RIJKSWATERSTAAT INFORMATION

Rijkswaterstaat
Ministry of Infrastructure and Water Management

Implementing CEDR Climate Adaptation tools in The Netherlands

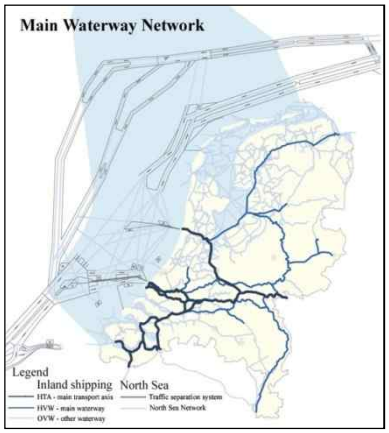
Roadapt methodology, Stresstesting Highways by Rijkswaterstaat

Kees van Muiswinkel
November 20th, 2018
CEDR End Event

The Netherlands, densely populated Delta, 60% below water level

Rijkswaterstaat manages

Highway network: 3.102 km



Waterway network: 8.000 km

Water system 90.000 km2

Ambition: resilient transport system

- Safe and seamless
- Accessible
- Beneficial for citizens, economy and society
- Resource efficient
- Environmentally friendly and adaptable




Transport infrastructure and mobility



more dependancy on telecom, electricity, chain effects

influenced by climate and extreme weather




Challenges

- Aging infrastructure
- Budgets under pressure
- Consequences of climate change unknown for decision makers
- Uncertainty (eg. sea level rise & precipitation)
- Need for knowledge of risks, costs and benefits



Rijkswaterstaat & CEDR Climate Adaptation

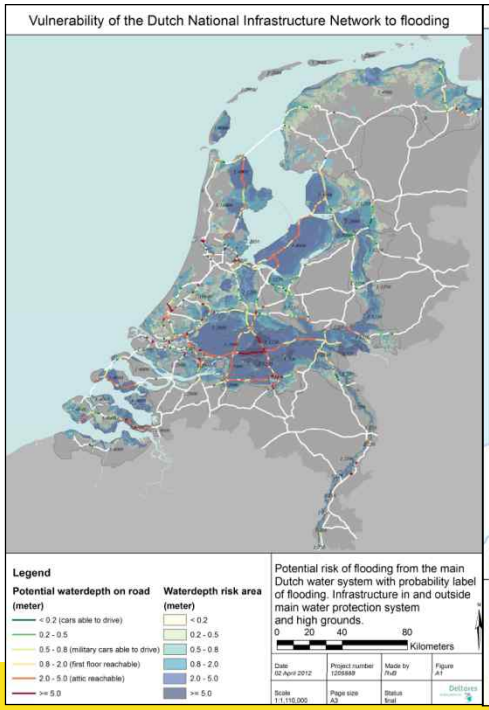
Executive board (PEB) - implementation of Climate Adaptation:

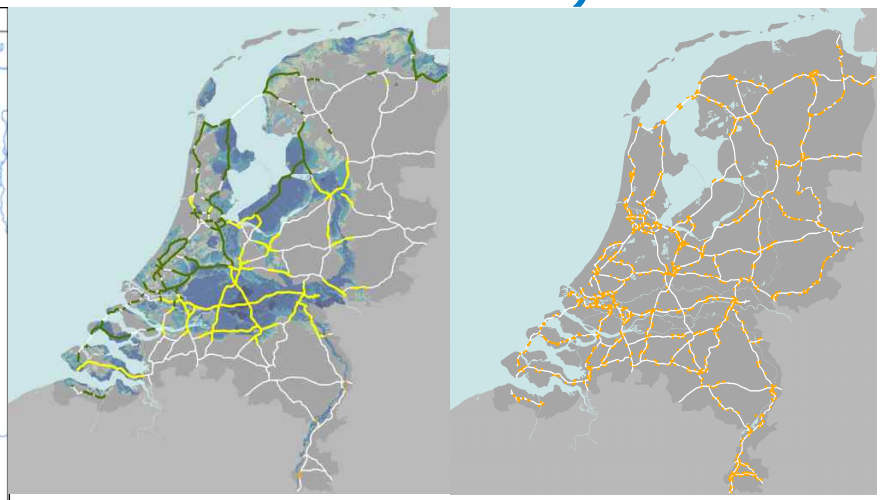
- 2008 Road owners getting to grips with Climate Change: SWAMP - **blue spot investigation 2011-2014**
- 2012 Road owners adapting to Climate Change: ROADAPT- apply in **InnovA58 project and 2018-2019 Highway Network Stresstest**
- 2015 From desk to road: Plan to **implement Detector** products in Innovation Program in **2019**!

