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Sustainability & Resilience

# How can we adapt our Railways to Climate Change?

izt Institute for Futures Studies and Technology Assessment

RailTech Europe Utrecht June 2022

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# Content

- Motivation for Adaptation to Climate Change
- ARISCC Objectives & Results
- Case Studies
- Recommendations

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# ARISCC Drivers

## Drivers

- Global Climate Change Adaptation framework
- EU /National Adaptation Strategies & Mandatory Reporting Schemes
- More frequent extreme weather events & extensive damage

## Railways have to answer the following questions

- What are the potential impacts of Climate Change on your business?
- What & where are your vulnerabilities?
- What are the associated risks for safety & performance?
- What adaptation measures and actions do you implement?

# ARISCC Drivers 3

Natural hazards /danger processes for railways

# ARISCC Objectives

**ARISCC**

- **Focuses on integrated management of weather & climate related natural hazards**
- **Starts with managing today's weather conditions & extreme weather events**
- **Helps to prepare railways for the challenges of future climate & weather conditions**

# ARISCC Scope & Coverage

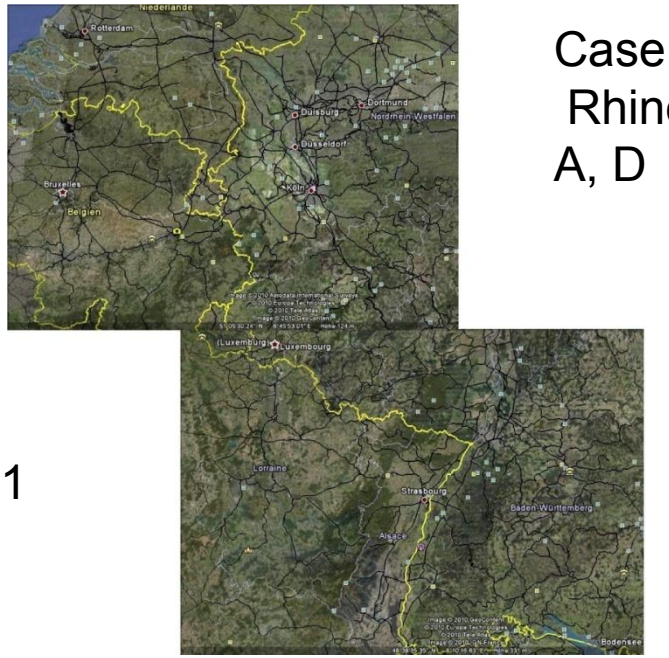
| Factor | Trend | Effect | Impact on Railways/Assets |
|---|---|---|---|
| All listed factors/events will occur more often and their impacts will be more severe according to the existing climate models | | | |
| **1. Temperature** | **change of distribution patterns, higher average and maximum temperature** | | |
| 1.1 High temperatures and heat waves | | overheating | infrastructure equipment |
| | | | rolling stock equipment |
| 1.2 Sudden temp changes | | tension | track buckling |
| 1.3 Intense sunlight | | overheating | track buckling, slope fires, signalling problems |
| **2. Precipitation** | **change of distribution patterns, more extreme events** | | |
| 2.1 Intense rainfall | | soil erosion, land sides, flooding | damage to embankments, earthwork |
| 2.2 Extended rain periods | | slower drainage, soil erosion | other infrastructure assets, operation |
| 2.3 Flooding: coastal, surface water, fluvial | | landslides | drainage systems, tunnels, bridges |
| 2.4 Drought | | desiccation | earthworks desiccation |
| **3. Wind** | **change of distribution patterns, more extreme events** | | |
| 3.1 Storm/gale (inland) | | higher wind forces | damage to installations, catenary |
| | | uprooting of trees | restrictions/disruption of train operation |
| 3.2 Coastal storms & sea level raise | | Coastal flooding | embankments, earthwork, operation |
| **4. Lightning strikes and thunderstorms** | | Overvoltage | catenary and signalling |
| **5. Vegetation** | **faster plant growth, new plants** | | vegetation management |

# ARISCC Results

## Case Studies West Coast Main Line (UK) & Rhine Valley (A,D)

- Priority Setting, Vulnerability Mapping, Risk & costs assessment
- Scenarios 2030/2050 with & without adaptation

