Analysis of the vulnerability of the existing transport infrastructure

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Brussels, 6 December 2017
Analysis of the vulnerability of the existing transport infrastructure

- PT Framework for Climate Change Adaptation
- Climate Vulnerabilities on transport networks:
  - What we know and what we need to know
  - Assessing transport networks vulnerabilities
- Adapting Transport Authorities
  - From vulnerabilities to adaptation policies
CLIMATE CHANGE ADAPTATION IN THE TRANSPORT SECTOR
EXPERIENCE FROM PROJECT PREPARATION AND NETWORK MANAGEMENT
Session 1 – Analysis of Climate Vulnerabilities on Transport Networks

Public Institute
Indirect State Administration
Financial and Administrative Autonomy

IMT
INSTITUTO DA MOBILIDADE E DOS TRANSPORTES, I.P.

PLANNING AND INFRASTRUCTURE
ENVIRONMENT
SEA
INTERNAL AFFAIRS

REPÚBLICA PORTUGUESA

Jaspers Network
IMT
PT Framework for Climate Change Adaptation
Strategic Framework for Climate Policy

Interministerial Commission on Climate Change and Air Policy

CLIMATE CHANGE

- National Strategy for Climate Change Adaptation (ENAAC 2020)
- Low Carbon Roadmap 2050
- National Climate Change Programme
- Emissions Trading Scheme

Air

- National Strategy on Air Policy (ENAR)

Adaptation monitoring and reporting

National System for Policies and Measures and Inventories (SPeM)

National System for Inventories (SNIERPA)

Environmental Fund

EU Funding (Portugal 2020; LIFE;… 2014-2020)

Source: RCM n.º 56/2015, July 30
National Strategy for Climate Change Adaptation

**COORDINATION**

- **Coordination Group**
  - Coordenação geral: Agência Portuguesa do Ambiente (APA)
  - Coordenadores áreas temáticas
  - Coordenadores GT sectoriais
  - Regiões Autónomas
  - Associação Nacional de Municípios Portugueses

**Scientific Panel**

**THEMATIC AREAS**

- SECTORIAL WG
  - Investigação e Inovação
  - Financiamento e Implementação da Adaptação
  - Cooperação Internacional
  - Comunicação e Divulgação
  - Integrar a Adaptação – Ordenamento do Território
  - Integrar a Adaptação – Gestão dos Recursos Hídricos

- **Sectorial WG**
  - Agricultura
  - Biodiversidade
  - Economia
  - Energia
  - Florestas
  - Saúde Humana
  - Segurança de Pessoas e Bens
  - Transportes e Comunicações
  - Zonas Costeiras e Mar

**ENAAC 2020 OBJECTIVES**

- Improve knowledge on Climate Change
- Implement adaptation measures
- Promote adaptation adoption on sectorial policies

**Source:** RCM n.º 56/2015, July 30

**WG TRANS**
WG TRANS

• **Coordination:**
  Instituto da Mobilidade e dos Transportes (IMT) and Autoridade Nacional de Comunicações (ANACOM);

• **Structure:**
  Divided in two subgroups, that work independently (Transport/Communications);

• **Competences:**
  Study, monitor and propose measures to safeguard transport infrastructures and services, which present a vulnerability to climate change impacts worthy of concern.

• **Members:**
  Autoridade Nacional de Aviação Civil (ANAC), Associação Nacional dos Transportadores Rodoviários de Pesados de Mercadorias (ANTRAM), Associação Nacional dos Transportadores Rodoviários de Pesados de Passageiros (ANTROP), Associação das Sociedades Concessionárias de Auto-estradas ou Pontes com Portagens (APCAP), Comboios de Portugal (CP), Instituto da Mobilidade e dos Transportes (IMT) and Infraestruturas de Portugal (IP).
WG TRANS – Progress so far:

HIGHLIGHTS:

