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ROAD DISASTER MANAGEMENT USING THE LATEST INFORMATION TECHNOLOGIES

SUMMARY OF PIARC WORKSHOP IN KYOTO - JUNE 2022

A PIARC BRIEFING NOTE

TECHNICAL COMMITTEE 1.5 *DISASTER MANAGEMENT*

Disaster Management

STATEMENTS

The World Road Association (PIARC) is a nonprofit organization established in 1909 to improve international co-operation and to foster progress in the field of roads and road transport.

The study that is the subject of this report was defined in the PIARC Strategic Plan 2020– 2023 and approved by the Council of the World Road Association, whose members are representatives of the member national governments. The members of the Technical Committee responsible for this report were nominated by the member national governments for their special competences.

Any opinions, findings, conclusions and recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of their parent organizations or agencies.

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TECHNICAL COMMITTEE 1.5 *DISASTER MANAGEMENT*

AUTHORS

This report has been prepared by Technical Committee 1.5 on “Disaster Management” of the World Road Association (PIARC).

The authors of this report are the speakers and the panelists of PIARC international workshop on road disaster management using latest information technologies held on June 30, 2022. All have made significant contribution for to share the knowledge and experiences on how their country and organizations deal with this topic.

They are listed below in alphabetical order.

Name	Country	Affiliation
ADACHI, Yukio	Japan	Chair, TC 1.5, PIARC (Hanshin Expressway Co., Ltd., JPN)
CHEN, Chin-fa	Taiwan	Ministry of Transportation and Communication, TWN
CHINNICI , Sara	Italy	Member, TC 1.5, PIARC (ANAS, ITA)
ENDO, Kazuo	Japan	Member, TC 4.2, PIARC (Honshu Shikoku Bridge Expressway Co., Ltd., JPN)
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EVANCE, Caroline	Australia	Chair, TC 1.4, PIARC Co-Chair, Climate Change, Resilience and Disaster Management Committee, REAAA
GILLES, Pierre	Belgium	French speaking technical secretary, TC 4.2, PIARC (Service public de Wallonie, BEL)
HIGUMA, Kouji	Japan	Metropolitan Expressway Co., Ltd., JPN
KUBO,Ryuji	Japan	East Nippon Expressway Co., Ltd. JPN
MEDINA, Marcelo	Chile	Spanish speaking technical secretary, TC 1.5, PIARC (Ministry of Public Works, CHL)
MIYANISHI, Hiroyuki	Japan	Central Nippon Expressway Co., Ltd. JPN
NISHIGAKI, Yuji	Japan	West Nippon Expressway Co., Ltd. JPN
OHNISHI, Yuzo	Japan	Kyoto University, Professor Emeritus JPN
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SOGA, Yasumasa	Japan	Hanshin Expressway Co., Ltd., JPN
VAZA, Herry	Indonesia	Member, TC 1.5, PIARC (Ministry of Public Works and Housing, IDN)
YOTSUI, Saki	Japan	Ritsumeikan University, JPN

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- East Nippon Expressway Company Limited
- Central Nippon Expressway Company Limited
- West Nippon Expressway Company Limited
- Metropolitan Expressway Company Limited
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- Public Works Research Center
- Hanshin Expressway Research Institute for Advanced Technology.
- Japan Anchor Association
- Japanese Technical Association for Steel Pipe Piles and Sheet Piles
- Japan Bosai Platform
- Nippon Koei Company Limited
- CTI Engineering Company Limited
- Chodai Company Limited

EXECUTIVE SUMMARY

2022R29EN

ROAD DISASTER MANAGEMENT THE USING LATEST INFORMATION TECHNOLOGIES

SUMMARY OF PIARC WORKSHOP IN KYOTO JUNE 2022

A PIARC BRIEFING NOTE

The international workshop was jointly organized by PIARC via its Technical Committee 1.5 “Disaster Management" and the JARA (Japan Road Association). The event was greatly cooperated by REAAA (Regional Association of Asia and Australasia) via its Climate Change, Resilience and Emergency Management Committee. The event was also friendly cooperated by PIARC TC 1.4 (Climate Change and Resilience of Road Networks) and PIARC TC 4.2 (Bridges). This event provides information on the Road disaster management Using latest information technologies through world case studies on disaster management.

This workshop aims to share world case studies on disaster management. The goal of the workshop is to exchange latest disaster management technologies. The workshop invited eight speakers and seven panelists from nine countries and regions all over the world. It will include discussions of most updated information and communication in disaster management, financial aspects of disaster management, and panel discussion of strategies and tools for road disaster resilience.

This workshop discussed that the continuing information exchange on good knowledge and best practices sharing of new infrastructure, rehabilitation, and retrofit technologies for climate change adaptation and disaster resilience will save the money and time and make acceleration for building the resilience society not only in LMICs but also in HICs.

This workshop also identifies the importance of the hybrid format in post COVID time. Hybrid format can enhance the opportunities to meet face to face and can also encourage the participation of travel difficulty engineers in all over the world.

CONTENTS

1. INTRODUCTION

The international workshop named “Road disaster management using latest information technologies through world case studies on disaster management” was held at the Kyoto international community house, Kyoto, Japan, in June 30, 2022.

