



Public Warning Systems in the Americas

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5G AMERICAS WHITE PAPER

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1 EXECUTIVE SUMMARY

Cell broadcast-based Public Warning Systems (PWS) have been specified by the Third Generation Partnership Program (3GPP) and standardized by multiple Standards Development Organizations (SDOs) throughout Europe, Asia, and the Americas. There are many benefits in using cell broadcast-based PWS for the general public and for cellular operators versus using point-to-point alerting methods such as Short Message Service (SMS) and Over-the-Top (OTT) applications to provide wireless emergency alerts. This paper advocates the use of cell broadcast-based PWS for providing wireless emergency alerts to the public within a given country as well as to support the receipt of alerts for users who are roaming internationally.

2 INTRODUCTION

This 5G Americas white paper discusses PWS and other alert systems in the Americas. Many countries in the Americas have deployed and are in the process of enhancing PWS. Industry participants in the U.S. and Canada have developed standards and have collaborated with 3GPP in developing standardized functionality for PWS. The goal of this paper is to advocate for the use of cell broadcast-based systems for PWS and inform vendors, operators and regulatory authorities of the benefits associated with such systems. In addition to discussing the cell broadcast-based systems as defined in 3GPP, this paper will also discuss international roaming support for PWS. Another objective is to gain an understanding of varied emergency alert systems currently in use throughout the Americas.

3 BENEFITS OF CELL BROADCAST-BASED SYSTEMS FOR PWS

Point-to-Point communication techniques, for example SMS and Over-the-Top (OTT) Smartphone Apps, as shown in Figure 3.1, have a number of challenges that make them undesirable for PWS; they are not designed for critical authority-to-individual emergency alerting.

- Sometimes they can experience delivery delays when attempting to deliver messages to a large number of recipients in a short period of time
- Messages are addressed to phone numbers and not to users within a specific alert area, so if a user roams into a cell site in an alert area (shown in red), it may not receive an alert
- SMS could possibly be spoofed by individuals who wish to cause public disruption due to false alert messages
- Smartphone subscribers must have a data services subscription with their wireless operator in order for the smartphone apps to receive alert notifications via the wireless operator's cellular network

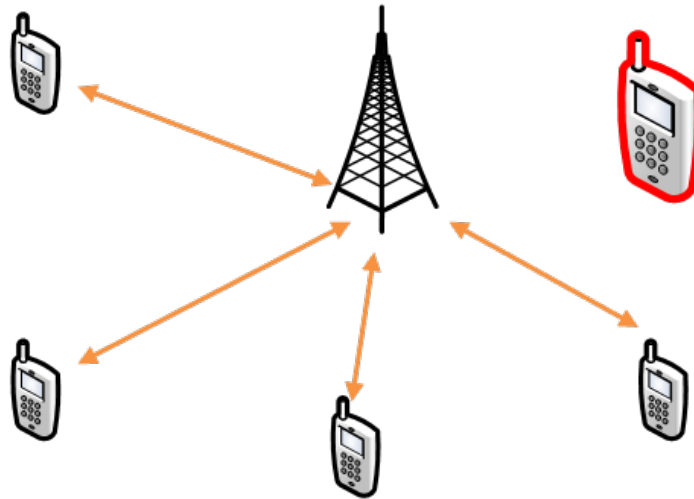


Figure 3.1. Point-to-Point Communication.

Cell broadcast-based systems, as shown in Figure 3.2, are an effective method for the delivery of short and critical emergency alerts to users in an affected area without the need for subscription or determining the device's location. Any user in the geo-targeted area typically will be able to receive the alert.

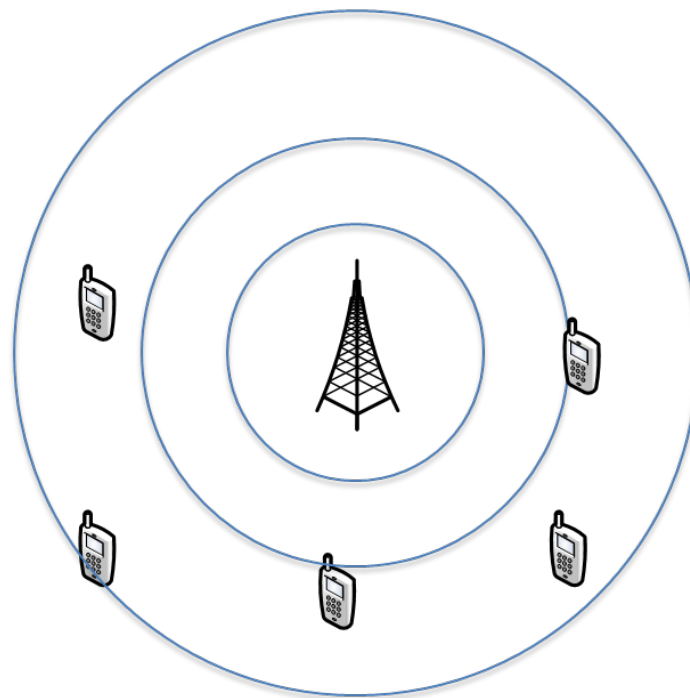


Figure 3.2. Cell Broadcast Communication.

Figure 3.3 shows the geo-targeting aspect of PWS. Authorities send an emergency alert and its corresponding geo-targeted area (shown in red) to a Commercial Mobile Service Provider (CMSP). The CMSP will then determine which cell sites in the geo-targeted area should broadcast that alert (shown in yellow) so as to be received by cellphone users connected to those cell sites (sectors).

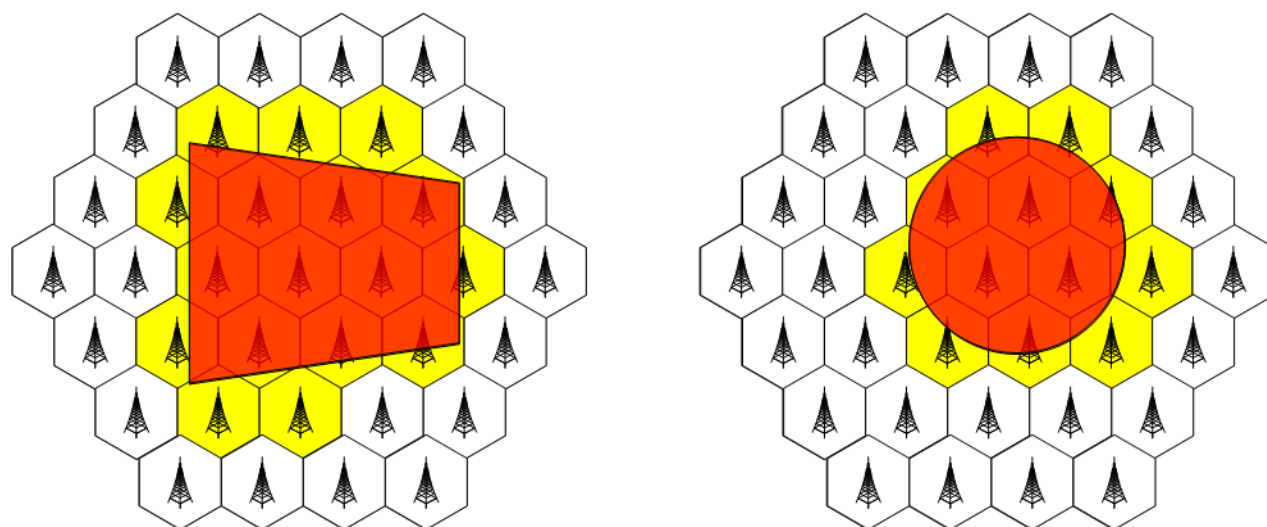


Figure 3.3. Geo-targeting Aspect of PWS.

Cell broadcast-based emergency alert communication has advantages over point-to-point methods including:

- There are typically no significant delivery delays when attempting to deliver messages to a large number of recipients in a short period of time due to the underlying broadcast technology
- There is no cell broadcast subscription required for receiving emergency alerts via cell broadcast technology
- Messages are broadcast to all devices within a specific alert area, so if a user roams into a cell site in an alert area, the user will receive the alert
- Smartphone subscribers do not require a data services subscription with their wireless operator in order for their device to receive an emergency alert via cell broadcast

4 FUNCTIONAL COMPONENTS OF PWS

4.1 HIGH-LEVEL OVERVIEW OF PWS

Public Warning System (PWS) is a 3GPP technology that uses cell broadcast capabilities to effectively provide short text-based alerts and warnings to the public via a broadcast message sent to an alerting area defined by cell site coverage. Cellular phones in that area will receive and display the alert to the user if those phones are enabled to receive particular types of messages. PWS makes use of a Cell Broadcast Center (CBC) to provide a message for broadcast over the air interface to devices in the alerting area.

Devices enabled to receive particular message types will receive all messages broadcast in the area to those message IDs to which the device is listening.¹

A message of the type ‘imminent threat’ (for example, a tornado warning) may be used by a CBC to communicate an alert to all devices in the alert area which are “listening” for imminent threat alerts. Cell broadcast messages are rebroadcast (repeated) by the network at periodic intervals to ensure that all devices in the area receive the alert. Devices that were not originally in the alert area may receive the alert upon entering the area. Messages are to be displayed only once to prevent users from growing weary of receiving multiple messages for the same emergency event.

Devices may receive multiple messages of the same type. Each message is assigned a serial number by the CBC to allow for differentiation of messages of a particular type. Serial numbers also enable a correlation mechanism that allows a cellular phone to keep track of which messages broadcast by the operator network have been displayed to the device already, and which are new messages requiring display.

4.2 DIFFERENT TYPES OF PWS

3GPP does not prescribe a particular user interface for PWS messages received by a cellular phone. In practice, different regulatory regimes (for example, the U.S., Canada, Europe, Japan and South Korea) have developed their own unique requirements for the “look and feel” of the receipt of a PWS alert on a device. Such tailoring of PWS to a particular region is useful to meet regulatory requirements in that region; however, such tailoring can create challenges for international roaming.

