The Role of SAMBRO as Cross-Agency Situational-Awareness Platform for Disaster Risk Management

Biplov BHANDARI, Nepal; Nuwan WAIDYANATHA, Sri Lanka and Manzul HAZARIKA, India

Keywords: Early Warning, Common Alerting Protocol, Interoperability, Situational-Awareness, Data Standard

SUMMARY

Philippines, Maldives, and Myanmar have a lot of coastal regions and therefore are vulnerable to natural disasters. One of the major challenge for the government is to maintain an effective coordination and cooperation among different governmental and non-governmental organization (McEntire, 2002). International development agenda such as the Sendai Framework advocates the implementation of Early Warning System (EWS) by the national governments to reduce the risk (Pearson & Pelling, 2015). But as most of the existing early warning systems vary as per different organizations, the existing problem becomes more pronounced. On the other hand, free and open source softwares together with cross-agency situational awareness platforms and the interoperable data standards like Common Alerting Protocol (CAP) and various other ICT advancements are presenting themselves as a solution to this complex problem (O'Donnell & Pagotto, 2012).

Sahana Alerting and Messaging Broker (SAMBRO) is designed to increase the coordination among different organization and act as a warning broker to bridge the gap. SAMBRO implements CAP as a data standard, thus it is capable of machine to machine communication with any other system implementing CAP. The advantage provided via this platform includes the alerts issued at the central level can be received at the local level. Thus, in exercise the alerts issued by the National Warning Centers can be received National Disaster Management Organizations which can further be received by National Response Organizations. Following the alert, the National Response Organization can relay the same warning to the public with detailed descriptions of the disaster with instructions and contacts to follow-up, through various available medium like Email, SMS, RSS Feeds, FTP, Mobile Push Notification, Social Media like Facebook, Twitter and/or TV Scrolling etc. SAMBRO provides a Common Operating Picture for all the stakeholders to visualize the alerts per the risk level. A color-coded polygon where color implying the risk level associated with an area provide visual impressions to the brain.

To this end, the CAP-on-a-MAP project developed and implemented SAMBRO in Philippines, Maldives, and Myanmar. The project applies Agile Scrum methodology for system development involving end-user in designing, building, testing, rebuilding and iterating from the very beginning

until the desired solution is met. The paper discusses intricacies of applying the EWS in place, various challenges that are encountered along the way and discuss different strategies applied which could be used as a reference for the future early warning designers and overcoming similar challenges.

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1. INTRODUCTION

Disasters are increasingly claiming life and property each year around the world. The unplanned urbanization in many underdeveloped and developing countries have exposed their communities to the severe threat of disaster. The globally increasing disaster are from a result of natural and anthropogenic climate change causes (World Economic Forum, 2015). This increasing global natural disasters is also reflected by figure 1 that presents the number of disaster by various regions from 1980 to 2009[1]. Overall, we can surmise that the developing countries under Asia-Pacific and African region are some of the most vulnerable to disasters. One of the reason for the better preparedness of the countries in the North American and European region is the implementation of effective disaster preparedness, mitigation and management (Annelli, 2006).

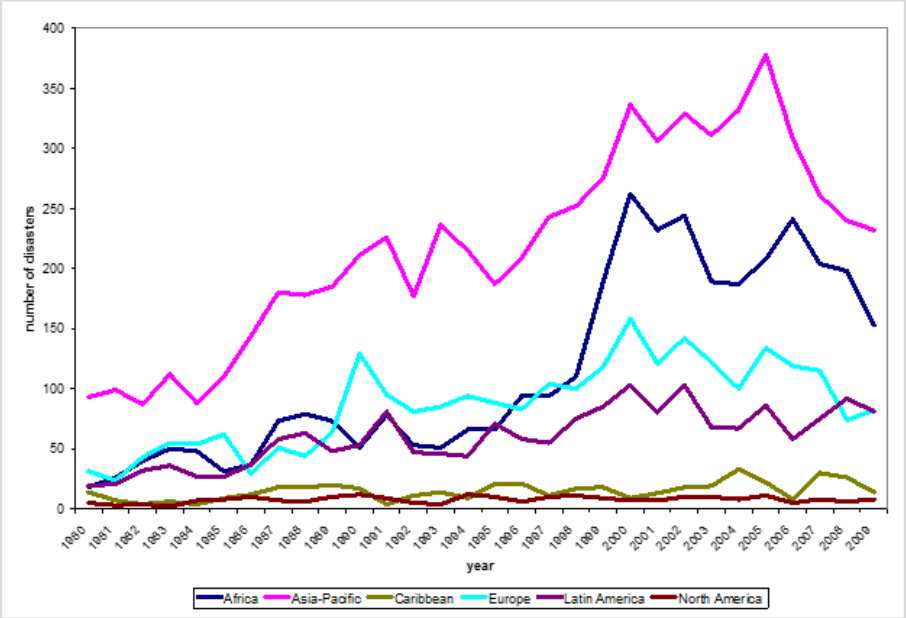

Figure 1: Increasing trend of disasters from 1980 to 2009

[1] Disaster risk in Asia and the Pacific (2010), Protecting Development Gains - Reducing Disaster Vulnerability and Building Resilience in Asia and the Pacific, The Asia-Pacific Disaster Report, 2010, a joint publication of UNESCAP and UNISDR.

