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Making the DC Report Adaptive to the Local Situations in the Philippines

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Abstract: Using the Satellite Report for Disaster and Crisis Management or "DC Report" to disseminate early warning message can be more useful in the Philippines if the technology is tailored to the local conditions and its existing practices. The DC Report is one of the services of the Quasi-Zenith Satellite System (QZSS or *Michibik*i), which is owned and managed by the Government of Japan. In December 2023, the DC Report technology was demonstrated at the Office of Civil Defense (OCD) campus in Quezon City, Philippines. In this paper, the outcomes of the DC Report demonstration are highlighted, including: 1) the Philippine government's experience in creating and disseminating warning/alert message as well as its limitations; 2) the potential contributions of the DC Report technology in augmenting the local existing early warning systems; and 3) the next immediate actions to be undertaken to make the DC Report practically useful in disseminating the warning message.

Keywords: QZSS, DC Report, Demonstration, QGIS Plugin, Prototype Receivers

1. INTRODUCTION

One of the services of the Quasi-Zenith Satellite System (QZSS or *Michibiki*) is the Satellite Report for Disaster and Crisis Management or "DC Report" (QZSS, 2024). Since this service uses satellites to disseminate the early warning message, communities-at-risk can be warned even if the ground communications system is damaged. In a survey conducted by ADRC among ten of its thirty-two member countries, Potutan and Suzuki (2023) highlighted four common issues in disseminating early warning message: 1) inability to transmit the message to the community-at-risk due to the disruption of communications network caused by a disaster; 2) distorted and delayed arrival of the message due to many channels and levels of command; 3) warning message is sent to incorrect areas due to non-targeted approach of dissemination, e.g., mass dispatch of SMS or WhatsApp groups; and 4) warning message could not be received due to limited network coverage, such as in island communities or those living in mountainous areas.

During the Great East Japan Earthquake in 2011, evacuation alerts could not be disseminated to the impacted areas due to power outages and severe damage on telecommunications infrastructure, including Wi-Fi and cellular networks (Cabinet Office, 2022). This experience validated the importance of installing a back-up system that could be used in case a similar large-scale disaster occurs. As a result, the National Space Policy Secretariat (NSPS) of the Cabinet Office Japan decided to introduce and promote the DC Report service – not only in Japan, but also, in the countries of Asia Pacific region – emphasizing two essential functions: 1) to serve as back-up system in the event of large-scale disaster; and 2) to augment the early warning systems in areas that have limited telecommunications network (Cabinet Office, 2018; GNSS Asia, 2021).

As of March 2024, the QZSS comprises four satellites hovering over the Asia-Pacific region, providing the platform to transmit early warning message. By 2025, three more satellites will be added to the QZSS constellation. With a total of seven satellites, the signal as well as the coverage for DC

Report service will be further enhanced. In preparation for the overseas operationalization of the DC Report service, the *Japan Team on the DC Report Demonstration* – with members from the Cabinet Office Japan, NTT Data, Asia Air Survey, and Asian Disaster Reduction Center – have conducted a total of nine demonstrations covering the following countries: Australia, Bangladesh, Cambodia, Fiji, Indonesia, Malaysia, Nepal, Philippines, and Thailand. This paper is about the demonstration conducted in the Philippines.

(1) Objectives

The main objective of this paper is to describe the learnings from the DC Report demonstration in the Philippines by specifically answering the following:

- What are the existing systems for creating and disseminating the warning message to the communities-at-risk? What are the limitations of the existing systems?
- How can the DC Report complement/augment the existing message dissemination system? What needs to be modified in the prototype models so that the DC Report technology can be integrated into the existing systems?
- What actions are needed to make the DC Report practically useful in disseminating the warning message?

(2) Methodology

On 12-13 December 2023, the Japan Team (i.e., ADRC, AAS, and NTT Data) and the Office of Civil Defense's Information and Communications Technology Division (OCD/ICTD) jointly organized the DC Report Demonstration in Camp Aguinaldo, Quezon City, Philippines. Over thirty officials from the Office of Civil Defense (OCD), Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), Department of the Interior and Local Government (DILG), Department of Information Communications and Technology (DICT), and other member agencies of the National Disaster Risk Reduction and Management Council (NDRRMC) participated in the demonstration.