Good for networking, exchanging knowledge, joint investments

Better products , more value for money !!

Investigation of blue spots + risk assessment – SWAMP methodology (Deltares 2011- 2014)





Flooding from sea or rivers: high damage, low risk; by pluvial flooding: average damage, high risk

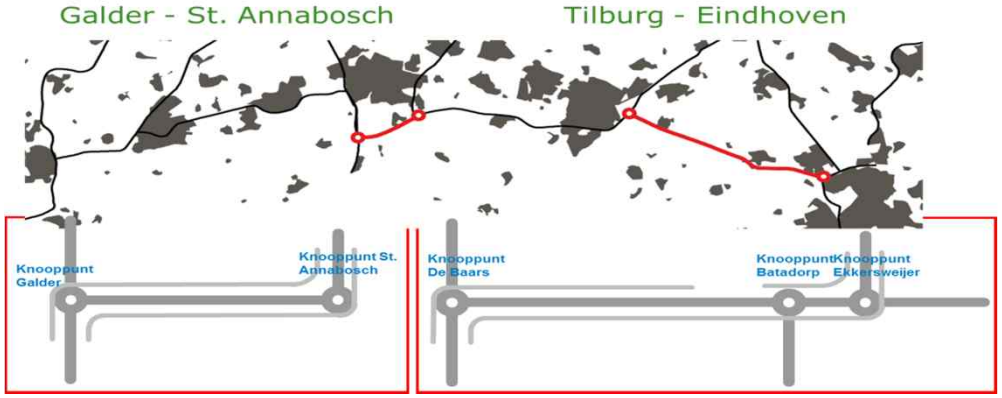
InnovA58 project (2016-2018)

Aim

- Increase robustness and resilience of InnovA58 and surroundings
- Derive lessons for broader application in Dutch Highway Network

Challenge

Use of CEDR tools for the most cost effective approach,
resulting in climate and extreme weather resilient highway



ROADAPT in InnovA58 towards adaptation strategy

	ROADAPT step – tools*	What did we do
1	Quick Scan**	2 workshops: 1. to determine climate threats for the A58 infrastructure and the surrounding environment 2. to determine key risks and potential measures
2	Vulnerability Assessment	GIS methodology with several steps to determine vulnerabilities in the road network. The output consists of maps with these vulnerabilities.
3	Socio-economic Assessment	2 methods: - Cost Effectiveness Analysis - Cost Benefit Analysis
4	Adaptation Strategy	Dynamic adaptation pathways to determine an adaptation strategy

*** Available on CEDR website**
**** recently applied in A20 project again**

Example: potential measures for bridges

Potential measure	Pro's	Cons
Increasing the capacity by enlarging the bridges	- Sustainable till 2100	- Very expensive - Decapitalization of existing bridges
Increasing the capacity by intensifying maintenance	- Affordable - Rijkswaterstaat can execute the maintenance	- Less effective - Sustainable till 2030/2040
Creating upstream water retention	- Very effective - Sustainable beyond 2100	- Expensive - Outside of the sphere of influence of Rijkswaterstaat

