



Rijkswaterstaat  
Ministry of Infrastructure  
and Water Management

# Mainstreaming Dutch Highway Network Climate Stresstest results

FHWA-AASHTO- Rijkswaterstaat-CEDR  
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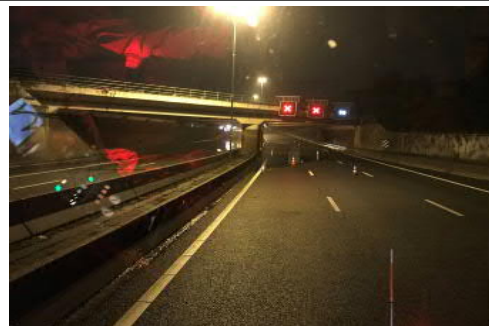


# Content

- Introduction
- Dutch Highway Stresstest, results and further steps
- Regional Validation and Risk Scoring



# Effects of extreme rainfall







# Heat and drought



2020: 3rd dry and warm year in Holland !

new weather patterns are there to stay



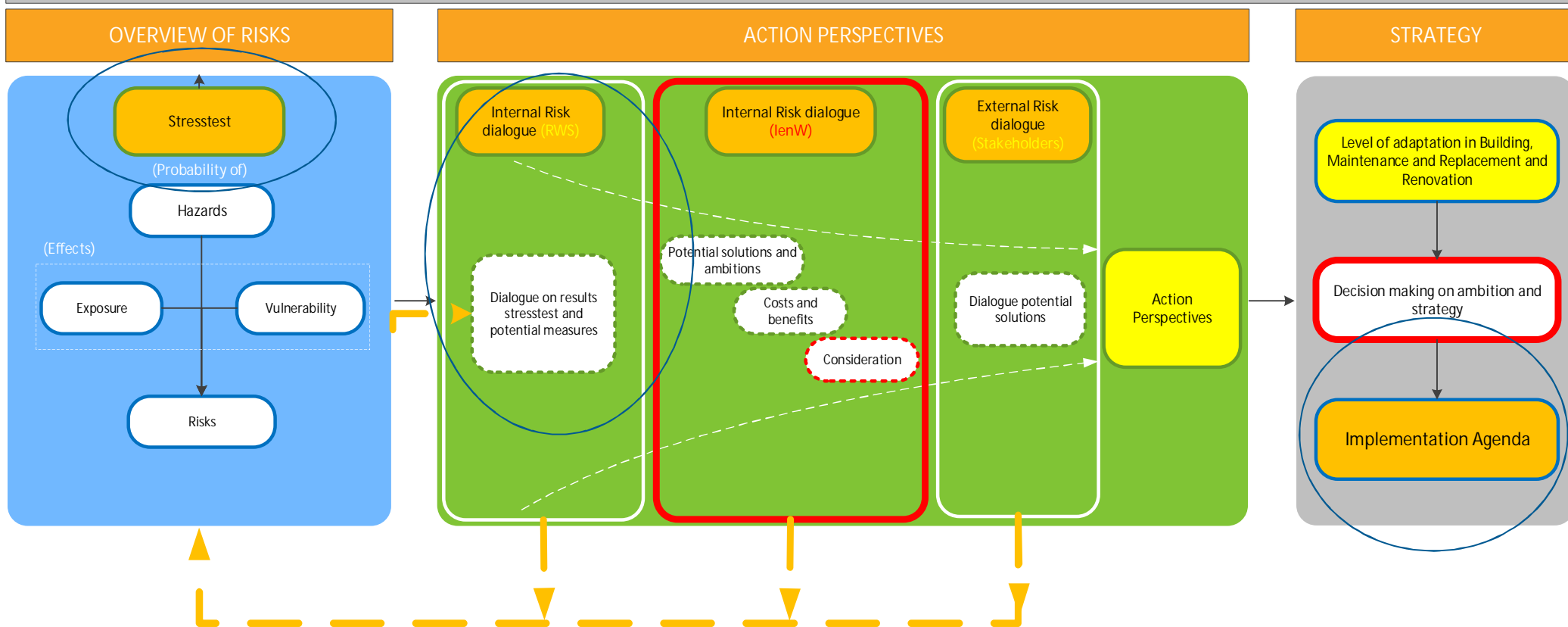
## Short and long term transport network effects due to extreme weather phenomena