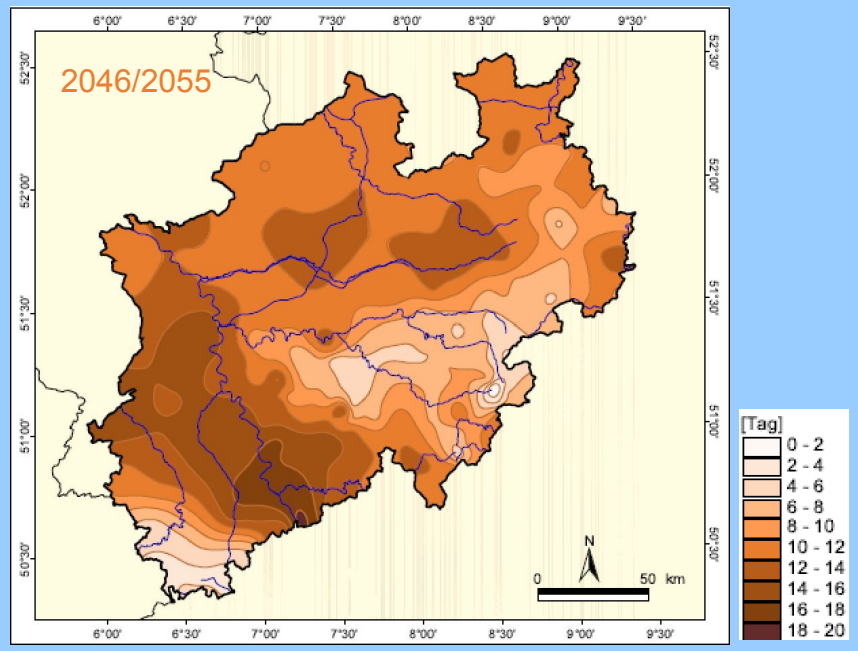
Case Study 1
WCML, UK

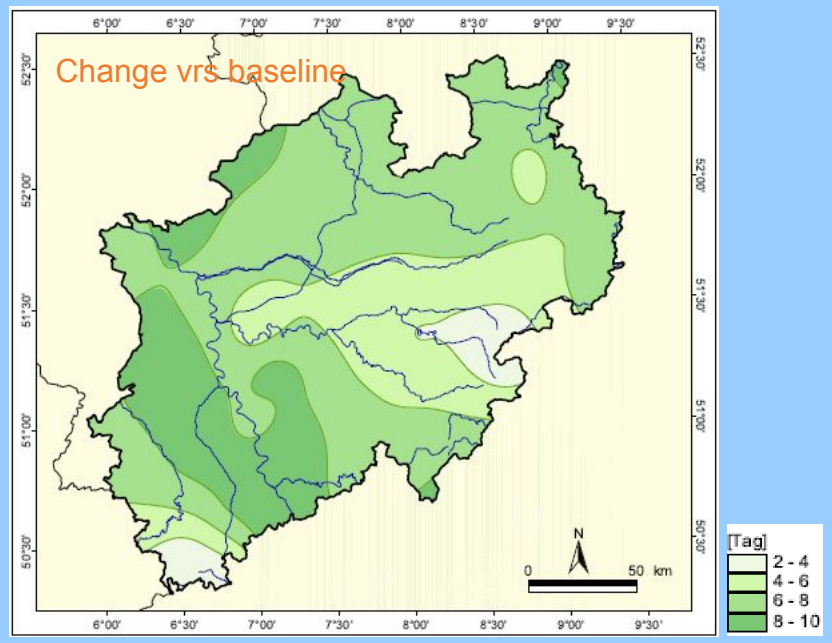


Case Study 2
Rhine Valley
A, D

# ARISCC Case Studies – Rhine Valley

## Expected Climate Loads for the Rhine Valley around 2050

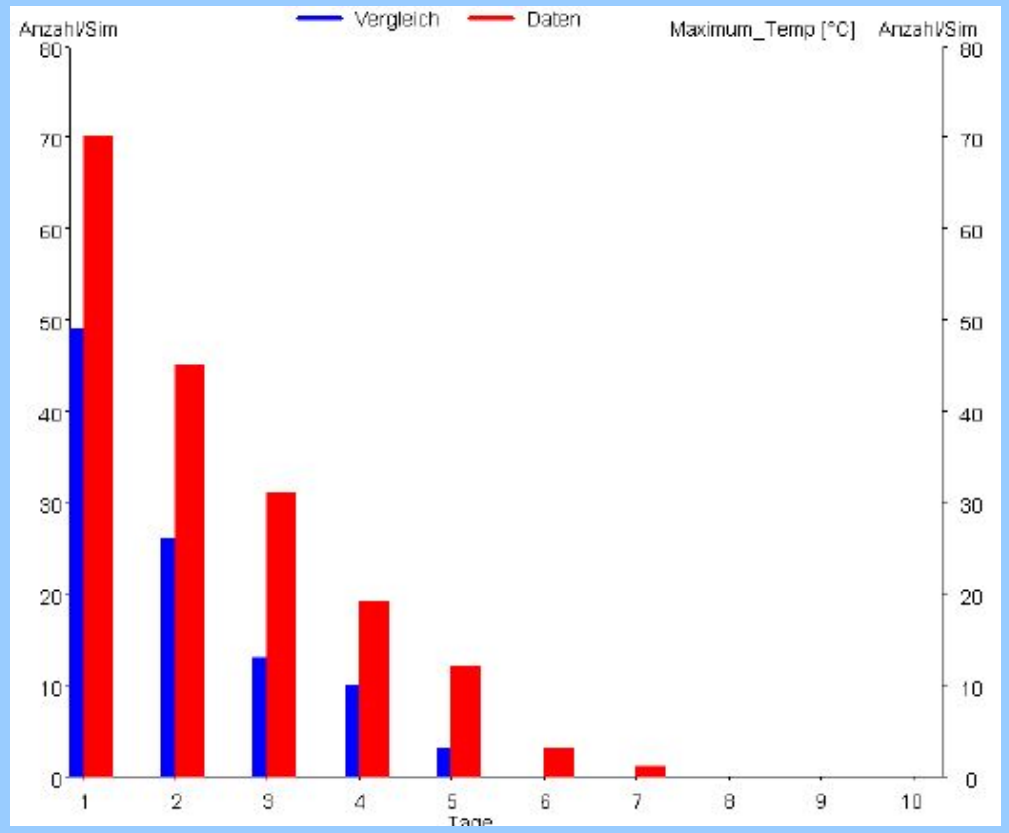



Number of hot summer days in NRW in 2046/2055 and change from the baseline 1951/2000

# ARISCC Case Studies – Rhine Valley 2

## Expected Climate Loads for the Rhine Valley around 2050 (2)




**More & longer heat waves!**

Periods with $T_{max}$ > 30°C
1981/90 and 2091/2100
for the upper Rhine Valley;

Source: WettReg 2007

# ARISCC Case Studies – Rhine Valley 3

## Expected Climate Loads 2050 for the Rhine Valley (3)

- Temperature raise will continue, average change is 2°
- The number of warm/hot days will increase significantly
- Total precipitation will increase with regional and seasonal differences
- Air pressure will significantly increase, as well as sunshine duration and radiation
- All these effects will also influence vegetation growth & thus have further impacts on infrastructure!