4.2.1 WEA/CMAS – U.S.

Commercial Mobile Alert Service (CMAS) was contemplated by the FCC and by industry starting around 2006 after the passage of the Warning Alerting Response Network (WARN) Act.² The Cellular Telecommunications Industry Association (CTIA) advocated for a change of name of CMAS to something more palatable to the general public; thus, the term “Wireless Emergency Alert (WEA)” superseded the term “CMAS”. WEA was initially deployed by multiple cellular operators in the U.S. around 2012.

Based on FCC requirements, cellular phones that receive a WEA alert for display to the user must provide a unique alerting tone and a unique vibration cadence to allow hearing and non-hearing users the ability to differentiate emergency alerts from other messages received by a device (for example, SMS text messages, Instant Messaging and email). The audible WEA alert tone is similar to the Emergency Alerting System (EAS) tone that is used concurrently with display of an emergency message crawl on a television screen or with the audible emergency alert message on an FM or AM radio station.

The user can “opt-out” of receiving certain types of WEA alerts, for example, amber alerts for missing or abducted children. WEA users in the U.S. are not allowed to opt-out of Presidential alerts. WEA alerts were originally required to use English language text only with a maximum of 90 characters.

¹ 3GPP TS 23.041, *Technical Specification Group Core Network and Terminals; Technical realization of Cell Broadcast Service (CBS)*. March 2018.

² *Security and Accountability for Every Port Act of 2006 (SAFE Port Act)*, Public Law 109-347, Title VI Commercial Mobile Service Alerts (WARN ACT). Available at www.govinfo.gov.

WEA is a voluntary service from a regulatory standpoint in the U.S. Wireless operators may choose to opt-in to support WEA. Due to the perceived importance of WEA to the general public, the FCC requires notification at the point of sale of cellular devices of whether the device supports WEA or not.

Originally, WEA alerts were not supposed to interrupt ongoing voice/data sessions. Also, phone numbers and URLs were explicitly prohibited from inclusion in WEA alert text. Required Monthly Text (RMT) messages are sent by the Alert Originators and were required to be supported by the cellular operators.

In the U.S., alert originators generate an alert which is aggregated by a Federal Alert Gateway (operated by the Federal Emergency Management Agency, or FEMA) and distributed to Commercial Mobile Service Providers (CMSPs) and other distribution outlets by the Integrated Public Alerting and Warning System (IPAWS) managed by FEMA.

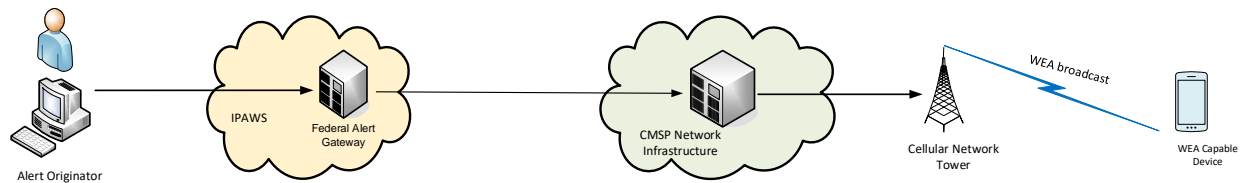


Figure 4.1. WEA Service Environment before WEA Enhancements.

4.2.1.1 ENHANCEMENTS TO WEA

The FCC set implementation deadlines for enhanced WEA (May 2019) and for enhanced geo-targeting (November 2019) in the following two FCC publications:

- (1) FCC 16-127, Federal Communications Commission Report and Order and Further Notice of Proposed Rulemaking In the Matter of Wireless Emergency Alerts Amendments to Part 11 of the Commission's Rules Regarding the Emergency Alert System; September 29, 2016.
- (2) FCC 18-4, Federal Communications Commission Second Report and Order and Second Order on Reconsideration In the Matter of Wireless Emergency Alerts Amendments to Part 11 of the Commission's Rules Regarding the Emergency Alert System; January 31, 2018.

The FCC has extended the original WEA requirements to include Spanish language alerts and to expand the maximum number of characters in an alert from 90 to 360 for LTE and future radio technologies. The FCC now requires that WEA alerts are presented even if there are ongoing voice/data sessions on the user's device. The FCC also mandated that clickable URLs be supported in the text of WEA messages.

The FCC added requirements for operator support of state/local WEA test messages as well as for public safety messages (therefore, messages not tied to imminent threat to life/property).

The FCC has significantly enhanced the geo-targeting requirements for WEA alerts (covering 100 percent of the broadcast alert area with no more than 0.1-mile overshoot). The industry has developed a consensus position that the only technically feasible method for meeting the FCC requirements for geo-targeting is to use device-based geofencing. This requires the alert area polygon coordinates to be broadcast by the network to the user devices so that a user device can determine its own location and then make a decision about whether to display the alert to the user.

Effective November 2019, the FCC requires devices to store all received WEA messages for a period of 24 hours unless the user explicitly deletes those messages after they are received.

4.2.1.2 EARLY EARTHQUAKE WARNING SYSTEM (EEWS)

There are currently no FCC requirements for the support of EEWS; however, several western states in the U.S. have expressed interest in using WEA over LTE for early earthquake warnings. It is interesting to note that 3GPP PWS includes a service called Earthquake Tsunami Warning System (ETWS), which differs significantly from WEA in that ETWS has a very rapid and very short primary notification and a secondary (later) notification with more information for the user. While ETWS could be used in the U.S. to support early earthquake warnings in the future, the current direction of standards activities in the U.S. is such that WEA for LTE will be used to support the near-term EEWS requirements of various states.

4.2.2 WPA/NPAS – CANADA

Wireless Public Alerting (WPA), as a part of National Public Alerting System (NPAS), is the solution used to provide PWS in Canada under the rules and regulations governed by Canadian Radio-television and Telecommunications Commission (CRTC). The WPA system, following the WEA architecture principles, also utilizes Cell Broadcast System (CBS) technology for the broadcast of the related text messages with minimal latency and with accurate geo-targeting, however, limited to LTE (and beyond) networks.

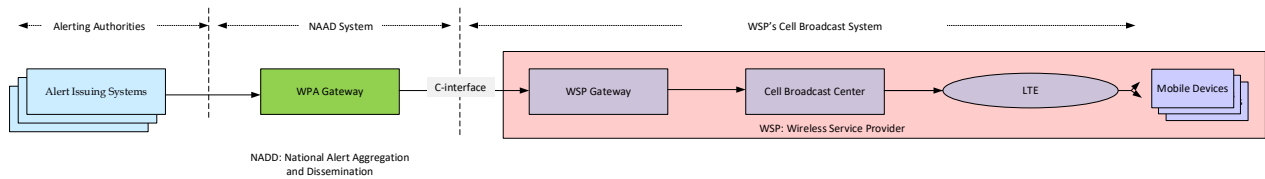


Figure 4.2. An overview of WPA Architecture.

The alert text carried within a WPA message can have up to 600 characters (1200 octets with UCS-2 format) with one of the following language rules:

- English
- French
- Bilingual: English + French
- Bilingual: French + English.

In the case of bilingual, three asterisk (***) separate the text in two languages. Note that the 600-count on the number of characters applies to the display characters of two languages combined plus the three asterisks.

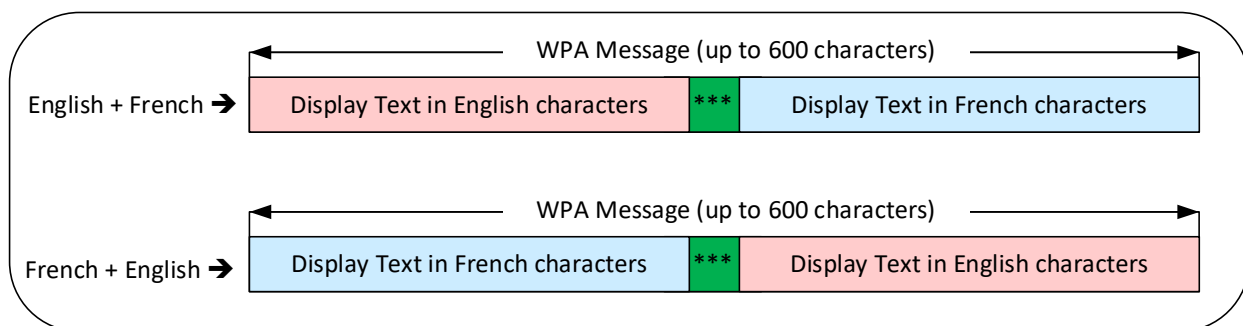


Figure 4.3. Bilingual WPA Message Format.

All WPA messages are broadcast using the same class as used for Presidential Alerts (English) in WEA. Once in a year (end of May), alert authorities may also issue a Public Awareness Test message that follows the same principles of any other WPA messages. If additional testing is required (for example, verifying the latency, geo-targeting accuracy, bilingual message reception capability), the alert authorities may issue System Test message that is invisible to the public and are broadcast in the same class as used for Required Monthly Test (RMT) in WEA.

In WEA, the alert text is broadcast using GSM 7-bit character set. In WPA, the alert text is broadcast using UCS-2-character set. Therefore, mobile devices enabled to receive PWS and UCS-2 character-set, will receive the WPA messages in the same way as US Presidential Alert WEA messages (i.e. opt-out not allowed) in English.

The mobile devices receive the System Test messages if and only if the Wireless Service Provider (WSP) have enabled them to receive such messages. In other words, those System Test messages are invisible to the public, in the sense, are not received by the public mobile devices.

4.2.3 EARTHQUAKE AND TSUNAMI WARNING SYSTEMS (ETWS) – JAPAN

Earthquake and Tsunami Warning System (ETWS) is the solution used to provide PWS in Japan. The ETWS message broadcast is done using two types of notifications:

- Primary Notification
- Secondary Notification

The ETWS Primary Notification that signifies the occurrence of primary shock waves resulting from an earthquake is more sensitive to the timing requirements as compared to an ETWS Secondary Notification. As specified in the 3GPP TS 22.268, the ETWS Primary Notification is expected to reach the mobile devices within 4 seconds after it is received by the CBC. Due to this timing requirement, the Cell Broadcast technology as used in GSM and UMTS networks is not suitable to transmit the ETWS Primary Notification, even though the broadcast is still managed by a CBC.

