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Working Party on Transport Trends and Economics

Group of Experts on Assessment of Climate Change Impacts and Adaptation for Inland Transport

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Item 3 of the provisional agenda
Climate change and transport assets data

Climate change impact analysis

Note by the secretariat

I. Background

1. The Group of Experts on Assessment of Climate Change Impacts and Adaptation for Inland Transport (GE.3) had agreed at its nineteenth session that in selection of the indices for analysing future climate impacts, it is important to consider indices which would be of interest to many transport infrastructure managers across ECE countries. At the same time, in the selection of the indices GE.3 should also be mindful of resource implication needed for the analysis.

2. At the same session, GE.3 had decided to construct a simple survey for consulting transport infrastructure managers on the relevance of specific impacts and climate indices as well as on relevant climate thresholds.

3. While the survey was able to confirm the interests of infrastructure managers in specific climate impacts (such as flooding, heatwaves, windstorms), information on thresholds was not fully obtained, perhaps due to regional differences. To that end, GE.3 at its twentieth session had requested a small group of volunteers from Canada, Germany, Climate Service Germany and University of Birmingham to collect more information on thresholds, possibly through interviews with interested survey respondents.

4. In course of its intersessional work and after having carried out a few interviews, the small group decided to do a desk-research in identifying the suitable thresholds.

5. This document was prepared to present the results of the desk research. It further contains a proposal for indices and thresholds for consideration by GE.3 for undertaking a useful analysis of future climate change impacts.

II. Results of desk research

6. The small group reviewed in particular two European Union funded projects:

- Extreme weather impacts on European networks of transport (EWENT) (Ewent Deliverables (vtt.fi)), and
- Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions (WEATHER) (WEATHER - Home (weather-project.eu))

7. The EWENT project – report D3.4 (Consequences of extreme weather) – discusses impacts of extreme weather events on transport with a focus on the weather phenomena and their thresholds which lead to those impacts for each mode of transport (cf. EWENT_D34_v12_20120209.pdf (vtt.fi).

8. The project in particular focused on the following phenomena for road and rail transport:

- high temperature
- snowfall
- heavy precipitation
- wind gusts
- low temperatures, and
- blizzard

9. It presents the impacts and lists related consequences linked with the phenomena exceeding specific threshold levels:

- for high temperature (daily maximum temperature): ≥ 25°C, ≥ 32°C and ≥ 43°C (included for road and rail)
- for heavy precipitation: ≥ 50mm/24h, ≥100mm/24h and ≥150mm/24h (included for road and rail)
- for low temperature (daily minimum temperature): ≤ 0°C, ≤ -7°C and ≤ -20°C (included for rail)
- for snowfall: ≥ 1cm/24h, ≥ 10cm/24h and ≥ 20cm/24h (included for rail)
- for wind gusts: ≥ 17m/s, ≥ 25m/s and ≥ 32m/s (included for rail)

10. Interestingly, the lower thresholds for high temperature and heavy precipitation suggest impacts which may disrupt operation but do not cause damages to road infrastructure, while for rail the lower thresholds may not only disrupt operation but also lead to infrastructure damage.

11. The EWENT project members obtained the consequences through the review of reported weather phenomena with the corresponding impacts on transport systems. More than 190 cases were reported and reviewed, of which 79 were associated with heavy rain, 59 with heavy snow, 81 with strong wind, 15 with low temperatures and 11 with high temperatures.

12. The analysis allowed the EWENT project members to establish a rough assessment on the probability with which negative impacts start to occur when the weather phenomena exceed the given thresholds, as below:

Phenomena	*Threshold 1 harmful impacts possible, 0.33*	*Threshold 2 harmful impacts likely, 0.66*	*Threshold 3 harmful impacts certain, 0.99*
Wind (gust speed)	≥17 m/s	≥25 m/s	≥32 m/s
Snowfall	≥1 cm/d	≥10 cm/d	≥20 cm/d
Rain	≥30 mm/d	≥100 mm/d	≥150 mm/d
Cold (mean temperature of the day)	<0°C	<-7°C	<-20°C

Phenomena	*Threshold 1 harmful impacts possible, 0.33*	*Threshold 2 harmful impacts likely, 0.66*	*Threshold 3 harmful impacts certain, 0.99*
Heat (mean temperature of the day)	≥+25° C	≥+32°C	≥+43°C
Blizzard	Blizzard is considered to occur when Threshold 1 values of Wind, Snowfall and Cold are realised simultaneously		

