

TECHNICAL COMMITTEE 1.4 – CLIMATE CHANGE AND RESILIENCE OF ROAD NETWORKS

1.4.1. Uniform and holistic methodological approaches to Climate Change and other hazards resilience

Strategies / Objectives

- Identification of hazards and environmental threats within the context of road infrastructure resilience.
- Approaches to:
 - Risk management within the context of resilience
 - Decision-making and uncertainties/deep uncertainties
 - Emergency management with the context of resilience
 - Resilience management and resilience engineering
- Economic aspects of resilience management
 - Identification of the socio-economic impacts of hazards on roads.
 - Identification of decision areas that need enhanced economic information, and on the key users of such information.
 - Impact and economic evaluation of measures to increase resilience on the availability of road transport infrastructure, and the cost-effectiveness of different adaptation strategies.
- Define criteria to implementation of resilience into asset management practice.
- Take into account works carried out by *T.C.E.1 – Adaptation Strategies/Resiliency* within Cycle 2016-2019, in particular the re-evaluation of 100 already case studies to identify those with this holistic methodology.
- Encourage coordination with other TCs and TFs, such as *T.C.1.5 – Disaster Management, T.C.2.4 – Road Network Operation/ITS, T.C.3.2 – Winter Service, T.C.3.3 – Asset Management, T.F.3.1 – Road Infrastructure and Transport Security, T.C.4.1 – Pavements, T.C.4.2 – Bridges, T.C.4.3 – Earthworks, T.C.4.4 – Tunnels* and *T.F.4.1 – Road Design Standards*.

Owners and operators are required to manage a very broad spectrum of threats in the future. These alone and in combination (in particular) have a significant impact on the availability of road networks. Therefore, owners and operators must address these key challenges to ensure a reliable operation of their road networks, mobility and supply chains. It is also clear that there are interdependencies with other modes of transport as well as cascading effects which should be considered as part of a comprehensive uniform and holistic (all-hazard) approach. These hazards include:

- Climate change and extreme weather
- Aging infrastructure, state of good maintenance and repair
- Natural disasters
- Man-made disasters
- Cyber and cyber-physical threats.

Without forgetting that Climate Change is one of the main risks faced by the road network, there are others, as listed. For example, cyber-attacks are ranked fifth in term of likelihood, with expected increased risks in 2019, leading to more disruption of operations. The WEF Global Risks Report reflects on new instabilities caused by the deepening integration of digital technologies into every aspect of daily

life. In the context of the rapidly advancing digital transformation, digital technologies will also play an increasingly important role in the operation of road infrastructure, whereby the aspects of cyber security, cyber physical security and cyber resilience will play a decisive role in the future.

This results in the question of creating the basis for a PIARC all-hazard framework for resilient road networks. This development requires a very close cooperation and networking effort with other Technical Committees.

Additionally, the road network is a fundamental component to the effective running of the economy. Where disruptions occur due to a range of hazards, the network is as a result compromised, and this leads to serious loss in financial and economic costs to agencies, road operators and transport users. Resilience is therefore of high importance to ensure that road user costs and socio-economic costs are reduced. In principle, when considering financial aspects within the framework of resilience management, the measurement of vulnerable road infrastructure and adaption options should be considered.

The deployment of 21st century mobility services depends on the availability of quality infrastructure. Transportation systems and their services need to be affordable, safe, timely, reliable and secure in order to provide optimal societal outcomes and contribute to the UN Agenda 2030 (NZTA, 2013). Additionally, the Sustainable Development Goal 13 highlights that Climate Action has the specific goal to ‘Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries ‘.

The lack of quality infrastructure systems will delay the systematic implementation of such services. Low quality infrastructure and services induce extensive economic, social and environmental costs for transit authorities and users (e.g. accident costs, travel time and freight delays, vehicle operating costs and externalities). Additionally, the socio-economic impacts of hazards/climate change onto vulnerable communities is an issue identified by Sustainable Development Goal 1 – No Poverty, where “By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters”.

It is estimated that the amount of global investment required for roads will be US\$ 34 trillion between 2016 and 2040, while the current trend of investments for this period does not exceed US\$ 26 trillion (Global Infrastructure Hub, G20). In other words, each country should spend more than 1.27 percent of GDP while current expenditure on average is approximately 1 percent of its GDP only. Many countries, both emerging and advanced, “have paid insufficient attention to maintaining and expanding their infrastructure assets, creating economic inefficiencies and allowing critical systems to erode” (Woetzel & al., 2016). On the contrary, a state of good repair and maintenance of existing infrastructure contributes significantly to increasing “resilience”.