The two-day event comprised three parts. The first part was the introduction of the basic concepts: a) Early warning systems in the Philippines, and b) QZSS DC Report. The second part was the demonstration of the two sets of tools: a) QGIS Plugin – a tool for creating and sending message to the QZSS, and b) Prototype receivers – the tools for receiving the message from QZSS. The final part was the administration of survey questionnaires on QZSS DC Report. Outcomes of the demonstration are described in the succeeding sections.

2. CREATING AND DISSEMINATING THE ALERT MESSAGE

PAGASA, which operates under the Department of Science and Technology (DOST), is the national meteorological and hydrological services agency of the Philippines. It is the key agency that utilizes science-based knowledge to issue warning and alert messages to the public in order to protect them against natural calamities.

(1) Creating the Alert Message

Like many other meteorological and hydrological (Met-hydro) agencies abroad, PAGASA adopts the Common Alerting Protocol (CAP) in issuing a warning message. According to the Global Disaster Preparedness Center (2018), CAP-alert includes key facts on: What is the emergency? Where is the affected area? How soon should people act? How bad will the emergency be? How sure are the experts? What should people do?

To facilitate creating CAP-alerts, PAGASA established the Met-hydro Decision Support Infosys (MDSI) in 2013 to integrate information from all available Automatic Weather Station (AWS) as well as Automatic Rain Gauges (ARG). MDSI includes File Transfer Protocol (FTP) with high availability platform as well as robust SMS collection server that caters to all SMS-based data reception for AWS and ARG. Furthermore, MDSI integrates imagery from Doppler radar stations on a Google Application Programming Interface (PAGASA, 2022).

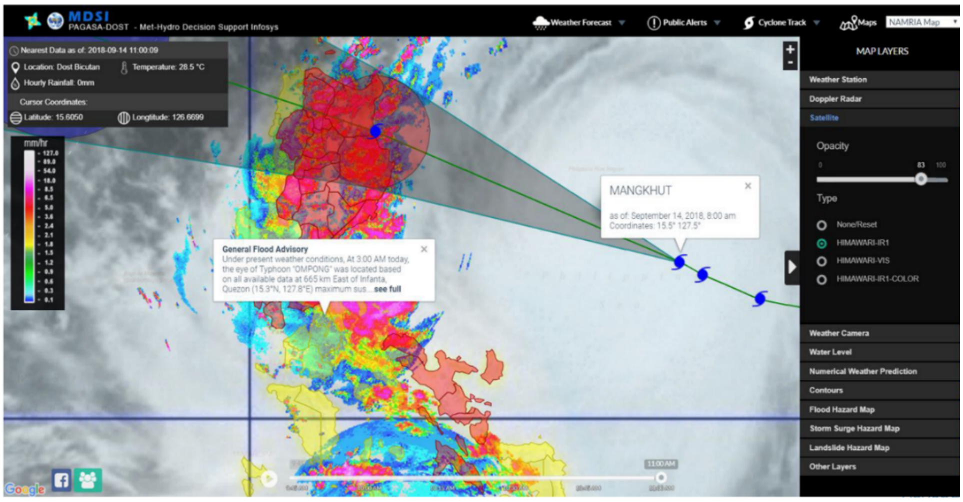

Figure 1. Image of MDSI website showing CAP-Alert for floods and TC Mangkhut (Amador, 2023)

According to Amador (2023), PAGASA has been creating CAP-alerts for tropical cyclones (TC) in partnership with *Google's Crisis Response* (https://crisisresponse.google/forecasting-and-alerts/) since 2014 to provide people access to trusted information. Then in 2016, PAGASA installed the Sahana Alerting and Messaging Broker (SAMBRO) system to aggregate local CAP-alerts for tropical cyclones. Since 2023, more CAP-alerts are being developed for: 1) river basin bulletin, 2) flood advisory, 3) lightning detection, and 4) thunderstorm. Following the development of CAP-alert for river basin bulletin, a CAP system has been installed in some of the River Basin Centers (RBCs) so that they can automatically issue the alerts.

(2) Disseminating the Alert Message

The National Disaster Risk Reduction and Management Operations Center (NDRRMOC) is the key agency in the Philippines mandated to disseminate warning and alert message. NDRRMOC operates 24 hours, 7 days a week (24/7) monitoring/receiving advisories and warnings from trusted agencies (e.g., PAGASA) and disseminate them to the general public, media, and other stakeholders (Figure 2).

