The effect of road networks on the forest wildfires 'size

Zohreh Mohammadi, Peter Lohmander, Jan Kašpar, and Robert Marušák

Faculty of Forestry and Wood Sciences, Czech University of Life Sciences Prague, Czech Republic
Optimal Solutions in Cooperation with Linnaeus University, Umea, Sweden

Introduction

Most of the annually forest burned area, human casualties, and severe property damage caused by large fires emanate from an increase in climate changes (Howard 2014). In addition, if they are not discovered and extinguished in time, fires may cause very large economic losses and will seriously affect the surrounding environment (North et al. 2015). Thus, the rapidity, accuracy, and high efficiency of forest fire prevention systems are crucially important for controlling forest fires (Pourtaghi et al. 2016). Forest road network plays an undeniable role in shortening the response time of firefighting activities (Zhang et al. 2020). Pinto et al. (2020) analyzed the landscape properties and the effect of climate on fire occurrence and size in Sweden. They estimated population density and road network impacts on the size of the fire. They assume a higher density of human ignitions in more accessible parts of the forested landscapes and higher suppression efficiency, due to reduced initial attack time. Podolskaia et al. (2020) during the fire season, use the spatial representation of forest fire locations and offer timely suitable technical options to access them. This study deals with the effects of road infrastructure as a mitigation tool under climate future on fire occurrence.

Attack time

the attack time was considered as a variable impacted by road networks. In fact, considering this factor when planning road network management and roadside fuels management could enhance the effectiveness of road networks in containing wildfires. Similarly, efforts to monitor, store, and communicate road and roadside conditions to firefighters have the potential to enhance road use in fire operations (Thompson et al. 2021).

Method

- The road network length effect on fire size was evaluated indirectly.
- A GIS technology was advanced to create forest fire access routes for special firefighting vehicles moving from a ground firefighting base (fire-chemical station) to the place of the forest fire detection; the technology insists of a statistical and geospatial accessibility analysis of the routes.
- ArcGIS Network Analyst extension applies the popular Dijkstra's algorithm for finding the shortest roads (Eklund et al. 1996). The optimal route from its fire station to fire incident was based on the travel distance, travel time, and outputs of the best roads between the incidents and the chosen stations (Fig. 2).
- By calculating the length of each road segment and the required transition time, all the necessary parameters for calculating the fastest possible road to simulated fire positions can be obtained.
- The attack time calculated as a function of forest road length network (Fig 1).

Fig.2. case study area (East of Prague in Czech Republic)

Results

A rise in attack time leads to larger forest fires since the fires have more time to spread before the firefighters arrival to the fire spots. additionally, the forest road networks are the most effective element on the attack times. Consequently, if the attack times reduces via road network improvements or other investments, such as investments and innovation of aerial and field fire brigade equipment, tactic and time, etc., then the future fire sizes can be reduced, even under the impacts of climate change.

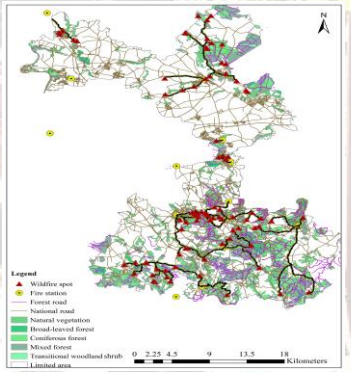

Fig.3 the most available road between the closest local fire station to forest wildfire spots using Dijkstra algorithm in Prague –East in Czech Republic

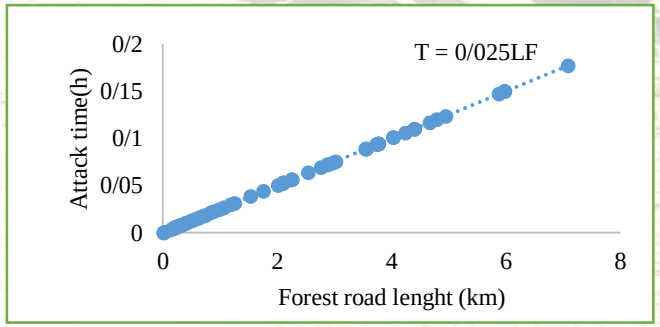

Fig.1. The attack time (h) as the function of forest road length

Discussion

This study was appropriate to study how the size of forest fires are affected by the attack time and road. In case forest management methods, infrastructure, and the capacities of fire brigades are not adapted to the new climate, larger areas destroyed by fires are likely. Thompson et al. (2021) also illustrated that elements influencing real-time operational effectiveness consists of the amount and type of suppression resources, time available to stage resources, and make the road accessible. Kweon (2019) confirmed that the distance to the road is one of the most important factors in determining transportation cost and travel time, and it can be easily evaluated by measuring the circuity of road networks. In fact, considering this factor when planning road network management and roadside fuels management could enhance the effectiveness of road networks in containing wildfires. Similarly, efforts to monitor, store, and communicate road and roadside conditions to firefighters have the potential to enhance road use in fire operations (Thompson et al. 2021).

Conclusion

In case forest management methods, infrastructure, and the capacities of fire brigades are not adapted to the new climate, larger areas destroyed by fires are likely. Forest managers via increasing road density and reduction of attack times, can significantly reduce the severity of forest fires.

References

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