

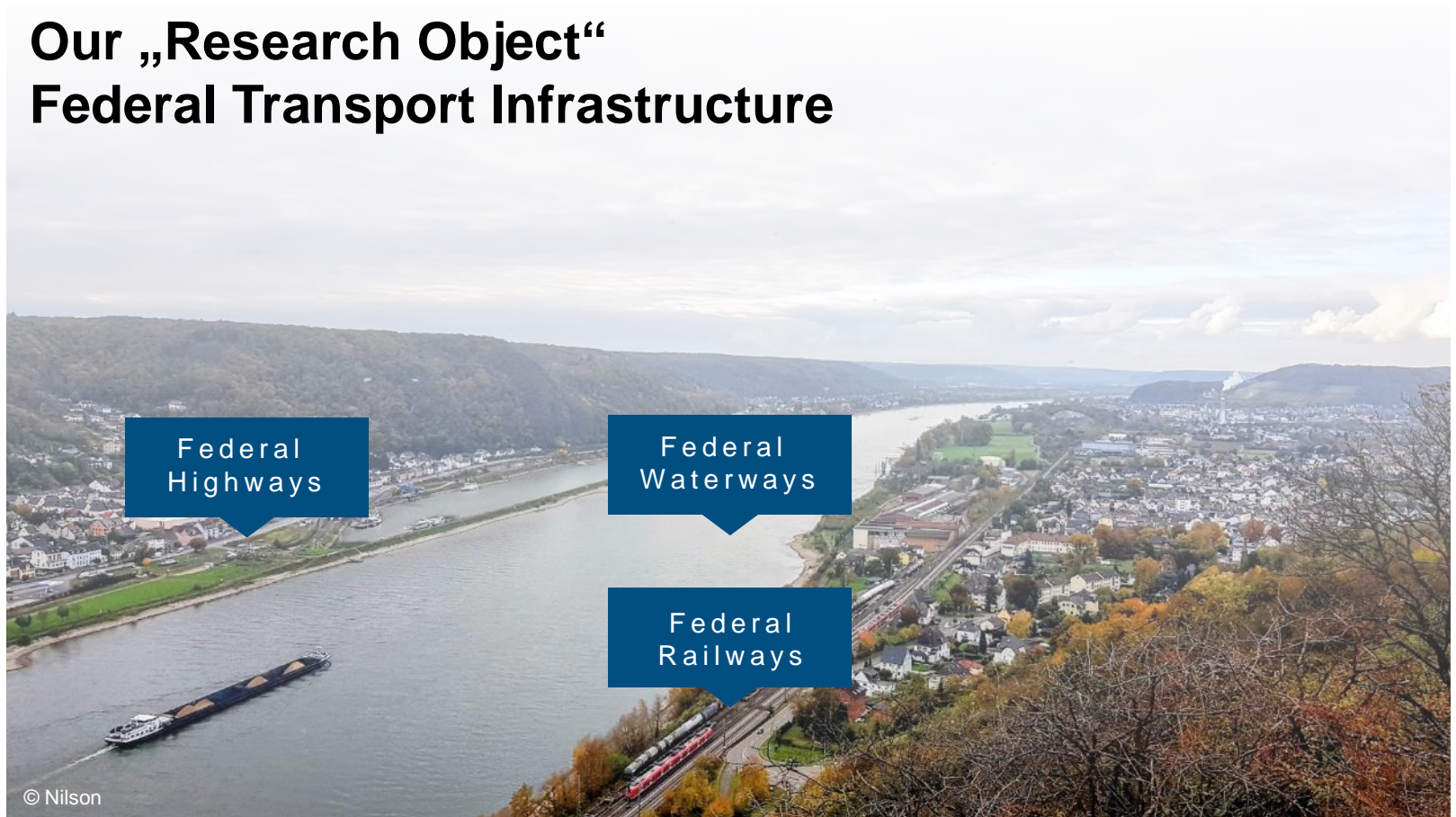


# BMVI Network of Experts

**Climate change impacts and adaptation in transport – challenges and approaches in Germany**

Dr. Lara Klippel

# Our „Research Object“ Federal Transport Infrastructure



© Nilson



## Mass movements



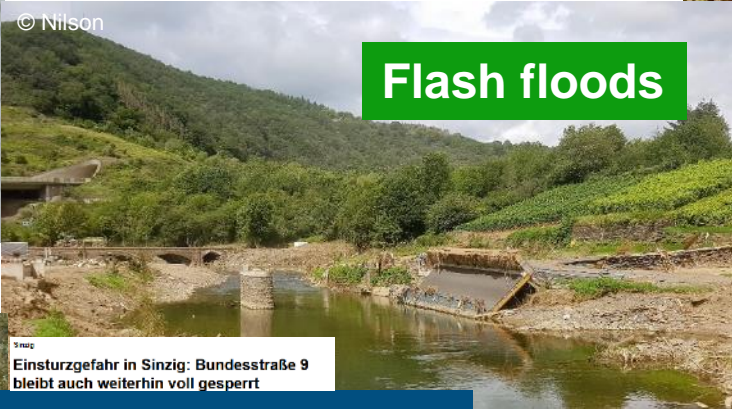
© Volkmer

Teilweise Öffnung der B42 frühestens am 19. April

# Impacts

© Nilson

## Flash floods



Ympg  
Einsturzgefahr in Sinzig: Bundesstraße 9 bleibt auch weiterhin voll gesperrt

## Heat

CASTROP-RAUXEL  
Glühende Hitze im Ruhrgebiet! Hier schmilzt bereits der Asphalt



© Nilson

© Düll



## Windthrow

Ausnahmen beachten  
Sturmschäden am Auto – wer zahlt wann und was?



