Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

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Climate proofing multimodal corridors in the Netherlands

System robustness

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Kees van Muiswinkel - Rijkswaterstaat

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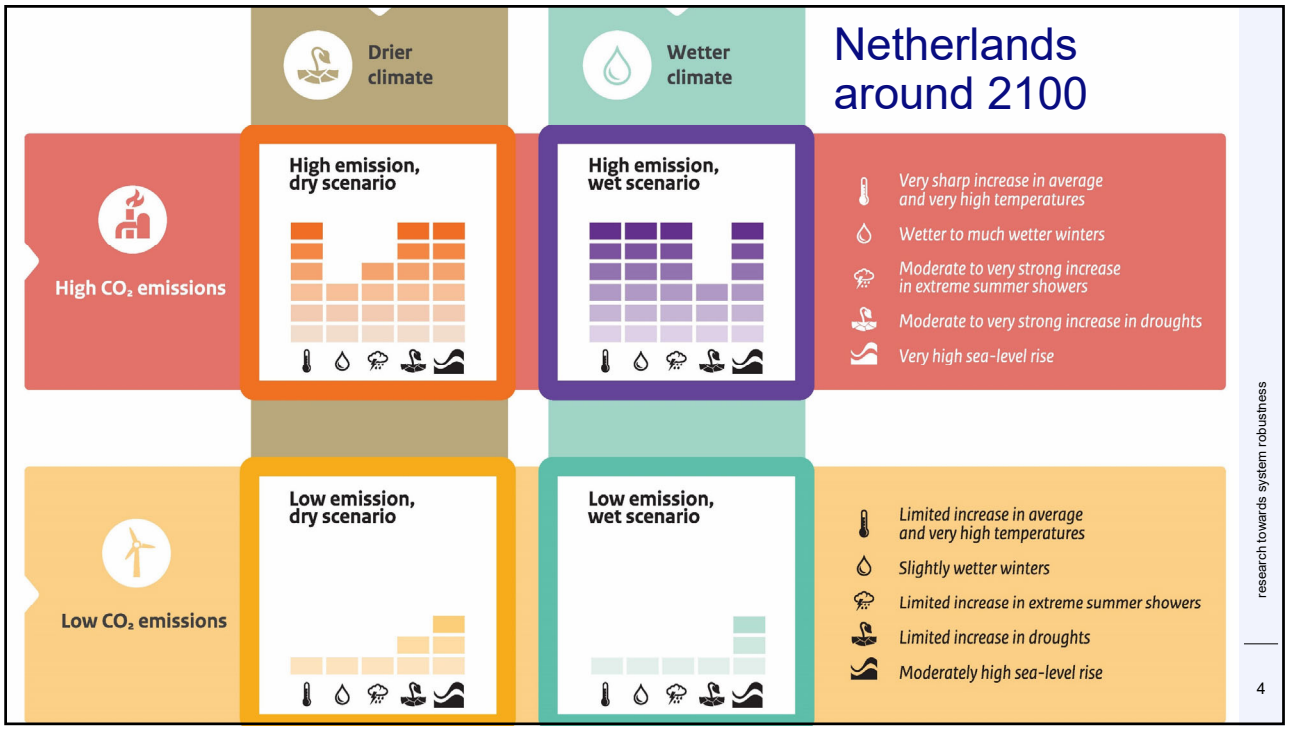

