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DISASTER INFORMATION MANAGEMENT FOR ROAD ADMINISTRATORS

TECHNICAL COMMITTEE E.3 *DISASTER MANAGEMENT*

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE
AIPCR PIARC

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 2016-2019 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 government for their special competences.

Any options, 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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DISASTER INFORMATION MANAGEMENT FOR ROAD ADMINISTRATORS

AUTHORS/ ACKNOWLEDGEMENTS

This report has been prepared by Working Group 1 of Technical Committee (TC) E.3 on "Disaster Management" of the World Road Association (PIARC). TC E.3 was chaired by Keiichi Tamura (Japan). Yukio Adachi (Japan) and Marcelo Medina Santibanez (Chile) were the English and Spanish-speaking Secretaries respectively. Working Group 1 was focussed on one of the issues E.3.1 "Disaster Information Management". The WG1 members and other contributors who contributed to this report are:

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The aforementioned contributor(s) drafted each section using information from their country, literature, and other members and contributors of TC E.3. The drafts have been reviewed in successive group meetings. Yukio ADACHI (JPN – WG1 Co-Leader), James ELLIOTT (UK – WG1 Leader), and Chris NAGEL (AUS – Co-leader) harmonized the report originally drafted in English. Marcelo MEDINA SANTIBANEZ (Chile- WG1 Co-leader) and his colleagues translated the report into French and Spanish.

The authors wish also to thank all TC E.3 members for their valuable contribution and insight in reviewing the final draft of this report.

Thanks also go to all persons who contributed to the international survey performed by TC E.3, the results of which are presented and discussed in the report.

EXECUTIVE SUMMARY

2019R09EN

DISASTER INFORMATION MANAGEMENT FOR ROAD ADMINISTRATORS

Countries that experience disasters acquire unique disaster management knowledge and develop tailored countermeasure technologies based on their experiences. As societies diversify, damage caused by disasters changes as society changes. Therefore, the type of technology necessary to manage disasters in each country needs to continually adapt as populations grow and society changes. Most disaster management technologies have been developed to respond to the emergency management phase. Previous disaster management technology has been mainly developed in the area of hard management, such as safe infrastructure. More countries are currently considering the management of disasters with a series of continuously applied management techniques through the pre-event, emergency, and post-event phases. This has identified the benefits of combining hard and soft management techniques to improve overall disaster management outcomes.

Any kind of disaster management activities that impact road users are triggered by the provision of disaster information. The quality of the information provided to road users governs the quality of the subsequent disaster management. Moreover, with the unprecedented increase in mobile telecommunications and social media which can instantaneously convey a huge amount of important information to road users, management of disaster information to road users plays a very important role in disaster management.

Therefore, advanced technology to provide timely and accurate information management, either in the pre-event and emergency phases, is critical to effective management of disasters in order to reduce or prevent primary, secondary or subsequent disaster impacts to road users.

Disaster-prone countries have developed their unique management technologies based on their disaster experiences. In order to share these technologies, knowledge exchange forums have been developed. Current trends in disaster management include an emerging realisation that paying more attention to the disaster management activities and their interaction with the public and society produces better results. This compares to the traditional disaster management approach of prioritising making infrastructure safe.

Moreover, encouraging the sharing of disaster management technologies including information management using a web-based platform provides easily accessible risk and disaster management data. This helps those countries with less resources to avoid the costly technology research and development phase and go straight to implementing proven technologies where they will have the greatest impact.

To assess the background described above, Working Group 1 (WG1) of the PIARC Technical committee E3 on disaster management has carried out a four-year study of “Disaster Information Management”, “Disaster Management with the Public”, and developed a web-based “Risk and Disaster Management Manual”.

EXECUTIVE SUMMARY

- In the area of “Disaster Information Management”, current practices were analyzed using the results of an international survey. Best practices were identified such as advancement of disaster information processing in Australia, Dominica, and Japan, advancement of tsunami information sharing and warning in Chile and active information provision using Social Networking Services (SNS) in USA and UK. The application of ITS technology in disaster information management in Japan was also assessed.

- In the area of “Disaster Management with the Public”, disaster management techniques in various countries were analyzed corresponding to different disaster characteristics. According to the survey results, current trends were identified in the field of public engagement. Best practices in this field were identified in the area of road disaster prevention activities integrated with residents in Australia and UK, and mutual cooperation with road-side residents in Chile and Japan.

- For the web-based “Risk and Disaster Management Manual", principles, methodologies, and case studies were compiled from previous PIARC TC activities in risk and disaster management and made available to the public using the PIARC web database.

This report has been divided into chapters on Disaster Information Management and Disaster Management with the Public. In each section the background including the findings from the international survey are presented as well as case studies from which lessons learnt are summarized. Recommended actions for road organizations are then been summarized in the report conclusions.

This report identified “Disaster Information Management” and “Disaster Management with the Public” as current important technologies to manage disasters with adapting to the society changes. The report highlighted some case studies for the best practices for improving the management technologies in disaster situations. Therefore, this information would be very beneficial not only to the countries with the disaster risk, but also to the countries, especially to the LMICs, for improving the structures in management of disastrous situation.

This report also highlights the fact that these identified management technologies has limitations for applying to the countries because risk-awareness is a key influence on the ability of a country to prepare for managing disasters. Therefore, careful investigation of the risk awareness of the society is needed for their transferability and applicability in advance.

We hope that the information and best practices of this report presents through advanced cases studies related to disaster management will be shared around the international road community and applied to road disaster prevention activities for countries that suffer from natural disasters.

CONTENTS

1. INTRODUCTION

1.1. SCOPE AND OBJECTIVES

Disaster can be defined as “a crisis situation that far exceeds the capabilities” - Quarantelli, 1985. Therefore, disaster management can be explained as a series of activities to improve the capability of society. Disaster management usually aims to reduce, or avoid, the potential losses from hazards, assure prompt and appropriate response to a disaster, and achieve rapid and effective recovery [1.1]. Disaster management can be achieved by assembling many element management techniques.

The Terms of Reference of the 2016-2019 Strategic Plan for WG1 are presented in Table 1.2.1:

Table 1.2.1. Terms of Reference for TC E.3

TC E.3.1 Disaster Management	
Strategies	***Outputs***
To maintain and disseminate information related to road administration response strategies for natural disasters. Study and document practices to ensure a quick and safe recovery from major disasters.	Update of the Disaster Management Manual elaborated by TC 1.5 (Risk Management) in current cycle. Report on case studies and recommendations.

Technical Committee (TC) E.3 “Disaster Management” of PIARC focuses on two major current disaster management activities that aim to lessen the impact of disaster. One is “Disaster Information Management for road administrators” and the other one is “Disaster Management and Recovery Techniques for Road Administrators”. In order to progress research on these two topics, TC E3 comprises of two working groups (WGs):

WG1 – Disaster Information Management for road administrators (Issue E.3.1)

> “To maintain and disseminate information related to road administration response strategies for natural disasters.”

WG2 – Disaster Management and Recovery Techniques for Road Administrators (Issue E.3.1)

> “Study and document practices to ensure a quick and safe recovery from major disasters”.

Current disaster management techniques are summarized in Figure 1.1.1. Each management phase, “Mitigation”, “Preparedness”, “Response”, and “Recovery”, includes soft and hard management techniques. WG1 covers the area of soft management techniques such as “Disaster management with public” and “Information sharing and management”. WG2 covers the area of conventional but well advanced techniques for disaster management. These are regarded as hard management techniques.

The scope of the WG1 study is as follows:

- Disaster information management

- Requirements for disaster information by road administrators (Visual inspection by road authorities, Road side equipment and new technologies) and use of web data provided by the public (Prove data, SNS data and etc.)
- Acquisition and provision of disaster information through road administration devices and public and web media
- Match and mismatch between information required and provided (Driver oriented or administration oriented)
- The difference between the needs of web visitors and provided information

- Disaster management with the public
  - Measuring techniques of public perception of risk acceptance and their applications
  - Public involvement in disaster prevention decisions
- Update risk and disaster management manual
  - Enrich contents in risk management as well as disaster management.

The following items were out of scope of the WG1 study:

- ITS technology in daily road operations (e.g., Traffic safety, Congestion control)
- How safe is safe enough?
- Structural design criteria and safety index against natural external loads
- New web application development of disaster management manual.

This report is an output of WG1, i.e. soft management techniques to manage disasters.. It is a product of a number of activities that have been undertaken by the members of WG1 including providing examples of practices and relevant case studies using information form their country, information from international workshops and seminars held in Austria, Czech, Japan, Cuba, Chile, Vietnam and USA, literature review and from contributions provided by other members and contributors members of TC E.3.

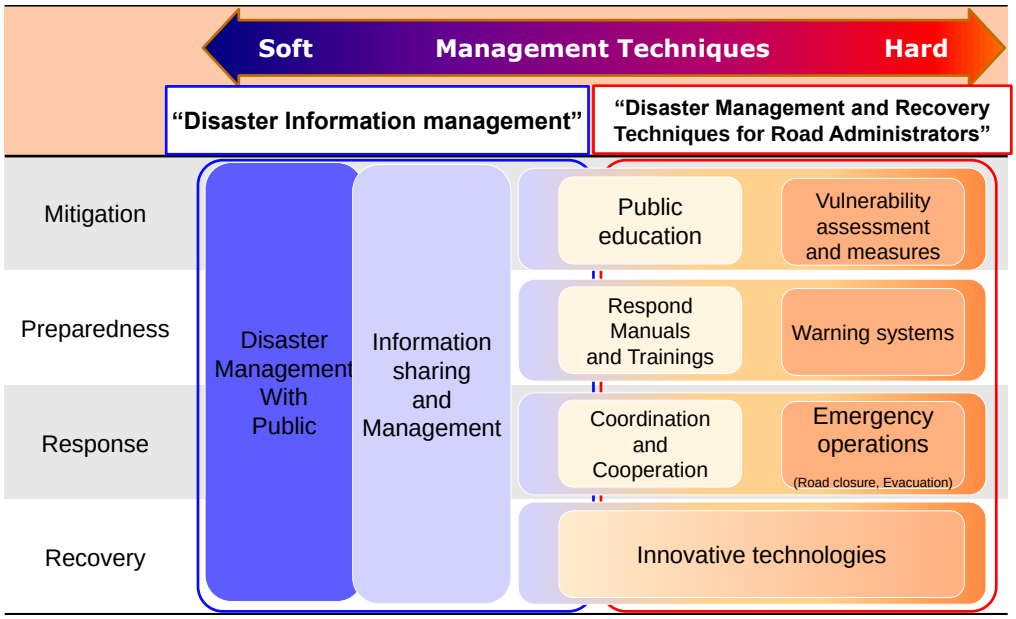


Figure 1.1.1. Overview of techniques in disaster management and the study area in this cycle

1.2. STRUCTURE OF REPORT

The structure of this report is represented below (Figure 1.3.1) and preceded by a brief explanation of the contents of each Section:

Section 1 provides a general introduction of this report.

Section 2 presents disaster management principles.

Section 3 presents the current practices of disaster information management, which was analyzed using the results of an international survey, withbest practices identified such as centralized management of disaster information in Japan, information provision actively using SNS in the United States, tsunami information and warning in Chile.

Section 4 presents disaster management techniques in each country, which were analyzed according to the types of disasters experienced, with best practices identified in the areas of disaster prevention activities involving road users in Australia and UK, and road disaster prevention activity against the tsunami with road side residents in Japan.

Section 5 presents principles, methodologies and case studies collected in the past PIARC TC activities in risk and disaster management, which are available in the searchable PIARC web database.

Section 6 summarizes the conclusions of the report and Section 7 presents a listing of references.

In addition to case studies and methodologies collected internationally, an international survey was conducted with respect to best practices in information management and disaster management with the public.

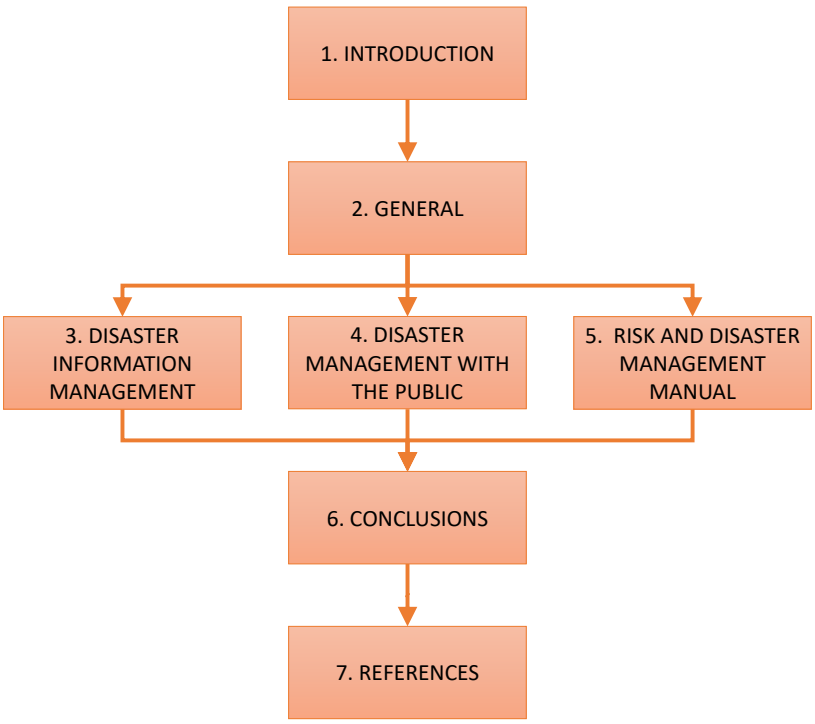


Figure 1.3.1 Structure of this report

2. GENERAL

Countries that experience disasters have been accumulating their unique disaster management and countermeasure technologies. As society diversifies, the damage that disasters cause has also changed. Therefore, technologies necessary for disaster management in each country are also changing as the society grows. Most disaster management technologies have been developed for the emergency management phase. From another point of view, previous disaster management technology has been mainly developed in the area of hard management such as safe infrastructure. However, due to the limitation of improvements in this area, the importance of management techniques in pre-event, emergency and post-event phases has been recognized, demanding a combination of hard and soft management.

Disaster management activities of road organisations are triggered by the disaster information provided. The quality of the information governs the quality of the management. Moreover, the explosive widespread use of mobile devices means governments can instantaneously convey a huge amount of important information to road users. Information management plays an very important role in disaster management. Therefore, advanced technology in information management in the pre-event and emergency phases is essential for best practice disaster management to reduce or prevent primary, secondary or subsequent disaster damage to road users.

In the 2010 Chile earthquake, a wide area of Chile's coastal area was devastated by the giant tsunami after the earthquake. From the view point of information management, a crucial tsunami-warning system failed to alert residents to the fact that they were in the path of an incoming giant wave [2.1]. In the 2011 East Japan Earthquake, 40% of the drivers travelling on highways at the time of the earthquake continued their driving even though they recognized the VMS signs of "STOP" or "Earthquake Road Closure" or information about a tsunami coming from radio or other media[2.2]. In the 2011 East Japan Earthquake, passable road maps delivered from car manufacturers and web and social media contributed to the emergency activities in the

Figure 2.1 Role of information management in disaster management

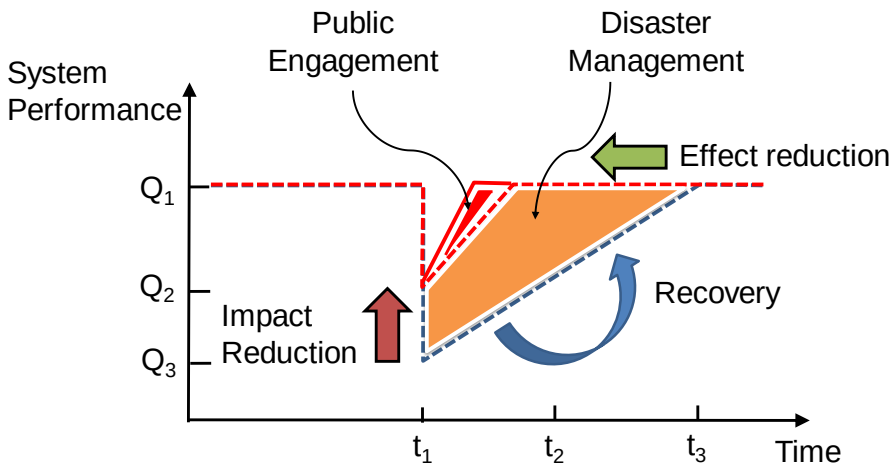


Figure 2.2. Image of role of public engagement and disaster management in system performance curve

hazard region [2.3]. As described above, information management took a main role in disaster management and current information technologies have created a new area of disaster management.

Countries that experience disasters have developed their unique management technologies based on their disaster experiences. Diverse knowledge exchange has being undertaken to share these disaster management technologies. An emerging trend is to review traditional disaster management, with its focus on making infrastructure safe, as this limits the mitigation and reduction of the impacts of disasters. According to current experiences, public engagement or public involvement activities have become an important part of infrastructure development, and disaster management . Disaster management now pays more attention to disaster management activities with the public and the society [2.4].

In the 2011 Queensland floods, a wide area of eastern Australia was significantly impacted by three months of consecutive flood events. According to the lessons learned from this flood, the local government leads major campaigns to engage local communities and encourage individuals to be active in preparedness for the storm season [2.5]. As one of the lessons learned from the 2011 East Japan earthquake, a lot of the residents survived on the highway embankment in the low-lying area. Now highway companies and local residents have made an agreement to promote cooperation in daily maintenance of the highway embankment and in emergency rescue in a tsunami disaster [2.6].

To encourage the sharing and implementation of disaster management technologies and practices, an easily accessible, webbased risk and disaster management database has been requested. A lot of previous PIARC activities related to disaster management have been compiled. In order to promote the dissemination of this important information, PIARC developed a “risk and disaster management manual” that is available on the web. This report covers the outline of the manual.

According to the background described above, the WG1 of the PIARC Technical committee E3 on disaster management made a four-year study on “Disaster Information Management”, “Disaster

Figure 2.3 Cover page of risk and disaster management manual

Management with the Public" and the web-based "Risk and Disaster Management Manual". In this report, the role of disaster information management, disaster management with the public, and the risk and disaster management manual are discussed and major case studies are collected and displayed.

3. DISASTER INFORMATION MANAGEMENT

3.1. INTRODUCTION

In the development of this topic, a large number of disaster specialists from the PIARC member countries have participatedin analysing important needs in information and communication in emergency situations.

The management of information and communication should be part of a planned process that road organizations use to manage risk and disaster. Information and communication management is currently considered as an indispensable part of disaster management. Both the protocol development and tool investment in information and communication management are becoming very important tasks that should be developed by road organizations. Information is the most valuable asset not only during an emergency but also in the pre-event and post-event situation, so it is very important to study the ways of managing disaster and disasterrelated information and data.

Disaster management activities rely on information, which enable better coordination among all agencies who deal with emergencies. This task will be more effective where the information management issues are well understood and there is a exchange of information between agencies and the public through appropriate communication techniques and processes. It should be noted that the tasks of collecting, communicating and disseminating information in emergencies is always dealt with in complex and stressful situations, where the public only require the most immediate and urgent information.

Such information should be collected, analyzed and provided to the public and technical agencies. It is also important to understand that information for the public and technical agencies should be consistent for better understanding of disaster situations and to assist individuals in preparing against subsequent and anticipated events. However, public information and technical information is required to be presented differently to communicate effectively to different audiences. Effective and efficient procedures for communication or administrative structures for sharing this information are required and should be implemented early.

New computer software and other tools based on new technologies greatly assist in information processing and collection. Social media, web media and SNS services are very powerful tools to almost instantly disseminate any kind of data to many people worldwide. Current technology creates a real advantage, which combined with databases, improves information analysis and sharing. However excessive reliance on new technology can be inappropriate. Road administrators should be prepared for electricity outages and damage to communications facilities such as phone towers to disrupt communication. It should also be pointed out that road administrators should consider sharing information with other countries, in order to get a good comparison of results.

In this report, current practices regarding disaster infomation management of different countries through an international survey and collection of case of study were reviewed to identify the best practices for dealing with an emergency or disaster situation. Recommendations have been made to help road organisations understand and manage the context of the emergency and facilitate information management and public communication tasks.

3.2. INTERNATIONAL SURVEY

3.2.1. Development of international survey

The survey on disaster information sharing and management is a tool that allows an overview of information management during an emergency situation. The goal of the survey was to collect information management data in the disaster timeline shown in Figure 3.2.1.1. As indicated in Figure 3.2.1.1, the survey was planned from when the emergency occurred, the first response phase and dissemination of the disaster information to the public.

The survey questionnaires related to road administration emergency management were prepared by the WG1 – Disaster Information Management, focused on the disaster response phase, analyzing current practices among PIARC member countries and others.

The survey included questions on basic information of responders, and questions on disaster information sharing and management practices in their organizations. The survey was based on several key issues to investigate the information management process. In total, the survey included six questions on public information and two questions on technical information.

- Communication structure: This first question related to communication issues during emergency situations. It aimed to review if roads administrations are aware of the importance of communication skills, in order to improve resilience and avoid misunderstandings.
- Communication plan: This question related to several planned actions or activities that should be done to deliver information to road users or other organizations.
- Communication action before the public announcement: This question aimed to get an overview of road administration agency procedures before delivering user/public warnings or information.
- Gathering emergency information for the public announcement: There are many ways to gather information, especially with new technology, so it is relevant to overview this task.
- Standardized forms to gather public information (SitRep): The concept of standard forms (SitRep) is useful to manage a huge quantity of data, where that information must be similar to be easily collated. Also, they are optimal to avoid the dependence on technology.

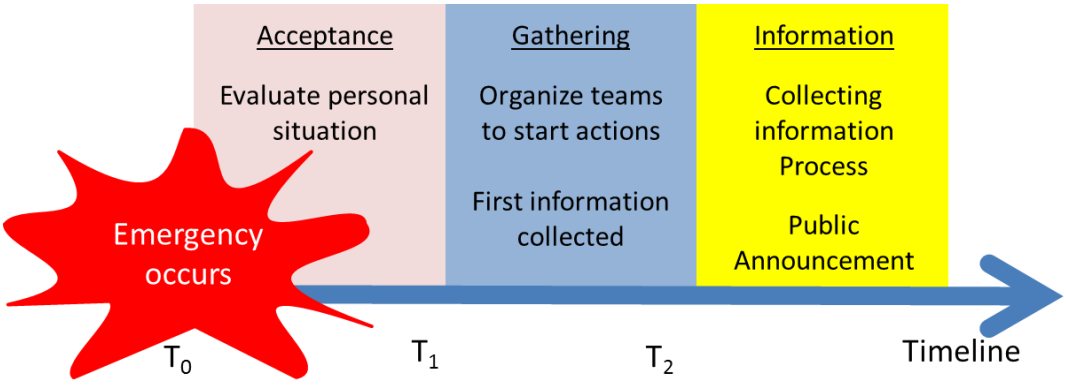


Figure 3.2.1.1. Timeline of infomation management in emergency

EN *ES* *JP*

Figure 3.2.1.2. International survey documents

- Public and technical information: Usually roads administrators use a special vocabulary that is not known by the general public, so misunderstandings or lack of relevant information could occur between agents and users/public, including political authorities. Therefore, it is relevant to understand if countries are aware and provide different information to technical and non-technical stakeholders.
- Use of technical information: This question focussed on the use of technical information collected during emergencies.
- Technical information gathering method: It is necessary to know if there are non-traditional methods or any other kinds of procedure to collect technical information. It is logical to consider using new technology, but in a disaster situation technology is not necessarily the most reliable way to get information.