# ARISCC Case Studies – Rhine Valley 4

## Discussions with infrastructure manager (DB Netz)

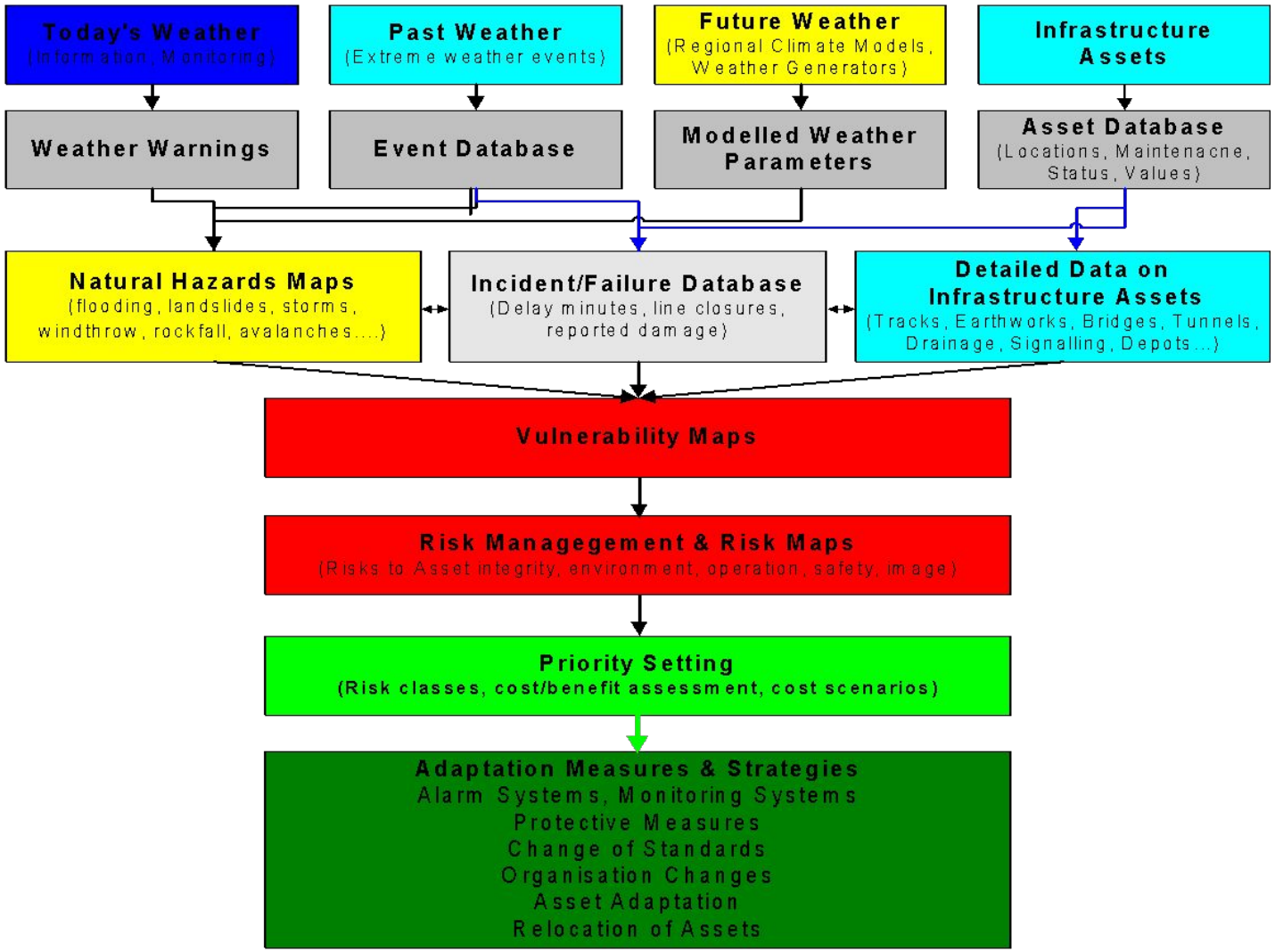
Adaptation to Climate Change is becoming an issue!

Consistent data base to be established: extreme weather events, damage..

Priorities (from todays perspective):