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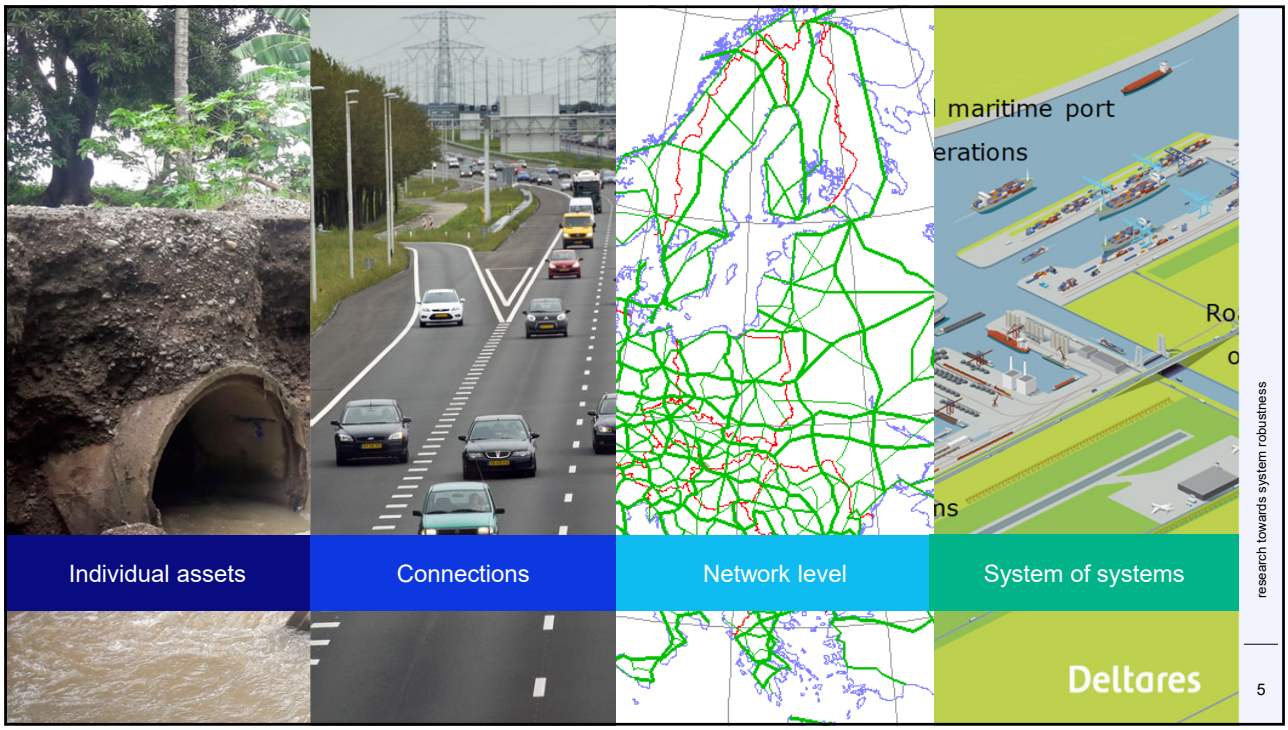

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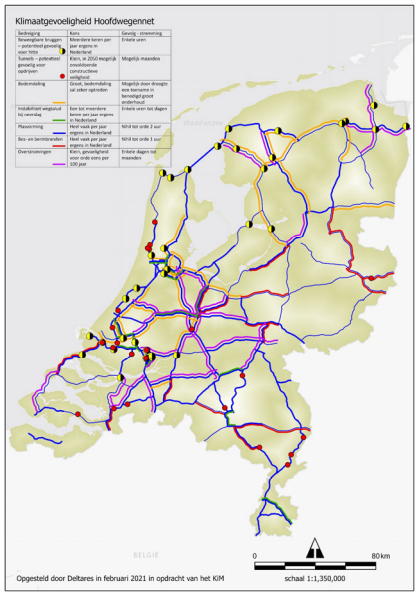
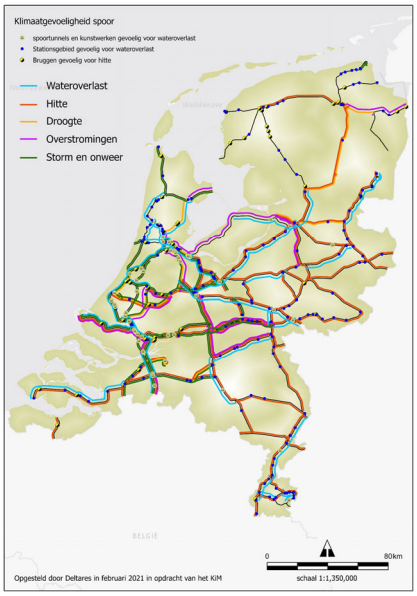
Stress testing