dealing with uncertainty - climate change is (just?) one aspect



ROADMAP Climate Resilient Networks : an iterative process



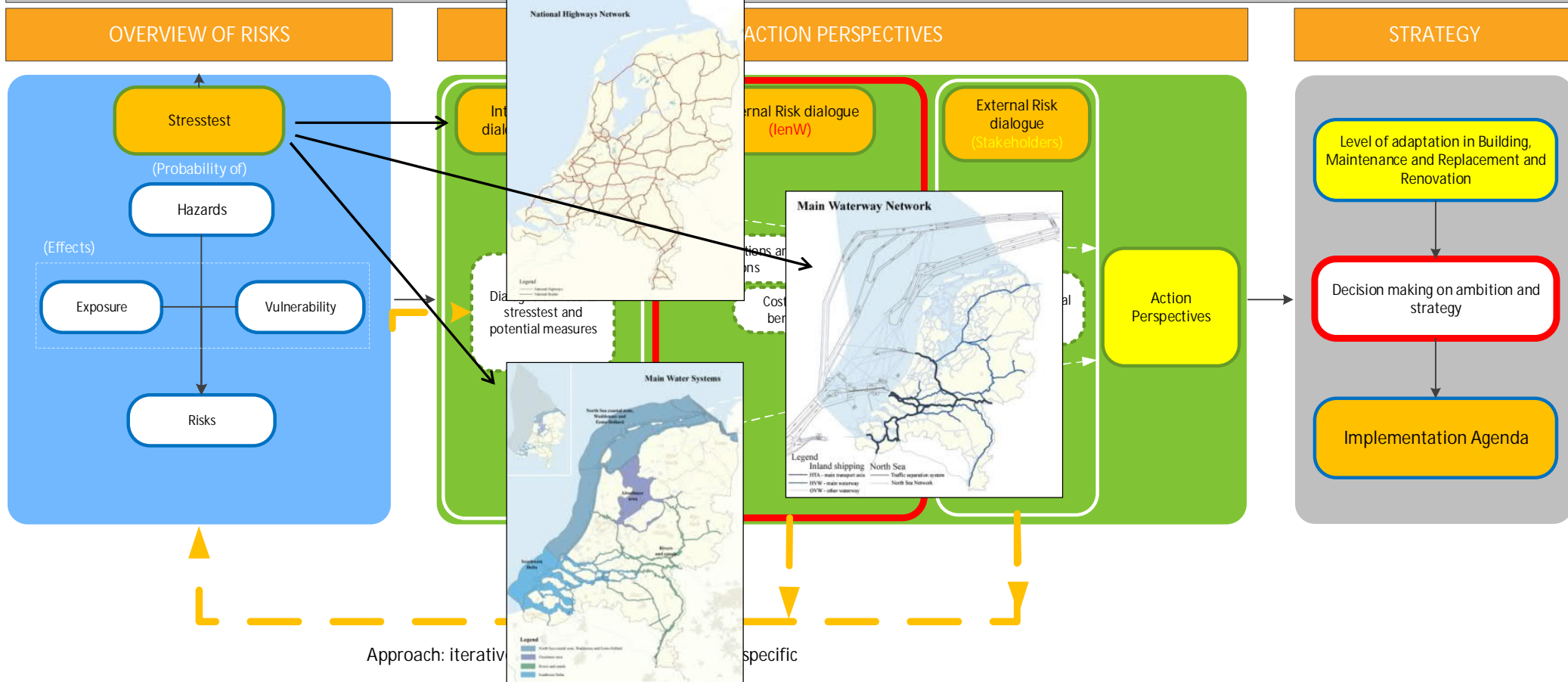
Approach: iterative proces from globally to more specific

Stresstest follows from



Dutch Climate Change Adaptation Policy

### ROADMAP Climate Resilient Networks : an iterative process







# Threats/hazards in Road Network Stresstest

- Extreme rainfall - pluvial flooding
  - Puddles on the road
  - Bad visibility
  - Erosion, instability embankments
  - Uplift of tunnels and light materials
- Fluvial and coastal flooding
- Heat
  - Thermal expansion of pavements
  - Bridges get stuck
- Drought
  - Unequal settlements due to drought related soil subsidence
  - Roadside fires