The survey form was originally developed by TC E.3 Technical Secretaries from Chile and Japan, and the final draft was translated into three languages (English, Spanish and Japanese) in February 2017.

3.2.2. Results of international survey

The survey was sent to PIARC CT E3 members and also to South American countries, by the cooperation of DIRCAIBEA (Council of Road Administration Directors from Iberia and Latin America). The answers were received from 19 countries shown in Table 3.2.2.1.

An initial analysis was made to the communication structure. According to the survey results, all of the survey countries have a similar communication structure, composed of collecting information from different kind of sources, managing information and processing information in the management control center, and disseminating and announcing information through VMS or public media. The general communication structure is shown in Figure 3.2.2.1.

Some countries pointed out that the vital role of the emergency management center is not only road operation management but also communication management. One of the main roles of communication management is to coordinate sharing the disaster and emergency information among road organizations, related organizations and road users through internal and external communication. This function is very important but only generic communication plans have been developed in each country. There are few examples of pre-determined detailed communication plans for emergency situations. Figure 3.2.2.2 (a) shows a typical internal communication diagram between a central communication center and their branch offices in road organizations. Figure

Table 3.2.2.1 the number of collected International survey results

Survey Type	Received	Countries
Survey through TC Members	13	Austria, Australia (2), Chile, UK, Japan (6), USA(2)
Survey through First Delegates	4	Canada-Quebec, Denmark, Hungary, Mexico
Survey through Related Organizations	1	Dominican republic
Others	1	Malaysia
Total	**19**	

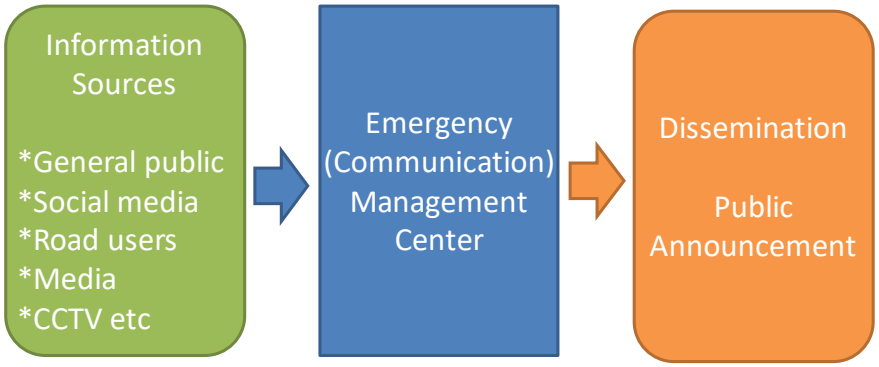


Figure 3.2.2.1. General structure flow of communication in emergency in terms of public information

3.2.2.2 (b) shows an external communication diagram from collection of the disaster information to dissemination of the disaster information to the public.

Figure 3.2.2.3, developed in the disaster management study in the PIARC previous cycle [3.1], indicates the importance of cooperation inside road-related organizations. This figure also shows the importance of communication between road-related and non-road-related organizations. This diagram can also be applied to communication:

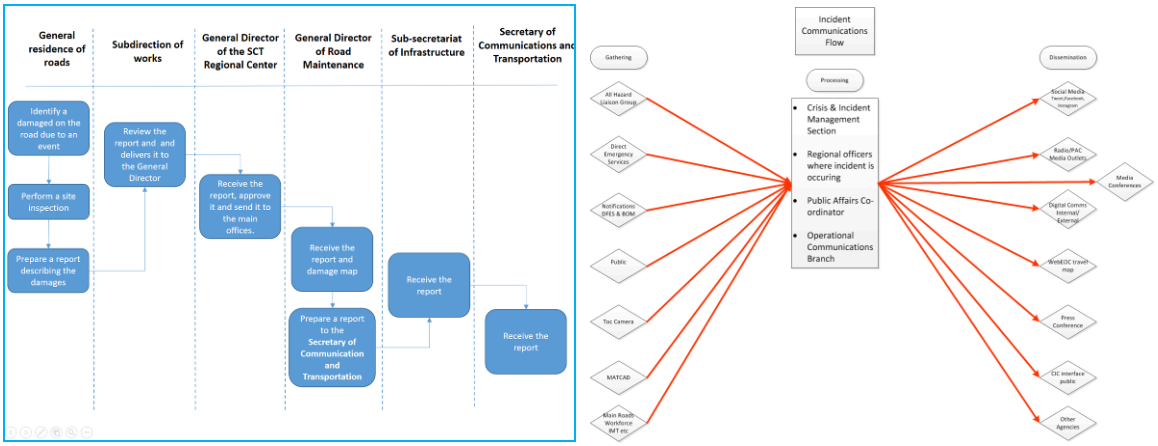
1) Communication in federal, state and municipal level

2) Coordination in ministry level

3) Coordination with relevant authorities

4) Coordination with technical specialists and political authorities.

According to the findings from the survey, it is identified that enhanced internal communication results in emergency management improvements.. To ensure effective communication, daily communication practices are necessary. Coordination with technical specialists and political authorities is also a part of internal communication which is needed for decision making. In order to strengthen such decision making, clarification of authority and responsibilities, is essential.



(a) Internal communication Structure (MEX) *(b) External communication structure (AUS)*

Figure 3.2.2.2. Internal and external communication structure

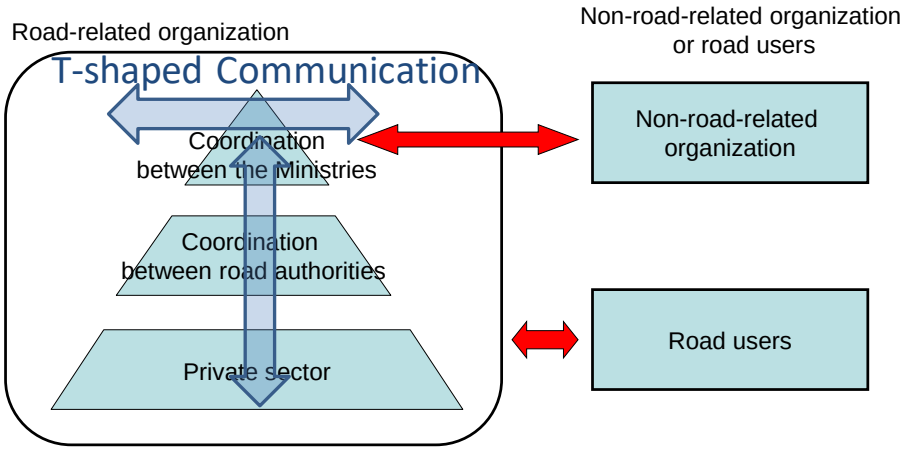


Figure 3.2.2.3. The cooperation structure proposed by PIARC TC 1.5 in the 2012-2016 cycle.

Figure 3.2.2.4 shows the general status of situation reporting. Half of the survey countries have a standard form (SitRep) to report the incident/disaster situation. Other countries reported the incident/disaster situation in free format. Whether the standard situation reports (SitReps) are prepared or not, most countries had developed a database or report system for better emergency response. SitReps are very effective to standardise information and are easy to use but may not be as effective for irregular incidents such as multiple modes of incidents/disasters. However, they are an efficient way of systematizing information and as a backup plan when communications systems are lost. As for free format reporting system, it is powerful to report any kind of incident and disaster, but the quality of the report depends on the skill of the reporter.

Figure 3.2.2.5 shows the difference between processing public information and technical information. They each have a particular function, therefore pubic information and technical information are treated differently in general. However some countries tried to link both kinds of information in order to show the technical background to the public.

Standard Form	Data Base
	
Standard form (SitRep) to gather information to allow departments to tailor public information	Information is gathered in database system.
8/12 countries	12/12 countries

Figure 3.2.2.4. Reporting system of disaster information.

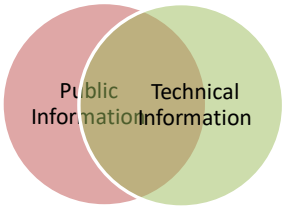
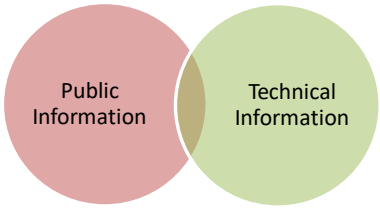
	
Public information office serves as the liaison between technical and public information	Public information and technical information disseminate separately considering their functions.
4/12 countries	8/12 countries

Figure 3.2.2.5. Public information and technical information

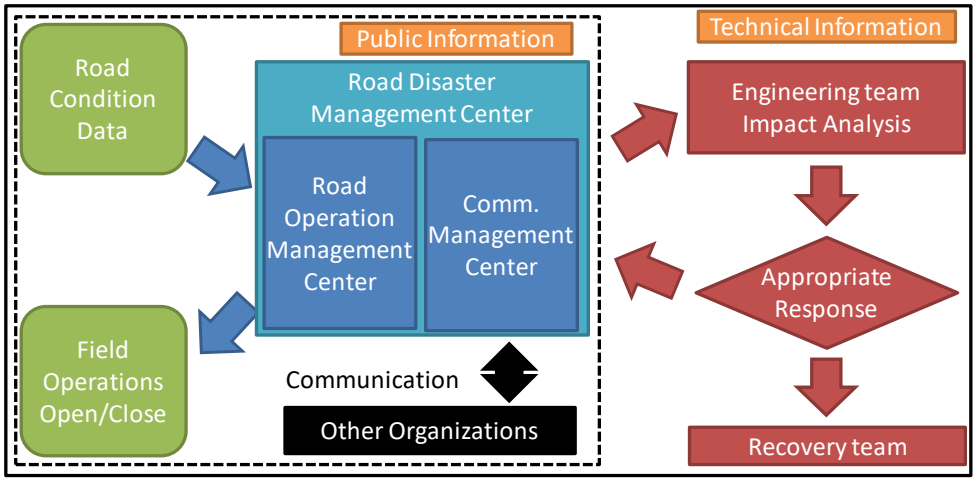
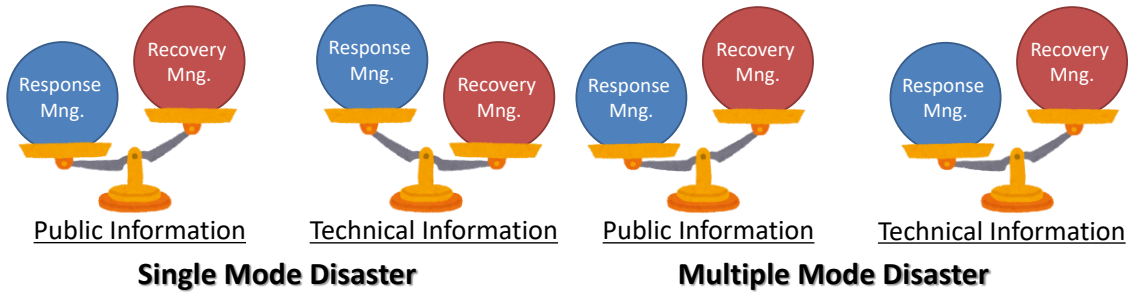


Figure 3.2.2.6. General structure flow of communication in emergency in terms of technical information

Figure 3.2.2.6 shows the general flow of technical information. The collection of disaster information is the same as for public information. The difference is that the technical information is processed by a special engineering team. After the engineering analysis of the disaster, an appropriate response is fed back to the management center. Analysis and synthesis of public and



(a) Single mode disaster *(b) Multiple mode disaster*

Figure 3.2.2.7. Public and technical information in response and recovery management

technical information in the management center is required before it is made public, to effectively respond and avoid a secondary disaster.

Generally speaking, as shown in Figure 3.2.2.7, public information is very important to response management, whereas the technical information is very important in recovery management. This is one of the reasons why public information and technical information are treated separately. This idea is effective in management of single mode disaster. In the case of a multiple mode disaster, such as simultaneous multiple disasters or consecutive multiple mode disasters, technical information is also very important in response management, such as earthquake and tsunami, land slide and debris dam, and also heavy rain and flooding. Therefore, linking public and technical information should be considered in disaster management.

Figure 3.2.2.8 shows the current preparedness of communication tools where communication is restricted. In the survey countries, there are no alternative tools except tools shown in Figure 3.2.3.9. Survey answers in relation to tools used where no communication line is available are varied. This indicates that preparation for the loss of communication lines should be considered.

Figure 3.2.2.9 shows a summary of the communication recovery for the 2011 East Japan earthquake and tsunami. The communication tools recovered gradually from elementary to complex tools. Countries should prepare for communication in this environment.

3.2.3. Summary of international survey

3.2.3.1 Gathering information (Social network, ITV, etc.)

Despite all road authorities having similarities in communication structures, a detailed communication planning is not described well in their manuals. Communication structure in emergencies is a key component of information management. Development of a communication structure is urgently recommended in many road organizations.

Social media and communication technology allow efficient exchange of information. But it can become risky when information comes from several sources and each one has a different interest and goals.

Reliability of information is required in order to inform and not misinform, especially when the population is facing a major disaster.

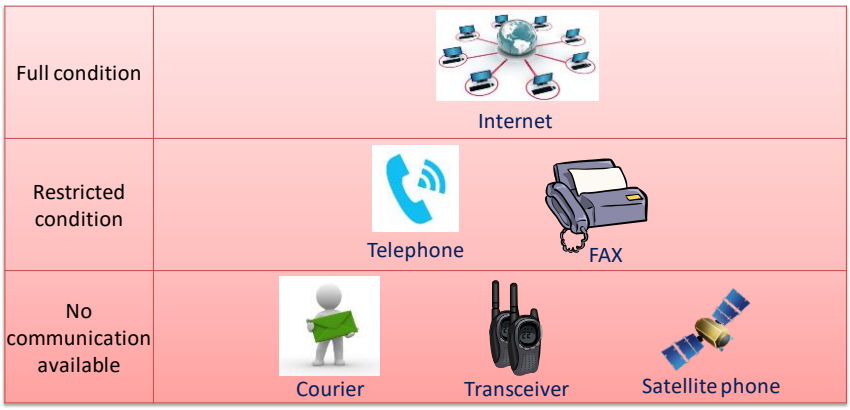


Figure 3.2.2.8. Preparedness in communication tools where communication is restricted

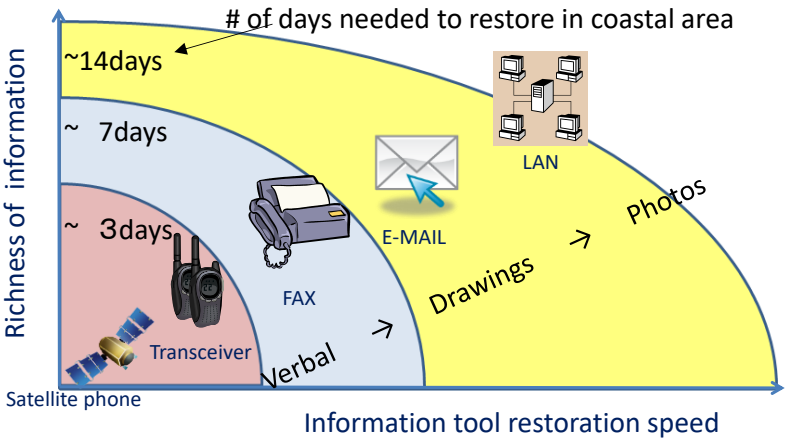


Figure 3.2.2.9. Communication speed with the recovery of communication infrastructure

User information is very fast but less reliable than road agency information, due the requirement to firstly validate it.. Preliminary technical information is useful to establish preliminary frameworks for resources and budget.

The importance of backup for complex communication scenarios should be taken into consideration. While information gathering methods that rely on technology are important, it is convenient to have a method for instances where there is a lack of connection.

Media sharing needs behavioural rules, as excessive text or fake images add inefficiency to the process.

During a scenario of full communication, the internet and social media are widely accepted as reliable and efficient ways to transfer data. However, old technology is reliable when a communications restriction appears.

3.2.3.2 Sharing information (mass media, web media, social network)

Social media and new technology are changing communication and how information is shared.

Data is transmitted worldwide very fast and to many people instantaneously. But in an emergency situation, systems or technology could be affected. That is why it is important to establish how to transmit the information in several situations.

Questions in the survey aimed to understand what systems are used as backups in extreme situations.

3.2.3.3 Road users information and technical information

User information and technical information are different due to their different objectives. What users need is information about connectivity and traffic conditions (average operational status and connectivity) but road agencies need information about infrastructure conditions and damage to establish emergency teams for response.

Technical information about infrastructure damage is more detailed and slow to be obtained. Damage needs to be identified on site or via monitoring technology, and also needs a technical vocabulary that is not always understandable for road users.

This must be taken into account when you define the ways to share information in multiple mode scenarios, as technical information must be deposited in a database in order to process it and obtain relevant data for planning, but user information is not necessarily useful as historical data as long as users are informed.

Technical information should be standardized and not rely on a particular software package or database, which may contribute to misunderstanding and bad decision making. This will require some training and coordination among road agencies and organizations.

3.3. CASE STUDIES

3.3.1. General

The following case studies are contributions from each country and refer to disasters and how they were faced. The objective of gathering this information is to strengthen the exchange of knowledge and analysis of the different cases, which allows road agencies to extract lessons that could be applied to their work.

3.3.2. Communication problems during major disasters (Chilean case study)

3.3.2.1 Introduction

On February 27, 2010, Chile was hit by an earthquake that reached a magnitude of 8.8 MW. After the earthquake, a tsunami reached the shore causing most of fatalities. Figure 3.3.2.1 shows the epicenter of the 2010 Chile earthquake.

At Valparaiso city, SHOA (Hydrographic and oceanographic service of the Chilean Army) officials maintained the cancellation of the tsunami, ignoring the data of an oceanographer expert who insisted that they were misunderstanding the data and "destructive waves" were about to reach the coast. The same warning was sent by PACIFIC TSUNAMI WARNING CENTER (PTWC) officials from Hawaii, one hour and ten minutes after the earthquake.

The civil counterpart of SHOA, the National Emergency Office of the Ministry of the Interior (ONEMI), misinterpreted the alert sent by that agency.

The regional and later the national authorities misunderstood the information, which caused the death of dozens of people.

The earthquake tested the country's capacity to face a greater emergency. The tragedy left 525 dead, more than two million homeless and more than 370,000 homes damaged.

3.3.2.2 Analysis of problems occurred

(1) Information sent from the Biobío Region was not considered at ONEMI

Minutes after the earthquake occurred, Regional ONEMI of the Biobío Region called to the EARLY WARNING CENTER (CAT) of ONEMI to report an earthquake grade from IX to X on the Mercalli scale. The receiver of this call reported that it was a minor grade (VII). This error resulted in the lack of warnings for evacuation of coastal areas.

(2) Unknown message from Pacific Tsunami Warning Center PTWCH

The Pacific Tsunami Warning Center in Hawaii (3:39) sent a message to SHOA, reporting the earthquake at 8.5 on the Richter scale. However, the SHOA did not receive this report because the signal at that moment is lost. Therefore, it was necessary to wait for the satellite signal, which only reports every hour.

Figure 3.3.2.1 Epicenter of 2010 Chile earthquake

Figure 3.3.2.2 & Figure 3.3.2.3 Coastal area just after the earthquake

Figure 3.3.2.4 & Figure 3.3.2.5 Coastal area after the tsunami

(3) Language

Hawaii sent the first report with the magnitude and due to the null confirmation by the SHOA, they communicated by phone with Chile, but the person who answered did not speak English. A Cuban geophysicist who worked in the office in Hawaii should have delivered the message.

Figure 3.3.2.6 Tsunami inundation damage

(4) Communications

At the time the tsunami arrived on the coast, the shift officials of the CAT sent the data by radio to the civil protection network, informing that the magnitude of the earthquake in the city of Concepción had been grade VII, and did not consider the information from the region.

Later, the Maule and Biobío region could not establish more contact with ONEMI, which meant that there was no information about the sighting of the destructive waves in those places.

(5) Only eight installations of the Genmercalli naval and maritime network received the message

When the SHOA decided to send the tsunami alert, by email, fax and radio, both to ONEMI and to 70 installations of the Genmercalli naval and maritime network, only eight received the message. The SHOA believed that everyone had received the signal and they did not wait for confirmation from the other locations.

(6) Wrong information

The SHOA reported that when the radio message was sent to ONEMI, warning of the presence of an eventual tsunami, it was not made public because the National Emergency Office had warned that the epicenter was on the ground, discarding the alert of a seaquake.

(7) "Tsunami warning"

From the SHOA a fax entitled "Tsunami Warning" was sent, which included the probable hours of arrival of the waves to the coast. But ONEMI did not send the tsunami alarm, because they understood that the first waves had not arrived, however a second wave had already arrived at Pichilemu town.

(8) Cancellation of tsunami warning

Fifty minutes after the SHOA sent the "Tsunami Warning" by fax, a new message was sent canceling the tsunami alert. At least 32 people were killed by waves that arrived after an hour of sending the new message.

(9) The only SHOA oceanographer was not heard

When the oceanographer, head of the tsunami section of the SHOA, knew that the tsunami warning had been canceled, they asked their superior why that decision had been made, to which they were told that the tide gauges indicated that the sea was beginning to stabilize. Subsequently, they went to the graphs, and realized that it was very possible that more destructive waves would arrive to the Chilean coasts. When they warned that a "tsunami alarm" should be established, their statements were dismissed.

(10) An anomalous variation of only 20 centimeters

At 5:17 in the morning, the ONEMI consulted the SHOA for the situation on Juan Fernández Island, 47 minutes after the first wave had already entered the archipelago. At 5.18 the SHOA informed the ONEMI, that there was only an anomalous variation of twenty centimeters in the level of the sea.

(11) "Tsunami confirmed"

Another alert that came to the SHOA was from the naval base of the port of Talcahuano, through a text message that announced "confirmed tsunami on base. Average sea level 6 meters in Sub Force. A wave flooded without breaking."

The message was sent at 5:34, 26 minutes before the arrival of the largest wave to the port, that information should be considered as a sighting of a trained observer, however the SHOA reported that this message was received at 6:43.