Main road network



Main rail network

Inland water network

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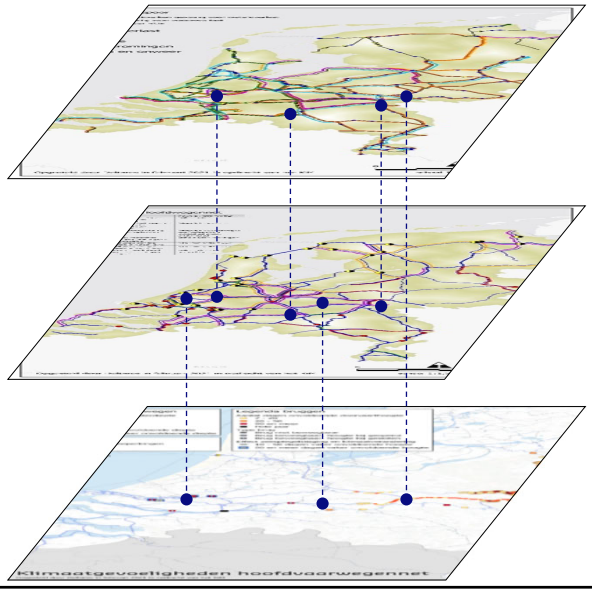
System robustness – resilience of transport



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Climate resilience

- Vulnerability for climate threats
  - Per asset
- Impacts
  - Damages (physical)
  - Losses (users/society)
  - For connections and networks
- Adaptation strategy
  - High level strategies per climate threat
  - Quantitative substantiation for some

- What performance is required?
- What is definition of climate proof?
- How much may it cost?
- What does it bring to society?

- System analysis is lacking
- Prevention of sub optimizations
- Promote maximum societal output

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Where can adaptation happen to enhance resilience?

Ministry
Ports

Infrastructure authorities

Infrastructure adjustments

Transport companies / industry

Usage adjustments

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Approach to develop a research plan ‘system robustness’

LITERATURE

INTERVIEWS

WORKSHOP

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Insights and knowledge gaps

- All modalities are sensitive for climate change
- Drought is the main driver for a multimodal approach
  - Recent droughts in 2018 en 2022
  - Low water levels, restricted lock use, salt intrusion
  - Impact mainly felt in Germany
  - Business climate under pressure
- Low flexibility in flow of goods
  - 10% modal shift after 10 days of extreme low water levels, mainly to railways
  - Shortage in capacity road and railway, non existing platform for modal shift

