CEDR Transnational Road Research Programme
Call 2015

Final conference
DeTECToR Workshop 19/11/18
Introduction to the DeTECToR tools

Sarah Reeves, TRL
Topic areas

A. Economic costs associated with integrating climate change into decision making

B. Embedding climate change into practice and procurement
   • Implementing existing climate change research into practice
   • Embedding climate change into procurement processes
Topic A: Risk assessment and cost-benefit tool

- Provides a network level climate change risk assessment highlighting areas at most risk
- Enables comparison of the costs of implementing different adaptation options to address these risks
**Topic B: Procurement collaboration platform**

- Provides information and examples on including climate change mitigation and adaptation in procurement and operations
- NRAs able to update and share examples of their approach
Workshop outline

1. Demonstration of the procurement tool
   Ewa Zofka, IBDiM 15 mins

2. Overview of the risk assessment and CBA tool approach
   Andreas Leupold, Alfen Consult 10 mins

3. Demonstration of the risk assessment and CBA tool including the German pilot study
   Marek Skakuj, Heller Ingenieurgesellschaft 15 mins

4. Group discussions on implementation of the tools
   All 15 mins

5. Plenary feedback and discussions
   All 10 mins

6. Summary and close
   Reinhard David 5 mins
Procurement Tool

Ewa Zofka, IBDiM
Objectives of the Procurement Tool:

- Provide an avenue for sharing of best practices among NRAs
- Make it intuitive and user friendly
- Include information on ongoing projects and NRAs practices on how to embed CC into procurement and operations
- Make it collaborative: NRAs can include their own information and share their experience with others
- Learning platform for those NRAs who are less mature in the subject
Procurement areas covered within the tool:

- Understanding the sources and quantity of carbon emissions
- Understanding climate change vulnerability and assessing risk
- Establishing carbon reduction and adaptation policy and targets
- Selecting a procurement approach
- Assessing impact and stakeholder engagement
- Implementation in procurement
- Embedding in NRA operations
- Assurance and benchmarking
- Reviewing and improving/expanding the approach
Approach for Collaborative Tool: wiki based repository

TLS: Top Level Structure based on literature study

Understanding the sources and quantity of carbon emissions
Understanding climate change vulnerability and assessing risk
Establishing carbon reduction and adaptation policy and targets
Selecting a procurement approach
Assessing impact and stakeholder engagement
Implementation in procurement
Embedding in NRA operations
Assurance and benchmarking
Reviewing and improving/expanding the approach
Understanding the sources and quantity of carbon emissions

Contents
1 Introduction
2 Description of Tools and Methodologies
3 Environmental Product Declaration (EPD)
4 Case studies

Introduction
Road transportation is responsible for 26% of total energy consumption which relates to about 24% of all CO2 emissions, the main greenhouse gas (GHG) in the EU. Passenger cars are responsible for more than half of these emissions (European Commission, 2010). Despite manufacturers reducing CO2 emissions, increasing numbers of vehicles on the road have resulted in emissions continuously increasing by about 2% per year. Therefore, to fulfill the EU obligations with target 20-20-10 and tackle climate change, CO2 emissions from vehicles need to be reduced (European Commission, 2011). According to research done by the Swedish Road Administration, the majority of GHG emissions from infrastructure are generated by concrete, machines and transport (fuel), steel and asphalt (Figure below).

- CO2 sources
- Findings from research projects
- Description of currently used tools

Environmental goals that fall into the NRAs responsibilities include actions which contribute to carbon emission reductions. These include:
- Managing traffic so there is less idling time for vehicles;
- Reducing GHG emissions from domestic transport (emission targets);
- Enforcing use of low carbon intense construction materials for roads (also including technical requirements for green procurement); and
- Enforcing and encouraging low carbon intense maintenance techniques.

Description of Tools and Methodologies
Recent projects such as CEREAL, LICER and MIRAVEC provide different approaches summarised in summary sheets below. CO2 calculation tools that are currently available include Sweden’s Klimatkalkyl, Highways England’s carbon accounting tool, Dutch CO2
Understanding climate change vulnerability and assessing risk

• CC impacts on roads and why risk needs to be assessed
• Description of current risk assessment tools based on research and practice
Establishing carbon reduction and adaptation policy and targets

Introduction to CO2 reduction and adaptation targets

Case studies
Selecting a procurement approach

- Procurement types
- Different approaches
- Barriers
- Outcome based contracts for maintenance (KPIs)
Stakeholder engagement

Assessing impact and stakeholder engagement

Introduction

In order to successfully embed climate change into procurement, NRAs need to consider inclusion of climate change adaptation in the vision for the project from the outset. In many contracting authorities this means raising awareness and training people in service directorates that adaptation needs to be a core principle, rather than an “add-on” by the central procurement team at a later stage. NRAs then need to develop clear objectives (in consultation with the contractors market), benchmarks and indicators, and communicate this to stakeholders and potential bidders. Adaptation should be written into procurement documents and contracts. Dialogue with the suppliers is important to raise awareness of the climate change related project requirements and ensure common approach and understanding of technical solutions proposed by the suppliers to respond to the bids.

