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Working Party on Rail Transport

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Activities of the Inland Transport Committee and its Subsidiary Bodies

The impact of climate change on the railways: how to protect, adapt and mitigate

Note by the secretariat

Workshop Summary

I. Introduction

1. Acknowledging the great impact that climate change and related issues are having on railway transport, during the second day of the 76th Working Party on Rail Transport, the Workshop on "The impact of climate change on the railways: how to protect, adapt and mitigate" took place.

2. The Working Party welcomed the interventions and discussions that emerged during the Workshop and requested that the secretariat prepare the following summary document to further discuss the issue during the next sessions. A list of issues emerging from presentations and discussions enriched with examples has been provided.

3. About 130 participants attended the discussion and 11 presentations have been delivered by speakers from national and international institutions and railways.

4. The following speakers attended the Workshop:

- Mr. Matthew Krech, Transport Canada, Canada
- Ms. Eneida Elezi, Albanian Railways, Albania
- Ms. Nutsa Kiknadze, Georgian Railways, Georgia
- Mr. Justus Hartkamp, ProRail, Netherlands
- Mr. Andrey Lisitcyn & Mr. Grigoriy Kozyr, JSC Russian Railways, Russian Federation
- Mr. Ahmed Derya, Turkish State Railways, Türkiye

- Ms. Lisa Constable, Network Rail, United Kingdom
- Mr. Cheulkyu Lee, Korea Railroad Research Institute, Korea
- Mr. Carlo Borghini, Europe's Rail Joint Undertaking
- Mr. Marnix Van Der Heijde, European Union Agency for Railways
- Mr. Dániel Rapp, Ministry of Technology and Industry (Hungary), Hungary.

II. Climate change and emerging problems for Railway

5. The presentations offered the opportunity to analyse in the deep the problems related to climate change which are severely affecting the normal working of the railways. In fact, exceptional weather phenomena, which are becoming more frequent due to climate change, could cause disruptions and malfunctioning of the railway infrastructure system and ultimately influence railway transport services.

6. Presenters from Transport Canada and Georgian Railways highlighted the importance of climate change problems in countries with particular geographic and morphological characteristics, where extreme weather events could be intensified creating even bigger damages and more frequent disruptions.

7. As discussed by the speaker from ProRail, weather events account for just a minor part of the disruptive events which affect railways, nonetheless having a great impact; therefore, these problems could become difficult to manage in the next years when the number of extreme weather events is expected to grow.

8. Weather events linked to climate change will also have an intense economic impact: Network Rail reported that the full cost per year emerging in the United Kingdom's railway system due to weather events is estimated between 200 and 300 million pounds. Moreover, a drop in performance between 2% and 4% has been registered on adverse weather days, proving the importance of this issue.

9. The economic impact of weather events is clearly understandable considering two major events occurred in 2021 in Canada: in July, due to wildfires in Lytton, Class I railway's main lines leading to the port of Vancouver have been blocked causing a reduction of the railway's capacity of up to 50%; in November, flooding in British Colombia generated long lasting disruptions to railway services. Both affected the railway work, creating lines congestion particularly in Vancouver Port, and the Canadian economy, experienced losses in GDP, due to decreases in imports and exports.

10. Similar situations occurred also in other countries: in 2015, 2019 and 2020 flooding caused long lasting line closures in the Conwy Valley (Wales, UK). In 2022 the effects of a mudslide on a section of Hungarian railway line no.70 caused restoration costs of approximately 2.5 million euro. In Summer 2022 extreme rain caused rail transport interruptions in South Korea and some metro train stations have been waterlogged.

III. Monitoring, Adaptation, and mitigation strategies

11. Considering the great impact of weather events, which are becoming even more frequent, developing strategies to avoid or limit and manage the problems caused by weather events is highly recommended. In fact, an integrated and developed system could help to prevent damages to the infrastructure and, ultimately, disruptions in railway transport.

12. The speakers shared information about the projects which have been developed by their railways and institutions to mitigate and prevent these problems or to adapt to them. A

common framework is identifiable in the strategies elaborated; the different phases are explained in the following and for each of them a set of examples is provided.

1. Infrastructure analysis and risk assessment

13. In the first stage, an analysis of the rail infrastructure and of the previous weather events is performed identifying the strengths and weaknesses. The different criticalities which are present on the territory are evaluated thanks to a risk assessment, which can provide important information on the future threats connected to climate change and key data for deeper analysis.

14. The analysis should be performed in view of the needs of the rail operators and of the future actions that could be carried out. In fact, in South Korea, an integrated path has been developed: before implementing "adaptation actions" an analysis and a risk assessment should be performed. The analysis focuses on the current status of the infrastructure, particularly on the risk management system, and on data to improve the knowledge and comprehension of the climate phenomena affecting the country. Then, thanks to the analysis, different climate change scenarios and an impact assessment for each category of railway infrastructure and weather events are developed.