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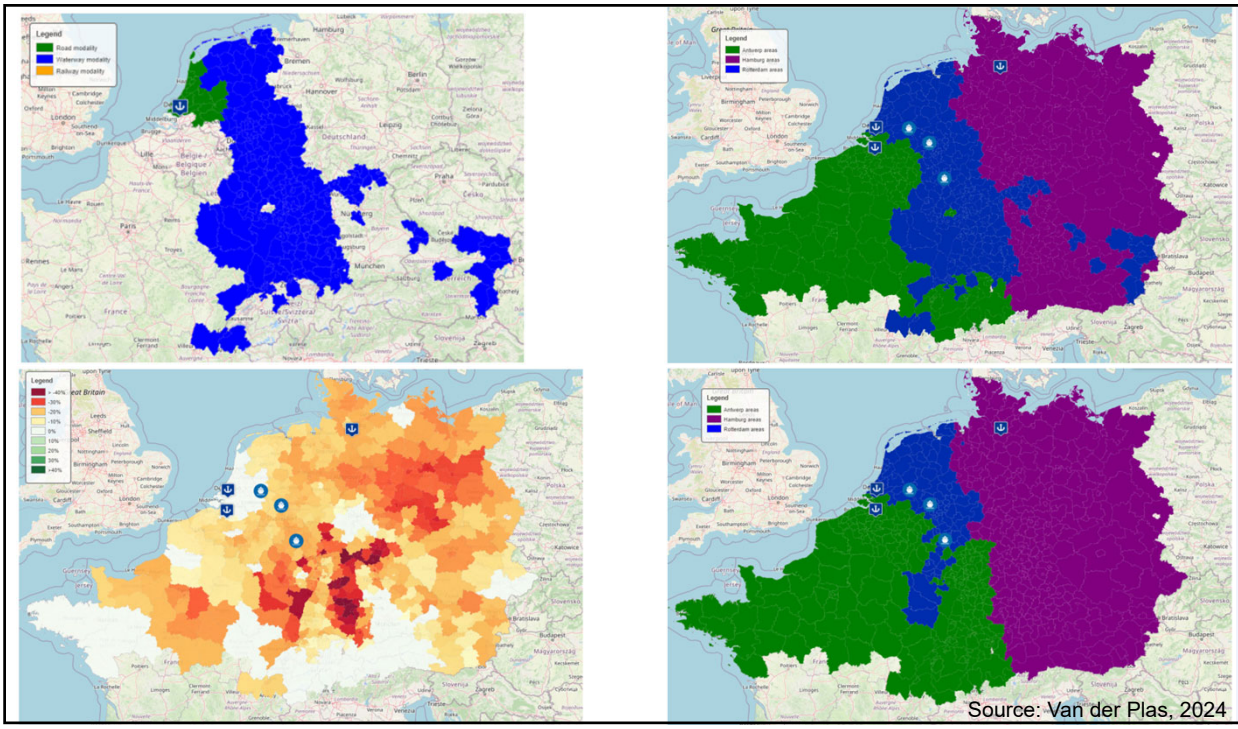

Source: Van der Plas, 2024

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Insights and knowledge gaps

- Wide consensus that system approach is required
  - Not only research on modal shift
  - Also a systemic approach of relation transport infrastructure and transport itself
  - Lacking insight in cascading impacts and dependencies with other critical infrastructures
- Significant shortage of knowledge and tools
  - Climate impact on multimodal transport system insufficiently understood
  - Future viability of modalities
  - Interaction between users and (multimodal) infrastructure
- Need for reliable data
  - Uniform European climate data
  - Monitoring the effects of infrastructure disruption on transport
- Need for an assessment framework
  - Interests of public and private parties
  - Economic criteria (costs and benefits)
  - Sustainability criteria
  - Broad prosperity (currently no consensus on definition)

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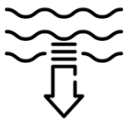
Core of change assignment: multimodality

- Drivers:



Low water

EU directive

- Lens:

- Objectives multimodality:
  - Reliability in drought conditions

  - Serving industries that are not close to waterways

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Challenges

- The shared sense of responsibility and **lack of ownership** → The need for more central coordination
- Integrating and building on previous studies requires **central coordination** across various domains
- Climate resilience policy is essential and complex to define. What are the **goals** being pursued?
- **Budget allocation and financing** for climate adaptation
- Complexity of **considering key infrastructure assets** (e.g., container transport hubs) and their relevant characteristics

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Targets and intended impact of system robustness

- Main target: climate proof transport
  - Future transport demand also met in a changing climate
  - Vulnerability understood at the system level
  - Guiding the adaptation of infrastructure and transport
- While considering
  - Economics
  - Broad prosperity
  - Energy transition
- Dilemmas
  - Adapting adaptation versus adapting transport
  - Maintenance versus construction
  - Short term versus long term horizon

