EGU2017-6343

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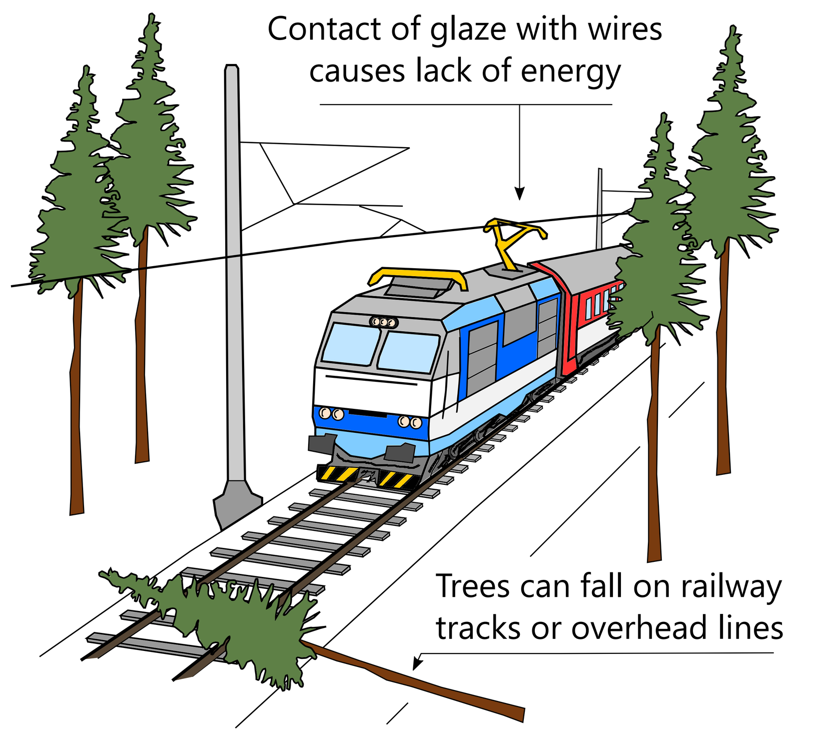
AN OVERVIEW OF NATURAL HAZARD IMPACTS TO RAILWAYS AND URBAN TRANSPORTATION SYSTEMS



1 INTRODUCTION

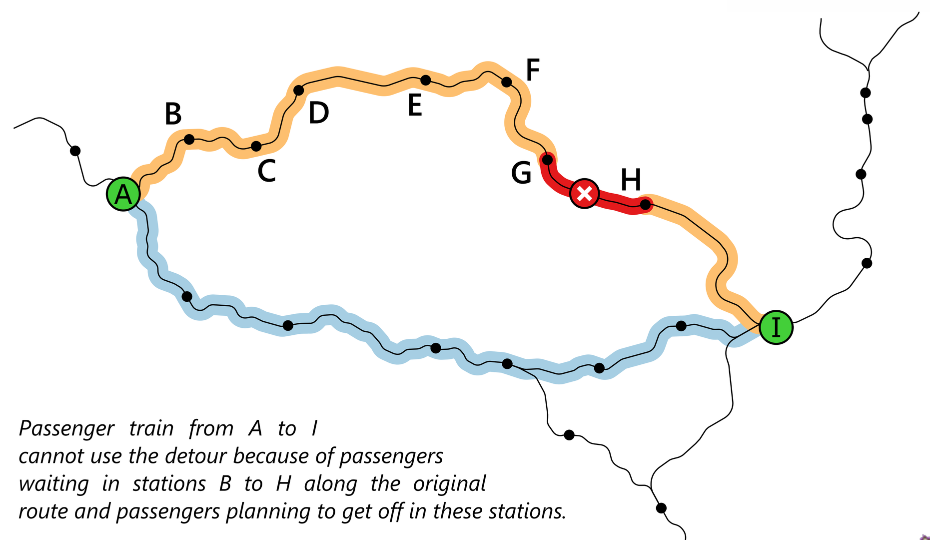
The most common natural hazards in the Czech Republic are floods, landslides, heavy snowfall, windstorms and glaze (black ice).

