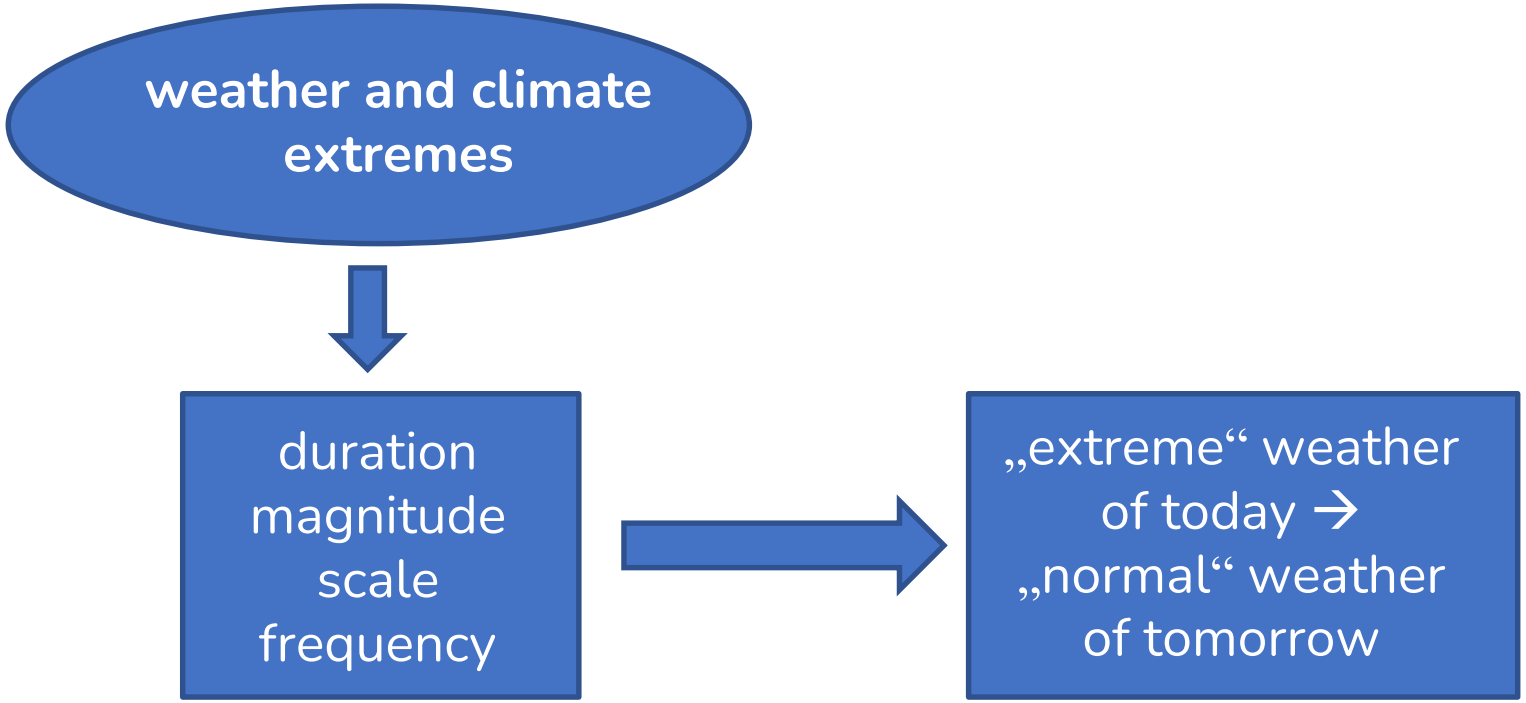
TRA
TRANSPORT RESEARCH ARENA
LISBON 2022

Heat and Drought Induced Impacts on the German Railway Network

Szymczak, Sonja; Backendorf, Fabia; Blauhut, Veit; Bott, Frederick; Fricke, Katharina; Herrmann, Carina; Klippel, Lara; Walter, Andreas