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Key climate threats

- Low water levels as main driver
- While considering disruption of road and railways linked to drought (i.e. wildfires)

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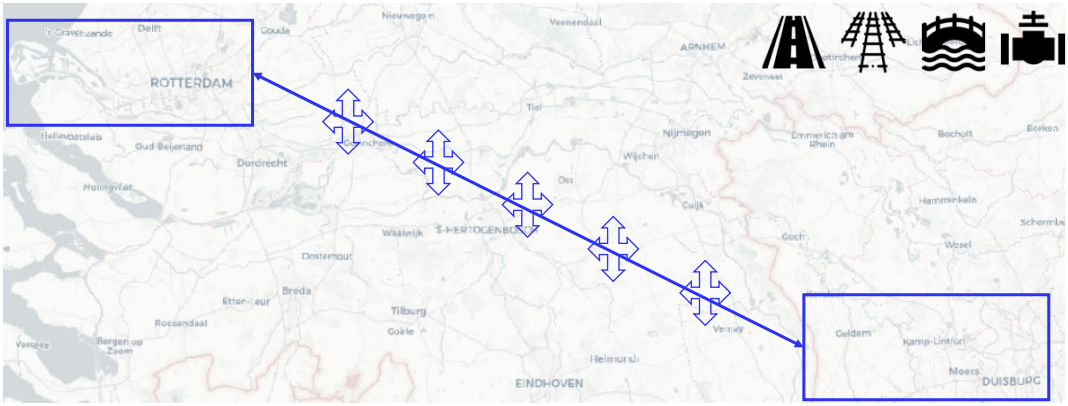
Geografische scope en modaliteiten



- Rotterdam – Ruhr
- Inclusief vertakkingen (Twente, Eindhoven, etcetera)

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Type of adaptation

Phase	Infrastructure measures	Transport measures
Prevention	+++	+
Preparedness		++
Respond		+++
Recover	+	++

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Time horizon

> 2080

Now | Short term (weeks to months) | Medium Term (until 10 years) | Long term (10 to decennia)

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Identified research activities

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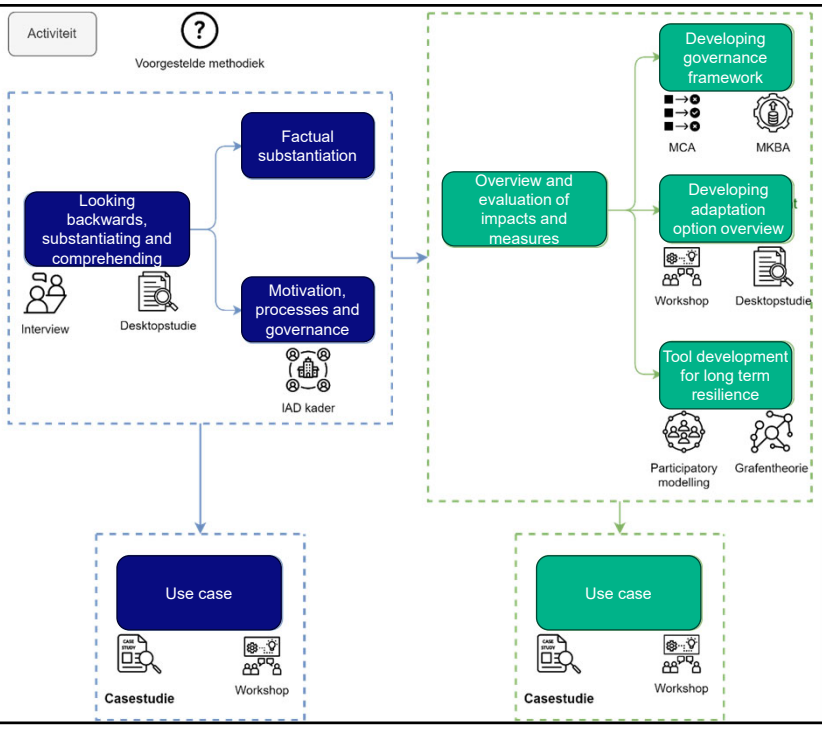
Methodology