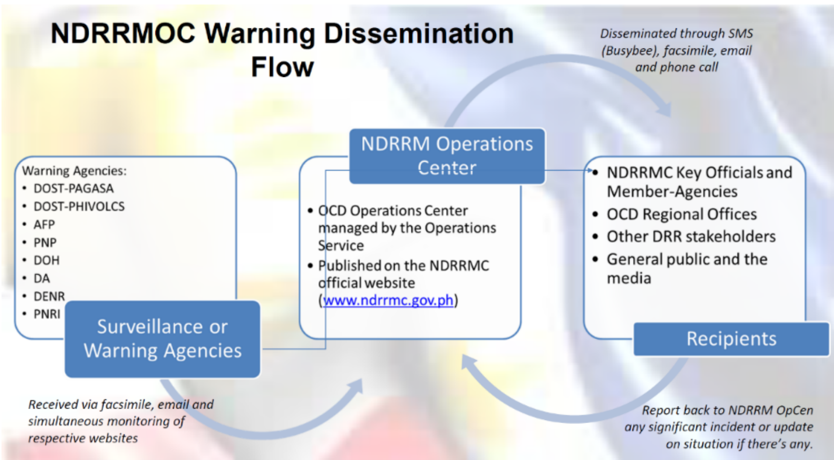

Figure 2. Flow of Warning Message Dissemination (Somido, 2023)

According to Somido (2023), in addition to using email, telephone, facsimile, and social media (e.g., Facebook, X, and WhatsApp), NDRRMOC also adopted other tools to disseminate warning and alert messages. Firstly, NDRRMOC maintains a web-based monitoring dashboard (i.e., *NDRRMC Monitoring Dashboard*) that digitally organized the data of hazards and events based on regional location, date and time of occurrence, and other relevant information. Data displayed on the dashboard are obtained from the relevant technical and warning agencies (e.g., Department of Science and Technology, Department of Health, and Armed Forces of the Philippines). Update-to-date weather situation, flood advisory, volcanic alert, earthquake and tsunami warning, and other imminent risks are shown on the dashboard. Secondly, NDRRMOC uses a web-based SMS platform to disseminate advisories directly to the mobile numbers of key NDRRMC officials as well as concerned OCD Regional Offices. Finally, NDRRMOC collaborates with the telecommunications companies (TELCOs) in providing Cell Broadcast Service (CBS), free of charge, where individuals in specific areas to be affected by disasters can receive mobile alerts/warnings, allowing them to make decisions such as to evacuate.

(3) Limitations and Gaps

A number of gaps and limitations were noted in the current early warning systems in the Philippines. Regarding data-sharing, participants mentioned that while each warning agency separately maintains its own databases, these are not yet integrated. Participants believed that if the databases are integrated, it would facilitate a more risk-informed forecast and effective issuance of advisories and alerts.

Regarding the creation of warning message, participants mentioned that CAP system is not yet applied to all types of hazards. Additionally, the usage of CAP system is still highly centralized, wherein many of the PAGASA regional offices do not have the infrastructure and capacity for creating CAP-alerts.

Regarding the dissemination of warning or alert message, participants mentioned the following challenges: 1) recipients are not specifically targeted to the communities-at-risk, e.g., message disseminated through SMS blast will be received by all registered users regardless of whether or not they in the areas that are likely to be affected by the disaster; 2) the cell broadcast service or CBS, which is designed to alert the communities-at-risk, is often delayed; and 3) all existing systems for message dissemination are still “one-way communication”, hence, the headquarters has no efficient way of getting feedback from the impacted communities whether or not they have successfully evacuated.

3. DEMONSTRATION OF THE DC REPORT

After gaining insights on the early warning systems in the Philippines, the DC Report demonstration was undertaken to show its potential contributions in augmenting the warning message dissemination and integrating the technology with the existing systems. The demonstration highlighted two operation segments: 1) How to create and send the message to the QZSS; and 2) How to receive the message from QZSS and disseminate it widely.