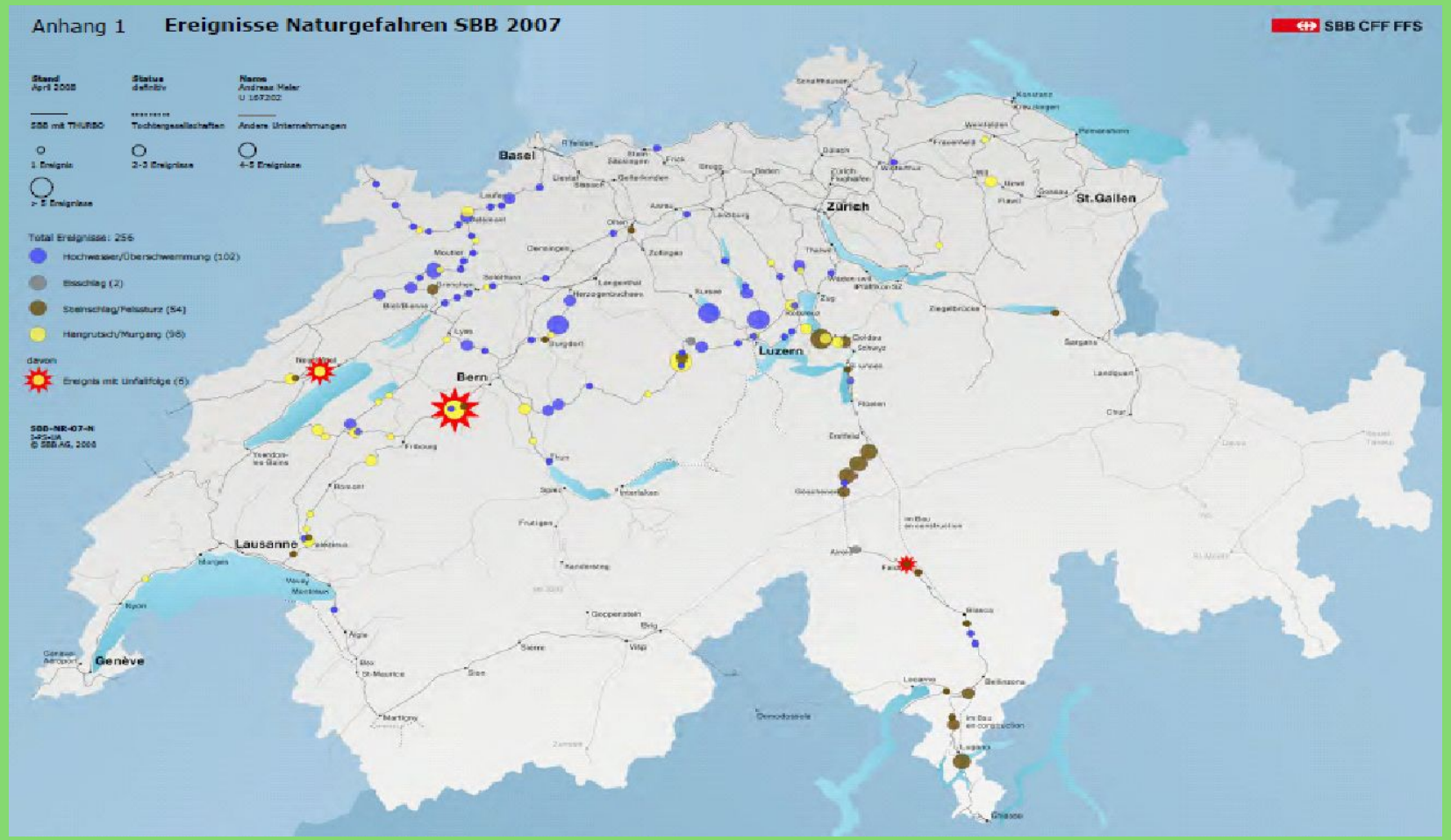
- Damage & delays caused by storms and gales
- Heatwaves and extended dry periods
  - Track buckling (maintenance problems, safety)
  - Destabilization of earth works
  - Climatization of trackside equipment)
- Flooding & vegetation (long-term): Surface/ fluvial flooding; Changing vegetation growth patterns

