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An integrated methodology for fire risk assessment management planning in peri-urban areas. Linking ML/ GIS modelling with in-situ research

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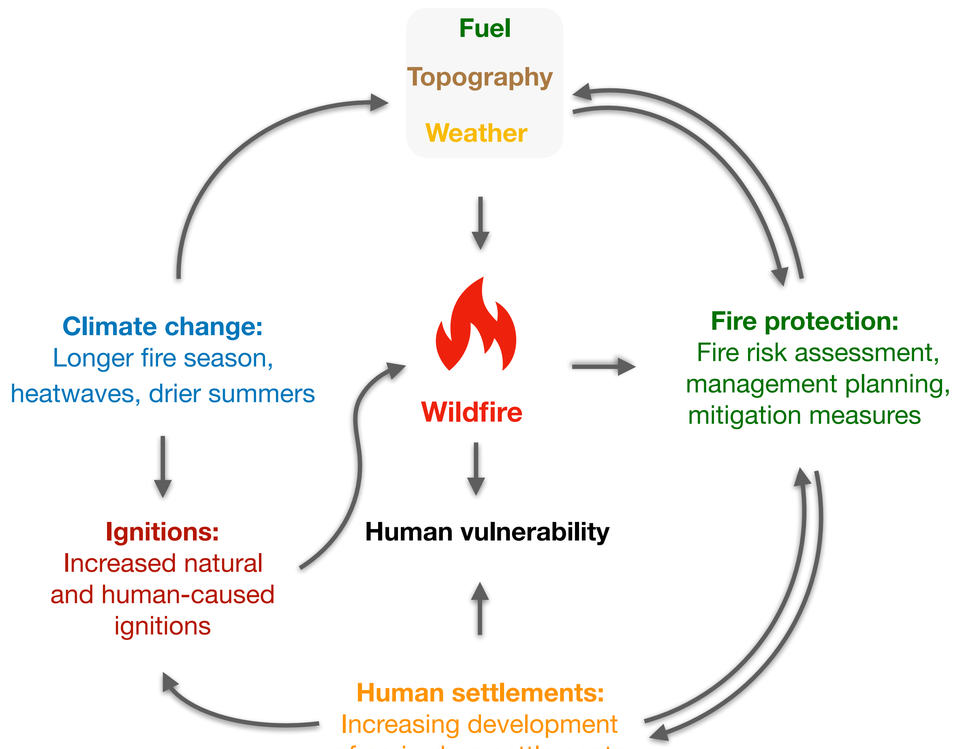
Motivation

- Forest fires represent an extremely serious environmental issue in the Mediterranean region. While the Mediterranean vegetation has already strongly flammable character that serves as a provoking mean for frequent and intense fires, climate change impacts has led to increased vulnerability and reduced adaptation (1).
- Fire risk assessments are necessary to reduce the impact of natural disasters and support decision making (protective measures, mitigation actions, emergency evacuation procedures, etc.).



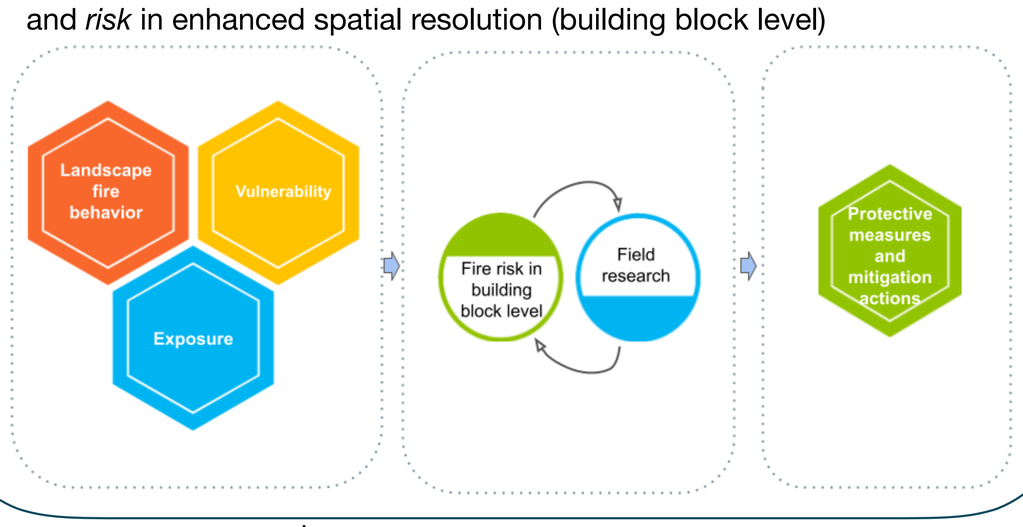
Problem formulation

- Peri-urban zones, mainly due to uncontrolled urban-sprawl and lack of proper planning, are more vulnerable to wildfires leaving people's lives and properties and the surrounding natural environment and ecosystem, exposed to increased disaster risk.
- Attica region, Greece, where the country's capital is located, is characterised by plethora of peri-urban settlements surrounded by intense morphological relief with steep slopes, and pine forests. Moreover, the region's rich natural landscape results in the intrusion of dense forest parts inside a significant number of settlements.
- Risk assessments and adaptation measures are identified as priority actions for managing climate change risks. Thus, the development of an integrated methodology for fire risk assessment and management planning in peri-urban areas, that are prone to forest fires is of vital importance.