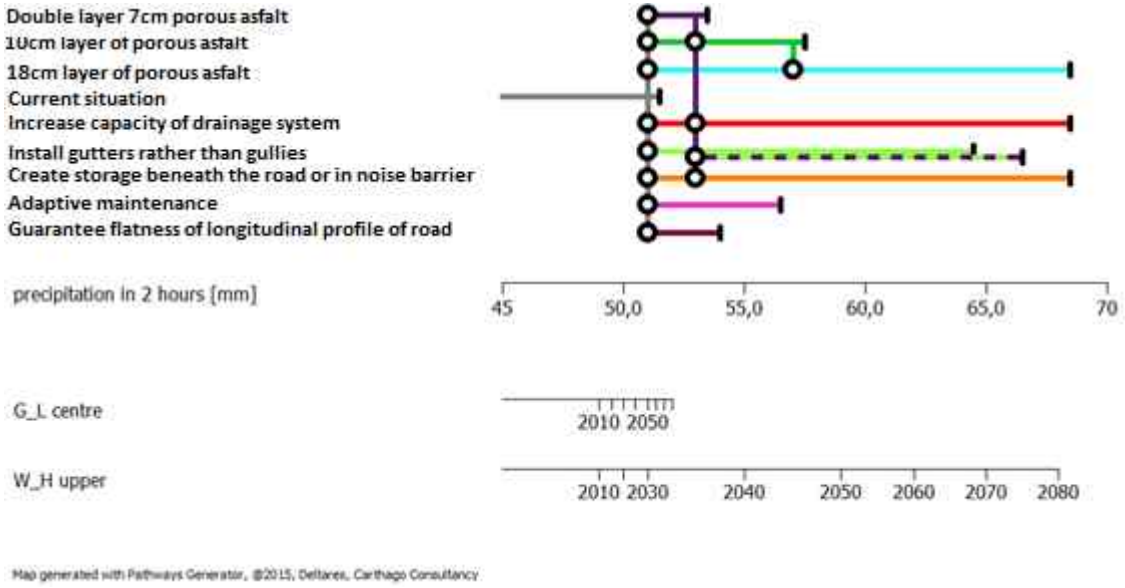
Other potential measures for the (Innov)A58

- Culverts - increase capacity by enlarging or intensifying maintenance
- Increasing inclination of road
- Water retention adjacent to the road
- Elevate road

ROADAPT Vulnerability Assessment

Potentially vulnerable locations for pluvial flooding

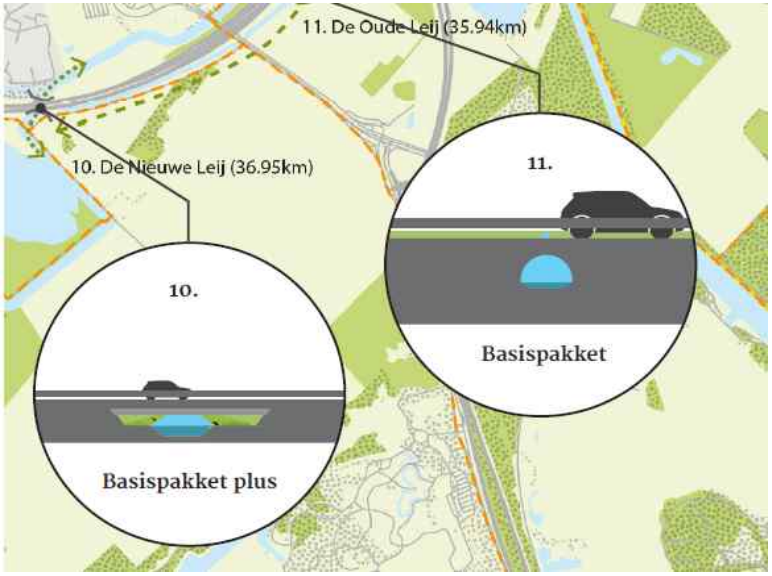
Dynamic Adaptation pathways*



Pathways for pluvial flooding: which measures now, which in the future

* Deltares reports available in English!!

