Global Earth Observation - Benefit Estimation: Now, Next and Emerging

GEOBENE

Assessing the economic, social and enviromental benefits of the GEO domains

Value of Weather Observations for Reduction of Forest Fire Impact on Population

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In this study we investigate how improvements in the weather observation systems help to reduce forest fires impact on population by targeting and monitoring places where ripe fires are likely to occur. For the purposes of population impact assessment we suggest a relevant index. In our model the air patrolling schedule is determined by the Nesterov index, which is calculated from observed weather data sets at different spatial resolutions. The reduction of fire impact on population, associated with utilization of finer grid/increased number of weather stations, indicates the benefits of more precise weather observations.

Subject of Research – Forest Fires model based on Nesterov index using

- "rough" and "fine" weather data grids
- varying number of weather stations / combining data sets (SoS effect)

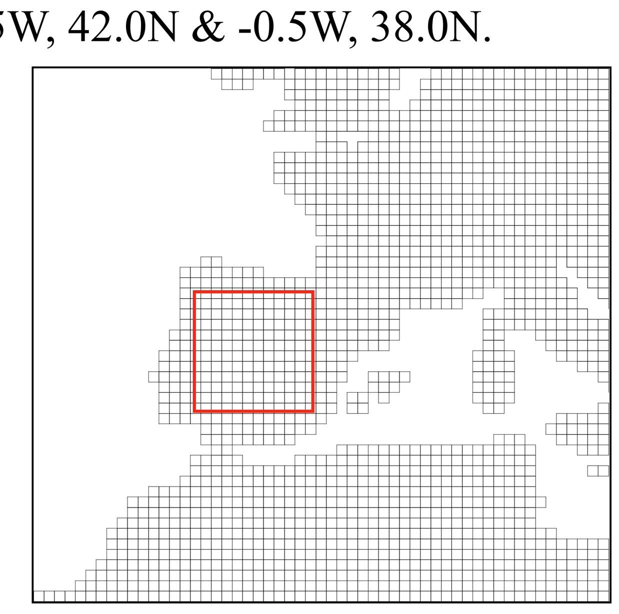
Objectives – Assessment of the incremental value of information in terms of

- saved forest / patrolling costs
- fire impact on population

Weather Dataset – JRC-AGRIFISH / MARS-STAT Data Base

- daily basis, interpolated
- Europe, 50 x 50 km grid for the year 2000 containing:
- maximum/minimum temperature (°C)
- mean daily vapor pressure (hPa)
- mean daily rainfall (mm)

Area and Grids – The area is partly covering the territory of Spain and Portugal located approximately between -7.5W, 42.0N & -0.5W, 38.0N.



- "Fine" grid: 12 x 12 cells, 50 x 50 km each.
- "Rough" grid: 6 x 6 cells, 100 x 100 km each.

Nesterov Index

$$I(t)=\sum_{k=s}^{t}(T_k-T_k^d)\cdot T_k,$$

here t – day number since the start of observations, T_k – daily temperature (°C), T_k^d – dew point temperature (°C) for the day k. For all the days with precipitation greater than 3 mm, the Nesterov index drops to zero and the summation restarts from the next day s.

Fire Impact on Population Index

$$FIPI = B / A \times D,$$

B – yearly burnt area (all parameters per grid cell), A – total area, D – population density (inhabitants per km²).

Fire Danger Classes and Air Patrol Frequency

Nesterov index	Fire danger	Fire danger class	Air patrol frequency
< 300	—	I	No patrol
> 300	Low	II	Once in 2–3 days
> 1 000	Medium	III	Once daily
> 4 000	High	IV	Twice daily
> 10 000	Extreme	V	Three times a day

Probabilities Assessment

Probability of a fire in case of ignition:

$$P(I) = 1 - e^{-aI},\ a = 0.000337.$$

Average number of ignitions during a day:

$$N(D) = (w(D)\, D\, b + l)\, S,\ \text{where } b = 0.1,\ w(D) = 6.8\, D^{-0.57},\ l = 0.02,$$

D – population density (habitants/km²), S – area (km²).

The probability of at least one fire in the area:

$$P_1(I, D) = 1 - (1 - P(I))^{N(D)}.$$

Simplifying Assumptions

- Homogeneous forest, no extreme winds
- Constant fire spread velocity v = 0.3 m/min
- Maximum fire duration is 24 h

Calculation Methodology

$$FIPI_{total}=\sum_{i,j=1}^{12}\left(D_{ij}\sum_{t=1}^{365}S_{ij}^{t}\right),$$

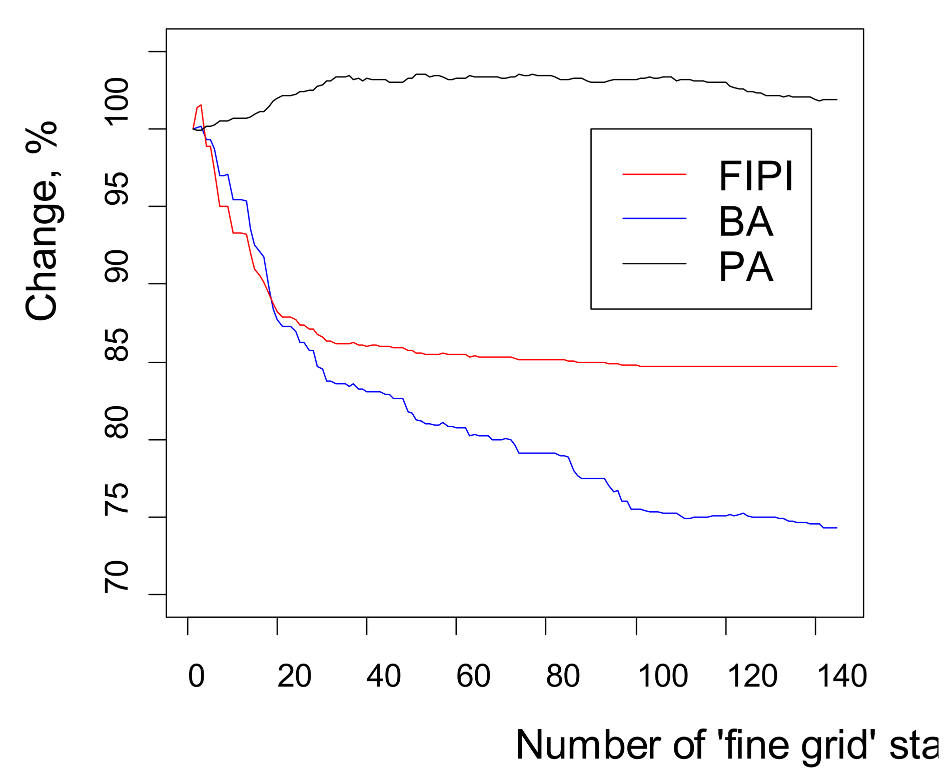
where D_{ij} – population density in the grid cell (i,j), and S_{ij} – expected relative burned area in the grid cell in day t implicitly depending on Nesterov index and population density.

Results

Total expected FIPI, burned area (% of total area) and cumulative patrolled area (times of the total area) for rough and fine grids and respective improvement ratios.

	Rough grid	Fine grid	Improvement
FIPI	0.4496	0.3807	15 %
Burned area	0.5261 %	0.3910 %	26 %
Patrolled area	295.2	300.8	-2 %

Dependence of the FIPI, burned (BA) and patrolled (PA) areas on the number of 'added' weather stations.



References

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