- WG TRANS - Established on May 2016
- Working procedures and proposed action plan for 2016-17
- 5 Working Sessions (2016-17)
  - R&D Funding for Transport:
    - Life
    - H2020
  - Civil Protection Emergency Response to extreme weather events:
    - Civil Protection Services
  - Climate Change Related Requirements for Major Transport Projects in the 2014-2020 Programming Period
    - JASPERS
- Survey on Climate Change Impacts and Adaptation for transport networks and nodes
  - UNECE
- Set Priorities for Climate Change Adaptation Funding
Climate Vulnerabilities:
What we know and what we need to know
We know Transport role on the Antropogenic climate change impact pathway

Source: Adapted from UNEP-GRID, and den Elzen et al. (2005).
We know the projected climate change scenarios

**Maritime region:**
- Heat Increase (2\textsuperscript{nd} threshold)
- Wind Increase (2\textsuperscript{nd} threshold)

**Mediterranean region:**
- Heat Increase (3\textsuperscript{rd} threshold)
- Wind Increase (2\textsuperscript{nd} threshold)
- Rain (1\textsuperscript{st} threshold)

**Most harmful extreme weather phenomena and their threshold values**

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>1st threshold: harmful impacts are possible, 0.33</th>
<th>2nd threshold: harmful impacts are likely, 0.66</th>
<th>3rd threshold: harmful impacts are certain, 0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind (gust speed)</td>
<td>(\geq 17 \text{ m/s})</td>
<td>(\geq 25 \text{ m/s})</td>
<td>(\geq 32 \text{ m/s})</td>
</tr>
<tr>
<td>Snowfall</td>
<td>(\geq 1 \text{ cm/day})</td>
<td>(\geq 10 \text{ cm/day})</td>
<td>(\geq 20 \text{ cm/day})</td>
</tr>
<tr>
<td>Rain</td>
<td>(\geq 30 \text{ mm/day})</td>
<td>(\geq 100 \text{ mm/day})</td>
<td>(\geq 150 \text{ mm/day})</td>
</tr>
<tr>
<td>Cold (mean temperature of the day)</td>
<td>(&lt; 0 \text{°C})</td>
<td>(&lt; -7 \text{°C})</td>
<td>(&lt; -20 \text{°C})</td>
</tr>
<tr>
<td>Heat (mean temperature of the day)</td>
<td>(\geq 25 \text{°C})</td>
<td>(\geq 32 \text{°C})</td>
<td>(\geq 43 \text{°C})</td>
</tr>
<tr>
<td>Blizzard</td>
<td>A blizzard is considered to occur when the threshold values of wind, snowfall and cold are realised simultaneously</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Projected changes in the frequency of adverse weather events relevant for transport across Europe**

- **Expected mean changes by the 2030s**
  - Increasing
  - Decreasing
  - No trend

- **Ranking**
  - 1st threshold
  - 2nd threshold
  - 3rd threshold

**Phenomena**
- Wind
- Heavy precipitation
- Heat waves
- Cold spells
- Snow
- Blizzards

**Source:** Climate Change, impacts and vulnerability in Europe 2016
And the climate change scenarios are often regionalized according to our needs (http://portaldoclima.pt)
We also know that the lifespan of the transport network assets will extend long enough to have to cope with climate change effects.
But we often lack the connection between climate trends, transport networks damage and climate vulnerabilities:

CLIMATE TRENDS → CLIMATE IMPACTS → DAMAGE

CLIMATE VULNERABILITIES

Source: Adapted from Pariaux, 2012.
Starting Point for WG TRANS:
No information on transport vulnerability studies in PT

Source: Climate Change, impacts and vulnerability in Europe 2016
Climate Vulnerabilities: Assessing transport networks vulnerabilities
• Survey on Climate Change Impacts and Adaptation for transport networks and nodes:

14 answers from WG Trans network
QUESTION 1

To which extent do you consider climate change and/or extreme weather events to be a problem for transport in your country/region (on a scale of 1–10)

- PERCEPTION THAT CLIMATE CHANGE HAS IMPACTS ON TRANSPORT INFRASTRUCTURE
- HIGH VARIATION OF OPINIONS REGARDING THE DIMENSION OF THE CHALLENGE.