With that in mind, Sendai Framework for Disaster Risk Reduction 2015-2030 has opted for Disaster Risk Reduction through the application of Early Warning Systems (EWS) that are centered around vulnerable communities based on risk and hazard analysis, organized with effective and coordinated response in recovery, rehabilitation and reconstruction (Wagner & Zia, 2015). United Nations Sustainable Development Goals has acquiescently advocated the importance of developing and the application of effective EWS *to ensure healthy lives and promote well-being for all at all ages* (Goal 3), *make cities and human settlements inclusive, safe, resilient and sustainable* (Goal 11) and *take urgent action to combat climate change and its impacts* (Goal 13).

The overall aim of this paper is to deliver the insights on design of alerting and messaging broker namely Sahana Alerting and Messaging Broker (SAMBRO), with implication from the implementation in the South East and South Asian region. These countries include the Myanmar and the archipelago of Philippines in South East Asia along with the archipelago of Maldives in South Asia. The project titled 'CAP on a MAP' was designed to integrate various stakeholders and institutions under a common hood to provide situational awareness and provide semi-automated technology for warning and public alerting activities.

2. GOALS AND OBJECTIVES

Often the problem for the National Disaster Management Centers (NDMC), National Warning Centers (NWC), line agencies, aid agencies and various stakeholders is lack of platform and procedures to exchange alerts and early warnings (McEntire, 2002). This problem results in uncoordinated, duplicated efforts additionally lack of awareness to the most disaster risk regions in the country. However, the information management for EWS should be reliable, effective, efficient and redundant to ensure the alerts and warnings reach the goal of providing crucial information to at risk communities.

The long-term goal of this project is to realize the state-of-the-art alerting information management system and address the current underlying challenge of the coordinated alerts and warnings in each beneficiary country. The overall objective is to bring together all the stakeholders under one roof to provide a coordinated information exchange during a disaster additionally helping them during the disaster preparedness phase.

The following are the specific objectives to address our goal:

- To improve the national capacities for providing hazard and location specific alerts/warnings per risk levels.
- To improve the national capacities for maintaining a register of alerting/warnings authorities for creating, authorizing, issuing, auditing, and receiving MASA alerts.
- To help national agencies to share situational-awareness information with the responders, line-agencies, and NGOs to consolidate their efforts and operate as one entity to minimize the duplication of efforts.

- To develop a group of master trainers through Training of Trainers (ToT) in respective countries equipped with training materials.

3. TECHNOLOGY

We will address the underlying design principles and technologies behind SAMBRO. Overall, SAMBRO implements CAP[2] version 1.2 for alerting and warnings activities. Furthermore, SAMBRO is built by using the free and open source information management platform for disaster and humanitarian, called EDEN (Emergency Development Environment) provided by the Sahana community.

3.1 Common Alerting Protocol (CAP)

The CAP is an international open standard data format for emergency alerts and public warnings. The interoperable CAP data standard is provided and maintained by the Emergency Management Technical Committee as part of OASIS (The Organization for the Advancement of Structured Information Standards). It is a recommended standard by the International Telecommunication Union (ITU) and documented as ITU-T X.1303. Moreover, the implementation of CAP is advocated by the World Meteorological Organization (WMO) via 185 member nations and International Federation of Red Cross and Red Crescent Societies (IFRC).

It is designed for '*all-hazards*' which means it can be used for all kind of hazards and disasters. The application of CAP can range from natural and anthropogenic disasters to power outages, child abduction, dam warning and others. Additionally, CAP can be applied to trigger alerts through '*all-media*' that includes but is not limited to siren, mobile communication devices, fax, radio, television, and various internet and digital based communication networks.

