

Assessment of the impact of natural and anthropogenic factors on the probability of fire incidents in Polish forests

Forest fires are one of the main disturbances of forest ecosystems, causing huge economic, natural and social losses in Poland and around the world. Forest fires threaten property, health and human life, affect unfavorable geochemical changes, CO₂ emissions into the atmosphere and a decrease in biodiversity. Almost all forest wildfires in Poland are a direct consequence of intentional or unintentional human activity. At the same time, there must be adequate natural conditions to ignition. Given the global upward trend in the number of fires associated with climate changes, this problem is important not only from a scientific but also from an economic, environmental and social point of view.

Issues related to forest wildfires are studied around the world and although many potential factors are known that can affect forest fires, the significant role of local conditions in shaping the strength, direction and interdependence in the impact of individual elements of the natural environment on forest wildfires is emphasized. This is the reason why direct implementation of research results from one place in the world to another is impossible.

In Poland, fire risk was tested mainly for the development of effective fire prevention systems and rapid response strategies. Only four meteorological factors were directly considered in the existing fire forecasting system, and forecasts are created for 60 large-area zones excluding the winter period. Therefore, it can be stated that knowledge about the causes of forest wildfires in Poland is still incomplete and needs to be supplemented.

Therefore, the main goal of the project is assessment of the impact of natural and anthropogenic factors on the probability of forest wildfire occurrence in Poland. This goal will be implemented for forest fire events from 2007-2019 using meteorological data from the mesoscale WRF (Weather Research and Forecasting) model, forest habitat characteristics from the Forest Data Bank, topographic and anthropogenic data from the Central Geodetic and Cartographic Documentation Center and other databases containing information about the parameters of forest habitats. Fire data will come from the National Forest Fire Information System.

The research methodology will be based on two main types of analysis: 1) spatial analysis and 2) regression analysis. Spatial analysis, carried out in Geographic Information Systems, will allow the assignment of information on external conditions to the locations of forest fire occurrence - in this case to individual grid cells with 4 km x 4 km resolution, selected as the level of analysis. The basic research method that is planned to achieve the assumed goal is logistic regression. It enables the investigation of binary events (presence-absence) by quantifying the impact of each of the factors and their combined impact on the probability of the phenomenon, here: forest fire. Spatial extension of that method, proposed by us as an adequate to study the impact of environmental parameters on the occurrence of phenomena, is geographically weighted logistic regression (GWLR), which also takes into account the possible non-stationarity of external factors, i.e. their variable impact on the probability of fires occurrence depending on their location in space.

The result of the research is to identify factors (and determine their quantitative impact) affecting the occurrence of forest wildfires in Poland. Presumably, the results will also indicate threshold conditions and theoretical assumptions to improve the forecasting of forest fire risk in Poland, carried out continuously in time and space.

One of the main contributions of this project to Earth sciences is to propose and test the usage of the GWLR model for predicting geohazards. It is possible that this method (taking into account local differences in the impact of external factors on the phenomenon) can also be used globally.