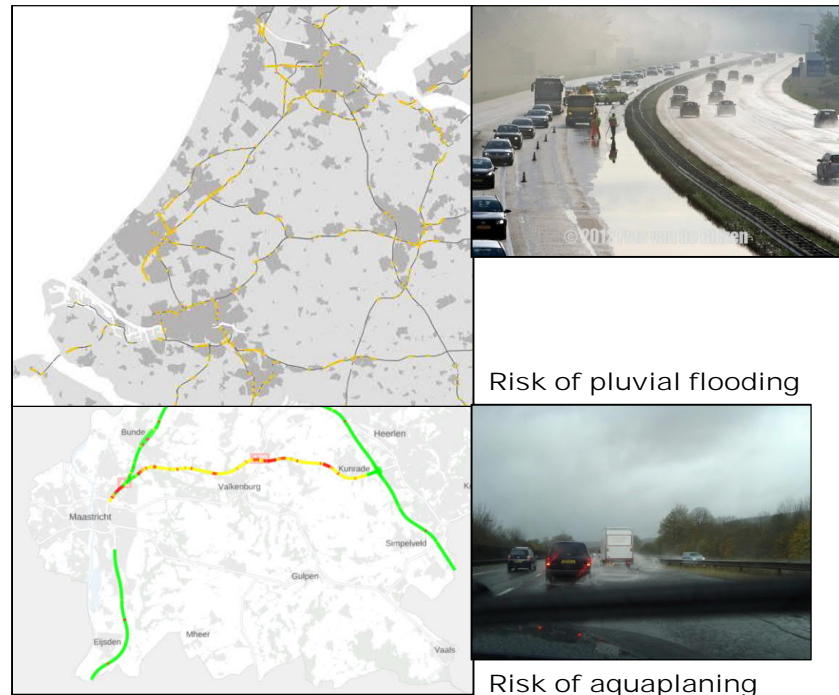
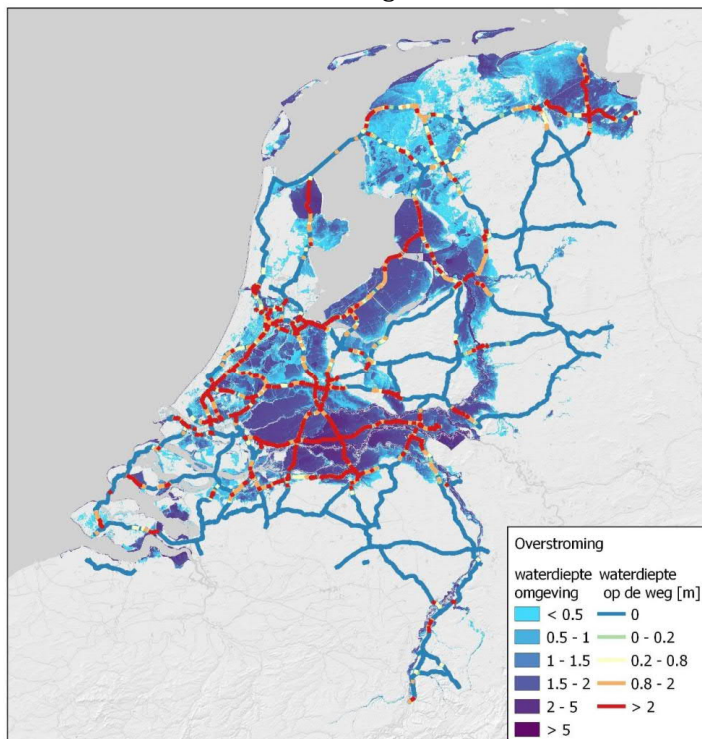