This workshop was jointly organized by PIARC via its Technical Committee 1.5 “Disaster Management" and the JARA (Japan Road Association). The event was greatly cooperated by REAAA (Regional Association of Asia and Australasia) via its Climate Change, Resilience and Emergency Management Committee. The event was also friendly cooperated by PIARC TC 1.4 (Climate Change and Resilience of Road Networks) and PIARC TC 4.2 (Bridges).

This workshop was the first event to be conducted in a full-fledged hybrid format, both in-person and online, after the Corona Disaster. Hybrid format enables not only the remote participation but also enhancement of collaboration using the benefit of it. In recent years, "collaboration" has been a key word in PIARC's activities. It is a fact that "collaboration" has been realized with increasing speed by using online meeting tools. This workshop promoted the collaboration with REAAA, PIARC TC1.4, and PIARC TC4.2, as a result, many technical presentations and case studies were made from 9 countries and regions including Japan. This rich workshop was the result of COVID-19 influence in a positive sense.

This workshop consisted of keynote presentation session, two technical presentation sessions, panel discussion session, and acitivty report session. This workshop covers the topics of "Recent road infrastructure maintenance technologies essential for advanced disaster management", "Information and communication in disaster management", "Financial aspects of disaster management", "What are the strategies and tools for road disaster resilience". Figure 1.1. shows the webinar promotion webpage and Table 1.1 shows the webinar agenda.

This briefing note shows the outline of the workshop and summaries the discussions at the workshop.

Figure 1.1. Workshop Flyer

09:30 – 09:50 Opening Session

Welcome remarks: *Mr. KIKUKAWA, Shigeru, President, Japan road association (JARA)*
Welcome remarks: *Mr. SENOO, Kei, Technical advisor, World Road Association (PIARC)*
Welcome remarks: *Mr. HASHIBA, Katsuji, Vice president, Regional engineering association of Asia and Australasia (REAAA)*
Opening remarks: *Dr. ADACHI, Yukio, Chair, PIARC Technical committee 1.5*

10:00 – 11:40 Technical Session 1 :

Disaster Management for a heavy snowfall on Expressway - Record-breaking snowfall and Extensive vehicles stuck on Kan-etsu Expressway -
Mr. KUBO, Ryushi, Director, East Nippon Expressway Co., Ltd., JPN
Disaster management of Hanshin Expressway with seismic simulation
Dr. SOGA, Yasumasa, Hanshin expressway Co., Ltd., JPN
Road Emergencies in Chile and Information Management
Mr. MEDINA, Marcelo, Ministry of Public Works - Roads Directorate, CHL
Using the Latest Information Technologies to Establish the Road Early Warning System and Response in Taiwan
Mr. CHEN, Chin-Fa, Ministry of Transportation and Communications, TWN

11 :40 – 11:55 Activity Report Session

WG1 activity report: Information and communication management in disaster
Mr. GRUBER, Jan, WG1 leader, PIARC Technical committee 1.5
WG2 activity report: Financial aspect of disaster management
Dr. YOTSUI, Saki, WG2 Co-leader, PIARC Technical committee 1.5
WG3 activity report: Update disaster management manual
Mr. ZBARNEA, Constantin, WG3 Leader, PIARC Technical committee 1.5

13 :00 – 13:40 Keynote Session

Recent road infrastructure maintenance technologies essential for advanced disaster management
Dr. ONISHI, Yuzo, Prof. emeritus, Kyoto University, JPN

13 :50 – 15:30 Technical Session 2 :

Natural hazard risk management -Towards an assessment of the regional impact of damage to road bridges-
Dr. YOTSUI, Saki, Ritsumeikan University, JPN
Minimize Expressway Closure Time in Natural Disaster
Mr. NISHIGAKI, Yuji, West Nippon Expressway Co., Ltd., JPN
REAAA Resilience Initiatives for Road Transport
Ms. EVANS, Caroline, Chair PIARC TC 1.4, Co-Chair REAAA Resilience Committee, AUS
Evolution of economic impacts of natural disasters
Ms. CHINNICI, Sara, ANAS, ITA

15 :40 – 16:50 Panel Discussion Session :

Future Vision of Expressway Operation and Disaster Management with "i-MOVEMENT"
Mr. MIYANISHI, Hiroyuki, Central Nippon Expressway Co., Ltd., JPN
Application to comprehensive disaster prevention information system utilizing i-Dreams
Mr. HIGUMA, Kouji, Metropolitan Expressway Co., Ltd., JPN
Seismic Retrofit for Long-Span Bridges
Dr. ENDO, Kazuo, Honshu-Shikoku Bridge Expressway Co., Ltd., JPN
Disaster risk reduction in Indonesia
Dr. VAZA, Herry, Ministry of Public Works and Housing, IDN
Climate Change Adaptation and Resilience of Road Networks (in Low- and Middle- income countries)
Dr. RUBARENZYA, Mark Henry, Uganda National Roads Authority, UGA
US Transportation Resilience Strategies
Mr. ENGELBRECHT, Christopher, Missouri Department of Transportation, USA
How to deal with a major flood when your country is not used to it?
Dr. GILLES, Pierre, SPW Mobility and Infrastructure, BEL

16 :50 –17 :00 Closing Session

Closing remarks: *Dr. ISHIHARA, Yasuhiro, Chair, International committee, JARA*

Closing remarks: *Mr. MALLÉJACQ, Patrick, Secretary general, PIARC*
Closing remarks: *Dr. ADACHI, Yukio, Chair, PIARC Technical* committee *1.5*

Table 1.1 Workshop program

OPENING

QUESTION AND ANSWER

TECHNICAL PRESENTATIONFROM SITE

PANEL DISCUSSION (ON-SITE AND WEB)

TECHNICAL PRESENTATIONFROM WEB

CLOSING (WEB)

KEYNOTE SPEECH

ON-SITE PARTICIPANTS AT THE VENUE

2. KEYNOTE PRESENTATION

Recent road infrastructure maintenance technologies essential for advanced disaster management

Dr. ONISHI, Yuzo, Prof. emeritus, Kyoto University, JPN

In road disaster prevention inspections, it is important to predict as accurately as possible when, where, on what scale, and in what form a disaster will occur, but it is not easy to grasp these factors even with advanced academic knowledge and technical capabilities.