Methods of Stakeholder Engagement

Workshops

Workshops are intended to gather together suppliers and NRAs around one table so they can discuss the best approaches regarding KPIs. An understanding needs to be reached on how these KPIs can be achieved and demonstrated throughout the entire duration of the project covering entire life cycle of the investment project or maintenance contract.

Information seminars

It is beneficial to have periodic information seminars for the suppliers about what are the climate change related requirements, how to use the carbon assessment tools and how “carbon/environmental” financial incentives or additional points can be gained by the contractors.

Collaboration and innovation days

These types of events can be organised by the NRAs to encourage the exchange of knowledge and ensure greater collaboration. Presenting the most recent state of the art in climate change related requirements and technologies to mitigate the negative effect of climate change provides an opportunity to meet and discuss any issues. During such events innovative approaches regarding asset management to better optimise costs for repairs and proactive maintenance to preserve the infrastructure life can also be presented and encouraged.

Use of collaboration tools

These are accessible online such as the procurement Wikipedea tool created for this project, or the UK Department of Transport carbon calculation tool (WebTag), etc. which ensures the collection of data and exchange of knowledge. These tools can be used by the NRAs and road agencies at various stages of their maturity regarding procurement because information included in the tools is easily accessible and meant to help them to learn and implement various approaches based on best practices available in one tool. Each agency has a chance to upload their own best practices and requirements so others can use them as a reference.

Recommendations for NRAs

Sharing good practice

A stronger mechanism is needed for sharing knowledge. Contracting authorities should make best use of the full range of public sector networks on climate change and procurement including collaborative procurement opportunities. NRAs should seek and share good practice case studies. This should include examples of specifications and evaluations, and capture the full range of adaptation measures (i.e. not just design features, but end-user behaviour measures too).

Guidance and support
Embedding in operations

- Mitigation and adaptation strategies
- Case studies

Embedding in NRA operations

Sweden Case Study

Trafverkverk has introduced procurement requirements designed to reduce carbon emissions from its infrastructure projects. At the start it decided its approach had to follow six basic rules: • Take a long-term perspective • Be technical neutral • Include monitoring • Provide incentives for doing more • Impose a penalty for not fulfilling requirements • Include an assessment of the impact

The approach involved measuring the carbon emissions associated with an infrastructure project over its lifecycle, setting carbon reduction targets and providing suppliers with financial incentives to meet these targets. Functional specifications are utilized which provide tenders with the freedom to suggest innovative materials and designs which reduce carbon, but still achieve the required functionality. There was a wide spread consultation process involving contractors, material manufacturers and consultants before the procurement requirements were introduced and an impact study was carried out to assess the likely impact of introducing the new requirements.

TOOLS

Trafvekverk developed an LCA tool called Klimatiska [Climate Calculator] to provide a consistent way for its staff and suppliers to estimate the GHG emissions and energy use associated with a project over its construction, operation and maintenance. The tool uses information provided by the user about the specific materials and design being used in the project together with default data to calculate a CO2eq value for the project. Incorporated into the tool is a database containing emission factors for around 40 construction materials. The user selects the type of component/material, and provides the quantities and transport distances; information already recorded for costing purposes.

The tool is used at different stages in the project planning and procurement processes, firstly by the NRA to establish a baseline and set appropriate targets and then by the supplier to select a low carbon design for tender submission and establish the final carbon value. As the project progresses additional detail can be added providing a more accurate estimation. The tool was initially developed in Excel, but is now available online. It is reviewed and updated annually including adding data from new EPOs (verified by a third party).