© Nilson

Neuer Regen ab Freitag  
Hochwasser in Hessen: Die Pegel steigen weiter  
Abbildung: www.wetter.de

## River flooding

## Mass movements



© Stelle für Eisenbahnunfalluntersuchung

**Arbeiten nach Felssturz bei Kestert gehen weiter: Züge rollen ab 2. Mai**



© Düll

## Windthrow

Sturm legt durch Deutschland

**Bahn stellt Regionalverkehr in mehreren Bundesländern ein – Warnung vor Sturmflut an der Nordsee**

Der erste heilige Herbststurm des Jahres richtet deutschlandweit Schäden an. Entwurfliche Bäume stützen den Bahnverkehr – in Berlin sind offenbar mehrere Menschen in Autos eingeschlossen.

# Impacts

© Nilson



Freie Umweltbilanz der Bahn

**Schäden an Gleisen und 80 Bahnhöfen**

Stand: 18.07.2023 17:41 Uhr

## Flash floods

## River flooding



© Nilson

Kuvert Regen ab Freitag

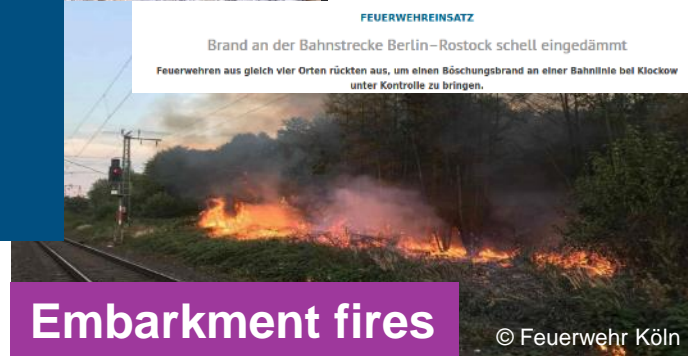
**Hochwasser in Hessen: Die Pegel steigen weiter**

Zuletzt: 18.07.2023 17:41 Uhr

**FEUERWEHREINSATZ**

**Brand an der Bahnstrecke Berlin–Rostock schnell eingedämmt**

Feuerwehren aus gleich vier Orten rückten aus, um einen Böschungsbrand an einer Bahnlinie bei Klockow unter Kontrolle zu bringen.



## Embarkment fires

© Feuerwehr Köln



## Flash floods



Hochwasser  
**Ahr-Risikokarte: Fast alle Häuser dürfen aufgebaut werden**



## Erosion

# Impacts

© Nilson



## Water quality

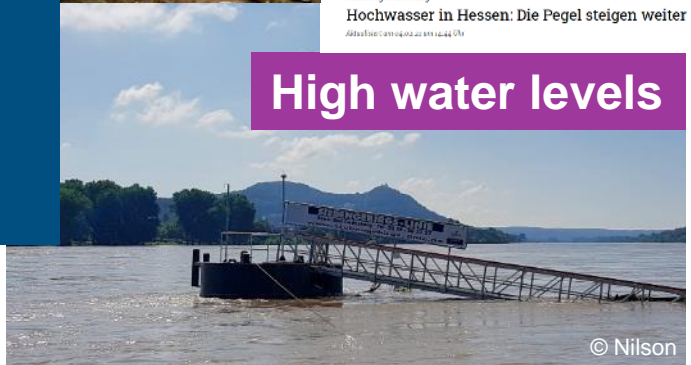


Wasser des Rheins wird wärmer: Was bedeutet das für das Welterbe Mittelrheintal?

Neuer Regen ab Freitag  
Hochwasser in Hessen: Die Pegel steigen weiter  
Abbildung: © 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025