[2] http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html

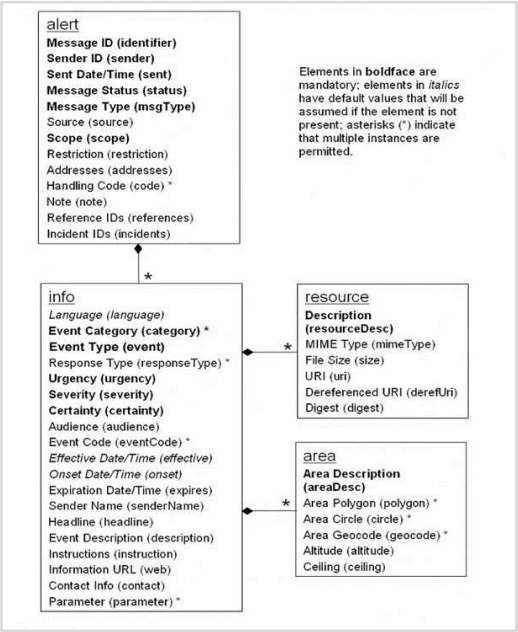

Figure 2: CAP Document Object Model

CAP is an Extensible Markup Language (XML) data format. XML is the format for the transmission of information used by different kind of applications and systems. Each CAP alert message consists of a parent node called <alert>. Each <alert> consists of one or more child node called <info>. Each <info> segment consists of one or more <area> and/or <resource> segment (figure 2).

The <alert> segment consists of qualifying elements for alert. These elements include unique message identifier, sender identifier, the message type, the status of the message, the scope of the message and any additional notes regarding the message, etc. The <alert> alone can be used for the message acknowledgement, updating or cancellation of the message, but generally an <alert> would consists of one or more <info> segment(s).

An <info> segment provides the detailed information on the event of the alert. Multiple <info> segments, inside <alert> segment, can be used to provide multilingual information. An <info> segment provide information on the certainty of occurrence of the event, urgency of the event and level of severity, detailed description of the event, instructions to follow, web URL for detailed information, contact details, effective and expiry date of the event etc.

The <area> segment consists of the geographical area where the <info> segment applies. The <area>is usually provided as polygon or circle expressed as the list of latitude and longitude in the specified format. However, geocodes can be a very useful representation for archipelago nations of

Philippines and Maldives.
The <resource> segment provides options for attaching extra information relating to the event as digital media like audio, video, pdf, CAP file, etc.

3.2 Sahana Eden Disaster Management Platform

The Sahana Eden is a disaster management platform (Careem, De Silva, De Silva, Raschid & Weerawarana, 2006), consisting of more than 20 modules including project management, warehouse and asset management, alerting and incident management, disease and patient tracking and health facilities management. Eden also provides mapping and digital document library together with messaging module. Different templates are developed for different applications utilizing these core modules and building upon them.

With more than 60 successful deployments, including those by the American Red Cross, City of Los Angeles, United Nations Office for Coordination of Humanitarian Affairs (OCHA), IFRC, Asian Disaster Preparedness Center (ADPC), National Library of Medicine (NLM) has already prove the maturity and significance of Sahana Eden platform.

Sahana follows the Rapid Application Development (RAD) process, therefore permitting to concentrate on implementing the various workflows. The common features like authorization, permissions etc. can be used with a very or no cost associated. Sahana is the wrapper over the web framework Web2Py. It follows the MVC (Model-View-Controller) architecture framework. Additionally, Sahana allows the CRUD (Create, Read, Update, Delete) operation over the network implementing HTTP (The Hypertext Transfer Protocol). The codebase is hosted in GitHub and open to use under MIT license.

3.3 Sahana Alerting and Messaging Broker

Sahana Alerting and Messaging Broker (SAMBRO) is the alerting and warning template developed using the Sahana Eden platform. It has been transformed since its initial 1.0 version (Waidyanatha et. al., 2010), and in its current 2.0 version, it implement the latest CAP Version 1.2 as the underlying data structure. SAMBRO is designed to serve as aggregator of the CAP message, publisher and disseminator of the warnings and alerts.

Various features of the SAMBRO is summarized in following points:

Multi-Agency Situational Awareness (MASA) - Together with the alerting and warning modules, SAMBRO uses other modules from the Eden which can be used to manage the directory of organization, the registry of persons, their associations, manage the events of interest. The alerts and warnings issued by multiple stakeholders including organizations and their branches are presented under a common alerting picture to provide a situational awareness.

Alert Hub and Message Broker - Alert Hub allows the aggregation of alerts from various disparate system implementing the CAP protocol. Organizations and their branches can subscribe to the alert feed from other organizations and their branches. SAMBRO's machine to machine communication allows for messages validation while importing the alerts into their private system. Following this, it allows the message to be relayed, transformed and translated to various dissemination medium to reach out single or multiple destinations. In this regard, SAMBRO allows for the subscribing and publishing activity. The alerts generated by subscribing to the alert feeds from other sources are called external alerts.