Klimatiska:

- enables efficient and consistent approaches to calculate GHG emissions and energy use for infrastructure using a life cycle perspective (aligning with ISO 14040:2006 and EN 15904)
- builds on existing data (e.g. collected for costing) and is simple to use.
- Klimatiska version 1.0 was developed in 2013, after which further development has taken place.
- from 2015 climate calculations are a mandatory requirement for new investment projects with a budget over > 50MSEK that are due to be completed by 2020 (Guideline TOOK 2015: 0007)
- it is used for decision making, improvement work and reporting; from early planning to climate declaration of completed road
- Since February 2016 (version 5.0) it has been expanded to enable the calculation of the carbon associated with the maintenance of existing roads. Screenshots from the Klimatiska user interface show the data input categories and output of results (figures below).
Selecting a procurement approach

Procurement processes are heavily regulated at a national and European level in order to encourage a fair, competitive market, while ensuring that requirements are met. In broad terms, requirements can only legally be included in public procurement if it can be shown that they are clearly linked to the procurement of the lot or work and are necessary for the procurement and within the control of the supplier. This is not always easy to achieve with sustainability and climate change adaptation requirements, where specific targets can be difficult to set.

As much of road construction and maintenance is now outsourced to private contractors, embedding climate change in procurement is key to addressing both climate change mitigation and adaptation. The key issue is how to incorporate the contracting authority’s needs for climate change mitigation and adaptation into procurement processes (including through development of output specifications, project requirements, evaluation criteria & approaches) in a way that is objective and not challenging (Cambray, et al., 2009).

Embedding climate change in procurement programs for NRAs is presented in figure below (Based on Pekkala, 2002)

Inclusion of climate change into NRA procurement processes is a key element of controlling negative effects of road operations, maintenance and future construction. However, a concern of many NRAs is that including climate change in performance and outcome-based contracts will result in an increase in the proposal costs submitted by tenders. The experiences of Traffic Denmark and ProRail who both implemented measures to reduce carbon through their procurement processes suggest that if costs rise, this is a small and short-term effect as competition acts to decrease prices. With adaptation actions the situation is more complex, as whilst some adaptation measures do not increase the overall price, others require additional investment with the economic benefits being realised in the long term.

Recommendations for embedding climate change in procurement based on (Pekkala, 2002) are presented below
How to use it: upload your own info

Editing Selecting a procurement approach

Procurement processes are heavily regulated at a national and European level in order to encourage a fair, competitive market, which can create restrictions or perceived restrictions on NRA procurement processes. In broad terms, requirements can only legally be included in public procurement if it can be shown that they are clearly linked to the subject matter of the procurement and within the control of the supplier. This is not always as easy to achieve with sustainability and climate change adaptation requirements, where specific targets can be difficult to set.

As much of road construction and maintenance is now outsourced to private contractors, ‘embedding climate change in procurement’ is vital to addressing both climate change mitigation and adaptation. The key issue is how to incorporate the contracting authority’s needs for climate change mitigation and adaptation into procurement processes (including through development of output specifications, project requirements, evaluation criteria & approaches) in a way that is objective and not challengeable (Cambra, et al., 2005).

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Recommendations for embedding climate change in procurement’ based on (Pakkala, 2002) are presented below

In order to identify where (i.e. what mechanisms are available) and how (e.g. use of KPIs) climate change can be included in procurement processes, there needs to an understanding
Trust – Understand – Commit

**Edit: insert text**

**Editing Selecting a procurement approach**

- Deflection
- Cracking
- Texture

- • Signs - visibility & structural fastening
- • Road markings - visibility & skid resistance
- • Lighting - % in working order & no two consecutive not working
- • Vegetation (grass) - None greater than prescribed height
- • Bridges
- • Guard rails
- • Sound barriers
- • Drainage systems

The NRAs need to define the outcome-based criteria that meet or exceed the quality requirements in the contract. Also, the contractor is then responsible for performing the work and activities that meet these requirements. It is very important that there is a mutual understanding between the industry and the procuring road agency organisation on what repercussions or end results might occur.

Summary:

- This is a minor edit

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Risk assessment and CBA tool approach

Andreas Leupold, Alfen Consult
Embedding Climate Change in decision making process

- Change of Regulations for construction
- Change of Materials
- Change of Operations and Maintenance
- Route selection in the early planning phase
Module – Risk Analysis – Introduction

- Result of the research review
  - RIMAROCC,
  - ROADAPT,
  - EWENT,
  - **RIVA** → methodology for a network wide risk analysis merging climate projections and asset data (e.g. position, condition, material)

Description of the RIVA-methodology

- risk potential was analysed as a **function** of **cause** (potential of hazards) and **effect** (potential of impacts)
- hierarchically-structured indicator-model
- complex cause-effect chains (CEC) were used for the systematic description of typically damage / restrictions caused by the climate
- so called damage(s)-patterns categories (DPC) were developed → main unit of measurement of RIVA methodology
Module – Risk Analysis – Introduction

- Indicators are associated either to the sphere of causes or to the sphere of effects and are broken down by dimensions of content (characteristics of the infrastructure and the climate).