## High water levels



# Coast



Extreme waves

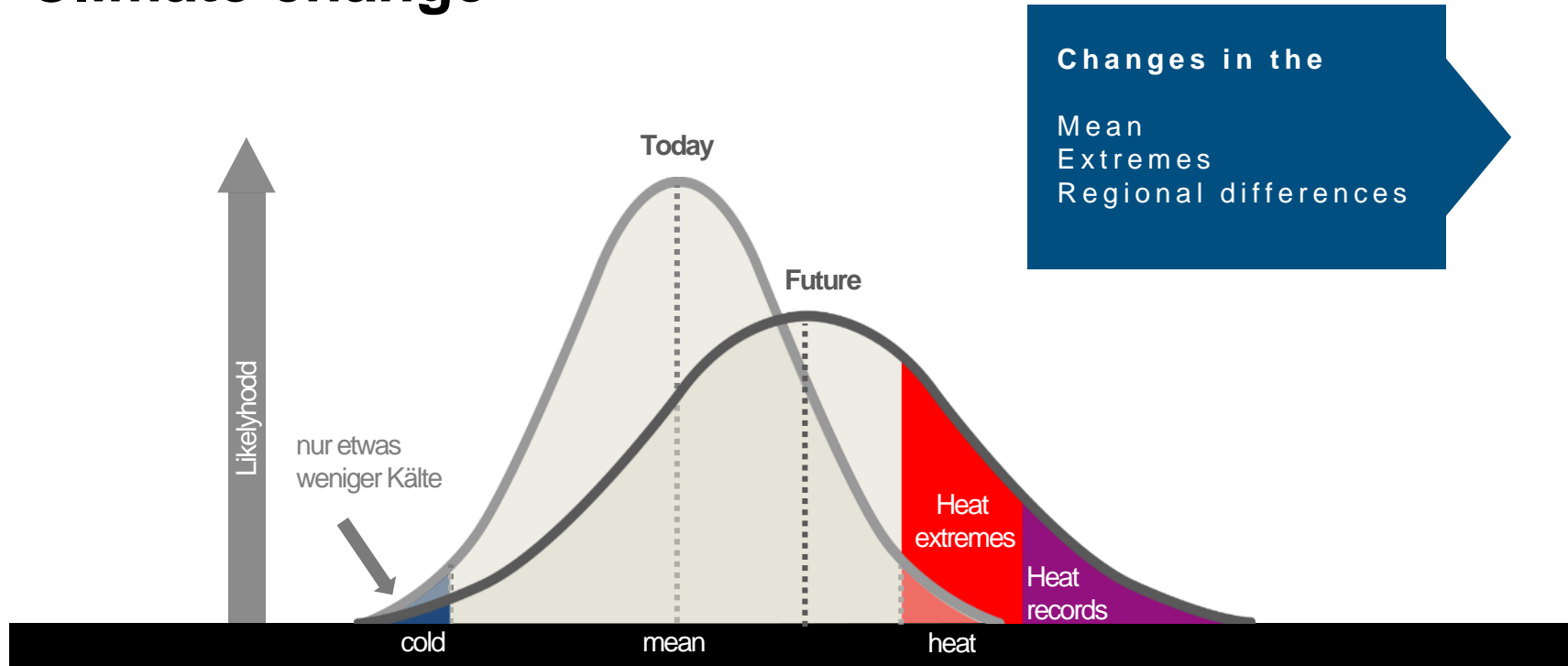
Sea level rise

Wadden Sea

Storm stide

Tidal changes

# Climate change



...similar challenges



...better together



# WINDTHROW

FEDERAL HIGHWAYS

FEDERAL RAILWAYS

16.11.2021

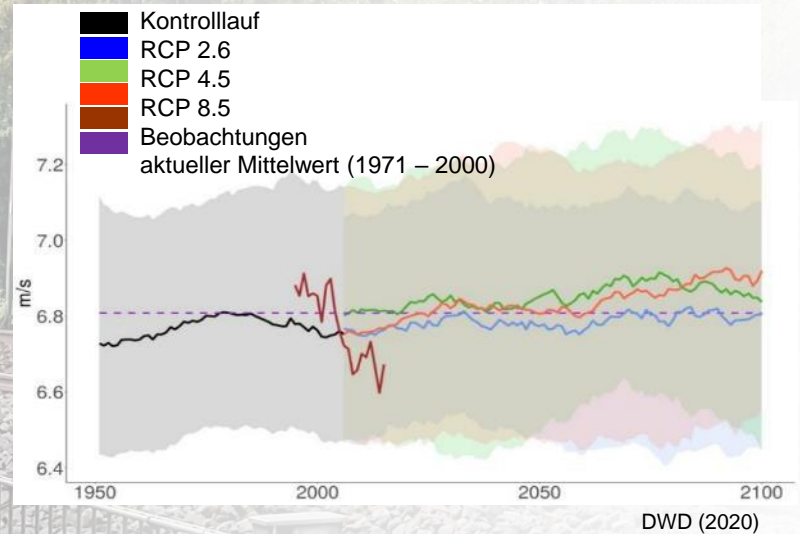
24  
4

**Tree is a  
potential danger  
as soon as tree  
height exceeds  
the distance to  
infrastructure**

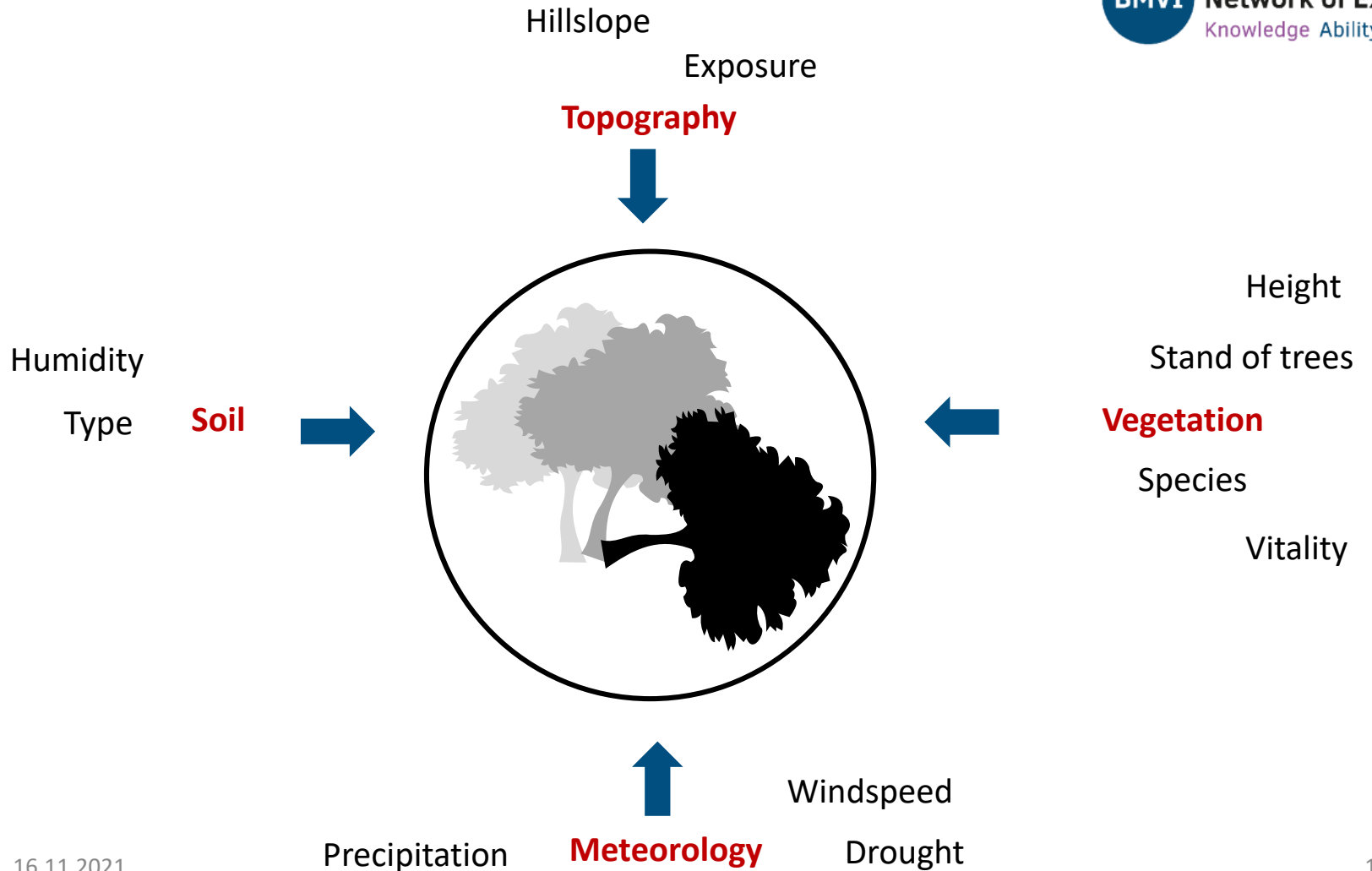


**Wind**

30-yr running mean 98.  
 percentile daily windspeed (m/s)