1. The impact of heat and drought on railway operation



Rail infrastructure is expected to operate for more than 50 years

- Climate change adaptation must be integrated into long-term railway planning, design and management processes

1. The impact of heat and drought on railway operation

European Railway Agency (ERA):

extreme heat one of the major weather-related threats to railway traffic infrastructure and service

direct impacts of high temperatures	consequences
• thermal expansion in structures (e.g. buckling of rails) • electronic malfunctions of trackside objects • excessive sag of overhead powerlines	• higher number of disruptions • speed reductions to reduce derailment risk due to buckling • extra track inspections necessary

1. The impact of heat and drought on railway operation

indirect impacts of heat and drought

higher frequency and magnitude of climate-related natural hazards

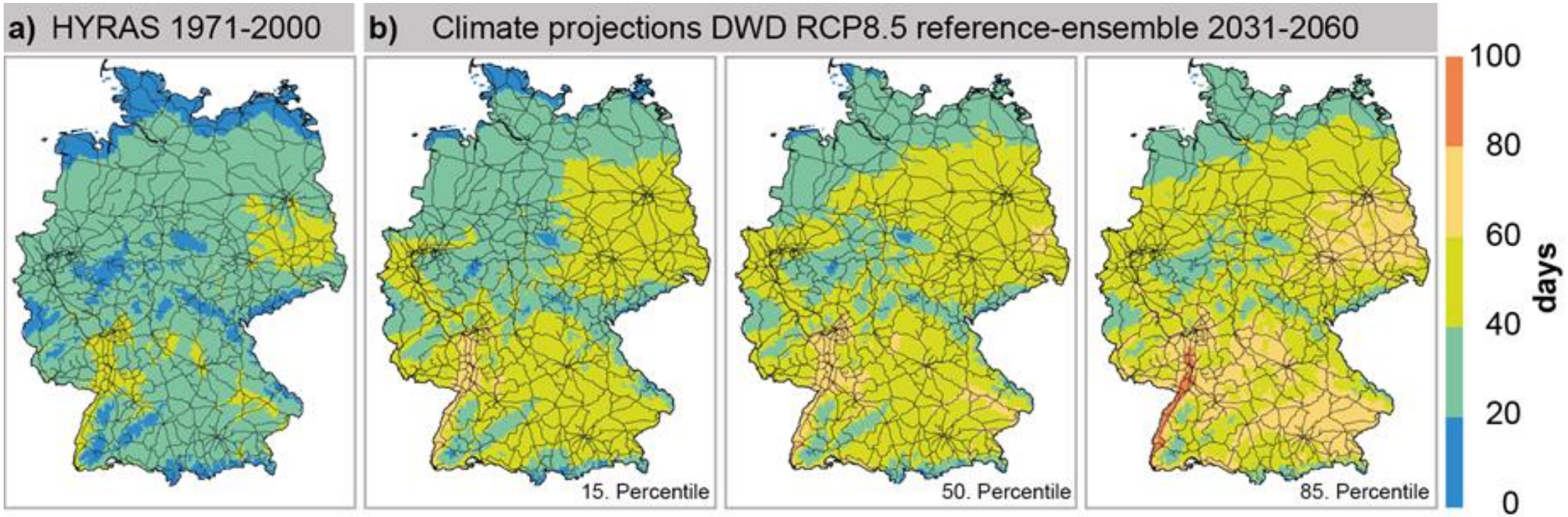
- wildfires and embankment fires
- tree falls
- landslides