It is necessary to show, as concretely as possible, how disaster prevention management should be carried out at the road management site for the potential disaster areas identified in the road disaster prevention inspection that require special attention in terms of management.

Those involved in disaster management are expected to do their best to achieve the ultimate goal of preventing disasters as much as possible and minimizing damage at the any stage of disaster management cycle, disaster prevention, mitigation, and avoidance, and preventive maintenance.

The below are the key conclusions:

1. In managing road disasters, it is important to consider which framework to use: preventive, follow-up, or predictive.

2. In the case of new infrastructures, it is effective for later road disaster prevention and maintenance to record and save the construction details including the construction process as 3D data based on i-construction and BIM/CIM methods. In the case of existing infrastructure, periodic inspections should be conducted, 3D data should be saved, and past data and other data should be carefully compared from a preventive perspective. In both cases, the use of drones is promising.

3. Many people are feeling the limitations of conventional 2D design, such as the lack of human resources and the work efficiency, as well as to improve quality and reduce costs. However, there are many barriers to a sudden shift to 3D, and the best way is to "get the best of both worlds" in a mixed environment of 2D and 3D, such as utilizing 3D models by making use of drawing data assets from 2D design.

4. Although 3D data is intuitive when displayed and useful for detecting defects, the hurdle for data creation is high. However, technological advances have made it possible to use a variety of equipment, and there are high expectations for the future. The use of equipment requires rapid information sharing.

5. Utilization of 3D data, incorporation into BIM/CIM, and record keeping are useful for disaster prevention of infrastructure, and it is hoped that they will be widely applied through case studies and education.

3. INTRODUCTION PRESENTATIONS

WG1 activity report: Information and communication management in disaster

Mr. GRUBER, Jan, WG1 leader, PIARC Technical committee 1.5, CZE

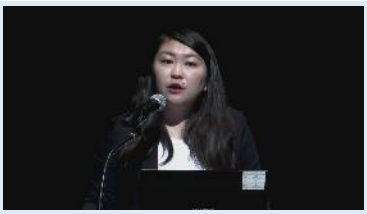
The PIARC Technical Committee 1.5 - Disaster Management established a task related to the topic "Using Big Data and Social Networks for Disaster Management" within the ongoing cycle. The presentation presents the results achieved so far in this task, which deals with new information evolutions such as big data and social networks. The result was the creation of an information report to provide an overview of the project's methodology and a summary of the findings of the survey results, which came from 22 countries with the following distribution by continent; 8 (Asia), 8 (Europe), 5 (Americas) and 1 (Oceania).

As part of this task, TC 1.5 - WG1 (Working Group 1) conducted an international survey, the main results and findings of which are based on an analysis that shows that there is extensive collection and analysis of big data and information from social networks throughout the life cycle of disaster/emergencies.

The main themes of the survey questions were the types of information collected about big data and social networks and the frequency of collection, validation techniques and ensuring the accuracy of collected data, analysis and dissemination of data (technology, software, etc.), benefits for road administrations and road users, and pandemic applications COVID-19.

The presentation includes comments on several key areas, preliminary survey results, conclusions and recommendations for decision-makers and international organizations, based on a review of international literature, collection and analysis of case studies and collaboration with global road administrations. Further analysis of survey information and case studies will be developed and presented in the final report.

WG2 activity report: Financial aspect of disaster management



Dr. YOTSUI, Saki, WG2 Co-leader, PIARC Technical committee 1.5, JPN

Road networks are exposed to natural elements and disasters that may cause severe damage to these assets. It is therefore important to be financially prepared and have disaster management processes in place, including various sources of parallel funding. Our international survey results suggest the need for every road administration to invest in the development of new warning and monitoring systems for events such as floods, heavy rains and heavy snowfalls. It will be also particularly important to systematically quantify the financial risk associated with different disaster scenarios and to make use of cost-benefit analysis for all investment plans. In anticipation of major disasters, with the great potential to induce financial losses, it is highly

advisable to rely on a variety of parallel funding sources. Where possible, greater financial risk sharing between the public and private sectors should be encouraged.

WG3 activity report: Update disaster management manual

Mr. ZBARNEA, Constantin, WG3 Leader, PIARC Technical committee 1.5, ROM

Terms of reference for Working Group 3 regards the updating of the Disaster Management Manual. The work of the previous cycle TC E.3 was revised and updated using the latest experience on efficient strategies and methods for managing various disasters on roads network. Now the manual contains basic concepts, case studies of lessons learned and experiences gained and the latest disaster reduction technologies that contribute to the promotion of efficient and effective disaster management. The manual was finished as a book and now we are working to publish the sixth PIARC online manual that will be soon available on disaster-management.piarc.org.