# ARISCC Results - Integrated Natural Hazard Management



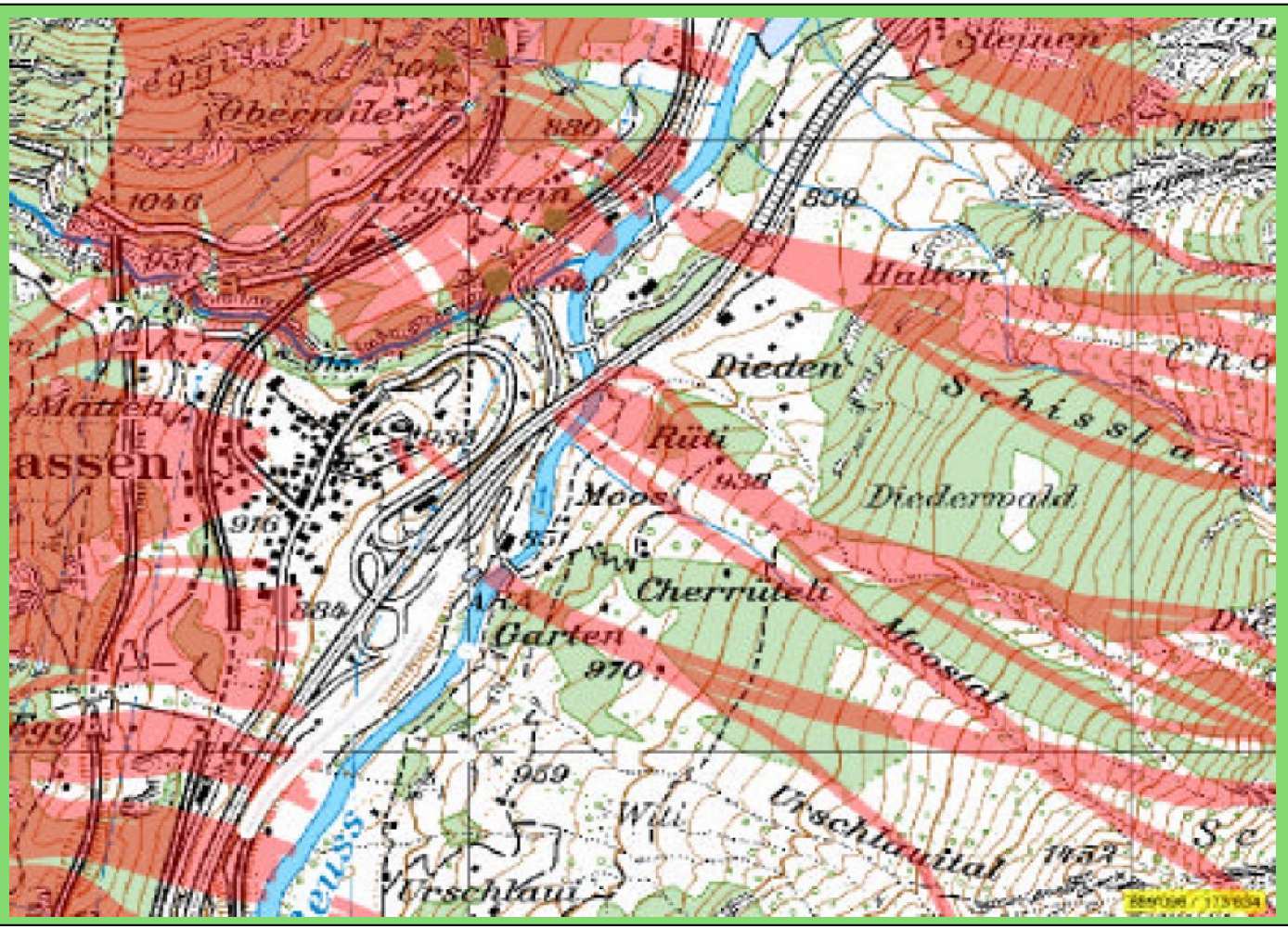
# ARISCC Results & Products 2

## Event Database & Maps



# ARISCC Results & Products 3

## Hazard Maps



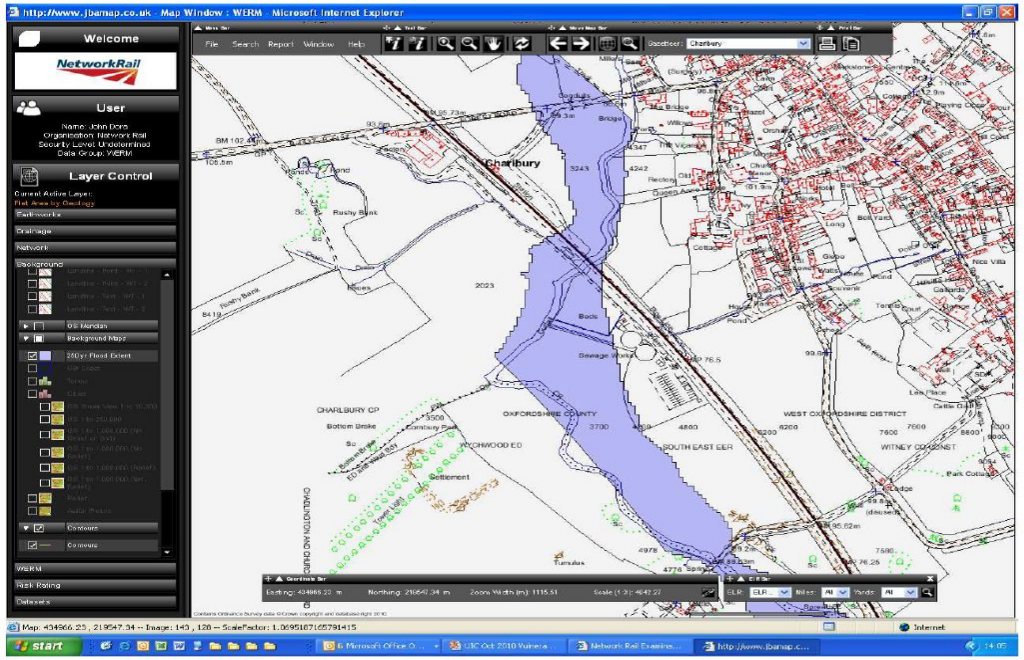

Map for potential rock fall hazard in Switzerland

modelling, digital relief data, data on slopes,composition of earth, precipitation data (SBB)