# Highway Stresstest – results online !

Fluvial and coastal flooding

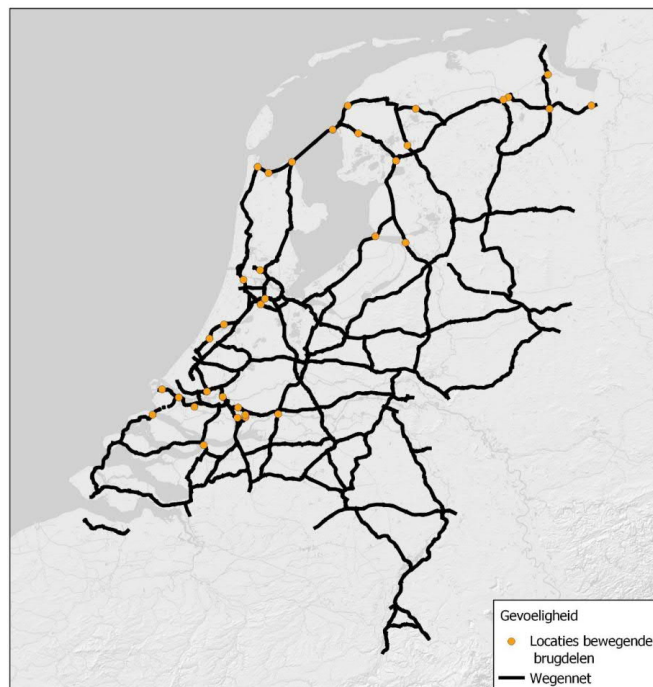


(visualization and interactiveness are being improved)



# Highway Stresstest – results

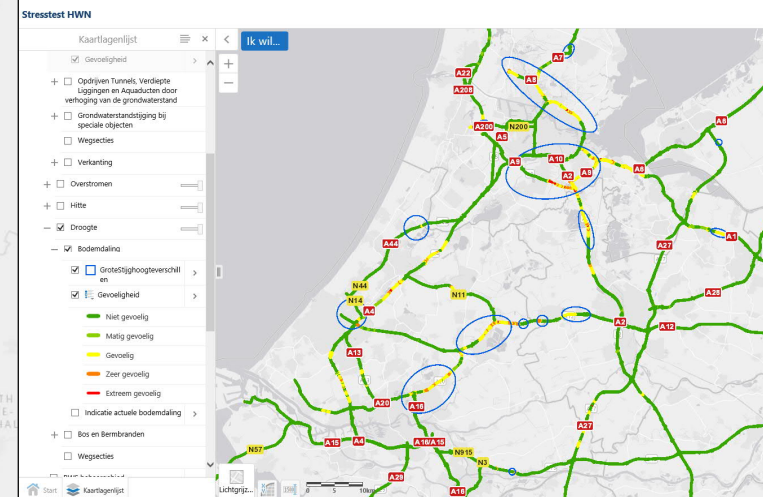
Vulnerable bridges



Vulnerability of roadsides to fire



Vulnerability to soil subsidence





## Next steps

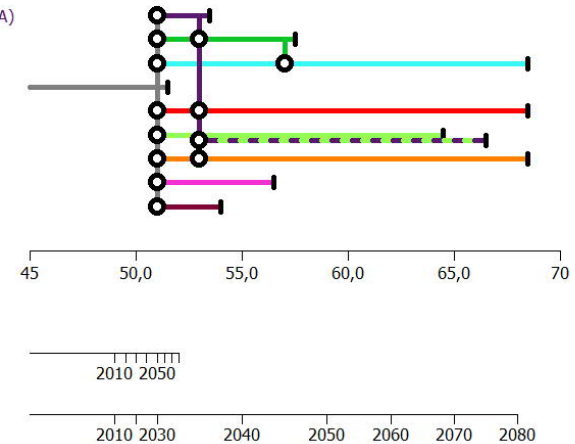
- Risk dialogues with stakeholders
  - Verification of results
  - Acceptable level of resilience?
  - Ambition?
  - Prioritization?
- Mainstreaming in
  - Performance management - maintenance
  - Replacement and renovation program
- Adaptation strategies

Drainage via 7 cm thick porous layer (double layered PA)  
Drainage via 10 cm thick porous layer  
Drainage via 18 cm thick porous layer  
Current Situation (storage in PA taken into account)  
Enlarging capacity of stormwater drainage system  
Use of gutters instead of manholes  
Water storage under the road or in noise barrier  
Adaptive maintenance  
Ensuring levelness of longitudinal profile

precipitation in 2 hours [mm]

G\_L centre

W\_H upper





# Climate resilient infrastructure

from stresstest to regional action perspective and measures







## Rijkswaterstaat approach for the regional units

2 steps:

1. Validate stresstest with asset managers
2. Start with the 'internal risk dialogue'
  - Which risks are/aren't acceptable?
  - What measures to take?