4. TECHNICAL PRESENTATIONS (1)

4.1. TECHNICAL PRESENTATIONS

Disaster Management for a heavy snowfall on Expressway - Record-breaking snowfall and Extensive vehicles stuck on Kan-etsu Expressway –

Mr. KUBO, Ryushi, Director, East Nippon Expressway Co., Ltd., JPN

In December 2020, a record-breaking heavy snowfall caused a large-scale and long-lasting vehicle stagnation of approximately 2,100 vehicles on the E17 Kanetsu Expressway in Yuzawa, Niigata Prefecture.

In the 2020 season, similar events occurred one after another in various regions in Japan, and the Ministry of Land, Infrastructure, Transport and Tourism in Japan changed its policy from the conventional approach of "securing winter traffic routes as much as possible" to "thoroughly avoiding large-scale vehicle stagnation ".

Therefore, NEXCO East Japan Niigata Regional Head Office developed preventive measures based on a risk management framework for winter road according to the lessons on the past. As a result, the occurrence of large-scale vehicle stagnation was suppressed in the 2021 season, even with heavy snowfall.

In preparation for further heavy snowfall, the office has been working on the establishment of the "Niigata DX" project that links past experiences and initiatives, aiming to improve sustainable operational capabilities.

Disaster management of Hanshin Expressway with seismic simulation

Dr. SOGA, Yasumasa, Hanshin expressway Co., Ltd., JPN

Hanshin Expressway is studying the construction of a digital twin model in cyberspace that exhibits the same properties and behavior as bridges and tunnels in real space. We aim to realize "cyber infrastructure management", in which the performance of structures is evaluated and predicted through analysis and simulation with this model, and the results are reflected in the real world for optimal management.

In particular, we are working on seismic simulations of the entire Hanshin Expressway network, assuming large-scale earthquakes such as the 1995 Southern Hyogo Prefecture Earthquake and the Nankai Trough earthquake.

By simulating various earthquakes, we can identify weak points on the Hanshin Expressway network and identify bridges that truly need reinforcement. Disaster prevention drills can also be conducted for these earthquake scenarios.

In the future, we would like to use digital twin technology not only for earthquakes, but also for natural disasters and traffic simulations.

Road Emergencies in Chile and Information Management

Mr. MEDINA, Marcelo, Ministry of Public Works, -Roads Directorate-, CHL

Chilean territory is always affected by natural disasters, due to country location on the rings of fire that causes volcano activity, earthquakes and a geography that generate alluviums during summer time, as well as other types of natural disasters (wild forest fire, floods, snow avalanches, tsunamis, etc.), causing several damages to road infrastructures.

Since 2015 the Chilean Road Administration has collected relevant information about damages and effects on the road network through a Close Source Information System that allowed to generate automatically Emergency Maps published on internet for road users.

Currently Chilean Road Administration is getting a step forward to generate an Opened Source of Information for users, in order to improve service of road network, adding citizen collaboration in the detection of road emergencies and merge it with the available Closed Information Source. This project contains a visual interphase for administrators and a simple mobile application to collect information on site, with the goal of provide a simple channel for reporting problems in the road network, provide background information for incidents management and integrate information in the current systems without generating a parallel system.

Using the Latest Information Technologies to Establish the Road Early Warning System and Response in Taiwan

Mr. CHEN, Chin-Fa, Ministry of Transportation and Communications, TWN

The briefing take Suhua Highway as a case study, the most famous coastal highway in Taiwan. The characteristics of the Suhua Highway are similar to the Highway 1 Big Sur Coast Highway in California, USA. One side is close to the coast and the other side is a hillside. , the scenery is very beautiful and the traffic is heavy, but there are often rockfall injuries.

Briefing focuses on how to apply information technologies such as Drone, Big Data, and Internet of Things to integrate into the early warning system,For transmiting real-time emergency road message to passersby avoid possible disasters in time . The early warning mechanism has been in operation for more than 10 years, and by using information technologies applications has been

on line for more than 4 years, no one was injured by falling rocks during this period. The implementation effect has been verified to be excellent in Taiwan.

4.2. QUESTIONS AND ANSWERS

- Mr. Medina said the ways to combine information from the opened and closed sources. He said we do not know yet which way will be the most efficient or the best way to combine those kind of information, but we have some ideas what to do with that information: 1.- Location of the events: Using a digital map and GIS tools with the opened source information we are able to locate position (km) on the road network, 2.- Show Emergency Records: Share information from the closed source to the opened source, in order to keep users informed, 3.- Get on site photographs of the events from users: To preliminary evaluation of the events and make decisions. We are starting with the management of this kind of information but our main goal is to keep informed users and authorities, as well as generate information of damages on the road network for further analysis and planning.
- Mr. Kobo said that reduction of the traffic is important and essential to the snow fall disaster management. He talked also about Japan is currently implementing the pre-announced and planned road closure policy with supported by the public.
- Mr. Kubo also said that real-time collection of the disaster information is essential. He added some words that they are planning to installed more ITVs in order to enhance the monitoring function whereas they currently receive the information through ITVs installed in every 2km and handy and web-connected camera of emergency personnel.
- Mr. Kubo explained that the mental care to the drivers, who are left behind their cars of the road, is also important according to the previous lessons. He suggested an alternative approach that the road manager may ask to the drivers to leave from their cars, and may get back them to their cars again after road condition become recovered.
- Mr. Kubo explained there is another approach, to force to remove the stuck cars, when the number of the stuck cars is limited. He also mentioned that the presented approach might be better when a large number of the cars stuck in the same time.
- Dr. Soga said that the digital twin technology is very effective for mitigation, preparation, and response to the disaster. He explained that expanding his model, which is currently composed for bridge sections that composed for 80% of the Hanshin Expressway, is necessary with earth works and tunnel sections and other road network components.
- Mr. Chen said that the road managers in Taiwan can receive disaster information by drones, to identify the disaster location by GPS, and to recognize the car number by image processing of the car left in the disastrous area, by using their the most updated IT disaster management technologies.

