Extreme Weather Impacts on European Networks of Transport
- summary of relevant findings

Project for the call TPT.2008.1. Assessing disruptive effects of extreme weather events on operation and performance of EU transport system

AASHTO Spring Meeting
Traverse City, May 20, 2012

Dr. Pekka Leviäkangas
VTT Transport & Logistics
Bio of Pekka

Principal Scientist  VTT Technical Research Centre of Finland
Vice-President  Jaakko Pöyry Group subsidiary JP-Transplan
Corporate Analyst  Finnish Railways (VR Group)
Road Policy Engineer, R&D Manager  Finnish Road Administration S-E district
Cost engineer  Finnmap Ltd.

-----------------------------
Adjunct professor, University of Oulu, dept. of industrial engineering and management, *business and investment analysis in transportation*

Adjunct professor, Technical University of Tampere, dept. of logistics and business information management, *transport and logistics*
VTT in brief

Customer sectors
- Biotechnology, pharmaceutical and food industries
- Electronics
- Energy
- ICT
- Real estate and construction
- Machines and vehicles
- Services and logistics
- Forest industry
- Process industry and environment

Focus areas of research
- Applied materials
- Bio- and chemical processes
- Energy
- Information and communication technologies
- Industrial systems management
- Microtechnologies and electronics
- Technology in the community
- Business research

VTT’s operations
Research and Development ■ Strategic Research ■ Business Solutions ■ Ventures ■ Expert Services ■ Corporate Services
VTT on the map
Goal and research strategy of EWENT

The goal of EWENT project is to assess the impacts of extreme weather events on EU transport system. These impacts are monetised. EWENT will also evaluate the efficiency, applicability and finance needs for adaptation and mitigation measures which will dampen and reduce the costs of weather impacts. The methodological approach is based on generic risk management framework that follows a standardised process from identification of hazardous phenomena (extreme weather), followed by impact assessment and closed by mitigation and risk control measures.

EWENT will start this by identifying the hazardous phenomena, their probability and consequences and proceed to assessing the expected economic losses caused by extreme weather when it impacts the European transport system, taking also into account the present and expected future quality of weather forecasting and warning services within Europe.

EWENT will apply the IEC 60300-3-9 risk management standard framework all the way through its research process and the project’s work breakdown also follows the standard structure.
Definition of the object

WP1: Identification

WP2: Probabilities
WP3: Consequences

WP4: Cost estimation

WP5: Risk assessment

WP6: Mitigation strategies

WP7: Dissemination

WP8: Management

OBJECTIVE: Risk management strategy for the EU transport system to prepare for and mitigate the impacts and costs of extreme weather phenomena

WP1: Extreme weather phenomena that have potential internal and external cost impacts on EU transport system; the threshold criteria for weather parameters

WP2: The probability of extreme weather and scenarios for increased probabilities and intensity

WP3: Impact mechanisms for system failures or disturbances (mobility meltdown, reduced safety and security) and operational failures (predictable mobility of passengers and goods); impacts on selected transport system performance indicators

WP4: Estimation of expected costs of extreme weather on time axis, based on identified impacts and scenarios: infrastructure (material damages), operations and traffic (accidents, time delays)

WP5: Evaluation of likely scenarios and most relevant costs; listing of prospective mitigation and adaptive strategies; risk panorama for EU transportation system

WP6: Assessing the effectiveness and preliminary investments required by different mitigation strategies on time axis; e.g. new weather information services, new institutional co-operative models (especially between authority functions and across national boundaries), development needs of standards and engineering guidelines for transportation infrastructures
# The consortium

<table>
<thead>
<tr>
<th>Beneficiary Number</th>
<th>Beneficiary name</th>
<th>Beneficiary short name</th>
<th>Country</th>
<th>Date enter project</th>
<th>Date exit project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Coordinator)</td>
<td>VTT Technical Research Centre of Finland</td>
<td>VTT</td>
<td>FI</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>German Aerospace Center</td>
<td>DLR</td>
<td>DE</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Institute of Transport Economics</td>
<td>TÖI</td>
<td>NO</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Foreca Consulting Ltd</td>
<td>Foreca</td>
<td>FI</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Finnish Meteorological Institute</td>
<td>FMI</td>
<td>FI</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Meteorological Service of Cyprus</td>
<td>CYMET</td>
<td>CY</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>Österreichische Wasserstraßen GmbH</td>
<td>via donau</td>
<td>AT</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>European Severe Storms Laboratory</td>
<td>ESSL</td>
<td>DE</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>World Meteorological Organisation</td>
<td>WMO</td>
<td>UN</td>
<td>6</td>
<td>30</td>
</tr>
</tbody>
</table>
Modal coverage