To conclude: Climate Change Adaptation InnovA58



ROADAPT methodology applied, together with regional stakeholders

Long term adaptive approach, combined with restructuring A58 (extra lanes)

Combine measures for multiple benefits: water discharge; migration plants and animals; recreation

Climate Resilient Networks project

1. **Stresstest** of highways (2018-2019) and waterways (ROADAPT based methodology). Input for determining performance levels and actual measures

2. Determine **performance levels & acceptable risks**

3: Learning by doing in **Pilots**

Stresstest

- Project 'climate robust networks' currently underway
- Objectives for 2020
  - Insight in risks for the national road network due to extreme weather taking climate change into account
  - Evaluation and prioritization of risks
  - Adaptation strategy for a climate robust network in 2050
- Results
  - Maps
  - Analyses
  - Support and awareness
  - Insight in level of acceptable risk

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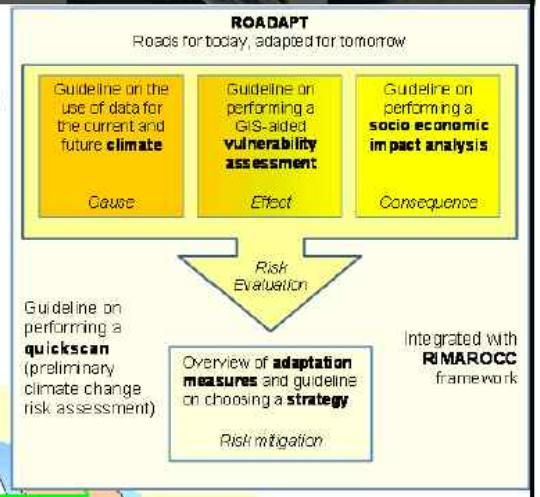
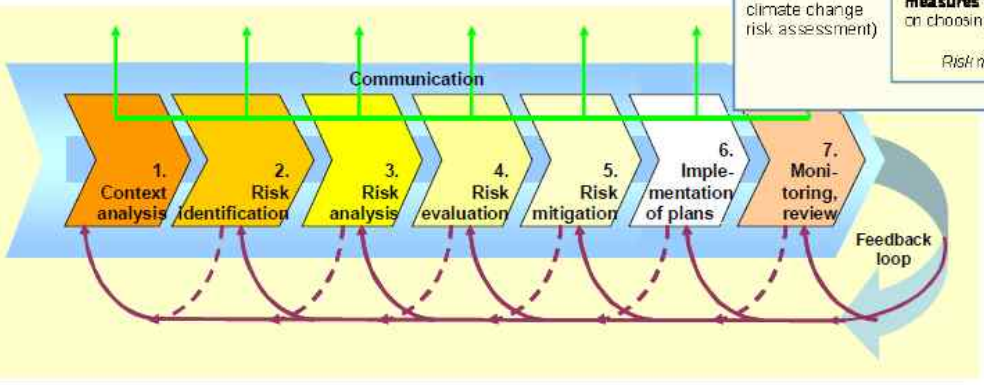
Scope - threats

	Threats	Results
Fluvial flooding	Flooding of the road due to failure of flood defences	Map
Pluvial flooding	Flooded road due to incapacity of storm water run-off system	Map
	Flooded road due to influx from surrounding	Map
	Aquaplaning risk	Map
	Erosion of embankments	Map
	Run-off water flow to surroundings is too high	Analysis
	Water quality demands of run-off are not reached	Analysis
	Uplift of tunnels and lightweight materials	Analysis
	Bad visiblity during heavy rainfall	Analysis
Heat	Thermal expansion of pavements	Map
	Bridges get stuck	Map
	Less maintenance ability during periods of heat	Analysis
Drought	Unequal settlements in dry periods	Map
	Decreased skid resistance during rainfall after long dry period	Analysis
	Wild- en verge fires	Analysis

Frameworks

- RIMAROCC (2010) and ROADAPT (2015)
  - Risk based
  - Step by step guidelines





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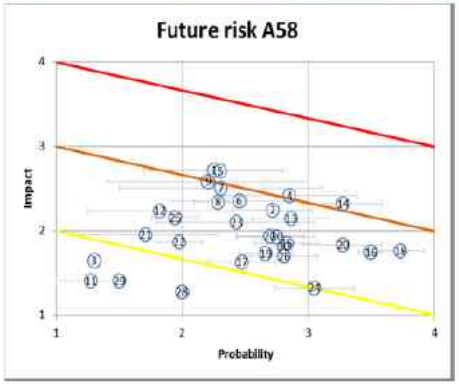
before