Average value: 5,3
QUESTION 2

Critical transport infrastructure: Please list below the transport arteries (road, rail, inland water transport) and nodes (ports, airports, freight villages/ logistics centers/ intermodal centers) considered as critical in your country/region/organization and specify their criticality.

FIRST PROBLEM

• DEFINE CRITICAL INFRASTRUCTURES ON A CLIMATE CHANGE CONTEXT

ADOPTED SOLUTION

• MAJOR INFRASTRUCTURES THAT ALLOW INTERNATIONAL AND NATIONAL CONNECTIONS AND/OR WITH A RELEVANT HISTORY OF EXPOSURE TO EXTREME WEATHER EVENTS AFFECTING THE INFRASTRUCTURE NORMAL CAPACITY.

• TEN-T Network + Nodes
• UNECE E-Roads + National main roads (IP’s)
• National main rail tracks (Metropolitan Areas + Corredor Atlântico)
• Roads+Rail with relevant history of weather related disturbances

Analyzed infrastructure:
• 30 roads
• 17 railroads
• 7 ports (lacking data)
• 3 airports (lacking data)
Do your Government / organization plan any investments in the next 5 years in the above mentioned critical infrastructure? If yes, please specify the investment and indicate its total value (in million €).

Do planned investments in the above indicated critical infrastructure consider impacts of extreme weather and/or other climate related factors? If yes, please specify for each investment.

**Estimated Investment (over 5 Years)**

- **€237 Million**
- **€400 Million**
- **€637 Million**

**Source (photos): Lusonotícias (2013) and CP(2017)**
Which of the following weather or climate related factors have impacted your critical infrastructure mentioned above (check all that apply)

- Precipitation/floods
- Winds
- Fog
- High temperatures
- Low/High river flow
- Mean sea level and surges

**WEATHER OR CLIMATE FACTORS WITH LARGER HISTORICAL IMPACT**

- VARIABLE ACCORDING TRANSPORT MODE
- PRECIPITATION/FLOODS, HIGH TEMPERATURES AND WIND ARE THE FACTORS WITH LARGER IMPACT
- MEAN SEA LEVEL AND STORM WAVES AND SURGES ARE THE FACTORS WITH LESS IMPACT
Which of the following weather or climate related factors have impacted your critical infrastructure mentioned above (check all that apply)

**ASSETS:**
- A – Toll Operations
- B – Sliding slope
- C - Underground drainage
- D - Road side telematics equipment
- E - Drainage
- F - Crossroads
- G – Connections
- H – Signs and signals
- I – Lightning
- J - Bridges
- K - Road Pavement
- L - Non specified infrastructure

<table>
<thead>
<tr>
<th>ID</th>
<th>Designação</th>
<th>Origem</th>
<th>Destino</th>
<th>P/I</th>
<th>V</th>
<th>N</th>
<th>AT</th>
<th>BT</th>
<th>S/D</th>
<th>NMM</th>
<th>SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>IP 1</td>
<td>Aveiro</td>
<td>Lisboa (Sacavém)</td>
<td>A, B, C, D</td>
<td>H, I</td>
<td>A, J, K</td>
<td>J</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>IP 1</td>
<td>Lisboa</td>
<td>Montijo</td>
<td>E</td>
<td>H, I</td>
<td>A, J, K</td>
<td>J</td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>IP 2/ E 802</td>
<td>Portelo</td>
<td>Faro</td>
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<td>L</td>
<td>L</td>
<td>L</td>
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</tr>
</tbody>
</table>
HISTORICAL VARIATION OF WEATHER OR CLIMATE EVENTS

- MOST ANSWERS REFER THAT LACK OF HISTORICAL DATA DETERS THE ANSWER TO THIS QUESTION

- ALL ENTITIES THAT EVALUATED THE HISTORICAL VARIATION POINTED THAT THE MAGNITUDE OF DAMAGE FROM WEATHER OR CLIMATE EVENTS HAS REMAINED MORE OR LESS THE SAME

QUESTION 5

Over time, has the magnitude of damage and/or disruption caused by weather or climate related events:
QUESTION 6

Have users of the critical infrastructure requested implementation of effective response measures?