NOTE: In GSM and UMTS, a delay of up to 2 minutes can occur before the broadcast begins. Furthermore, the lowest value of repetition period in GSM is 1.883 seconds.

Accordingly, a different technique (therefore, Paging command) is used to broadcast the Primary Notifications. In the other words, the ETWS Primary Notifications are sent to the GSM/UMTS based mobile devices in the Paging command.

NOTE: With the use of Paging for ETWS Primary Notification, the 2 minutes delay downstream toward the mobile devices from the BSC/RNC is reduced to about 2.5 seconds.

The ETWS Secondary Notifications that carry additional information about an earthquake or tsunami use the cell broadcast technology over GSM, UMTS, LTE (and beyond) networks.

Since the above indicated timing delays do not exist in the LTE networks (and beyond), ETWS Primary Notifications are broadcast using the same technique as used for the ETWS Secondary Notifications with the following differences:

- ETWS Primary Notifications do not carry any text
- ETWS Primary Notifications are broadcast for a short duration of time

The following ETWS notifications are defined:

- Earthquake
- Tsunami
- Earthquake and Tsunami
- Test
- Other emergency type

The Test message are invisible to the users. In other words, the mobile devices do not receive the Test message unless specifically configured to receive.

At any given time, no more than one ETWS Notification broadcast can occur in a given area. In other words, the network that is currently broadcasting a ETWS Notification (Primary or Secondary) upon receiving a request to broadcast a new ETWS Notification of the same type (therefore, Primary or Secondary) for the same area, would automatically stop the current broadcast and replace it with the new broadcast.

4.2.4 KPAS – SOUTH KOREA

Korean Public Alerting System is the solution used to provide PWS in South Korea. KPAS, following the WEA architecture principles, also utilizes CBS technology for the broadcast of the related text messages with minimal latency and with accurate geo-targeting.

The KPAS messages are broadcast using the following classes:

- KPAS Class 0 type of messages
- KPAS Class 1 type of messages

The KPAS Class 0 messages are broadcast in the same class as used for Presidential Alerts in WEA which means users cannot opt-out of these messages. The KPAS Class 1 messages are broadcast in the same class as used for WEA Extreme, WEA Severe and WEA Amber messages.

The equivalent other type of WEA messages (therefore, Required Monthly Test, CMAS exercise, CMSP own use, WEA Public Safety Alerts, WEA State/Local Test) are not used with KPAS. As in the case of WEA, the network can broadcast the KPAS messages in such a way that the devices could display the text,

independent of the preferred language setting, or based on the preferred language setting. The following table summarizes the above comparison:

Table 4.1. KPAS Class 0 and Class 1.

KPAS Class	WEA message type
KPAS Class 0	Presidential
KPAS Class 1	Extreme, Severe, Amber

The Mobile devices enabled to receive PWS will receive the KPAS messages in the same way as WEA messages. The KPAS Class 0 messages in the local language are always received and presented. The mobile devices receive the KPAS Class 1 messages based on the opt-in settings within the devices. The mobile devices receive the KPAS messages in the additional languages based on the preferred language setting.

4.2.5 EU ALERT

European Alert (EU Alert) is the solution used to provide PWS in Europe. EU Alert, following the WEA architecture principles, also utilizes CBS technology for the broadcast of the related text messages with minimal latency and with accurate geo-targeting.

The EU Alert may be broadcast in local language(s) and, optionally, in the additional language(s). The EU Alert messages are broadcast using the following classes:

- EU Alert Level 1 type of messages
- EU Alert Level 2 type of messages
- EU Alert Level 3 type of messages

The EU Alert Level 1 messages are broadcast in the same class as used for Presidential Alerts in WEA which means users cannot opt-out of these messages. The following table compares the EU Alert levels to WEA message types:

Table 4.2. EU Alert Levels to WEA Message Types.

EU Alert type	WEA message type
EU Alert Level 1	Presidential
EU Alert Level 2	Extreme
EU Alert Level 3	Severe
EU Amber	AMBER
EU Info	Not used

Even though the above types are defined, not all European countries support them. For example, in the Netherlands, only EU Alert Level 1 in the local language is supported.

A mobile device capable of receiving EU Alert messages always receives the EU Alert Level 1 message in local language. Mobile devices receive the other EU Alert messages based on the opt-in settings within the devices and can receive those messages in the additional languages based on the preferred language setting.

5 LATIN AMERICA AND THE CARIBBEAN WARNING SYSTEMS

This section provides an overview highlighting the type of systems supported by many countries in the Caribbean, Central and South America as well as Mexico. These countries have developed emergency alerting systems designed to address either natural disaster and/or terror attacks. Many Countries use Cell Broadcast Systems and Short Message Service for emergency alerts. However, other Countries use radio, television, social media and email.

5.1 CARIBBEAN

5.1.1 OVERVIEW

At a regional level, the Caribbean Disaster Emergency Management Agency (CDEMA) is an intergovernmental agency whose objective is disaster management in the Caribbean Community (CARICOM). The CDEMA has an integrated and proactive approach to disaster management. Its objective is to reduce the risk and loss of natural and technological events, taking care of the sustainable development of the region. It currently has 18 participating states or territories: Anguilla, Antigua and Barbuda, Bahamas, Barbados, Belize, Dominican, the Virgin Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos and the Virgin Islands.

CDEMA Early Warning Protocol for the population includes not only publication in traditional media, but also the use of mobile services providers to inform on the dangers ahead.

5.1.2 THE CARIBBEAN REGION

For the purposes of this paper, the term Caribbean includes the Bahamas, Barbados, U.S. Virgin Islands, Jamaica, Puerto Rico, Trinidad and Tobago, and the Dominican Republic. WEA and SMS represent most of systems used in the Caribbean; a few countries use radio, television as well as email to send emergency alerts to the general population.

5.1.2.1 BAHAMAS

In September 2017, National Emergency Management Agency (NEMA), began a pilot program using text messages as part of the early warning notification system to the inhabitants of Bahamas. This test was deactivated December 31, 2017 and was intended for users who registered in a specially designed portal for this test (www.alertbahamas.com).

5.1.2.2 BARBADOS

The agency in charge of emergency warnings is the Department of Emergency Management (DEM), whose primary function is to be responsible for the development and implementation of the Emergency Management Program in Barbados. It is also responsible for coordinating the activities of emergency

management. The public receives early warning notifications through television, radio, print media and telecommunications services. Telecommunications services targeted via early warnings to specific segments of the population may include these mechanisms: mobile and fixed lines, fax, SMS, VHF/UHF radio, television and e-mail.

5.1.2.3 UNITED STATES VIRGIN ISLANDS

The agency in charge PWS is the Virgin Islands Territorial Emergency Management Agency (VITEMA), whose primary function is emergency management. The organization also works in preparedness for tsunamis, earthquakes and other natural disasters.

As part of the United States, VITEMA is supported by the FEMA. Likewise, VITEMA also have WEA messages, which are emergency messages sent by authorized Government emergency agencies, through a mobile operator. These allow devices to receive alerts shortly after they are sent, thus warning the population. WEA looks like a text message of not more than 90 characters, showing the type of alert and time, any action to be taken, and the entity issuing the alert. WEA is supported by the United States Federal Communications Commission (FCC).

5.1.2.4 JAMAICA

The Office of Disasters Preparedness and Emergency Management (ODPEM) is the agency in charge of PWS in Jamaica. Regarding Early Warnings, the ODPEM has a system that communicates to the population through television, radio, print media and telecommunications services. They can be managed in a segmented way. These mechanisms include the sending of text messages (SMS) to the inhabitants.

5.1.2.5 PUERTO RICO

In Puerto Rico, the State Agency for Emergency and Disaster Management establishes policy concerning emergency situations that affect the island.

Puerto Rico has WEA messaging. These allow receiving alerts at the exact moment in which they occur, warning the population. WEA looks like a text message of not more than 90 characters, showing the type of alert and time, any action to be taken, and the entity issuing the alert. The WEA system is implemented by the United States Federal Communications Commission (FCC).

5.1.2.6 TRINIDAD AND TOBAGO

The Office of Disaster Preparedness and Management (ODPM) is the official institution in charge of disaster warning and response in Trinidad and Tobago.

The objective of the ODPM Early Warning System is to develop risk management and climate change systems to generate and distribute warning information in a timely and significant manner. Its objective is to enable communities to prepare for imminent danger and act accordingly to reduce losses. The critical elements of their function are knowledge of the risks; monitoring, analysis, and forecast of hazards; communication or dissemination of alert and warnings; and local capacities to respond to the received warnings.

Concerning early warnings notifications to the public, the ODPM has agreements with Broadband Mobile (BMobile) and Digicel to inform the population utilizing Emergency Short Message Services (ESMS).

5.1.2.7 THE DOMINICAN REPUBLIC

The Emergency Operations Center (COE) is the agency that coordinates all actions among the institutions of the national disaster prevention, mitigation, and response system.

In 2008, the Alert Information System was established through Resolution No. 079-08³ and it is highlighted that the COE can make “use of telecommunications networks and systems installed throughout the national territory, for the transmission of text or voice messages that must reach the users of telecommunications services, whether by telephone or broadcast, so that they may be duly informed of the possible occurrence of an emergency situation.”

The COE creates the alert, keeps the alert updated and has a list of the people considered vital for the dissemination of emergency information or the execution of actions based on the information received. Once the disaster event has been identified, COE will inform the Dominican Institute of Telecommunication (INDOTEL), which must notify operators of the alert.

The Alert Information System has a second phase that provides information to the population through official releases using television channels, systems, and signals of cable broadcasting networks. Once received, this information will also be distributed by AM and FM radios.

5.2 CENTRAL AMERICA

5.2.1 OVERVIEW

In this region, the Coordination Center for the Prevention of Natural Disasters in Central America (CEPREDENAC) operates. It is an intergovernmental organization that is part of the Central American Integration System (SICA) and consists of the National Commission for Risk Prevention and Emergency Care (CNE) of Costa Rica; the General Directorate of Civil Protection, Disaster Prevention and Mitigation of El Salvador; the National Coordinator for Disaster Reduction of Guatemala; the Permanent Commission on Contingencies (COPECO) of Honduras; the National System for Disaster Prevention Mitigation and Response (SINAPRED) of Nicaragua; and the National System of Civil Protection (SINAPROC) of Panama. Its functions are to promote and coordinate inter-regional cooperation. Furthermore, it is responsible for the exchange of information, experiences and technical and scientific advice on disaster prevention, mitigation, response, and care between member nations.