Methodology

The integrated methodology developed consolidates state-of-the-art **machine learning** techniques, **geoinformatics, analytics** and **field observations.**

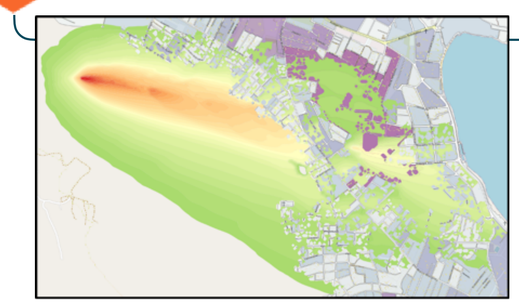
- Historical analysis of observations from meteorological stations, time series from ERA-5 model and diachronic burned areas from FireHUB archive*.
- Development of AI model (dedicated to the AOI) for the determination of the areas with high fire ignition probability.
- Integration of multi source datasets to define *hazard, vulnerability, exposure* and *risk* in enhanced spatial resolution (building block level)

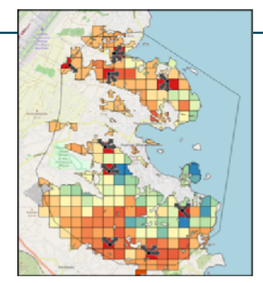


* http://ocean.space.noa.gr/diachronic_bsm/

Landscape fire behaviour

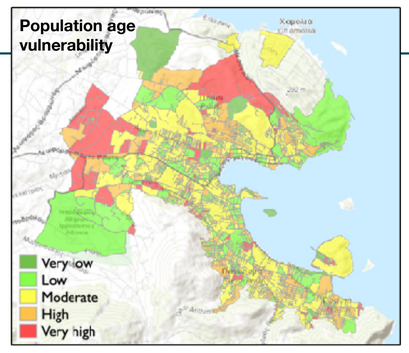
- Spatiotemporal simulations of fire spread, generated by applying the FlamMap model
- The determination of the most probable ignition points for possible fire outbreaks was derived by the BEYOND's daily fire risk forecasting machine learning model modified for seasonal forecasts (2, 3).

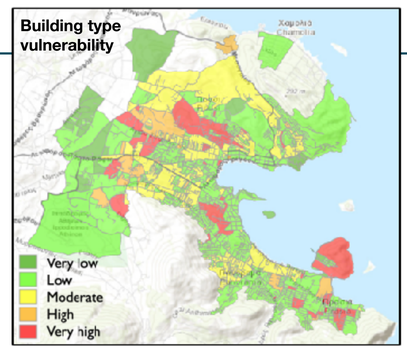




Vulnerability

This layer is produced by coupling population (density and age) and building characteristics based on 2011 census data (provided by the Hellenic Statistical Authority). Population density and age layers are used as attributes of social vulnerability (4), while the building characteristics are of vital importance to identify vulnerable to fire areas by taking into account the building materials (e.g., wood).

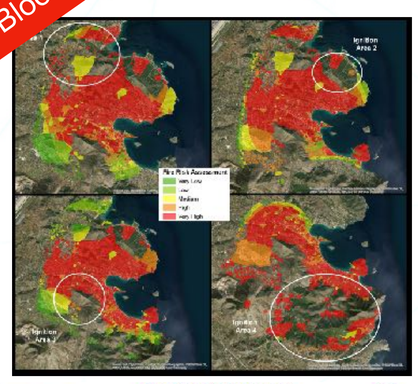




Exposure

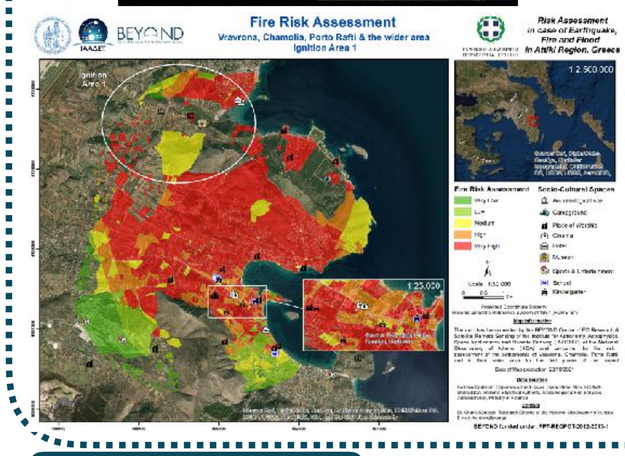
The exposure layer refers to the land value layer (€/m2) as an indicator of the qualitative estimation of the possible economic effects in the area, in case of a fire event.

Building Block level



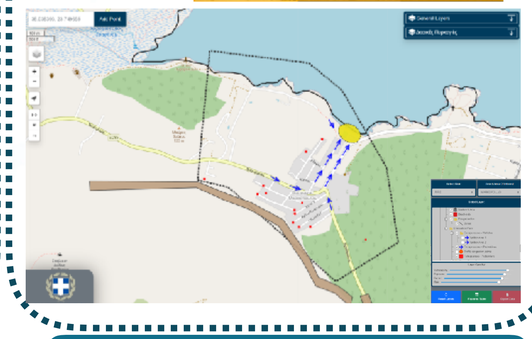
Fire risk

Combination of the layers of hazard vulnerability and exposure



Field research

Final validation and update of the risk maps. Important areas and critical points are recorded and included in the mitigation suggestions and management planning.



Results

- Several fire risk maps were produced for distinct ignition areas under multiple weather scenarios.
- Field research work was conducted in order to further examine the critical areas, validate the risk maps and finally develop useful guidelines for fire risk mitigation measures and emergency response plans during the incidence.
- The most significant issues were the poor quality of the road network along with numerous dead-ends and high street slopes, the absence of fire safe areas around constructions, the use of flammable materials in buildings (wood frame construction) and the absence of fire suppression mechanisms installations.

http://perifereia-attica.beyond-eocenter.eu/

Acknowledgements

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