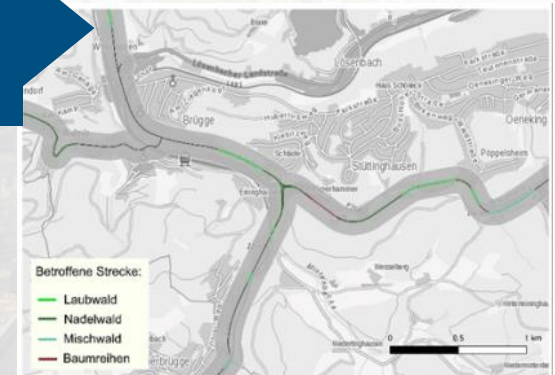




# 23-25%

of the Federal Railways and  
Highways cross tree-covered areas

Exposure



Bott et al. (2020)

**Sensitivity:**  
Electrification of rails

(c)

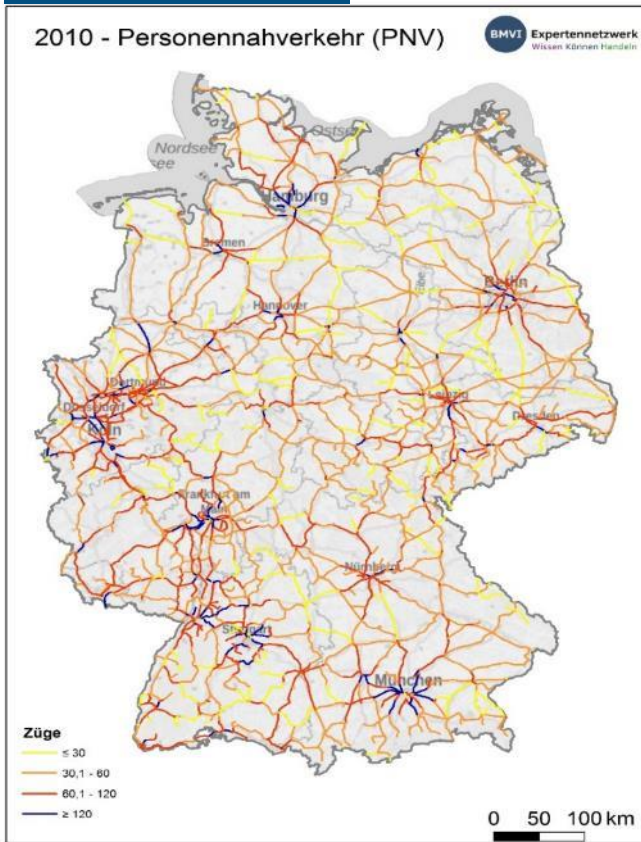


Bott et al. (2020)

**Criticality**

Number of trains (e.g. passenger transport)

2010 - Personennahverkehr (PNV)



Hänsel et al. (2020)