Inclusion of various target users - The system include all kind of users - Subscribers (Alert Recipients), Publishers (Alert Issuers), Implementer (Super Users) and Map Admin (GIS personnel). The technology permits the flexibility to include user groups based on the use cases. Subscribers can subscribe to the alerts and filter them based on the event of interest, various alert level relating to the event, language of the alert, the medium of the alert reception, etc. Figure 3 shows the subscription form used to filter the alerts based on various parameters and the medium through which alert is received.

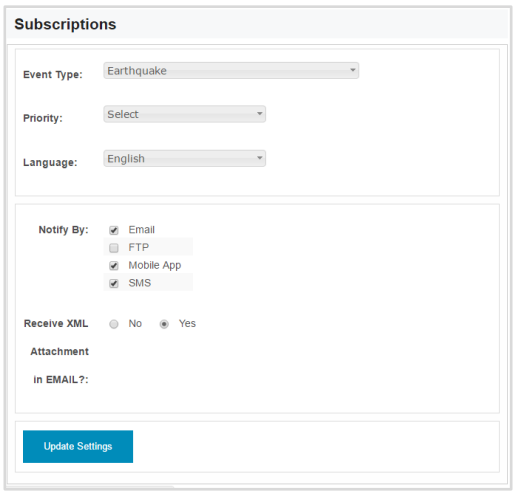

Figure 3: Subscription form and filtering for the alerts

Here the publishers are responsible for creation, update, and cancellation of the alert following the principles of CAP. Further, an extra layer of security is provided by dividing the publishers as '*Alert Editor*' & '*Alert Approver*', where the former is responsible for creating the alerts, while the latter checks the alerts and make necessary corrections before disseminating to various users. Typically, when '*Alert Editor*' completes designing the message, an Email along with a Short Message Service (SMS) is sent out to '*Alert Approver*' providing the link to review the alert.

Implementer's work is normally one go where he creates the users, assign designated roles, configure different Email, SMS, RSS and other settings and subscribe to other similar system to receive the alerts.
Map Admin are responsible for GIS data preparation and import work relating to GIS.

Communication Channels - SAMBRO is designed to be write once disseminate through all. Therefore, a single entry of message in the system can disseminate the warning through Email, SMS, Google Cloud Messaging (GCM), File Transfer Protocol (FTP), RSS Feeds, TV Scrolling, Cell Broadcasting, social media like Facebook, Twitter, etc. and allows the download of the warning bulletin etc. Different templates are setup for different dissemination media through Extensible Stylesheet Language (XSLT) allowing easy customization of any message.

Admin Forced Subscriptions - There are two kind of subscriptions. Self-subscriptions and admin based subscriptions. Since some personnel are compulsory to receive the alerts in the ground in order to perform the certain type of Standard Operating Procedures (SOPs), the admin can forcefully subscribe them to receive the alerts.

Audit Trail and 3W - WHO, WHAT, WHERE? - SAMBRO provides a way to visualize all the system-generated alerts and the external alerts. It provides answer to who issued the alert, what's the status and where it was issued - 3W information. Similarly, the audit trail feature of SAMBRO provide information on who logged into the system, who approves the message, when it was approved, and others. Similarly, once the alerts are approved and disseminate through the system, a snapshot of the approved alerts not depending on the external references are stored in separate table.

Localization - SAMBRO can be fully customized to make everything in Local Language. It's easy to translate using Web2Py. Once can put some efforts on the translation to allow to receive Email, SMS in local language as well.

Mobile and Web Based - Under the project, "CAP on a MAP" both web based and mobile applications (IOS/Android) were developed.

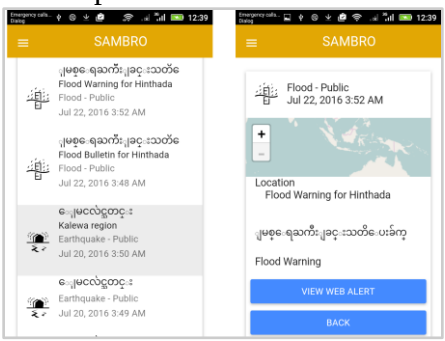

Figure 4: SAMBRO Mobile App is available in both Android and IOS store

The mobile application (figure 4) was developed with a focus on helping the first responders in the field to issue the warnings. For example, the first responders on the field helping with the fire rescue does not have computer but may have mobile phone to issue the alerts.

The mobile application also acts as wake up call. Whenever new alerts are issued through the system, a siren is triggered.
The web system allows the visualization of the alerts through the Common Alerting Picture (figure 5).

Figure 5: SAMBRO web system of Philippines showing Common Alerting Picture

Similarly, the profile page (figure 6) for each alert provide information and visual representation on the qualifying elements, the detailed information, any resources associated with the alerts and the web map visualization of the <area> segment of the alert. The web application is localized to provide the information in the local language.

