Title of PhD project: Modeling and prediction of catastrophic damage in forest ecosystem caused by a strong wind in different geoclimatic domains

The leading unit: University of Silesia in Katowice

Requirements:

1. Master degree in physical geography, geomorphology, meteorology, climatology, soil science, Quaternary geology, forest ecology, or similar.

2. Knowledge of various meteorological phenomena impacting forest ecosystems, natural disturbance regimes in different climate zones, and knowledge of wind types and wind features of various origins will be assets.

3. An essential aspect of project realization will be a practical knowledge of statistical methods and modeling in R or Python. The applicant should know the basics or be ready to learn skills allowing usage of one of these computer programs.

4. English language skills are essential for a positive evaluation of a potential candidate. Results of the Ph.D. project must be presented in English and published in international journals with a high impact factor (IF).

Tasks description:

1. Climate time series; their modeling and analyses.

2. Modeling and analyzing data related to forest ecosystem disturbances (spatial data from various geodatabases, integration, and validation).

3. Construction of the complete database that includes response variables and potential predictors.

4. Modeling and prediction by applying statistical and machine learning methods (e.g., logistic regression, random forest, support vector machines, etc.)

5. Preparation of prediction maps (probability maps) of study sites in different climate zones.

6. Analysis of the results in the context of the hazard and risk assessment and environmental consequences of catastrophic damage in forest ecosystems.

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Abstract:

Forest ecosystems are the most significant terrestrial reservoir binding CO2, and through this helping to decrease the content of this greenhouse gas in the atmosphere. However, forest ecosystems have been extensively altered by human activity and are threatened by numerous natural disturbances that decrease their ability to mitigate atmospheric CO2. This project aims to analyze and model catastrophic changes in forest ecosystems caused by a strong wind of different origins. Potential study areas include selected forest ecosystems in Poland, Czech Republic, Switzerland, Great Britain, Finland, United States, Chile, Puerto Rico, and China. The main task is to analyze and select potential predictors explaining forest damage caused by a strong wind. Historical analysis of time series (wind speed and direction, temperature and precipitation) and spatial analysis of damage allow modeling of factors impacting the damage level. This data can aid a better prediction of carbon sequestration by forest ecosystems. In this project, the following variables will be taken into account: biotic variables describing forest stand features (e.g., tree age, species, biomass, diameter at breast height, etc.), abiotic variables (e.g., elevation, slope, soil type, etc.), and climatic variables (e.g., raster layers from CHELSA, and WorldClim databases). Machine learning techniques will be applied (e.g., random forest, support vector machines, and others). They allow defining the non-linear relationship between variables and data analyses featuring non-normal distributions. One of the modeling effects will be prediction maps that define the potential spatial distribution of damage. Because places of severe damage in forest ecosystems caused by strong wind are vulnerable to mass movements, the project will also aim to evaluate geohazards related to windthrows. This information can be significant from the viewpoint of national administration and institutions in charge of forest resources. For this reason, the project has cognitive, methodological, and practical meaning.

Other information:

1. The Ph.D. project will be supervised by dr. Łukasz Pawlik, e-mail: lukasz.pawlik@us.edu.pl, the University of Silesia in Katowice, Poland.

2. It is possible to do some project tasks in the scientific institution abroad provided obtaining financial support from the National Agency for International Exchange or similar offering international scholarships (e.g. Fulbright Commission).

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