(1) Basic Concept of DC Report

For the Philippine context, the basic concept of the DC Report was demonstrated with the following scenario,

- PAGASA creates the warning message using the QGIS Plugin (MT44 format so that the satellite can read) and sends this warning message to the OCD
- Upon receiving the message, the OCD transmits the message to the control station in Japan using internet or virtual private network (VPN)
- After that, the control station in Japan transmits the message to the QZSS (Michibiki)
- In about 15 seconds, the message will be received by the communities-at-risk who have receivers (prototype models) in the target areas (designated by ellipse)

- Communities-at-risk will receive the message in text, audio, and map display

Figure 3 shows the basic flow of transmitting the warning message in the DC Report as demonstrated in the Philippines.

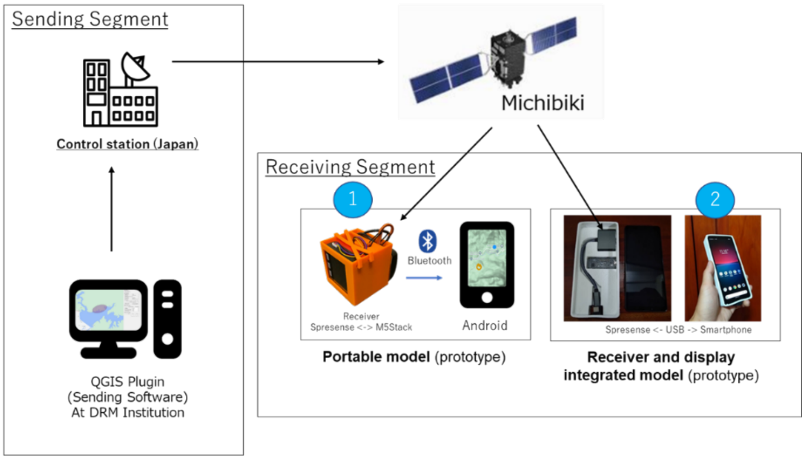

Figure 3. Basic Concept of the DC Report as demonstrated in the Philippines

(2) Demonstrating the *Sending Segment*

In order to send the message to the QZSS, it must be in MT44 format (i.e., coded information within 250bit /1 second) so that the satellite can read it. Of the 250bit, the MT44 message uses 122bit for the common early warning system format or "EWS format" containing the coded information for country, target area, hazard type, warning level, and other related information. Moreover, the MT44 message allocates 68bit or "extended format" to allow country governments to customize additional information (Figure 4). The extended format is unique feature under QZSS.

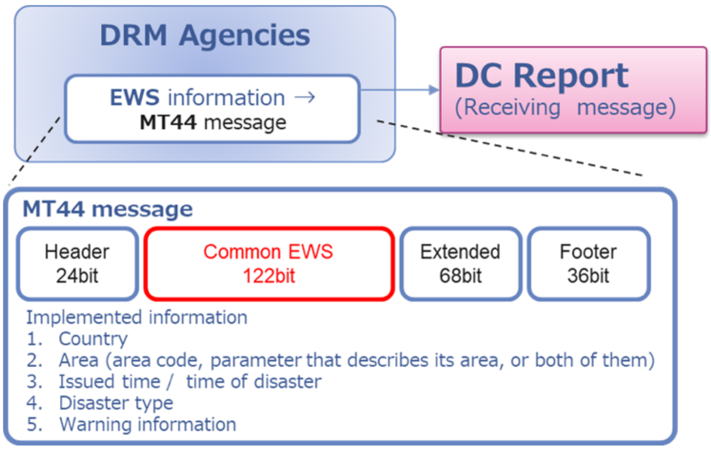

Figure 4. Coded information in the "EWS format" of MT44

In conformity with the MT44 format, a QGIS Plugin (open-source GIS software https://qgis.org/en/site/) has been made available (free of charge) to users of DC Report service. With the QGIS Plugin, creating and sending a warning message to the QZSS becomes easy by simply clicking on the appropriate selection from the pulldown menu shown on the computer screen. Moreover, the location where to send the warning message can be designated by simply marking an ellipse on the map (Figure 5). By doing such, only those individuals within the ellipse could receive the message.

