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**Climate Change and Transport:**
**Group of Experts on Climate Change Impacts and Adaptation for Transport Networks and Nodes**

# Chapter 4 "Lessons learned and recommendations"

### Note by the Secretariat

## I. Introduction

1. The Group of Experts on Climate Change Impacts and Adaptation for Transport Networks and Nodes (hereafter called the Group of Experts) was able to learn valuable lessons in course of its work, which was aimed at the identification of main inland transport infrastructure assets in the United Nations Economic Commission for Europe (ECE) region that might be potentially impacted by the changing climate. Section I of this document presents these lessons learned.

2. Based on the lessons learned, the Group of Experts has formulated a number of recommendations as provided in section II of this document. These recommendations should presumably serve as a basis for continuation and advancing the ECE work on adaptation of inland transport infrastructure to climate change in an effective way.

## II. Section I – Lessons learned

3. The following are lessons learned by the Group of Experts from the implementation of its 2015–2019 mandate:

(a) The identification of inland transport asset inventories at risk to climate change is a complex and long-term endeavour, in which the consideration of accurate transport infrastructure data with relevant – at appropriate spatial resolution – climatic projections is just a first step, yet a challenging one.

(b) While more climate resilient transportation systems are important for many reasons (e.g. social, economic, safety, cultural), the limited responses to the questionnaire suggest that many countries do have suitable information for analysing climate change impacts that have affected or would be expected to affect their transport infrastructure. It appears that countries have only quite recently started building capacities on transportation adaptation, while the major focus of climate change efforts is generally given to climate change mitigation. The case studies provided in Part II of this report show a growing capacity and expertise in some countries in the analysis of climate risks and impacts for the transportation systems. Discussing and sharing this expertise can help raise awareness of potential approaches or solutions among climate change transportation practitioners across the ECE region.

(c) Data limitations can preclude the consideration of climate risks to transportation. For example, data sets on inland transport infrastructure and its usage (for example, traffic volumes, freight processed) are not widely available across the ECE countries. This may be due to lack of collection and processing of such data, or a lack of publication or sharing. The availability of such information in a uniform and readily accessible way would allow for a more comprehensive analysis of network criticality, which is an important condition for prioritizing adaptation needs.

(d) Harmonized climatic data do not exist for the entire ECE region at the spatial resolution finer than 200km. Different approaches to downscaling climate data were used in this report. While this does not present a problem for analyses in climate changes separately for Europe and Canada as done in this report, the results of the analyses are not directly comparable.

(e) Analyses undertaken on six climate indices for the European part of the ECE region and three indices for Canada as proxies for assessing changes in the potential impacts of climate change and extreme events on inland transport infrastructure are a good starting point towards raising awareness of possible future climatic impacts on inland transport assets and operations in the ECE region. It should encourage interest and commitment for more comprehensive and complete analysis covering the entire region and covering more specific indices as well as explicit impact modelling where possible. Ideally, such analysis should benefit from a data set produced with a consistent methodology.

(f) The analyses enabled a preliminary identification of potential areas that may be affected in the future by highest absolute increases in events as assessed with the proxy indices. Matching these changes with the infrastructure data gave a first indication on the sections of networks and nodes that are located in areas exposed to highest absolute changes and which may be exposed to increased risks in the future. At the same time, analysis of changes in relative terms could also provide interesting results in terms of projected changes and needs for adaptation measures. A combination of analysis in absolute and relative terms could be envisaged in the future.

(g) This first step analyses, however, are insufficient to understand whether a specific node or section of network may be affected from slow onset climate changes and/or extreme events, and what disruptive impacts such changes and events could have. Complementary analyses are needed, as a second step. These include, for example, assessing natural and anthropogenic factors (like underlying geomorphology, geology and land use) and an evaluation of individual characteristics of a specific transport asset (like its age, conditions and quality and its specific structures and their corresponding thresholds to extreme weather events). They may include further downscaling of projections, impact modelling and assessment of cause-effect relationships between climate parameters and impacts on the transport assets and operations, including socio-economic objectives. They should also include intermodal dependencies and may include cross-sectoral dependencies. Such complex analyses were not in scope of the 2015–2019 mandate of the Group of Experts but would be worth pursuing in the future.

(h) There is more than one way to assess climate change impacts and related risk to the transportation systems. Several of them have been introduced by the case studies in Chapter 1 of Part II. Although there are slight differences in the approaches, terminology and level of detail, and thus the required input data, there are a lot of similarities with respect to the final result of such analyses that help in identifying and prioritizing adaptation needs. Sharing the existing national approaches and methodologies may support others in identifying and pursuing approaches to assess and address climate change risks.

(i) It became clear during the process of this work that assessment of impacts on transport assets and operations from climate change and identification of suitable adaptation measures should also consider intermodal and cross-sectoral interactions, for the latter, for example with the energy and water sectors. Such considerations are important in order to avoid maladaptation. In addition to cross-sectoral interactions, it is also important to consider transboundary climate impacts and adaptation measures. Efforts such as this may be worth pursuing in the future.

# III. Section II – Recommendations

4. The Group of Experts, drawing from the lessons learned in the process of the implementation of the 2015–2019 mandate, recommends the following:

(a) The results achieved within the 2015–2019 mandate of the Group of Experts should be widely disseminated to create awareness and understanding of the urgency of work in analysing the impacts from climate change on inland transport infrastructure and operations and in identifying adaptation measures, as well as to obtain support for such work at all levels.

