Implementing CEDR Climate Adaptation tools in The Netherlands

Roadapt methodology, Stresstesting Highways by Rijkswaterstaat

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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

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

* Available on CEDR website
** recently applied in A20 project again
Example: potential measures for bridges

<table>
<thead>
<tr>
<th>Potential measure</th>
<th>Pro’s</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increasing the capacity by enlarging the bridges</strong></td>
<td>- Sustainable till 2100</td>
<td>- Very expensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Decapitalization of existing bridges</td>
</tr>
<tr>
<td><strong>Increasing the capacity by intensifying maintenance</strong></td>
<td>- Affordable</td>
<td>- Less effective</td>
</tr>
<tr>
<td></td>
<td>- Rijkswaterstaat can execute the</td>
<td>- Sustainable till 2030/2040</td>
</tr>
<tr>
<td></td>
<td>maintenance</td>
<td></td>
</tr>
<tr>
<td><strong>Creating upstream water retention</strong></td>
<td>- Very effective</td>
<td>- Expensive</td>
</tr>
<tr>
<td></td>
<td>- Sustainable beyond 2100</td>
<td>- Outside of the sphere of influence of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rijkswaterstaat</td>
</tr>
</tbody>
</table>
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. **Stress test** 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
## Scope - Threats

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

  - Risk based
  - Step by step guidelines
## Qualitative risk assessments

**before**

- 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
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

Deltamet
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
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
More information*

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* Deltares Slides: Thomas Bles, thomas.bles@deltares.nl
25
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