

Forest fire risk evaluation in Poland

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According to the Joint Research Centre (located in Ispra, Italy) in the years 2006 - 2015 Poland was classified in the third position (after Portugal and Spain) counting the average annual number of forest fires (8260) and in the ninth position calculating burnt area (3745 ha). Regarding the average burnt area of a single forest fire, which can indicate the efficiency of the forest fire protection system, Poland holds the eighteenth position (average burnt area around 0.45 ha). The forest fire risk evaluations together with adequate organization are the basis of the efficiency of the fire protection system. The methods for risk analysis (both potential and dynamic) were elaborated at the Forest Research Institute in the framework of research projects ordered by General Directorate of State Forests.

Potential fire risk

It distinguishes potential risk, which determines the susceptibility of the forest to burn, and dynamic risk, which determines the probability of fire occurrence. The methods for determining potential fire risk and its mapping are applied at the three different scale levels: national (classification for regional directorates of State Forests, regions (NUTS 2) and sub region (NUTS 3)), regional (classification of forest districts and counties), and local (classification of forest districts' stands).

The classification on the national and regional levels is made using assigned ranks of frequency of fire occurrence, stands and climatic conditions together with anthropogenic factors and thereby the forest fire risk category is established.

The forest fire risk category is established once every 10 years according to the number of points collected using elaborated equations based on statistical analysis of the following four parameters:

1. The average annual number of forest fires in 10 years period occurring on 10 km² of forest area,
2. The sum of percentage share of stands growing on the particularly fire-prone habitats: dry coniferous forest, fresh coniferous forest, fresh mixed coniferous forest, moist coniferous forest, mixed moist coniferous forest and riparian forest,
3. The average relative air humidity at 0.5 m height and percentage share of number of days when litter moisture drops below 15% at 9.00 am,
4. The average number of inhabitants on 0.01 km² of forest area.

If the index value is upper than 25, the forest is classified in the high danger category (category I), between 16 and 24 the forest is classified in the medium danger category (category II), and if the score is lower than 15, forest is classified in the low danger category (category III). Figure 1 presents the results of forest fire risk categorization on the national level, including regional directorates of State Forests and the regional level of the forest districts.

The forest fire risk category determines the distribution of the financial resources for the forest fire protection system and also decides about the preparations in case of fire occurrence, which include early detection, radio communication and alarm, density of the fire access roads, water supplying points and fire-fighting equipment.

The forest fire risk evaluation at the local level is made for the forest district area (average forest district area 17, 500 ha), starting from the smallest unit, which is the sub-compartment (average 3 ha), with the possibility for further generalization up to compartment level (average 20 ha) and forest range level (average 1300 ha).

