

Deltares

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Investing in climate resilient road infrastructure

Case study; Pluvial floods in the Netherlands

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Table of contents

- Methodology
- Exposure – Vulnerability – Risk; pluvial floods
- Interventions (measures)
- Cost Benefit Analysis
- Financing

Methodology



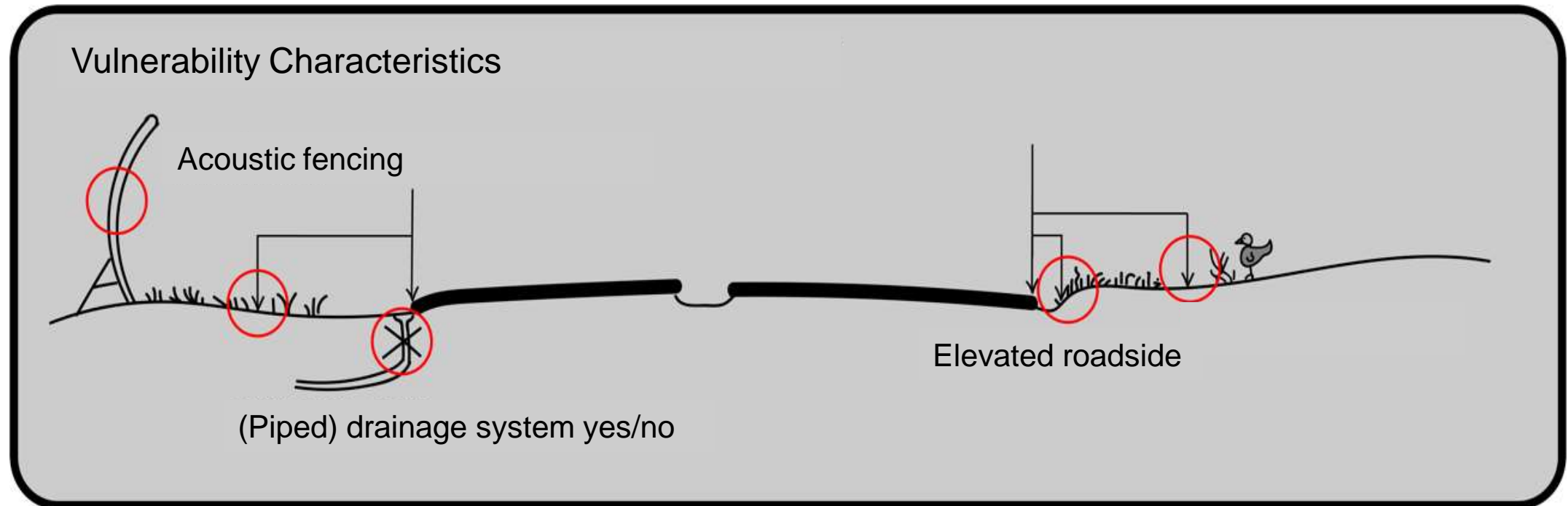
Exposure

Main road network in The Netherlands

- 1,300 km highways
- 600 km national roads
- Divided into ~ 7,000 segments (approach – exit)



Vulnerability



Vulnerability

Combined vulnerability

Each 100 m section evaluated for;

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



Vulnerability; Details



Elevated roadside (near)



Elevated roadside (far)