Whereas floods and lanslides usually cause **direct** damage to the transportation infrastructure, other hazards predominantly cause **indirect** losses.

Railway traffic depends on electricity, which via system substations, powers the tracks. The outage has an immediate impact on railway traffic since locomotives, specifically for personal traffic, are powered by electricity.

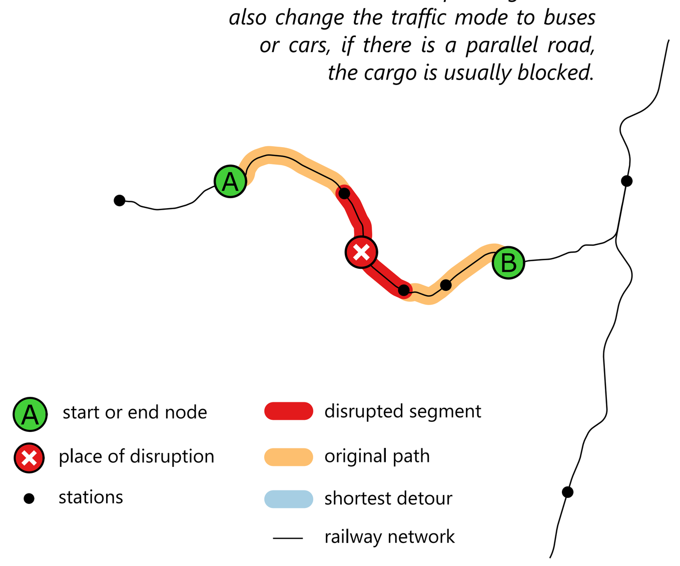
Natural processes, which can cause power failures, are usually highly energetic, e.g. landslides, floods and windstorms. We focus here on processes with low energy which are also able to terminate vulnerable traffic which relies on electricity: glaze and falling trees.

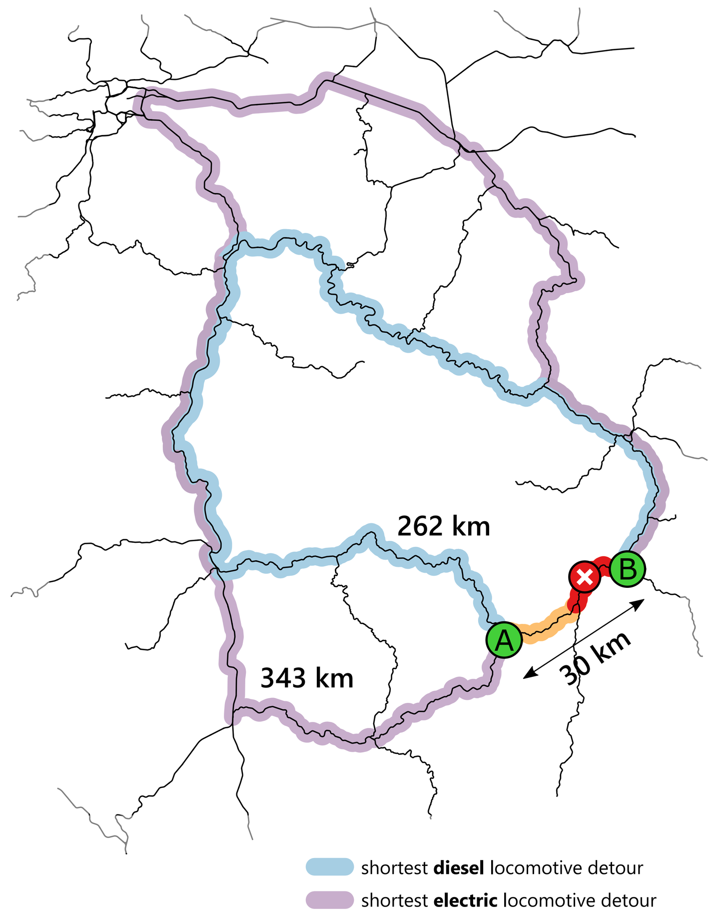
2 NETWORK CONSEQUENCES



Passenger train from A to I cannot use the detour because of passengers waiting in stations B to H along the original route and passengers planning to get off in these stations.