The Early Warning System for Central America (SATCA) operates within the CEPREDENAC. SATCA's purpose is to strengthen the capacity to anticipate natural disasters in the region and its objective is to integrate all the early alert information available to communicate it to those who need it, for which it collects the information from regional agencies and the rest of the world.

CEPREDENAC has an “Early Warning System through SMS Mobile Messages” with the ability to automatically detect sensible earthquakes with a magnitude of 4.0 degrees in the Richter scale and beyond, registered throughout Central America, sending the information to mobile phones subscribed to this service, free of charge.

5.2.2 CENTRAL AMERICA BY REGION

³ In Resolution No. 079-08, <https://indotel.gob.do/media/6227/17-resoluci%C3%B3n-no-079-08.pdf>

Within this paper, the focus is on Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. None of the Countries listed have initiatives that include mobile-based services for early warning alerts; hence, WEA is not supported.

5.2.2.1 COSTA RICA

In Costa Rica, the National Commission for Risk Prevention and Emergency Response (CNE) is responsible for the coordination of preventive work in situations of imminent risk, mitigation and response to emergency situations. Since 2006, this country has had a National Law on Emergencies and Risk Prevention (N° 8488 In National Law on Emergencies and Risk Prevention⁴) that overcomes a series of gaps in previous legislation that limited the actions of the institution.

The dissemination is carried out by the National Communications Network, a radio communications system coordinated by the CNE, which links different institutions, emergency committees and observation and surveillance posts throughout the country, to speed up the exchange of information for decision making in alert or emergency situations.

The network operates continually year-round. It also has 17 repeaters in different parts of the national territory, which covers approximately 90 percent of the country.

Currently, the CNE program does not include alerting to mobile devices.

5.2.2.2 EL SALVADOR

The body responsible for PWS is the General Directorate for Civil Protection, Disaster Prevention, and Mitigation. Its mission is to manage and coordinate emergency and disaster prevention and mitigation activities amongst the institutions of the National Civil Protection System.

Aside from using social networks for warning communications, as of February 2018, there were no known uses of mobile networks to disseminate warning messages.

5.2.2.3 GUATEMALA

The National Coordinator for Disaster Reduction (CONRED), is the entity in charge of preventing, mitigating, attending and participating in the rehabilitation and reconstruction of the damages caused by disasters. The Executive Secretariat of the National Coordinator for Disaster Reduction (SE-CONRED) was created by Decree 109-96⁵ of the Congress of the Republic.

One of the functional components that SE-CONRED oversees, is the Early Warning System, which is responsible for reporting any emergency or disaster-type information to an organized group of emergency personnel so they are prepared for any risk and ready to carry out evacuations. Once a disaster has occurred, an alert is issued to community leaders who may be at imminent risk and to local entities responsible for providing evacuation support. Likewise, the general population is informed of the imminent risk.

⁴ <https://www.ucr.ac.cr/medios/documentos/2015/LEY-8488.pdf>

⁵ Decree 109-96 of the Congress of the Republic, https://conred.gob.gt/site/documentos/base_legal/Ley_CONRED.pdf

SE-CONRED does not use mobile services to issue warning, apart from communication through social networks.

5.2.2.4 HONDURAS

In 1973, the Permanent Emergency Council (COPEN) was created in Honduras, through Decree Law No. 33, and is charged with providing assistance to affected people in response to disasters and emergencies. In 1990, by means of the Decree Law No. 990-E of the December 12, 1990⁶, the Permanent Contingency Commission (COPECO) was created.

COPECO aims to ensure that disaster risk reduction becomes a national and local priority; identify, assess and monitor disaster risk and enhance early warning; use knowledge, innovation and education to establish a culture of safety and resilience at all levels; and reduce the underlying risk.

The alert system is based on traditional mass media; at present, it does not have an official mobile services tool.

5.2.2.5 NICARAGUA

The body in charge of warning alerts is the National System for Disaster Prevention, Mitigation, and Response (SINAPRED). Its objective is to reduce the vulnerability of the people at risk of experiencing natural and man-made disasters.

The service has an early warning system, but it does not include mobile services.

5.2.2.6 PANAMA

In Panama, the National Civil Protection System (SINAPROC) is responsible for planning, researching, conducting, monitoring and organizing policies and actions that seek to prevent or mitigate the effects of disasters for people and property.

The agency does use social networks to communicate warning and disaster information but does not have an application for mobile services.

5.3 MEXICO

5.3.1 OVERVIEW

In Mexico, the institution in charge of disaster prevention and mitigation is the National Center for Disaster Prevention (CENAPRED). Its work aims to support the technical requirement of the National Civil Protection System (SINAPROC). It coordinates research, training, instrumentation and dissemination activities for natural and anthropogenic phenomena that could lead to disasters. During 2015, the Federal Telecommunications Law⁷ was amended to include in the obligation for mobile operators to provide early warning messages to their end users. Depending on the system as noted in table 5.1, SMS may be used as part of alerting activities.

⁶ <http://www.bvs.hn/Honduras/Leyes/LEYpercent20DEpercent20CONTINGENCIAS.pdf>

⁷ http://www.dof.gob.mx/nota_detalle.php?codigo=5352323&fecha=14/07/2014

5.3.2 MEXICO

The following early warning systems depend on CENAPRED.

Table 5.1. CENAPRED EWS.

System	Phenomenon	Information	Coverage	Start Date	Time of Notice
National Seismological Service	Seismic	www.ssn.unam.mx	National	1910	Warning of an occurrence
Mexican Seismic Warning System (SASMEX)	Seismic	www.cires.org.mx	Cities of Mexico, Oaxaca, Chilpancingo, Acapulco and Morelia	1991	Seconds before the arrival of an earthquake that has already occurred. It depends on the distance of the epicenter and the energy of the earthquake.
Popocatepetl Volcano Monitoring System	Volcanic	www.cenapred.gob.mx	Areas surrounding the Volcano	1994	Warning of an occurrence
Early Warning System for tropical cyclones (SIAT-CT)	Tropical cyclone	http://smn.cna.gob.mx www.proteccioncivil.gob.mx www.cenapred.gob.mx	National	2000	72 hours in advance.
National Tsunami Warning System	Tsunami	www.bit.ly/1w3MNJa	Mexican Pacific Coast	2013	For local tsunamis, minutes in advance; for regional, distant or transoceanic ones, hours.
Early Warning System for fires in Mexico	Forest fires	www.conabio.gob.mx	National	1999	Warning of an occurrence
Meteorological National Service	Meteorological	http://smn.cna.gob.mx	National	1877	Warning before the occurrence and prognoses

Source: CENAPRED⁸

⁸ In https://www.gob.mx/cms/uploads/attachment/file/111703/298_INFOGRAFASISTEMASDEALERTATEMPRANA.PDF

Each of the warning systems described in Table 5.1 has its own formats for communicating with the public focused on mass media and leveraging other forms of municipal communications such as loudspeakers in public buildings and schools.

In the case of seismic activity, SASMEX is a useful resource that makes the design and practice of simulations more efficient to reduce seismic vulnerability. The SASMEX warnings are broadcast on most commercial television, radio stations, SASPER and SARMEX receivers. In 2010, the Mexican Hazard Alert System SARMEX protocol was developed and reduces the activation times of the receiver. In addition, SARMEX has a prerecorded early warning sound that can be heard and clearly identified from the rest of the emergency messages from the NOAA Weather Radio Specific Area Message Encoding (NWR SAME). SARMEX also uses Twitter to communicate its alerts in real time.

The Early Warning System (SIAT) is also used in Mexico; it is a coordination tool that alerts the population about cyclonic threats. SIAT is structured so that timely and formal warnings specify and systematize activities for each of the different members of the System, depending on the intensity, trajectory, and distance of the tropical cyclone.

5.4 SOUTH AMERICA

5.4.1 OVERVIEW

This section covers those emergency systems developed in South America. Countries in South America tend to use SMS and CBS technologies as a method of sending emergency alerts.

5.4.2 SOUTH AMERICA BY REGION

South America, in the context of this white paper, includes Argentina, Brazil, Bolivia, Colombia, Chile, Ecuador, Paraguay and Peru.

5.4.2.1 ARGENTINA

Originally developed in 1999, but not operational until 2015, the Argentina Federal Emergency System (SIFEM) was designed to detect, at an early stage, natural disasters and terror related activities. National and regional emergency-related agencies are coordinated to support emergency management responses for natural disasters and terror attacks.

It was proposed to use SMS; however, it is not clear today whether SMS is used for early warning systems in Argentina.

5.4.2.2 BRAZIL

The National Center for Natural Disaster Monitoring and Alert (CEMADEN) is responsible for alerting the population when there is a natural disaster. Brazil has a significant number of natural disasters that are often of great intensity, particularly those related to floods, avalanches and landslides, which may cause deaths and severe economic and material losses. Natural disaster alerts are sent to the National Center for Risk and Disaster Management (CENAD), of the Ministry of National Integration, which supports the national civil defense system.

Natural disaster alerts used in Brazil are sent using SMS.

5.4.2.3 BOLIVIA

Bolivia uses SMS for emergency alerts. This system works from the implementation of a software system called TERA (Trilogy Emergency Relief Application), which will work for two risk management situations:

- 1) when it is necessary to carry out risk alerts, in the event of fire, earthquakes or flood threats, which will allow the sending of messages to involved authorities and affected individuals;
- 2) when the emergency arrives and it is necessary to communicate to the affected regions or municipalities with imminent threats warnings

5.4.2.4 COLOMBIA

In Colombia, the National Unit for the Disaster Risk Management (UNGRD) is responsible for coordinating, promoting and strengthening capacities for risk reduction and disaster management. Currently, with the Vive Digital 2014-2018⁹, the development of the National Emergency Telecommunications System is detailed. Its objective is to guarantee the continuous provision of communication services before, during and after a critical natural disasters and emergencies.

Within this plan, the implementation of a system for sending early warning text messages is done via mobile telephone networks.