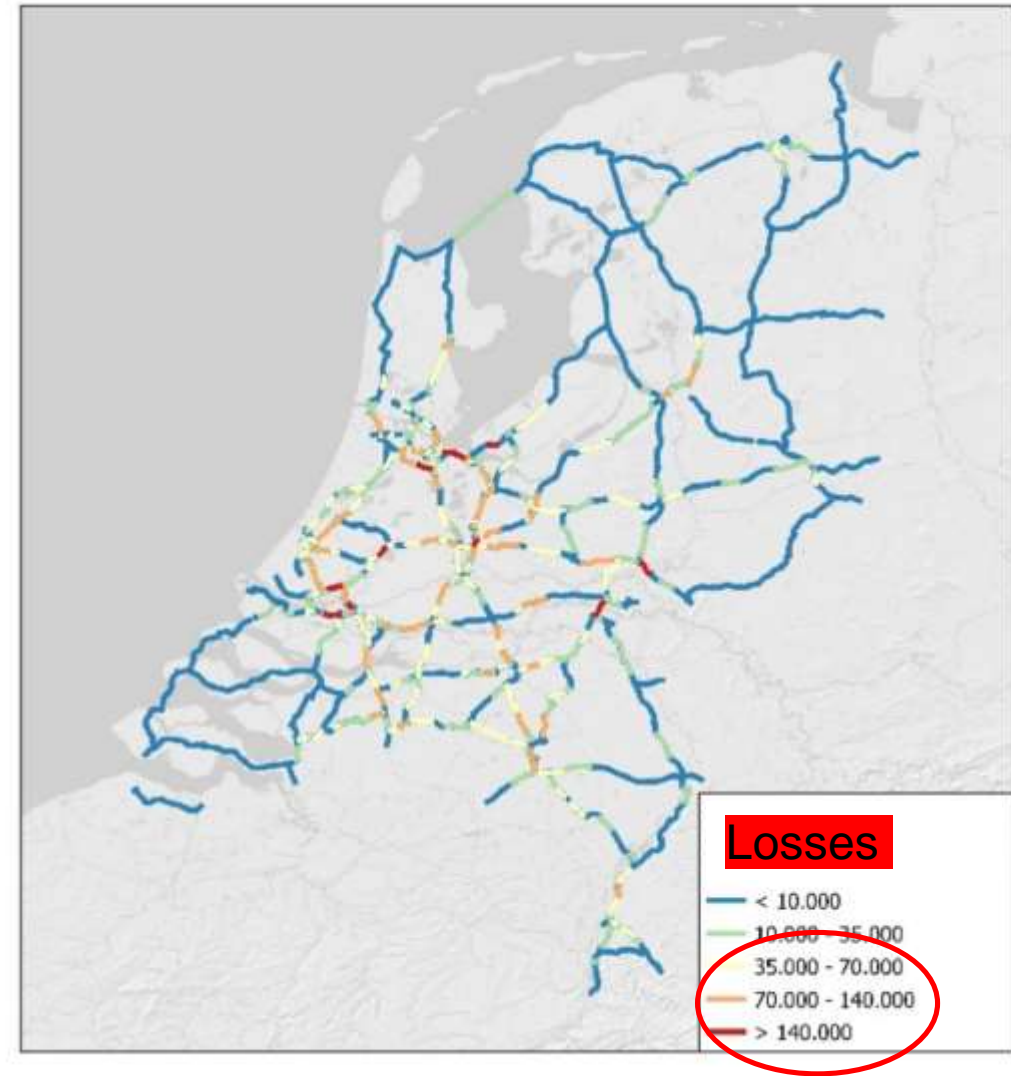
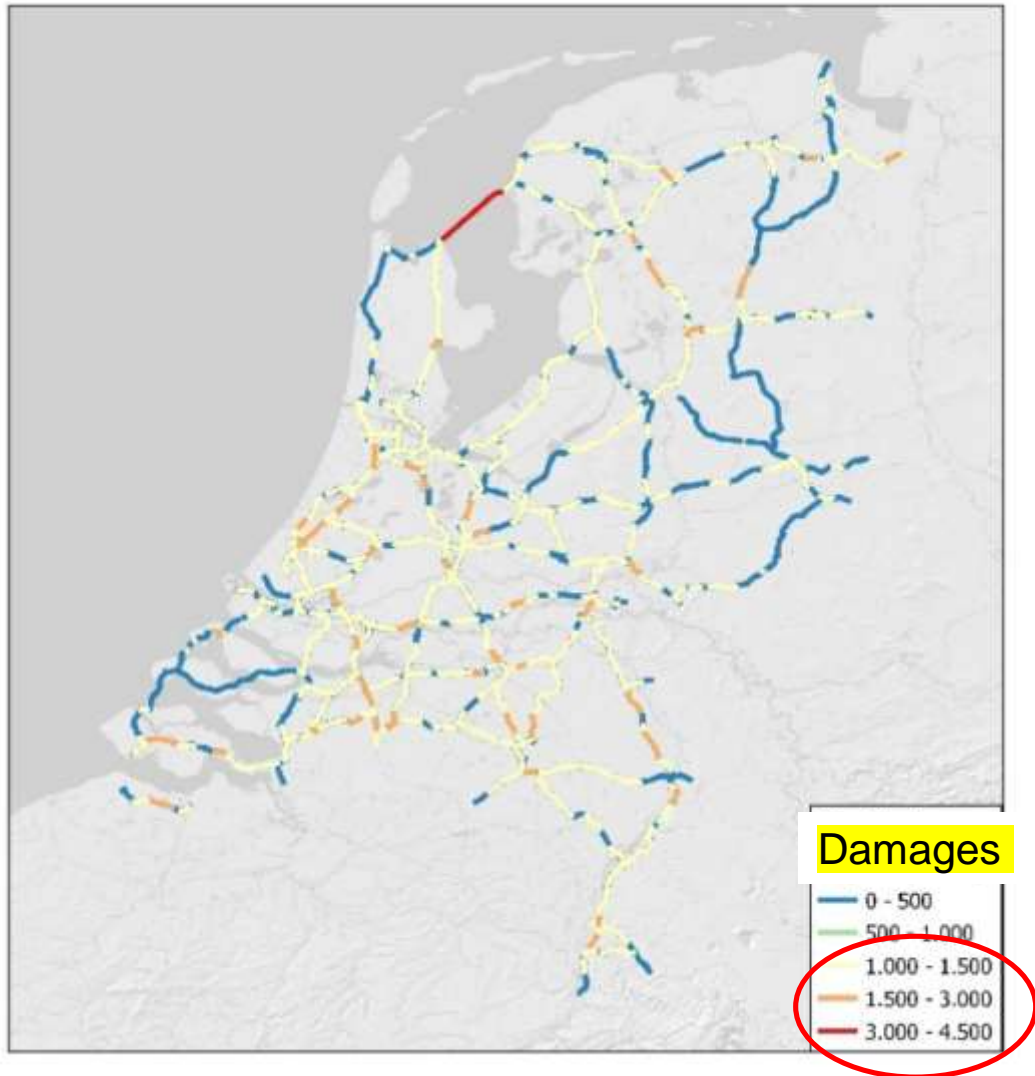


