Increasing Transport Resilience
The ROADAPT framework in practice

Mike Woning

JASPERS Networking Platform Seminar
Climate Change Adaptation in the Transport Sector – Experience from Project Preparation and Network Management

Brussels, 6th December 2017
Deltares facts and figures

Offices and registrations in: India, Singapore, Indonesia, USA, Brazil and UAE

- Legal form: Foundation under Dutch law
- Workforce: 840
- Number of nationalities: 28
- Annual turnover: 113 million euros
- Locations: Delft and Utrecht
- National and international activities
- Unique in-house facilities
Geo-experimental facilities

Advanced geotechnical lab

Microbial en geochemical lab

Geocentrifuge (ng) for models (1g)

Test laboratorium
Impact of weather and CC on assets

Asset life cycle

Weather + climate change
As a result...

- Extreme weather may have **significant impact** on (the use of) infrastructure
- Weather is changing due to climate change: extreme events are becoming **extremer** and **more frequent**
  - More weather related unwanted events
  - Increasing challenges for efficient Asset Management
Goal: share our experience with climate change & infrastructure projects

- Basics of method
- Examples of projects
  - InnovA58, Netherlands; client National Road Authority
  - CREMA contracts, Paraguay; client National Road Authority & World Bank
  - Blue Areas, Netherlands; Prorail
  - Tuzla, Turkey; client Turkey: World Bank, Chamber of Industry
- Questions?
Fundamentals of ROADAPT method

**ROADAPT framework**

- **Hazards**: extreme weather, geological hazards & climate change
  
  *Cause (probability)*

- **Vulnerability**: characteristics of CI that make it susceptible
  
  *Effect (probability)*

- **Impact**: influence on functioning of CREMA corridors
  
  *Consequence*

**Approach:**

- Use data/information/models if present
- Use expert local knowledge if not present (semi quantitative approach)

**Probability**

**Risk evaluation**

**Impact**

**Prioritize**

**Building resilience**: Adaptation measures & policy guidance

*Risk management Strategies*

**Mitigation**
CEDR: most important high frequency causes of road flooding

Water in area around the road
- Surface run-off
- Pluvial flooding

Heavy rain on the road itself
• Recommendations on how to derive IDF curves for both the current and future climate.
• Including recommendations to overcome the specific challenges of having no information on hourly rainfall data for the future
  • “7% increase of rainfall intensity per one degree increase of dew point temperature”
Climate change – analogues tool

- Climate analogues tool plus guidance has been developed
- Only available for daily and five daily data
- Sub-daily data not available throughout Europe
Vulnerability Assessment - probability

Goal: determine **where** the threats play a role

- Determine factors that influence the likelihood of a threat occurring (no modelling) in GIS environment
  - Road characteristics
  - Characteristics of surroundings
- Combine vulnerability factors to VA map
VA - Overloading of hydraulic systems crossing the road (threat 3)

Building Resiliency to Climate Events in the Road Network of Paraguay

Legend
vulnerability index
0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

Vulnerability Assessment:
Overloading of hydraulic systems crossing the road (Threat 3)
Routes 8 and 10

Date
26-09-2017

World Bank Contract
7183637

Mapping by
Andreas Burzel

Version
3.0 (draft)

Deltares Project
11200918

Status
draft

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Vulnerability Assessment:
Flooding due to overflow of rivers and creeks (Threat 1)
Routes 8 and 10

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15 December 2017
Impact - consequence

(Workshop) criteria

<table>
<thead>
<tr>
<th>Impact level</th>
<th>Safety</th>
<th>Availability</th>
<th>Repair cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (very high)</td>
<td>Several casualties</td>
<td>The road is completely unavailable for a long period of time (months)</td>
<td>Inability to pay for extremely high repair costs by MOPC alone</td>
</tr>
<tr>
<td>4</td>
<td>Casualty</td>
<td>The road is completely unavailable for a limited period of time (weeks)</td>
<td>Repair cost exceed the reserves of MOPC</td>
</tr>
<tr>
<td>3</td>
<td>Heavy injuries</td>
<td>The road is completely unavailable for a short period of time (days)</td>
<td>Repair cost exceeds yearly budget</td>
</tr>
<tr>
<td>2</td>
<td>Minor injuries</td>
<td>The road is partially unavailable for a short limited period of time (days - weeks)</td>
<td>Part of expected exceptional maintenance and repair operations</td>
</tr>
<tr>
<td>1 (very low)</td>
<td>Only material damage</td>
<td>The road is partially available again within hours.</td>
<td>Part of routine maintenance</td>
</tr>
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</table>

Extra travel time alternative routes + value of time

Interdependency of critical infrastructures
Goal: **which threats** pose the biggest risk

- **Identify** relevant threats
- **Prioritize** by collaborative scoring of relevant threats
  - Impact (safety, availability, socio-economic, etc)
  - Current probability (historic events, expert judgement)
  - Determination of future probabilities (climate change)
- Determination of biggest risk threats → priority
Adaptation Strategies - mitigation