- Yes. After extreme weather events the users usually request implementation of corrections to the infrastructure resiliency.
- Some transport infrastructure operators report having received user requests to increase vegetation cutting area, improve road pavement, slope stabilization and road runoff water control.

QUESTION 7

Please provide any other comments/information you would like to submit regarding the above questions.

- The historic experience of operating transport infrastructure built in the recent decades does not provide a knowledge base wide enough to provide a correct evaluation on the changing weather condition.
- Other operators stressed that a correct adaptation of the transport infrastructure to climate change effects also has effects on lowering GHG emissions.
Is there information available on the following climate change impacts that have affected or will potentially affect critical infrastructure in your country/region/organization?

**DATA AVAILABILITY**

- AVAILABILITY OF DATA FOR MAJOR ROAD AND RAIL INFRASTRUCTURES ON PRECIPITATION, TEMPERATURE AND WINDS

**DATA GAPS**

- LACK OF DATA REGARDING RIVER WATER LEVELS AND COASTAL SEA LEVELS AND STORM WAVES/SURGES
- LACK OF PRECIPITATION, TEMPERATURE AND WINDS DATA FOR ROADS+RAIL WITH RELEVANT HISTORY OF WEATHER RELATED DISTURBANCES

If yes, have the observed trends already necessitated or will require adaptation responses?

- FEW ANSWERS AND NO SIGNIFICATIVE TRENDS IDENTIFIED
QUESTION 10

Please indicate the basis for weather/climate information used in the estimation of impacts and the design of response measures regarding your critical infrastructure (check all that apply)

<table>
<thead>
<tr>
<th>Basis</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Observations</td>
<td>x</td>
</tr>
<tr>
<td>Modelling</td>
<td>x</td>
</tr>
<tr>
<td>Modelling validated by long term observations</td>
<td>x</td>
</tr>
</tbody>
</table>

- CIVIL PROTECTION SERVICES
- PORTUGUESE SEA AND ATMOSPHERE INSTITUTE
QUESTION 11

Are downscaled forecasts or assessments available for your critical infrastructure regarding the following climate forcing and factors? If so, at which time scale? (Check all that apply)

<table>
<thead>
<tr>
<th>Factor/forcing</th>
<th>10 years</th>
<th>30 years</th>
<th>50 years</th>
<th>&gt; 50 years</th>
<th>Not available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation (average/extreme precipitation) and floods</td>
<td>x</td>
<td>IPMA</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Temperature (averages and extremes)</td>
<td>x</td>
<td>IPMA</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Winds (e.g. average and extremes, number of days of high winds)</td>
<td>x</td>
<td>IPMA</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>River water levels</td>
<td>x</td>
<td>IPMA</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Coastal sea levels and storm waves/surges</td>
<td>x</td>
<td>IPMA</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

FORECASTS AVAILABILITY

- AVAILABILITY OF FORECASTS FOR ALL FACTORS FOR ALL TIME RANGES
- STRONG AVAILABILITY OF 30 YEARS FORECASTS (IPMA)

INCONSISTENT ANSWER?

- RIVER WATER LEVELS AND COASTAL SEA LEVEL AND STORM WAVE/SURGES FORECASTS BUT LACK OF DATA REPORTED ON CLIMATE CHANGE IMPACTS?
QUESTION 12

At which thresholds do you expect that the integrity and functionality of the critical infrastructure of your country/region/organization will be significantly impaired?