5. TECHNICAL PRESENTATIONS (2)

5.1. TECHNICAL PRESENTATIONS

Natural hazard risk management -Towards an assessment of the regional impact of damage to road bridges-

Dr. YOTSUI, Saki, Ritsumeikan University, JPN

The panelist presented on the current status and challenges of the risk management and risk finance system for roads and bridges in Japan. Extreme natural hazards are becoming more severe and widespread due to global warming. Moreover, according to the Ministry of Land, Infrastructure, Transport and Tourism and the Tokyo Metropolitan Government's scenario for an earthquake that impacts the Tokyo area, road restrictions following earthquake will last at least one week after the disaster. If roads are closed as a result of landslides, it may take several months or more to restore them. Thus, it is very important to take action as quickly as possible to conduct temporary repairs as well as main restoration. The financial burden on national and local governments has also increased. We need a compensation system that takes into account both regular operation and times of disaster, and it is necessary to promote Public Private Partnership / Private Finance Initiatives.

Minimize Expressway Closure Time in Natural Disaster

Mr. NISHIGAKI, Yuji, West Nippon Expressway Co., Ltd., JPN

Recent years, a number of Natural disasters are increasing due to the climate change.

In 2018, NEXCO-West experienced two severe damage cases such as torrential rainfalls at the Kochi expressway and the Sanyo expressway and strong wind damage by typhoon at the Kansai International Airport Access Bridge. It was a challenging to response and operate recovery work efficiently and quickly because of size of damages. However, NEXCO-West accomplished to minimize expressway closure time with flexible traffic operations and restoration works.

According to these experience, NEXCO-West is taking the measures for future disasters such as installation of high energy absorbing fences and rigid protective barriers in the median strip, and extending the length of the emergency opening in the median strip.

In addition, NEXCO-West started to provide advance announcement of expected road closures to change road user’s action during a severe weather.

NEXCO-West shares these knowledges to reduce social impact of the natural disasters for other road operators.

REAAA Resilience Initiatives for Road Transport

Ms. EVANS, Caroline, Chair PIARC TC 1.4, Co-Chair REAAA Resilience Committee, AUS

Climate change, resilience and disaster management are areas of great interest to the Road Engineering Association of Asia and Australasia (REAAA). This presentation provided an overview of work being conducted by the REAAA Climate Change, Resilience and Disaster Management Working Committee. This included presentation of the Terms of Reference, strategic priorities, workplan, and development of a report to investigate the opportunities for implementing road and infrastructure climate change resilience in Asia and Australasia.

Cooperation with PIARC has been a key strategic initiative of REAAA for many years. There are close connections between this REAAA Committee and the activities of PIARC Technical Committees (TC) 1.4 Climate Change and Resilience of Road Networks and TC 1.5 Disaster Management. This presentation described the collaborative work being undertaken across PIARC and REAAA, and the connections between these Associations in the area of resilient roads.

The presentation also outlined the alignment of the REAAA with PIARC TC1.4 and 1.5. In particular the investigation of uniform and holistic methodological approaches to climate change and other hazard resilience, and the update of the PIARC Climate Change Adaptation Framework for Road Infrastructure (2015), which considers new and innovative approaches such as criticality assessments, and adaptation pathway approaches in the context of climate change.

Evolution of economic impacts of natural disasters

Ms. CHINNICI, Sara, ANAS, ITA

The panelist presented the article "*Evidence for sharp increase in the economic damages of extreme natural disasters*" (M. Coronese et al.|21450–21455|PNAS October 22, 2019|vol. 116|no. 43| www.pnas.org/cgi/doi/10.1073/pnas.1907826116).

The article highlights how the economic damage caused by natural disasters related to climate change has increased considerably in recent decades, due to the increased effects generated by each individual event. More precisely, the researchers estimated that between 1970 and 2010 the economic impact of a particularly nefarious disaster (among the 1% most damaging) increased by about 20 times and that, each year, a single event of this magnitude costs about $26 million more than the previous year. The study also reveals that the increase in the costs of disasters is more dramatic in temperate areas.

On a global scale the study documents a general decrease of casualties, but if the analysis is specialized according to the type of hazard and country income class, it is pointed out a decrease

in deaths due to floods only in high-income countries and a concerning increase in casualties linked to extreme temperatures in poor and rich countries alike.

5.2. QUESTIONS AND ANSWERS

- Dr. Yotsui said technical information sharing and financial international assistance is important to the improvement of disaster management in LMICs.
- Mr. Nishigaki said it is important to steadily develop their disaster management technologies in the context of appropriate priorities. He also said it is also important to share our disaster experiences and technologies with LMICs.
- Ms. Evans and Ms. CHINNICH said it is also important and essential to share the disaster experiences, knowledge, and technologies of HICs with LMICs through the international organization channels.