(12) There is no more tsunami warning

Around 5:20 in the morning, the former mayor of the Biobío Region told Radio Biobío that there was no "Tsunami Warning". When thousands of people heard this message on the radio, they decided to return to the risk areas in Talcahuano and Dichato cities, where waves would take more lives later.

3.3.2.3 Lessons learned - Application to the Highway Administration

(1) The information flows from the place where the emergency situation is occurring

It is necessary to establish a hierarchy of communication, using all possible means, with the aim of obtaining information from the affected area and, through planned communications, clearly establish the procedure and obligations of each officer.

(2) The language must be correct

Although the information will flow within the country, a formal language must necessarily be established to avoid misunderstandings or lack of communication. In addition, guidelines must be established on the veracity, extent and content of the information.

(3) Misinformed decisions

Information is the key for authorities' decision-making. Correct and pertinent information improves the effectiveness of that decision.

(4) Technical decisions at higher hierarchical levels

Disaster management staff at a local level may be best placed to make operational decisions during emergency events, while keeping central authorities informed so they can coordinate response efforts effectively.

3.3.3. Emergency Action Plan for Roads Administration in Chile -Implementation of the Emergency Action Plan and Information Recovery (Chilean case study)

3.3.3.1 Context

The Roads Administration of the Ministry of Public Works of Chile is in charge of maintaining the connectivity and trafficability of the national road network. Due to the country's location on the globe, Chile is over the Ring of Fire, generating the largest earthquakes worldwide. Notwithstanding, the country is exposed to all kinds of natural catastrophes, except for hurricanes, due to the temperature of the sea water. However, in recent years there have been many tidal waves and waterspouts, due to climate change, that have reached land, causing isolated damages. In this sense, and considering only the response phase in the process of emergencies, the Roads Department requires an immediate reaction, through the correct transmission of information and communication to users. To do this, we have tools to quickly assist on any point of the national network, which makes it a strategic government entity. Due to the above, an Emergency Action Plan was implemented at the national level, in order to face emergencies on road infrastructure in a coordinated and efficient manner.

3.3.3.2 Emergency Action Plan

The objective of the Emergency Action Plan is to generate an efficient and known information flow and coordination for all levels of command that participate in a disaster or emergency situation, in any part of the national territory, and with a high level of reliability, that enables better decision making by authorities and communication to users. Likewise, it is about having a unique, ordered and collaborative database, which also allows interoperation with other systems.

3.3.3.3 Implementation Strategy

To carry out the above, the issue was divided into two parts to be reviewed, Communication and Information, understanding that they are parallel and related processes.

COMMUNICATION refers to the transmission of relevant data to users, in order to keep the public informed about the situation of the road network during an emergency, avoiding greater problems in the areas in question.

For this, the necessary information was collected in a coordinated way, to be transmitted it to the users through the agreed means. This task prevented the large number of reports that each authority requested separately, according to various interests and haste.

Notwithstanding, the response phase during an emergency situation is a time of great stress, which is why clearly establishing what each actor must do minimizes the tension and allows the response to be smoother and more efficient.

The information required by the authorities was generated through interviews and consultations through the Working Group of Emergency Coordinators at the Ministerial level, where the necessary concepts for communication with users were established. The result contains what each concept means, since the language tends to be somewhat different at a technical level.

On the other hand, INFORMATION refers to the generation of the historical database (SIEMOP – Public Works Emergency Information System) of damage on each of the roads that make up the road network.

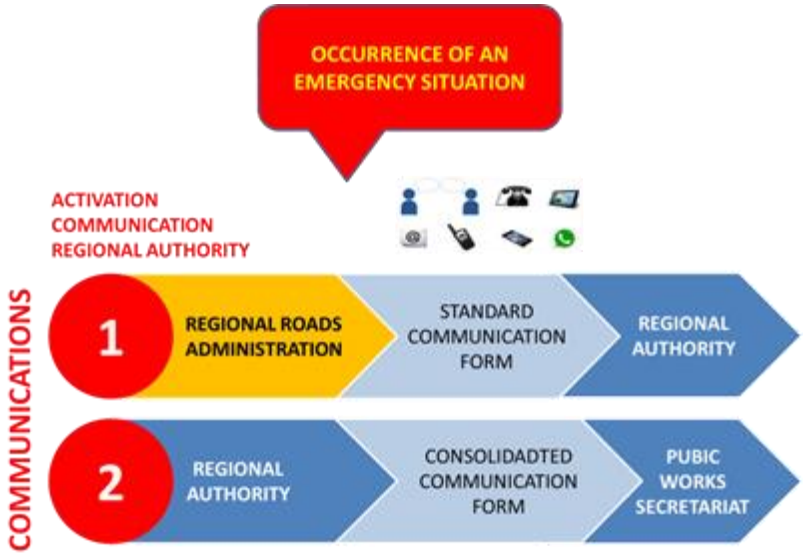


Figure 3.3.3.3. Coordination scheme for communication

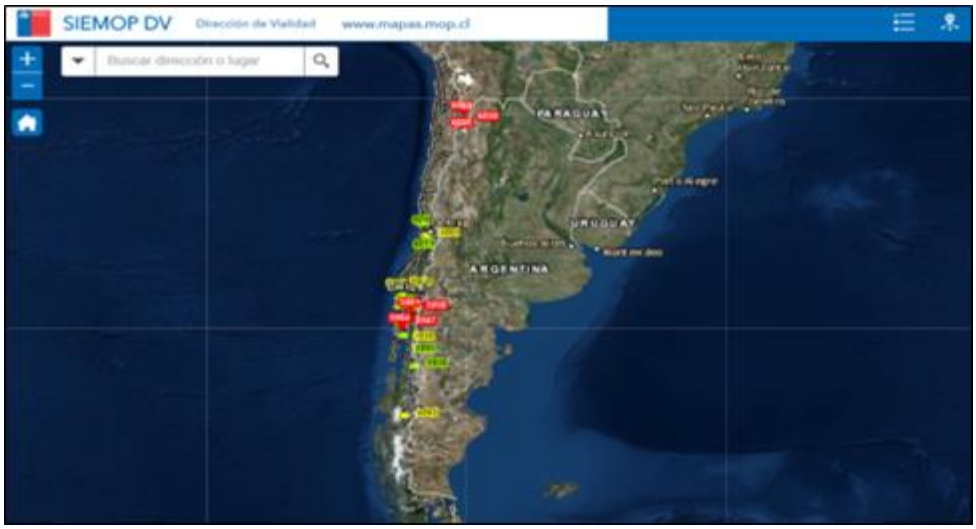


Figure. 3.3.3.4 – Internet view of national emergencies
(Chilean Roads Directorate – Sub-department of Cartography and GIS)

Figure. 3.3.3.5 – Coordination scheme for data record and review

At the same time, the data is collected in the official database with specific information for the production of GIS maps and the monitoring of the emergency event.

It should be noted that, as long as the emergency records are entered, the maps are generated automatically, allowing it to be viewed through the internet for all types of devices available.

This requires ongoing coordination and consistency of guidelines to record information to the database.

3.3.3.4 Results and conclusions

The Road Administration has had a database of road damage since the launch of the SIEMOP in 2015.

It is worth highlighting the case in the Atacama Region, the driest desert in the world, where mudflows caused great damages to roads, in consecutive years and similar magnitudes, in the autumn season.

Having data about locations on the road network that suffered recurrent damage informed agencies about where to undertake mitigation works that would provide a higher degree of resilience to the infrastructure.

It was also possible to share the information with other organizations through the Geographical Information System.

The available social media were used to communicate the news coming from the affected areas, which kept the authorities constantly informed.

From the coordination and generation of the official database, the next steps are to obtain other products for the improvement of emergency management:

- Estimation of the preliminary budget for recovery and the economic impact

- Relationship between emergency records and works performed

- Traceability of information.

A communication structure was created with permanent trainers, instructions, procedures, coordination meetings, quality control processes and quality assurance, that allow automatic processes to be reliable, keeps users informed and updates a database of the damage to road infrastructure.

In addition, with the decrease of report requests, human resources were released to operate the SIEMOP (record information).

The fact that the system is published on the internet allows staff to record information at any time and from any part of the planet, covering the entire Ministry of Public Works Infrastructure, and not only applied to roads.

3.3.4. Disaster Information Management (Dominican Republic case study)

3.3.4.1 Emergency operations center (EOC)

The Caribbean Region is located in the path of hurricanes and exposed especially to natural disasters caused by hydro meteorological phenomena.
The cyclonology of the Dominican Republic is marked by multiple impacts of hydro meteorological events. It should be noted that from 1871 to 2004 some 22 phenomena have impacted the coasts of the country, with the following nine storms and hurricanes the most intense because of their adverse effects:

1. Hurricane San Zenón (September 3, 1930): winds of 324 km/h caused the loss of 4500 lives and more than 20,000 injured, with an estimated economic cost of USD $20 million.

2. Hurricane Flora (October 3, 1963): winds that reached 350 km/h caused the death of 400 people and economic losses of more than USD $60 million.

3. Hurricane Ines (September 26, 1966): caused 60 deaths and estimated economic losses of USD $10 million.

4. Hurricane David (August 31, 1979): winds that reached 200 km/h. More than 1000 people died and losses were estimated at USD $20 million.

5. Storm Hydrangea (1996): hit the eastern part of the country, leaving nine dead and millions in losses to infrastructure, agriculture and the tourism sector.

6. Hurricane Georges (September 22, 1998): caused 247 deaths and economic losses of USD $ 1.4 billion.

7. Hurricane Jeanne (September 17, 2004): caused 11 deaths and losses of more than USD $250 million.

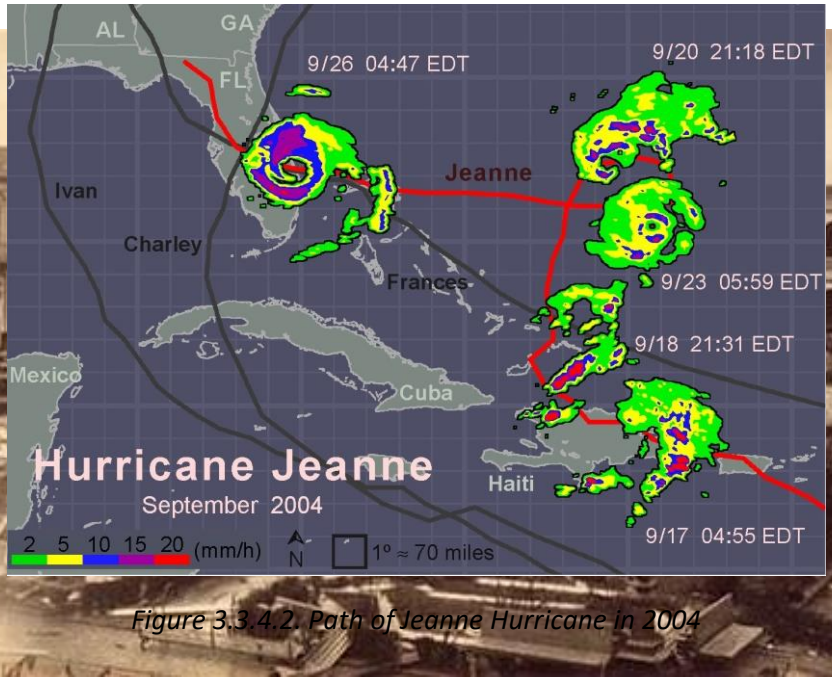


Figure 3.3.4.2. Path of Jeanne Hurricane in 2004

Figure 3.3.4.1. Destruction caused by San Zenón Hurricane in the Dominican Republic

8. Storm Noel (October 28, 2007): caused 87 deaths and losses of more than USD $250 million.

9. Storm Olga (December 11, 2007): caused 31 deaths and losses of more than USD $120 million.

In the last 34 years, the Dominican Republic has been impacted by 16 tropical cyclones, of which five have impacted as hurricanes and eleven as tropical storms. This shows that approximately every decade our country has been impacted by an average of five hydro meteorological phenomena, these being manifested with greater recurrence in the eastern and southern regions of the country.

It should be noted that the estimate of economic losses in the last six severe events that have impacted the country amounts to an approximate amount of USD $2.34 billion, according to estimates made by ECLAC.

Hydro meteorological events produce a great variety of damages, which can be: social, environmental, economic and structural, however, it immediately produces damages in hydraulic

resources, in buildings, in the agricultural sector, damages in the communication routes, streets and roads due to landslides, damage to aqueduct systems, industries and free zones, sewerage systems, pipelines and gas supply due to broken pipes; damage to bridge structures and irrigation channels, water intakes, insulators and transformers in electrical substations, wired and wireless communication systems.

Mild or severe damage can also be reported in homes, in storage tanks for fuels, water and chemical products. In special cases the damage is to infrastructure and services that are considered vital for the management of an emergency, since they should continue to function when there is a disaster, such as premises of the first response institutions, hospitals, primary care centers, rural clinics and telecommunications both state and private, ports and airports etc. There may also be partial or total damage to some structures that house many people during a certain time, such as public and private schools, clubs, sports centers, community centers, commercial places, cinemas, theaters, convention centers, hotels, churches, public offices and universities.

3.3.4.2 Definition

The Emergency Operations Center (COE), complies with the provisions of Law 147-02, which establishes that it will be responsible for integrating public, private and community efforts to ensure timely and efficient management of all human resources, technical, administrative and economic that are essential for the prevention, mitigation, response, rehabilitation and reconstruction in the face of emergency situations and/or disasters that may arise.

The magnitude of social and economic damages that historically have resulted from these adverse events for our nation, have shown how destructive these phenomena can be, if at the time we do not have the management tools that allow us to manage risk effectively and efficiently.

This is why having a plan that systematically operationalizes the procedures, responsibilities, functionsand intervention resources in a systemic manner, involving all the institutions that are part of the SN-PMR, will be essential to achieve a timely and integrated response to an adverse event.

The general objective of this "Contingency Plan" is to provide adequate risk management to increase the inter-institutional response capacity from a systemic approach to face the impact of a hydro meteorological event. Similarly, this plan has specific objectives:

a) Guarantee actions to reduce the effects of the impact of an adverse event.

b) Facilitate the decision-making process to guarantee a response in real time.

c) Provide an updated flow of information through the CNE, in order to keep the political level informed about the evolution of the situation.

d) Coordinate inter-institutional actions in order to guarantee an efficient and timely operation.

e) Enhance the use of management tools and instruments to produce an adequate response and rehabilitation.

f) Maintain an adequate flow of information with the different SN-PMR institutions.

Figure 3.3.4.4. Dominican Republic COE meeting

Figure 3.3.4.5. Application for mobile phones used to communicate emergency information to the public.

3.3.4.3 MISSION OF THE COE:

It is the operational body responsible for promoting and maintaining coordination among the different levels, jurisdictions and functions of the institutions involved in managing and responding to an adverse event in the country, to achieve self-sufficiency in the handling of an emergency situation or case of disaster of any nature (Law 147-02).

3.3.5. Information provided by related organizations in heavy snowfall (Japanese case study)

3.3.5.1 Background

Heavy snowfall in January 2016 closed a highway in Niigata prefecture for 38 hours. As a result, 74 stranded vehicles in Nagaoka City, Route No. 8, resulted in a massive traffic disorder for about 50 hours, which had a major impact on economic activities and daily living.

In this disaster verification committee, there were requests such as "We want information that is easy to understand, aggregating information from related organizations", "We want information in real time", "Live camera information is effective" etc.

For this reason, this committee established the Information Communication Headquarters (ICH) to strengthen information sharing among related organizations at the time of heavy snowfall, adjust the snow removal route, and provide information to road users.

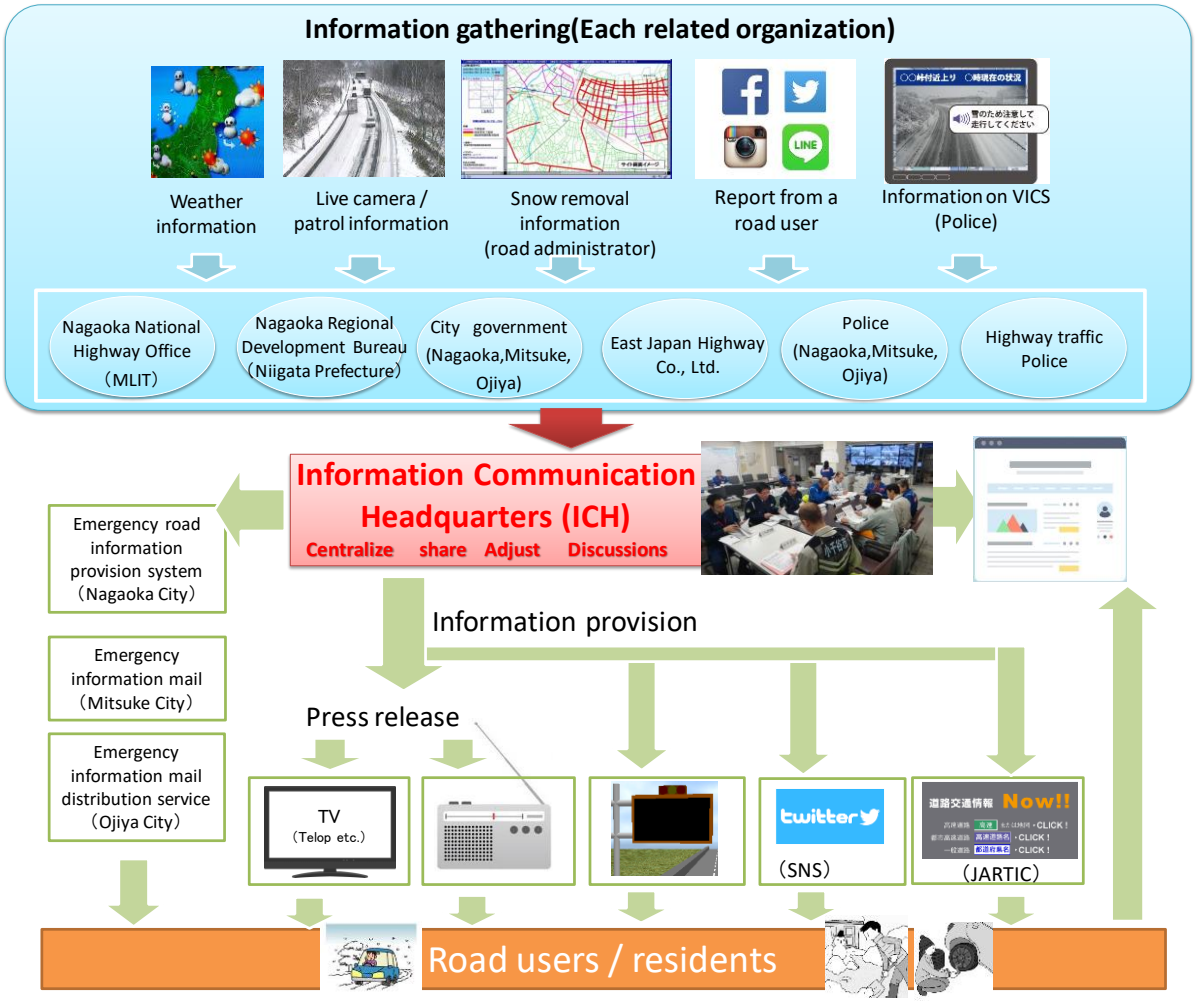


Figure 3.3.5.1.Information provided by Information Communication Headquarters

Figure 3.3.5.2.Information Communication Headquarters at work

3.3.5.2 About the ICH

The ICH is established when a weather strike has issued an alarm, a road closure or the like occurs and there is a danger it will continue.

There, they collect and share information (such as road conditions, snow removal situations, accident information, etc.) owned by related organizations (national highway offices and highway companies, prefectures, police). Furthermore, it adds information on trains and buses separately collected by Nagaoka City, and unifies it. In addition, stakeholders gather and talk about the adjustment and correspondence of the information provided at the ICH. Based on those results, we will send information to drivers and residents using media such as FM (Emergency Interrupt Broadcasting), Area mail, Homepage, SNS, Cable television and so on.

In addition, Nagaoka city notifies the public of the radio frequency and the website address as a key source of information via city brochure (Snow and ice special edition), the leaflet at SA/PA and etc. and the related institution and other administrators provide the website link at their web page for easy access to the information.

At the same time, we regularly carry out information communication training assuming events will occur due to concentrated snowfall.

3.3.5.3 Effect

On January 12, 2017, there was a fear of heavy snow due to a strong winter-shaped atmospheric pressure arrangement and Niigata Local Meteorological Observatory announced "Niigata prefecture weather information on heavy snow and high waves". On January 14th and 15th, because we are also preparing for the National Center Test (the unified entrance examinations for universities), we opened ICH from an early stage.

Figure 3.3.5.3.Sharing traffic situation

In the ICH, we provided road information on the road information board and Twitter on the Nagaoka national highway office. At the same time, utilizing "FM Nagaoka", we sent weather and alert information twice a day on January 12th and four times on January 13th. Also, in preparation for the heavy snow, we requested related organizations to do early snow removal etc.

As a result, while there was a snowfall of about 3-5cm on January 13th and 14th, there was no traffic hindrance and there was no significant speed reduction and traffic flow could be secured.

In the Nagaoka area, the establishment of the ICH has made it possible to collect and provide comprehensive emergency information beyond the boundaries of road transport-related agencies, and it has been confirmed that it can lead to safe and secure actions of residents and drivers.

3.3.6. Collecting and sharing disaster information (Australian Case study)

3.3.6.1 Event communication approach

(1) Whole-of-Governmet

The Queensland Government Crisis Communication Plan outlines the approach for communication with stakeholders and is designed to:

●Contribute to achieving the objectives of the Queensland State Disaster Management Plan (QSDMP) (2017)

●Clarify roles and responsibilities of the lead agency during a major issue or crisis, and agencies that support it

●Ensure coordinated, consistent communication by the government with stakeholders

●Protect and manage the government's reputation.

The model is scalable, underpinned by a number of key principles (empathy, consistency, integrity, collaboration and effectiveness) and reflects the identified lead agency's central role in coordinating public information in a crisis.