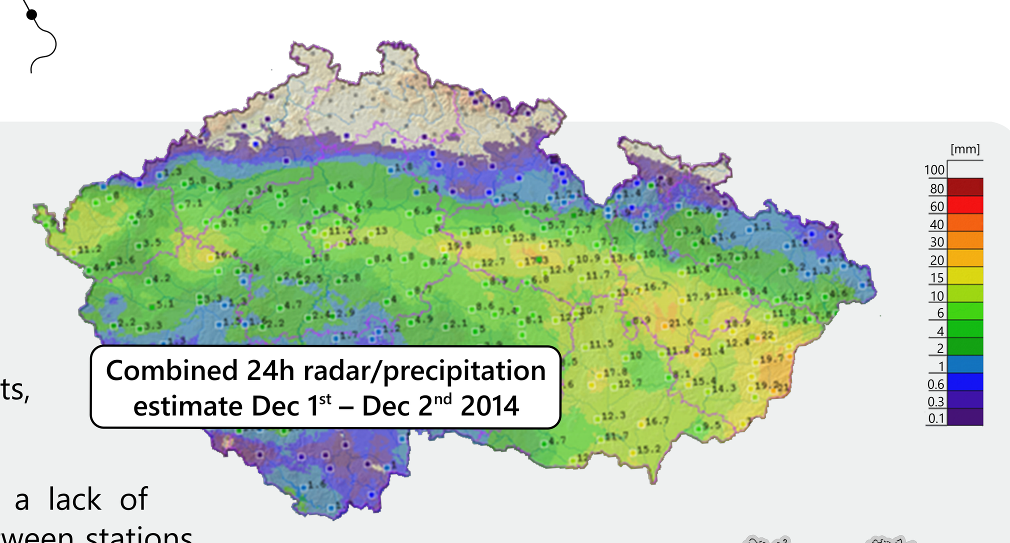
Some parts of the Czech railway network do not have a detour. Whereas passengers can also change the traffic mode to buses or cars, if there is a parallel road, the cargo is usually blocked.





Despite the fact that the Czech railway network rank among the densest in the world, most of the detours are cost inefficient. The shortest detour from A to B by diesel locomotive is 232 km longer than the original route. By an electric locomotive, it is 313 km longer than the original route.