5.4.2.5 CHILE

In Chile, emergency management is focused on the Emergency and Early Warning System and on strengthening the nation's Civil Protection System, due to the various risk variables throughout the country.

Chile has the Emergency Alert System (SAE) for mobile phones, which sends alert messages for tsunamis, earthquakes of greater intensity, volcanic eruptions and forest fires to notify the affected population. The mass alert, that will be automatically sent via text to a geo-referenced area, will not be affected by cellular network congestion, since it uses other frequency channels to reach the phones safely. The SAE is mandatory for all the mobile phones and networks in the country since March 2017. The SAE allows the National Office for Emergencies (ONEMI) to send a flood of alerts through text, audio and vibration to all cellular devices. For a cell phone to be compatible with SAE, it must support CBS technology and instantly deploy through a pop-up window the alert message with the title "Emergency Alert". This message, which will be up to 90 characters long, will include the date and time in its header and can only be interrupted by the user.

5.4.2.6 ECUADOR

At the regulatory level, within the Organic Telecommunications Law¹⁰, Article 8 establishes that "in the event of a natural disaster or emergency, the providers operating public telecommunications networks have the obligation to allow direct and immediate control by the governing body of national defense, etcetera".

When a catastrophe strikes, the Information and Communications Technologies (ICT) coordinates aid activities with national entities, as well as with the international community through the Ecuador emergency

⁹ In the Vive Digital 2014-2018 Plan. <http://www.mintic.gov.co/portal/vivedigital/612/w3-article-19654.html>

¹⁰ Organic Law of Telecommunications. <https://www.telecomunicaciones.gob.ec/wp-content/uploads/downloads/2016/05/Ley-Org%C3%A1nica-de-Telecomunicaciones.pdf>

services system. Within this framework, early warnings are sent by different means: 1) Wireless Operators: voice calls, sending SMS alerts, social media; 2) Trunked National Network; 3) radio and TV broadcasting; and 4) satellite communications.

5.4.2.7 PARAGUAY

In Paraguay, the National Emergency Secretariat (SEN) was created in 2015 and coordinates all activities for risk management and reduction. This organization ensures coordination between civil society organizations, government sectors and public institutions. Its functions include preventing and counteracting the effects of disasters; promoting, coordinating and guiding the activities of the public institutions for prevention, mitigation, response and rehabilitation; investing in research and monitoring of adverse events; and promoting early warning mechanisms.

SEN's early warning services are carried out by social media and it currently does not leverage any other types of mobile services.

5.4.2.8 PERU

In Peru, the agency in charge is the National Center for Estimation, Prevention and Reduction of Disaster Risk (CENEPRED). Its objective is to develop technical and management standards. In addition, it provides specialized technical assistance to public and private entities in order to estimate, prevent and reduce disaster risks. The use of mobile networks in the country's early warning system through mobile networks has regulatory support through the Supreme Decree N° 051-2010-MTC¹¹, which approved the General Regulatory Framework of the Emergency Communications System, promulgated by the Ministry of Transport and Communications (MTC). Operators must send SMS messages in the event of an emergency or natural disaster.

6 INTERNATIONAL ROAMING FOR PWS

3GPP PWS-based systems for wireless emergency alerting have been deployed in many countries around the world. The goal for international roaming for PWS is that a user can roam in any country and be able to receive wireless emergency alerts broadcast in the roamed-to country. There are many challenges that must be overcome to promote seamless international roaming for PWS:

- 1) Use of differing applications in the User Equipment (UEs) to support PWS by operators in different countries
- 2) Differing languages used for broadcast of PWS alerts in different countries
- 3) Activation of alert levels for different kinds of PWS alerts (for example, Presidential alerts versus Amber Alerts)
- 4) Support of different character sets for PWS alerts
- 5) Support of differing PWS alert message lengths
- 6) Support of special ringtone and vibration cadence for PWS alerts
- 7) Support of a special alert banner for PWS alerts

ATIS-0700025 (CMAS International Roaming Specification) describes the issues in the preceding list and provides suggestions for solutions to provide for international roaming support for PWS. ATIS is currently

¹¹ In Supreme Decree N° 051-2010-MTC. In <https://www.osiptel.gob.pe/articulo/ds051-2010-mtc-comunicaciones-emergencias>

working on version 2 of ATIS-0700025 (Enhanced WEA International Roaming Specification). Cell broadcast-based PWS provides a higher probability of allowing international roamers to receive wireless emergency alerts in a roamed-to country when compared to methods such as SMS or subscription to OTT apps for emergency alerting as cell broadcast-based PWS requires no subscription and no advance “sign-up” to alerting apps or SMS-based subscriber lists. The lack of the need to sign up in advance, or to subscribe to some special service when roaming, is the single biggest advantage of cell broadcast-based PWS for international roaming support versus the point-to-point emergency alerting methods.

7 CONCLUSION

Cell broadcast-based PWS used in the Americas are standards-based systems that have been specified by 3GPP and standardized by multiple Standards Development Organizations (SDOs) throughout Europe, Asia, and the Americas. There are operational benefits of using cell broadcast-based PWS for cellular operators and to the general public versus using point-to-point alerting methods such as Short Message Service (SMS) and Over-the-Top (OTT) applications. This paper concludes that the use of cell broadcast-based PWS for providing wireless emergency alerts to the public. This paper also concludes that cell broadcast-based PWS best promotes the receipt of wireless emergency alerts for users who are roaming internationally.

As previously stated, cell broadcast-based emergency alert communication is an excellent emergency alert transport method as there are no significant delivery delays of messages that are broadcast to many users within a specific alert area, and the smart phone subscribers do not require a data service subscription to receive alerts using cell broadcast.

8 APPENDICES

8.1 APPENDIX A: EARLY WARNING SYSTEMS IN SELECTED LATIN AMERICAN MARKETS

8.1.1 ARGENTINA

In Argentina, the Federal Emergency System was created in 1999 (SIFEM) by decree 1250/99¹²; it aims at the early detection of natural phenomena. However, it was not put into operation until 2015, when it was announced that it would be launched to coordinate national and regional emergency-related agencies.

The SIFEM is made up of representatives of ministries, the Secretariat of Civil Protection, the Federal Police and of Airport Security, Gendarmerie, Prefecture, Military Geographic Institute, Joint Chiefs of Staff, National Meteorological Service, Hydrographic Institute, Health Emergencies, White Helmets, ports and road agencies, among others.

By the end of May 2013, Bernardo Biella, National Deputy for the Union for Social Development (Udeso), presented a bill proposing to amend the 25,367 Law, which dates from 2000, and that created the 911 emergency services to include SMS alerts. Nevertheless, the initiative did not materialize¹³, and, for the time being, the country does not have early warnings by these means.

8.1.2 BRAZIL

The National Center for Natural Disaster Monitoring and Alert (CEMADEN) is responsible for alerting the population when there is a natural disaster that poses a risk. Brazil has a significant number of natural disasters that are often also of great intensity, in particular those related to floods, avalanches and landslides, which may cause deaths and severe economic and material losses.

The CEMADEN was created in 2011 by Presidential Decree number 7,513, and it is a body linked to the Ministry of Science, Technology, Innovation and Communications (MCTIC). It has a specialized scientific technical structure, and develops scientific, technological and innovation capacity to improve natural disaster alerts. It is a multisectoral program that allows coordinated action among the different agencies involved in monitoring and alert, alarm and articulation, response and mobilization issues.

For the consolidation of the National Natural Disaster Monitoring and Alert System, Cemaden was created in agreement with different institutions to implement, complement and consolidate the network of meteorological, hydrological and geotechnical instruments for environmental monitoring, in addition to data from automatic rain gauges, and those received through meteorological radars and semi-automatic rain gauges located in the highest risk areas of the country.

The results of the research and tools developed by the Center, the availability of data provided by Cemaden and by the networks of other federal and state institutions, together with the availability of a group of professionals with knowledge in these areas, allows the early dispatch of alerts of natural disasters for areas of risk located in all regions of the national territory.

¹² In Federal Emergency System. In <http://servicios.infoleg.gob.ar/infolegInternet/anexos/60000-64999/60916/norma.htm>

¹³ In 25,367 Law. <http://servicios.infoleg.gob.ar/infolegInternet/anexos/65000-69999/65412/norma.htm>

Natural disaster alerts are sent to the National Center for Risk and Disaster Management (Cenad), of the Ministry of National Integration, which supports the national civil defense system. The Cenad was created in 2005, with the 5,376 Decree number, and aims to manage the strategic actions of disaster preparedness and response in national territories and in the international arena.

One of the information systems used by Cenad is the National Network of Radio Amateur Emergencies (Rener), which was created in October 2001 with the aim of supporting efforts by traditional mass media when or if they cannot be used.

On the other hand, the Cenad has a natural disaster alert system through SMS. Also participating parts are the Ministry of Integration, the Civil Defense units of each of the States and the National Telecommunications Agency (Anatel). The system had a first experience with coverage in the North and the Northeast of the country, and allows to know alerts before heavy rains, floods, land movements or avalanches, among other alerts.

Each citizen must register to be able to receive free notifications. To do this, the address and zip code must be sent to the number 40199. The SMS service is paid for and operated by the telecommunications companies, without any cost to the citizen, nor to the Government. Thus, if a dangerous event is detected for a certain area, the information is transmitted to the registrants with certain instructions. In general, these messages are related to water emergencies, since, due to Brazil's geographical conditions, they are the most common.

8.1.3 BOLIVIA

In Bolivia there is an Early Warning Unit, under the Ministry of Defense, whose objective is to alert the population in the case of an imminent emergency or disaster. It is the body in charge of developing and implementing an Early Warning System based on coordinating, organizing and to execute early warning operations in the national territory.

To achieve these objectives, the unit is responsible for collecting, analyzing and evaluating the hydrometeorological, geological and other data, to determine when a natural disaster can be generated. This would then enable them to alert immediate action agencies, vulnerable population and the areas at risk.

To meet this objective, the Ministry of Defense signed an agreement with local operators during 2016 to inform the population about these events through text messages (SMS). This will develop the National Early Warning and Emergency Response System, which will contribute to the implementation of Law 602 on Risk Management¹⁴.