In addition to increasing the robustness and the protection level of elements of the road infrastructure, investments in improving resilience also contribute to enhancing the availability of the road infrastructure, and identification of approaches and tools e.g. Sustainability Rating tools, which includes requirements and guidance for dealing with resilience. These aspects also require an in-depth consideration within the tasks of the work of this T.C.

The aim of this Issue is to explore the effectiveness of a PIARC all-hazard framework for resilient road networks. In this respect, one could perhaps say that the climate change is a subsystem of a (future) resilience framework.

It is recognized that in related this Issue, there are starting points for this concept to be explored further. This will include the development of uniform and holistic methodological approaches to climate change and other hazards resilience. This task will also further develop the concept of the effectiveness of economic and financial methodologies addressed by the T.C.s, and to bring together and evaluate these by way of best-practice case study approaches.

Firstly, it is necessary to review the work carried out by *T.C. E.1 – Adaptation Strategies / Resiliency* (SP 2016-2019), that collected more than 100 case studies. Although this already provides a very good basis for work in the 2020-2023 cycle, the existing collection of case studies should be continued and extended with regard to the issues identified for the 2020-2023 cycle. The tasks to undertake will be to:

- (Re)Evaluate already collected case studies from the previous cycle, including identification of

case studies especially with regard to holistic methodologies on the topic of resilience, resilience measures and to approaches to financial aspects of resilience management.

- Develop a survey/questionnaire on the topics of holistic resilience approaches, resilience measures and financial aspects of resilience management.
- Coordinate and collect positions with the relevant T.C.s, in particular with those of Strategic Theme 4 "Resilient Infrastructure".
- Compilation, categorization and pre-evaluation of suitable case studies, framework approaches and etc. with regard to the tasks within this T.C.

A roundtable/Workshop involving other T.C.s (i.e. T.C.s of ST 4 "Resilient Infrastructure", *T.C .1.5 - Disaster Management*, *T.F. 3.2 - Road Infrastructure and Transport Security*) could then be undertaken at a coordinated meeting location. This will provide an opportunity to share case studies and best-practice approaches, and ensure that the developments of each related T.C. are complementary. Additionally, a Seminar in a LMIC will also be undertaken throughout the cycle.

It is important to identify commonalities and links with this T.C. and other related T.C.s in order to avoid any overlap. Collaborative actions across T.C.s are proposed in this ToR by way of joint Seminars, technical sharing of objectives of the T.C. throughout the cycle, and a potential Special Project with common synergies across these T.C.s.

A Briefing note could provide a summary of the preliminary findings from the internal Case Study Task Force, and will benefit the T.C. in the development of the Full report.

The findings to date will then be presented at the Conference Session called "Winter resilience", for World Winter Service and Road Resilience Congressin Calgary, and other possible conferences such as (TRB Annual meeting, TRA, IABSE, IABMA, ETC.).

Finally, a Full report will be developed using case studies. This will provide the basis for a PIARC all-hazard framework for resilient road networks.

Outputs	Expected Deadlines
<ul style="list-style-type: none"> • Collection of case studies 	<ul style="list-style-type: none"> • December 2021
<ul style="list-style-type: none"> • Full report based on case studies 	<ul style="list-style-type: none"> • December 2022

1.4.2. Update of the PIARC International Climate Change Adaptation Framework for Road Infrastructure

Strategies / Objectives

- Update of the PIARC Climate Change Adaptation Framework based in the work carried out on the other ToR of this T.C.:
 - Setting a strict separation of processes and methodologies.
 - Split the framework into two separate parts:
 - Part 1: processes and their descriptions
 - Part 2: overview of possible methodologies for risk assessment and risk management, their data requirements and application limitsWith integration of best-practice case studies.
- Consideration of new and innovative methodological approaches, in particular critically assessment, adaptation pathways and evaluation of the overall economic value of adaptation measures.

The International Climate Change Adaptation Framework for Road Infrastructure was initiated during the Strategic Plan Cycle 2012-2015 of the World Road Association. *T.C.1.3 - Climate Change and Sustainability* developed a proposal for a ‘special project’ with the aim to create an international framework for climate change adaptation which would be of practical use for road assets owners and managers. It was supported when in May 2014, the World Road Association launched a call for proposals for PIARC special projects. Accordingly, the International Climate Change Adaptation Framework for Roads was published and disseminated during the World Congress in Seoul, November 2015.