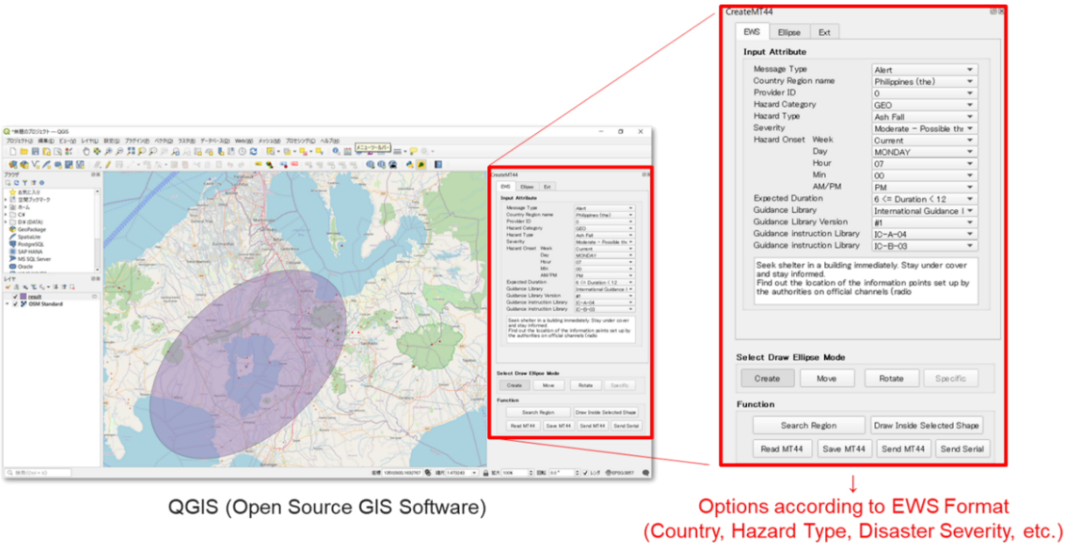

Figure 5. View of QGIS Plugin showing the ellipse and pulldown menu in creating the message in MT44 format

After demonstrating the QGIS Plugin, one of the participants inquired whether a polygon, instead of an ellipse, can be used to delineate clear boundaries of the target area to where the warning message will be sent. While the current QGIS Plugin settings do not allow this kind of operation, the settings can be modified to allow the use of polygon. So, this will be one of the updates to be made in the QGIS Plugin. Another participant clarified that while QZSS can process the transmission of message in about 15 seconds after creating it, can the QZSS send the same message to the receiver more than once? Members of the Japan team said that the QZSS can send the same message within 4 seconds interval. Furthermore, one participant inquired whether there are alternative options available for OCD Operations Center to send the warning message to the control station in Japan if the Wi-Fi and cellular networks are damaged. Members of the Japan team said that under this scenario, one of the three OCD operations sub-centers in the Philippines must send the message to control station in Japan.

(3) Demonstrating the *Receiving Segment*

What happens to the message after it is sent to the QZSS? In order to receive that message on the ground, a receiver device that decodes the message from MT44 format is needed. During the DC Report demonstration, two prototype receiver models were utilized (Figure 6).

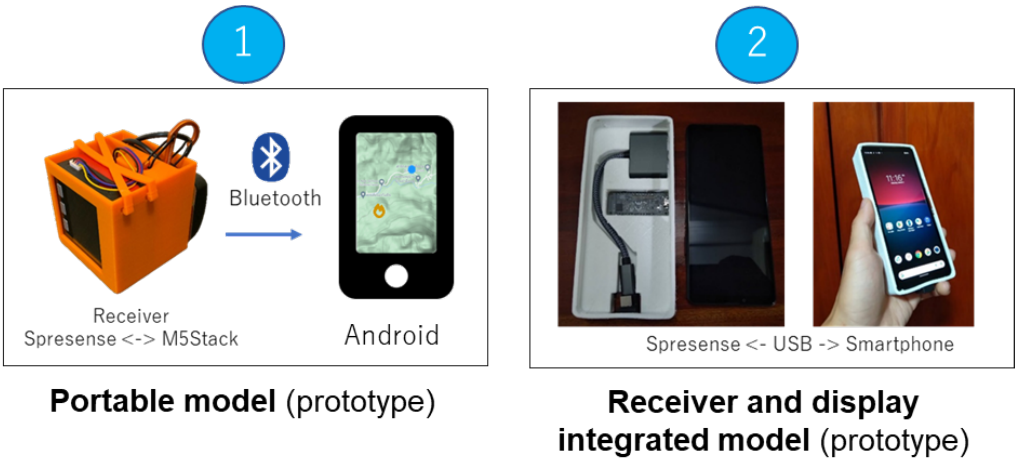

Figure 6. Prototypes of QZSS Receivers demonstrated in the Philippines

In the *portable prototype model*, the receiver device receives the DC Report from QZSS and transmits it to the smartphone via Bluetooth. In the *integrated prototype model*, the smartphone receives the DC Deport directly. If the individual, holding the receiver, is within the target area (covered in the ellipse), that individual will receive the warning message in the form of vibration, audio, text, and map display using a smartphone application (Figure 7).