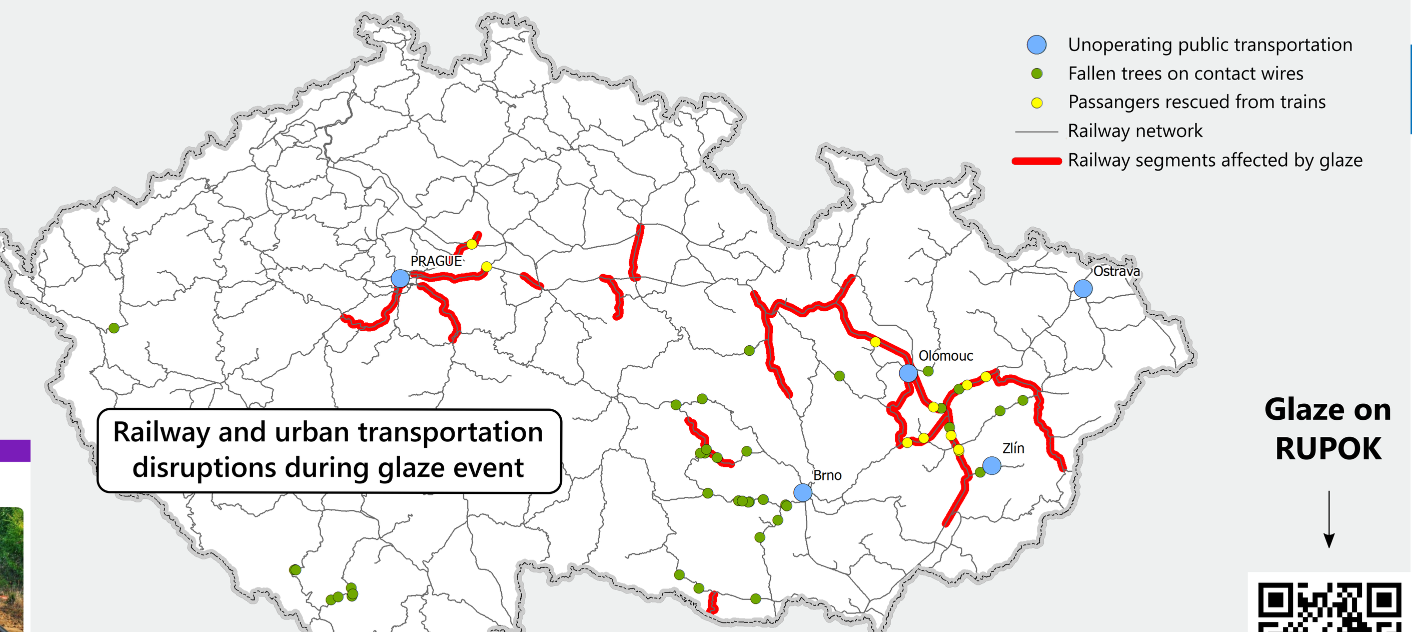
3 CASE STUDY A DECEMBER 2014 GLAZE



Freezing rain on 1st to 2nd December led to the formation of glaze on the supercooled ground and protruding objects, especially metal ones.

The contact of glaze with wires caused a lack of energy, many trains had to stop often between stations and in inaccessible terrain. This led to significant indirect losses on the urban tram lines and railways.

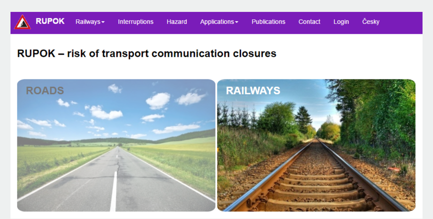
Approximately 100 thousand passengers were directly affected, hundreds of which spent up to 17 hours locked in wagons without air-conditioning or heating due to the lack of electricity.



Glaze on RUPOK

RUPOK – Risk of Transportation Closures

A web map application for assessment of impacts of natural hazards to the transportation infrastructure.



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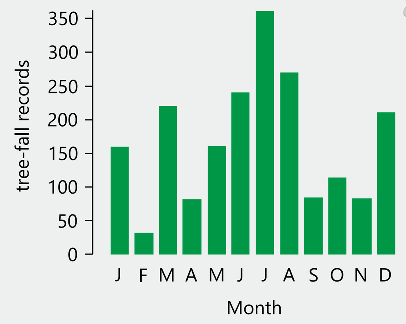
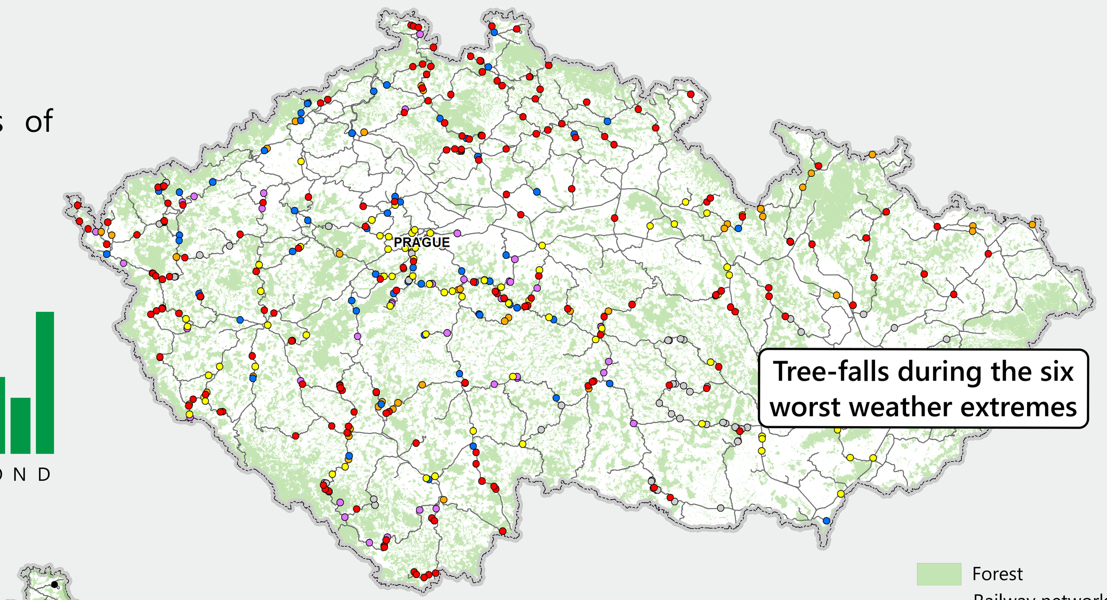
4 CASE STUDY TREE-FALLS 2012 – 2015