Such a risk dialogue can lead to: maintenance, new projects, adjustment of building standards, etc.

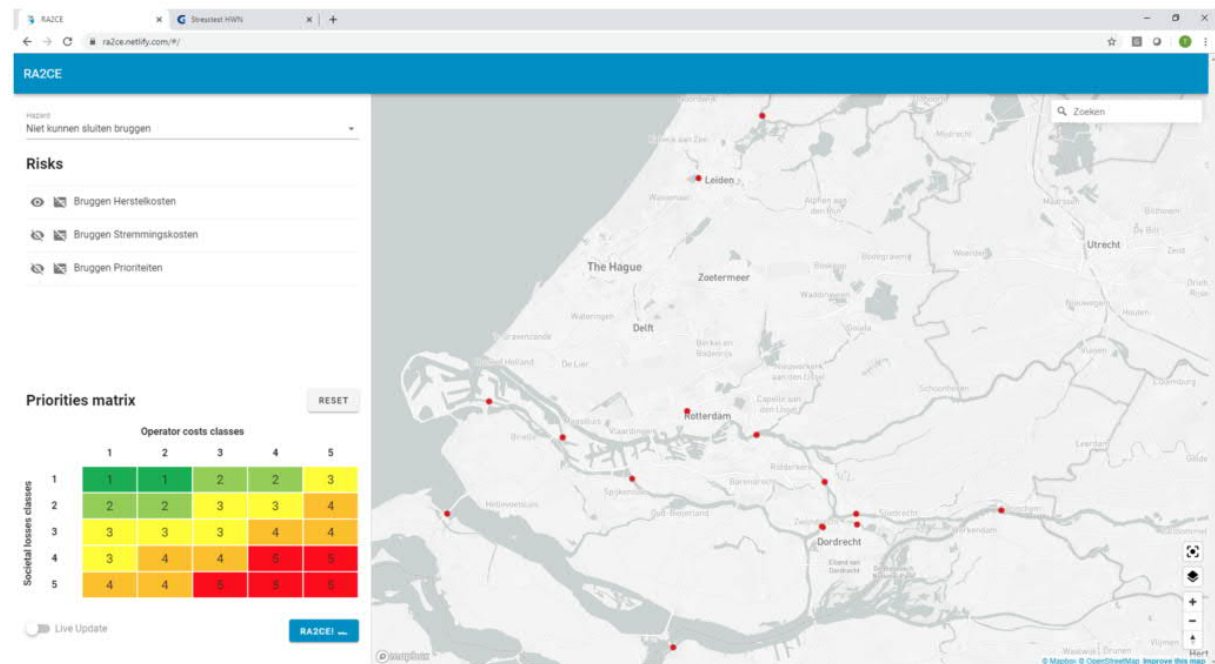




# Assessment of climate risk

Example of bridges  
1. Location of risks

In essence every bridge is vulnerable to malfunction due to heat. This makes it difficult to prioritize asset management.



Conclusie gevoeligheid: in stresstest zijn alle beweegbare bruggen als even gevoelig aangeduid; (nog) geen onderscheid mogelijk