Figure 6: Profile Page for individual alert, including local language. The red color area represent high urgent alert.

4. METHODOLOGY

The project 'CAP on a MAP' is the result of more than a decade of research and implementation. The early information stocktaking and the stakeholder consultations provided information on different public-private partnership initiatives in the early warning, to avoid the duplication but focus on the problem. Similarly, the activity also provided the opportunity to understand the existing techniques for early warning in each country and their needs. Some broad topic like public broadcast services for early warnings, priority calling and text-messaging for emergency, alert levels and color codes, capacity building, roles and responsibilities of NWC and NDMO came out from the discussions.

The experts from the national level disaster implementing agencies are involved with the public alerting activities in a daily basis. They understand its significance and importance but have not successfully unmasked it with data standard. Thus, it was realized that the waterfall model and other traditional software development model may not work best with the project because they require documentation of complete requirements, followed by an architectural and high-level design development (Leau, Loo, Tan & Tham, 2012). This realization has identified three major areas in information system design were identified: (1) User-Centered Design (UCD), (2) Agile Software Development Model and (3) action research.

UCD is a design process in which end users are involved from the early stage in the development of the system. Rather than to make the end-user remember and follow the new steps, the UCD takes into the existing knowledge, understanding of the user and build the system's User Experience (UX) and User Interface (UI) on the knowledge (Abras, Maloney-Krichmar & Preece, 2004). This allows the end user to quickly adapt and make sense of the information system. The information gathered from the early information stocktaking allowed us to perform rapid prototyping in form of sets of mock wireframes and design for the better UX and UI before beginning the work of actual coding. These sets were then iterated based on the suggestions received and reiterated till the desired solution was achieved.

Agile Software Development model allows for the rapid prototyping by dividing a project into the chunk of small tasks, developed and tested independently, allowing for the involvement of the end user from the very early stage in each chunk, close collaboration and communications between the development team and the business side (Schwaber & Beedle, 2002). The project practiced Scrum Agile methodology, where the stories of the user collected from the information stocktaking and consultations went into the backlog catalog, along with other ideas from the earlier SAMBRO compilation. The wish lists in the backlog catalog were placed in the order of priority. A small chunk of work, called as sprints was developed every week or couple of week (Schwaber & Beedle, 2002). With each sprint, a potential shippable product increment was developed and added. Meetings were held every week with the implementing organization to report and test about the developments. This also helped to determine what should be developed next.

Action Research (AR) allows us to practice the set of actions as an approach of research that helps in the knowledge generation. AR comes from a background which assumes that theory and practice can be closely integrated by learning from the results of intervention that are planned after a thorough diagnosis of the problem context (Davison, Martinsons & Kock, 2004).

The project implemented empirical methods of systematic observation and experiment rather than deductive logic or mathematics in order to provide the workable solution (Sjoberg, Dyba & Jorgensen, 2007). After few months of development, all the stakeholders from each country were invited to experiment with the SAMBRO. This provided us insights on the shortcomings of the current system and the expectations of the end user. The second set of iteration of helped to shape the information system in a more stable and desired state. After a few months of silent tests, simulations were carried out in each country mimicking the real case scenario. The simulation was performed as Table Top Exercise, Technology Acceptance Model, real time scenarios use-cases, etc. Thus the platform evolved with the iterative process of silent tests, tabletop exercises, discussions, and development.

5. DISCUSSIONS WITH RECOMMENDATIONS

Multi-Hazard Multi-Agency

Figure 7 shows the percentage of alerts per event of interest issued by Department of Meteorology and Hydrology (DMH), Myanmar as of January 2, 2017. The major events of interest for DMH are tsunami, flood, cyclone and earthquake. Similarly, Figure 8 shows the number of alerts issued per month through SAMBRO since its operationalization in September 2016. The information extracted by combining the data on location with the alert activities can help in making a proper plan on disaster infrastructure.

Similarly, as of January 2017, there are more than 30 organizations including Relief and Resettlement Department, General Administration Department, City Development Committee, Department of Public Health, Irrigation, Food, Fisheries, etc. under a common platform. Likewise, there are more than 850 recipients ready to receive the alerts as soon as Department of Hydrology and Meteorology (DHM) publishes them through various medium.