A. Looking backwards, substantiating and comprehending

B. Overview and evaluation of impacts and measures

C. Use case studies



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research towards system robustness

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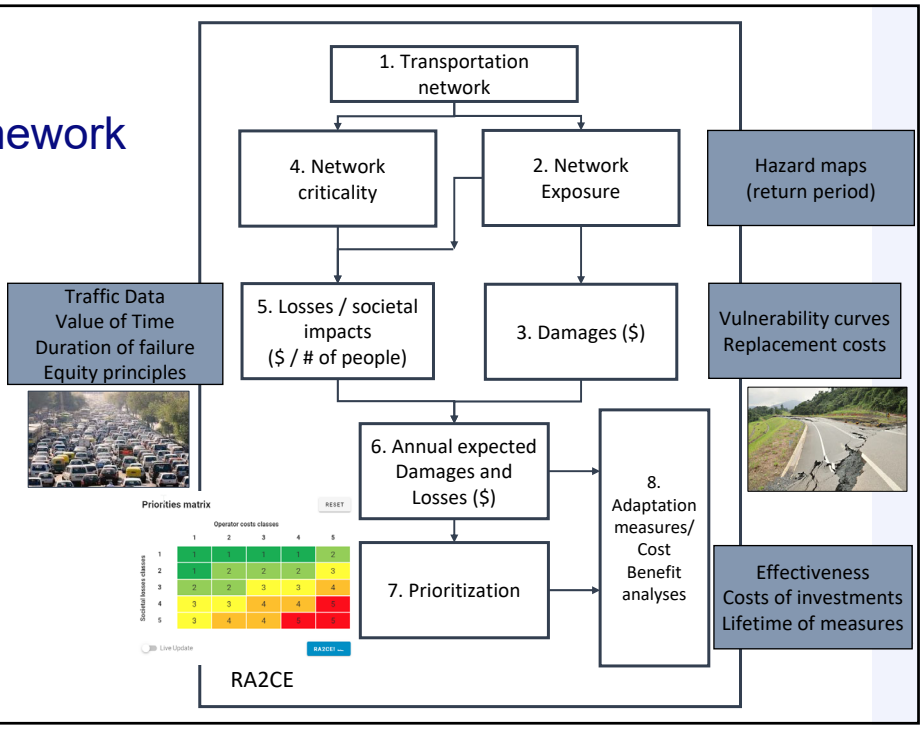
The RA2CE modeling framework

- Graph-based network analyses
- Hazard model output can serve as input
- Output has different visualisation options
- Fast and Flexible



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Adaptation Planning for highways in the Netherlands

As Ministry of Infrastructure

Gain insight in the measures to take to achieve future resilience by making the best investments

To do this

RA2CE delivered maps with overview of cost beneficial interventions based on efficacy of the interventions on the hazard impact

Which results in

Cost-savings due to better informed investment planning and spatially explicit

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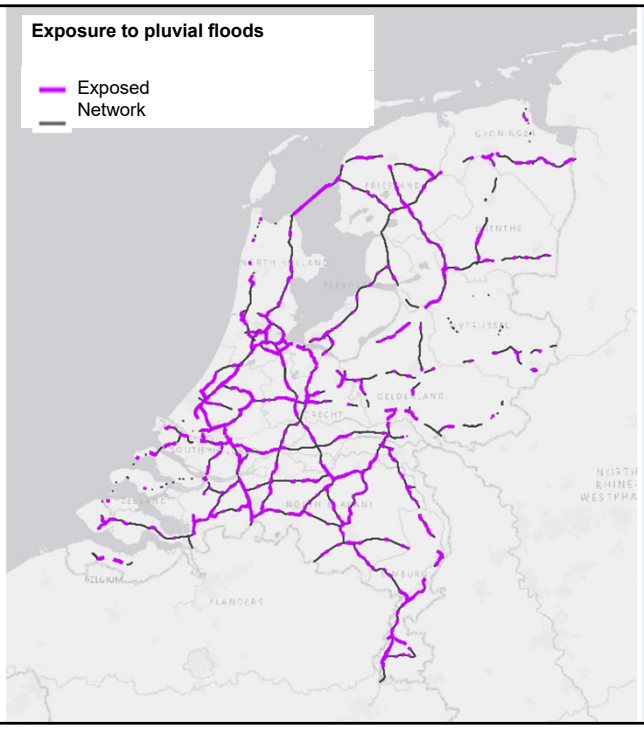
Exposure