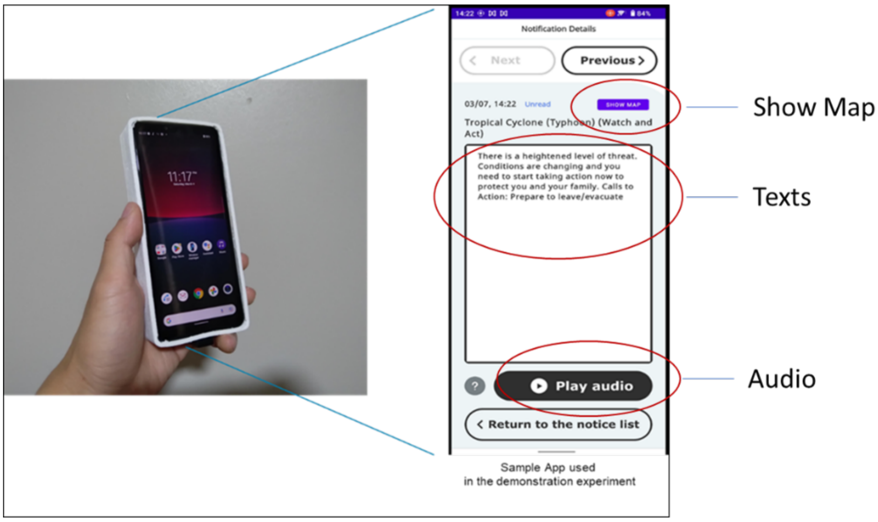

Figure 7. DC Report can be received in the form of vibration, audio, text, and display

After demonstrating the prototype receivers, the participants provided a number of insights for improvement. Firstly, there was a suggestion to also use Wi-Fi, in addition to Bluetooth, in transmitting the message from the portable receiver to the smartphone. Since Bluetooth can only transmit the message within a short distance, the use of Wi-Fi can expand the coverage. Secondly, knowing that the prototype smartphone App (*i.e.,* Resident) is currently compatible only with Android operating systems (OS), there was a suggestion to make the App compatible with other operating systems including Apple, Samsung, and Nokia. Finally, considering that the portable receiver can transmit message via Bluetooth (or through Wi-Fi), there was a suggestion to further explore its capacity to activate sirens, horn speakers, or electronic signboards to notify communities-at-risk.

(4) Potential Contributions of the DC Report

Following the demonstration of the DC Report, the participants affirmed that this new technology can serve as a back-up system for disseminating the warning message in case of telecommunication systems' disruption from the disaster. Aside from using it as a back-up system, the DC Report technology can be also useful in transmitting the warning message immediately and correctly to areas that have limited telecommunications coverage.

Generally, the DC Report technology offers at least four value-added features in terms of warning message dissemination.

- <u>Robustness</u>: The DC Report can transmit the warning message even if the ground communication systems are disrupted by extreme disaster event. If there is power outage or damage to communication towers (e.g., Noto Peninsula Earthquake of January 2024), the warning message can still be transmitted to the disaster-affected areas using the DC Report.
- <u>Immediacy</u>: The DC Report addresses the issue of delay or distortion of warning message, as it does not pass through many communication channels or administrative levels of command. After sending the message to the QZSS, the receivers can receive it within just 15 seconds.
- <u>Correctness</u>: Using the positioning function of the QZSS, the DC Report can transmit the warning message only to a designated target area (i.e., marked with ellipse) that would be

likely affected by the disaster. If individuals are outside the target area, they will not receive the warning message.

- <u>Comprehensiveness</u>: Since it uses the QZSS, the DC Report can be transmitted to areas with limited network coverages, such as the communities living in mountainous regions or small islands.

4. DISCUSSIONS

Considering the limitations of the existing systems for disseminating warning message in the Philippines (e.g., delayed cell broadcast service and untargeted recipients of SMS messages), the DC Report technology can be one of the solutions in addressing those issues. If the Philippine government decides to adopt the DC Report technology, participants suggested that the QGIS Plugin and the receivers must be tailored to the local situations. Subsequently, in order to ascertain its effectiveness, the tailored DC Report technology must be first piloted before adopting it to a wider scale.

