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PROPAGATOR: a synchronous stochastic wildfire propagation model with distributed computation engine

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PROPAGATOR is a stochastic model of forest fire spread, useful as a rapid method for fire risk assessment. The model is based on a 2D stochastic cellular automaton. The domain of simulation is discretized using a square regular grid with cell size of 20x20 meters. The model uses high-resolution information such as elevation and type of vegetation on the ground. Input parameters are wind direction, speed and the ignition point of fire.
The simulation of fire propagation is done via a stochastic mechanism of propagation between a burning cell and a non-burning cell belonging to its neighbourhood, i.e. the 8 adjacent cells in the rectangular grid. The fire spreads from one cell to its neighbours with a certain base probability, defined using vegetation types of two adjacent cells, and modified by taking into account the slope between them, wind direction and speed. The simulation is synchronous, and takes into account the time needed by the burning fire to cross each cell. Vegetation cover, slope, wind speed and direction affect the fire-propagation speed from cell to cell. The model simulates several mutually independent realizations of the same stochastic fire propagation process. Each of them provides a map of the area burned at each simulation time step. Propagator simulates self-extinction of the fire, and the propagation process continues until at least one cell of the domain is burning in each realization. The output of the model is a series of maps representing the probability of each cell of the domain to be affected by the fire at each time-step: these probabilities are obtained by evaluating the relative frequency of ignition of each cell with respect to the complete set of simulations.

Propagator is available as a module in the OWIS (Opera Web Interfaces) system. The model simulation runs on a dedicated server and it is remote controlled from the client program, NAZCA. Ignition points of the simulation can be selected directly in a high-resolution, three-dimensional graphical representation of the Italian territory within NAZCA. The other simulation parameters, namely wind speed and direction, number of simulations, computing grid size and temporal resolution, can be selected from within the program interface. The output of the simulation is showed in real-time during the simulation, and are also available off-line and on the DEWETRA system, a Web GIS-based system for environmental risk assessment, developed according to OGC-INSPIRE standards.
The model execution is very fast, providing a full prevision for the scenario in few minutes, and can be useful for real-time active fire management and suppression.