(Piped) drainage system



Acoustic fencing, no drain

Risks; Damages and losses from pluvial floods



Interventions; Longlist Measures

Additional maintenance of roadsides

Additional maintenance of drainage system

Additional maintenance of pavement

Implementation of improved (piped) drainage system (when missing)

Improvement of existing drainage system (when present)

Early replacement of road pavement

Increase longitudinal inclination of road

Increase discharge capacity of piped drainage system

Build open concrete drains alongside the road

Increased height of road embankment

Costs, effectiveness and Cost Effectiveness Analysis

Measure	Overall efficiency	Costs (€)	Cost Efficiency
Improved maintenance roadside entire network	100%	2.659	26,59
Improved maintenance roadside after monitoring	100%	1.500	2,81
Improved maintenance pavement	5%	425	85,02
Improved maintenance road drainage system	40%	16.908	422,70
Longitudal inclination of the road	15%	10.000.000	666.667
Increase discharge capacity of drainage system	75%	605.000	8.067
Construct piped drainage system (when not available)	100%	605.000	6.050
Improve piped drainage system (existing system)	75%	6.050	81
Implement concrete open drainage system	100%	302.500	3.025
Increase height of road embankment (prevent flooding)	100%	15.000.000	150.000

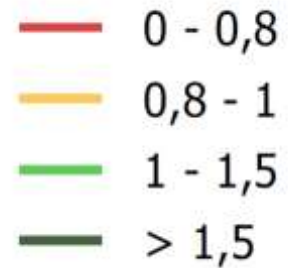
Selected measures

- Additional maintenance of roadsides (after monitoring)
- Additional maintenance of drainage system
- Additional maintenance of pavement
- Construct piped drainage system (when missing)
- Improvement of existing drainage system (when present)

Cost Benefit Analysis

Additional maintenance of roadsides (after monitoring)