Information &  
Services



Regulations  
and standards

# Adaptation



Construction

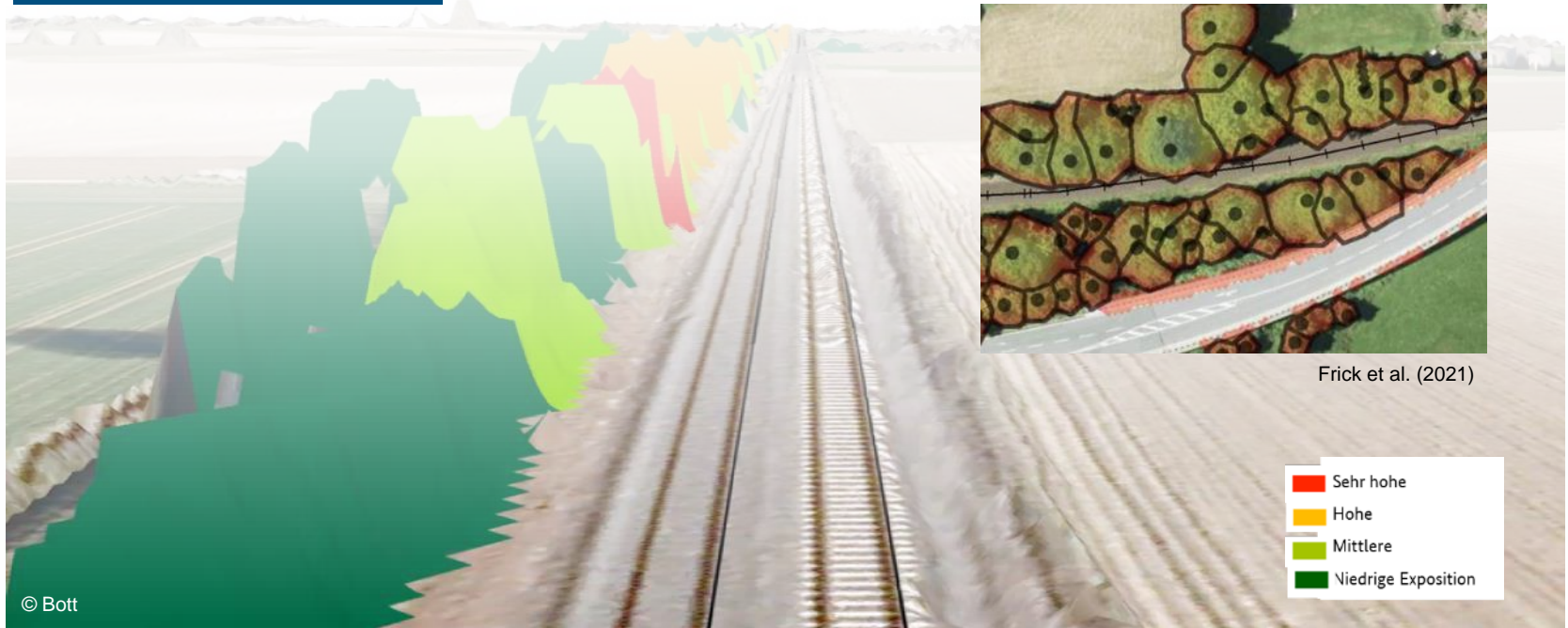


Management



## Vegetation Management

GIS Tool to identify vulnerable trees





# FLOODING

## THE RHINE

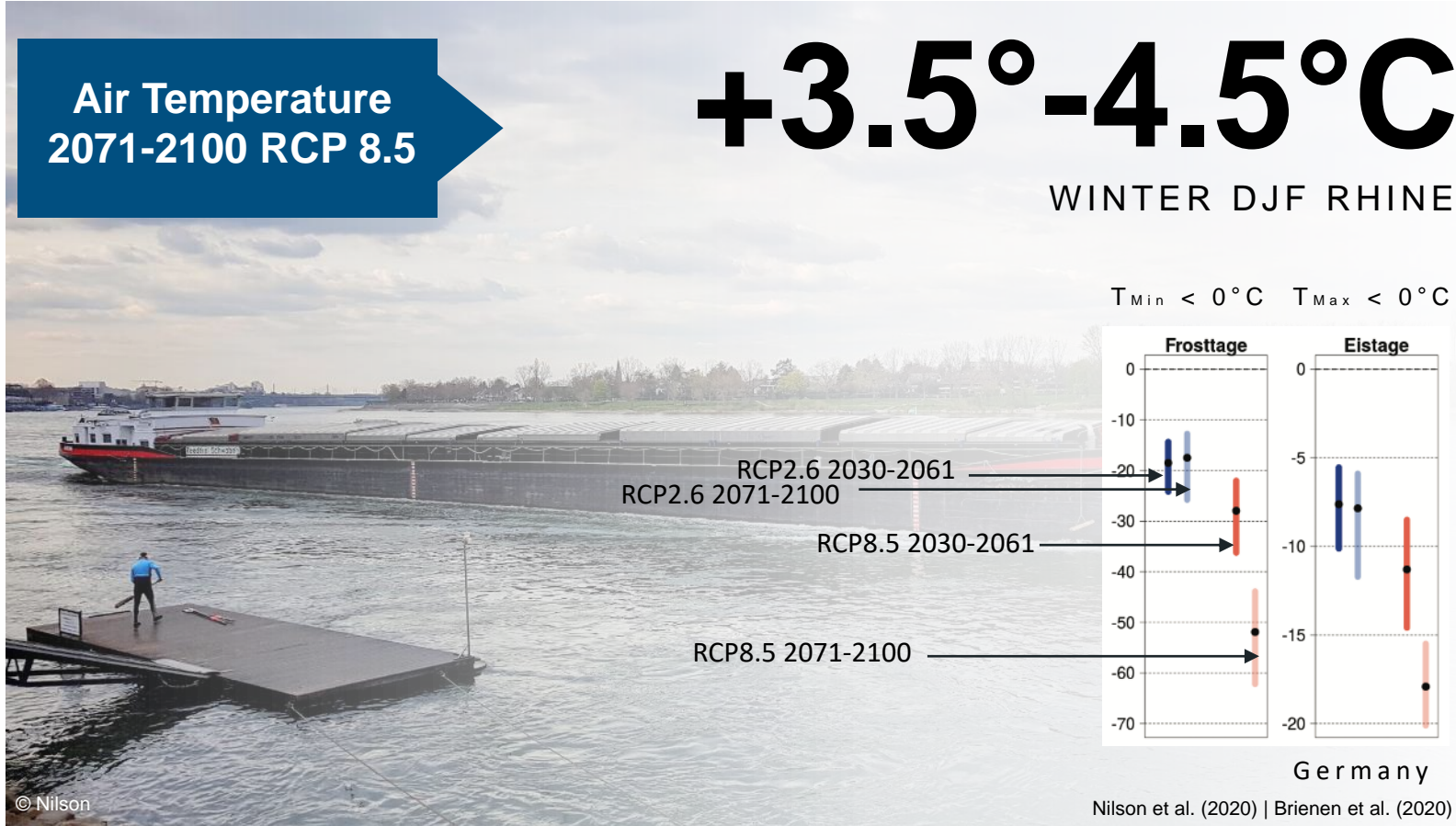
16.11.2021



**Air Temperature  
 2071-2100 RCP 8.5**

**+3.5°-4.5°C**

WINTER DJF RHINE