The Crisis Communication Network provides overall communication support and direction, and includes key communication representatives from all Queensland Government departments. The lead agency instructs the Public Information Capability (PIC). The PIC drafts materials and monitors traditional media and digital channels, and engages with stakeholders. Other government agencies retain responsibility for updating, maintaining and monitoring their own

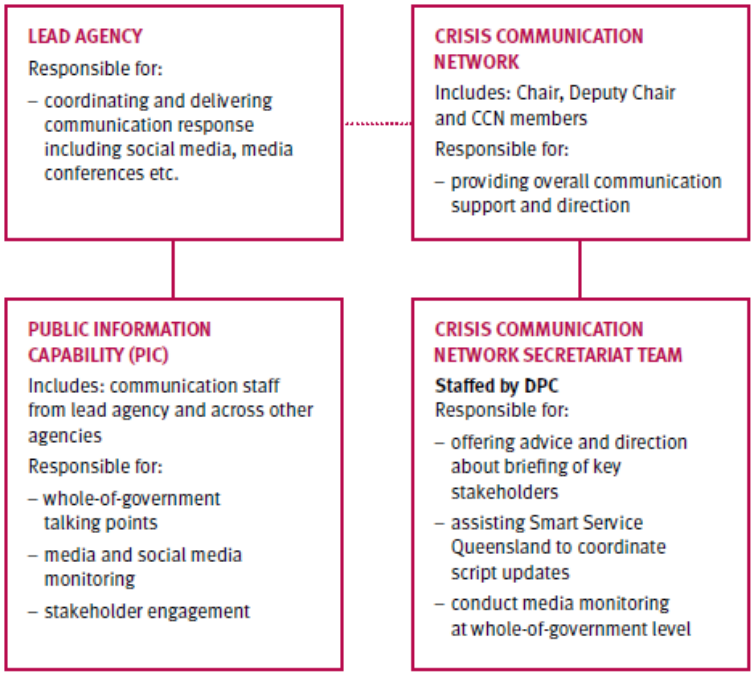


Figure 3.3.6.1 Roles and responsibilities (Queensland Government Crisis Communication Plan) [3.2]

digital platforms.

During a disruptive event, the Department of Transport and Main Roads (TMR) is responsible for communicating transport-specific issues and works to keep the public informed of changes to the transport network including impacts on trains, buses, ferries, roads or other TMR service delivery. Activity also includes further amplifying whole of government messaging and ensuring information is correct.

(2) Working with other agencies

The State Disaster Coordination Centre (SDCC) prepares and distributes the following state-level reports:

●State updates – provides an overall situational awareness (audience is Local Disaster Management Groups-LDMGs and District Disaster Management Groups-DDMGs)

●Executive summaries – provides a strategic summary to key stakeholders, senior executives of Queensland Fire and Emergency Services (QFES), Queensland Police Service (QPS) and State Disaster Coordination Group (SDCG) members

●Key messages – for use as speaking points by government personnel, the Premier and Ministers

●Information about the event and associated disaster response operations is also provided to the Australian Government.

With respect to alerts and warnings provided by the SDCC, each agency/Queensland Disaster Management Arrangements (QDMA) stakeholder is responsible for further disseminating these through their communication networks.

The Queensland Government issues and crisis response framework is outlined below. This extensive network of strategic and operational bodies exists in Queensland to respond to major issues and crises.

3.3.6.2 Event communication – internal

During disaster events, information is collected internally within TMR through an established reporting process.

Districts that have been impacted by the disruptive event consolidate district information in a Disruptive Event Management Team (DEMT) Situation Report (SitRep). The SitReps may include information on road closures or other road network impacts. TMR's TransLink and Customer Services Safety and Regulation divisions and Maritime Safety Queensland branch also provide information, as appropriate. Queensland Rail information is also included.

This information includes what the impacts of the event are – for example, flooding or other access issues with key links such as highways and major local roads. It also covers activities planned to occur within the next 12–24 hours, such as inspecting affected roads and bridges once the water recedes or commencement of repairs.

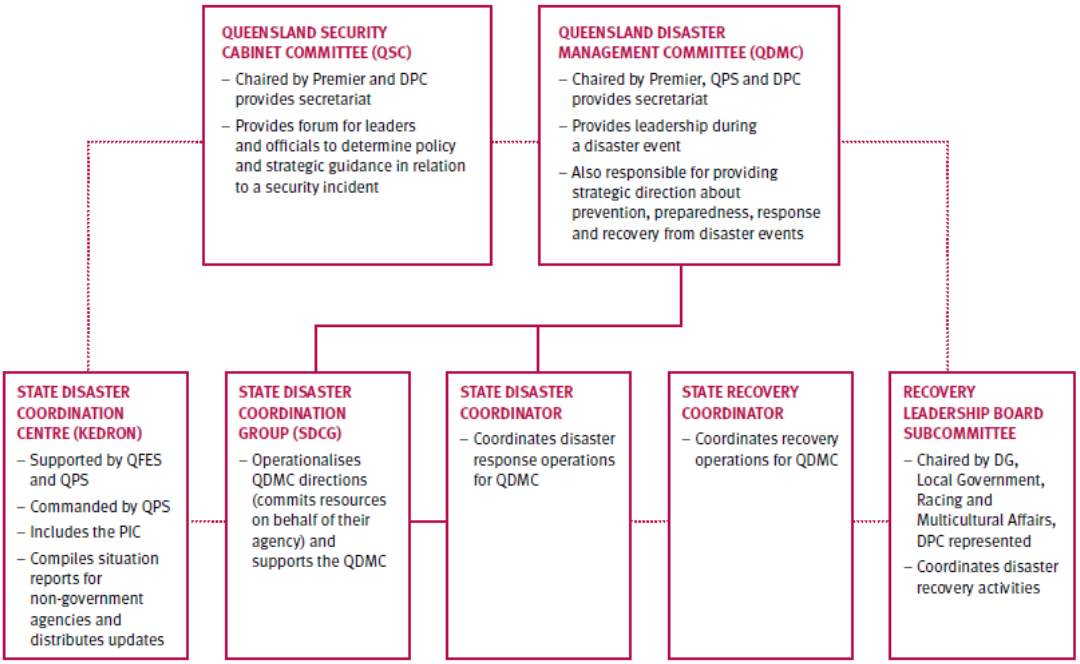


Figure3.3.6.2 Issues and crisis response framework (Queensland Government Crisis Communication Plan) [3.2]

Once approved locally, reporting is sent to the SDCC via departmental Liaison Officers who consolidate the information and produce a Strategic Overview using information from reports, DEMT SitReps and any other relevant identified information. Following approval, this information is provided through the reporting system at the SDCC and disseminated to key stakeholders.

The daily reporting schedule is at 6am, 1pm and 6pm. This may however change, dependent on the type and impact of the event.

3.3.5.3 Event communication – external

Public information during the response phase of a disruptive event provides the community with awareness of hazards and information about events and recommended actions, such as local evacuation arrangements and specific measures available for vulnerable groups (e.g. the elderly, ill and people with a disability).

Channels used are varied and are not limited to traditional media such as radio, television and print.

At the state level, the Australian Bureau of Meteorology (BoM) maintains a presence in the SDCC, and during events a forecaster is embedded within its operation. BoM provide timely updates for situational awareness to support the planning, preparedness, and response and recovery efforts.

A media room has been established within the SDCC complex which is used extensively during disruptive events for live crosses and media conferences. The spokesperson, usually the Premier or senior government official from relevant lead agency, is accompanied by an Auslan sign

language interpreter. This underpins the importance of the message and ensures it is widely accessible.

(1) Queensland and Australian Government online information

Queensland Government Disaster Management – contains consolidated information from a number of agencies as to warnings, emergency alerts and dealing with disasters.
Likewise, a number of agency specific websites clearly display disruptive event warnings and information:

- Queensland Police Service
- Bureau of Meteorology warnings
- Queensland Fire and Emergency Services news and bushfire warnings
- Queensland Reconstruction Authority Flood warnings
- Inspector-General Emergency Management
- Rural Fire Service bushfire information
- State Emergency Service

(2) Transport and Main Roads online information

TMR website

The TMR website is updated to advise of any impacts to service delivery at customer service centres or online services.
The TMR website also includes links to whole-of-government disaster pages, including information regarding natural disaster and drought assistance.

Social media

TMR uses Facebook, Twitter, Instagram and LinkedIn during disruptive events to communicate with the public. Messages are delivered with the immediacy required during and after events. Reposting and retweeting of other relevant information also occurs.

13 23 80 Call Centre

In a disaster, the public may contact the call centre for information or assistance related to registration or licensing matters.

QLDTraffic

This is the department's point of truth providing accurate and timely traffic and road condition information to the public. This assists motorists to make informed travel decisions, with the potential to reduce disruption and minimise congestion.

The QLDTraffic app is also available for download via the App Store and Google Play.

The website and telephone service (13 19 40) are regularly updated to reflect current conditions. During disruptive events key messages are also placed on the homepage of the website.

Notices to Mariners

These notices are circulated by Maritime Safety Queensland, a branch of TMR, communicating safety information to mariners, organisations and other interested parties.

TransLink website

TransLink Division leads and shapes Queensland's passenger transport system, incorporating multiple transport modes into an integrated transport network. Information is available through the TransLink website providing timetabling and travel information. It also provides information under its 'Get Ready' program encouraging customers to prepare for severe weather events and natural disasters affecting services.

MyTranslink app

This app provides push notifications for access to bus, train, ferry and tram information, with customisable features to ensure users can get service updates that matter to them. MyTransLink is available for download via the App Store and Google Play.

3.3.7. Disaster Management Using Social Networking Service (SNS) Technology (USA case study)

In an emergency, it is critical that the public have accurate, real time information on road conditions. Of the various tools Caltrans uses to meet this objective, the power and ease of mobile SNS applications allows Caltrans to meet a greater number of consumers in a manner they are familiar and comfortable with. Given the domination of mobile devices in social network communications, the ability to meet consumers where they are at any time becomes even more valuable during emergencies.

To best meet consumer needs, Caltrans Headquarters Public Information Officers collaborate with the Public Information Officers (PIOs) in each of its 12 Districts across the State. These PIOs monitor internal and external information sites to collect information on incidents as they develop. Various media sites are monitored for information on road closures, mudslides, wildfires, emergency repairs, snow impacts, and more. Once the data is gathered it is validated then made available to the public using popular SNS applications such as Facebook, Twitter, YouTube and the Department's website. Currently these are the only programs the Department uses for social media communication. The same information is used to send more formal press releases to the media. Caltrans also monitors news outlets and response agencies' Twitter and Facebook feeds for information to repost.

How all this is done is a collaborative process using traditional back-end research before information goes out to social media. Caltrans Public Affairs is a 24/7 operation consisting of a headquarters unit and 12 regional offices. Through these offices they collectively research and receive data through:

- Media inquiries
- Inquiries and reports from the traveling public
- Composing and issuing news releases
- Issuing traffic alerts
- Social media postings
- Staging and attending press conferences and media events
- Creating and posting materials for Caltrans websites.

To assemble the data in a form that is easily consumable by the traveling public, Caltrans dedicates the following resources to its SNS efforts:

- Public information officers
- Videographers
- Photographers
- Graphic designers
- Digital print operators
- Research writers
- Administrative support personnel.

The benefit Caltrans has experienced using SNS technology is the speed, frequency and simplicity at which information can be delivered to the public. Traditional information sources such as print

media, television, and web sites cannot match the speed and simplicity of a SNS post. And with mobile devices now able to manage more data with better graphics, the combination of well worded posts with graphics can now speak to a larger audience with greater clarity. During emergencies, having access to clear and accurate information is vital for affected populations and first responders alike.

Looking forward, Caltrans envisions increasing its SNS footprint by using developing technologies to increase its messaging to the public. Tools, such as Google Analytics, have helped Caltrans understand if the information it is disseminating is being used and at what level of frequency. Areas that are not meeting intended targets are refined before sending out the next post. Such tracking of post viewings allows adjustments to the needs of the consumer.

Additional goals include more safety messaging across several platforms, better use of SNS analytics to track audience preferences, better implementation approaches based on performance metrics, and enhanced use of mobile technologies. These objectives, along with our existing traveler advisory services, will help Caltrans achieve its mission of providing a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

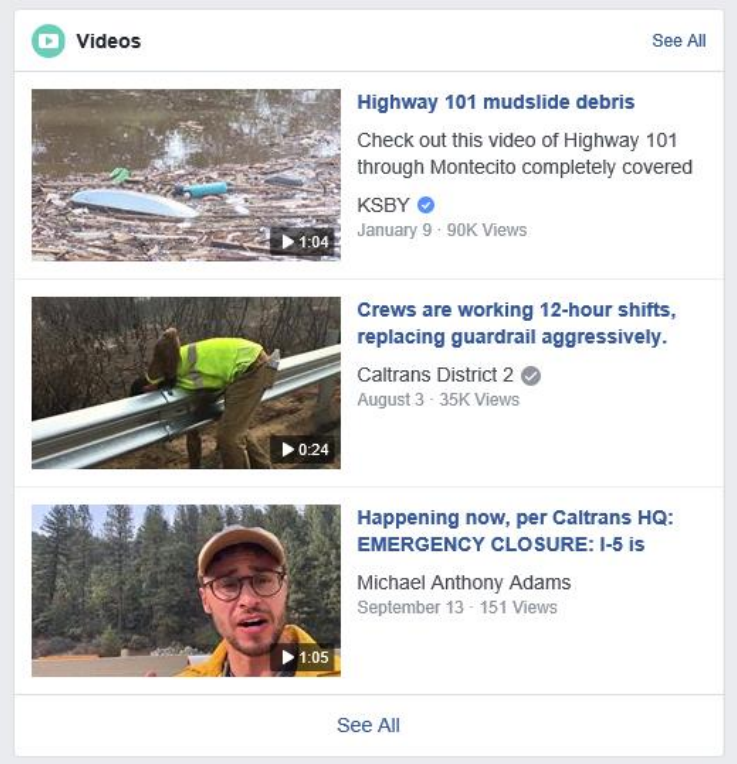


Figure 3.3.7.1 Caltrans Facebook

Figure 3.3.7.2 Caltrans YouTube

Figure 3.3.7.3 Caltrans Twitter

3.3.8. Transport Scotland Forth Road Bridge Closure (UK case study)

3.3.8.1 Background to the Forth Road Bridge Unforeseen Major Closure

At the time of this major event, the Forth Road Bridge provided a strategic link down the east coast of Scotland, linking Fife with Edinburgh. It was opened in 1964 and at the time was the longest span outside the USA (4th in world). The bridge length is 1822m with a main span of 1006m. It carries unrestricted traffic on two running lanes in either direction with no hard shoulder. Its main Towers are 156m high. It is owned by the Scottish Government, and managed by its national transport agency, Transport Scotland. The Forth Bridges Unit is operated and maintained by Amey on behalf of Transport Scotland.

The bridge is of strategic importance with a 22-mile road detour each way if it is closed, with an estimated economic impact to Scotland of approximately £1 million per day.

3.3.8.2 Major Event Timeline

Following identification of a broken bridge element by Inspectors on the 1st December 2015, on 3rd December evening the bridge was closed to all traffic. Within 48 hrs Transport Scotland in partnership with stakeholders developed a Repair and Resource Plan with staff rosters to manage this major event 24/7. A Major Event cell was created which then developed the Traffic Diversion Plan, from which a Communication Strategy was developed. A press conference was held on the 6th December (Sunday PM) which gave details of the travel plans for Monday morning onwards. This was provided to the public and broadcast through all available media.

The bridge was closed to all traffic from 3rd December, following initial engineering mitigation

Figure 3.3.8.1 Forth Road Bridge

Figure 3.3.8.2 Traffic information by Traffic Scotland

measures it reopened to all traffic except HGVs on 23rd December. From 4th February to 20th February there was phased re-opening of the bridge to all traffic. After further repairs were completed the bridge was load tested and fully reopened to all traffic on 20th February. The total closure timeline was 50 days.

3.3.8.3 Previous resilience planning and response experience

Transport Scotland had previous experience of both proactive and reactive resilience responses for major events such as the Glasgow 2014 Commonwealth Games and the Ryder Cup as well as severe weather such as flooding, landslides and significant snowfall. It drew on this experience to develop and deploy a suitable, scalable response to this particular unforeseen challenge, in particular to manage reduced bridge capacity and persuade road users to use alternative routes and modes, retime their journeys or to not travel.

3.3.8.4 Road travel planning

Transport Scotland supported by its bridge maintenance agents decided that the developed traffic solution needed to give the public the feeling that this was not just a diversion route but properly planned and resilient. The team called on a national bus company and the regional rail company to increase their capacity. Spare buses from around the country which were usually used for planned events were driven to Scotland to support the travel plan. A total of 10,000 additional bus seats and 11,000 rail seats were provided. A Bus/HGV only corridor was created on the strategic routes to prioritise these users. This solution was effective and spanned political divides and was a collegiate response. Over 70,000 vehicles and 100,000 people were displaced by the closure each weekday. Southbound car use dropped from 85% to 70% and public transport increased from 15% to 30%.

3.3.8.5 Working in Partnership

During this major unforeseen event Transport Scotland, its managing trunk road agents Amey and BEAR (road maintenance service provider) worked with Local Councils, Stagecoach (UK bus company), Police Scotland and ScotRail in a partnership approach to increase the available (people and goods) transport capacity as alternative to that lost due to the full closure of the Forth Road Bridge. Work was also carried out to support the commercial and health sectors with continuity of critical movements. The UK Department for Transport (DfT) played its part by helping secure relaxations in European Union laws that restrict the maximum hours that HGV drivers could work for during the closure.

A partnership approach was also taken in developing and implementing a temporary structural effective repair to allow the bridge to reopen to all but HGV traffic by 23rd December.

3.3.8.6 The importance of communication including social media

From the outset of this major unforeseen event Transport Scotland knew it would be high profile with bridge users, the public and politicians. There was as expected significant media, public and political interest. It was also likely from the outset that there would subsequently be a Central Government Inquiry. Therefore all actions taken needed to be properly planned and recorded for future scrutiny auditing for what Scottish Ministers described as "an event of national significance".

'Feeding the media machine' was vital to keep all stakeholders fully informed during development of the mitigating transport plan and bridge repair proposals and up to the bridge being reopened.

At all times Transport Scotland was committed to fill any information void and provide complete transparency about its planning and delivery. As part of this the Forth Road Crossings website, Twitter and Facebook accounts received a significant increase in users and required a 24/7 response.

By the end of the event compared to the previous three months there were 13.5 million tweets (a 33% increase in followers), 4.5 million Facebook impressions (64% increase in followers) and 1.1 million visits to forthroadbridge.org (178% increase in users).

3.3.8.7 Conclusions and lessons learned

Ultimately a Scottish Parliament Committee review concluded that the required closure of the Forth Road Bridge in December 2015 was an unforeseen event. Notably while there was a high degree of travel disruption, with all the subsequent knock-on effects, no lives were directly lost over the duration of the closure.

Building on existing working partnerships between Transport Scotland, key travel providers and bridge and road maintainers was important to develop and implement major traffic diversion plans and communication strategies.

Providing continuous and relevant information to all travel users at all stages of the event played a key role in keeping bridge users in touch with events, maximising the use of alternative travel modes and restoring confidence. The use of coordinated messaging through multiple information outlets also ensured the maximum distribution of information during the sequence of events and

Figure 3.3.8.3 Forth road bridge *Figure 3.3.8.4 Forth Road Bridge*

minimised travel disruption.

Other key learnings coming out of this experience which other national/regional roads authorities may wish to consider include:

- building and maintaining an experienced resilience team – this should be multi skilled including engineering, communication, administration, etc

- ensuring that this resilience team has staff resilience in itself to guard against burn-out while covering annual leave and sickness
- periodically have this same resilience team carry out training exercises to simulate events if they go for lengthy periods without real time activation
- maintaining and enhancing your professional transport and wider function networks– you will probably need to draw upon these at critical points during a real time response
- if a major event/disaster does occur, building your response around your existing processes and resilience team, and add to these base arrangements as demands dictate.

3.3.9. GIS-based Disaster Information Management System (Japanese case study)

This report will introduce the application of GIS-based disaster information management system of Hanshin expressway in Japan in order to improve internal disaster information management, especially to improve information sharing within an organization.

3.3.9.1 Back ground

Hanshin Expressway experienced enormous damage such as collapse of bridges and falling bridges due to the 1997 Kobe earthquake. Unpredicted and large damage to telecommunication facilities caused a major obstacle to disaster information management activities such as rapid and accurate information collection and sharing of highway damage information. According to these lessons, Hanshin Expressway developed a comprehensive disaster information management system that collects and shares basic disaster information such as the customers' injuries, the status of remaining vehicles, the damage situation of roads, the situation of employees' participation, etc. In addition, the Hanshin Expressway started operation of a new comprehensive disaster information management system using the geographic information system (GIS) in 2012. The goal concept is displayed in Figure 3.3.8.1. The goal is not only disaster information management system but also s comprehensive GIS-based maintenance information system. In order to achieve best operation of the disaster information system, it is very important all engineers and inspectors must be accustomed to use the system in daily operation. The feature of this system is not only to be an information collection and sharing tool that supports prompt and efficient investigation, inspection, emergency restoration activities at the time of disaster, but also a support tool for daily road maintenance management work. Currently this system has been utilized as a basis of maintenance management and disaster information management in the Hanshin Expressway.

3.3.9.2 Characteristics of GIS-based Disaster Information Management System

(1) Design policy

This system was developed to perform daily work and disaster work on a shared system as shown in Figure 3.3.8.2 and Figure 3.3.8.3. By making the system familiar from daily work, disaster work

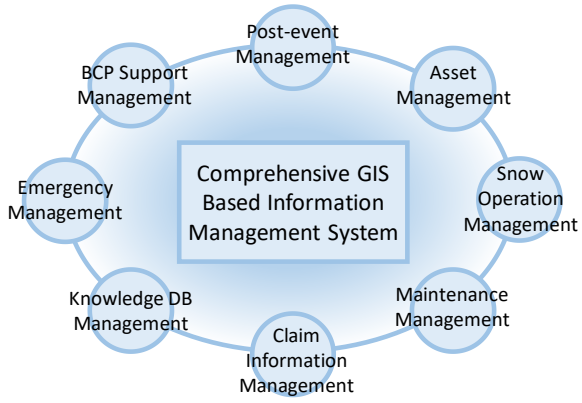


Figure 3.3.9.1 Image of comprehensive GIS based information management system

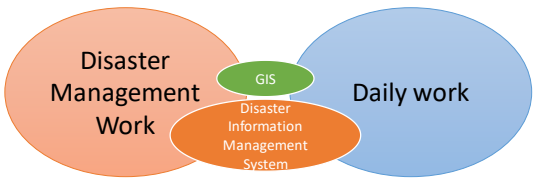


Figure 3.3.9.2 Design concept of disaster information management system

can be an extension of daily work.

