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A REGIONAL ANALYSIS OF THE ROLE OF MULTI-HAZARD EARLY WARNINGS FOR COASTAL COMMUNITY RESILIENCE IN ASIA

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Abstract: Coastal hazards are one of effects of climate change across the world. The impact of climate change on coastal communities are further complicated with rising coastal population, migration to coastal areas, rapid increase of development activities in coastal areas along with weak coping capacities. Coastal communities, including Asia, face multiple coastal hazards: tsunami, coastal erosions, cyclones, flooding due to sea level rising and coastal pollution. Asia reports the highest number of coastal hazards during the last couple of decade compared to other regions. This is due to population growth, rapid urbanization and development activities, weak intuitions and weak coping strategies. Hence, leading global initiatives emphasize the role of multi-hazard early warning systems as a strategy to reduce coastal disaster risks and enhance their resilience. Nevertheless, most of available early warnings in Asia focus on single hazard. For example, Indian Ocean Tsunami Warnings and Mitigating System mainly focus on preparing for future tsunami threats in the Indian Ocean. Inadequacy of existing early warning systems to face multi hazards as well as transboundary nature of hazards and its effects promote member countries in Asia to call for a regional cooperation for multi-hazard early warning system. However, the region suffers from many challenges when building regional cooperation towards effective multi-hazard early warning system. Therefore, this paper aims to emphasize the importance of regional cooperation for effective multi-hazard early warning system and to explore the gaps in the existing system. In order to achieve the stated objectives, the study conducted a detailed literature review followed by a regional survey. Regional survey data were collected as an online survey and analysed qualitatively. The results revealed that regional cooperation helps in many ways to enhance resilience capacities among coastal communities in Asia. Nevertheless, existing regional cooperation does not deliver its expected level due to capacity gaps identified by the survey. Gaps are identified within capacity development, training and innovation in multi-hazard early warning system. This paper is a partial outcome of a project funded by the European Commission to enhance resilience capacities among coastal communities through development of regional cooperation on multi-hazard early warning system in Asia.

Keywords: Asia; Coastal hazards; Regional cooperation; Multi-hazard early warning; Capacity building

1. Introduction

Coastal hazards are one of the effects of climate change across the world (Spalding et al., 2014). Population live in low elevated coastal zones (LECZ) are estimated as 638 million in 2000 and are expected to rise from 58% to 71% until 2050 (Merkens et al., 2016). This increasing population along with migration and changes in socio-economic conditions contribute to increase coastal hazards across the globe (Seto et al., 2011, Hugo, 2011, Spalding et al., 2014). The highest absolute population growth in LECZ is expected in Asia 238 to 303 million (Merkens et al., 2016).

Asia reports the highest number of coastal hazards during the last couple of decade compared to other regions (Dutta and Basnayake, 2018). For example, recent earthquake and tsunami incident in Palu in Indonesia recorded more than 2000 deaths and are expected to rise further (CNN, 2018b); Cyclone Giri in 2010 affected more than 75% of homes in Rakhine state in Myanmar (Dutta and Basnayake, 2018); Typhoon Haiyan hit the Philippines on 8th of November 2013 resulting more than 6,300 deaths, more than 28,000 casualties and more than 16,078,000 displaced people (NDRRMC, 2013). The situations have been furthermore worsened by weak institutions and weaker coping capacities within Asian countries.

Hence, many international frameworks highlight the significance of early warning system as an effective strategy of reducing risks and enhancing resilience (Alfieri et al., 2012, UN-ESCAP, 2015b). With rapid increase of hazards with multiple types, many good practices highlighted the necessity of early warnings to cover this multi- hazard with multi-level approach (Golnaraghi, 2012). Nevertheless, most existing early warnings in Asia focus on single hazards and face many challenges. Hence, this paper aims to achieve following objectives;

- To emphasize the importance of regional cooperation for effective multi-hazard early warning system
- To explore the gaps in the existing MHEW system in Asia

The study is conducted as preliminary stage of the project CABARET (Capacity Building in Asia for Resilience Education) funded by the European Commission to enhance capacity building for resilience education in Asia.

