WEATHER

Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions

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The Vulnerability of Transport Systems towards Weather Extremes

Summary Report of the WEATHER Workshop 1, Brussels, 14. September 2010

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Content

1 Preliminaries

1.1 The Workshop

The first official workshop of the WEATHER project was successfully conducted at September 14th 2010 at the premises of the German Research Foundation (KOWI) in Brussels. High ranking experts have exchanged knowledge, experiences and uncertainties on the vulnerability of road, rail air and waterborne transport towards weather extremes and climate change. The primary intention of the one-day workshop was to discuss adverse effects of extreme weather conditions on transport infrastructure assets and their management, service operations, users and safety across transport modes, hazards and climate regions. The results have been integrated in the WEATHER project deliverable D2 on Transport System Vulnerabilities.

The workshop was attended by the folloiwng experts and project members:

External Experts	
Kenneth Nathanaelsson	Swedish Transport Administration
Klaus Gspan	ASFINAG - Motorway and Express Roads Financing Society Austria
Webb Matthew	Transport for London
Prof. Chris Baker	University of Birmingham , UK
Samuel Brunet	RFF - Réseau Ferré de France
Astrid Felderer	ENVIRONMENT AGENCY AUSTRIA
Henrik Littorin	SWEDAVIA - Swedish Airports
Bettina Kohler	Etihad Airways
Anne-Laure Le Merre	CER – Community of European Railways and Infrastructure Companies
Teresa Freing	Nordwestbahn
Reik Donner	Potsdam Institute for Climate Impact Research
Klaudia Ratzinger	Natural Hazard Management of the Austrian Federal Railways
Francesco Bretti	EACI
Guillaume Dufresne	CLECAT - European Association for Forwarding, Transport, Logistic and Customs Services
Dennis Hart	EUROCONTROL
Rachel Burbidge	EUROCONTROL

Project advisory Board and related	
Roberto Arditi	SINA - Società Iniziative Nazionali Autostradali, Italy
Martin Burkhardt	UIRR – International Union for Combnined Road-Rail Transport
Robert Rausch	DRK – German Red Cross

Michel Ray	EGIS

Project team

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Evangelos Mitsakis	CERTH-HIT
Norbert Sedlacek	Herry Consult
Nina Nesterova	NEA Transport Research and Training
Jan Kiel	NEA Transport Research and Training

This document summarises the main statements and conclusions of the workshop. All presentations key presentations can be downloaded from the WEATHER webiste at http://www.weather-project.eu/weather/inhalte/Vulnerability_Workshop_Sept10.php

1.2 The WEATHER project

Records of reinsurance companies clearly highlight the rising damages caused by natural catastrophes and extreme weather events, which can at least partly be attributed to climate change. While many studies focus on CO2 mitigation in transport, research on the vulnerability of the sector on climate driven effects, namely extreme weather events, is coming up only recently. Little knowledge has so far been developed on the economic costs of climate and extreme weather driven damages to transport, and even less evidence is available on the options, costs and benefits of adaptation measures. Thus there is a need for European studies addressing local conditions.

In front of this background the WEATHER project aims at analysing the economic costs of more frequent and more extreme weather events on transport and on the wider economy and explores the benefits and costs of suitable adaptation and emergency management strategies for reducing them in the context of sustainable policy design. The research is carried out by an international team of eight European institutes. The project runs for 30 months from November 2009 until April 2012. The weather project is funded by the 7th RTD framework program of the European Commission and is supervised by the Directorate General for Research.

2 Presentations and Discussions

To date, two workshops have been carried out in the framework of the WEATHER project turning around the topic of transport sector vulnerability to climate and weather:

- Kick-off workshop 17.11.2009 in Brussels and
- Workshop 1, 14.9.2010 in Brussels

The following paragraphs provide a brief overview of the contents of the workshops. The respective presentations may be accessed through the weather website at www.weather-project.eu/weather/inhalte/proj-events.php.