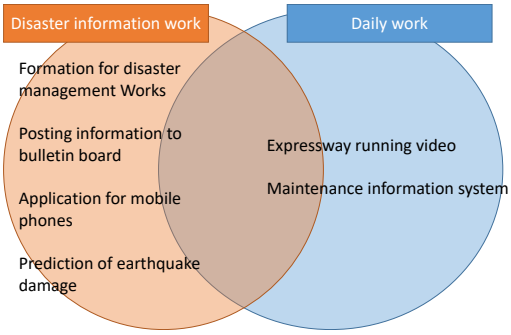


Figure 3.3.9.3 Functions of disaster information management system

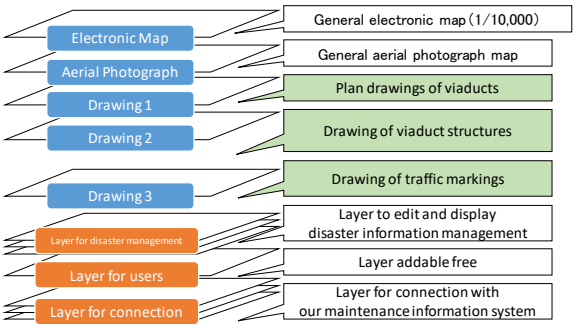


Figure 3.3.9.4 Disaster information management system using GIS

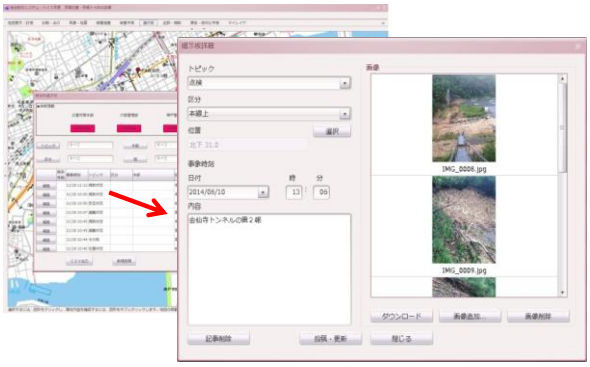


Figure 3.3.9.5. Web based bulletin board

(2) Management system based on GIS

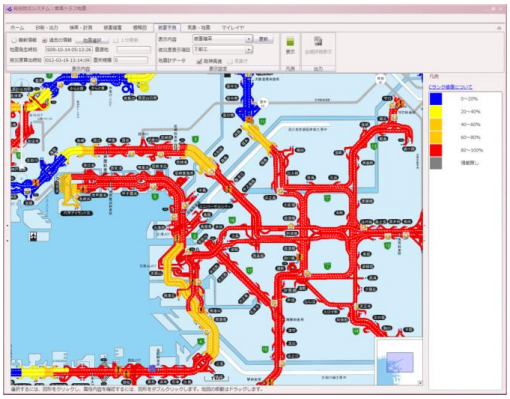
Utilization of GIS enables accurate information from on site to be displayed on a map so that it is possible to quickly, accurately and easily collect and share disaster information. In this system, electronic map/aerial photographs are used as the background map. Also, road centre lines, structure lines, girder frameworks of bridges and the like can be displayed on the background map. Recently, an additional improvement was finished and the system can display structures such as bridges in slab panels, pavement in 30m long sections, tunnels in 20m long sections as polygons with relevance to location coordinates. Along with this development, the system can search structure information, maintenance management information, and disaster information on all roads cross-referenced to position information easily and precisely. An image of the GIS-based disaster information system is shown in Figure 3.3.8.4.

(3) Functions for disaster situation

1) Function to display disaster response system

Function to inform and display the status of disaster response system related to earthquake disasters and wind and flood damage.

Figure 3.3.9.6. Image of input and view from mobile devices and its application



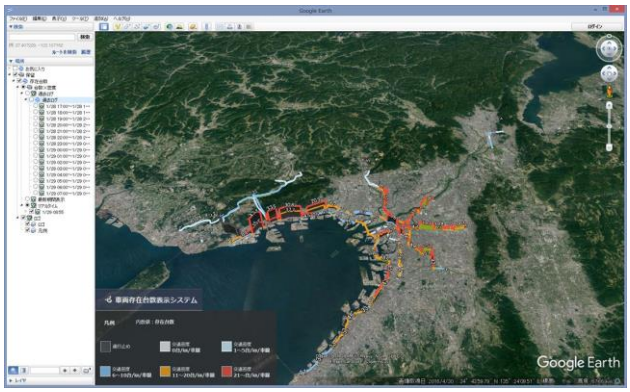


Figure 3.3.9.7 Image of earthquake damage *Figure 3.3.9.8 Image of vehicle counter system*

2) Function to display bulletin board

Function to collect and share disaster information using web-based bulletin board. Since all information is provided together with location information, disaster information is shared on the map. The information on this bulletin board is useful not only for disaster information but also for correspondence history so it is useful for PDCA action in following the event.

3) Functions to input and browse from mobile devices

Function to input and browse disaster information bulletin board from mobile devices. This will allow all inspectors and engineers to share the same information no matter where they are.

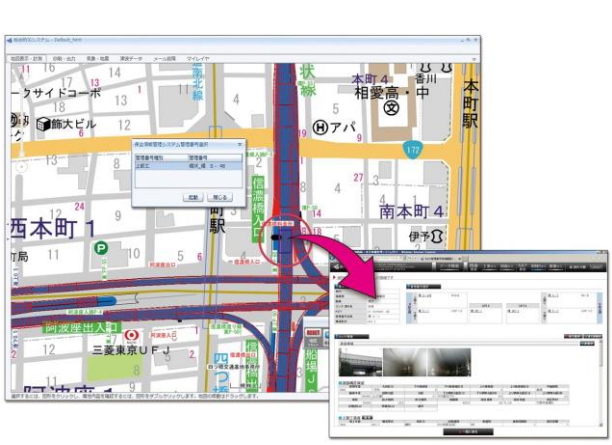
4) Function to predict earthquake damage immediately

Function to predict earthquake damage immediately such as bridge pier and bearing from earthquake acceleration history information observed by the Japan Meteorological Agency and Hanshin Expressway. As a result, in a limited time immediately after the earthquake occurrence, it

is possible to carry out a more efficient inspection and to establish an initial operation system for emergency response.

5) Function of vehicle counter system

Function to display the number of vehicles on the expressway at every intersection span (averagely 1.5km) at any time.



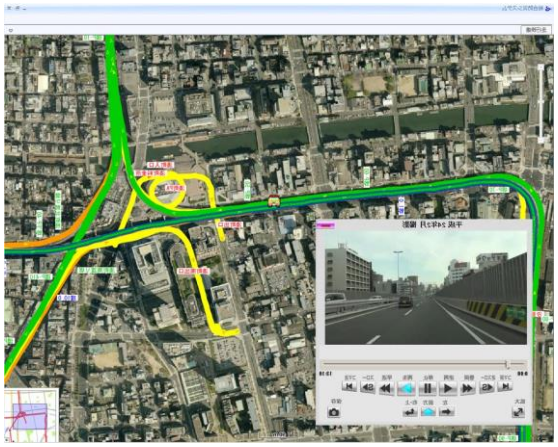


Figure 3.3.9.10 Link to maintenance information system Figure 3.3.9.9. Expressway running view

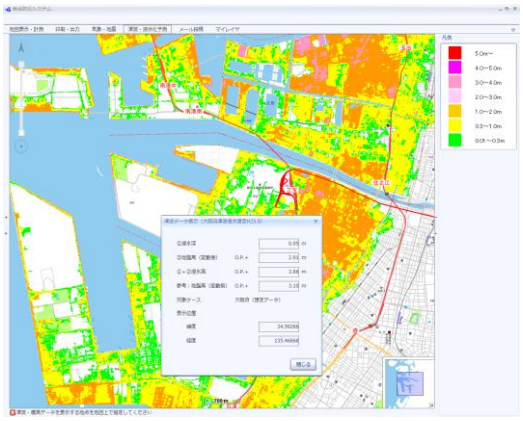


Figure 3.3.9.11 Displaying tsunami inundation height

(4) Functions for daily management

1) Function of Expressway View

Function to display car-view video and positions on elevated expressways. This function provides a wide-angle, high-resolution video function beyond Street View.

2) Function link to maintenance information management system

Function link to maintenance information management system from structure polygon such as bridges, tunnels and pavement on the GIS map. The maintenance information management

system manages structure information and repair/inspection history so that it is possible to seamlessly acquire information on maintenance records from GIS.

3) Function displaying tsunami inundation height

Function to display estimated result of inundation height and flooded area due to tsunami, assuming closest plate boundary earthquake by 10m mesh basis. It is used to consider disaster prevention plans for structures and facilities where tsunami inundation is expected.

4) Function to support winter operation

Function to support winter operation such as checking road surface condition, spraying anti-freezing agent, and snow removal work.

3.3.9.3 Application to daily and disaster operation

This report introduced the outline of the GIS-based disaster information management system implemented to Hanshin expressway. As for the first trial for developing this information system under the limited computer resources, the system was developed only for disaster information management purposes and for dedicated devices. As a result, obstacles were found in terms of actual use. For that reason, the current system was designed to be used on a daily basis. As a result, the engineers have gradually become accustomed to the system from the day-to-day maintenance work, and it has grown to become a system that is indispensable also in the event of a disaster. It is very effective to share disaster information in real time from the top of the business to the bottom. For this reason, it is an effective way to develop a disaster information system from collaboration with daily work.

3.4. CONCLUSIONS AND RECOMMENDATIONS

Information management is becoming a key component in disaster management with the progress of internet communication technology. Currently large and important progress can be seen in disaster information management. TC E.3 WG1 focused on the role of information management in disaster management. TC E.3 WG1 lays special emphasis on investigating the current progress through an international survey and demonstrating the successful practices in disaster information management. Conclusions and reccomendations are summarized below :

●Disaster information management in general

- Information management is the primary and fundamental elemental part in emergency management. Developing a reliable information collection and sharing system is the first step of disaster management.
- Within an organization’s disaster management approach, develop a specific disaster information management strategy and action plan.
- As part of the disaster information management strategy, define how you engage with internal and external stakeholders and understand their information needs and expectations.
- Many countries have realized the importance of the information management center and they had many experiences of managing disaster situations effectively and successfully by developing such a center. Develop an information management center to mitigate the effect of the disaster.

- Develop specific communication procedures rather than structure and test these to ensure the procedure works well in emergency situations.
- A proactive approach in information management will receive positive reaction from road users.

●Disaster information management in detail

- Develop an Emergency Information System that incorporates damages, associated costs, working modality to face the emergency and monitor recovery progress.
- Highly advanced information communication tools are available now. Develop information management system using traditional communication tools as well as highly advanced information communication tools.
- Understand what information people need during the phases of a disaster and that this can be different to the information that road agencies give out, which may lead to unintended response behaviors during and after a disaster. This should be part of an organization's disaster management testing.
- Analyze previous disaster information, develop communication scenarios and continually review them, especially for single mode and multimode emergencies.
- Monitor roads' trafficability and connectivity, and information provided by users and other authorities or organizations, and disseminate the information via media according to agreed protocols.
- Use all available media to maintain communication and coordination.
- Visibility of road repair is essential for the community in terms of information management.
- Develop an information management system on a business-as-usual platform that allows integration between government agencies for disaster response.

●New tools for disaster information management

- Establish alliances with media.
- SNS is a powerful tool for information dissemination but SNS is also a potential tool for disaster information collection in an emergency. Further research is needed on advanced disaster information management systems using the advantage of potential SNS tools. The benefit Caltrans has experienced using SNS technology is the speed, frequency and simplicity with which information can be delivered to the public.
- Road administrators have responsibility for managing fake news and disseminating accurate news on any kind media, especially by SNS.

●Disaster management in general

- A business continuity plan (BCP) is an action plan that is formulated so that operations can continue and full operations can be rapidly restored in the event of a disaster. A BCP is important to ensure the stability of the regional economy and the preservation of life.
- Management of public and users expectations is important in order to try to be clear about what the public and users expect from Roads Directorate and make clear what they will get. So the goal is to keep users frustration levels low by been realistic with the expectations and make them understand the spirit of the project.

4. DISASTER MANAGEMENT WITH THE PUBLIC

4.1. INTRODUCTION

The role of disaster management is to minimize the impact to the infrastructure, and to reduce the effect on human life and society. Figure 4.1.1 shows the typical system performance curve in a disaster event. The system recovery can be expressed by the impact reduction which can be expressed by the height drop in the curve and the effect reduction which can be expressed by the gradient of the recovery curve. The area which is surrounded by the impact reduction and effect reduction shows the effect of the disaster management.

The area surrounded by the impact reduction and the effect reduction greatly depends on the disaster maturity of the society and the public perception of the disaster risk. PIARC has studied the public perception of disaster risk in previous cycles. But the public perception of risk and public risk allowance is very difficult to be measured by any quantitative analysis.

The countermeasures to disasters are different in each country. The survey reflected that previous disaster experience and the public perception of disaster risk influence disaster countermeasure policy. Therefore, in this study, this technical committee makes a hypothesis that disaster management measures reflect the public perception of disaster risk indirectly. As discussed above, disaster management can be performed by two elementary methods, impact reduction and effect reduction. This report approaches disaster risk perception from the view point of disaster countermeasures in impact and effect reduction through the international survey for measuring the public perception of risk.

During this survey, a new approach to the disaster management was identified in many countries. The new approach is public engagement in disaster management or, it can be said, disaster management with the public. The basic idea of disaster management with the public is advocated internationally by the Hyogo Framework for Action 2005-2015 [4.1]. The framework proposes three dimensions: sector types (public, business and community), partnership arrangements (legislated and formal to informal agreements), and partnership roles (strategic, resilience-building, response and recovery). These three organizations can work together under various partnership arrangements for preventive or responsive measures in emergency and disaster management. Disaster management with the public is a policy to make a strong foundation for a

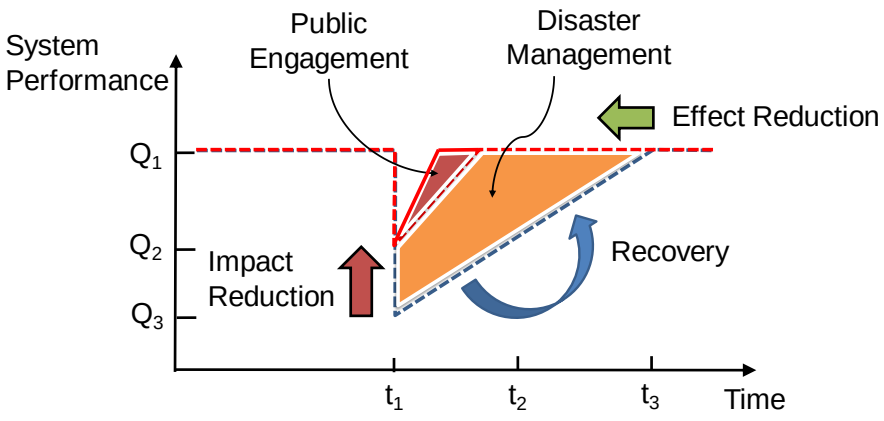


Figure 4.1.1. System performance curve and disaster management

resilient society. The effect of disaster management with the public can be expressed in the system performance curve as shown in Figure 4.1.1.

In this chapter, current disaster management practices to minimize the impact and the effect of the disaster are summarized according to the international survey results regarding the disaster risk perception and the major countermeasures against heavy rain, earthquake, land slide and flood disasters. Then the current practices in disaster management with the public are demonstrated and identified and displayed in the case studies. Finally, the conclusions and recommendations are listed.

4.2. INTERNATIONAL SURVEY

An international survey was conducted in order to investigate disaster perceptions through the disaster countermeasures that are taken in each country. Also the survey included questions on public disaster risk perception and disaster management practices. The survey questionnaires were comprised of facing disasters (one question), disaster management policies (four questions) and disaster management practices (one question), and were developed in three languages as shown in 3.2.1.2. The survey was performed firstly by member countries of TC E3, E1, and A3, and secondly to all PIARC countries through first delegates and related regional road organizations such as DIRCAIBEA. Finally, 19 samples were obtained and preceded to the analysis.

4.2.1. Disaster environment

The first question regarding the disaster environment was made to identify the disaster risks of

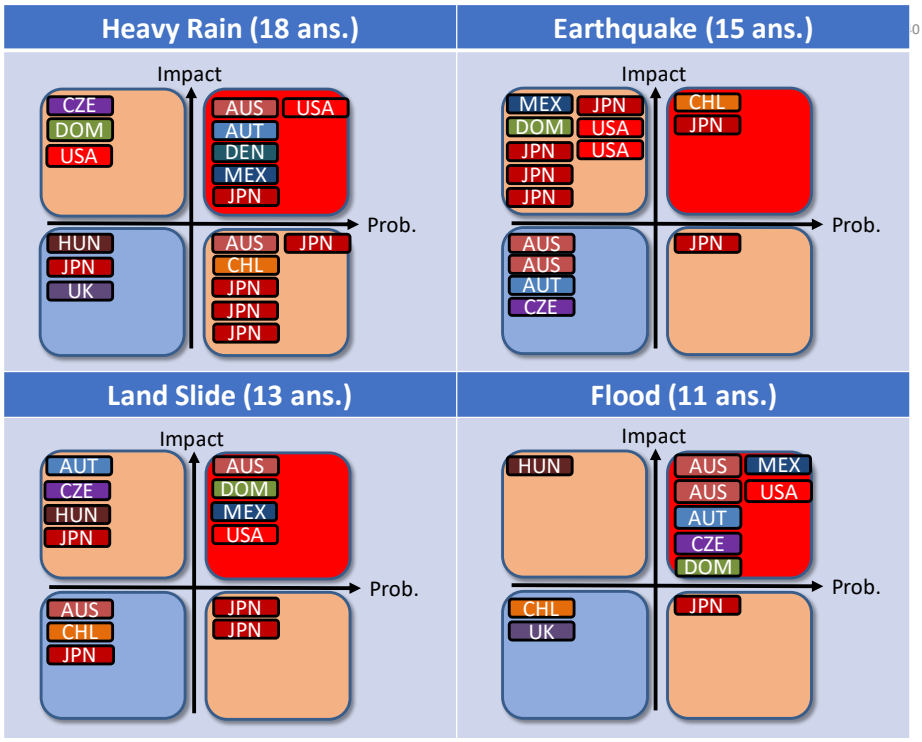


Figure 4.2.1.1. Major disasters categorized into impact and probability matrix

survey countries, categorizing into the probability/impact matrix. In this survey, four major disasters were investigated : heavy rain, earthquake, landslide and flood. Figure 4.2.1.1 shows the

identified disasters shown in an impact and probability matrix. There are several answers from the same countries. The risk awareness is different in each organization even though they are in the same country. The worst disaster worried about in survey countries in terms of probability and impact was identified as “Heavy rain”. Heavy rain is the most frequent disaster but the risk perception of heavy rain is different in each country and road organization. The same analysis can be made to other disasters. The impact/probability risk matrix is painted in red, orange and blue, which are refer to high, medium, and low risk respectively.

4.2.2. Differences in disaster management methodologies and practices

Disaster risk perception and awareness can’t be easily to be measured. However, countries have developed own disaster management methodologies and practices based on their disaster experience. Therefore, this report tries to investigate disaster risk perception and awareness by analysing the difference in disaster management methodologies and practices by comparing the answers of different countries.

4.2.2.1 Heavy rain

Heavy rain is the highest risk event among surveyed countries, so a lot of countermeasures were identified. Figure 4.2.2.1 shows the major countermeasures against heavy rain. Countries were categorized into “Heavy rain is high probability and high impact event”, “Either of high probability and low impact, or low probability and high impact event”, and “low probability and low impact event”. Thereafter, the categorized countries are referred to as “High risk awareness”, “Moderate risk awareness”, and “Low risk awareness” countries, respectively. Figure 4.2.2.1 reveals that the high risk awareness countries introduced a different level of countermeasures in each impact-probability quadrant. On the other hand, low risk awareness countries introduced countermeasures that are relatively simply implemented. In other words, it can be said that a

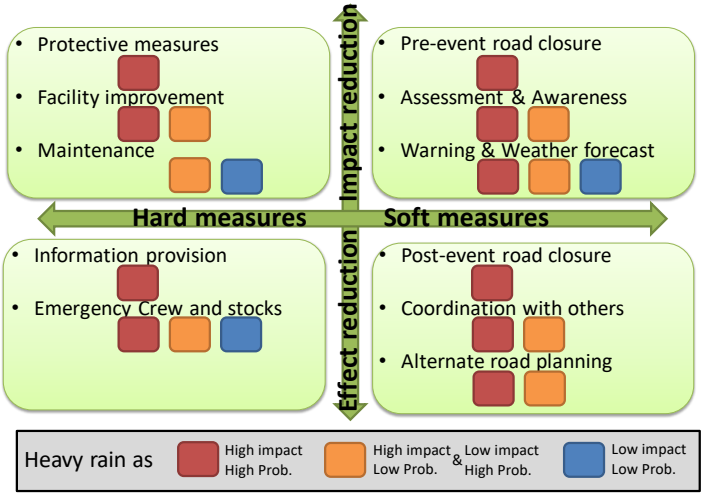


Figure 4.2.2.1 Major countermeasures against heavy rain in various disaster situation countries

variety of countermeasures is taken in the high risk awareness countries whereas limited countermeasures are taken in the low risk awareness countries. The high, middle, and low risk awareness countries introduced the same countermeasures in the top-right and bottom-left

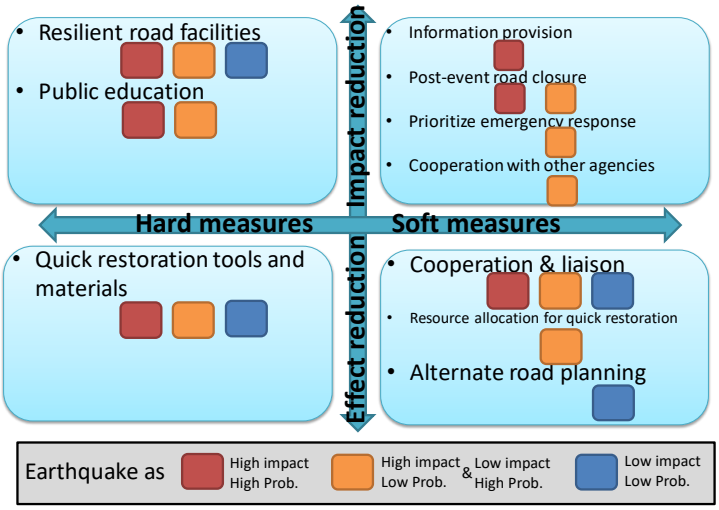


Figure 4.2.2.2 Major countermeasures against earthquake in various disaster situation countries

quadrant, whereas they introduced different countermeasures in the top-left and bottom-right quadrants. The measures in the top-right and bottom-left quadrant seem minimum measures in every country for forecastable events like heavy rain. The countermeasure in the bottom-left quadrant is “Emergency crew and stocks”. This seems to be the only countermeasure for this quadrant for all countries.