- Aggregation (combination) of individual indicators is the basis for the derivation of indices as composite indicators (for each DPC and for each analysed element) → CVC, CVV, RPH, RPE, oRP.
Module – Risk Analysis – Introduction
Module – Risk Analysis – Introduction

- Combination Value of Climate CVC
  - combines indicators of the dimension climate for a DPC in the considered road section
  - Using of different indicators to describe a climate event
  - Using Cordex-projections (12x12km)
  - 2011-2040, 2041-2070, 2071-2100
  - Value range of 1 to 4

<table>
<thead>
<tr>
<th>climate indicator</th>
<th>value (2041-2070)</th>
<th>expression category</th>
<th>weighting</th>
<th>combination value (2041-2070)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-01.1 - number of hot days per year</td>
<td>15.58</td>
<td>low</td>
<td>25%</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medium</td>
<td>20%</td>
<td>0.40</td>
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<tr>
<td></td>
<td></td>
<td>high</td>
<td>30%</td>
<td>0.30</td>
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<tr>
<td></td>
<td></td>
<td>very high</td>
<td>20%</td>
<td>0.20</td>
</tr>
<tr>
<td>K-01.2 - number of summer days per year</td>
<td>49.07</td>
<td>low</td>
<td>15%</td>
<td>0.15</td>
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<tr>
<td></td>
<td></td>
<td>medium</td>
<td>20%</td>
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<td>high</td>
<td>30%</td>
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<tr>
<td></td>
<td></td>
<td>very high</td>
<td>20%</td>
<td>0.20</td>
</tr>
<tr>
<td>K-01.3 - number of heat waves per year</td>
<td>0.70</td>
<td>low</td>
<td>30%</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medium</td>
<td>20%</td>
<td>0.40</td>
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<td></td>
<td></td>
<td>high</td>
<td>30%</td>
<td>0.30</td>
</tr>
<tr>
<td>K-01.4 - number of tropical nights per year</td>
<td>5.02</td>
<td>low</td>
<td>30%</td>
<td>0.30</td>
</tr>
<tr>
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<td></td>
<td>medium</td>
<td>20%</td>
<td>0.40</td>
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<tr>
<td></td>
<td></td>
<td>high</td>
<td>30%</td>
<td>0.30</td>
</tr>
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<td>K-01.5 - maximum temperature of the period</td>
<td>39.87</td>
<td>low</td>
<td>100%</td>
<td>2.00</td>
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<td>medium</td>
<td>20%</td>
<td>0.60</td>
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<tr>
<td></td>
<td></td>
<td>high</td>
<td>20%</td>
<td>0.60</td>
</tr>
</tbody>
</table>
Module – Risk Analysis – Introduction

Excursus – Climate data

➢ Demands
  ▪ Adequate resolution (fine grid)
  ▪ Present conditions (for calibration) and projections of future climate conditions

➢ State of the art: CORDEX Dataset, European Domain
  ▪ Grid size: about 12 × 12 km
  ▪ Common to gridded data of present climate and regional climate projections of the most recent generation of global and regional climate modes

➢ Processing within DeTECToR
  ▪ Cropping to target regions (e.g., Alpine region, Scotland)
  ▪ Computation of required climate properties and indicators
  ▪ For projections under a “climate protection” (RCP2.6) and a “business as usual” (RCP8.5) greenhouse gas scenario
  ▪ Integration of the data into the DeTECToR tools for decision support and procurement

Image source: CORDEX community website www.cordex.org
Module – Risk Analysis – Introduction

- Combination Value of Climate CVC
- Combination Value of Vulnerability CVV
  - combines indicators of the dimension vulnerability for a DPC in the considered road section
  - Using of different indicators to describe a vulnerability (e.g. traffic, materials, location, condition, age)
  - Value range of 1 to 4