(1) Tailoring the prototypes to the local conditions

Regarding the QGIS Plugin, among the recommendations include updating the Plugin settings to integrate polygon shapes or specific political map boundaries in designating the areas that will be likely impacted by the disaster. By using a polygon, the likely-affected areas can be accurately designated with the identification of corresponding local government administration that is responsible for response. Another recommendation is to link the data from flood and landslide sensors to the QGIS Plugin so that it can automatically create and send a warning message to the QZSS. In this way, time can be reduced and errors from manually inputting the warning message into the QGIS Plugin can be minimized.

Regarding the prototype receivers, among the recommendations include developing a "sim-style" receiver that can be compatible with any smartphone operating systems (e.g., Android and IOS), particularly considering the older cellphones (e.g., Nokia and Samsung) which are still being used in remote communities in the Philippines. Corollary to this, the Japan government may consider partnering with the smartphone manufacturers in the Philippines to integrate the QZSS receiver in their newer smartphone models. Furthermore, a prototype receiver might also be developed specifically for the fishermen, local seafarers, and small boat industries so that they can receive the warning message while in the middle of the ocean.

(2) Pilot Application of the DC Report

As suggested by the participants, the DC Report can be piloted in one of the municipalities in the Philippines whenever the modifications for the QGIS Plugin and the prototype receivers are made. OCD specifically mentioned the municipality of La Trinidad, Benguet, which is one of the 50 sites of the Philippine Institute of Volcanology and Seismology's (PHIVOLCS) *Dynaslope Project*. This project develops an early warning system for deep-seated and catastrophic landslides through landslide sensor technology and community participation. In La Trinidad for instance, sensors are installed in specific locations to automatically activate the sirens for early warning. The Municipal Disaster Risk Reduction and Management Officer (MDRRMO) of the La Trinidad, who participated in the demonstration, welcomed the idea and will be interested to serve as focal point if his municipality will be chosen as pilot area. Aside for La Trinidad, other potential pilot cases can be Catanduanes Province, Borongan City, or Butuan City, where improvement projects in information and communications are jointly undertaken by OCD and the Philippine Disaster Resilience Foundation (PDRF).

5. CONCLUSIONS

To make the DC Report adaptive to the Philippine situation, the demonstration found that the QGIS Plugin and the prototype receivers need to be modified. Regarding the QGIS Plugin, one suggestion is to use polygon (instead of ellipse) in designating the boundaries of target area where the warning message will be sent. Another suggestion is the integration of sensors and QGIS Plugin to automatically send the warning message to the QZSS. Regarding the prototype receivers, three modifications may be highlighted: 1) allow the use of Wi-Fi, in addition to Bluetooth, in transmitting the message from the portable receiver to the smartphone to expand coverage; 2) make a "sim-card type" receiver that is compatible not only with Android, but also with other smartphone operating systems including, Apple, Samsung, and Nokia; and 3) add capacity to the receivers to activate sirens, horn speakers, or electronic signboards to notify communities-at-risk. Once the DC Report technology is tailored to these local conditions, the next step is to pilot test it in one of the municipalities of the Philippines to further assess its feasibility.

As to the potential future operations of the DC Report in the Philippines, the participants suggested that OCD/ICTD may be tapped as the focal point to coordinate and seek the official endorsement of the NDRRMC. The Chief of OCD/ICTD welcomed this suggestion and mentioned that if ever the DC Report is adopted, its operations will be guided by principles that are grounded on the local situations. Firstly, OCD/ICTD will pursue a cheaper option by not requiring the residents or community members to buy a receiver nor a new smartphone since this will only add burden. So, if the portable receivers can activate sirens and horn speakers, it might be a better and cheaper option to adopt. Secondly, OCD/ICTD will pursue a collaborative approach in the DC Report operations by engaging all members of the NDRRMC, and collaborate with other relevant line agencies, local governments, and private sectors.

Overall, the participants viewed the DC Report as a robust back-up system for warning message dissemination, particularly in the event of communications system's disruption due to disaster. Moreover, the participants also viewed the DC Report as a valuable system in disseminating warning message to a wider area, immediately and correctly.

ACKNOWLEDGMENTS

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