<table>
<thead>
<tr>
<th>i.d</th>
<th>Line name (European level i.e. E-Roads)</th>
<th>From</th>
<th>To</th>
<th>Extreme temperatures (high, in °C)</th>
<th>Extreme temperatures (low, in °C)</th>
<th>Extreme wind speed (in km/hr)</th>
<th>Extreme river water level (high in metres)</th>
<th>Extreme river water level (low in metres)</th>
<th>Extreme coastal water levels/storm surges (in metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Autoestrada do Norte /IP 1</td>
<td>Lisboa /Valença</td>
<td>Porto /Castro-marim (37.230910 ; -7.448240)</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
</tr>
<tr>
<td>3</td>
<td>CRIP Circular Regional Interior do Porto (Provincial IP1)</td>
<td>Carvalhos</td>
<td>Francos</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
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<td>NO DATA</td>
</tr>
<tr>
<td>4</td>
<td>EN 125 (ER)</td>
<td>Faro</td>
<td>Olhão</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
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<tr>
<td>5</td>
<td>IP 2/ E 802</td>
<td>Portelo</td>
<td>Faro</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
</tr>
<tr>
<td>6</td>
<td>EB01 /IP3</td>
<td>Vila Verde da Raia</td>
<td>Figueira da Foz</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
</tr>
<tr>
<td>7</td>
<td>IP 4/ E82</td>
<td>Porto</td>
<td>Quintanilha</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
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<tr>
<td>8</td>
<td>IP 5</td>
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<td>NO DATA</td>
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<tr>
<td>9</td>
<td>IP 6</td>
<td>Peniche</td>
<td>Castelo Branco</td>
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</tr>
<tr>
<td>10</td>
<td>IP 7</td>
<td>Lisboa</td>
<td>Caia</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
<td>NO DATA</td>
</tr>
</tbody>
</table>

**Thresholds**

- FEW KNOW THRESHOLDS
- KNOW THRESHOLDS FOR MAJOR INFRASTRUCTURES
- KNOW THRESHOLDS FOR SOME RELEVANT HISTORICAL EVENTS
Survey on Climate Change Impacts and Adaptation for transport networks and nodes

Weak Points

- Lack of operators data to allow a more detailed response to the survey
- Lack of answers from airports and ports

Strong Points

- Raised the awareness to climate change adaptation
- Raised the awareness on needed data by transport services and infrastructure operators
- Created a network of people that deal with climate change adaptation within transport sector
- Vulnerability data provides framework for adaption efforts focus
Adapting Transport Authorities: From vulnerabilities to adaptation policies
How to use this survey data?
Example 1: Crosscheck transport vulnerabilities to extreme weather events identified for wider regions

<table>
<thead>
<tr>
<th>Extreme weather event</th>
<th>Impact on Road</th>
<th>Impact on Rail</th>
<th>Impact on Water-borne</th>
<th>Impact on Aviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat waves</td>
<td>Damage to pavements</td>
<td>Rail buckling</td>
<td>Low river flow (due to drought), imposing restrictions on loading capacity, navigation problems and speed reduction</td>
<td>Damage to runway pavement</td>
</tr>
<tr>
<td></td>
<td>Vehicle failure (tyres)</td>
<td>Material fatigue</td>
<td></td>
<td>Forest fires reducing visibility</td>
</tr>
<tr>
<td></td>
<td>Forest fires</td>
<td>Increased instability of embankments</td>
<td></td>
<td>Take-off weight limitations</td>
</tr>
<tr>
<td></td>
<td>Fatigue of drivers</td>
<td>Overheating of equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forest fires causing damage to infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold spells</td>
<td>Reduced surface friction</td>
<td>Ice on trains and catenary</td>
<td>Warm and early winters followed by a rapid decrease in air temperature may result in rougher ice cover formation and lead to ice jams and damage to navigation signs and infrastructure</td>
<td>Reduced runway friction</td>
</tr>
<tr>
<td></td>
<td>Road maintenance</td>
<td></td>
<td></td>
<td>Runway maintenance</td>
</tr>
<tr>
<td></td>
<td>Technical failure of vehicles and infrastructure</td>
<td></td>
<td></td>
<td>Deterioration of pavement</td>
</tr>
<tr>
<td></td>
<td>Deterioration of pavement</td>
<td></td>
<td></td>
<td>Technical failure of vehicles and infrastructure</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Icing of aircraft</td>
</tr>
<tr>
<td>Heavy precipitation (large-scale systems)</td>
<td>Reduced visibility and surface friction</td>
<td>Flooding and landslides damaging infrastructure</td>
<td>High river flows, resulting in problems for passage of bridges, dike instability (speed limitations) and restrictions to the height of vessels</td>
<td>Reduced visibility and runway friction</td>
</tr>
<tr>
<td></td>
<td>Floods and landslides</td>
<td>Scour to structures</td>
<td></td>
<td>Floods</td>
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<tr>
<td></td>
<td></td>
<td>Increased instability of embankments</td>
<td></td>
<td>Reduction in airport throughput</td>
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<tr>
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<td></td>
<td></td>
<td>Runway clearance</td>
</tr>
</tbody>
</table>

Source: Climate Change, impacts and vulnerability in Europe 2016
How to use this survey data?