Tree-falls onto railway tracks or overhead lines rank among the most common causes of disruptions of a natural origin.

We have analyzed evidence of 2,039 tree-falls in the Czech Republic between 2012 – 2015. Almost 32 % of them were only directly caused by 14 weather extremes.

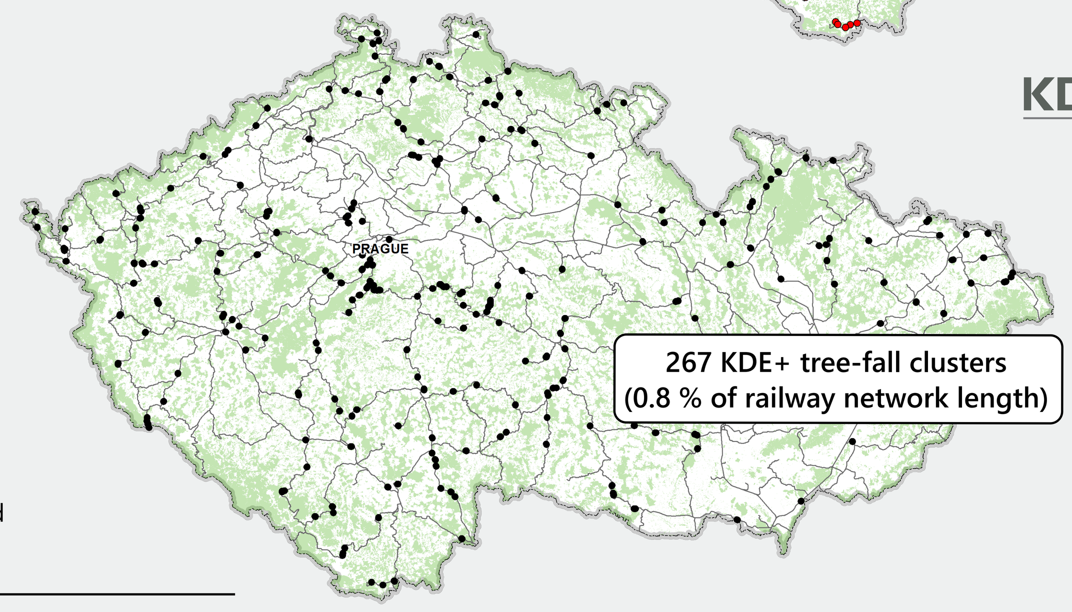
The tree fall hazard was then computed using empirical data, data on land use and a generalized rule of succession.





