Engineering Risk Analysis Group
Prof. Dr. Daniel Straub

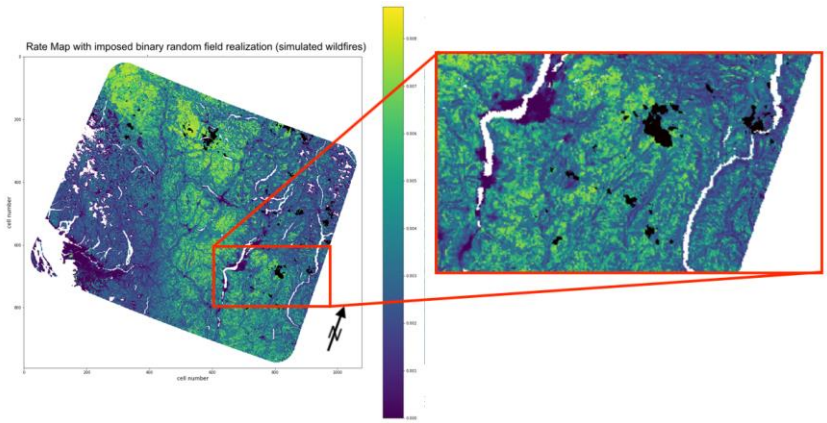
Master's Thesis - Environmental Engineering

Wildfire in Southern British Columbia, Canada - probabilistic Assessment and Simulation

Maximilian Wittmann, October 2019

Background

Wildfire is constantly gaining economic, ecologic and societal relevance as a natural hazard: increasing property losses, its influence on the global carbon cycle, as well as societies facing accelerating wildfire-related expenses outline the importance of this peril. To improve the understanding of wildfire hazard and risk, this study proposes (i) a Wildfire Hazard Level Module (WHLM) to infer meso-scale (500 x 500m), location-specific wildfire occurrence rates, based on ecologic, topographic, anthropogenic and wildfire-historic side conditions; this is connected to (ii) a Wildfire Simulation Module (WSM) to simulate spatially explicit wildfire perimeters. These peril-footprints are then used to assess wildfire risk measured as areal extent and affected population.



Wildfire Occurrence Rate Map of Southern British Columbia as inferred by the WHLM (blueish color: low rates, yellowish color: high rates); Detail red box: wildfire footprints in black as simulated with the WSM.

Methodology

The WHLM is based on Poisson Regression analysis to estimate wildfire occurrence rates, dependent on the aforementioned side-conditions. The WSM utilizes random fields V_x calculated via a Gaussian copula function with marginal distributions F_{Y_X} and stretched exponential dependence structure $P(\Delta_{i,j})$:

$$V_x = Copula\left(F_{Y_X}, P(\Delta_{i,j})\right)$$

The dependence structure is fit to wildfire observations in the study area. An indicator function transfers the resulting random fields to binary random fields. All modelling is based on satellite-sensed data to ensure global transferability of the approach. 10,000 years of wildfire activity were simulated.

Results

For the surrounding of the city of Kelowna, B.C, the simulation yields a chance of populated area to be affected by wildfire of 10.27% (return period: 9.74 a); based on empirical observations, the chance of that to happen can be calculated to 11.11% (return period: 8.74 a). The expected cumulative area burned per year is estimated at 1,360.5 ha and the expected affected population per year to 8.657×10^{-5} [x100%] (corresponding to 13.18 statistical residents).
A central finding of this thesis is further that probabilistic wildfire simulation demands for the explicit incorporation of spatial dependence structures.

In cooperation with Munch Re, Geo Risks Unit

Supervised by M. Sc. Hugo Rosero-Velasquez, Prof. Dr. Daniel Straub (TUM), Dr. Jan Eichner (Munich Re)