4.2.2.2 Earthquake

Earthquake is second highest risk event among surveyed countries, so a lot of measures were taken in many countries. Figure 4.2.2.2 shows the major countermeasures against earthquake in various countries. The survey revealed that disaster resilience activities greatly depend on their risk awareness. A clear trend in terms of disaster resilience activity was found in the bottom-right quadrant. Earthquake is an unforecastable event. The measures in the top-left and bottom-right quadrant seem minimum measures in all countries to unforecastable events like an earthquake. As pointed out in the summary of heavy rain, a variety of countermeasures is taken in the high risk awareness countries whereas limited countermeasures are taken in the low risk awareness countries. Seismic strengthening measures might be different in each risk awareness level, but the survey did not investigate the performance level of each countermeasure.

4.2.2.3 Land slide

The survey on land slide also revealed the disaster resilience activities greatly depend on risk awareness. All countries take almost the same hard countermeasures, whereas they take different soft countermeasures. Especially in the top-right quadrant, the answers are very different; this might reflect the difference in the disaster level.

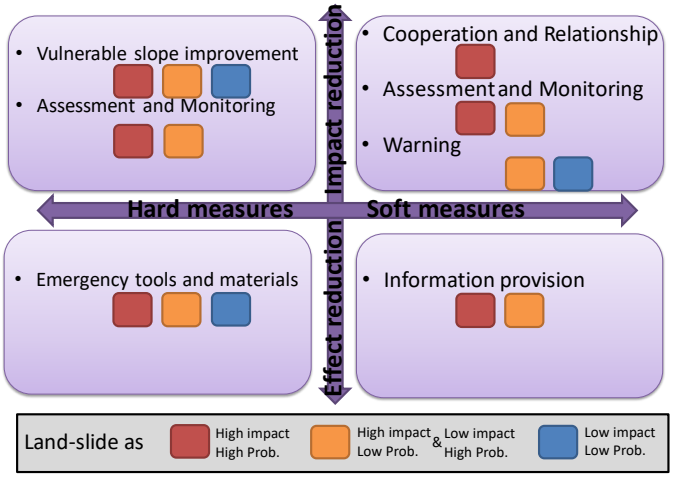


Figure 4.2.2.4 Major countermeasures against land slide in various disaster situation countries

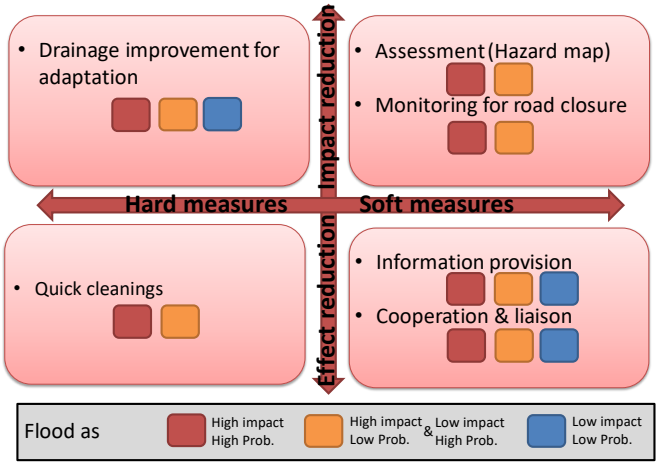


Figure 4.2.2.5 Major countermeasures against flood in various disaster situation countries

4.2.2.4 Flood

Small samples were obtained from this survey but a clear trend is identified. The survey also revealed that disaster resilience activities depend on risk awareness. The same answers are obtained in the top-left and bottom-right quadrant in all countries. Flood is a predictable event, but is not easy to mitigate. This might be the reason for the same answer in those quadrants. The answers also identified that low risk awareness countries do not take any countermeasures in the top-right and bottom-left quadrants.

4.2.3. Current policy in disaster management identified by survey

Th einternational survey reveals that countries have developed their own disaster management manuals. There is no exception. But the maturity level of the manual depends on their country's situation and their experiences. Figure 4.3.1.1 shows the current cover range of disaster management manuals. Most countries developed their disaster management manual with pre-

event, emergency, and post event phase activities. Most of the manuals are developed as generic, not for specific frequent disasters.

The PDCA cycle has been well implemented to disaster-prone countries because their disaster management manuals had been updated reflecting recent disaster events. Most countries update their disaster management manual periodically. Looking at the most recent changes, some key words can be found in the results of the survey. Current major significant changes in disaster management are related to public engagement or information to the public. These are community, public, partnership etc. listed in Table 4.3.1.1. These key words came out from the lessons from their recently experienced disasters regardless of the type of disaster.

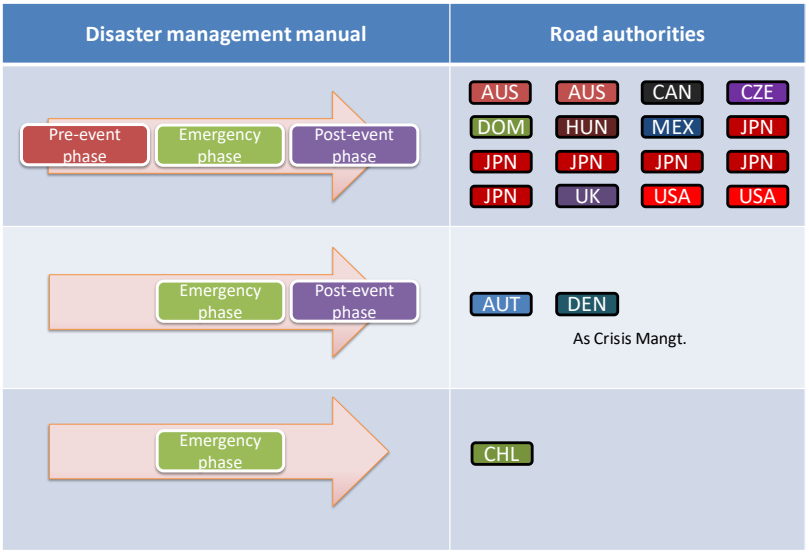


Figure 4.3.1.1 Current cover range of disaster management manuals

Table 4.3.1.1. Recent changes or topic in road disaster management policy

Countries	Recent changes or topic in road disaster management policy
AUS	Disaster management partnership with the public (2010-2011 Queensland flood) * Disaster management arrangements are based on the partnership with local communities.
CHL	Revise communicational planning to the public and consultation process to the public Revise design specifications (2010 Chile earthquake) * Consultation process to define some details at the final solution process with the public
JPN	Tsunami evacuation with the public (2011 East Japan earthquake) * Use embankment slope as evacuation space in tsunami area
UK	Public engagement: Regional community resilience groups * Develop regional community resilience groups working with local communities to warn and inform and to encourage a degree of self help.
Other countries	Periodical update

4.2.4. Summary of international survey

This survey tries to investigate disaster risk perception and awareness by analyzing the difference in disaster management methodologies and practices by comparing the answers of different countries. According to the Figure 4.2.2.1, Figure 4.2.2.2, Figure 4.2.2.3, and Figure 4.2.2.4, generally speaking, there is a risk awareness dependency on disaster countermeasures. The high risk awareness countries introduced a different level of countermeasures in each impact probability quadrant; on the other hand, low risk awareness countries introduced relatively simple countermeasures. It can be concluded that this trend reflects the risk perception of each country. However, a clear trend in individual countermeasures could not be found. The only slight trend was found between the forecastable and unforecastable events. All countries take the same measures in the top-left and bottom-right quadrant as minimum measures for forecastable events, whereas, all countries take the same measures in the top-right and bottom-left quadrant as minimum measures for unforecastable events. In other words, there might be risk awareness dependency in the top-right and bottom-left quadrant for forecastable events and also there might be risk awareness dependency in the top-left and bottom-right quadrant for unforecastable events. Further study is needed to investigate the characteristics of the risk perception.

The concept of disaster management with the public is based on public-private sector partnerships in reducing vulnerability and building resilience to emergencies and disasters. The basic idea of so-called “disaster management with the public” is advocated internationally by the Hyogo Framework for Action 2005-2015 [4.1]. The framework proposes three dimensions: sector types (public, business and community), partnership arrangements (legislated and formal to informal agreements), and partnership roles (strategic, resilience-building, response and recovery). Three organizations can work together under various partnership arrangements for preventive or responsive measures in emergency and disaster management. The international survey identified the good case studies on disaster management with the public. The collected reports are displayed in the next chapter.

4.3. CASE STUDIES

4.3.1. General

According to the survey, the current trend is identified in the field of public engagement. The best practices in this field are identified in the area of road disaster prevention activities integrated with residents in Australia and UK, and mutual cooperation with the roadside residents in Chile and Japan. The summary of each case studies are displayed in this chapter.

4.3.2. Disaster management partnership - Severe Tropical Cyclone Debbie (Australian case study)

4.3.2.1 Severe Tropical Cyclone Debbie, 25–29 March 2017

Severe Tropical Cyclone (STC) Debbie crossed the north Queensland coast near Airlie Beach on 28 March 2017, after crossing the Whitsunday Islands as a large and powerful Category 4 strength system (Bureau of Meteorology, 2017). As shown in the track and intensity map below, the remnant tropical low turned southeast and produced major flooding in central and southeast Queensland and northeast New South Wales during the following few days.

STC Debbie caused significant damage to national, state-controlled and local road networks. The response across Queensland has been described as the most successful response of its kind from a disaster event management perspective, with all levels of government working together.

4.3.2.2 Preparation

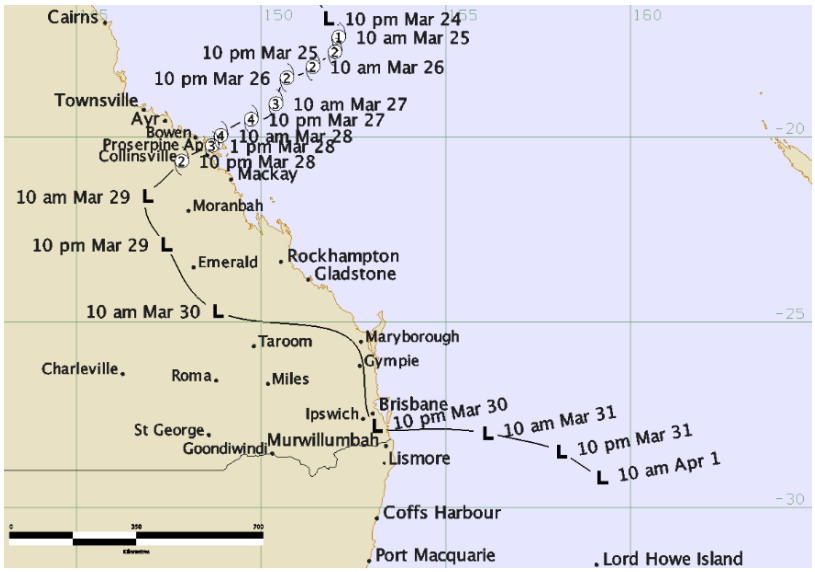


Figure 4.3.2.1 Footpath of Severe Tropical Cyclone Debbie
(Source: Australian Bureau of Meteorology [4.2])

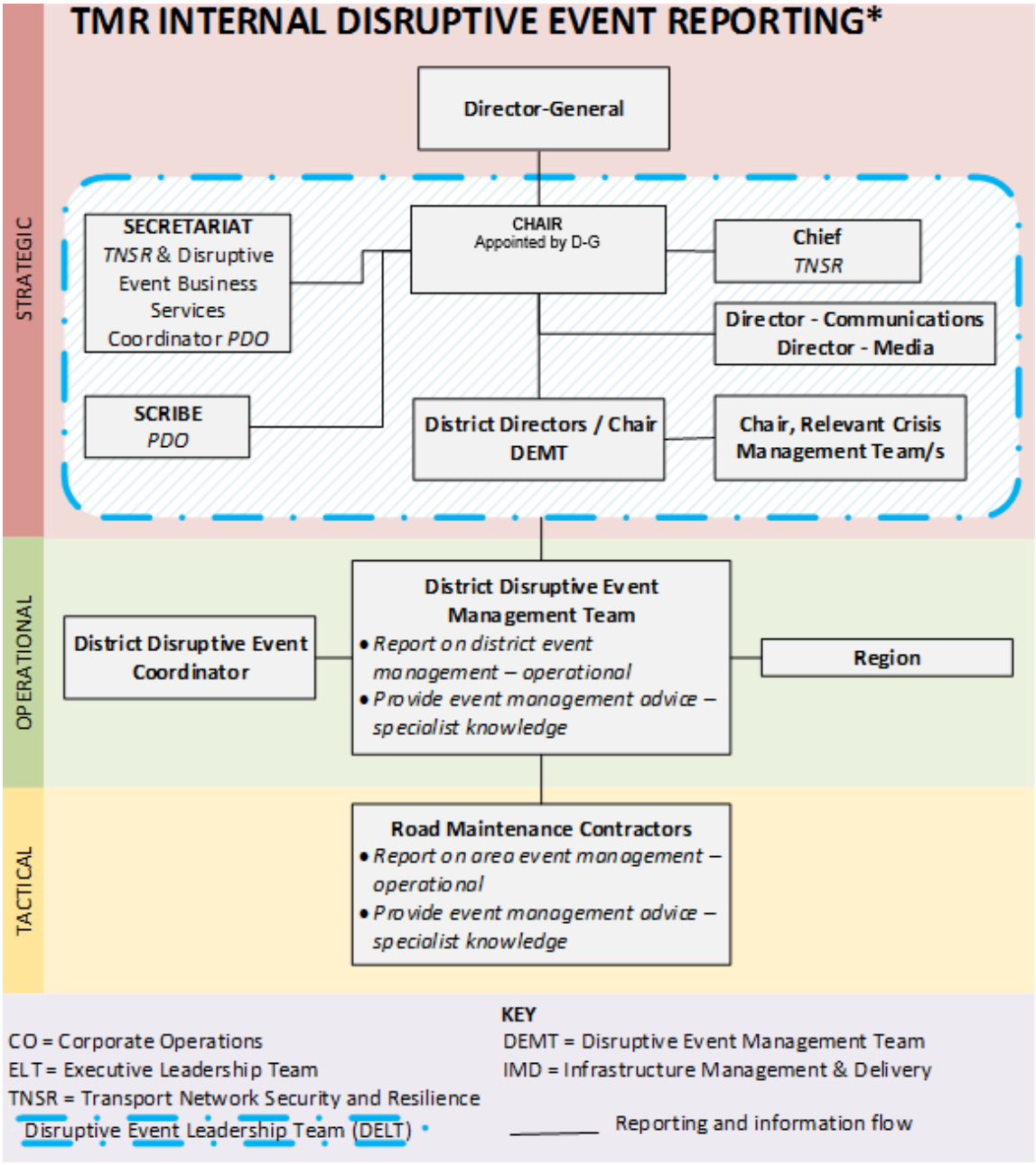


Figure 4.3.2.2 TMR internal disruptive event reporting structure [4.3]

The Department of Transport and Main Roads (TMR) led three key areas – transport infrastructure, providers and regulation, and roads and transport recovery – through participation in District Disaster Management Groups (DDMGs). In advance of STC Debbie, relevant Local Disaster Management Groups (LDMGs) and DDMGs were stood up, and a State Disaster Coordinator was appointed.

Overall leadership of the TMR preparation and response was provided by the Disruptive Event Leadership Team (DELT). Disruptive Event Management Teams (DEMTs) were established in relevant districts and included TMR areas – TransLink, Maritime Safety Queensland, Program Delivery and Operations, and Customer Services – and District Disaster Liaison Officers (DDLO). DDLOs, as TMR's representatives, provided transport systems advice collaborating with rail, bus,

tram, ferries, taxi, limousine and maritime services to provide input to support planning arrangements. TMR's commercial road infrastructure business RoadTek also prepared by mobilizing resources at key locations.

As the cyclone approached, districts built their situational awareness, obtaining information for inclusion in regular situation reports, produced three times daily, with information communicated to relevant stakeholders. Flood sensors and Closed Circuit Television (CCTV) at key locations assisted with operational and disruptive event monitoring. Mapping tools that identify high-risk areas, roads and bridges also informed preparations.

4.3.2.3 Response

In the aftermath of STC Debbie, TMR's Road Maintenance Performance Contractors and RoadTek crews cleared trees and landslips to make roads safer and open so that emergency response vehicles could gain access, assess impact and commence restoring services to affected communities.

Road closure protocols were used and inspectors captured information on roads and bridges to

Figure 4.3.2.3 TMR's new traffic and travel information service

Figure 4.3.2.4 Granite Creek Bridge repair

feed back into QLDTraffic, the traffic and travel information service, in real time to provide accurate and timely information to the public.

TMR worked directly with the freight and heavy vehicle industry through the Flood Recovery Road Access Group (FRRAG), which supports and enables road access for freight and heavy vehicles during disaster events. The FRRAG assisted with heavy vehicle permitting and network access, primarily to support flood recovery but also acknowledging economic drivers.

TMR provided input into state-level reports prepared and distributed by the State Disaster Coordination Centre (SDCC) including:

- State updates – provided an overall situational awareness for the State Disaster Coordination Group (SDCG)
- Executive summaries – provided a strategic summary to the State Disaster Coordinator/Queensland Disaster Management Committee and senior executives of key response agencies
- Key messages – produced for use as speaking points by government personnel, Ministers and the Premier.

Information about the event and associated disaster response operations was also disseminated to the Australian Government.

Districts used VHF radio as the main form of communication during the event, due to loss of power or the mobile network not having capacity for the volume of usage. In one district, the Queensland Police Service (QPS) also used their VHF system during the event, as they had done previously during STC Yasi.

Following STC Debbie, networking and communication between adjoining districts was flagged as an area that required further development. Issues identified included contact details for TMR staff in other districts not being readily available and adjoining DDMGs standing up or down on different days, causing confusion for staff and other stakeholders. Relationship building across districts will assist with this issue.

4.3.2.4 Communication with industry

A large cotton crop was saved from rising floodwaters in the aftermath of STC Debbie, after TMR fast-tracked a heavy vehicle permit to allow harvesting equipment to reach the farm in time. TMR issued an Emergency Heavy Vehicle Permit within four hours of receiving the request to allow a farmer near Goondiwindi to move oversize agricultural equipment on state-controlled roads. Cotton Australia had approached TMR on behalf of the producer, requesting urgent assistance for him to be able to move two oversize cotton pickers from one part of his property to another to harvest 200 hectares of cotton that were about to be inundated by floodwaters. This event was just one of many, as TMR staff worked a 24-hour permit hotline in response to the disaster to respond to emergency permit applications. More than 100 calls were responded to and 29 permits issued outside of ‘business as usual’ hours.

4.3.2.5 Communication with the community

STC Debbie marked the first opportunity for QLDTraffic – TMR's new traffic and travel information service – to prove itself during a major emergency impacting Queensland's transport network. On Thursday 30 March 2017, the day STC Debbie made its way to southeast Queensland, the QLDTraffic website handled more than 560,000 visits, with more than 5000 Queenslanders using it simultaneously. That was more than double the previous single day record and, compared to a normal day, was almost a hundredfold increase. More than 1000 real-time updates were made during the event to get correct information out quickly and effectively. TMR's social media team also helped keep Queenslanders informed by pointing 150,000 visitors to the QLDTraffic service and encouraging other agencies and organizations to promote QLDTraffic on their own social media feeds..

4.3.2.6 Communication to facilitate the response effort

A severely damaged bridge on the main national highway linking Mackay and Rockhampton was reopened to traffic after just 36 hours, enabling critical generators to reach communities without electricity. One end of the bridge was completely washed out by storm water run-off, which meant only the concrete approach was supporting the bitumen surface. Road crews installed a temporary sandbag wall to make the bridge safe for travel. While the bridge repairs were carried out, bridge traffic was limited for safety and more than 65 permits were issued to allow emergency and essential service vehicles to travel north along the Bruce Highway through Granite Creek. Just 36 hours after work commenced, temporary repairs to the bridge were completed and the highway officially reopened to two-way traffic, enabling more service vehicles to assist in the cyclone response effort.

Following STC Debbie, TMR had access to real-time information about disaster damage to the state-controlled road network for the first time via the Recording Asset Damage and Restoration (RADAR) damage capture application. The RADAR app was developed to enable TMR to collect

Figure 4.3.2.5 TMR crew pothole patching and updating RADAR near Rockhampton

photo evidence with GPS data, which is required to prove the eligibility of disaster recovery works under the Commonwealth/state funding arrangements, the Natural Disaster Relief and Recovery Arrangements (NDRRA). The RADAR initiative has two components:

• RADAR app – used on mobile devices to capture photos and data in the field via a simple site form, then save data to the cloud

• RADAR desktop – where the data is downloaded, managed and reports generated.

Initial feedback from users was that the RADAR mobile app made the collection of information in the field quicker and easier. Having photos and other data automatically saved in the damage capture platform eliminated the previous process of having to travel back to the office, manually enter data into a spreadsheet and download photos from a camera. The RADAR desktop component enabled damage evidence to be downloaded instantly and progressively assessed for eligibility back in the office. This enabled TMR staff to store, manage and report photos in the required format for funding submissions, which resulted in significant time savings.

4.3.3. Further strengthening of the disaster-prevention measures for tsunami (Japanese case study)

Making use of the lessons learned from the Great Hanshin-Awaji Earthquake in 1995, the Great East Japan Earthquake in 2011 and Kumamoto Earthquake in 2016, NEXCO-West deploys a business continuity plan for the company that envisions disasters such as earthquake and tsunami, and works together as a group to further reinforce our disaster-prevention measures.

A business continuity plan (BCP) is an action plan that is formulated so that operations can continue and full operations can be rapidly restored in the event of disaster. A BCP is important to ensure the stability of a regional economy and preservation of life. NEXCO-West recognizes our role in the event of a disaster and promotes disaster management activities.

NEXCO-West is monitoring traffic conditions and facility operations on an around-the-clock basis and coping with traffic accidents, fire, broken down car, congestion, road obstacles and disasters. In addition, we provide clear information in real time to customers and related authorities.