<table>
<thead>
<tr>
<th>Vulnerability Indicator</th>
<th>Weighting (planned)</th>
<th>Traffic Volume DTV-SV</th>
<th>Location/Orientation</th>
<th>Longitudinal Inclination</th>
<th>Cracks</th>
<th>Top Layer Material</th>
<th>Depth of Ruds</th>
<th>Thickness of Asphalt Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X &lt; 4000</td>
<td>mountains and northern slope</td>
<td>X &lt; 2%</td>
<td>PA (OPA), MA (GA)</td>
<td>X ≥ 4</td>
<td>15%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000 ≤ X &lt; 9000</td>
<td>mountains and eastern slope</td>
<td>2% ≤ X &lt; 5%</td>
<td>SMA, AC (AB)</td>
<td>4 ≤ X</td>
<td>10%</td>
<td>100%</td>
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<tr>
<td></td>
<td></td>
<td>9000 ≤ X &lt; 12000</td>
<td>mountains and western slope</td>
<td>5% ≤ X &lt; 7%</td>
<td>3 ≤ X &lt; 4</td>
<td>4 ≤ X</td>
<td>15%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12000 ≤ X</td>
<td>lowland or mountains and southern slope</td>
<td>7% ≤ X</td>
<td>2 ≤ X</td>
<td>0%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Weighting (result)</td>
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<td>28%</td>
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<td>22%</td>
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<td>28%</td>
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</tr>
</tbody>
</table>

**Expression Category**
- Low
- Medium
- High
- Very High

**Percentage in Section**
- 1
- 2
- 3
- 4

**Weighting (result)**
- 28%
- 0%
- 22%
- 28%

**Combination Value**
- 0.278
- 0.000
- 0.264
- 0.095

**Overall Risk Potential (ORP)**
- 1.760

Risk Potential of Hazard (RPH)
Risk Potential of Effect (RPE)
Module – Risk Analysis – Introduction

- Combination Value of Climate CVC
- Combination Value of Vulnerability CVV
- Risk Potential of Hazard RPH
  - Combines CVC and CVV
  - Value range of 1 to 4
Module – Risk Analysis – Introduction

- Combination Value of Climate CVC
- Combination Value of Vulnerability CVV
- Risk Potential of Hazard RPH
- Risk Potential of Effects RPE
  - Aggregation of five categories of impact for each DPC of the considered road section
    - Refurbishment
    - Maintenance
    - Operation
    - Accidents
    - Traffic interruptions
  - Value range of 1 to 4
Module – Risk Analysis – Introduction

- Combination Value of Climate CVC
- Combination Value of Vulnerability CVV
- Risk Potential of Hazard RPH
- Risk Potential of Effects RPE

- Overall Risk Potential oRP – final result
  - Merging Risk Potential of Hazard (RPH) and Risk Potential of Effect (RPE)
  - Value range of 1 to 4
  - Final result variable of the RIVA-assessment methodology
Module - Cost benefit analysis - overview

- New way to combine risk assessment and cost-benefit-analysis in the context of climate change for a network wide evaluation

- in general
  - The result of the risk assessment is starting point
  - calculation for three climate projection periods (2011-2040 | 2041-2070 | 2071-2100) for the current situation
  - evaluation period of 30 years
  - lifecycle approach
  - assessment of
    - direct costs
    - indirect costs (benefits are expressed as cost saving)
  - comparison of three adaptation measures and do-nothing option
  - option with the lowest sum is the best option
Module - Cost benefit analysis

- Result of the risk assessment / lifecycle approach / evaluation period 30 years
  - transformation of the periodical result (RPH) of the risk assessment to an annual basis
  - Indicators of vulnerability distinguished as
    - variable during the lifecycle (e.g. condition)
    - constant (material, location)
  - (simplified) Approach – “linear” development of lifecycle related indicators
  - Recalculation of annual RPH-values for each DPC for each asset
- Assessment / interpretation the Level of Occurrence (LoC) of an climate event during the period
  - as an exponential function of RPH
  - basis for assessment of direct and indirect costs
Module - Cost benefit analysis

- Assessment of Direct Costs
  - Regular reconstruction costs (as depreciation); considering reduced LCP caused by the climate
  - (additional) implementation costs of Adaptation Actions
  - (additional) operation and maintenance costs of Adaptation Actions
  - Repair costs after climate event (as function of LoC)

- Assessment of Indirect Costs
  - in case of regular reconstruction
  - in case of climate event (as function of LoC)
  - costs for loss of journey time
  - congestion costs
  - accident costs
Module - Cost benefit analysis

- Input
  - central cost related input interface
    - Lifespan
    - Construction costs (per m²)
    - Operation/maintenance costs as share of the construction costs
    - Duration of reconstruction
    - Traffic (average speed of hgv, pc)
    - Time costs rate
    - Accident costs rate
  - Sources
    - National transport plan
    - Assumption

- Results
  - Aggregation of direct and indirect costs
    - for each (3) Adaptation Action and for the do-nothing option
    - for each projection period
    - Option / Action with the lowest sum of direct and indirect costs will be the best
    - Results for the Adaptation Actions are shown in relation to the do-nothing option

Look into the tool
Demonstration of the risk assessment and CBA tool

Marek Skakuj, Heller Ingenieurgesellschaft
How it works?