14. The WEATHER project refers to several thresholds that can be used for determining the impacts of extreme weather events on transport systems:

- heat: several days exceeding 35°C or single events exceeding 38°C
- low temperatures: several consecutive weeks remaining below -5°C
- rainfalls: single event with more than 200mm, or consecutive days exceeding 200 mm

III. Proposal for future climate change impact analysis

15. Mindful of the resource implication needed for the analysis, the small group proposes to focus specifically on analysis of impacts related to high-temperature and heavy precipitation, at the level of thresholds identified in the EWENT project (and listed above). It is historically well known that persistent heavy rains, river floods as well as flash floods can lead to immense damages to different transport sectors. Overall, floods amongst different weather-related disasters, generate some of the largest amounts of economic damages and fatalities.

16. Altogether, the frequency of extreme weather events such as river and coastal flooding and heat waves is likely to increase in most parts of Europe. Increased number of extremely hot days, high overall temperatures along with wind variability and low humidity will surely cause a rise in the number of fires. This includes particularly wildfires and forest fires. Presently, in Europe, river floods and windstorms appear to be the most damaging climate-related hazards. However, this scenario is projected to change in the upcoming years. By the end of the century, heat waves and droughts will likely account for 90% of the climate hazard damage[1]. Even though the exposure will be rather country specific, such events are expected to have an impact on all regions. The occurrence of events, such as floods and heatwaves, poses risks to transport infrastructures as well as operations, thus impacting the entire transportation sector in the economy.

17. To this end, the small group proposes to simulate future changes for the following climate indices by using the methods applied in https://unece.org/sites/default/files/2021-01/ECE-TRANS-283e_web.pdf:

18. For high temperatures:

- Annual count of days when daily maximum temperature is greater than 25°C
- Annual count of days when daily maximum temperature is greater than 32°C
- Annual count of days when daily maximum temperature is greater than 43°C

19. For heavy precipitation:

- Annual count of days with daily precipitation greater than 50 mm,
- Annual count of days with daily precipitation greater than 100 mm,
- Annual count of days with daily precipitation greater than 150 mm

and

[1] www.sciencedirect.com/science/article/pii/S0959378017304077

- Annual count of days with 3-day precipitation greater than 100 mm
- Annual count of days with 3-day precipitation greater than 150 mm

20. The future report could then analyse the simulated changes in the context of information on current incidents causing disruption to transport services which the Group of Experts is exploring to collect.

21. In addition, the small group also recognizes that there is a lot of interest from transport professionals in impacts on transport operations from windstorms. This is due to the fact that the stability of commercial vehicles to crosswind forces is a complex and challenging problem. For example, the high-speed rail industry, which is a growing sector in terms of passenger numbers, train speeds and the number of railway lines across Europe can be vulnerable to crosswinds. With clear indication that optimisation of commercial rail vehicles involves designing high-speed trains to be as long and light-weight as possible, and given that aerodynamic loads, caused mainly by high wind speeds have huge impact on train stability, it is important to assess and project the wind conditions in which railways are expected to operate in the future.

Box – windstorms and high-speed railway

The effects of external aerodynamics on high-speed trains are usually pronounced under the interaction of strong crosswinds, creating a complex flow field around a train, leading to a series of steady and unsteady aerodynamic forces and moments. Such aerodynamic loads may induce significant changes in the vehicle dynamic behaviour, when compared to a no-crosswind condition. The weight of the train is an important factor which counteracts the aerodynamic overturning forces. Therefore, an obvious deterioration in the running performance of a train in terms of safety can be anticipated under high aerodynamic loads, caused mainly by high wind speeds. Consequently, it has been suggested that high-speed trains are potentially at a risk of derailing or overturning due to the impact of strong crosswinds. This statement has also been supported by several researchers who suggested that design factors on the new generation of trains may lead to a huge impact on train stability, especially in light of the fact that drag, and aerodynamic effects increase significantly with the square of speed.

22. Overall, road and railway are the two major modes of transport that seem to be affected by high winds. Not only do high winds have an impact on vehicles, they can also lead to branches or even fallen trees appearing on the road and railway tracks. Since passenger safety cannot be compromised on, it is suggested that the feasibility of analysing projected changes will be investigated. This shall be helpful in identifying wind speeds beyond which road and rail vehicles may engage in accidents (such as derailment or overturning). Thereafter, if necessary, proposals could be made on implementing safety measures, such as speed control or adjustments to the surrounding infrastructures, to improve the safety and the stability of high-speed trains as well as road vehicles.