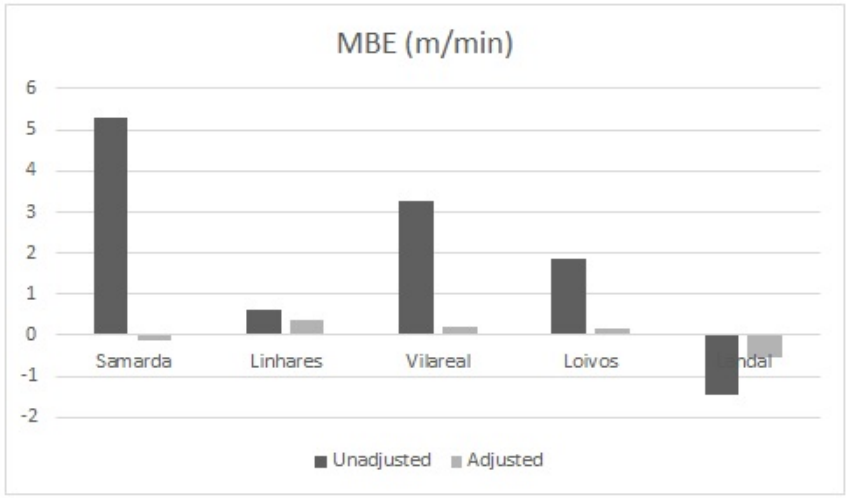
Results

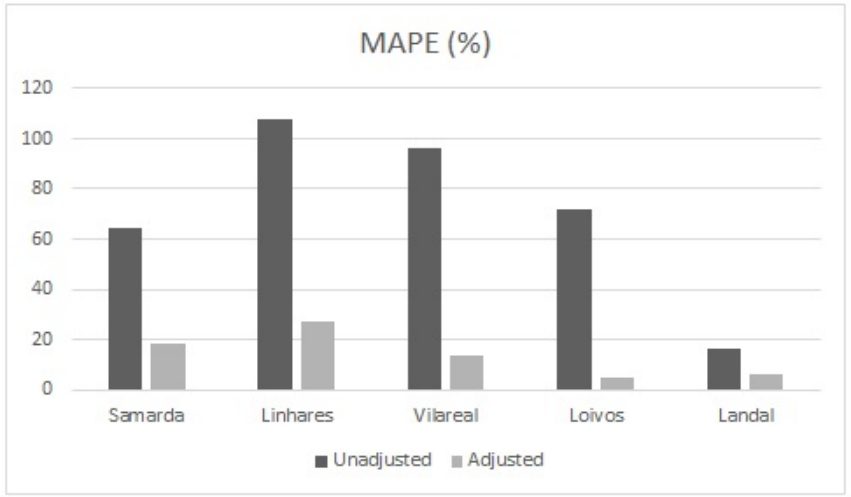

RoS
14
12
10
8
6
4
2
0
1
2
3
4
Satellite RoS
Simulation RoS
Adjusted Simulation RoS

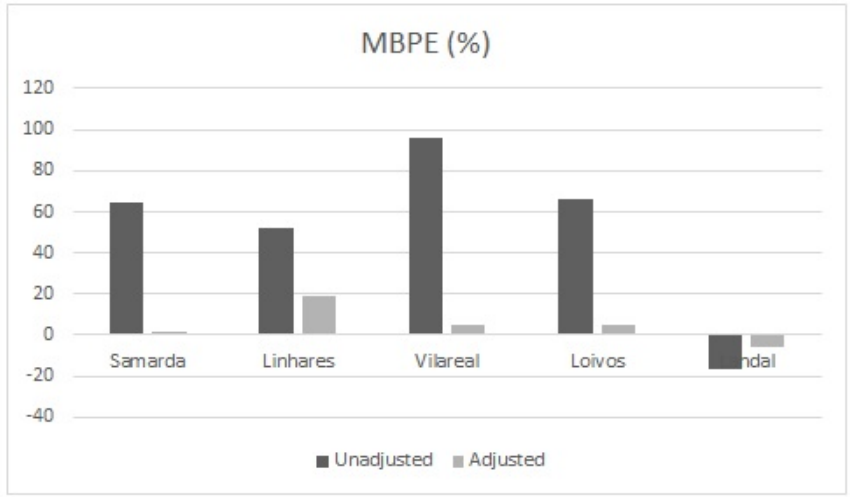

RoS Error
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1
2
3
4
Unadjusted Sim error
Adjusted Sim error

Results


MAE (m/min)
6
5
4
3
2
1
0
Samarda
Linhares
Vilareal
Loivos
Landal
Unadjusted
Adjusted


MBE (m/min)
6
5
4
3
2
1
0
-1
-2
Samarda
Linhares
Vilareal
Loivos
Unadjusted
Adjusted


MAPE (%)
120
100
80
60
40
20
0
Samarda
Linhares
Vilareal
Loivos
Landal
Unadjusted
Adjusted


MBPE (%)
120
100
80
60
40
20
0
-20
-40
Samarda
Linhares
Vilareal
Loivos
Unadjusted
Adjusted

Conclusion

- **Primary Goal:**
  - Improve the Accuracy of Wildfire Simulations
- **Improvements to Simulation:**
  - A cost-effective, near-real-time approach
- **Final Results:**
  - MAPE from an average of 71.43% decreased to 13.99% over 5 case studies
- **Limitations:**
  - 1-3 hour data availability delay.
  - Accuracy of satellite data affected by cloud cover or hot smoke plumes.
  - ROS adjustments are only done on burned fuels.

Thank you for your attention.

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