Asset Information

Risk Assessment Module

Climate Projection

Cost-Benefit Calculation Module
What are the answers, you can expect from the software?

What will the climate look like in the future?

How will the changes affect the infrastructure?

What should be done to minimize the risks?
Trust – Understand – Commit
Trust – Understand – Commit
Trust – Understand – Commit
Trust – Understand – Commit

Configuration
Cost Benefit Analysis
Adaptation measures

Risk assessment
- Combination Value of Vulnerability (CVV)
- Combination Value of Climate (CVC)
- Risk Potential of Hazard (RPH)
- Risk Potential of Effect (RPE)
- Overall Risk Potential (ARP)

Assets
- Asset object

Climate data
- Hot days (K-01.1)
- Summer days (K-01.2)
- Heat waves (K-01.3)
- Tropical nights (K-01.4)
- Max temperature (K-01.5)

Background
- DSM
- None

Damage Pattern Category
(DPC-05a) heat-related damages and restrictions on the asphalt road surface
High temperatures lead to a reduced viscosity of the asphalt, which can cause damages and restrictions, e.g., in the form of increased rut development.

Projection Period
2071 - 2100

The climate data is analysed for these four 30-year periods: 1971 - 2000 (based on climate model data representing the state of the climate at the end of the 20th century - 2040 - 2070 - 2071 - 2100). These periods have been chosen in order to be comparable with other studies. They are the foundation for a near-future projection, a medium-term projection and a long-term projection. The period from the 20th century is, e.g., required to determine climate change signals.

Greenhouse Gas Concentration
Low
Representative Concentration Pathways (RCPs) are trajectories used for modelling of greenhouse gas concentration. The Intergovernmental Panel on Climate Change (IPCC) has determined four RCPs, i.e., four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. Out of these four the lowest and the highest were selected for DETECTOR in order to mark an "event corridor" for different future developments. - Low Concentration according to scenario RCP 2.6 - High Concentration according to scenario RCP 8.5
Trust – Understand – Commit
Longer section to get an overview
Trust – Understand – Commit

Shorter section to go deeper
Asphalt surfaces
Concrete surfaces

- Concrete pavements are created using a concrete mix of Portland cement, coarse aggregate, sand, and water. Concrete surfaces have been refined into three common types: jointed plain (JP), jointed reinforced (JR), and continuously reinforced (CR). Under particular climate conditions concrete pavements (or slabs) can expand and additional forces lead to pavement damage.

- The climate data is analyzed for these four 50-year periods: 1971–2000 based on climate model data reproducing the state of the climate at the end of the 20th century, 2011–2040, 2041–2070, 2071–2100. These periods have been chosen in order to be comparable with other studies. They form the foundation for a near-future projection, a mid-term projection, and a long-term projection. The period from the 20th century is e.g., required to determine climate change signals.

- Representative Concentration Pathways (RCPs) are trajectories used for modeling greenhouse gas concentration. The Intergovernmental Panel on Climate Change (IPCC) has determined four RCPs, i.e., four possible climate futures. Low concentration according to scenario RCP 2.6 - High concentration according to scenario RCP 8.5.
Trust – Understand – Commit

Bridges
Trust – Understand – Commit
Trust – Understand – Commit
Trust – Understand – Commit
Trust – Understand – Commit
Trust – Understand – Commit
Trust – Understand – Commit
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<thead>
<tr>
<th>Country</th>
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<td>Austria</td>
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<td>31287</td>
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<tr>
<td>Germany, Federal State of Bavaria</td>
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<td>25832</td>
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<td>Germany, Federal State of Saxony</td>
<td>Test Project</td>
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<td>Scotland</td>
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Summary

• DeTECToR Tool presents complex data from different sources in a clear way. This enables rational and future oriented decision-making

• DeTECToR Tool is flexible and fully configurable to meet new requirements and provide better understanding of your data

• DeTECToR Tool turns your data into information
## Consortium contact details

<table>
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