<table>
<thead>
<tr>
<th>Depth of analysis</th>
<th>Aviation</th>
<th>Land transport</th>
<th>Marine &amp; waterways</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passenger</td>
<td>Road</td>
<td>Light</td>
</tr>
<tr>
<td></td>
<td>Freight</td>
<td>Rail</td>
<td>Ocean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Short sea/ coastal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inland ww Freight</td>
</tr>
<tr>
<td>Detailed</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Brief</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excluded</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The transport system is viewed from three angles:
- **infrastructure**: these are direct material damages or deterioration of physical infrastructures
- **operations**: these are harmful impacts on traffic safety and transport reliability (both freight and passenger)
- **indirect impacts to third parties**, e.g. supply chain customers and industrial actors.
Cost impact vs. cost absorption

System impact disruptive level

*rain fall
*snow fall
*wine speed
*etc.

Intensity

Impact

Costs associated!

Disruptive level

Cost absorption
Impact analysis – example railways

**Phenomena**

- Thunderstorms
- Storm winds
- Snow storms

**Impact**

- Lightning strikes
- Falling trees
- Stacking snow
- Electricity shocks
- Power failures
- Line cuts
- Frozen switches
- Traffic control systems
- Power supply systems
- Switches

**Consequences**

- System failure
- Time delays
- Accidents
- Customer dissatisfaction
- Disturbances is operations
- Increased maintenance / repair costs
Schedule & other info

• The project started in December 2009.
• Duration: 30 months.
• Total budget: ca 2 MEUR

• http://ewent.vtt.fi/
WP1 - Phenomena
What’s in it?

- Long list of extreme weather phenomena with critical threshold values
- A set of causal maps
- Analysis of >200 media reported cases
- Review of 150 scientific and professional publications
<table>
<thead>
<tr>
<th>Threshold</th>
<th>Impacts</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\leq 0^\circ C$</td>
<td>This is an important threshold related to slipperiness (ice formation, form of precipitation: rain/sleet/snowfall). The temperature itself is rather a modifier of hazardous conditions for transportation than a main cause. Low temperature combined with precipitation and wind can have a disruptive effect on traffic. Occurrence of freezing drizzle, increased frequencies of freeze-thaw cycles.</td>
<td>Increased accident risk in road traffic. The occurrence of freezing drizzle might be hazardous for aviation and road traffic. Premature deterioration of road and runway pavements.</td>
</tr>
<tr>
<td>$\leq -7^\circ C$</td>
<td>The effect of salting for ice removal decreases in low temperatures. So, even relatively small amounts of snowfall can cause slippery conditions on highways when packed on the road surface by traffic. Rail points may get stuck by drifting snow in low temperatures (observed in Finland and Canada). Ice formation on rivers may start if there are many cold days in a row. Some vehicles might have fuel problems (&quot;summer diesel sort&quot;).</td>
<td>Increased accident risk, delays and cancellations in road and rail traffic (e.g. Eurostar trains during winter 2009/10). Inland waterway transport might be disrupted.</td>
</tr>
<tr>
<td>$\leq -20^\circ C$</td>
<td>Some vehicles might have fuel problems (Oslo, winter 2009/10). Rivers get ice-covered if there is a long-lasting cold period. Dangerous wind chill conditions occur when moderate winds prevail.</td>
<td>Public transport may encounter breaks due to fuel problems. (Oslo, winter 2009/10), riverboat traffic may stop. Limitations to transport personnel working outdoors.</td>
</tr>
</tbody>
</table>
The climate zones
WP2 - Probabilities

A) Multi-model mean

B) Upper limit

C) Lower limit
Six regional climate models

The chosen regional climate change projections are:
- SMHIRCA-ECHAM5-r3
- SMHIRCA-BCM
- SMHIRCA-HadCM3Q3
- KNMI-RACMO2-ECHAM5-r3
- MPI-M-REMO-ECHAM5-r3
- C4IRCA3-HadCM3Q16

Projections for
- 2011-2040
- 2041-2070
Source: FMI
Summary map of the mean changes by 2050s:

- Extremes are growing?
- Underestimation of heat-related problems?
- Precipitation increasing slightly and drought increasing strongly…?
Fog-hours in three major airports for 1975-2009

- Zurich
- London Gatwick
- Oslo

Year: 1975 to 2010

Hours: 0 to 400
Status of the European Severe Weather Database

Application, e.g., tornado incidence

Reports per year per 10,000 km³

Tornado 1990 - 2009

ESWD
www.eswd.eu

Output formats at essl.org/ESWD/:

