

# WSDistance: Program for calculating the availability of water resources for forest fires

## Introduction

The decisive factor determining the time required to extinguish a forest fire is the fire's place of origin. Another decisive factor is the distance of the fire to a water source. Transport of water, which generally occurs over difficult terrain in Central Europe, represents one of the most important factors in successful fire extinguishing. The further the water supply is from the fire, the more forces and supplies are needed to ensure a continuous supply of water to fight the fire. The importance of both these factors (the fire's location and distance to a water supply) depends on the density and quality of the forest road network, as well as on the availability of trained personnel. The water supply for fighting fires must satisfy several basic requirements and especially an adequate accessibility for vehicles (Cerbu et al., 2013). With the development of firefighting mechanization, however, these requirements have been significantly reduced such that information on all water sources and roads in forested areas is becoming increasingly important. Proper documentation and optimization of water supplies for fighting fires in European forests has been largely neglected. Only in Poland, each location in a forest must be located within 3–5 km (depending on the forest fire risk category) of a water supply with a minimum volume of 50 m<sup>3</sup> (Szczygiel et al., 2020). Austria and Germany, in contrast, have no regulations regarding the availability of water sources in forests; the constructions and mapping of water sources is not regulated and is done only by local management. In the Czech Republic, it is obligatory to have one water reservoir in each cadastral territory (i.e., a relatively homogenous land area of about 600 ha on average). The use of the software makes it possible to detect areas which, in the event of large-scale fires, cannot be covered by fire-fighting water. In 2020, international team of scientists used this model in central Europe. The results indicate that any shortage in water availability can be eliminated by water supplies that are useable but that are not currently part of the database used by Fire Rescue Service of the Czech Republic. A thorough and regular updating of the database of water supplies is therefore required.

## Description

Calculating the availability of water for forest firefighting is an iterative process. At every step, the distances to the water supplies in which water is still available and the coverage of the nearest forest area with water from these water supplies are calculated. Separate input and output layers are created for every step of the iterative calculation. First, the distances to the water supplies with available water are calculated. The calculated distances from the forest (cell of forest) to the water supplies change in every step according to availability of water in each water supply. The zones (areas) of the closest forest to the individual water supplies are also changing. In the next step, the distribution of water to the nearest forest is calculated for each water supply. The volume of water required to extinguish a fire is first assigned to cells of the nearest forest and is then calculated and assigned to cells of increasingly distant forests. The distribution of water from the water supply is terminated when the requirements for water for all cells in the zone of the closest forest are satisfied, or when the entire volume of the water supply is depleted. The total volume of water available for extinguishing a forest fire is calculated as the sum of the volumes of available water from all water supplies during all steps of the simulation. In some cases, water from several water supplies is required to extinguish a forest fire. In this case, the distance to the water supplies is calculated as the average of the distances to the water supplies weighted by the volume of water obtained.