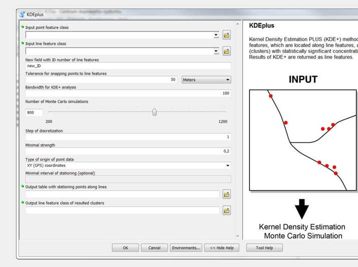
A list when at least 40 records of tree-falls were registered

Rank	Cause	Date	Records
1	Cyclone Niklas	30. 3. – 1. 4. 2015	178
2	Windstorm	4. 8. 2013	80
3	Glaze	1. – 3. 12. 2014	69
4	Flood	2. – 3. 6. 2013	69
5	Windstorm	8. 7. 2015	47
6	Windstorm	10. 1. 2015	45

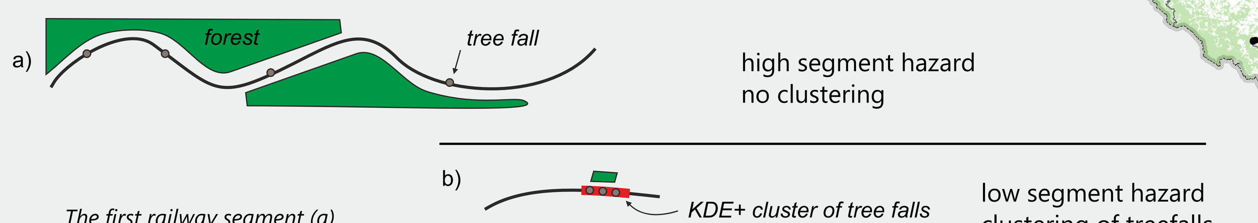


KDE+

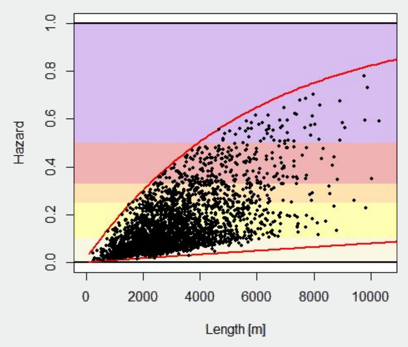
- Cluster identification software
- Implementation of KDE+ method
- KDE+ toolbox for ArcGIS
- Download from www.kdeplus.cz