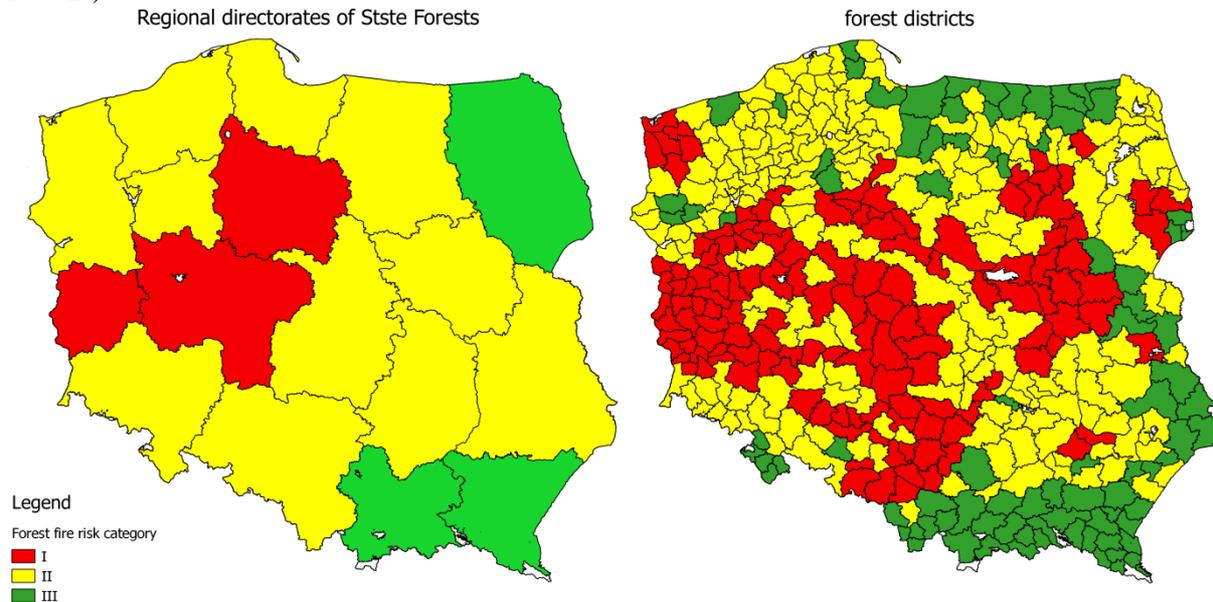


Figure 1. Forest fire risk category in Poland - regional directorates of State Forests and forest districts.

The classification of the flammability of forest stands according to the forest habitat types was based on an analysis conducted using 32423 forest fires, which occurred in the years 2007-2017. For the calculation the flammability index, consideration was given to the number of fires and the burnt area relatively to the area occupied by particular forest habitat types and land cover types.

This index is the ratio between the number of fires or the burnt area and the proportion of a given stand type. The weights of individual indices depend on the correlation between the density of fires or the burnt area and the presence of selected stand types. As the result the cumulative flammability index was elaborated.

On the basis of the cumulative flammability index it is possible to classify a forest stand as one of the three flammability classes: class A (high flammability), class B (medium flammability) and class C (low flammability). Figure 2 presents the example of stand flammability classification at the compartment level.

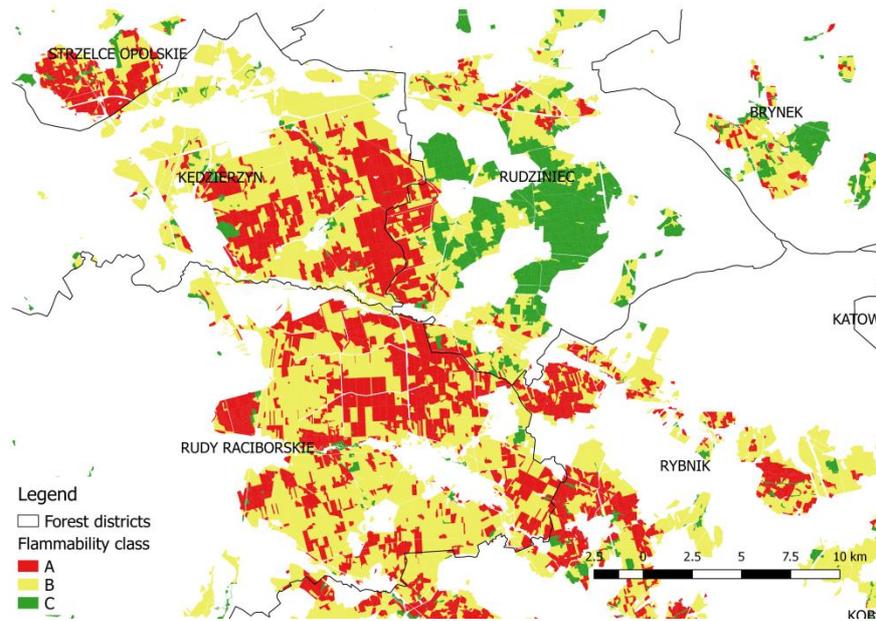


Figure 2. Forest fire danger map for Regional Directorate in Katowice - flammability classes at the compartment level.