2.1 The Insurance Sector

At the WEATHER kick-off workshop on November 17th 2009 in Karlsruhe, **Petra Löw** (Munich-RE) emphasized the climate change research for the insurance business. The NatCatSERVICE database contains roughly 26000 entries back to 1950 and covers overall and insured losses, but does not differentiate between sectors. The main driver for the strong increase of damages and victims reported are socio-economic factors rather than climate change. But the extraction of climate trends is enforced in co-operation with the London school of Economics. Main difficulties are encountered with national biases in data reporting and the long delays in data provision, which in some cases exceeds 10 years. Transport is generally encoded under the heading “marine business”; specific evaluations of transport losses in the heat summer 2003 lead to insured losses due to the interruption of transport activities of €40 million.

Petra Löw, Munich RE
Insurance sector outlook on expected development of climate related costs (1509 KB)

2.2 Road and urban public transport

Among the various climate conditions affecting the Swedish road sector, **Kenneth Natanaelsson** (Trafikverket) lists temperature, rainfall, wind, winter, fooding and sea level rise. But among these impacts related to water are the most costly. A detailed assessment of landslide activity raises major safety concerning in the southern Part of Sweden already in the near future. Major impacts of storm surges and intensive rain on small catchment areas on bridge will cause high costs. Improvement of competences and knowledge on vulnerabilities and the review of rules and regulations is the necessary way forward to prevent from major losses. Presented is the Swedish risk assess-

ment model including direct and indirect risk, such as the impact of delayed or cancelled trips on companies and their reputation).

Roberto Arditi (SINA on behalf of ASECAP, the Association of European Toll Motorway Operators) highlights the importance of roads to access emergency areas, commonly substituting other modes. Thus, the restoring of road sections may be very rapid, as in the case of the Autostrada Turin – Milan after the summer flood 2000 taking only 14 days. A means of increasing knowledge on infrastructure conditions and damages is the equipment of vehicles with LASER measurement technology for high-speed road observation and the instant generation of digital maps through point clouds. In snow conditions motorway capacity per lane may drop by 75%, entailing long-range traffic obstructions. Due to climate change the number of very hot days will increase with impacts on road construction practices and the termal expansion of bridge joints and pavements. On the other hand a decrease in very cold days may positively impact snow removal costs and the environmental impact from salt. But the main problems will be encountered with increased precipitation causing floodings, overload of drainage systems, wash-out. landslide affecting the structural integrity of roads, bridges and tunnels.

Matthew Webb (TfL) presented TfL's strategy for assessing and adapting to climate change. Climate conditions assumed until 2050 include temperatures rise by 3°C with -30% to -40% rainfalls in summer, +1.5 to -2.3°C and +25% to -30% rainfalls in winter, rising sea level and more extreme events. Most penalising events in the recent past were the summer heat 2003, 2007 rainfalls and the longest frost and snow periods in the two past winters (2009/2010 and 2010/2011. The list of risks of assets to climate change identified by TfL embraces tracks, drainages, bridges, embankments, signals, stations, green estate, surface and interchanges. Most important in the process of adapting to changing climate conditions is the internal and external communication, time table setting, emergency planning and the consideration of customer comfort. Existing activities by TfL include flood risk assessment, road drainage works, underground groundwater management and tunnel cooling. Early results from TfLs risk assessment report suggest that all weather risks, including heat, snow and ice, and high winds are manageable with some consideration in the rail sector. Concerning underground very hot days and rain and flooding are serious risks with a very high likelihood to occur in the future and a high impact level.

Kenneth Natanaelsson, Swedish Transport Administration
Impact on roads in Sweden (965 KB)

Roberto Arditi, ASECAP
Weather and consequent impact on main roads (5158 KB)

Matthew Webb, Transport for London
TfL – Managing Adaptation to Climate Change (1585 KB)