15. The analysis could deliver information about every section of the infrastructure, focusing on the different risks. Areas with higher risks are listed by Georgian Railways, and a "unique card" describing the causes of the risks, such as flood hazards, is prepared for each of them. Creating instruments such as the "unique cars" could be very useful in having an overview of the whole infrastructural system and could be used to replicate effective strategies in different sections with similar problems.

16. Deeper analysis concerning problems with a greater impact and/or priority could be developed. As an example, an analysis of the conditions of the existing watersheds and culverts has been performed by Turkish State Railways. Developing the analysis, the Turkish territory has been divided into 7 different regions and a priority level has been assigned to each according to previous incidents. Then, thanks to hydrology studies, culvert design flows have been calculated to verify adequacy.

17. Analysis could also be performed to avoid future problems in developing new projects. In fact, ProRail in the Netherlands developed "Scorecard Climate- adaptation ProRail projects" comprising several maps helping to determine the expected climate risks for the new projects. Moreover, a simulated stress test on railway lines has been performed showing the current sections' capacity in operating despite weather effects.

2. Infrastructure's risks monitoring

18. Thanks to the previous analysis, the infrastructure sections showing higher risks are identified. For each, a monitoring system could be set up to provide real time information and, thus, help to prevent incidents and make possible prompt restoration interventions if necessary. In the presentations, a set of possible technological solutions have been provided, some of the most innovative and/or effective ones are listed below.

19. Transport Canada is testing various innovative technological instruments to control its infrastructure status and possible risks. To monitor landslides, which are expected to occur more frequently due to increasing precipitations, the usage of the satellite InSAR platform has proven to be effective with cm-scale precision, however, the quality of data could be affected by weather conditions. The emerging data are compared with others from UAV photogrammetry and ground-based RTK-GNSS measurements. For the water levels, a system combining UAV and Lidar technologies and instrumented hi-rail is used to detect information with different spatial and temporal resolutions. Studies to identify the best technologies investigating tie plate icing have been conducted, such as ultrasonic testing.

20. For monitoring purposes, a well-developed system could be effective even when using simple technologies. In Türkiye, TCDD Maintenance Tracking Center is using water level detectors and water detecting sensors to monitor culverts and bridges, this system has proven to be cheap and effective. In South Korea, the Rail Infrastructure manager is using rail temperature sensors to avoid damages due to the extreme heat days which are expected to become more frequent.

3. Renovating railway infrastructure

21. When identified by the analysis and/or the monitoring systems, preventive renovation and maintenance of the rail infrastructure could be necessary to avoid or at least limit high risks of disruptions. Even if they are expensive in the short time, these measures could lead to money savings in the future.

22. A great effort in renovating railway lines is carried out by Georgian Railways: the largest infrastructural project of the last decades is being developed in the country, this will have positive effects both on railway operations and safety.

23. Carrying out renovations of the infrastructure, a long-term approach is recommended, as done by NetworkRail which set an important goal of "preparing the infrastructure to minimise the impacts of climate change by 2050". This means renovating the infrastructure to prepare it to face future weather conditions through investments that could make the railway infrastructure more resilient. Climate resilience is pursued through all the asset management and engineering process and integrated by standards and guidance. An example of a good renovation strategy is identifiable in repairing and resilience investments in Conwy Valley where the expenditure to protect tracks from flood helped in avoiding economic losses and has already paid for itself in less than 2 years avoiding new infrastructural damages.

24. As for the analysis, the renovating projects could be related to specific issues. Turkish State Railways are focusing on problems related to water flows, thanks to the data collected through the analysis and the monitoring system, watershed regulations, increases in the hydraulic capability of the structures and renovation and/or rebuilding have been planned and some of them have been already carried out.

25. A wider approach could also be followed: Korean infrastructure manager is working on different problems to prevent damages from weather events: developing higher safety standards to prevent abnormal lighting while increasing the electrified lines' share, working to limit damages emerging from the precipitations, and investing to renew unsafe sections of the infrastructure.

4. Emergency plan and maintenance staff

26. An emergency plan should be elaborated, even for extreme situations, indicating how to manage the emerging problems, and limiting the inconvenience, especially for passengers. A coordinated organization, including staff trained to deal with emergencies and proper instruments, should be set up to manage future difficulties.

27. A good example has been analyzed by the delegate of the European Union Agency for Railways, who reported about the Dutch approach operating since 2010: in the Netherlands, every train can be evacuated within 2 hours and complimentary services. This example has already served as a starting point for future improvements: in fact, inspired by the Dutch practice, Regulation (EG) 1371/2007 on rail passengers' rights and obligations, Article 18 has been introduced, setting a list of rules that should be followed by EU's rail operators in case of more than 60 minutes delays.