# ARISCC Results & Products 4

Vulnerability Maps

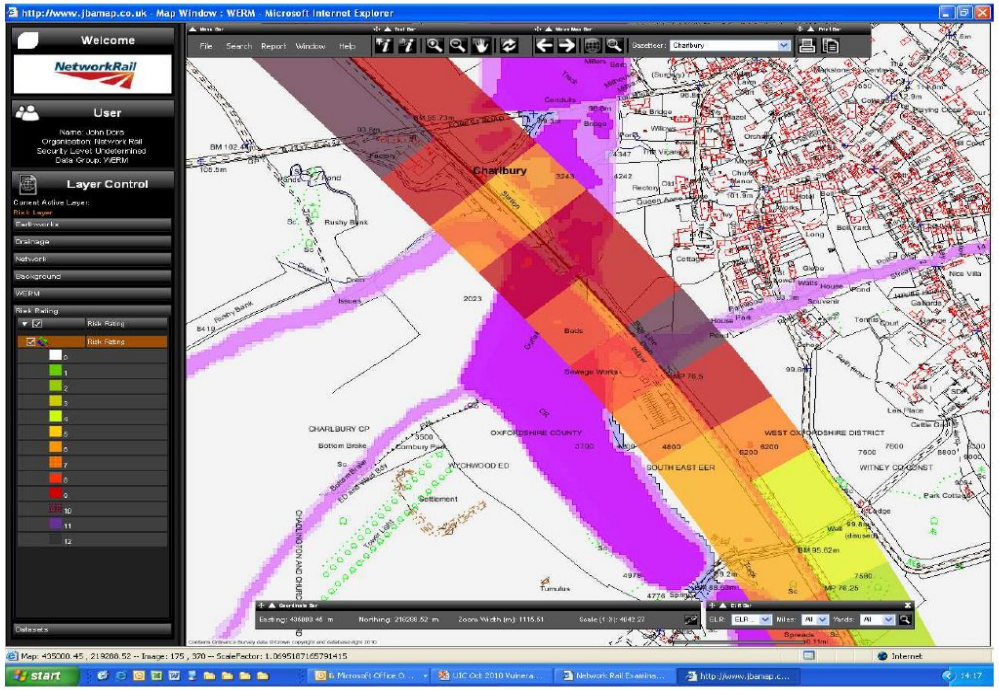
## Add 250 year floodplain



# ARISCC Results & Products 5

Vulnerability Maps

## Process data into viewable risk bands




+ Water flow routes
+ Water sinks & depths

# Best Practice & Knowledge Exchange

## New railway line between Copenhagen and Ringsted (Banedanmark)

Upgrade track Copenhagen – Ringsted; Climate Change Impact Assessment

Investigate robustness to CC for 100-year operation period

Highest impact from increased precipitation & water flow

20% increase in intensity of rainfall in heavy downpours!

Change of standard for new line:

**Copenhagen – Ringsted's drainage system has +30% capacity!**

# ARISCC Recommendations

## General Recommendations

- Develop pro-active adaptation strategy, short/medium/ long-term
- Systematic capacity building (knowledge, experiences, processes)
- **Main Focus: 3Rs**
  - **Readiness**
  - **Resilience**
  - **Recovery**

# ARISCC Recommendations 2

## Recommendations 2

- Develop weather information and warning system
- Set-up centralized event database
- Perform systematic hazard mapping
- Establish links to central asset database
- Develop vulnerability maps

# ARISCC Recommendations 3

## Recommendations 3

- Perform Systematic Risk Analysis
- Rethink maintenance - Rearrange & prioritize measures
- Support adaptation strategies and programs
- Implement Organizational changes
- Change norms & standards
- Establish Integrated Natural Hazard Management

# ARISCC Benefits

- Improved weather warning & information
- Vulnerable parts of infrastructure identified
- Keep & improve railway infrastructure performance & avoid damage, protect costumers & personnel
- Learn from the experienced
- Optimized Maintenance of Assets
- Prepared for future weather & climate conditions
- Reporting on adaptation strategy & measures

Thank you for your attention!

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