The role of (trackside) vegetation

+: cooling effect on the surrounding → reducing of peak temperature values

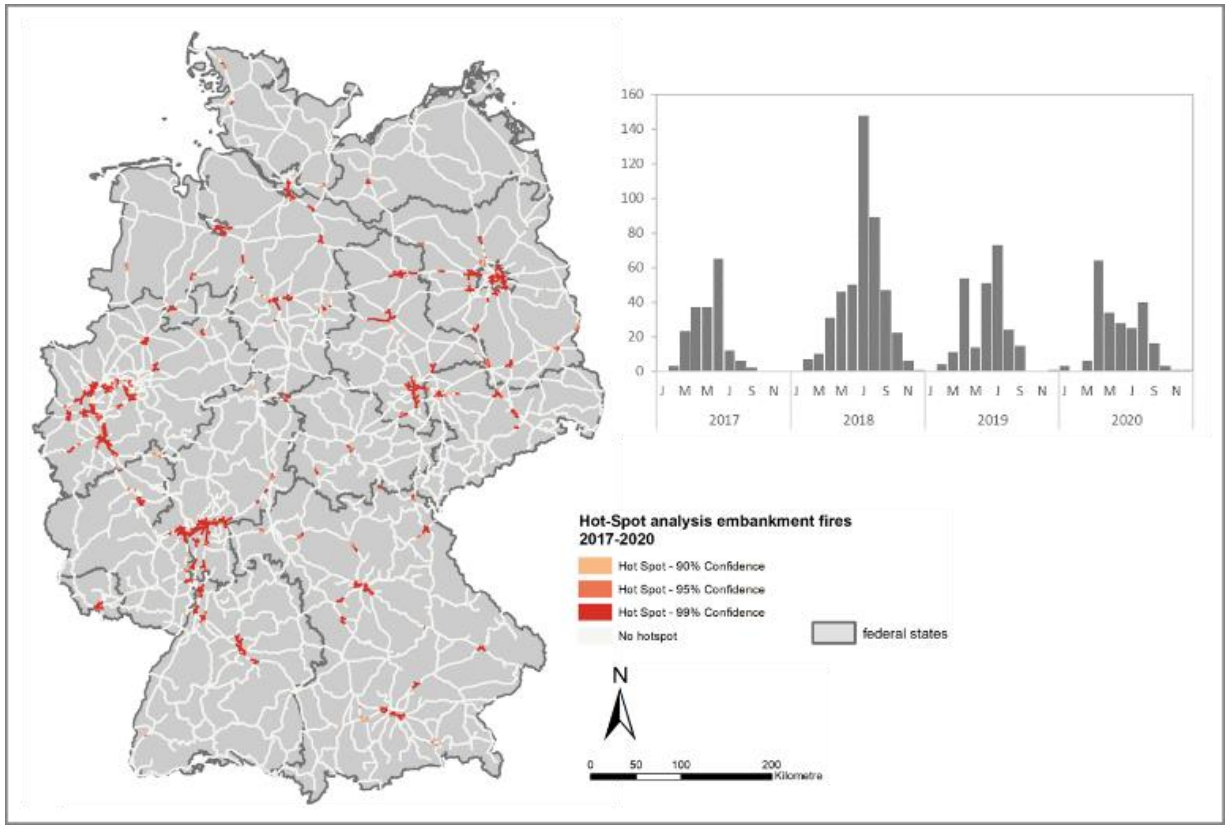
−: impacts caused by vegetation are a major threat for rail traffic

2. Heat-prone parts of the German railway network



Number of summer days (days with maximum temperatures ≥ 25°C) today and in upcoming decades.

3. Embankment fires – triggering factors and spatio-temporal distribution



Spatial and temporal distribution of disruptions in the operating sequence due to embankment fires along the German railway network between 2017 and 2020.

Fire risk assessment:

Risk of ignition → often described in fuel maps

Extent of a fire after ignition (spread potential) → mainly driven by topography

3. Embankment fires – triggering factors and spatio-temporal distribution

Triggering factors

- meteorological factors
  - precipitation
  - humidity
  - cloud cover
  - air temperature
  - wind direction and speed
- prolonged dry periods
- vegetation-related characteristics