In the 2016-2019 cycle, tasks related to adaptation to climate change were assigned to Technical Committee *E.1 - Adaptation Strategies/Resilience*. *T.C. E.1* had the task to formulate proposals for the refinement of the International Climate Change Adaptation Framework for Road Infrastructure, based on the case studies analyzed during the cycle and on findings from direct implementation of the Framework.

The final report developed by *T.C. E.1* summarizes the results of the work on the refinement of the Framework. It provides examples of implementation, discusses the applicability of the Framework for various purposes, reports on feedback from countries comparing the Framework to their own ongoing adaptation work. It also reports the results of a benchmarking exercise, where the Framework was compared to other approaches for adaptation of roads to climate change. The report concludes with a list of proposed options for the refinement of the current PIARC Framework (2015).

The work undertaken by *T.C. E.1* as part of SP 2016-2019 has therefore shown that the PIARC Climate Change Adaptation Framework is in general a good basis to analyze road networks and to select and assess the adaptation measures with regard to the consequences of climate change.

However, it also has become clear that the approach of the framework with a combination of processes and methodological approaches does not always meet the requirements of the users. Furthermore, it becomes clear from the work in the cycle 2016-2019 that, adjustments to the Framework processes are required to ensure more effective world-wide application. In addition, it has been shown based on the case studies analyzed, that new and innovative approaches have been put into practical use since the release of the framework in 2015.

For these reasons, there is a need for a fundamental update of the PIARC Climate Change Adaptation Framework, which is to be considered in this Issue. For it, the following points are to be addressed:

- The work should be based on case studies and in the work conducted previously by *T.C. E.1*.
- Strict separation of processes and methodologies.
- Division of the framework into two separate parts. In particular, this includes progressing the findings from both *T.C. E.1* WGs by way of:
 - Part 1 should contain only processes and their descriptions (e.g. inclusion of the

suggested refinements to the Framework from *T.C. E.1* WG2 into the development of an updated Framework)

- Part 2 should include an overview of possible methodologies for risk assessment and risk management, their data requirements and application limits (e.g. inclusion of worked examples of the methodological approaches identified in the *T.C. E.1* WG1 report. This includes integration of best-practice case studies and data requirements and converting these into worked examples for each phase of the updated Framework). For example, how to perform a risk assessment, which measures to implement, and how to calculate costs and benefits.
- Consideration of new and innovative methodological approaches, which may also result in a modification of the processes of the framework. In particular, questions relating to criticality assessments, the concept of adaptation pathways and the evaluation of the overall economic value of adaptation measures are to be mentioned here.
- Furthermore, it is also considered necessary to identify ways of considering aspects of road resilience in the context of asset management.

The aim of this task is to extend the work developed by *T.C. E.1* into the abovementioned new Framework. The framework is an approach to resilience from climate change.

Firstly, it is necessary to undertake a survey/questionnaire on the topics of holistic resilience approaches, resilience measures and economic aspects of resilience management, jointly with the proposed task for Issue 1.4.1, and to review the work carried out so far by *T.C. E.1*.

A roundtable/Workshop involving other T.C.s (i.e. T.C.s of S.T. 4 - Resilient Infrastructure, *T.C. 1.5 - Disaster Management*, *T.F. 3.2 - Road Infrastructure and Transport Security*) will then be undertaken at a coordinated meeting location. This will provide an opportunity to share case studies and best-practice approaches, and ensure that the developments of each related TC are complementary. Additionally, a Seminar in a LMIC will also be undertaken throughout the cycle.

The findings to date will then be presented at the Conference Session called “Winter resilience”, for World Winter Service and Road Resilience Congress in Calgary, and other possible conferences such as (TRB Annual meeting, TRA, IABSE, IABMAS,...).

Finally, a Full report will be developed, which provides a fundamental update of the PIARC Climate Change Adaptation Framework.

Roundtable / Workshops with participation of all relevant T.C.s and T.F.s will be carried out during this cycle. In addition, Climate Change Adaption Framework for Roads will be updated.

Outputs	Expected Deadlines
<ul style="list-style-type: none"> ● Roundtable with participation of all relevant TCs and TFs 	<ul style="list-style-type: none"> ● February 2022
<ul style="list-style-type: none"> ● Update Climate Change Adaptation Framework for Roads 	<ul style="list-style-type: none"> ● December 2022