The system works from the implementation of a software system called TERA (Trilogy Emergency Relief Application) for two risk management situations:

- a) when it is necessary to carry out risk alerts, in the event of fire, earthquakes or flood threats, which will allow the sending of messages to involved authorities and affected families
- b) when the emergency arrives and it is necessary to communicate to a certain region or municipality with imminent threats of the presence of a disaster

¹⁴ In the Risk Management Law. In http://www.cepb.org.bo/calypso/juridica/adjuntos/ley_602.pdf

8.1.4 COLOMBIA

In Colombia, the early warning function is carried out by the National Unit for the Disaster Risk Management (UNGRD), which is responsible for directing, guiding and coordinating disaster risk management in response to sustainable development policies, and for coordinating the operation and continuous development of the national system for disaster prevention and response, SNPAD.

The UNGRD is also responsible for monitoring the operation of the SNPAD and for improving it at the national and territorial levels. It must also coordinate, promote and strengthen capacities for risk knowledge, risk reduction and disaster management. It must also propose and articulate the policies, strategies, plans, programs, projects and national procedures for managing these events.

The UNGRD oversees the Early Alert System, an autonomous mechanism, that does not need to be connected to another system. Its function is to warn about water levels and to warn the community in areas with high risk of torrential flooding of the possible manifestation of a natural phenomenon. This works by means of sensors that, when they notice the flooding of a river or lake, warn the population with sirens.

On the other hand, within the Vive Digital 2014-2018 Plan¹⁵, the deployment of the National Emergency Telecommunications System is detailed. Its objective is to guarantee the continuous provision of communication services for situations before, during and after a critical event, produced by a natural or anthropic unintentional event. Within this plan, the implementation of a system for sending early warning text messages on mobile telephone networks.

8.1.5 CHILE

The National Emergency Office of the Ministry of the Interior and Public Security (ONEMI) is the technical agency of the State of Chile in charge of the coordination of the National Civil Protection System. It was created by the Decree Law number 369, in March 1974. Its functions include planning, promoting, articulating and executing prevention, response and rehabilitation actions in the face of situations of collective risk, emergencies, disasters and catastrophes of natural or man-made origin.

In addition, ONEMI's management is focused on the Emergency and Early Warning System and on strengthening the Civil Protection System, together with emergency and support in emergency situations, due to the various risk variables throughout the country.

To notify the population, Chile has the Emergency Alert System (SAE) for mobile phones, which sends a message in case of tsunami risks, earthquakes of greater intensity, volcanic eruptions and forest fires threatening homes. The mass alert, automatically sent via text to a geo-referenced area, will not be affected by cellular network congestion, since it uses other frequency channels to reach the phones safely.

The SAE is mandatory for all the mobile phones and networks in the country since March 2017. The SAE allows ONEMI to send a massive alert through text, audio and vibration to all those using a cellular device. For a cell phone to be compatible with SAE, it must support CBS technology and will instantly deploy, through a pop-up window, the alert message with the title "Emergency Alert". This message, which will be up to 90 characters long, will include the date and time in its header and can only be interrupted by the user. The messages emit a sound signal different from any usual notification, with vibration and to the maximum audible level, which may not last less than 3 minutes, unless first interrupted by the user.

¹⁵ In the Vive Digital 2014-2018 Plan. <http://www.mintic.gov.co/portal/vivedigital/612/w3-article-19654.html>

Every telephone sold in Chile must have within its box, a seal that details in which bands the company operates the SAE service. If it has the seal in Figure 8.1, it means that the telephone has all the bands of all the current technologies in the country. Whenever the user wants to port his number, he will not have problems with the telephone in the new company. In the case of the seal in Figure 8.1, the telephone is ready for all bands and companies.



Figure 8.1. Seal for SAE Service in Chile.

In the case that the SAE does not work in any of the bands, the band corresponding to the technology will be erased by an X, thus informing the users in which bands the system does not work.

8.1.6 ECUADOR

The body in charge of Emergency Warning Systems in Ecuador, is the Secretariat of Risk Management, which should lead the National Decentralized System of Risk Management. Its aim is to guarantee the protection of people and communities from the negative effects of natural or man-made disasters. To do so, it must generate policies, strategies and norms that promote skills aimed at identifying, analyzing, preventing and mitigating risks to face and manage disaster events. It is also responsible for recovering and reconstructing the social, economic and environmental conditions affected by possible emergencies or disasters.

At the regulatory level, within the Organic Telecommunications Law¹⁶, its article 8 establishes that “in the event of a natural disaster or emergency, the providers operating public telecommunications networks have the obligation to allow direct and immediate control by the governing body of national defense...etcetera.” In addition, article 24 remarks they must “have contingency plans, to execute them in cases of natural disasters or internal commotion to guarantee the continuity of the service...etcetera.” Also, they will “comply with the services required in cases of emergency, such as gratuitous calls, provision of auxiliary services for Public Security and the State...etcetera.”

Under these circumstances, when a catastrophe strikes, ICT allows to coordinate aid activities with national entities, as well as with the international community. Through the ECU 911 system (a technological platform that articulates its video surveillance services, emergency buttons, community alarms, reception and dispatch emergency services by means of calls) the population is alerted.

Within this framework, early warnings are deployed by different means:

- 1) Operators: voice calls, sending SMS alerts, social media
- 2) Trunked national network
- 3) Radio and TV broadcasting

¹⁶ See Organic Law of Telecommunications. <https://www.telecomunicaciones.gob.ec/wp-content/uploads/downloads/2016/05/Ley-Org%C3%A1nica-de-Telecomunicaciones.pdf>

4) Satellite communications

8.1.7 MEXICO

In Mexico the institution in charge of preventing the population from any type of catastrophe is the National Center for Disaster Prevention (CENAPRED). Its work aims to support to the National Civil Protection System (SINAPROC) with regard to technical requirements. To this end, it carries out research, training, instrumentation and dissemination activities on natural and anthropogenic phenomena that could lead to disaster situations. It is also responsible for taking action to reduce and mitigate the negative effects of such phenomena.

Early warning systems depend on CENAPRED as shown previously in Table 5.1. Each of the warning systems described in Table 5.1 has its own formats for communicating with the public. These are mainly focused on mass media and information by means of loudspeakers in public buildings and schools. There are several mobile applications on the market that often warn on natural catastrophes; however, these are not of official, but part of private initiatives that replicate information from state agencies.

In the case of seismic movements, SASMEX is a useful resource that makes the design and practice of simulations more efficient to reduce seismic vulnerability. The SASMEX warnings are broadcast on most commercial television, radio stations, SASPER and SARMEX receivers. Since 2008, VHF transmitters have been installed to broadcast the SAS signal using NWR (National Weather Radio) protocols and SAME (Simple Area Message Encoding) codes. In 2010, the Mexican Hazard Alert System SARMEX protocol was developed, which, without detriment to the NWR-SAME functions, reduces the activation times of the receiver in addition to having a prerecorded early warning sound that can be heard and clearly identified from the rest of the emergency messages the NWR-SAME receiver has. SAMEX also uses Twitter to communicate its alerts in real time.

On the other hand, the Early Warning System (SIAT) also works in Mexico; it is a coordination tool that alerts the population about cyclonic threats. Its operation is based on the main actors of the National System of Civil Protection: the citizenship, civil society and its organizations; the research institutions of the hydrometeorological phenomenon; the mass media and the governmental structure of the National System of Civil Protection. It is structured so that timely and formal warning triggers specific and systematized activities for each of the different members of the System, depending on the intensity, trajectory and distance of the tropical cyclone.

During 2015, the Federal Telecommunications Law¹⁷ was amended to include in its article 190 the obligation for mobile operators to inform the population of early warning provisions. The norm establishes that “in the terms defined by the Institute in coordination with the competent institutions and authorities, priority shall be given to communications in relation to emergency situations...etcetera”.

On the other hand, the National Water Commission (Conagua) of Mexico deployed a project for the prevention and protection of the population against hydrometeorological phenomena. The agency will inform users via sending text messages about the development and location of cyclones in different areas of the national territory. In this way, it will send localized information to areas that are most at risk of being affected by these phenomena.

The deployment aims to contribute to the reduction of the risks generated by cyclones that the population may face. For this, it works intensely to strengthen the technical and forecasting capabilities to issue more

¹⁷ In Federal Telecommunications Law. http://www.dof.gob.mx/nota_detalle.php?codigo=5352323&fecha=14/07/2014

accurate warnings. According to the agency, better results are achieved if the population in strategic areas is informed promptly and directly, as will be the case when receiving specific text messages on their mobile phones.

LS Conagua plans to send, upon the request of each person, information that allows to know the development and location of hydrometeorological phenomena that could generate effects in a determined zone of the national territory. The procedure of the service is simple: once the warning is issued by the National Meteorological Service (an area dependent on Conagua), the operators send text messages (SMS) prepared by the authority that help to reduce the risks for their users. The system has the possibility that the operator can know trajectory of phenomenon and to determine who is most frequently found in these risk areas. Thus, it is possible to inform timely the users via preventive and informative messages issued by the authority.

8.1.8 PARAGUAY

The prevention function is in charge of the National Emergency Secretariat (SEN), which was created in 2015 with the Law number 2,615/05¹⁸, and its operation is regulated by the Decree number 11,632/2013. This institution responds directly to the executive branch, and its function is to manage and reduce disasters risks.

SEN coordinates all activities related to risk management and reduction. It must ensure cross-cutting work between civil society organizations, players, and government sectors and institutions and in addition, to generating plans, programs and projects for the reduction of threats, vulnerabilities and risks.

The agency has two strategic areas: risk management, which coordinates and articulates between the scientific knowledge and the different levels of government; and risk reduction, where the aspects related to disaster preparedness, response are worked on. Its functions include preventing and counteracting the effects of disasters; promoting, coordinating and guiding the activities of the public institutions for prevention, mitigation, response and rehabilitation; investing in research and monitoring of adverse events, and promoting early warning mechanisms.

SEN's early warning services are carried out by social media. Outside that environment, it does not have other mobile services associated to this type of actions.