The characteristic of the fire attributes of the forest stands is completed by land cover fuel models (surface fires stand for 85% of total number of forest fires) elaborated on the basis of the field work. The results of the above mentioned work was the elaboration of the forest land cover fuel load models: peat fuel type, litter fuel type, moss fuel type, coniferous herbaceous fuel type, broadleaved herbaceous fuel type, clear-cut surface fuel type and open area fuel type. This characteristic was described by: fuel load [kg/m²], calorific value [kJ/kg or MJ/kg], bulk density (apparent) [kg/m³] and fuel moisture content [%] (moisture range and flammability threshold). Moreover, the periods of particular flammability and tabular summary of the fuel load and calorific value dynamic in relation to stand age. It facilitates the use of the data of fuel load for "Fire model" application designed to forecast the fire propagation.

Dynamic fire risk - calculated daily, during the fire season (1.03 – 30.09) for 60 prognostic zones using data collected by 135 meteorological stations (measures recorded every 10 min.), which consists in: temperature (TP), relative air humidity (WP), sum of daily precipitation (OP) and moisture content of pine litter *Pinus sylvestris* L. (WS). The forest fire risk degree is calculated twice daily (at 9.00 a.m. and 1.00 p.m.) and forecasted 24 h ahead.

The example of the equation for forest fire risk degree calculation is presented below:

$$Wiel_prog_09 = 0.9608 - 2,1348 \cdot e(0,05 \cdot TP_09) + 241,5402 \cdot e(-0,05 \cdot WP_09) - 4,4492 \cdot e(0.2 \cdot OP_09) + 64,3136 \cdot e(-0,1 \cdot WS_09)$$

The forest fire risk degree determines the tasks to be fulfilled by forest service and the operational readiness of fire service. Figure 3 presents the example of forest fire risk map.

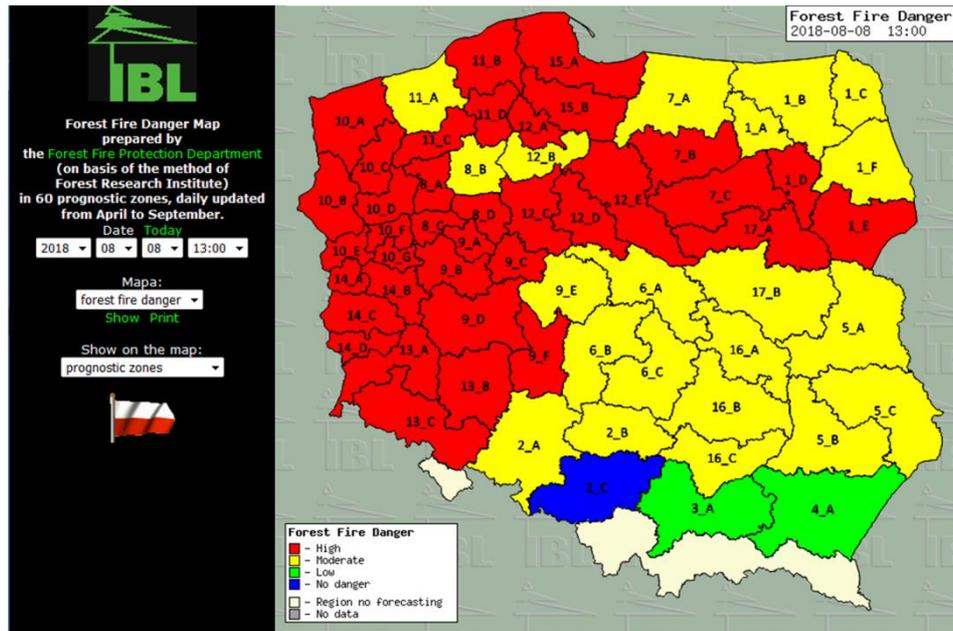


Figure 3. Forest fire danger map - four degrees scale.

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- Forest fires in Europe, Middle East and North Africa 2006-2015
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Presenter's bio:

Ryszard Szczygiel - associate professor, head of Forest Fire Protection Laboratory, fire fighting and forestry education background, focused on forest fire protection, in particular forest fire modelling, forest pyrology and methods for extinguishing forest fires, author or co-author of more than 120 scientific publications, 90 research works, technical and organization implementations for State Forests in Poland.

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