The Traffic Control Center has collected information on unplanned events such as traffic accidents, fire, broken down cars, congestion, road obstacles and disasters to provide such information to

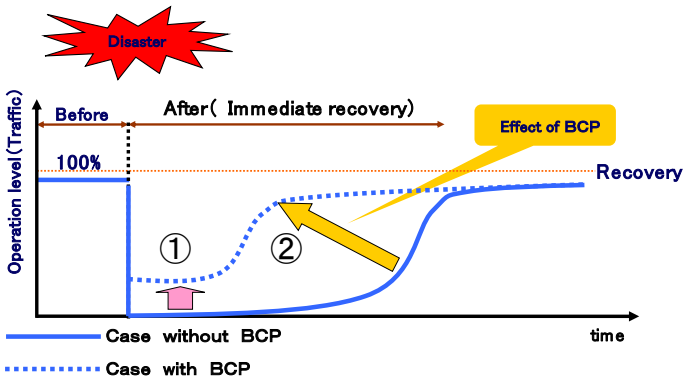


Figure 4.3.3.1. BCP Concept Chart

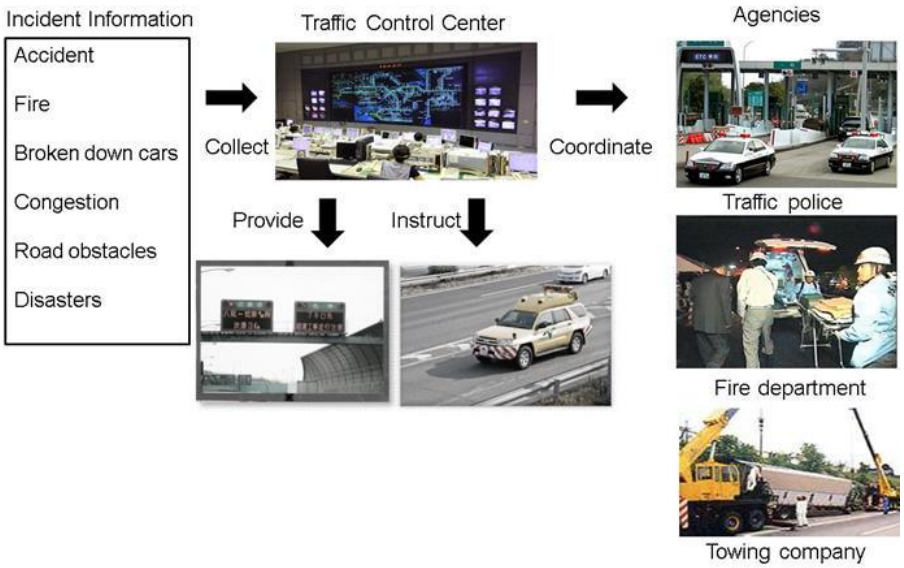


Figure 4.3.3.2. Flow of Traffic Control Operations

our drivers. When unplanned events occur, we provide instructions to the Traffic Management Patrol Squad on-site so they can take appropriate actions to handle the situation and coordinate with the related agencies such as Traffic Police, Fire Department, and other safety and support agencies.

In readiness for earthquakes, NEXCO-West are taking comprehensive anti-disaster measures including anti-seismic reinforcements of bridge piers and measures to prevent bridge collapses, as well as establishing a system for speedily opening up roads. We are also working to reduce the duration of road closures caused by snow and fog.

Regarding various countermeasures against earthquakes and tsunamis, NEXCO-West takes preparations to make durable expressways by reinforcing bridges against earthquakes. Slope

reinforcement work is based on inspection results and geological condition and NEXCO-West screens out dangerous locations outside expressways and discusses these measures with related authorities.

In January 1995, the Great Hanshin Earthquake struck, devastating the Hanshin-Awaji area with a magnitude of 7.2. That incident spurred us to reinforce bridge piers throughout the expressway system. A lot of retrofit works has been intensively carried out for strengthening expressway structures to make sure of safer expressway network as shown in Figure 4.3.3.3. Also, even when a large-scale disaster occurs, the center needs to play a role as an emergency traffic route that supports life-saving as well as relief goods transport in the stricken region by restoring its functions in as short a time as possible. Though it is natural that road structures should be restored early, if the expressway control center itself is visited by a disaster and its early recovery is unlikely, then the Chugoku Branch is implemented as a backup for traffic control of each branch.

In March 2011, the Great East Japan Earthquake hit the eastern Japan with giant tsunamis. As was the case with the Great East Japan Earthquake, people can escape from a tsunami because expressways are located higher than their surroundings. The Pacific coastal part of expressway network of NEXCO-West anticipates giant tsunami with the probability of 70-80% in next 30 years, especially 34m height tsunami in Kochi town, Kochi prefecture. Live-save disaster management countermeasures are the first priority for both the local public and NEXCO-West as a road administrator, whereas the NEXCO-West has an important responsibility to keep expressways open for emergency and recovery traffic immediately after the event. As for the solution for controverstial tasks, NEXCO-West made an agreement with the local municipalities in which

(1)Slope reinforcement works

(1) Use of expressway embankment slope as evacuation facility for local residents

(2)Slope reinforcement works (3)Bridge pier reinforcement works

(2) Evacuation drill with local residents

Figure 4.3.3.4 Evacuation facility managed with local residents

Figure 4.3.3.3 Strengthening for Highways

expressway embankment slope can be used as a temporary area for refuge. In the municipal area of Tokushima expressway between Naruto J.C.T. and Tokushima I.C., NEXCO-West reached an agreement with the relevant local municipalities to set up a tsunami evacuation facility utilizing the embankment slope of the expressway and the back yards of the travel plaza. To ensure smooth evacuation on the event of tsunami, local residents and NEXCO-West regularly conduct evacuation drills for preparing the tsunami attack as a part of emergency drills of the local governments. This kind of cooperation disaster countermeasure activities with the public against tsunami disaster are becoming a major part of disaster management activities in road administrators.

In order to promote cooperation with other public authorities, NEXCO West and NEXCO Central signed an agreement with the Central Army of the Japan Ground Self-Defense Force (JGSDF) in order to strengthen partnerships on the following projects based on implementation for crisis management.

NEXCO-West has been promoting 100% safety and reliability for all customers as a top priority and tackling various countermeasures for expressway maintenance and traffic safety 24 hours a day, 365 days a year since its establishment to construct, operate, and maintain expressways as social infrastructure.

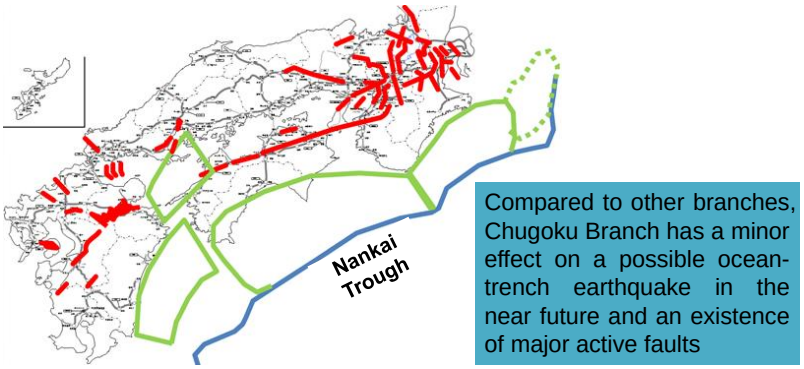


Figure 4.3.3.5 Plate boundary and active faults in western Japan

(1) Road condition surveillance drill for emergency route

(2) Communications test

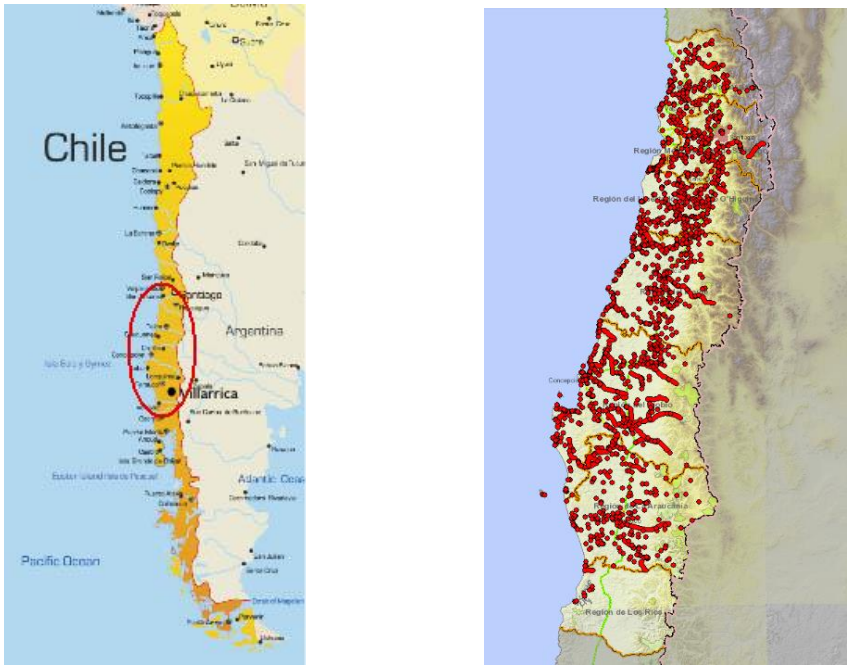
(3) Information exchange meeting

Figure 4.3.3.6 Emergency management activities with Japan self-defence-force

4.3.4. Revise regulation specifications (2010 Chile earthquake) and communication and consultation with the public (Chilean case study)

4.3.4.1 Introduction

On February 27, 2010, Saturday 3:34.17, Chile was hit by an earthquake that reached a magnitude of 8.8 MW. The epicenter was located in the sea near Curanipe and Cobquecura, about 150 kilometers northwest of Concepción and 63 kilometers southwest of Cauquenes, and 47.4 kilometers deep under the earth's crust, and lasted 2 minutes 45 seconds. It affected more than 630 kilometers of the national territory and 75% of the population, equivalent to 12,800,000 inhabitants. This earthquake is among the eight largest in the world, of which three have been in Chile.



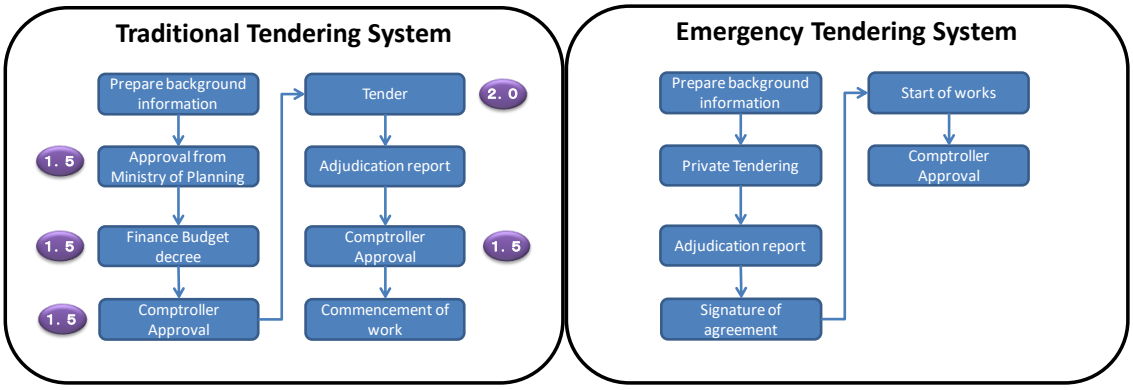
(a) Severely affected area in Chile *(b) Damaged points of road network*

Figure 4.3.4.1 Earthquake affected area at the 2010 Chile earthquake

The regions mainly affected by the earthquake were the Region of Valparaíso, Metropolitan, Libertador Bernardo O'Higgins, Maule, Biobío and Araucanía, where the road infrastructure was damaged mainly by soil settlements, subsidence, cracks in roads and berms; landslides, rock falls and slope undermining; structural damage, cracking, falling and collapse of bridges; settlement of bridge approaches; collapse of crossing pipes and collapse of footbridges.

4.3.4.2 Effects on disaster management

Administrative Regulations



(a) Traditional bidding system *(b) Emergency Bidding System*

Figure 4.3.4.2 Flow of bidding and contract

Due to the amount of damage on the road network, the need to face the most serious emergency points and provide a quick response to the public, some changes in the regulations were determined under supreme decrees:

1. Establishes six regions of the country as a catastrophe zone and grants wide powers to Regional Intendants to adopt and apply all the necessary countermeasures to respond as required and normalize the regions.

2. Modifies the Regulations of Public Investment Amount for Public Works Contracts and authorizes the execution of extraordinary works, up to 50% of the original budget.

3. Authorizes Ministry of Public Works to contract works directly without approval of Comptroller General of the Republic.

4. Changes to the public works bidding system, which reduces the administrative procedures for hiring during emergency periods from 8 months to 3 weeks.

Modalities for facing emergencies and reconstruction phase

In order to quickly respond to the emergencies caused by the earthquake, all available resources and modes for contracting works were used: in-house working, road network contracts, direct contracting and public tenders.

Through in-house working 72 events were attended, by roads network contracts 197 emergencies were responded to, detailed in 35 contracts modifications, 448 events were attended through direct contracting and tenders were grouped in 167 contracts.

New seismic criteria

In order to ensure that the same failures occurred in the 27F earthquake won't happen again, the Directorate of Roads established the application of new seismic criteria for the new structures, which includes:

- special analysis for crossed bridges
- beam seats extension in abutment and piers
- additional intermediate seismic bumps
- use of cross beams between beams in all bridges independent of the seismic zone
- anchoring of elastomeric decks to the support beams and beam seats

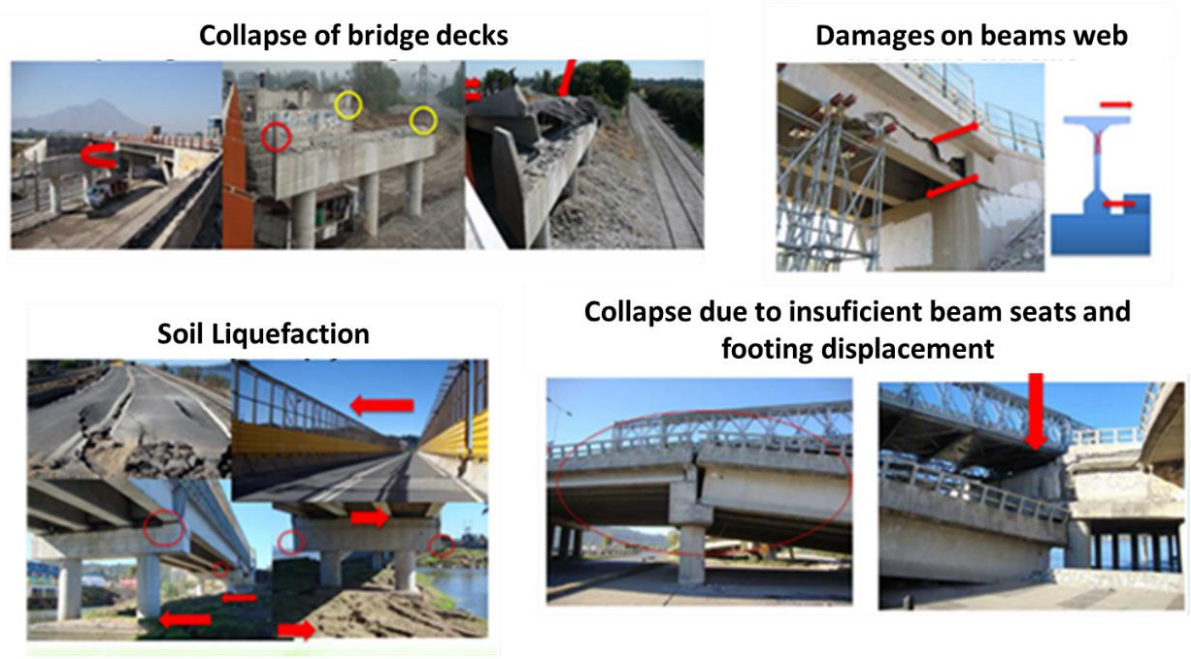


Figure 4.3.4.3 Damages to Bridges

- incremental accelerations to calculate connections (for example, decks, anti-seismic bars and joints)
- incorporation of integral bridges concept (that is, continuous decks and monolithic decks with abutment connection).

4.3.4.3 Communication with the public

There were so many errors in communication with the public that the result was a greater number of fatalities. The summary of these errors is an integral part of this report in the Chilean case studies. Unfortunately, learning about the communication discipline cost too much.

Currently, during emergency situations the relationship with the public is managed officially through the National Emergency Office. The Roads Department provides information about damage to the roads, through digital GIS layers, and established a formal procedure for emergency information, as well as a computer system for recording, analysis and transmission of information.

4.3.4.4 Consultation process with the public

The relationship between the Directorate of Roads and the public is carried out by regional governments, municipalities, neighborhood boards or other related organizations. Most of the time this relationship has the goal of explaining the scope of the contracts and the work to be done on the road network in their communes or provinces, as well as to request information on damage or problems. However, the information coming from these sources sometimes suffers from lack of objectivity, clarity and generally with different agendas.

Likewise, the website on Transparency of Public Administration has been made available, under the Probity and Transparency Law. This regulates the way to communicate, contribute and/or require information from the public sector.

(a) In metropolitan region

(b) In northern region *(c) In southern region*

Figure 4.3.4.4 Public involvementmeetings

4.3.4.5 Lessons learned and conclusions

Chile is a country that is constantly affected by emergencies, which is why it is important to have relevant information that allows us to assess the effects and understand which aspects of emergency management should be reinforced.

The case of the earthquake in 2010 generated the following changes in the management of emergencies by the Directorate of Roads:

(1) Normative scope

- Use of Agreement for Emergency Contracts as pre-evaluated templates.
- Template of public tenders for Emergency Contracts.
- Permanently update the normative instruments, or adopt reference standards.
- Chilean institutions are working to incorporate the experience in new regulations.
- Develop specifications for structures that consider the risks of micro-seismic impacts of various soil types

(2) Operative scope

- All modes for works execution should be available to be used (in-house working, road network contracts, specific contracts and direct contracting).
- Count on Regional and National Emergency Coordinators.

- Definition of priorities: accelerate access to basic services, recover the connectivity of the country, and recover minimum trafficability on public infrastructure to support economic activities.
- Use a method of quick infrastructure inspection through standard forms, in order to obtain bridges conditions.
- Define a portfolio of emergency projects.
- Improve communications network and satellite phones in case of communication collapse (the mobile phone network does not work properly in these cases).
- Keep a stock of provisional bridges for emergencies.

(3) Administrative scope

- Keep the Action Plan updated with the regional emergency officials.
- Establish Preventive Procedures before possible natural threats.
- Establish Action Procedures in the event of natural disasters.
- Establish a ministerial organization dedicated to the management of the emergency projects portfolio.

(4) Institutional scope

- Regional and national organization of technical teams assigned to catastrophe response.
- National Emergency Committee formed by the main Operative Ministers and coordinated by the National Emergency Office.
- Improve coordination among different public and private organizations, with special attention given to traffic management measures during the emergency.
- Review emergency response protocols of the Ministry of Public Works.

(5) Communicational scope

- Develop an Emergency Information System that incorporates damage, associated costs, working modes to respond to the emergency and monitor recovery progress.
- Keep updated Risk Maps for the infrastructure of the whole country.
- Enhance emergency information systems that allow integration between government agencies for disaster response.
- Internal training on emergency procedures.
- Training throughout emergency simulation.
- Use all available media to maintain communication and coordination.
- Permanent collaboration mechanisms of knowledge exchange with other countries.
- Specialized seminars for countries interested in disaster management.

(6) Consultation process with the public

- Establish the framework for communication through formal organizations.
- Present information through images,with easy access for users.
- Meetings to explain the scope of the contracts and works executed in their communes.
- Identify the most vulnerable infrastructure to focus investment efforts.
- Keep the community informed about the state of the infrastructure (detours, adequate signaling, etc.)
- Establish alliances with media.
- Management of public and user expectations.

4.3.5. Community resilience in Northern Ireland (UK case study)

4.3.5.1 Introduction

The Regional Community Resilience Group (RCRG) was formed in 2013 to help local communities to prepare for and respond to weather-related emergencies. The group was set up as a multi-agency governance group with the vision to develop consistent approaches to community engagement and development of community resilience activities across Northern Ireland. The aims of the group also include working on a multi-agency basis to facilitate sufficient planning and preparation to allow for adequate community response and recovery to cope with emergency incidents in pre-identified 'at-risk' communities. Membership includes a range of partners including local government and Department for Infrastructure Roads and Rivers.

In addition to helping local communities to develop Community Emergency Plans, resilience groups are advised of weather patterns so that they can make appropriate preparations for incidents that can affect property, the highway network and local communities. Importantly communities manage their own local plans and materials so that they can respond quickly and relieve pressure on the emergency services.

4.3.5.2 Why community resilience?

Following a very significant rainfall event in June 2012, which impacted the Greater Belfast Area and caused widespread disruption to roads and access for emergency vehicles, the NI Government's Performance and Delivery Unit carried out a review of the response to the flooding and made a number of recommendations.

One of the recommendations was to consider how to deliver appropriate flood warnings and inform the people of Northern Ireland.

To address this recommendation a four-stage 'Flood Warning and Informing Strategy' was developed and approved by the government's Civil Contingencies Group (NI), with a key theme to utilise existing weather and river level information to warn and support communities at known flood risk areas so that they could be better prepared for flooding.

The RCRG was formed in January 2013 to deliver the strategy and to develop a regional standardised approach that focussed on and prioritised local communities.

The group brings together partner organisations to develop and implement a Community

Figure 4.3.5.1. Logo of Regional Community Resilience Group (North Ireland, UK)

Resilience Delivery Program across the region. Membership includes a range of partners including local government, Department for Infrastructure Roads and Rivers, NI Water, the Met Office, the Police Service of Northern Ireland, Northern Ireland Fire and Rescue Service, the British Red Cross, the Consumer Council, NI Electricity and other government departments.

The purpose of the RCRG is to work on a multi-agency basis to facilitate consistent, prioritised and focussed planning and preparation for community response and recovery activities that will help pre-identified communities deal with emergency incidents. This includes resilience of roads before, during and post a flooding incident and the ability of emergency responders being able to use roads to reach communities. The group adopted flood risk as the initial topic on which to engage communities and develop resilience.

4.3.5.3 Work to Date

A pilot project with 10 communities was taken forward during 2014-15. In April 2015, an independent review of the pilot was carried out by the Consumer Council, supported by the British Red Cross. The findings of the review highlighted:

- 72% of residents felt better prepared for flooding as a result of the RCRG work
- 74% felt better informed about flood risk
- Seven out of 10 communities had an agreed community emergency plan.

The review concluded that the RCRG has been largely successful and should continue, however it did identify that it was resourced by the members' goodwill and commitment.

The future development in the area of community resilience is dependent on this goodwill and commitment continuing. The rate that this initiative can be rolled out to other communities is therefore determined by the available community resources.

Following the review the British Red Cross secured European Union (EU) funding to continue community engagement, though a project known as Community Resilience in Urban Areas (CRUA). This enabled a further rollout of the RCRG initiative in Northern Ireland during 2015-16. The additional locations were selected from a list of communities identified in the Flood Risk Management Plans for Northern Ireland, developed to fulfil the EU Floods Directive Requirements. These plans identified 20 Significant Flood Risk Areas and some of these significant

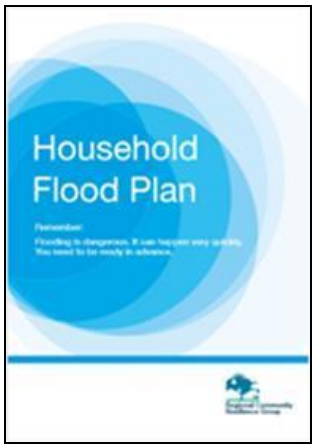


Figure 4.3.5.2. RCRG Household Flood Plan 2016 (North Ireland, UK) [4.4]
(https://www.nidirect.gov.uk/sites/default/files/publications/RCRG-household-flood-plan-2016.pdf)

flood risk areas were identified as further RCRG locations.