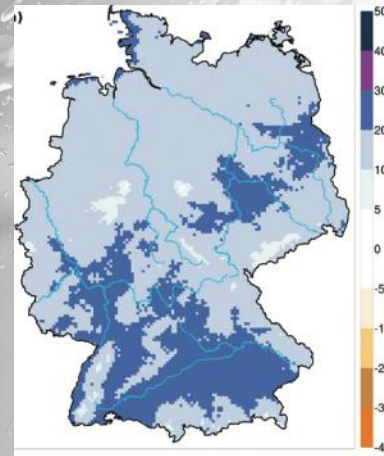


Precipitation  
2071-2100 RCP 8.5

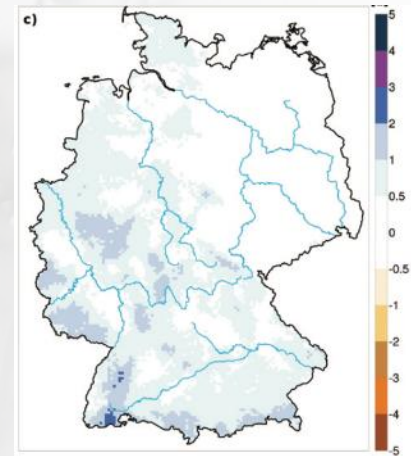
**+5-30%**

WINTER DJF RHINE

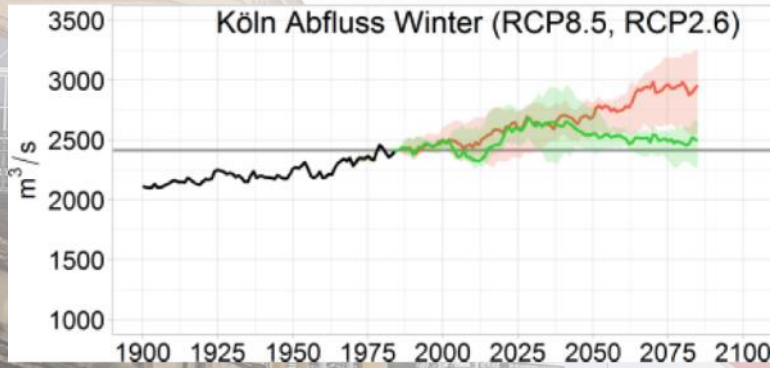
Mean Winter  
Precipitation %



Number of days with  
heavy precipitation in  
winter (>20 mm)

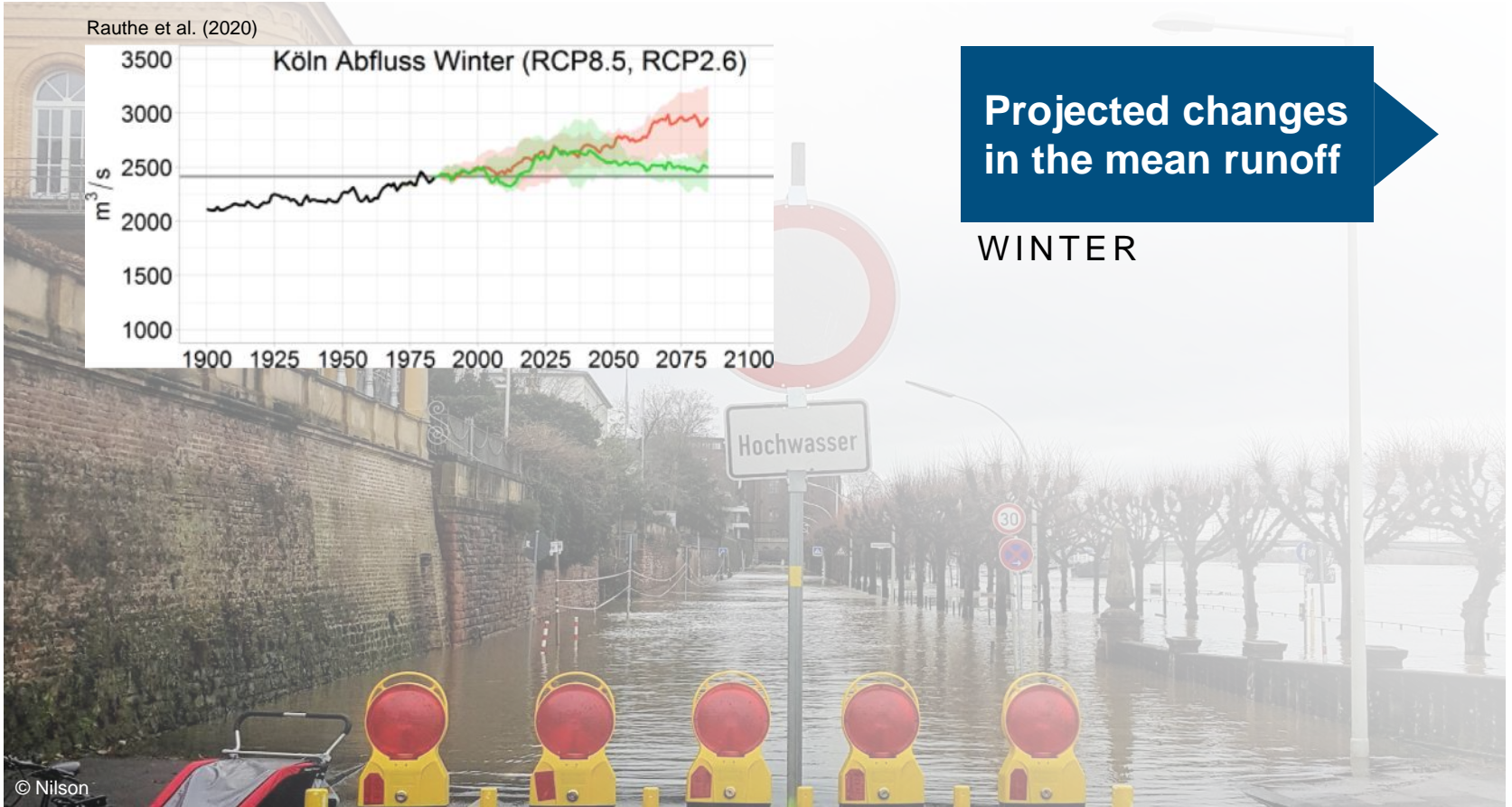


Rauthe et al. (2020)