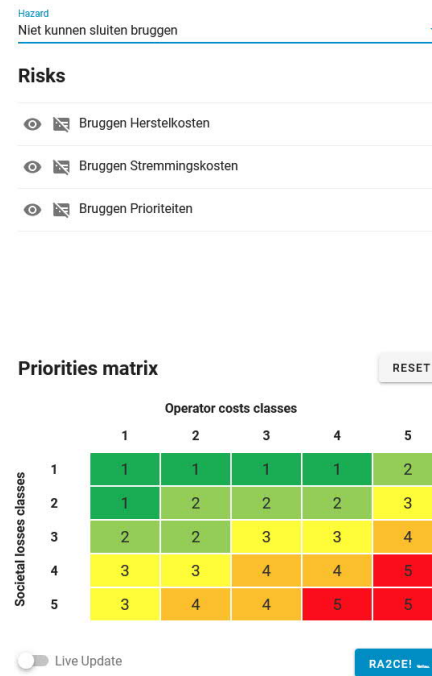
# Assessment of climate risk

Example of bridges  
2. Impact based on costs

Repair x traffic jams

Repair = costs RWS  
Traffic jams = societal costs

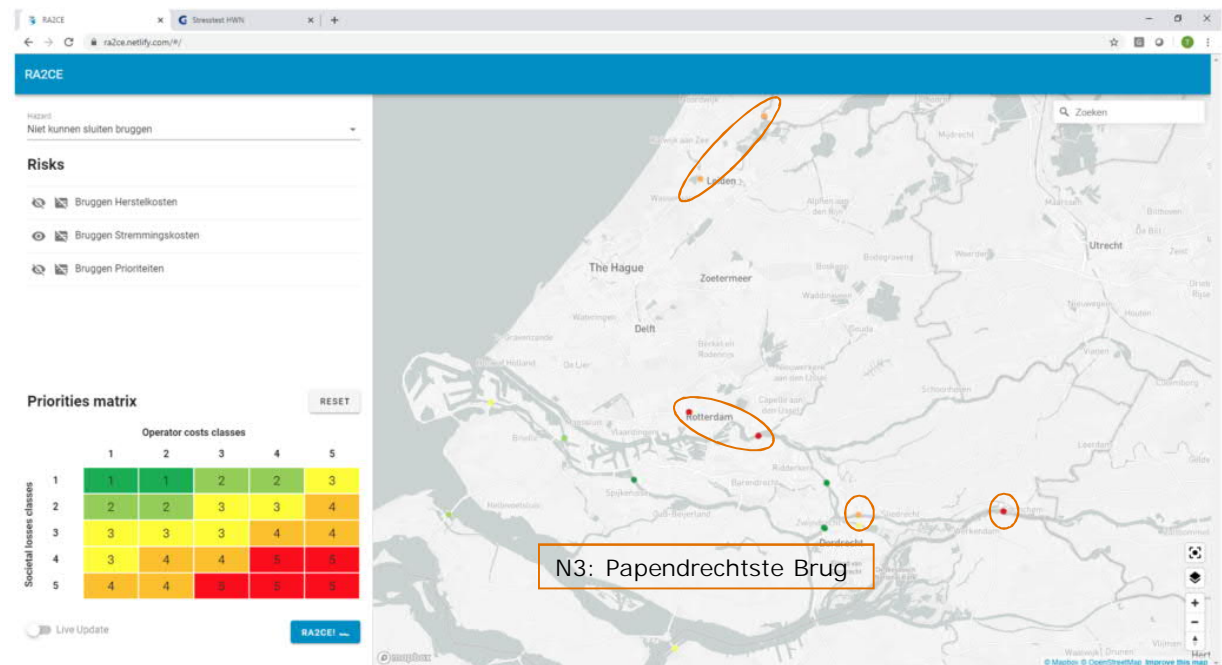
Based on the RA2CE  
module, developed by  
Deltares  
<https://ra2ce.netlify.app/#/>





# Assessment of climate risk

Example of bridges  
2. Impact based on costs



Conclusie prioritering: op dit moment is prioritering alleen mogelijk op basis van de stremmingskosten aangezien de herstelkosten gelijk zijn aangenomen voor alle bruggen.