2.3 Rail and intermodal freight transport

In the second session on railway and intermodal transport at the September workshop **Chris Baker** (University of Birmingham) discussed findings of the FUTURENET project funded under UK's EPSRC "Adaptation and resilience to climate change" programme. The effects of high temperatures on track (buckling,etc), the effects of high rainfall on earthworks, the effects of extreme precipitation levels on current drainage systems, and the effects of extreme winds on the overhead system are the major effects that are likely to be of concern to the railway industry in future. Hot dry summers impact the UK rail system by increased track buckling, desiccation of track earthworks, increased ventilation problems on underground railway systems and increased vegetation because of longer growing season. Warmer, wetter winters cause increased surface water and flooding and increased frequency of landslips, scours and washouts. Related costs in the London underground system between 1999 and 2004 caused costs due to passenger delays of around €10 million. Increasing in the frequency of extreme storms including intense rainfall and extreme winds increase the likelihood of dewirement, of train overturning derailment and of accidents or network disruption and track blockage. The FUTURENET project looks at these impacts in detail and seeks to work out solutions to improve the resilience of UK transport systems to changing climatic conditions.

French experiences with the vulnerability of railway infrastructure was presented by **Samuel Brunet** (RFF). Problems encountered include increased rain- and snowfalls resulting in damage on earthworks and structures, more and more serious storms resulting in troubles in electric and signalling systems and causing in tree falling and catenary injuries. Humidity affecting tunnel and earthwork fragility, and flooding imposing additional risk on embankments, fundaments, seawalls and electric facilities and further consequences of changes in precipitation patterns. Termperature-related problems include heatwaves as well as general changes in temperature (rail dilatation, electric systems failures). Consequences include dryness with increased risks for structure fundaments on clay and nearby rivers. On the contrary, coldwaves cause rail contraction, problems with catenaries and ice in electric systems. A study assessing the three

main lines in the Aquitaine Arc (Bordeaux) should be finalised by the 2nd quarter of 2011 with similar studies to follow.

Turning towards combined road-rail freight transport, **Martin Burkardt** (UIRR) stresses the several problems railway operations encounter under adverse weather conditions. Weather extremes have effects on infrastructure (e.g. lines, overhead lines), on terminal operation (swinging loads), on rolling stock and on loading units due to falling trees/branches, inundation of rail tracks and routes. Because of storms accompanied with falling trees etc. there are delays or stops of operation. Transalpine Railways have to handle landslides, avalanches and storms. Due to weather extremes transalpine railways close tracks in winter. Example: in the year 2002 there were landslides on the route line Bellinzona - Luino - Gallarante (DE – CH – IT) – the landslides cause two closure of this route for several weeks. Afterwards to line Bellinzona – Luino – Gallarante was reconstructed with galleries and fixing slopes. The monetary impact of operational disruptions and infrastructure damages are widely unknown and should be approached by current research activities.

Chris Baker, University of Birmingham
Extreme weather, climate change and the railways (5403 KB)

Samuel Brunet, Réseau Ferré de France
Rail infrastructure answer to extreme weather event (641 KB)

Martin Burkhardt, International Union of combined Road-Rail transport companies (UIRR)
Vulnerability of Combined Transport and measures to reduce impacts (1330 KB)

2.4 Air transport

Henrik Littorini (Swedavia) highlights two reports dealing with the consequences of climate change for the Swedish air transport sector: “Vulnerability analysis report from the aviation sector” (LFV, Swedish Civil Aviation Authority, 2007) and “The Consequences of Climate Change and Extreme Weather Events” (Swedish Government Official Report, 2007). Among the several weather and climate impacts assessed by these reports, in the past decade storms during winter season are the main extreme weather events that has (during short periods of time) affected Swedish air traffic. The main problems of heavy snowfalls are visibility, friction and passenger access to the airports. While current measures include a over-dimensioning of snow clean-up and cooperation with road and rail authorities, climate forecasts indicate less snowfall for Scandinavia.

Flooding and sea level rise is only considered problematic for a few smaller airports with old or under-dimensioned storm water systems and drainages. in the coming 50 years adaptation costs of €20 million are estimated to cope with the projected increase in precipitation, but these will largely part of continuous renovation activities. Frost is the main determinant for the dimensioning of runway superstructures. As climate models indicate warmer winters there are not additional costs of climate change to be expected. The problem of ice is more differentiated: there will be more days calling for de-icing and skid prevention, but less in the southern part. The overall need for de-icing and skid reduction will thus decrease, associated with cost savings of €5 million annually in 2050. A major problem for aviation are thunderstorms causing cross-winds and the drop of power supply. The lack of alternative airports in easy reach, the non-availability of reserve power systems and the dependency on computer systems makes airports particularly vulnerable. Adaptation costs are probably high, while information of climate models on the development of thunderstorms is hardly available. Finally, ash is raised being a problem to different parts of aircraft, as the measurement of ash concentration is still not satisfying and due to lacking co-ordination in the European airspace.