- Public: Map, HTML text table
- Users: also ASCII + CSV raw data

Source: Dotzek / ESSL

26/04/2010 n = 24688 reports since 1950

NMHS Partner
WP3 & WP4 – Consequences & Costs
### Present costs due to extreme weather, including all phenomena (ca. 2010)

<table>
<thead>
<tr>
<th></th>
<th>Accidents</th>
<th>Time costs</th>
<th>Infrastructure</th>
<th>Freight &amp; logistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road</strong></td>
<td>&gt;10 bill.</td>
<td>0.5-1.0 bill.</td>
<td>ca. 1 bill.</td>
<td>ca. 0.2 bill.</td>
</tr>
<tr>
<td><strong>Rail</strong></td>
<td>&gt;0.1 bill.</td>
<td>&gt;10 mill.</td>
<td>&gt;0.1 bill.</td>
<td>5 – 24 mill.</td>
</tr>
<tr>
<td><strong>IWT</strong></td>
<td>ca. 2 mill.</td>
<td>na</td>
<td>na</td>
<td>na 0.1 - 0.3 mill.</td>
</tr>
<tr>
<td><strong>Short sea</strong></td>
<td>&gt;10 mill.</td>
<td>na</td>
<td>na</td>
<td>na 0.2 - 1 mill.</td>
</tr>
<tr>
<td><strong>Aviation</strong></td>
<td>na</td>
<td>&gt;0.6 bill.</td>
<td>na</td>
<td>na 0.5 – 2.3 mill.</td>
</tr>
<tr>
<td><strong>Light traffic</strong></td>
<td>&gt;2 bill.</td>
<td>-</td>
<td>na</td>
<td>na -</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>&gt;12 bill.</td>
<td>&gt;1 bill.</td>
<td>ca. 1 bill.</td>
<td>&gt;0.3 bill.</td>
</tr>
</tbody>
</table>

The EU-27 grand total more than 15 bill. € p.a.
WP5 – Risk panorama
Total risk of transport mode of a country

= Vulnerability of the mode in a country × Probability of extreme weather phenomena

Extreme weather hazards of climate zone (where a country lies)

WP5 approach for risk assessment

Probability of extreme weather phenomena

Probability of negative consequences

Coping capacity

Exposure

Susceptibility (Resilience)

WP2

WP3

WP4

Cost of consequences

WP5 approach for risk assessment
Passenger transport system vulnerability indicator

- Road
- Railway
- Aviation
- Sea port

Countries: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.
Example: road infrastructure systems’ risk for damages or increased repair & maintenance in EU-27

Road Infrastructure Risk

<table>
<thead>
<tr>
<th>Mediterranean</th>
<th>Oceanic</th>
<th>Temperate Central</th>
<th>Temperate Eastern</th>
<th>Alpine</th>
<th>Nordic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>Freight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

May 2012  Copyright: P.Leviäkangas / VTT / EWENT consortium
Tentative conclusions & recommendations (subjective)

• On a meta-scale, the results seem logical, but the analysis is on meta-level too

• What-to-Worry:
  • Road system vs. other modes, other modes’ flexibility
  • Reliability / functionality / availability of the system (time costs)
  • Investments vs. maintenance
  • In EU: phenomena not handled in EU-projects:
    1) heat => drought => soil erosion / sand storms
    2) warming => from snow to liquid precipitation
  • The proactivity of the cities and municipalities
    • “risk concentration points” = all modes, all infrastructures, almost all people
  • Financing of necessary actions
Tentative conclusions & recommendations - 2

• Cannot escape uncertainty! Not to take action vs. proactive measures have equal uncertainties

• Increase intermodality / multi-modality / co-modality wherever it is feasible

• Include extreme / high-impact weather risks in project appraisal and budget programmes

• Take care of small things, not only strategic level: drainage, embankments, snow-plows, pumps, sandbags, avalanche fences, etc. etc. etc.

• Reducing risk now vs. response strategies to extremes (compare quality assurance philosophy)
INVITATION LETTER

To the
EWENT Dissemination Seminar
29-30 May 2012

World Meteorological Organization
7bis, Avenue de la Paix
1211 Geneva, Switzerland

Dear Sir/Madam,

You are cordially invited to the final dissemination seminar of the EU FP7 Project Extreme weather impacts on European networks of transport (EWENT, FPT7-TPT-2008-RTD-1) to be held in Geneva, Switzerland from 29 to 30 May 2012. The meeting will be hosted by the World Meteorological Organization (WMO).