# Assessment of climate risk

Example of bridges  
Papendrechtse bridge

During heat of 2019

- Malfunction of the bridge
- Rerouting of the traffic
- Stagnation of shipping
- Critical media attention





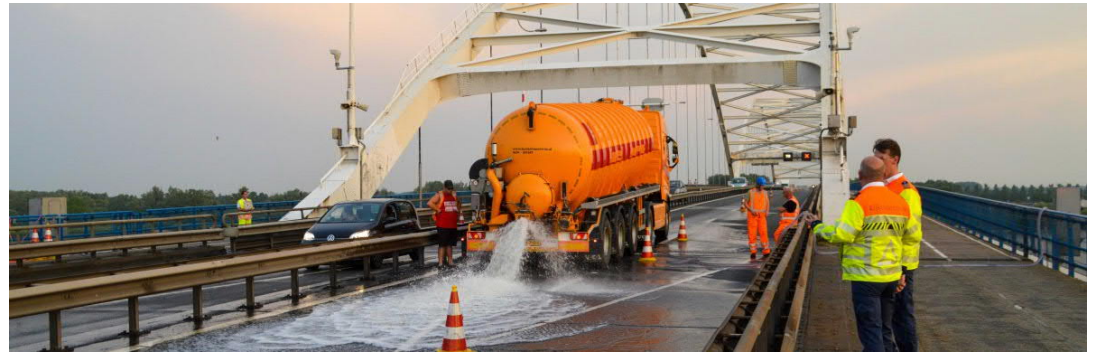
# Assessment of climate risk

Example of bridges  
2. Impact based on RAMSSHEEP

Reliability  
Availability  
Maintainability  
Safety  
Security  
Environment  
Economics  
Politics / image



		EFFECTS			
		1: NEGLIGIBLE	2: LIMITED	3: HUGE	4: SEVERE
RAMSSHEDP	A	Quite short nuisance to primary functions of the object; no nuisance to the network	Nuisance to the network is shorter than the lower threshold of all functional categories: 1. road traffic 2. maritime transport 3. water management	Nuisance to the network is shorter than the upper threshold of all functional categories, but longer than the lower threshold in one or more of the functional categories: 1. road traffic 2. maritime transport 3. water management	Nuisance to the network is larger than the upper threshold in one or more of the functional categories: 1. road traffic 2. maritime transport 3. water management
	M	Local repair easily executable	Repair with extra effort (e.g. due to special equipment or waiting period for spare parts)	Repair with lots of effort (e.g. execution of maintenance by forced access or waiting period for special spare parts or permits)	Repair outweighs the economical lifespan of the object; alternatively measurements are required (e.g. full-scale replacement)
	S	The failure will directly or indirectly lead to accidents with temporary injury without the absence of one or more people	The failure will directly or indirectly lead to accidents with temporary injury which requires medical assistant/hospital visit to one or more people	The failure will directly or indirectly lead to accident with lasting injury to one person	The failure will directly or indirectly lead to: - lasting injury to multiple people - fatal injury to one or more people
	SE	Possible undesirable human activities with little effects such as graffiti	Possible undesirable human activities with limited effects such as accessibility to unimportant areas	Possible undesirable human activities with huge effects such as digitally or physically access to confidential information	Possible undesirable human activities with severe effects such as digitally or physically access to (emergency) control of the object
	H	Health nuisance to one or more people on the long term	Temporary health damage to one or more people on the long term	Lasting health damage to one person	On the long-term: - lasting health damage to multiple people - fatal health damage to one or more people
	E	Negligible effect on flora and fauna	Limited effect on flora and/or fauna; no measurements required, will be resolved	Huge effect on flora and/or fauna; measurements required to prevent further effect	Severe, long-term effect on flora and fauna; full-scale measurements required
	C	Effect cost between the €100,- and €10.000,-	Effect cost between the €10.000,- and €100.000,-	Effect cost between the €100.000,- and €500.000,-	Effect cost above the €500.000,-
	P	Complaints	Locally reputational damage	Regionally reputational damage	National reputational damage