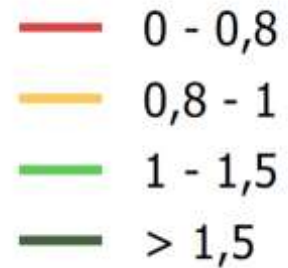
Benefit/Cost Ratio



Cost Benefit Analysis

**Construct piped drainage system
(when missing)**

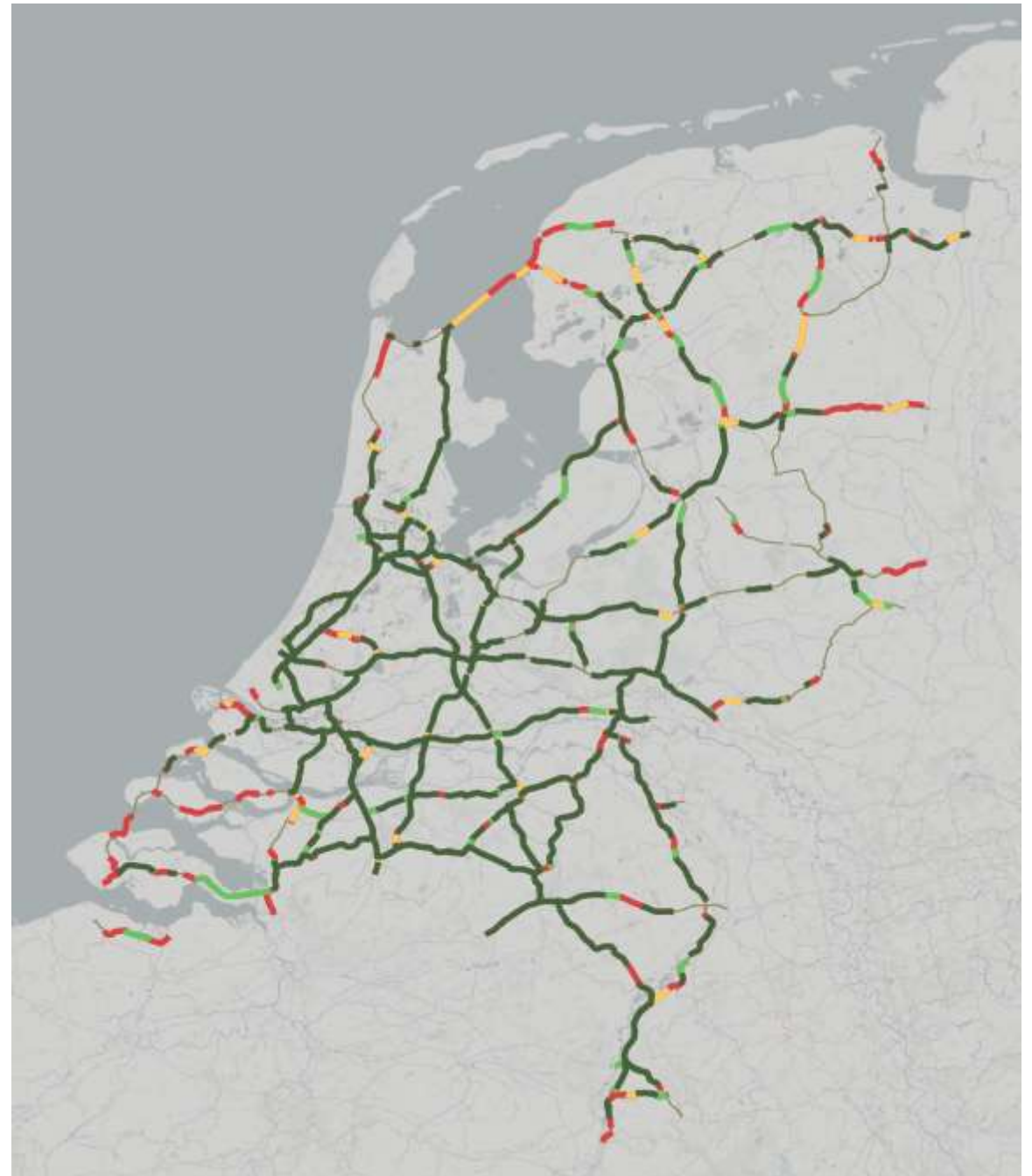
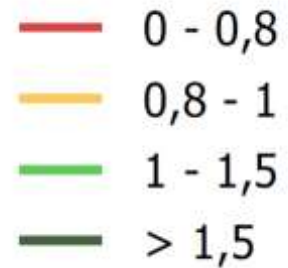
Benefit/Cost Ratio



Cost Benefit Analysis

Road segments that have an action perspective for 1 or more interventions

Benefit/Cost Ratio



Conclusion

- There is a clear economic rationale for increasing climate resilience of the road network in The Netherlands
- Monitoring and improved maintenance is a no-regret measure for the entire network

Financing of interventions on roads in The Netherlands

National Highways

- Financing through **regular budget** of the road authority (RWS)
 - Regular maintenance
 - Reinvestment
- Financing through **national infrastructure investment fund** (MIRT) for expansion and new roads
- **Budget** from national government (**general taxes**, incl. excise on fuel)

Financing of interventions on roads in The Netherlands

Provincial roads

- Financing from provincial road budget
- Budget from **road tax** (based on vehicle weight and fuel type)

Municipal roads

- Financing from municipal budget
- **Budget** from national government (**general taxes**) and **local taxes**

Questions

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