6. PANEL PRESENTATIONS AND DISCUSSIONS

6.1. PANEL PRESENTATIONS

Future Vision of Expressway Operation and Disaster Management with "i-MOVEMENT"

Mr. MIYANISHI, Hiroyuki, Central Nippon Expressway Co., Ltd., JPN

The environment surrounding Japanese expressways has been undergoing dramatic changes in recent years, including labor shortages due to the declining birthrate and aging population, diversifying customer needs, and an increase in road damage due to severe weather conditions. In response to these changes, NEXCO-Central is working on "i-MOVEMENT" to evolve expressway mobility by actively introducing cutting-edge ICT and robotics technologies. This presentation introduces some examples of i-MOVEMENT, such as the use of all lanes' monitoring of the entire expressway to immediately identify accidents and disasters, and the use of 3D models to accurately identify deformations before and after a disaster and to formulate restoration methods.

Application to comprehensive disaster prevention information system utilizing i-Dreams

Mr. HIGUMA, Kouji, Metropolitan Expressway Co., Ltd., JPN

Introduction of the "Comprehensive disaster prevention system" installed in "i-DREAMs" which is road maintenance and management system of Metropolitan Expressway Company Limited. i-DREAMs manages various road data in 2D and 3D point cloud data on GIS platform. Applying the "Comprehensive disaster prevention system" strongly contributes both to recover road network at emergency case and to secure the safety of Metropolitan Expressway.

Seismic Retrofit for Long-Span Bridges

Dr. ENDO, Kazuo, Honshu-Shikoku Bridge Expressway Co., Ltd., JPN

Past seismic events, such as 1995 Kobe EQ, caused severe damage on road bridges in Japan. It resulted in closing of road networks, which led to traffic delay as well as indirect economic losses. Seismic retrofitting is one of the most common approaches to enhance seismic resilience of road bridges. Due to the limited budget and human resources, it is important to proceed it in a systematic manner considering road class, traffic volume, bridge age, site seismicity.

Disaster risk reduction in Indonesia - After COVID 19 Pandemic in Road Sector

Dr. VAZA, Herry, Ministry of Public Works and Housing, IDN

There are limitations in disaster management while Covid-19 pandemic, such as limitation of movement and activities because of the social distancing, restriction for community activities and travelling, shortage of manpower and slow delivery of materials for construction, shortage of logistics caused by the disconnection of transportation and communication networks which leads to the absence of fuel supplies. Based on this experience, we must improve the implementation of disaster management with the support of a good database. The database consists of road network maps, ongoing projects engagement, disaster prone areas, existing roads and bridges, ongoing projects contractors, heavy construction equipment data and material supplier data.

Climate Change Adaptation and Resilience of Road Networks (in Low- and Middle- income countries)

Dr. RUBARENZYA, Mark Henry, Uganda National Roads Authority, UGA

Climate change impacts and other hazard events are causing more frequent and severe damage to road infrastructure and operations. In December 2021, PIARC Technical Committee (TC) 1.4 held a Seminar in Uganda that focused on ways in which road and transport agencies around the world are making transportation infrastructure more resilient to climate change. The goal of the Seminar was to exchange information between countries, with a focus on Sub-Saharan Africa.

Over 600 participants registered for the seminar, with most coming from Low- and Middle-Income Countries (LMICs). One of the lessons from the seminar is that a key factor for low participation by LMICs in PIARC activities is the difference between the topics and technologies addressed in LMIC Member's organizations and those in TCs and Task Forces.

US Transportation Resilience Strategies

Mr. ENGELBRECHT, Christopher, Missouri Department of Transportation, USA

Panel presentation included discussion related to US strategies for funding transportation resilience and sustainability, along with the introduction of a Social Vulnerability Index tool the US is utilizing to improve social equity in disaster response.

In 2021, the US Congress passed a $1.2 trillion funding package which provided much needed resources to improve infrastructure, create millions of jobs, and address climate change while

placing an increased emphasis on resilience, sustainability, equity, and safety for all users. The funding builds a national network of electric vehicle chargers, expands public transit options, replaces thousands of deficient transit vehicles, modernizes passenger rail and upgrades airports and ports to strengthen supply chains and prevent disruptions.

The Social Vulnerability Index (SVI) was also briefly discussed. SVI is a tool used to help address concerns related to disaster management and social equity. Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health including factors such as poverty, lack of access to transportation and crowded housing which may weaken a community's ability to prevent human suffering and financial loss in a disaster.

The SVI ranks census tracts on various social factors, grouping them into themes and providing an overall database ranking and map to determine the level of social vulnerability. Communities can then use these databases and maps to estimate needed emergency supplies, determine personnel needed to assist in a disaster, identify emergency shelter needs, and identify communities that will need continued support to recover following an emergency or natural disaster.

How to deal with a major flood when your country is not used to it ?

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Belgium, is not used to strong climatic disaster. But mid July 2021, heavy and stationary rains occur on a large part of the country with more than 288 mm on 72 hours (return period of 200 years). On some rivers the flow exceeded by a factor of 4 the previous maximum.

After this disaster, which caused 39 deaths, it was urgent to inspect many bridges.