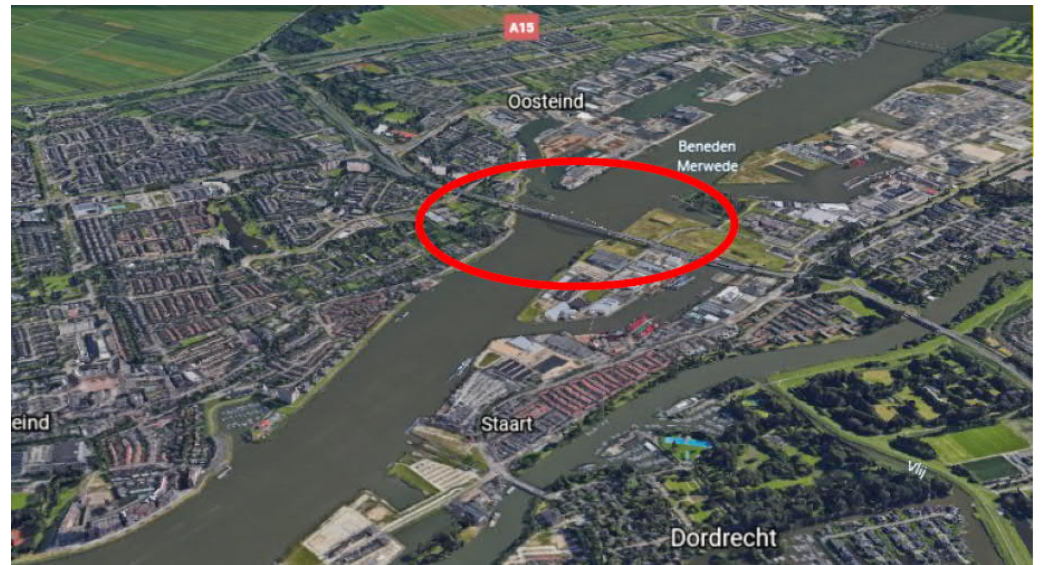
Risk Matrix		EFFECT			
		1: NEGLIGIBLE	2: LIMITED	3: HUGE	4: SEVERE
CHANGE	1: NEGLIGIBLE	Acceptable	Acceptable	Acceptable	Acceptable
	2: SMALL	Acceptable	Acceptable	Undesirable	Undesirable
	3: AVERAGE	Acceptable	Undesirable	Undesirable	Undesirable
	4: HUGE	Acceptable	Undesirable	Undesirable	Unacceptable
	5: CERTAIN	Undesirable	Undesirable	Unacceptable	Unacceptable





## Next steps

- 1) Validation of results with Asset Managers
- 2) "Internal risk dialogue WNZ"
  - 1) AM'ers
  - 2) RWS WNZ board
- 3) Upscaling to all RWS regional units
- 4) "External risk dialogue WNZ"

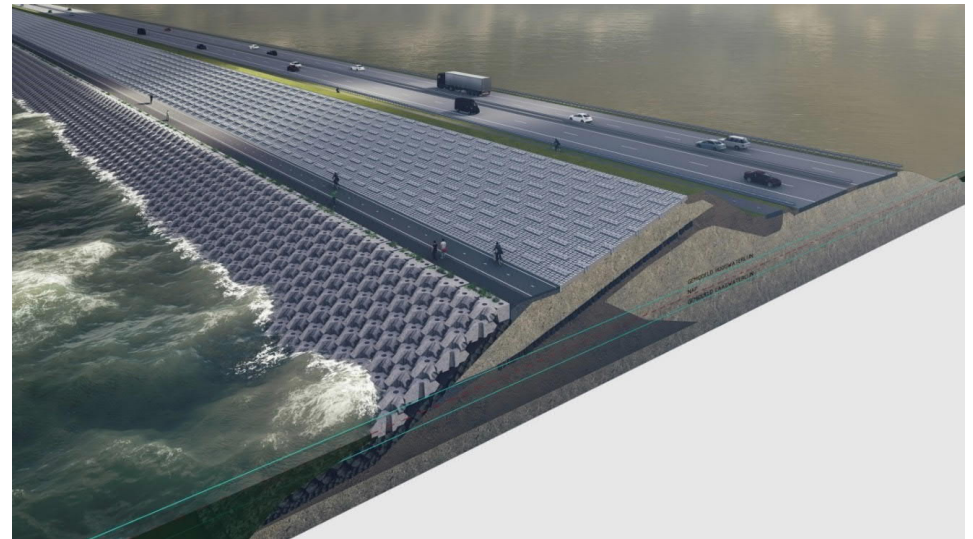






## More information

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Acknowledgement: some slides used from TR2019 Resilience Conference presentations:

<https://theafsluitdijk.com/>

Thomas Bles (Deltares): Stress testing the Dutch national highway network

Margreet van Marle (Deltares): (Quantitative) Multi-Hazard Risk Assessments for road network