Example 2: Identify Transport adaptation policies that can help coping the identified vulnerabilities

**SNCF (France)**
- Climate vulnerability cartography;
- Update of constructions and maintenance regulations for infrastructures;
- Strategic reflection on climate change crisis with other transport entities;
- Climate change indirect impacts evaluation: changes in passengers O-D, energetic crisis during long drought periods...

**AdapteCCa Platform (Spain)**
- Platform for sharing experiences on climate change adaptation (PT has also implemented a similar platform);

  Dissemination of the study on “Necesidades de adaptación al cambio climático de la red troncal de infraestructuras de transporte en España”.

**Norwegian Public Roads Administration**
- Revision of road transport regulations integrating climate change risks such as floods, ice and landslides, extreme rain events and sea level rise;
- Mandatory inspections on road drainage according to expected extreme weather events rise.

**Deutsche Bahn (Germany)**
- Revision of the protocols and operational plans for climate extreme events;
- Collaboration with the Standardization Institute to define the necessary standards updates to cope with climate change;
- Research on climate change adaptation strategies.
How to use this survey data?
Example 3: Identify new transport technologies that can help coping the identified vulnerabilities

Real time Information and Communication Technologies
smartphones, computers, satellites, sensors ...

Intelligent Transport Systems-ITS

Energy efficiency
Smart Infrastructure
How to use this survey data?

Example 4: Integrate it on operational management centers through GIS

<table>
<thead>
<tr>
<th>Road Network Management</th>
<th>Line</th>
<th>From</th>
<th>To</th>
<th>Passing through</th>
<th>Precipitation (average/extreme precipitation) and floods</th>
<th>Temperature (averages and extremes)</th>
<th>Winds (e.g. average and extremes, number of days of high winds)</th>
<th>River water levels</th>
<th>Coastal sea levels and storm waves/surges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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- Create common operational picture for extreme weather events
- Increase coordination between infrastructure and transport service operators
- Basis for integrated ITS systems
How to use this survey data?

Example 5: Propose priorities for transport investment funds

- Vulnerability studies for transport systems, namely threshold identification within foreseen climate change scenarios
- Infrastructure Climate Proofing
- Prevention plans for extreme weather events
- Emergency Plans for extreme weather events
- Studies for adapting transport planning to foreseen climate change scenarios
- Innovative traffic management systems that increase extreme weather events resilience
- Definition and development of new construction techniques that increase climate change resilience
- Climate risk cartography
- ITS systems for emergency communications during extreme weather events
- Adaptation of transport operators equipment
- Adaptation of coastal infrastructures to increase climate change resilience
How to use this survey data?

Example 6: Prepare an action programme for transport adaptation

1. **Monitor climate related variables**
2. **Identify climate change impacts (airports and ports)**
3. **Identify climate change vulnerabilities (airports and ports)**
4. **Integrate climate adaptation on transport planning**
5. **Monitor climate change adaptation on transport sector**

--------------- Possible Actions ---------------

- Obtain weather data for sites with known weather issues
- Survey ports and airports
- Survey ports and airports
- Integrate climate change adaptation on EIA
- Define indicators to report adaptation progress
CLIMATE CHANGE ADAPTATION IN THE TRANSPORT SECTOR
EXPERIENCE FROM PROJECT PREPARATION AND NETWORK MANAGEMENT
- Session 1 – Analysis of Climate Vulnerabilities on Transport Networks -

Transport Authorities Need to Adapt to Climate Change
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 Website:

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