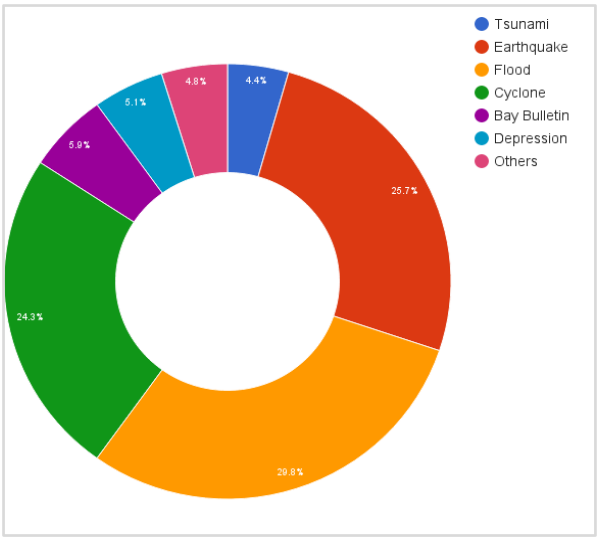

Figure 7: Alerts per Event Type as of January 2, 2017, for DHM

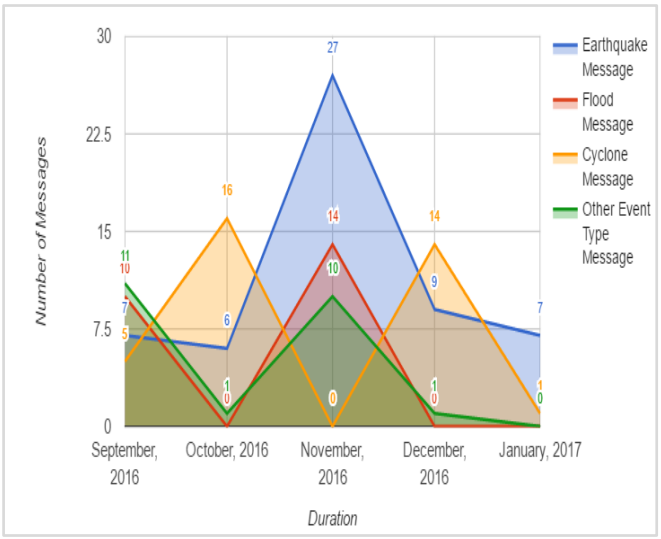

Figure 8: Number of messages per month per event type as of January 2, 2017, for DHM

Warning Conventions and SAMBRO

The warning practices were quite similar in three countries. In Myanmar, the officials at DHM used the telephones, fax, and Very High Frequency (VHF) radio to inform about the event to the other stakeholders for subsequent actions, and similar actions were performed by the next node until it reaches out to the community or public level. This is a manual process and would result large resources namely labor and time.

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) in Philippines already had their own system for issuing the CAP message. However, the warning dissemination in Philippines is like Myanmar. They use mostly fax and sometimes SMS for transferring the alerts from National Disaster Risk Reduction and Management Offices (NDRRMO) at different administrative level. Hence, PAGASA is yet to fully utilize the messaging broker feature of SAMBRO which would save the human and cost resources.

Similarly, NDMC from Maldives uses manual method of making phone calls, or using SMS and Viber group to inform about the hazard in various atolls.

The manual interventions may be acceptable for slow onset disasters with large warning horizons like droughts, cyclone, flood etc. but for rapid onset disasters with very less warning horizons (within minutes) like earthquake, dam outbreak, etc. However, SAMBRO is a compelling system that works much faster than manual procedures regarding multi-channel message disseminations.

DHM currently uses SAMBRO as well as follow up the traditional method, but looks forward to gradually replace the manual method.

Because 'CAP on a MAP' follows the User Centered Design approach, it was very important to design SAMBRO in a way to complement the existing SOPs. The existing SOPs were practiced during simulations using the traditional methods and through SAMBRO, and significant improvement in time was found.

Impact based alerting and Geocoding

The risk map in each country were very hard to acquire. The acquired ones were outdated, while some of them were in paper format rather than vector or raster format that would be consumed by the GIS module. Similarly, the NWC in each country have been practicing the method of impact based alerting by assigning the color to different alert levels. For example, there are five alert levels of volcano as given by the Philippine Institute of Volcanology and Seismology (PHIVOLCS)[3] as Alert Level 0: No Alert, Alert Level 1: Abnormal, Alert Level 2: Increasing Unrest, Alert Level 3: Increasing Tendency Towards Eruption, Alert Level 4: Hazardous Eruption Imminent and Alert Level 5: Hazardous Eruption.

Realizing this fact, the project introduced the concept of warning classifications. This would allow the implementing agent to construct different warning classifications for different event of interest and assign color to them to easily visualize in the map. This warning classifications were then linked with the urgency, severity, and certainty of the <info> segment allowing the flexibility of changing each of them for individual alerts.