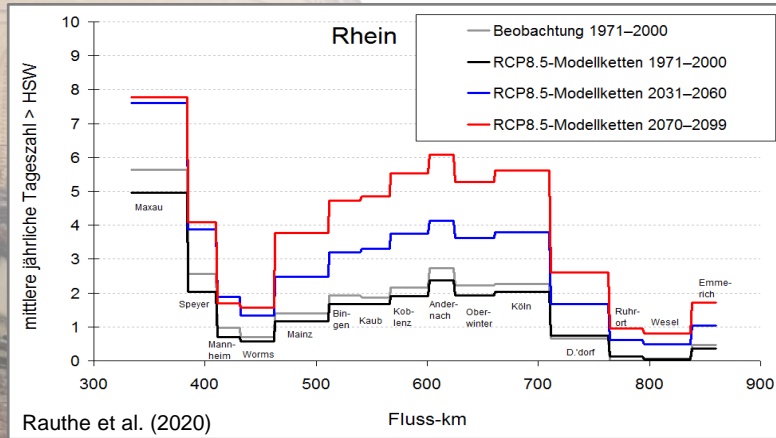
**Projected changes  
in the mean runoff**

WINTER



© Nilson





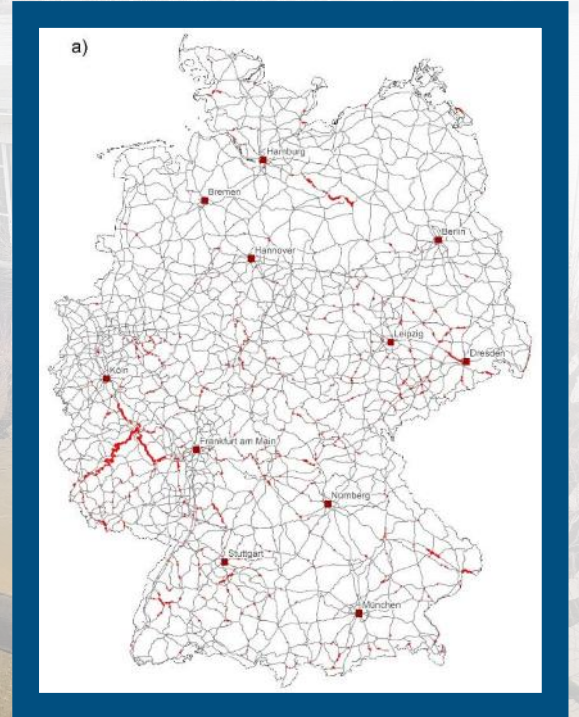
## HSW-Projections

Above this level the Rhine is closed for shipping

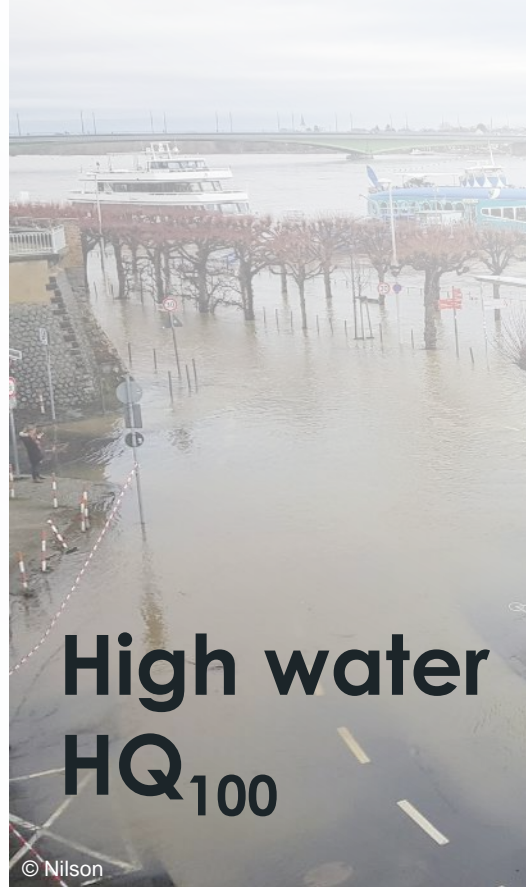




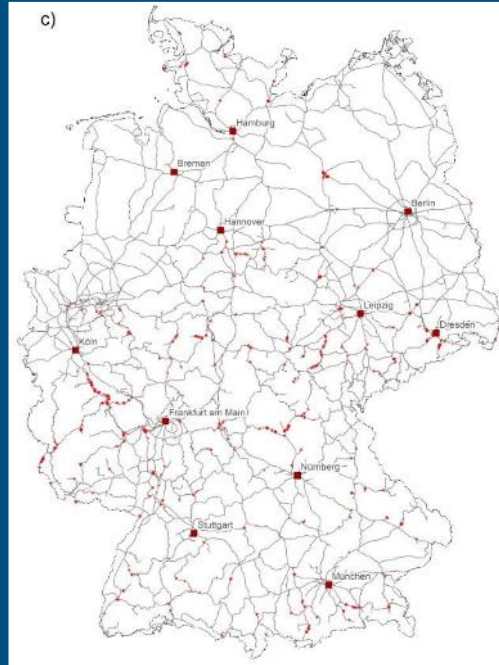
Rauthe et al. (2020)



Rauche et al. (2020)