'Household Flood Plan' and 'Community Emergency Plan' documents were developed so that a common resilience approach could be taken across Northern Ireland. These template documents allowed each community to be able to develop tailored plans to suit the individual needs of the community.

The EU CRUA project finished on 31 December 2016, however, engagement with all of the active communities continues under the RCRG. There is also less formal engagement with an increasing number of other communities, and in total the RCRG is now working with 30 communities at risk of severe weather, including a pilot group in Dromara, Co. Down, which is a community severely affected by snow in recent years.

4.3.5.4 Helping communities help themselves

While the RCRG has been effective in raising the awareness level of communities to the flood risks they may face, an even more important achievement is the development of the communities' appetite for 'self-help'. This is important, as it needs to be recognised that there are finite government and emergency services resources to respond to a flood event. In extreme events an important role of the multi-agency team when managing the emergency is to ensure that resources are deployed through prioritisation to maximum effect, as it is impossible to deal with all calls for assistance.

Through the information provided by the RCRG, communities have a better understanding of flood risk and the limitations of the likely response from government. They can therefore determine if they need to put in place self-help measures. For example, there are sand bags provided in suitable storage facilities that can be accessed by local people, enabling the community to self-help. This reduces the demands on government during extreme flood events.

To ensure communities are forewarned of predicted severe weather and the potential to cause disruption, the RCRG issues emails and/or text messages. Additionally, contact is often made directly with key residents to ensure the message is understood and being actioned.

4.3.5.5 Self Help is Key

While the RCRG has been effective in raising the awareness level of communities to the flood risks

Figure 4.3.5.3. Self help

they may face, an even more important achievement is the development of the communities' appetite for 'self-help'. This could not only provide communities with flood protection measures to their houses and municipal buildings but also provide some protection to road infrastructure and vulnerable assets such as culverts and bridges. However to be able to deliver this additional capability, local communities would have to be trained and provided with certain equipment and materials. The ability of a community to provide 'self-help' is therefore important, as it needs to be recognised that there are finite resources from official responders to respond to flooding and a key aspect of the engagement is to ensure an understanding of the limitations of weather warnings and infrastructure that can be delivered to communities.

The RCRG has also supported the rollout of flood warning instrumentation which issues text messages as water rises to pre-determined alert levels. In the past, such text alerts were restricted to 'official government use' only, but by working in partnership with communities this information is now being more widely shared.

It is important to note that community resilience is not in any way a method by which government departments or the emergency services may reduce their response or service to the community, but rather it provides an additional layer of support for those communities at risk.

4.3.5.6 What next for the RCRG?

Work continues to expand the group's activities and engage with more communities at risk of severe weather.

Further engagement is planned using the list from the Flood Risk Management Plans and developing this approach for other weather-related emergencies on a Roads and Rivers basis in communities that would benefit.

Flexibility when delivering community resilience is key and a partnership approach between communities and multi-agency partners is essential for a successful outcome.

Recent weather events continue to underline both the need for and the benefits of effective community resilience. This was evidenced during the severe flooding in the North West of Northern Ireland in August 2017, when community groups activated to take action and help themselves to prevent flooding to property on a night when the capacity of government resources to respond to the volume of calls for assistance was overwhelmed.

4.3.5.7 Case Study - Brilliant Resilient Broughshane

Broughshane is one of four active and thriving community resilience groups operating in the Mid and East Antrim Borough Council area of Northern Ireland.

Following initial support from Mid and East Antrim Borough Council, the Broughshane community resilience group has grown as locals with an interest in helping their own community have joined. By galvanising community support from residents, local community groups, young farmers and local anglers, a bespoke plan has been developed. This group of willing volunteers, each with their individual role to play, is connected by a telephone network that reaches across the community.

Originally an RCRG Pilot Project led by Mid and East Antrim Borough Council, the planning process also gained support, advice and guidance from other agencies including Department for

Infrastructure Roads and Rivers, Red Cross, PSNI, NI Fire and Rescue, Housing Executive and NI Water.

Lexie Scott, Chair of Broughshane Community Association said: “For many in our community, flooding and the fear of recurring flooding is very real and traumatic. We have strong community networks and the development of this plan has helped us to galvanise the support of local volunteers who have signed up to particular roles such as river watchers, weather alert receivers or a helping hand lifting sandbags.

"We have been provided with equipment and involved in decisions about where this equipment is best situated. This means that the decision regarding the best location for the local sand bag stores has been a community one. The plan empowers us and has provided an opportunity to make face-to-face contact with government officials. We have really appreciated the support of the statutory agencies throughout and, in particular, the help given by local Council officers. ”

A system of text alerts from the Met Office to nominated local residents has been put in place which raises awareness of weather warnings. Department for Infrastructure Roads and Rivers also provides a text alert service for rising river levels. A local panel of volunteer river watchers provides an additional alert to rising water levels. A Local Skills and Resource Register, with details of those volunteers and agencies who can help during a flood situation, has been compiled ensuring a swift and efficient response. The plan also has a very comprehensive and up-to-date contact list which is essential in emergency situations.

The group is now at the point of testing its arrangements and is currently working with Mid and East Antrim to undertake an exercise to make sure their planning dovetails with the responding agencies and will run smoothly to reduce impacts on the villagers and protect local property.

Figure 4.3.5.4. Brilliant Resilient Broughshane [4.5]

(https://www.fermanaghomagh.com/services/community/environmental-health/emergency-planning/?download=file&file=31466)

4.4. CONCLUSIONS AND RECOMMENDATIONS

The role of disaster management is to minimize the impact of disruption caused by natural or man-made events to road infrastructure, and to reduce the effects of disruption and recovery to human life and society. The physical size of a disaster disruption zone and impact to road infrastructure is influenced by the effects of disaster impact reduction measures. This greatly depends on the disaster maturity of the road organisation and society, and the public perception and reaction to the disaster risk. The work of TC E.3 WG1 has identified significant evidence that shows how the awareness of risk influences disaster management, and how effective countermeasures can be developed to support road disaster management activities and new trends in road disaster management. Conclusions and recommendations are summarized below :

- Perception of disaster risk and its influence on disaster management
  - Risk awareness is a key influence on the ability of a country to prepare for managing disasters. Countries with a high risk awareness prepare well against disasters and deploy many different types of countermeasures; on the other hand, countries with low risk awareness appear to only introduce relatively simple countermeasures.
  - In deploying soft and hard measures to reduce the impacts and effects of disasters, similar types of disaster management technologies are used by all countries for some countermeasures. Additionally, the degree of disaster risk awareness may have a correlation to the countermeasures in other quadrants, but this is not conclusive and further study is needed to investigate. Recommendation: Investigate the correlation of risk awareness to disaster management countermeasures.

- Disaster management with the public
  - Recently many unpredicted disasters were observed around the world, leading to severe consequences for road organisations, the public and society. This indicates that road organisations need to develop not only a mitigation strategy, but use their risk awareness to develop an adaptation strategy to improve future disaster management. Recommendation: Assess and develop adaptation strategies for disaster management aligned to mitigation strategies.
  - Several organisations are using SNS and ‘self-help’ within local communities to provide more effective disaster information and improve local resilience. Advances in technology together with societal change requires road organisations to continuously reappraise their disaster management techniques and interfaces with the public. Recommendation: Develop a disaster information management protocol which allows road organisations to use disaster information more effectively and positively influence local communities to become more self-sufficient during disasters.
  - The basic premise of “disaster management with the public” is advocated internationally by the UNISDR Hyogo Framework for Action 2005-2015. This important framework is now expanding into the road disaster management field. Disaster management with the public is one of the potential strategies for mitigating the effects of disaster events. Recommendation: Develop a public engagement policy between road organisations and society and develop a disaster management strategy with the public.

5. RISK AND DISASTER MANAGEMENT MANUAL

5.1. INTRODUCTION

The risk and disaster management manual will be an essential tool in risk management and disaster management for the road experts and officials all over the world.

The World Road association (WRA/PIARC) has set up technical committees dealing with risk and disaster management for the road sector for decades. As a result of significant efforts, massive knowledge has been accumulated in WRC as technical reports.

However, public readers have not been able to refer technical knowledge efficiently because the technical term of WRC/PIARC is generally four years and independent technical reports are released to the public by each term.

On the other hand, WRA/PIARC has already prepared sophisticated online manuals on some technical themes such as tunnel operation, ITS/RNO, road asset management and road safety, and readers easily access the website. An advantage of the online manual will be that consistent research is kept and handed over from one technical term to the next technical term.

Considering this, WRA/PIARC assigned technical committee E3 Disaster Management to create an online manual on risk and disaster management. As for the editing of this manual, existing technical reports from 2000 have been reviewed and rearranged to the appropriate order. Readers will be able to easily access and study risk and disaster management for the road sector in a “One-Stop Shop”.

5.2. STRUCTURE AND SUMMARY OF THE RISK AND DISASTER MANAGEMENT MANUAL

The structure of this manual is basically a rearrangement of the existing WRA/PIARC Technical Reports [5.1, 5.2, 5.3, 5.4, 5.5, 5.6, and 5.7] related to risk and disaster management and other related resources. This image is shown in Figure 5.2.1.

The section titled “Principles of Risk Management” is about the broad knowledge and principles of risk management. The reason why the risk management approach is applied is discussed, with some references and details such as ISO’s description about risk management, general approach and risk management processes.

The section titled “Application of Risk Management in the Road Sector” focuses on the role of risk management in the road sector, including organizational, project-oriented, road network-oriented and social acceptance components.

The section titled “Principles of Disaster Management” steps into the general principle of disaster management. During the PIARC cycles since 2000, there are several discussions on the disaster management, crisis management and emergency management.

The section titled “Application of Disaster Management in the Road Sector” is about the application of disaster management to the road sector. Methodologies and techniques of road disaster management are introduced. In the cycle of 2016-2019, disaster information management and road management against disasters are explored and the outputs of these studies are included.

The section titled “Risk Management and Disaster Management Kiosk” is about the kiosk of element techniques and case studies of risk and disaster management that PIARC Technical committee TC1.5 (in the 2012-2015 cycle) has prepared.

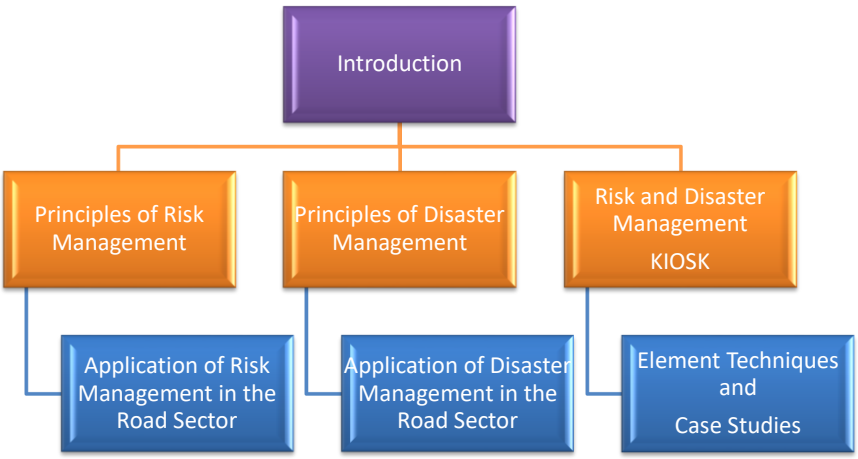


Figure 5.2.1 Contents of the Risk and Disaster Management Manual

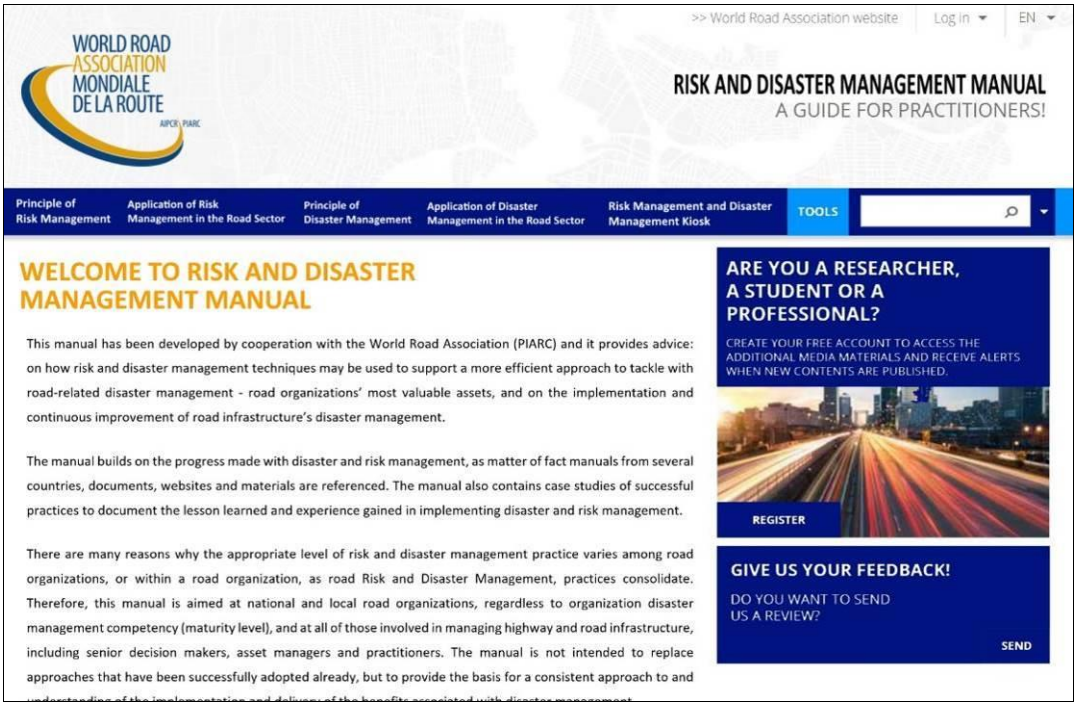


Figure 5.2.2 Home Page of the Risk and Disaster Management Manual website

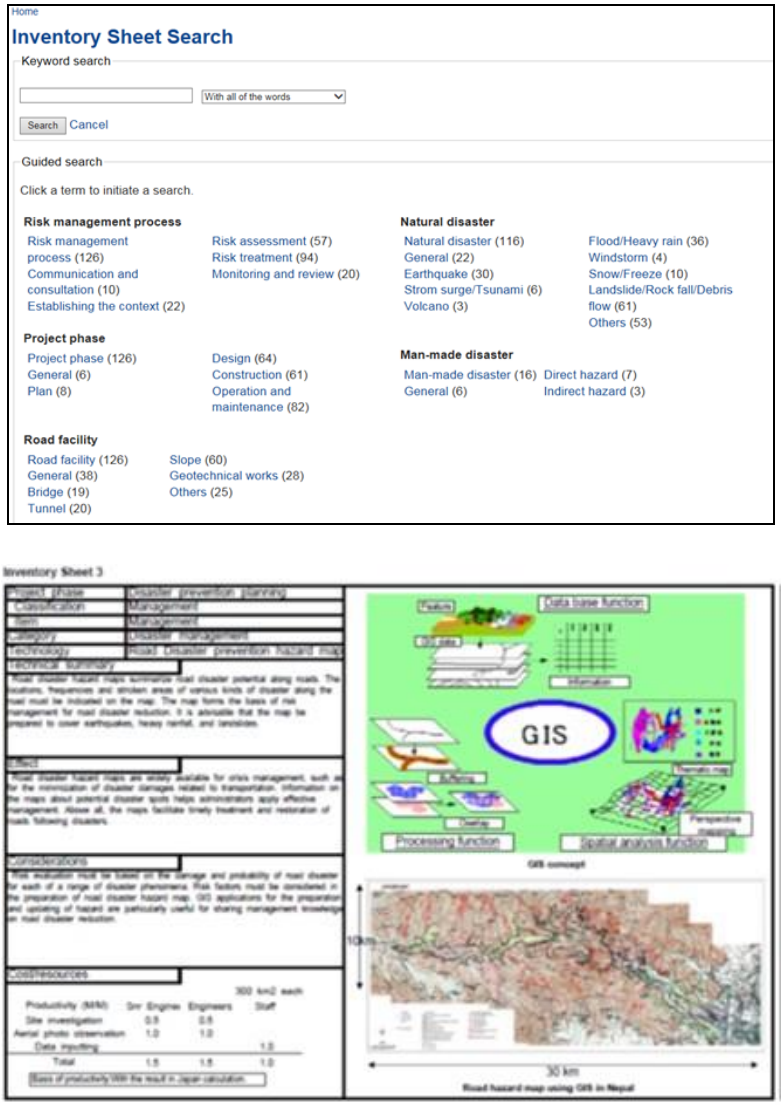


Figure 5.2.3 Inventory sheet search window and an inventory sheet in the Kiosk

The entire content is stored on the PIARC website – go to https://www.piarc.org/en/ and search for “Risk and Disaster Management Manual”.

5.3. RECOMMENDATIONS FOR DISASTER MANAGEMENT MANUAL

The Risk and Disaster Management Manual was designed to access the database application through the internet and was opened to all PIARC users in 2019. The web-based Risk and Disaster Management Manual is user-friendly and is equipped with a graphical interface. It is composed of manual documents and the Kiosk.

A superior point of the online manual is it can be easily revised and added to as more case studies become available. The technology of disaster management will continuously advance.

It is important to remember the lessons learned from disasters and pass these on to the next generation. This online disaster management manual and kiosk would be helpful to mitigate the damage of future disasters.

6. CONCLUSIONS

Disaster management is one of the fundamental strategies in operating a transport network. TC E.3 WG1 focuses on the role of information management in disaster management. This includes the study of not only information management but also disaster management with the public. TC E.3 WG1 lays special emphasis on demonstrating the successful practices regarding disaster information management and disaster management with the public that are helpful in implementing these strategies in practice all over the world.

[Recommendation for decision-makers]

●Disaster information management in general

- Information management is the primary and fundamental basis of emergency management. Developing a reliable information collection and sharing system is the first step of disaster management.
- Within an organization's disaster management approach, develop a specific disaster information management strategy and action plan.
- As part of the disaster information management strategy, define how you engage with internal and external stakeholders and understand their information needs and expectations.
- Many countries have realized the importance of an information management center and they have had many experiences of managing disaster situations effectively and successfully by developing such centers. Develop information management center to mitigate the effect of the disaster.
- Develop specific communicational procedures rather than structure and test these to ensure the procedures work well in emergency situations.
- A proactive approach in information management will receive a positive reaction from road users.

●Disaster information management in detail

- Develop an Emergency Information System that incorporates damages, associated costs and working modality to face the emergency and monitor recovery progress.
- Highly advanced information communication tools are now available. Develop an information management system using traditional communication tools as well as highly advanced communication tools.
- Understand that the information people need during the phases of a disaster can be different to the information that road agencies give out, which may lead to unintended response behaviors during and after a disaster. This should be part of an organization's disaster management testing.
- Analyze previous disaster information data, develop communication scenarios and continually review them especially for single mode and multimode emergencies.
- Monitor road trafficability and connectivity, and information provided by users and other authorities or organizations, and disseminate the information by media according to agreed protocols.
- Use all available media to maintain communication and coordination.

- Visibility of road repair is essential for the community in terms of information management.
- Develop an information management system on a business-as-usual platform that allows integration between government agencies for disaster response.

●New tools for disaster information management

- Establish alliances with media.
- SNS is a powerful tool for information dissemination but is also a potential tool for information collection in an emergency. Further research is required on highly advanced disaster information management systems using the advantage of potential SNS tools. The benefit Caltrans has experienced using SNS technology is the speed, frequency and simplicity with which information can be delivered to the public.
- Road administrator has responsibility for managing fake news and disseminate accurate news on any kind media, especially by SNS

●Disaster management in general

- Business continuity plan (BCP) is an action plan that is formulated so that operations can continue and full operations rapidly can be restored in the event of disaster. BCP is important from an angle to ensure the stability of regional economy and lives.
- Management of public and users expectations is important in order to try to be clear about what the public and users expect from Roads Directorate and make clear what they will get. So the goal is to keep users frustration levels low by been realistic with the expectations and make them understand the spirit of the project.

●Disaster management with the public

- Recently many unpredicted disasters have been observed around the world. This indicates that not only the mitigation strategy but also an adaptation strategy is needed for future disaster management. Develop adaptation strategy for disaster management in future.
- The basic idea of so-called “disaster management with the public” is advocated internationally by the Hyogo Framework for Action 2005-2015. This important action is now expanding to the road disaster management field. Disaster management with the public is one of the potential strategies for mitigating the effect of disaster events. Develop public engagement policy and develop the new disaster management strategy with the public.

[Technical Aspect]

●Risk and Disaster Management Manual

- A Risk and Disaster Management Manual was designed to be accessed through the internet and was opened to all PIARC users in 2019. The proposed web-based Risk and Disaster Management Manual is user-friendly and is equipped with a graphical interface. The manual is comprised of manual documents, toolbox, archives and links.

● Application of ITS and information management techniques to risk and emergency management

- Advances in technology and the progressive integration of Intelligent Transportation Systems (ITS) in road operation and surveillance have radically changed traditional approaches in preparing for, responding to and recovering from an emergency. The use of ITS in risk and emergency situation management clearly improves informed decision-making.

[Recommendation for International Road Organization & PIARC]

- Both developed and developing countries are still severely damaged by disasters. It is recommended that the International Road Organizations such as PIARC, IRF, REAAA and DIRCAIBEA pursue closer collaboration to disseminate information on disasters and risk management, and share experiences and good practice. Closer collaboration between road organizations and national governments should be encouraged.
- Disaster information management is a long-standing problem in disaster management, but in recent years it has become a bigger issue due to development of ICT technology. Widespread use of mobile devices have the potential to change conventional disaster management. International organizations should collaborate on the dissemination of new techniques to disaster-prone countries.
- Continue to collect good examples of risk management (international case studies) and disseminate information to governments, international and regional road organizations.
- Hold specialized seminars for countries interested in disaster management for permanent mechanisms for collaboration and knowledge exchange with other countries.

[Future Research Needs]

Technical commitees on Disaster Management of PIARC have worked vigorously on management techniques for disaster mitigation, preparedness, response, and recover from the view point of road administrators. However, road administrators have currently been facing to disasterous situation due to various kind of causes. Therefore future steps in this research area will need cover more wide range of emergency situation as follows ;

- Good practices in Emergency (natural disasters, infrastructure failures, attacks,...) planning.
- Evaluation and adaptation of road infrastructure for emergency situations.
- Management of emergency information through Big Data and social networks.
- Financial aspects of emergency management and recover

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