Combined exposure

Each 100 m section evaluated for;

- Elevated roadside (near & far)
- Presence (piped) drainage system
- Presence acoustic fencing, no drain



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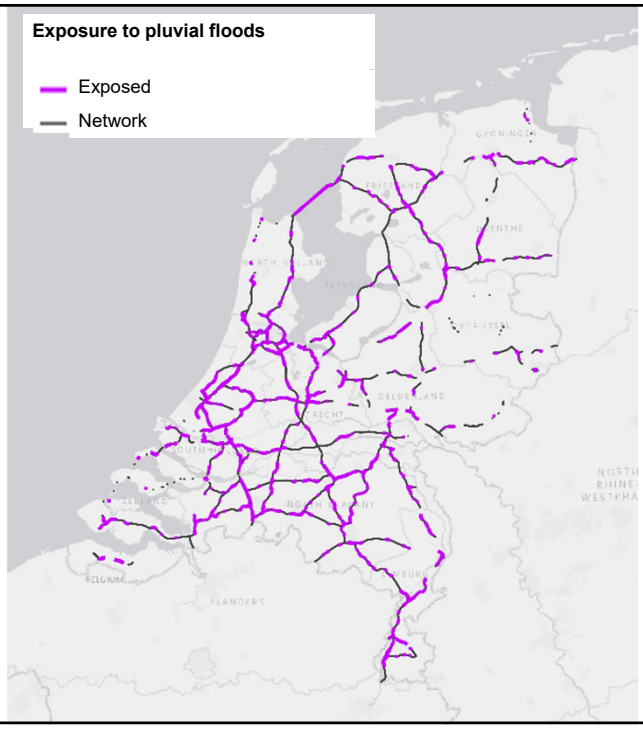

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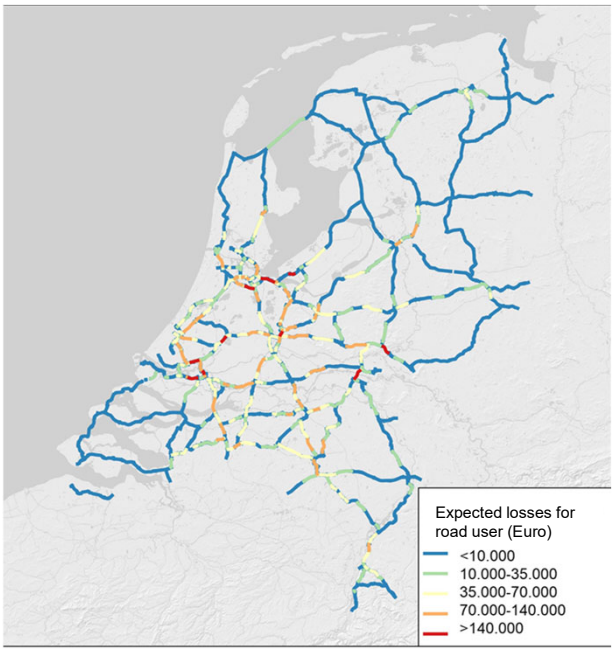

