Economic and Social Council

Distr.: General
15 July 2020

Original: English

Economic Commission for Europe

Inland Transport Committee

Working Party on Transport Trends and Economics

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

Nineteenth session
Geneva, 1 and 2 October 2020
Item 3 of the provisional agenda
Initiatives in climate change impact assessment and adaptation for inland transport

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Note by the secretariat

I. Background

1. The work on climate change impact assessment and adaptation for inland transport is evolving. This document, prepared by the secretariat in collaboration with Mr. Adonis Velegrakis (University of the Aegean, Greece), refers initiatives which the Group of Experts may consider and integrate in its work.

II. Introduction

2. There are different approaches to risk assessment and adaptation of transport infrastructure under Climate Variability and Change (CV&C) depending on the type of hazard: (a) episodic hazards due to extreme events, such as pluvial and fluvial flooding and extreme heat waves; and (b) slow-onset hazards, such as the effects of permafrost thawing that can create major challenges for the development and maintenance of transport infrastructure in large areas of the United Nations Economic Commission for Europe (ECE) region (ECE, 2013; ECE, 2020). This hazard diversity requires various sets of technological considerations and responses. Episodic hazards require risk reduction solutions including facility/network protection works, whereas slow-onset hazards need long-term risk retention and resilience building, which also require effective regulatory responses such as regional and national adaptation plans and planning policies.

3. Efficient adaptation and resilience building depend on the CV&C risk assessments. These are determined by the spatio-temporal scales and resolution as well as the available information (e.g. ECE, 2020). Large scale assessments, such as those involving the whole, or large swathes, of the ECE region, can inform regional and/or multi-national adaptation

policies, whereas those at the national scale can assist national adaptation policies and improve the allocation of the available human and economic resources. Finally, assessments at the local (facility) level are prerequisites for on-the-ground decision making and the design of effective adaptation measures.

4. Risk assessments of transport infrastructure/operations consist of different constituent assessments: (a) assessments of the climatic hazards induced by the changing climatic factors; (b) assessments of the exposure of the transport infrastructure/operations present in the hazard zones, which obviously requires reasonably accurate information on the location of transportation assets and networks; and (c) assessments of the vulnerabilities that make such transportation assets/systems prone to damages/losses from climate hazards, which, in turn, are controlled by the availability of technologies and materials for the construction and maintenance of technical measures, the human and financial resources and the effectiveness of governance.

5. In recent years, various approaches to risk assessments have appeared, which are based on significant developments in relevant observation technologies and tools (Yamazaki et al., 2017; Koks et al., 2019), and improved, integrated models to project future hazards and risks (ECE, 2020). On the basis of such risk assessments, the probability of a damaging climatic event and the severity of its impacts can be determined. The urgency of the adaptation responses could be then defined as e.g. the ratio between the time needed to plan/implement effective responses over the time available (Lenton et al., 2019).

6. Climate change adaptation of transport infrastructure may involve the construction of new resilient infrastructure as well as measures to enhance the resilience of existing infrastructure. Challenges include, among others: (a) lack of awareness of climate change impacts as well as of localized climate information; (b) mismatches between the time-frames for facility planning, the infrastructure lifetimes and the climatic factor/hazard projections and their inherent uncertainties; (c) lack of adequate funding; (d) inadequate regulation with competing priorities; (e) constraints relating to relevant R&D; and (f) lack of technical expertise and human capacity (UNCTAD, 2020).

7. There cannot be a single approach to the planning of CV&C adaptation for transport infrastructure due to its diverse and complex nature. A variety of tools and approaches are already being employed, including the widespread use of engineering/technological options. There is also an increasing need for socio-economic, institutional and ecosystem-based adaptation mechanisms as well as regulatory approaches and standards and guidance.