2. Literature Review

2.1 Coastal Hazards in Asia

Sea level rise is expected in Asia due to changing climate and global temperature rises (Merkens et al., 2016). A study conducted by the World Bank identified that China and Indonesia as the most vulnerable countries to permanent inundation due to sea level rise in Asia and the Pacific region. They predicted that more than 32,000 square kilometres of China's coastal area will be at risk and more than 23 million people will be affected, if sea level rise by one meter. Whereas, one meter sea level rise in Indonesia will inundate more than 13,800 square kilometres and will affect more than 2.8 million people (World Bank, 2018).

In addition, Asia frequently reported number of tsunami and cyclone incidents over the last decade. For example, recent tsunami incident reported in Palu, Indonesia in 2018 due to 7.5 magnitude of earthquake raising more than 18 feet waves (CNN, 2018b). In 2004, Boxing Day Indian Ocean Tsunami happened in Sumatra island with an earthquake with more than 9 magnitude generating more than 30 feet waves, flooded communities in the coastal line of the Indian Ocean (McKee, 2005). Fukushima in Japan was hit by an earthquake with a magnitude of more than 9 Richter Scale creating more than 30 feet waves. This made significant damages to high impact nuclear reactors reporting more than 22,00 death tolls and missing people (CNN, 2018a).

Cyclones are another common coastal hazard occurred in Asia. For example, Typhoon Haiyan in the Philippines recorded more than 5000 deaths in 2013 (BBC, 2013). Cyclone Nargis hit Myanmar in 2008 with a death toll of more than 85,000 and more than 50,000 missing people (IFRC, 2011). There was a sharp increase of storm related deaths during 2006-2015 when compared to previous decade. For example, reported number of deaths from the Philippines was raised from 3970 to 15880; from 530 to 770 reported deaths in Taiwan. Even though India has been able to reduce the number of deaths from cyclones, there were significant cyclone incidents reported in India. For example, Cyclone Phailin in 2013 and Cyclone Hudhud in 2014 (Amarendra et al., 2015).

As stated earlier, coastal hazards are more prevalent in Asia compared to other regions in the world (Zou and Thomalla, 2008). For example, of the reported 90 storms in 2015, 43 storms hit Asia and the Pacific region with massive impact on lives and property damages (Dutta and Basnayake, 2018) with more than 64% fatalities in 2015 (UN-ESCAP, 2015a) and more than 57% of affected people by coastal hazards in Asia during 1985-2006 (Zou and Thomalla, 2008).

Table 1: Most deadly hazards in the world (1996-2015)

Hazard	Country	No of deaths	Year
Earthquakes	Haiti	222,570	January 2010
	Pakistan	73,338	October 2005
	India	20,005	January 2001
	Turkey	17,127	August 1999
	Iran	26,796	December 2003
	China	87,476	May 2008
Earthquake and tsunami	India	16,389	December 2004
	Sri Lanka	35,399	December 2004
	Indonesia	165,708	December 2004
	Japan	19,846	March 2011
Storm	Honduras	14,600	October 1998
	Myanmar	138,366	May 2008
	India	9,843	October 1999

2.2 Coastal Resilience in Asia

As stated earlier, Asia suffers with many coastal related hazards throughout the history. Hence, some level of resilience mechanisms has been introduced at national level. For example, Vietnam has introduced some community based, an integrated approach for their coastal resilience. However, there were number of challenges with their system. For example, lack of coordination and meaningful participation of community hindered the efficiency and effectiveness of such measures introduced by the Vietnam Government (Reed, 2014).

Bangladesh is another highly vulnerable country in Asia from climate change and rising sea level affecting 20% of its population who live nearby coastal areas. Hence, several proposals were introduced by experts from different disciplines proposing hard measures such a building embankment and soft measures such as diversifying livelihood opportunities, empowerment of most vulnerable communities. However, many scholars and experts suggest that all these adaptation measures are to be further improved through better awareness programmes with community participation (Minar et al., 2013).