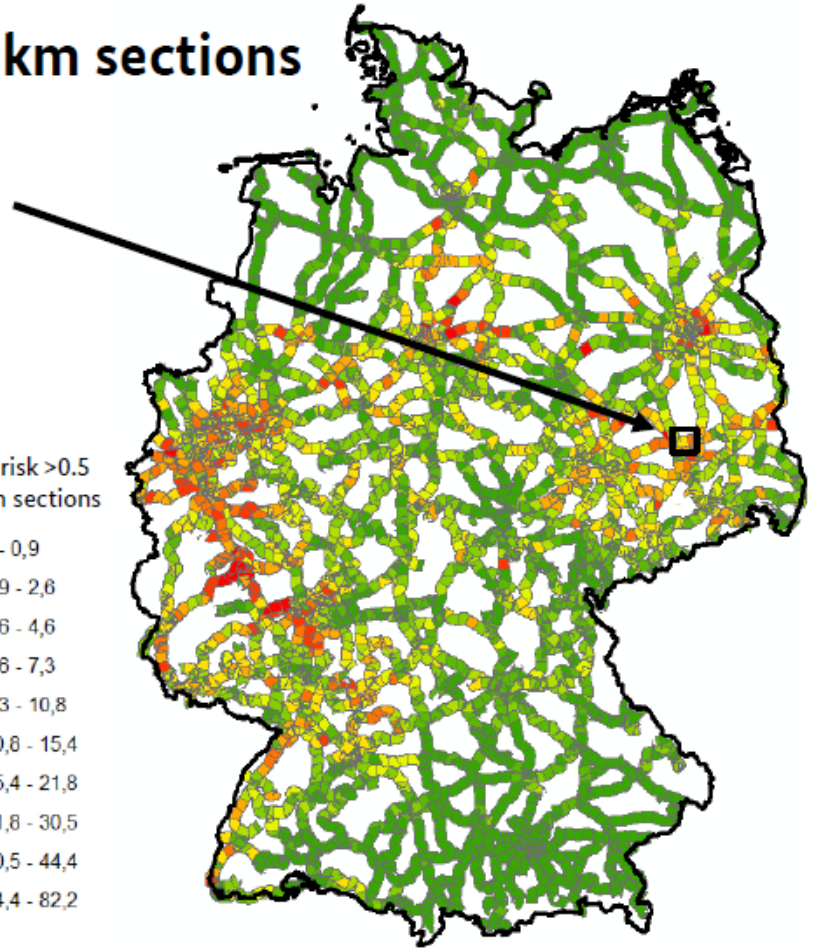
Factors used for the models for the embankmant fire risk map

Category	Variable
Infrastructure	Distance to curves and service
	Distance to settlements
Meteorology	Difference of wind direction angle to rail orientation
	Soil Moisture Index SMI, upper soil, summer average
	Surface temperature by Landsat8 / Sentinel 2
	Average wind
Topography	Angle between aspect of slope and rail orientation
	Aspect (slope)
	Elevation
	Slope (DEM-5m)
Vegetation	FuelMap classification