Without an existing methodology, this work (560 bridges inspected) was only possible through a great collaborative work. The inspection work was distributed among 40 people. Each day, each of them complete, after the inspection, a shared excel table (office 365) with a summary of the main information and establish a short inspection report on a shared folder. The shared excel table was connected to Batchgeo.com to have a live cartographic view map of the main information's, accessible to the main stakeholders.

6.2. PANEL DISCUSSIONS AND CONCLUSIONS

Good discussions of identifying and sharing the good experience for the strategies and tools for road disaster resilience were made after the panel round table discussions. The followings are the major findings.

- Regarding disaster mitigation, this session discussed the retrofit of existing assets considering social impacts as well as the response to unexpected events, as an important issue. This is also an urgent issue in addressing climate change. This session also identified the importance of the community resilience.

- In terms of disaster preparedness and response, there was discussion on the importance of the latest digital technologies and digital transformation technologies, such as sensing, monitoring, and data management. A panelist also identifies the digital database can also enhance the disaster resilience during pandemic situation. The progress of these technologies has been remarkable. Further evolution is expected.
- Regarding disaster recovery, it was discussed that cooperation and coordinated activities among organizations involved in disaster management are important issues. Panelists identify the effectiveness of the bridge engineering community for emergency inspection works after the disastrous event, and the effectiveness of the community vulnerability understanding for the disaster capacity resilience. It can be said that fostering social capital in a broad sense is also considered important in disaster management.
- This workshop also discussed that the continuing information exchange on good knowledge and best practices of new infrastructure and rehabilitation and retrofit of old infrastructure for climate change adaptation and disaster resilience will save the money and time and make acceleration for building the resilience society in LMICs.

7. RECOMMENDATIONS

7.1. RECOMMENDATIONS FOR DECISIONS MAKERS –

Recommendation 1: Collecting and sharing of accurate and real-time disaster information

Excellent disaster management action has been made based on the accurate disaster information and real time disaster information. In order to obtain better disaster information, efforts are being made to 1) expand monitoring facilities as a reliable method, and 2) incorporate open-source information recently, while acknowledging the uncertainty of the information. Road managers should continue their efforts to obtain better information on disasters while considering the condition of the road, road facilities and road conditions.

Recommendation 2: Use of IoT and digital twin technologies for disaster management

In recent years, there have been notable advances in digital technology, IoT technology, and digital twin technology. In particular, 1) the use of the latest sensing, monitoring, and analysis technologies, 2) the use of the latest mobile devices such as drones, and 3) the use of digital twin technology based on advanced computing technology to simulate disasters. In the area of disaster simulation, there have been remarkable achievements in advancing disaster management. Route managers need to maintain their antennas for the latest technological advances and make constant efforts to apply them to advancing disaster management.

Recommendation 3: Cooperated and coordinated activities in disaster management

Cooperation and coordinated activities among organizations, parties, and those involved in disaster management are important issues. This workshop identified the good case study 1) the cooperated and coordinated action of the bridge engineering community for emergency inspection works after the disastrous event in Belgium, 2) the promotion funding to develop the community vulnerability understanding for the disaster capacity resilience. It can be said that fostering social capital in a broad sense is also considered important in disaster management.

Recommendation 4: Knowledge and experience sharing through various channels:

It is very important and very essential to steadily develop their disaster management technologies in the context of appropriate priorities and appropriate technologies enough to mitigate the influence by the disaster. In this sense, knowledge and experience sharing is very important not only among HICs but also among LMICs.

7.2. RECOMMENDATIONS FOR PIARC

Recommendation A: A hybrid format meeting in post COVID time

This workshop identifies the importance of the hybrid format in post COVID time. Opportunities to meet face to face during the COVID-19 pandemic were greatly diminished, possibly resulting in weakened relationships among the disaster management community not only at the national and organizational level but also international level. Providing an opportunity for engineers involved in disaster management to create a community that encourages information sharing is necessary even during COVID-19. Beyond border activities are essential especially in unforeseen events. This workshop was held in hybrid format. The hybrid format can promote the face-to-face relations as

well as enhance the information sharing through the virtual participation. Hybrid format will be necessary format in post COVID time.

Recommendation B: Collaboration on information sharing among communities

This workshop also importance of the collaboration among different communities. This workshop was cooperated by not only within PIARC, TC1.4 "Climate Change and Road Network Resilience" and TC4.2 "Bridges", but also REAAA “Climate Change, Resilience and Emergency Management Committee”. The participation from different communities and the discussion among them create rich workshop and discussion. This will be resulted by hybrid format workshop and can be said this can be said the result of COVID-19 influence in a positive sense.

8. STATISTICS

8.1. WORKSHOP SUMMARY

The workshop summary was displayed in Table 7.1.1 “Workshop summary table”. There were 210 participants to the event. On-site was 75 and on-line was 135.

There were participants from five different countries at the site. No country statistics could obtain to the online participants, but according to the 412 registration statistics, those consisted with 68 nations and regions. Remarkable point was that there were so many applicants from LMICs compared to that before COVID-19. This reveals that a hybrid workshop is one of the solutions to achieve one of the PIARC goals, “Information sharing to LMICs”.

8.2. WORKSHOP EVALUATION

The summary of the wrkshop evaluation was shown in Table 7.2.1 “Workshop evaluation result”. The survey was delivered in Google Forms after the closing session. In total, 45 answers were obtained and analysed. The score of each question is over 3pt so that the workshop was successfully finished with great sucsesss. Compared to each score, we found that there was a room to improve the discussion.