© Nilson

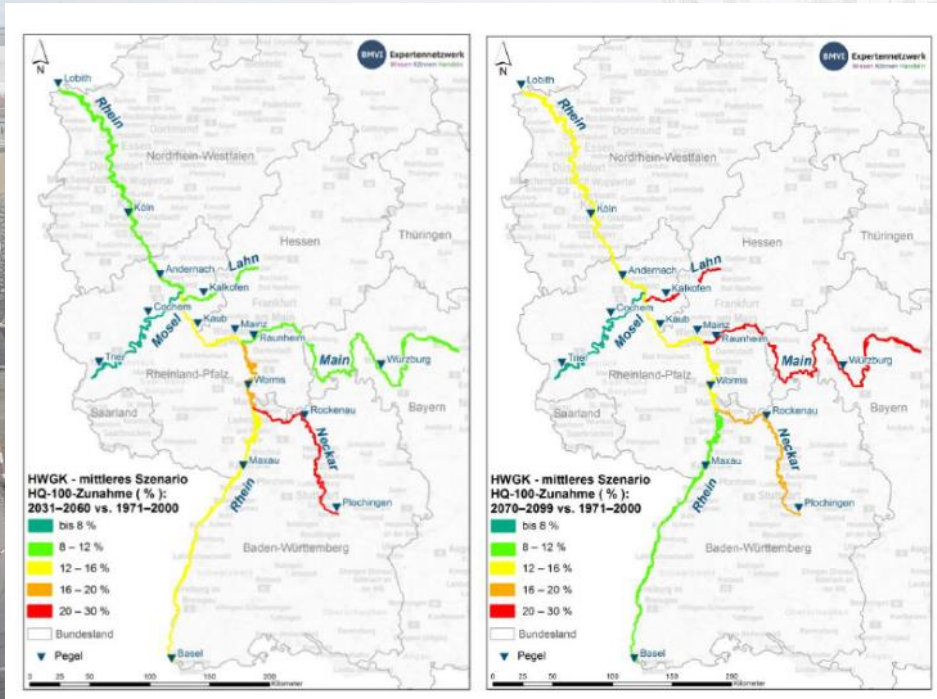


34.140 km

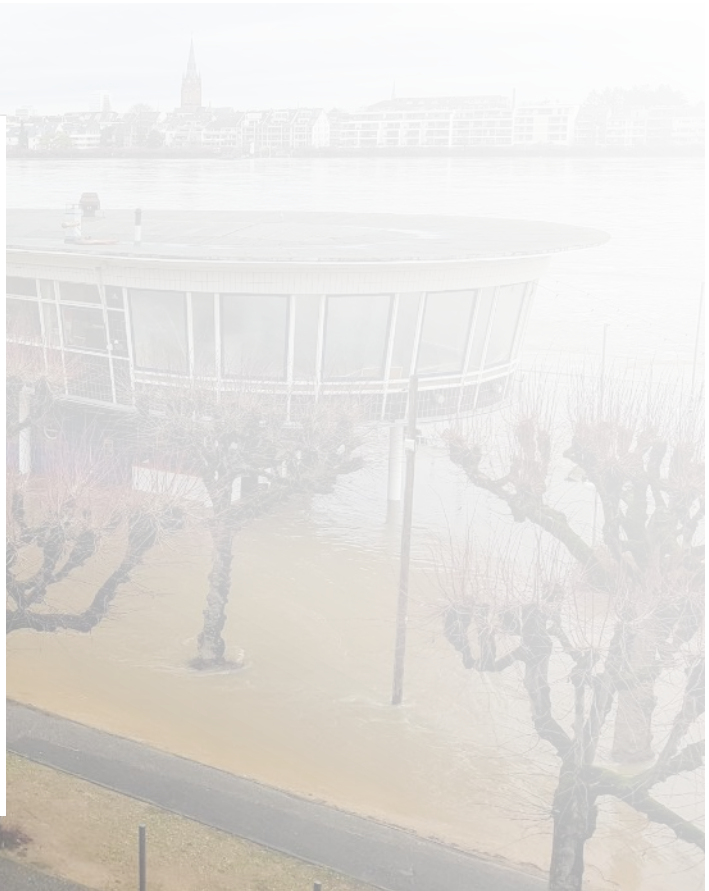
480 km  
1%



# Changes in HQ100



Rauthe et al. (2020)





Information &  
Services



Regulations  
and standards

# Adaptation



Construction



Management

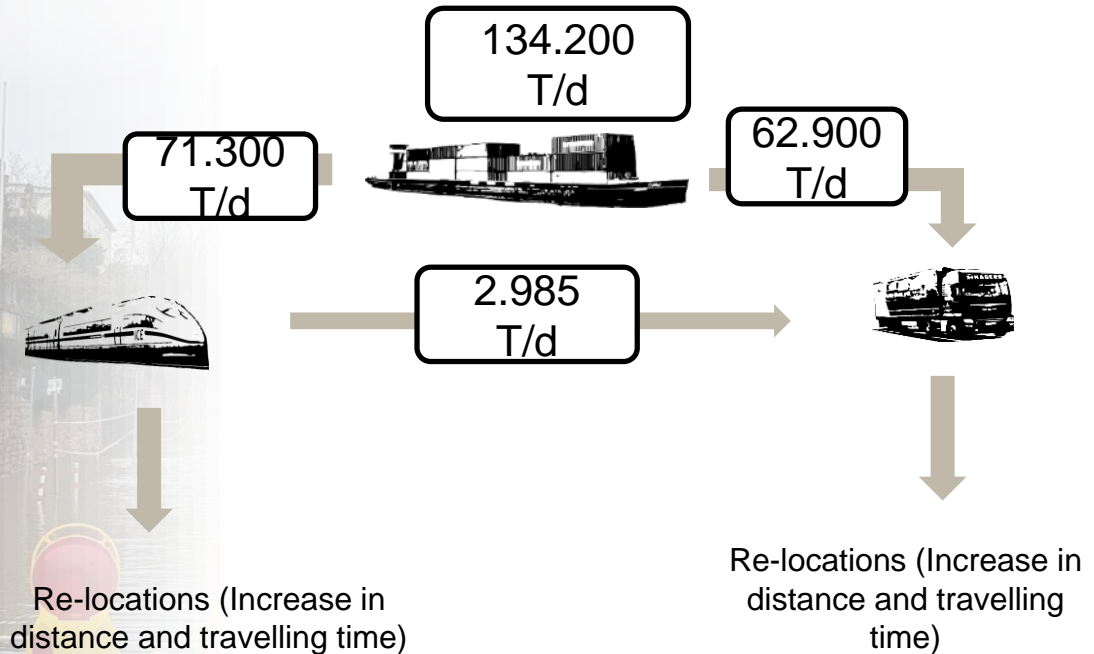


## Traffic Management | Stress test

### Modelling of traffic relocations

Hänsel et al. (2020)

21 Days of  
High Water  
Closure  
Road: B9  
Rail: 2630  
River Rhine





© Nilson

# Contact



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