8.1.9 PERU

The agency in charge is the National Center for Estimation, Prevention and Reduction of Disaster Risk (CENEPRED). Its objective is to develop technical and management standards. In addition, it provides specialized technical assistance to public and private entities in the processes of estimating, preventing and reducing disasters risk. It is also in charge of the reconstruction, with the purpose of protecting the life of the population and the patrimony of the people and the State.

The Disaster Risk Management Information System (SIGRID) is the body under CENEPRED responsible for carrying out early warnings in the country. As of January 2018, by order of the Ministry of Transportation and Communications (MTC), mobile operators of Peru must send messages when there are alerts for emergencies or natural disasters.

¹⁸ In Law number 2,615/05.

http://www.ifrc.org/docs/IDRL/Paraguay%20Ley%202615%20de%20creacion%20de%20la%20SEN_jyugsi61.pdf

The early warning system through mobile networks has regulatory support through the Supreme Decree N° 051-2010-MTC ¹⁹ which approved the General Regulatory Framework of the Emergency Communications System, promulgated by the MTC. After its enforcement, operators must send short text messages (SMS) in the event of an emergency or natural disaster.

8.1.10 CENTRAL AMERICA

In the region, the Coordination Center for the Prevention of Natural Disasters in Central America (CEPREDENAC) operates. It is an intergovernmental organism that is part of the Central American Integration System (SICA). It is made up of the National Commission for Risk Prevention and Emergency Care (CNE) of Costa Rica; the General Directorate of Civil Protection, Disaster Prevention and Mitigation of El Salvador; the National Coordinator for Disaster Reduction of Guatemala; the Permanent Commission on Contingencies (COPECO) of Honduras; the National System for Disaster Prevention Mitigation and Response (SINAPRED) of Nicaragua; and the National System of Civil Protection (SINAPROC) of Panama.

Its functions are to promote and to coordinate the international cooperation and the exchange of information, experiences and technical and scientific advice on disaster prevention, mitigation, response and care. Its objective is to reduce vulnerability and the impact of disasters as an integral part of the process of transformation and sustainable development of the region. To this end, it promotes the support and development of policies and measures for the prevention, mitigation, preparedness and management of emergencies.

It also looks to generate a culture of prevention and mitigation of disasters through the education, the preparation and the organization of the different social and economic factors from the region, as well as to contribute to the reduction of the vulnerability of the society, the productive sectors and of the infrastructure, plus other objectives related to mitigating the consequences of natural disasters.

The Early Warning System for Central America (SATCA) operates within the CEPREDENAC. Its purpose is to strengthen the capacity to anticipate natural disasters in the region. Its objective is to integrate all the early alert information available to communicate it to those who need it, for which it collects the information from regional agencies and the rest of the world.

This information is available on SATCAweb, where early warnings are published to facilitate fast and efficient access by the institutions responsible for the prevention, preparedness, planning and humanitarian response. The objective of the platform is to mitigate and reduce the impact of natural disasters on the most vulnerable populations to threats in the region.

CEPREDENAC also has an “Early Warning System through SMS Mobile Messages”. It has the ability to automatically detect earthquakes with a magnitude of 4.0 degrees in the Richter scale and beyond, registered throughout Central America, sending the information to mobile phones subscribed to this service, free of charge.

8.1.11 COSTA RICA

Costa Rica has a National Commission for Risk Prevention and Emergency Response (CNE). It is responsible for the coordination of preventive work in situations of imminent risk, mitigation and response to emergency situations. Since 2006, this country has had a National Law on Emergencies and Risk

¹⁹ In Supreme Decree N° 051-2010-MTC. In <https://www.osiptel.gob.pe/articulo/ds051-2010-mtc-comunicaciones-emergencias>

Prevention N° 8488²⁰ that overcomes a series of gaps in previous legislations that limited the actions of the institution.

This regulation introduces the concept of risk prevention and regulates the extraordinary activity the State is responsible for in the event of an emergency. It also grants the CNE the power to coordinate the National Emergency Prevention and Response System, where each institution must participate in the specific subjects of its competence and collaborate with the local risk prevention and emergency response committees.

The National Risk Management System is the integral, organized, coordinated and harmonious articulation of the organs, structures, functional relations, methods, procedures and resources of all the State institutions, seeking the participation of the entire private sector and the organized civil society. Its objective is to promote and implement public policy guidelines that allow, both the Costa Rican State and the different sectors of national activity, to incorporate the concept of risk management as a transversal axis of development planning and practices.

The dissemination is carried out by the National Communications Network, a radio communications system coordinated by the CNE, which links different institutions, emergency committees and observation and surveillance posts throughout the country, to speed up the exchange of information for decision making in alert or emergency situations.

The network operates 24 hours a day, 365 days a year, attended in 12-hour shifts with two operators. It also has 17 repeaters in different parts of the national territory, which allow a coverage of about 90 percent of the country.,

The system has a surveillance network, made up of communication bases that include the inter-institutional network, the Regional and Municipal Emergency Committees, along with some of the main hospitals of the region, as well as surveillance and early warning posts throughout the country. These posts receive performance reviews three times a day, to ensure they are constantly communicated. At the writing of this paper, the CNE does not have initiatives that include mobile services aimed at the population in early warnings.

8.1.12 EL SALVADOR

The body responsible for this issue is the General Directorate for Civil Protection, Disaster Prevention and Mitigation. Its objective is to manage and coordinate with the institutions of the National Civil Protection System the actions of Prevention and Mitigation of Disasters and Emergencies throughout the country. Its work is to identify, analyze, prevent and mitigate risks to face and to manage disasters. It is also responsible for recovering and reconstructing the social, economic and environmental conditions affected by possible emergencies or disasters. By February 2018, there were no known early warning implementations on mobile networks in the market by this agency beyond communication through social networks.

8.1.13 GUATEMALA

The National Emergency Committee (CONE) emerged in the country during 1969 with the aim of giving attention to an emergency and assistance to the population in case of disasters. In 1996, it was replaced by the National Coordinator for Disaster Reduction (CONRED), as the entity in charge of preventing,

²⁰ In National Law on Emergencies and Risk Prevention. <https://www.ucr.ac.cr/medios/documentos/2015/LEY-8488.pdf>

mitigating, attending and participating in the rehabilitation and reconstruction of the damages derived from the presence of disasters.

The Executive Secretariat of the National Coordinator for Disaster Reduction (SE-CONRED) was created by Decree 109-96 of the Congress of the Republic.²¹ It is the body with commitments and responsibilities at national, regional and global levels that must take concrete actions to promote the reduction of the impact of the disasters, which have clearly defined effects on sustainable development and the increase of poverty.

Within the functions of SE-CONRED is the Early Warning System, which is responsible for reporting any relevant event to an organized community structure, so that they are prepared for any risk situation and ready to carry out preventive evacuations. Once a disaster situation has been identified, an alert is issued to leaders to provide evacuation support in communities that may be at imminent risk. Likewise, all the inhabitants are informed that they are at imminent risk, with the aim of taking the relevant decisions at family level. The information is in charge of the authorities, since the SE-CONRED does not use mobile services to report this type of disaster, apart from communication through social networks.

8.1.14 HONDURAS

In 1973, the Permanent Emergency Council (COPEN) was created in Honduras, through Decree Law No. 33, in charge of helping society in times of disasters. Decree Law No. 990-E on December 12, 1990²² created the Permanent Contingency Commission (COPECO); its Law was amended by Decree No.217-93, October 13, 1993. Later, reforms were made to Regulation Decree No.121-99, on May 18, 1999, with the aim of creating an institution more in line with the role it must play.

COPECO aims to ensure that disaster risk reduction becomes a national and local priority; identify, assess and monitor disaster risk and enhance early warning; use knowledge, innovation and education to establish a culture of safety and resilience at all levels; and to reduce the underlying risk. The alert system is based on traditional mass media; at present, it does not have an official mobile services tool.

8.1.15 NICARAGUA

The body in charge of this matter is the National System for Disaster Prevention, Mitigation and Response (SINAPRED). Its objective is to reduce the vulnerability of the people at risk of suffering disasters caused by natural phenomena or generated by other instances. It also looks to generate synergies of all the institutional, sectoral and territorial components and civil society actors within a risk management process with a social, environmental and economic approach. The service has an early warning system, but it does not include mobile services.

8.1.16 PANAMA

In Panama, the National Civil Protection System (SINAPROC) is in charge of planning, researching, conducting, monitoring and organizing policies and actions that seek to prevent the material and psycho-social risks. It is also responsible for anticipating the danger that may be caused by natural and anthropogenic disasters.

Its functions include compiling and maintaining the information system for the planning of strategies and measures on risk management and civil protection. It must also promote a national plan of risk

²¹ In Decree 109-96 of the Congress of the Republic. In https://conred.gob.gt/site/documentos/base_legal/Ley_CONRED.pdf

²² In Decree Law No. 990-E. In <http://www.bvs.hn/Honduras/Leyes/LEY%20DE%20CONTINGENCIAS.pdf>

management, incorporating transversal axes as the development processes and plans of the country. It may also formulate and carry out plans of vulnerability reduction and risk management, in each of the social and economic sectors to protect the population, the production, the infrastructure and the environment.

Another function is to educate the population, and to generate analysis, research and technical and scientific information on natural and anthropogenic hazards, as well as to create manual, general and specific emergency plans so that the inhabitants may know the appropriate procedures. The agency resorts to early warnings through social networks but does not have an application for mobile services.

8.1.17 THE CARIBBEAN

At the regional level, the Caribbean Disaster Emergency Management Agency (CDEMA) is an intergovernmental agency whose objective is disaster management in the Caribbean Community (CARICOM). The agency is preceded by the CDERA (Caribbean Disaster Emergency Response Agency) and was established in 2009 with the aim of helping the community at risk moments.

The CDEMA has an integrated and proactive approach to disaster management. Its objective is to reduce the risk and loss of natural and technological events, taking care of the sustainable development of the region. It currently has 18 participating states: Anguilla, Antigua and Barbuda, Bahamas, Barbados, Belize, Dominican, the Virgin Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos and the Virgin Islands.

Among the objectives of the CDEMA is the regional organization to strategically handle the conduction and coordination of the comprehensive disaster management among the participating States. Other functions include mobilizing and coordinating disaster relief, mitigating the immediate consequences of these events; assuring, coordinating and providing reliable information on disasters, and other relief functions.