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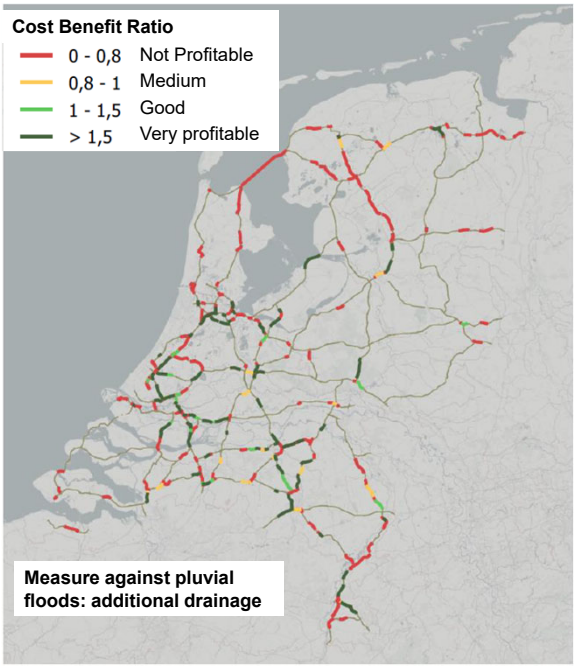

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CLARION

- 4-year EU project on resilient ports
- 2024 - 2027
- Pilot Demonstration 7: Hinterlands resilience model and Digital Twin to support the resilience of connected inland waterways, roads and railways infrastructure
  - Deltares
  - TUDelft
  - Port of Rotterdam

- Multimodal Hinterland Resilience Model
  - Using RA2CE (Resilience Assessment and Adaptation for Critical infrastructure)
  - Hinterland of Port of Rotterdam
  - Ambition to include hinterland of Hamburg and Antwerpen
  - Focus on adaptation of infrastructure by identification of hotspots
  - On network level as well as across networks

- Digital Twin EUs inland waterways
  - Simulation of inland waterway transport
  - North Western Europe
  - Infrastructure, hydrodynamics, vessel behaviour
  - Integrated system analysis across corridors
  - More resilient transport

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Discussion

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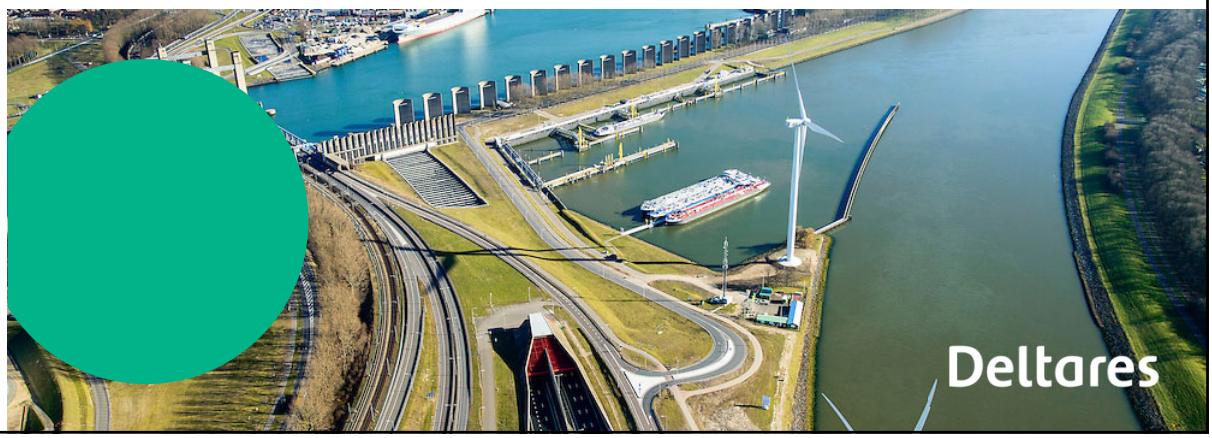

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