Qualitative risk assessments

- Collaborative approach
  - Awareness
  - No need for big data sets
- Risk based
  - Both likelihood and impact addressed
- Relatively fast and 'cheap'

- However
  - Awareness has been created
  - Understanding of most important threats has been gained



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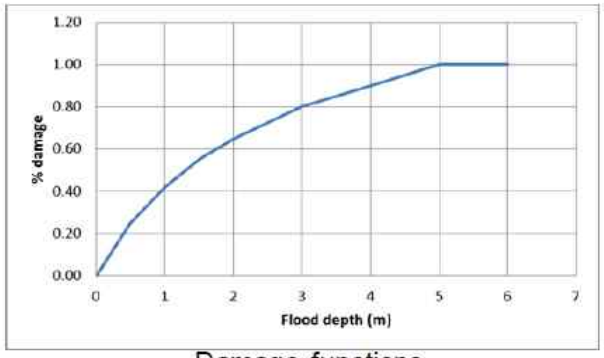
now also

Quantitative risk assessment

- Calculating
  - Susceptibility at different return periods
    - From a fixed threshold to dynamic thresholds
  - Impact at different return periods
    - Direct impact for road authority
    - Indirect impact for users / society



Damage functions

criticality
indirect damage

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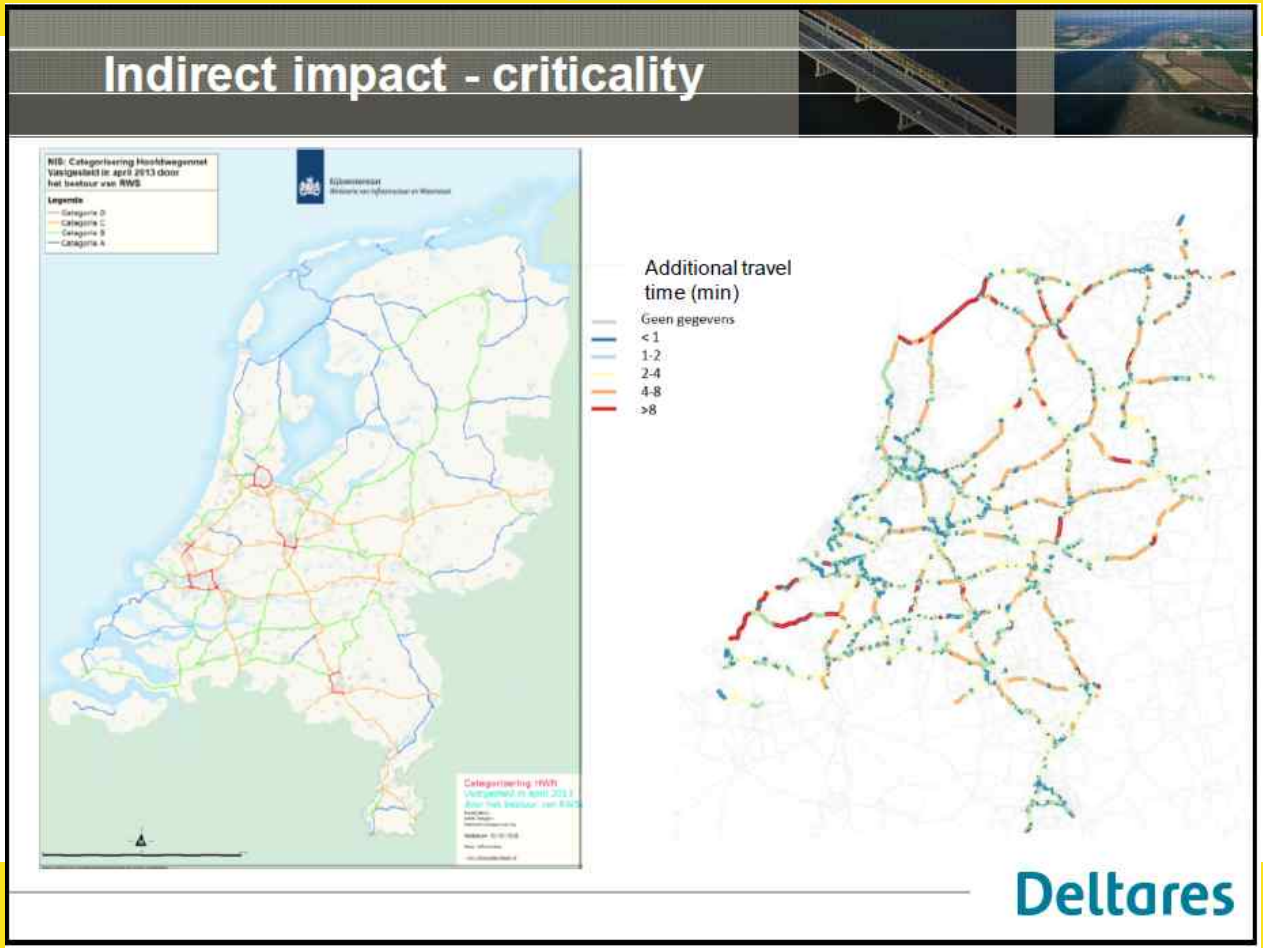
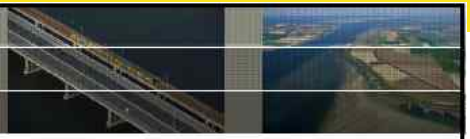
impact
depends
on location