The Caribbean Risk Information System (CRIS) is a virtual platform where the data and information of risk management are accessible. Its aim is to facilitate the analysis, research and to generate a greater consciousness of the risk and adaptation to climate change in the region. The CDEMA States are the main beneficiaries of this information, since it allows them to anticipate the main cause of disasters in the region. CRIS is also available for citizens and the private sector, thus creating a collaborative tool.

The main beneficiaries will be the participating States of CDEMA, in particular the actors of the national disasters organizations, the staff of the Coordination Unit and the DRM and CCA partners. These groups will benefit directly from the articulation and the development of CRIS. Private sector agencies, students and individuals can also benefit from access to the platform.

CDEMA Early Warning Protocol for the population includes not only publication in traditional media, but also the use of mobile services providers to inform on the dangers ahead. The different States participating in CDEMA have agreements with the telecommunications operators to carry out these alerts quickly and effectively.

8.1.18 BAHAMAS

The National Emergency Management Agency (NEMA), which is part of the Cabinet Office, is responsible for taking care of the population in the case of catastrophes. Its objective is to prepare the population to

preserve human life in times of crisis, by coordinating and integrating the work of different public sectors and organizations.

NEMA functions include mitigating planning, community preparedness, public information, and recovery coordination. It must also evaluate the plans of existing emergencies, to plan disaster policies; design, implement and train personnel for disaster management, among other functions related to the preparedness of its personnel and the public in general.

In September 2017, NEMA began testing a text message early warning notification system to the inhabitants of Bahamas. This test was active until December 31, 2017, and was intended for users who registered in a specially designed portal for this test (www.alertbahamas.com). The system was provided by Unified Messaging Systems Americas and was supported by the Inter-American Development Bank.

8.1.19 BARBADOS

The agency in charge is the Department of Emergency Management (DEM), whose main function is to be responsible for the development and implementation of the Emergency Management Program in Barbados, besides coordinating the activities of emergency management. The department became operational in 2007, starting with the Emergency Management Act.

The DEM is in charge of implementing a comprehensive national disaster management program that includes natural and man-made hazards. Addressing the phases of prevention, mitigation, preparedness, response and recovery. The agency also uses an integrated approach to emergency management to be able to identify risks and mobilizing the resources necessary to protect the population.

The DEM is also in charge of the National Emergency Management System, a mechanism that facilitates coordination with the various State, NGOs and private sector agencies that are responsible for taking care of the needs of natural or human disasters. Early warnings are notified to the public through television, radio, print media and telecommunications services, which are targeted via early warning to specific segments of the population. These mechanisms include mobile and fixed lines, fax, SMS, VHF/UHF radio, television and e-mail.

8.1.20 UNITED STATES VIRGIN ISLANDS

The agency in charge of emergency warning is the Virgin Islands Territorial Emergency Management Agency (VITEMA), whose main function is to manage the emergencies that happen in their territory. It is legally protected by the Virgin Islands Code, Title 23, Chapter 10. Its objective is to prepare for threats, coordinate responses and carry out the recovery of the territory.

Its greatest efforts are focused on planning and training to prevent the population from being affected by hurricanes and coastal storms. But it also works in preparedness for tsunamis, earthquakes and other natural disasters.

As part of the United States, the VITEMA is supported by the Federal Emergency Management Agency (FEMA). Likewise, they also have warnings of wireless emergency alerts (WEA), which are emergency messages sent by authorized Government emergency agencies, through a mobile operator. These allow to receive alerts at the exact moment in which they occur, warning the population. WEA looks like a text message of not more than 90 characters, showing the type of alert and time, any action to be taken, and the entity issuing the alert. The WEA system is implemented by the United States Federal Communications Commission (FCC).

8.1.21 JAMAICA

The Office of Disasters Preparedness and Emergency Management (ODPEM) is the agency in charge in Jamaica. It reports to the Prime Minister's Office with a Board of Directors. It is the only State office that offers this assistance in Jamaica.

Its functions include developing and implementing policies and programs facing possible natural disasters and other emergency events. In addition, it seeks to encourage and to support disaster preparedness and prevention measures for the civilian population. It is also responsible for generating early warnings, giving answers to the emergency, relief and recovery in this type of situations.

Regarding early warnings, the ODPEM has a system that communicates to the population through television, radio, print media and telecommunications services. They can be managed in a segmented way. These mechanisms include the sending of text messages (SMS) to the inhabitants.

8.1.22 PUERTO RICO

In Puerto Rico, the State Agency for Emergency and Disaster Management was created by law No. 211 on August 2, 1999²³. It established the public policy of the Commonwealth of Puerto Rico in relation to emergency situations that affect the island. Also, it declares that it is part of the public policy to protect the inhabitants in an emergency or disaster situation, quickly and effectively.

In Puerto Rico, they have wireless emergency alerts (WEA), which are emergency messages sent by authorized Government emergency agencies, through a mobile operator. These allow to receive alerts at the exact moment in which they occur, warning the population. WEA looks like a text message of not more than 90 characters, showing the type of alert and time, any action to be taken, and the entity issuing the alert. The WEA system is implemented by the United States Federal Communications Commission (FCC).

Nevertheless, during 2017 the authorities of Puerto Rico established a bill in their legislative chamber to create a "Wireless Alerts Notices Law for Users of Beaches and Coastal Areas in the face of Maritime Danger Conditions in Puerto Rico". The initiative is being carried out by the Commission of Economic Development, Planning, Telecommunications, Public-Private Partnerships and Energy of the House of Representatives. Meanwhile, the Senate is seeking to promote the "Puerto Rico Mobile Emergency Alert System Act". At the writing of this paper, there is no news on the progress of either initiative.

8.1.23 TRINIDAD AND TOBAGO

The Office of Disaster Preparedness and Management (ODPM) is the official institution in charge of the disaster warning and response mechanisms in Trinidad and Tobago. It has been active under this denomination since 2005, and reports to the Ministry of National Security.

The objective of the ODPM is to promote a culture of disaster risk prevention and education with an approach that seeks transparency of information to all the society. The focus is on generating comprehensive multi-risk responses that consider all elements of the disaster management cycle: preparedness, mitigation, response, and rehabilitation.

²³ In "Law of the State Agency for Emergency Management and Disaster Management of Puerto Rico". In <http://www2.pr.gov/ogp/BVirtual/LeyesOrganicas/pages/211-1999.aspx>

Among the objectives of the ODPM are to develop the national capacities of disaster risk management and adaptation to climate change. Besides coordinating the response and recovery operations with the purpose of protecting people, the environment, the economy, and ensuring a disaster-resilient nation.

The ODPM Early Warning System is made up of a set of capacities to generate and distribute warning information in a timely and significant manner. Its objective is to enable communities to prepare for imminent danger and act accordingly to reduce losses. The key elements of their function are: knowledge of the risks; monitoring, analysis and forecast of hazards; communication or dissemination of alert and warnings; and local capacities to respond to the received warnings.

With regard to early warnings notifications to the public, the ODPM has agreements with BMobile (TSTT) and Digicel to inform the population by means of Emergency Short Message Services (ESMS).

8.1.24 DOMINICAN REPUBLIC

The Emergency Operations Center (COE) is the agency that directs all actions of coordination among the institutions of the National Disaster Prevention, Mitigation and Response System.

COE keeps the President of the State informed about the emergency situation and the response operations. It also establishes a close relationship with the scientific institutions in order to keep the national situation updated in relation to potential threats. In addition, the COE must plan and direct all the coordination actions and facilitates the joint operation between the institutions of the National Prevention, Mitigation and Response System based on the alert declaration.

Since 2008, through Resolution No. 079-08²⁴ of the Dominican Telecommunications Institute (INDOTEL), the Alert Information System was established. It is highlighted that the COE can make “use of telecommunications networks and systems installed throughout the national territory, for the transmission of text or voice messages that must reach the users of telecommunications services, whether by telephone or broadcast, so that they may be duly informed of the possible occurrence of an emergency situation.”

The alert will be created by the COE, that will also keep it updated, and will have a list of the people considered vital for information dissemination of emergency or the execution of actions derived from it. Once the disaster event has been identified, the COE will inform INDOTEL, which must notify the operators of the alert.

The Alert Information System has a second phase that will provide information to the population through official releases in all the television channels and systems and signals of cable broadcasting networks. This information will also be distributed by AM and FM radios.

²⁴ In Resolution No. 079-08, <https://indotel.gob.do/media/6227/17-resoluci%C3%B3n-no-079-08.pdf>

8.2 APPENDIX B: ACRONYM LIST

3GPP	Third Generation Partnership Project
AM	Amplitude Modulation
ATIS	Alliance for Telecommunications Industry Solutions
CBC	Cell Broadcast Center
CBS	Cell Broadcast Service
CDEMA	Caribbean Disaster Emergency Management Agency
CMAS	Commercial Mobile Alert System
CMSP	Commercial Mobile Service Provider
CTIA	Cellular Telecommunications Industry Association
EAS	Emergency Alerting System
EEW	Earthquake Early Warning
EEWS	Earthquake Early Warning System
ETWS	Earthquake and Tsunami Warning Systems
EU-Alert	European Public Warning Systems
eWEA	Enhanced Wireless Emergency Alert
FEMA	Federal Emergency Management Agency
FCC	Federal Communications Commission
FM	Frequency Modulation
IPAWS	Integrated Public Alerting and Warning System
KPAS	Korean Public Alert System
LTE	Long Term Evolution
NEMA	National Emergency Management Agency
NOAA	National Oceanic and Atmosphere Administration
NPAS	National Public Alerting Systems
NWR SAME	NOAA Weather Service Specific Area Message Encoding
PWS	Public Warning System
RMT	Required Monthly Test
SASMEX	Mexican Seismic Warning System
SIAT-CT	Early Warning System for Tropical Cyclones
SM	Short Message
SMS	Short Message Service
UHF	Ultra-High Frequency
WEA	Wireless Emergency Alert
WPAS	Wireless Public Alerting Service

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The contents of this document reflect the research, analysis, and conclusions of 5G Americas and may not necessarily represent the comprehensive opinions and individual viewpoints of each particular 5G Americas member company.

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