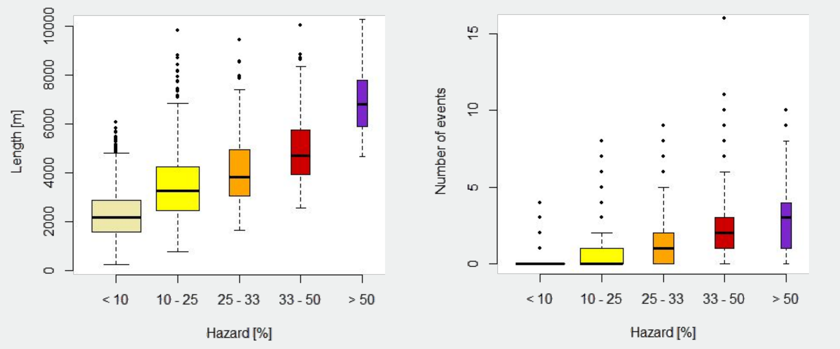
KDE+ toolbox for ArcGIS



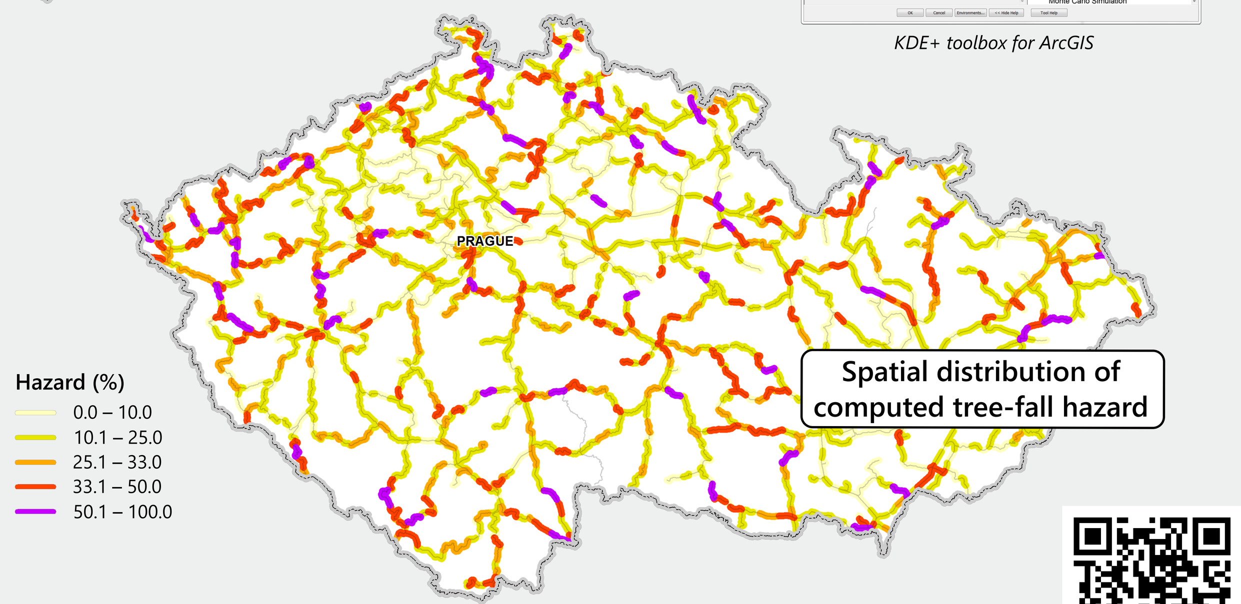
The first railway segment (a) is long with major exposure to the most dangerous land use category – forest, whereas the tree-fall hazard on the short segment (b) is low, due to low forest exposure. The tree-fall cluster on the short segment identifies a hazardous place (thick red line).



A relation between the length of a railway segment and the respective hazard.



The width of the boxes reflects the number of records in the respective hazard groups (the thick horizontal lines within the boxes represent group medians).



Tree-falls on RUPOK →

5 CONCLUSIONS

Blockages of railway segments will always cause significant traffic problems on railways. Detours (alternative routes) are either cost inefficient or even impossible.

The above-mentioned case studies present the fragility of the railway network system, particularly when electricity is the main means of energy for transportation.

The KDE+ clusters and the most hazardous railway segments should be among the first in the process of line vegetation monitoring in order to minimize potential losses.

The presented hazard model and KDE+ method can be widely applicable elsewhere. The KDE+ method can be applied to all point data places along lines.

Authors:

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Acknowledgements:

The results were produced with the financial support of the Ministry of Education, Youth and Sports of Czech Republic within the National Sustainability Program I, project of Transport R&D Centre (LO1610 and LO1415), on the research infrastructure acquired from the Operation Program Research and Development for Innovations (CZ.1.05/2.1.00/03.0064). We also thank Czech Raliway Infrastructure Administrator employees for providing us with data.

Publications:

Bíl, M., Andrášik, R., Nezval, V., Bílová, M., under review. Identifying Places along a Railway Network with the Highest Tree Fall Hazard. Applied Geography.

Zahradníček, P., Münster P., Bíl, M., Skalák, P., Štepánek, P., Farda, A., Panský, M., Brzezina, J., Bílová, M., Kubeček, J., under review. The Impacts of Severe Glaze Episode in the Czech Republic during Earl December 2014 and the Predictability of Such Events. Weather.

Bíl, M., Andrášik, R., Svoboda, T., Sedoník, J., 2016. The KDE+ Software: A Tool for Effective Identification and Ranking of Animal-Vehicle Collision Hotspots Along Networks. Landscape Ecology 31, 231–237.

Bíl, M., Vodák, R., Kubeček, J., Bílová, M., Sedoník, J., 2015. Evaluating Road Network Damage Caused by Natural Disasters in the Czech Republic between 1997 and 2010. Transportation Research Part A: Policy and Practice 80, 90–103.

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