Evaluation



Risk dialogue

- Comparison of risk levels of different threats
  - Combination of likelihood and impact
- Comparison of different impacts
  - For Rijkswaterstaat as National Road Authority
    - Calculation of annual expected damage (AED)
  - For users / society

Prioritization		direct impact as AED			
		1	2	3	4
indirect impact network category	A	1	1	2	3
	B	2	2	3	4
	C	3	3	4	5
	D	4	4	5	5

Safety		network category			
		A	B	C	D
effects of an event	eye damage	2	2	2	2
	slight inj.	3	3	3	3
	heavy inj.	4	4	4	4
	casualty	5	5	5	5

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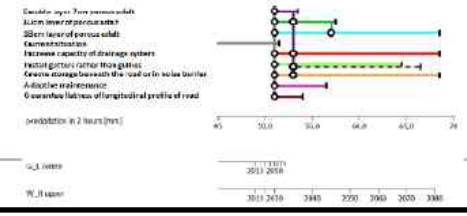
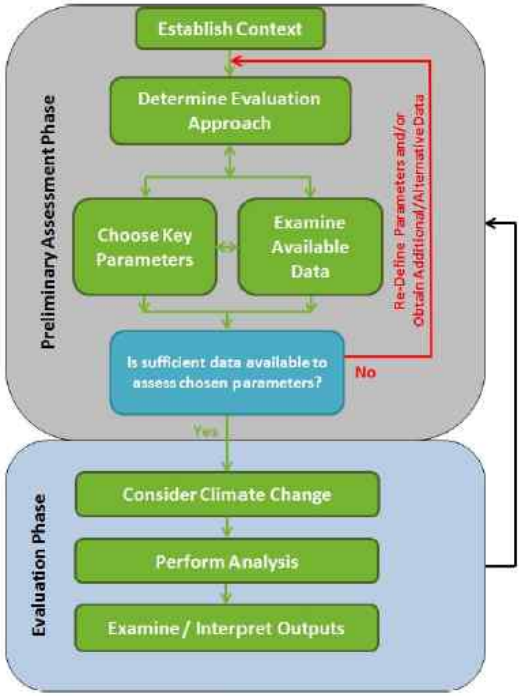
Adaptation strategy

- Looking into an uncertain future
- Objective to have a climate robust network in 2050

This requires:

- Balance between costs and benefits
- Effective solutions
- Adaptive construction
- Flexibility to switch from one measure to another





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More information*

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Measures at present

- Guidelines for:
  - water discharge from bridges, tunnels
  - climate in (planning) projects
  - adaptation in cost benefit assessment
- Climate adaptation in replacement and renovation program
- Change procurement requirements for maintenance
- Analysis of relationship between extreme weather and congestion
- Climate adaptation in performance management