8. Climate change risk assessments at the regional (ECE) scale are a prerequisite for raising awareness of the potentially devastating impacts and encourage commitment to more comprehensive studies at the national and local level to identify needs and build strategies for adaptation and disaster risk mitigation for (inland) transportation. Specifically for pluvial (surface) and fluvial (riverine) flooding, such assessments should include: (a) the technical characteristics of hazards (i.e. location, severity, frequency and likelihood of occurrence); (b) the exposure of infrastructure and operations to those hazards; and (c) the susceptibility of transportation assets/operations to hazard (vulnerability). The analysis of exposure and vulnerability should include physical, socio-economic health/safety and environmental dimensions as well as evaluations of the effectiveness of prevailing and alternative coping capacities in respect to different scenarios. Technologies for risk assessment include a variety of methods and tools, such as hardware (e.g. to monitor and estimate hazards, exposure, and vulnerability), software (e.g. knowledge and skills for technologies) and ’orgware’ including policies, institutional settings, regulation and governance structures at different levels.

9. On the basis of the above, the work of the new Group of Experts is to be guided by its Terms of Reference as contained in ECE/TRANS/2020/6, and the Group is expected to deliver on tasks (a) through (k), the last one being the preparation of its final report. At the same time, the detail of this work will be resource dependent, as it requires utilisation of new information and tools as well as substantial human resources.

III. Recent technologies for the assessment of CV&C risk assessments for inland transportation

10. In previous ECE Expert Group work (UNECE, 2013 and 2015; ECE, 2020), the major climatic factors/hazards that can pose risks for inland transportation have been detailed and analysed. These include pluvial and fluvial flooding, mean and (particularly) extreme temperature increases, extreme wind changes and, for coastal assets, mean and extreme sea level and wave changes. In the latest report (ECE, 2020), several indices have been selected and used to assess CV&C impacts on inland transportation. For the commencing Expert Group, these indices will be updated and new indices will be included (please see ECE/TRANS/WP.5/GE.3/2020/3). In addition, a more complete report based on new data sets and tools can be undertaken to assess the impacts of the flooding hazard (e.g. Alfieri et al., 2017; Alfieri et al., 2018). In this case, more complete infrastructure data sets could be collated/recorded and used in the report in order to assess CV&C impacts on inland transport infrastructure in more detail.

IV. Infrastructure mapping

11. In addition to the road and railway infrastructure information collated/held by ECE (e.g. ECE, 2020), additional (open access) data for roads, railways, bridges can be found in the OSM[1] data base (www.openstreetmap.org/#map=8/46.825/8.224, www.openrailwaymap.org/); the accuracy of this information has steadily increased in recent years (Barrington-Leigh and Millard-Ball, 2017; Meijer et al., 2018, Koks et al, 2019). Therefore, and depending on the available resources, collation, classification (in classes of different importance) and storing in an accessible and upgradeable GIS format within ECE will be of key importance to more accurate risk assessments; this data base could be a major contribution of the commencing Expert Group. Inland waterway ports, which have been already mapped by JRC[2] (Seville) and other organizations, can be also collated and included in the data base.

V. Flood hazard

12. There have been recent modelling efforts to assess fluvial flooding (by river bank overtopping) and pluvial flooding (caused by extreme rainfalls). The global pluvial and fluvial flood hazard dataset (Sampson et al., 2015), contains a gridded dataset (with a 3-arcsecond (c. 90 m) resolution) on the distribution of maximum projected water depth (in m) as well as hazard maps for 10 return periods (1 in 5 years to 1 in a 1000 years recurrence). This data set has a global coverage for the areas between 56°S and 60°N and, thus, includes a very substantial part of the ECE region. This information together with the infrastructure spatial information (see above) and flood design standards (e.g. Scussolini et al., 2016) could be used in the flood risk assessments. Finally, Estimations of related infrastructure damages could use publicly available information (e.g. World Bank, 2018; Koks et al., 2019).

VI. Other hazards

13. As mentioned above, ECE (2020) have provided regional CV&C impact projections for some of the climatic factors (e.g. temperature, precipitation/droughts) on the basis of the CORDEX projections (euro-cordex.net/). It is proposed that in the new work this effort should continue/updated on the basis of ever evolving projections and climatic scenaria (please see ECE/TRANS/WP.5/GE.3/2020/2).

[1] OpenStreetMap

[2] Joint Research Centre

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