28. In most countries, the maintenance staff is trained to face inconveniences emerging from climate change related issues in the shortest possible time, the monitoring systems and

other sources of information are crucial in improving the performances and allowing prompt interventions.

29. An appropriate maintenance staff could have an important role in preventing future difficulties and disruptions. Georgian Railways train special staff to maintain the railway sections as outlined in the "unique cards", avoiding damages to the tracks. The Operational weather management of NetworkRail can deal with weather events, including extreme ones, and minimize the problems emerging from seasonal bumps.

30. It should be considered that weather events could cause problems to the infrastructure but also the organizational system: ProRail is preparing maintenance teams for emergency repairs and is working on making possible timetable adjustments due to weather events.

IV. Contributing to slow climate change

31. The speakers cited frequently the major role that should be played by railway transport in reducing carbon dioxide emissions as defined in international agreements. In fact, a Rebel Group study cited in ProRail's presentation evaluated that a reduction in CO2 emissions between 2 to 8 million is possible by shifting from air transport to rail transport for certain European routes. Thus, some examples of best practices have been given and described below.

32. Acknowledging the importance of working to reduce carbon emissions, Albanian Railways, are projecting to improve the electrification of the country's railway system and expanding rail infrastructure, creating a sustainable alternative to private vehicle transport.

33. In Georgia, the renovation project will lead to a 98% share of railway lines electrified in the country, assuring a decrease in the current emissions levels. The redaction of GHG emissions reports is a crucial part of understanding the rails system's sustainable performance.

34. ProRail is focusing on offering sustainable solutions throughout the process: the shift to rail transport from other ways is strongly supported and it made even more sustainable considering that renewable energy sources have been installed to generate clean energy for railway transport. The materials, such as old tracks, are reused allowing for a decrease in wastes and costs. Even if not related to climate change, building ecoduct bridges used by wildlife to cross railway lines is increasing the sustainability of railway transport in the country.

35. Russian Railways has developed an environmental strategy that is aiming to reduce GHG emissions to make rail transport more sustainable in the country. To achieve this goal a wide range of initiatives have been put in place: monitoring, reporting and control systems have been developed, these will give information on the improvements and help to foster the project's development; major investments have been made to buy railway vehicles with a lower carbon footprint thanks to innovative power supply systems and to generate clean renewable energy for the electric ones. The sustainable strategy is being developed also in many other different fields, such as creating "green" container terminals and cooperating with research institutions.

36. Reducing emissions and life cycle costs and improving energy efficiency are key goals for Europe's Rail which aims to create a resilient and sustainable railway system.

37. During the presentations, other themes such as how to make rail transport more comfortable and reliable emerged. These could make the shift to railway transport easier, allowing for a faster path to GHG emissions in railway transport.

V. Cooperating with other entities

38. Strong cooperation and dialogue with different stakeholders have been indicated as key tools to find new solutions and/or improve the existing ones for the problems related to climate change which are increasingly affecting rail transport.

39. Railway operators could operate with various stakeholders aiming to achieve different goals. Monitoring culverts and watersheds, Turkey State Railways are working in connection with the Turkish State Meteorological Service, while Russian Railways are working with Russian federal executive authorities and research institutes to supervise and foster progress in carbon footprint reduction.

40. Specific projects and programs could be developed to create a structured cooperation system. In Canada, Railway Ground Hazard Research Program (RGHRP) and Rail Research Advisory Board (RRAB) are the most important two, these fora help in connecting rail operators with industry, government, and the academic world.

41. The effort of organisations such as Europe's Rail, which is trying to foster cooperation between European Union's countries in order to create a sustainable and integrated network, is fundamental in helping national railways and governments to pursue their objectives.

VI. Ending notes

42. The secretariat concluded the Workshop by summarizing what was previously presented and discussed, noting that the Member States and other delegates agreed on the importance of this Workshop in discussing important issues and offering different perspectives on a common problem

43. During the Workshop, different themes have been analysed and discussed: an overview of the different problems emerging due to climate change, with some significant examples has been provided and some of the strategies implemented to avoid the cited problems have been discussed. The great importance of rail in slowing climate change through carbon emissions reduction and the need to cooperate with different stakeholders have been also noted.

44. Future discussions and presentations could be useful in explaining the possible evolutions of the current strategies, analysing the results of already implemented projects and noting other countries that have developed their own to address problems related to climate change. In fact, adopting new plans and procedures, taking into consideration the strengths and weaknesses of the existing ones, could help further to address problems caused by climate change.

45. The development of new strategies could also offer the opportunity to continue the path to achieve the UN Sustainable Development Goals, particularly number 9 "Industry, innovation and infrastructure", which aims to foster a sustainable, inclusive, and resilient industrialization development and number 13 "Climate Action" which is specifically related to addressing solutions to fight climate change and its consequences.

46. The Secretariat wishes to thank all the participants and presenters for taking part to the Workshop and for their commitment in discussing such relevant themes for railway transport.