(b) Decision-makers and transport experts, from both the public and private sectors should be made aware of approaches, tools and methodologies which exist or can be developed to analyse the risks that climate change poses to inland transportation infrastructure and operations. To this end, specific awareness-raising material based on the Group of Experts' report should be prepared for publication in various sectoral media and for presentation at climate change adaptation fora and conferences.

(c) Public administration should consider making available geographical data for inland transport networks and nodes, at least for infrastructure of international importance. The ECE Working Parties responsible for administering the infrastructure agreements such as AGR[1], AGC[2], AGN[3] and AGTC[4] should ensure that the E Roads, E Rail and E Waterways networks as well as rail-road terminals are made available as geographical data showing the specific passage and location of the networks and nodes in GIS environment. To this end, it is recommended that each contracting party to the infrastructure agreements provides or confirms the geographical data for the E infrastructure networks and nodes on their territories with the ECE secretariat. Other ECE member States are encouraged to also provide geographical data for their main networks. The ECE secretariat should manage the ECE GIS for the infrastructure agreements.

(d) ECE member States should also consider establishing, if not done so yet, their infrastructure, including local networks, in GIS. The ECE secretariat should explore modalities for offering a possibility to ECE member States to use the ECE GIS when they do not have capacities to establish their own GIS.

(e) ECE member States should be urged to participate in transport censuses conducted periodically by ECE under the auspices of the Working Party on Transport Statistics. In this way, data on volumes of traffic for international road, rail and waterways networks are collected, processed and shared by ECE. Availability of such data is important to the analysis of network and node criticality, which in turn is important to the prioritization of adaptation needs. Mechanisms for an automatic harvest of data such as on traffic volumes published electronically by relevant national agencies should be explored by ECE secretariat with ECE member States.

(f) Effort should be devoted to obtaining a consistent climate projections data set for the entire ECE region. There will be possibilities for obtaining such data, for example, from the Cordex-Core project.

[1] European Agreement on Main International Traffic Arteries
[2] European Agreement on Main International Railway Lines
[3] European Agreement on Main Inland Waterways of International Importance
[4] European Agreement on Important International Combined Transport Lines and Related Installations

(g) Analysis of the six selected indices should be done for the entire ECE region. The analysis should be done in absolute and relative terms, be expanded to additional indices, as appropriate, so that more knowledge on impacts from a changing climate and extreme events on inland transport infrastructure can be established and made available to countries through ECE GIS. Also, as a next step, the overlay of the climate indices with the main transportation networks and nodes (including, where possible, ports and airports), should be expanded across the ECE region. This would enable broader analysis and supplement the transportation adaptation experiences and expertise of the Group of Experts during its 2015-2019 mandate.

(h) Countries should consider, using the efforts presented by the Group of Experts within this report, the advancement of further projects that seek to more fully understand vulnerability to climate change and extreme weather across their inland transportation systems. This could include, for example, analysis on the impacts from the projected changes taking into account the natural and anthropogenic factors modifying the risks to specific transport asset, assessment of the asset's characteristic, assessment of supply chains or intermodal shift, and possibly analysis on cross-sectoral interdependencies as well as bringing in relevant stakeholders and data into the process as required. Additionally, such projects should look to identify potential adaptation solutions for implementation, including through cross-sectoral analysis. The identification of adaptation measures could also benefit from exploration of potential synergies with mitigation measures.

(i) Countries with developed expertise should seek to share their knowledge and lessons learned gained from national or sub-national projects, programmes and initiatives with their international colleagues, to help build the information, knowledge and capacity across the ECE region and beyond to undertake climate change risk assessment and adaptation work relevant to the transportation system. They should share the knowledge from projects at all scales and involving all stakeholders. The case studies included in Part II of this report present one way that practitioners, in addition to those beginning to take steps towards strengthened climate resilience, can learn from each other's experiences.

(j) Countries with little experience in climate change adaptation work and those who have not yet engaged in the work of the Group of Experts should consider the notable opportunities presented by participation in such work, in particular from the valuable peer-to-peer exchanges and information sharing. They may consider to engage in such work in the future. They may also consider to develop, where possible with international assistance, national projects during which data could be analysed to better understand future impacts from climate change on their inland transportation system.

(k) The national projects should allow establishment of a knowledge database from the second-step analysis containing information on: (i) features and conditions that make a section of a network or a node in a higher risk area a "hotspot" due to that risk, and (ii) adaptation measures proposed and their cost-effectiveness to limit identified risks. The knowledge database could further include indicators for monitoring and evaluating adaptation measures. It could also include, if such information can be collected from the national projects, information on adaptation-mitigation convergent measures.

(l) The national projects should also contribute to elaboration of guidance and/or mechanisms for better integration of climate change impacts and projections into planning and operational processes. Effort should be made to develop such guidance and mechanisms and share among respective administrations.

5. Much advancement in climate change impact analysis on transport networks and nodes is still necessary. The Group of Experts, re-established under a new mandate and supported by the ECE secretariat in collaboration with WMO and other partners, would be well-placed to assist in such an advancement. In view of the recommended future actions, it would be sensible that a five-year workplan is considered.

6. Funding should be explored in support of the future activities. Countries from outside of the ECE region should be encouraged to participate in the future activities, both to contribute to these activities, and to learn from them.