Similarly, the concept of predefined alerting area was introduced to reuse the commonly occurring area for alerting purpose. The implementing agent would draw the impact area utilizing the mapping tool in SAMBRO referring to the paper maps or based on their experience. These predefined areas were prepared for different event of interest. However, for archipelago like Philippines and Maldives, it is very hard to draw the thousands of small islands. There is risk of maintaining too many geographic area or search through. Similarly, some island are so small that there is chance of excluding or including some of them. To overcome this, geocodes can play some important roles. Philippines have a well maintained geocodes by their survey department, which PAGASA uses to target the geographic area. The SAMBRO is currently used as alert hub by PAGASA, to aggregate the alert from various sources including their own. SAMBRO is designed in a way that it reads the geocodes from the CAP and process it to generate the actual polygon which can be visualized in the map.

Organizational Engagement

[3] https://volcanism.wordpress.com/about/volcano-alert-levels-philippines/

Various stakeholders and beneficiary organizations for the 'CAP on a MAP' project is shown in table 1. The major implementers project collaborated with was PAGASA, PHIVOLCS from Philippines, and NDMC from Maldives and DHM from Myanmar.

Table 1: "CAP on a MAP" beneficiary organizations

Country	**National Warning Center (NWC)**	**National Disaster Management Organizations (NDMOs)**	**National Response Organizations (NROs)**
Philippines	PAGASA; PHIVOLCS	Office of the Civil Defense (OCD).	Department of Social Welfare and Development, Local Government Units, Disaster Risk Reduction and Management Councils, Philippine Institute of Volcanology and Seismology, Philippine National Police, Bureau of Fire Protection
Maldives	Maldives Meteorological Service (MMS)	NDMC	Maldives National Defence Force (Coast Guard and Fire Search and Rescue Department); Maldives Red Crescent Society; Local Atoll Councils; Local Island Councils; Maldives Police; Maldives Red Crescent Society; Department of Health; Ministry of Tourism Arts and Culture; Ministry of Education
Myanmar	DMH	Relief and Resettlement Department (RRD)	General Administration Department; Department of Irrigation; Department of Health; Department of Agriculture; Department of Fisheries; Department of Inland Transportation; Fire Services Department; Myanmar Red Cross Society

The project aimed at bridging the gap between different stakeholders for sharing and exchanging alerts. However, the major challenge faced by the project implementing organization was to coordinate with the line agencies and relevant stakeholders. Albeit, various techniques including weekly and monthly meetings, silent tests were applied to increase the interaction, there was no significant progress. Despite this setback, regular workshops and trainings helped bring the

stakeholders under one roof which we later realized was short lived.
Furthermore, the government bureaucracy made it very difficult for stakeholders to engage continuously. If, for any cause, the government personnel involved in the project is transferred or leaves the office, there is very less possibility that next personnel will be assigned to the same objective. Often time there are large number of projects going, and without a proper Memorandum of Understanding (MoU), officials are reluctant to get engage in the activities in a regular basis and make it part of everyday work.

The active personals in the design, build, test, and iterative process from the implementing agencies were the junior staff. These staff members were unable to convey the bigger picture of SAMBRO and the implications of the project to their senior executives. Nevertheless, the lead implementing agent displayed a keen interest in operationalizing the system.

Technology related issues

The SAMBRO was accepted as easy to use tool for early warning dissemination. The organization long term and sustainable plan are the key factor that affect any technological implementation.
SMS services are required for number of purposes in SAMBRO. Post draft message by '*Alert Editor*', SMS and email with the link to the message approval is sent to '*Alert Approver*'. Similarly, one medium of alert dissemination is through SMS which uses its own XSLT template to derive the message. Similarly, for first responders in the field to be able to reply to the system about the recipient of the message. Generally, in open warning system, the task of the system is completed as soon as the message are sent out from the system. However, in SAMBRO, the implementing organization can keep a track of recipient of the message. The first responders are sent with a link that acknowledge back to the system. In this regard, the '*Ack*' message type of the CAP can be used. This can help to effectively manage the human resources in the response activity. However, acquiring SMS gateway was a tough nut to crack; not much of significant achievement was made.
Myanmar Posts and Telecommunications (MPT) and DHM are under the same ministry, i.e. the Ministry of Transportation and Communication. However, the bureaucratic government procedures took more than 6 months for DHM to bring MPT on board to provide bulk SMS services. Another issue was that MPT had no or very less experience in providing the mobile services Application Programming Interfaces (API). A technical specification was provided to MPT, however, no progress is made since. Currently, Myanmar do not exercise the SMS service.

PAGASA was very reluctant to undergo governmental procedures to acquire services from Globe Telecom, Smart Communications, or any other service providers. In fact, during the trainings and workshops, the project had to buy the bulk SMS service package to PAGASA. Although being a messaging broker in addition to CAP message generator (PAGASA has a system to generate CAP message, but this system is not message broker), PAGASA has yet to utilize this feature. They use SAMBRO as alert hub to visualize their geocoded CAP messages.