The below are some of the comments to the workshop and the PIARC.

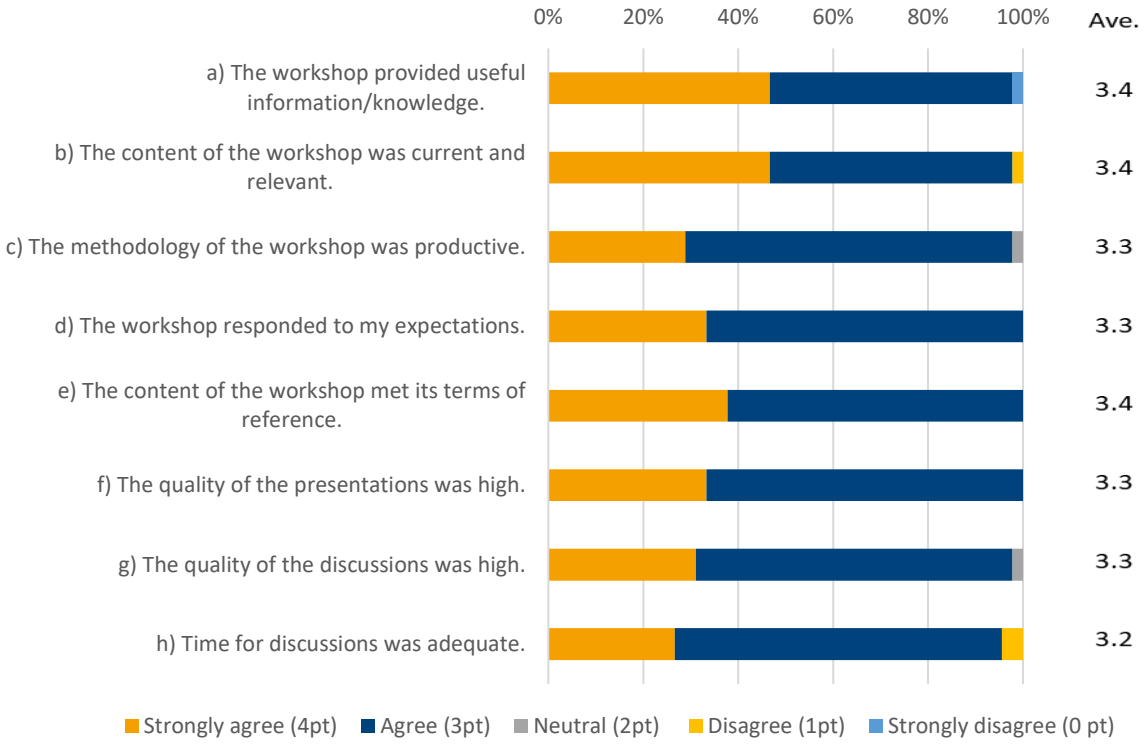
- Comments to the workshop
  - The i-MOVEMENT, i-DREAMs, and other initiatives were also very useful.
  - Very good representation and coverage of various disasters and management thereof to minimize the impact to road users
  - It seems that every country in the world is managing disasters in its own way, and I hope that we can minimize disasters by sharing the latest technology.
  - I could understand the importance of information and communication in disaster management.

- Comments to PIARC activity
  - I have never had a chance to hear about trends in other countries, so this seminar was very useful.
  - I learned that PIARC is involved in a wide range of activities, and I would like to participate again next time if I can participate via the web.
  - I would like to hear about infrastructure-related country initiatives for carbon neutrality.

Table 7.1.1 Workshop summary table

No.	Items	Remarks		
1	PIARC Technical Committee	PIARC TC 1.5 Disaster Management		
	Cooperated PIARC Technical Committee	PIARC TC 1.4 Climate Change and Road Network Resilience PIARC TC 4.2 Bridges		
2	Host country	Japan		
3	Workshop title	International workshop on Road disaster management Using latest information technologies		
4	Workshop venue	Kyoto International Community House, Kyoto, Japan		
5	Workshop dates	June 30, 2022 (Workshop) July 01, 2022 (Technical Trip)		
		On-site	On-line	
		Participants	Participants	Registration
6	Number of speakers from lower middle income and low-income countries	0	2	
7	Number of speakers from upper middle-income countries	0	0	
8	Number of speakers from high income countries	8	5	
9	Number of participants (exclusive speakers) from lower middle income and low-income countries	0	128	(57)
10	Number of participants (exclusive speakers) from upper middle-income countries	0		(46)
11	Number of participants (exclusive speakers) from high income countries	67		(92)
12	Total participants (sum of Q6-Q11)	75	135	(195)
13	Total participants from host country	71		(200)
14	Number of lower middle income and low-income countries represented	0		(27)
15	Number of upper middle-income countries represented	0		(14)
16	Number of high-income countries represented.	4		(27)
17	Was a PIARC Technical Committee meeting held the same week?	YES (2-day meeting)		
18	Was the seminar held in connection with another non-PIARC event? If yes, which event and organization?	Co-organized by REAAA		
19	Duration of the seminar, incl. field visit. Was a field visit organized?	YES		
20	Registration fees – (Currency)	Free		

Table 7.2.1 Workshop evaluation result



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