3. Embankment fires – triggering factors and spatio-temporal distribution

5m²

5km sections

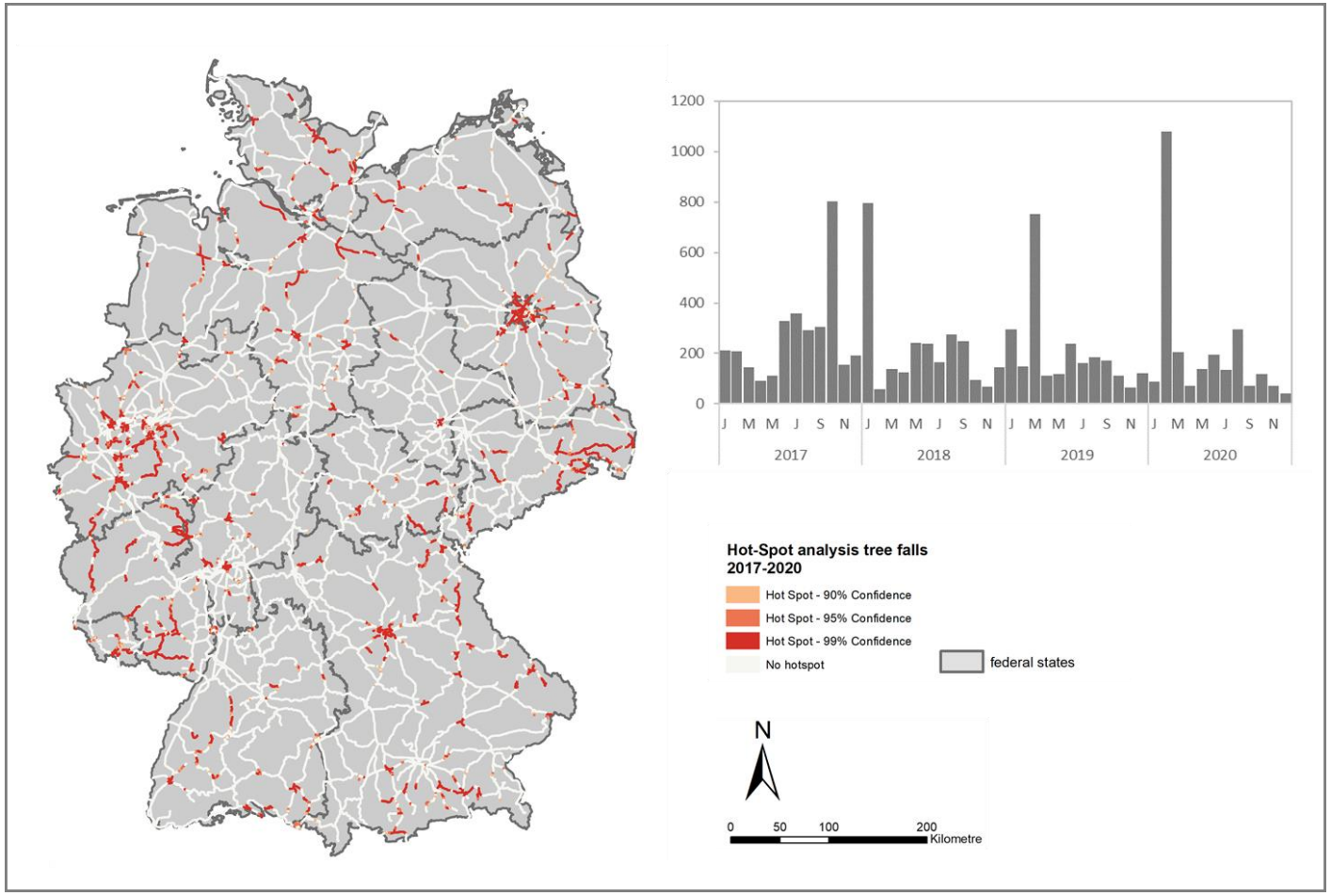


Risk (likelihood) of embankment fire

Identification of embankment risk

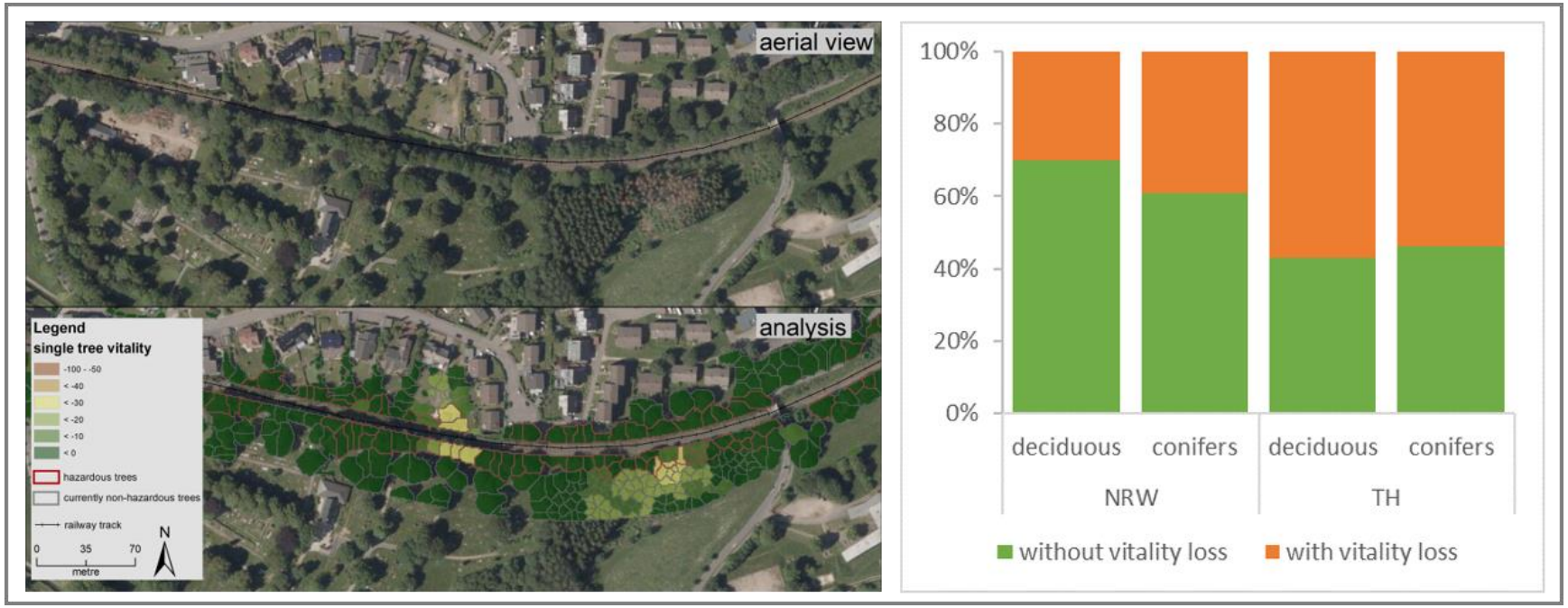
- Identification of drivers of embankment fires
- Risk mapping at multi scales (5m² - 5km sections)
- Evaluation of future embankment fire risk

4. The effects of heat and drought on trackside vegetation



Spatial and temporal distribution of disruptions in the operating sequence due to tree falls along the German railway network between 2017 and 2020.

4. The effects of heat and drought on trackside vegetation



Example of monitoring tree vitality along the railway network of Northrhine-Westphalia (left) and percentage of trees with and without vitality losses in 2020 in the close vicinity of the railway network in the federal states Northrhine-Westphalia (NRW) and Thuringia (TH), classified into deciduous trees and conifers (right).

5. Conclusions

Embankment fires and (drought induced) tree falls are a major threat to the German railway network.

Appropriate vegetation management is

- an important part of a proactive natural hazard management
- a valuable tool to make the German railway system more resilient to heat- and drought-related disurbances caused by trackside vegetation → contribution to climate change adaptation

Recommendations:

- promoting drought-tolerant and low-flammability species
- incorporation of parameters describing vitality and drought tolerance into existing vegetaton management and monitoring systems

Thank you!

Traconference

Transport Research Arena (TRA)

@TRA_Conference

traconference2022

TRAconference

traconference.eu

HOSTED AND ORGANISED BY:

AGÊNCIA NACIONAL DE INOVAÇÃO

IN COOPERATION WITH:

INSTITUTO DA MOBILIDADE E DOS TRANSPORTES, I.P.

CONSÓRCIO DE ESCOLAS DE engenharia
FEUP • FCTUC • IST • EEUM • UA • FCTNOVA

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

magellan
European Affairs Consultancy

CO-ORGANISED BY

European Commission

TOGETHER WITH:

ACARE

alice
Alliance for Logistics Innovation through Collaboration in Europe

CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

ECTP
INNOVATIVE BUILT ENVIRONMENT

ERTRAC

ERRAC
The European Rail Research Advisory Council

ETRA
European Transport Research Alliance

WATERBORNE