Project communicated with Communications Authority of Maldives (CAM) to provide the bulk SMS services to NDMC. Despite months of conversation, nothing came out from CAM. However, NDMC made a smart move to bring public private partnership with local bank to provide the SMS service. This partnership required NDMC provide credit to bank.

It was also found that most first responders in Myanmar do not have an email address. Therefore, a dummy email address was used. This also meant that they are deprived of receiving the email alert. The system can be customized to make registration through username instead of email, however efforts were made to create an email address.

The mobile app which was developed as value added to the project has some limitations. The siren trigger feature heavily depends on the Google Cloud Messaging (GCM) which requires active internet connection. However, the future version will have the combination of SMS and mobile push technology for reliable feature, which is research topic under Sahana Research and Action. Similarly, android platform versions less than 4.0 are not supported as these versions has very limited feature for developers and shares less than 2% of android market[4]. IOS which share equal market as android in Maldives was developed and supported. However, NDMC has yet to fully utilize the developed mobile app.

6. CONCLUSIONS

There are early warning systems in many countries already in place. However most of them are heterogeneous and do not share protocol for machine to machine communication. Thus, users are compelled to subscribe to the social media (Facebook, Twitter, etc.) page and other RSS feeds of the different department. SAMBRO has realized this gap and fits in very well at local or national or international level.

An ideal scenario is when SAMBRO instances are placed at different departments, subscribed to each other to easily share the alerts and warnings. Similarly, a national level instance can act as a "one stop shop" for alerts and warnings, under whose umbrella all the other instances work together. This would allow the national level filtering of warnings and the impact based alerting possible.

In the three countries, SAMBRO instances are placed. This single instance currently contains multiple stakeholders. With more practice and confidence, the NWC should bring NDMOs in line with using the SAMBRO, which should then subsequently transfer the technology to the response organization. NWC instance can then act as National Level Alert Hub (i.e. one stop shop) for all kind of disaster and user can only subscribe to the NWC instead of subscribing to each of the organization. For this to happen, national level policy and strategies are required to strengthen the concept.

[4] https://developer.android.com/about/dashboards/index.html

Similarly, the authors understand the complexity and difficulties in implementing these systems and therefore look forward to utilizing this knowledge to SAMBRO to help improve the institution's responsiveness in other Nations in the future deployments.

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BIOGRAPHICAL NOTES

Mr. Biplov Bhandari is a social and humanitarian technology practitioner, working in community engagement and empowerment. He currently works as Research Associate at Asian Institute of Technology, Thailand. As a member of the Sahana Software Foundation, Biplov works in the capacity of a Software Developer. In this regard, he was instrumental to the development, implementation and evaluation of the Location-based Sahana Early Warning System in Myanmar, Maldives, and the Philippines. Other affiliations involve membership with the International Coordination Council at AstaJa Research and Development Center.
He has received several awards for his work, including the Young Author Recognition and Best Paper at ITU Kaleidoscope 2016 and the International Space Apps Challenge Kathmandu 2014. He was also fellow and speaker at the 7th International Conference of Crisis Mappers (ICCM) in Manila Philippines in 2016. He was also listed as 40 Under 40, 2017: Remarkable Geospatial Professionals by xyHt magazine.
Biplov received his B. Eng. degree in Geomatics Engineering (2014), Kathmandu University, Nepal.

Mr. Nuwan Waidyanatha is a Sahana Software Foundation Board Director and a LIRNEasia Senior Research Fellow. He has strong credentials in emergency communication systems; especially, with the development and deployment of early warning and first response systems. He recently finished leading the design, development, and implementation of the Sahana Alert and Messaging Broker in Myanmar, Maldives, and the Philippines. For over a decade, Nuwan has been conducting emergency communication related action research and pilot implementations in the Asia Pacific Region; emphasizing on low-cost technologies, communication standards, and human computer interfaces. He has served the International Telecommunication Union, and LIRNEasia, on short term assignments, evaluating national emergency communications and recommending improvements in India, Timor-Leste, and Nepal.

He applies his Mathematics, Operations Research, Computer Engineering, and Systems Theory Masters and Bachelors education in his work, along with a Social Practices touch.

CONTACTS

Mr. Biplov Bhandari
Research Associate, Asian Institute of Technology
Member and Software Developer, Sahana Software Foundation
Km. 42, Paholyothin Highway,
Klong Luang, 12120, Pathumthani, Thailand
Tel. +66949422970
Email: bionicbiplov45@gmail.com, biplov@sahanafoundation.org, biplov@ait.asia
Blog: https://biplovbhandari.wordpress.com/