Goal: plan measures (best strategy)

Steps:

- **Identify** (long list of) adaptation measures
  - Expert judgement
  - Workshops
  - Adaptation measures tool

- **Prioritize** adaptation measures using cost effectiveness Analysis → selection of ‘best measures’

- Combine best measures to form Adaptation strategies
Adaptation Strategies - example

• Combination of best measures/ actions as function of time → Adaptation Strategy
• The map reads like a subway map, taking you from NOW to FUTURE
CREMA contracts, Paraguay – at a glance

- Population: 6.7M
- Tropical - subtropical climate
- Landlocked, relies on agriculture and export → roads of vital importance
- El Nino has major impact → flooding, erosion
- Goal: provide a risk based, objective approach to help build resilience of road network
**An impression of activities**

**Deskstop study of existing information**

<table>
<thead>
<tr>
<th>Location</th>
<th>Total (US$)</th>
<th>Category</th>
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<tbody>
<tr>
<td>1_1 San Juan Cnel. Bogado</td>
<td>3,284,176</td>
<td>Low</td>
</tr>
<tr>
<td>1_2 Cnel Bogado- Encarnación</td>
<td>3,342,198</td>
<td>Low</td>
</tr>
<tr>
<td>8_1 Carayao- Mbutuy</td>
<td>4,448,362</td>
<td>High</td>
</tr>
<tr>
<td>8_2 Mbutuy - Calle 6000</td>
<td>4,637,080</td>
<td>High</td>
</tr>
<tr>
<td>10_1 Mbutuy Yasi Cañy</td>
<td>3,150,366</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Site visit**

- Road/ asset information
- Socio- economic
- Climate information

**Workshops with local stakeholders**
Impression of results

IDF curves for Paraguay (NOW), Coronel Oviedo

Building Resiliency to Climate Events in the Road Network of Paraguay

Legend
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Vulnerability Assessment:
Overloading of hydraulic systems crossing the road (Threat 3)

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Vulnerability Assessment:
Flooding due to overflow of rivers and creeks (Threat 1)

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Map generated with Pathways Generator, ©2015, Deliarea, Carthago Consultancy
Paraguay – client value

• Provide Adaptation Strategies i.e. various paths for building resilience for high risk threats
• Provide recommendations for
  • Road Asset Management System
  • CREMA contracts
  • Alert & response plan
• Training of local authorities

→ Substantiate necessity of funding for alert & response plan
→ More security World Bank loan
→ Concrete and practical help for MOPC to make Paraguay road network more resilient, safer and reliable
InnovA58, Netherlands – at a glance

- Approximately 50km highway, important E – W connection
- Extra driving lanes planned (now is time to implement changes)
- (Relatively) rural area (flat), some cities/towns, agriculture, forest/nature, minor river/streams
- Goal: find innovative solutions for climate change challenges for road AND surroundings
InnovA58 – an impression

Typical assets

Scope

A58
- Extra lanes A58
- Major maintenance

Surroundings
Cities/towns
Nature
Creek crossings

Weather
Current climate
Climate change

RWS scope

(work into account if possible)

Mutual interest

Workshops with stakeholders, scoring of threats

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InnovA58 – client value

• Provide Adaptation Strategies (i.e. another way of building resilience instead of worst case approach) for high risk threats
• Comparison with Federal Highway Administration tools and methods

→ Collaborative approach with non-road related stakeholders e.g. municipalities, waterboards, nature organisations leading to social acceptance
→ Alternative (and flexibel) solutions to increase climate resilience for regular over-design measures
→ Method to include climate change into actual projects

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Vulnerability Assessment of current assets

→ Discussion with National government about acceptable risk levels for flooding
→ Internal process to open discussion about effects of climate change for railways
→ Technical process to evaluate and mitigate pluvial flooding locations
Tuzla – Istanbul – Business continuity planning

Risk matrix lifeline utilities ITOIZ

- natural gas
- Electricity
- Road transport
- Process water
- Waste water
- Storm sewer
- Communication

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Tuzla, Turkey – client value

Results of the project:
• Lifeline Utility risk assessment for natural hazards
  • 7 top risk scenarios
• Business Continuity Plan
  • Plan that addresses measures to increase resilience of the industrialized zone

Value for the client
• Increased competitiveness for industrial zone management
• First example of a BCP for an industrialized zone in Turkey
  • Methodology established
  • To be used for other industrialized zones in Turkey and the world

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Conclusions

- Method is widely adaptable for various
  - Climates
  - Hazards
  - Types of infrastructure
  - Available input data
- Results can be used for various reasons
  - Increase climate resilience
  - Better understanding of climate vulnerability
  - Prioritize action list & regions
  - Earmarking of funds
  - Secure (development) funding
  - Start discussion on responsibilities between organisations

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Thank you for your attention
More Information

For info or further questions on this seminar and the activities of the JASPERS Networking Platform, please contact the JASPERS Networking and Competence Centre at the following email:

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jaspers.eib.org

JASPERS Networking Platform:

www.jaspersnetwork.org