The perspective of air traffic control was introduced by **Rachel Burbidge** and **Dennis Hart** (Eurocontrol) by stressing on the impacts of the past winter. Reported are drops of aircraft movements by 0.5% in Frankfurt and heavy delays, cancellations and flight re-routing in Paris. The seasonal difference in weather-related ATFM-delays are considerable: the shares at all AFTM delays have e.g. varied between 17.6% in December 2009 to 55.0% in January 2010, clearly indicating the winter storm Daisy over Europe. But ATFM delays are primary delays which are the result of an imbalance between demand and available capacity en-route or at airports and thus depend more on airport and en-route capacities than on weather. At annual primary departure delays roughly 4% are due to AFTM-related weather and another 6% are reported weather delays by the airlines. Total annual delay costs amounted to €1.5 billion in 2008. Future challenges of ATC are three times more traffic, safety and environmental improvements by 10% while cutting costs by 50%. This shall be reached by a co-operative trajectory management of flight paths. Therefore, MET services need to move from a problem-focussed view and the wait-and-see approach using information systems designed in the 1950s towards as system of “mapping uncertainty with a high level of confidence”. In this system weather delays will not be prevented, and thus become more predictable. Climate change was considered a problem for the first time in the Eurocontrol work “Challenges of Growth” 2008 by discussing sea level rise impacts for airports, increased storminess and climate-driven demand changes. In Europe 34 airports are at risk through sea level rise with impacts on runway capacity, ground transport access routes and global knock-on effects. A useful indicator for storminess is the Convective

Available Potential Energy (CAPE), indicating a strong increase (3 days / a) until 2020, but a potential fall under current conditions until 2050. For spring and autumn predictions show significantly increasing trends until 2020 as well as 2050.

Henrik Littorini, Swedavia
Vulnerability and adaptation at Swedish airports (146 KB)

Rachel Burbidge, Eurocontrol
Weather, Climate and Air Traffic Management (3388 KB)

2.5 Inland navigation and maritime shipping

Ina final session **Nina Nesterova** and **Jan Kiel** presented the study teams approach to address the economic costs of weather extremes for inland navigation and maritime shipping. The main treats identified for IWW are droughts, floods and ice periods, causing suspensions of navigation and imposing considerable costs to the future development of the sector. For maritime shipping the main stresses are heavy rain, storms, floods and ice periods. Infrastructure damage statements of the ports and insurance reports will most likely uncover considerable burdens.

Nina Nesterova, NEA
Inland waterways, Maritime transport (285 KB)

3 Follow-Up

The results of the workshop contribute to Deliverable 2 “Vulnerability of Transport Systems” to be issued in February 2011. This document attempts to quantify the impact which extreme weather events impose on the transport sector to date.

In the further coarse of the project these costs of weather extremes are utilised to benchmark emergency management and adaptation technologies and strategies in and around the transport sector. In each of these subsequent working steps similar workshops will be conducted. These are foreseen at:

- End of February 2011: Workshop 2 on Crises and Emergency Management with the respective project report being due end of March 2011, and
- Mid May 2011: Workshop 3 on adaptation measures feeding into Deliverable 4, due end of October 2011.

Information on further project deadlines and activities can be obtained via the WEATHER project website at www.weather-project.eu

Comments on the workshop and all project deliverables are welcomed. Please address either specific project partners or the project coordinator:

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Arditi, R. (2010): Weather and Consequent Impacts on Main Roads. What impact will climate change have on roads in Sweden and how to deal with it? Presentation at the WEATHER Workshop (Vulnerability Workshop), 14. September 2010, Brussels.

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Baker, C. (2010): Extreme weather, climate change and the railways. Presentation at the WEATHER Workshop (Vulnerability Workshop), 14. September 2010, Brussels.

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