In addition, World Meteorological Organization has developed some global operational networks for example, Tropical Cyclone Programme, Emergency Response Activities, working with Joint Radiation Management Plan working with Atomic Energy Agency to measure any movement of airborne radioactivity to deal with nuclear accidents, working with Association of South-East Asian Nations (ASEAN) towards forecasts smoke and haze information due to wildfire in Asia (Golnaraghi, 2012). Many of the resilience measures including coastal resilience focus on a single hazard, engage with limited stakeholders and focus only on national level.

2.3 Multi-Hazard Early Warning Systems

Having understood this limitation by many experts and scientific communities, the necessity of introducing multi-hazard early warning at regional level has been emphasized recently.

Before that, there were initiatives on early warning systems in the global platforms for disaster management. Early warning systems have been recognised as a life-saving tool for many hazards for example, floods, bushfire, droughts, storms and other hazards due to its ability to effective monitoring and forecasting of future hazards and hence make necessary preparedness measures (Golnaraghi, 2012).

For example, Hyogo Framework for Disaster Reduction in 2005 emphasised the role of early warning by making a historical milestone from shifting post disaster response to a disaster reduction by introducing disaster prevention and preparedness measures (Golnaraghi, 2012). Its second priority focussed on identifying, assessing and monitoring disaster risks and enhancing early warnings (UNISDR, 2005). This has been identified as an essential element in any national to local level disaster risk management strategy towards resilience society for future (Golnaraghi, 2012).

This has been furthermore emphasised by the Sendai Framework for Disaster Risk Reduction in 2015. Their seventh global target is to substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030 (UNISDR, 2015).

Sustainable Development Goals (SDGs) too acknowledge the importance of MHEW in its 13th goal to strengthen resilience and adaptive capacities to climate related hazards and disasters in all countries by

integrating climate change measures into national policies, strategies and planning (UN, 2015). Further, it highlights the necessity of enhancing human and institutional capacity on climate change mitigation, adaptation, impact reduction and MHEW (Alfieri et al., 2012). This is because of its ability to help in achieving food security, healthy lives, resilient cities, environmental management and climate change adaptation when achieving 2030 agenda for SDG (International Network for Multi-hazard Early Warning Systems, 2018).

In addition, Paris Agreement furthermore stipulates early warning systems as strategies to enhance adaptive capacity and resilience as well as reducing vulnerabilities and losses due to climate change (UNFCCC, 2015).

The First Multi-Hazard Early Warning Conference (2017) presented key elements of an End-to End, people-centred multi-hazard-early warning system with:

- Disaster risk knowledge: systematic collection and analysis of data along with hazard dynamics and vulnerabilities
- Detection, monitoring, analysis and forecasting of hazards and possible consequences: continuous monitoring of hazard parameters for issuing accurate and timely warning
- Warning dissemination and communication: use of standards and protocols when issuing warnings to target groups
- Preparedness and response capabilities: through proper educational and awareness programmes for people to inform on options for safe behaviour to reduce disaster risks (International Network for Multi-hazard Early Warning Systems, 2018):

2.3 Early Warning Systems in Asia

Even though early warning is more effective when dealing with multiple hazards in reducing its impacts on economies, there need to be further improvements in MHEW in Asia and the Pacific. Specifically, communication and response capacities have been identified as key challenges in many countries in the region (UN-ESCAP, 2015b). Furthermore, most early warning systems work in isolation from policy making process since they are considered as highly scientific initiatives (UN-ESCAP, 2015b).

Similarly, existing early warning systems in Asia mostly focus on single hazard and mostly focus on tsunami and cyclones than multi-hazard.

- establishment of Indian Ocean Tsunami Warning & Mitigation System (IOTWMS) in 2011(Thomalla and Larsen, 2010)
- setting up of 24 tsunami warning centres in the Indian Ocean, increasing the number of sea level gauges from 4 to 100 (UN-ESCAP, 2015b)
- increasing the number of deep ocean Tsunameters for data sharing from 0 to 9 (UN-ESCAP, 2015b)

are some active early warning systems in Asia.

2.4 Regional cooperation for effective Multi-Hazard Early Warning Systems in Asia

There are many challenges hinders the efficiency and effectiveness of existing early warnings in Asia (Seng, 2013). For example, communication issues, preparedness and response capacities are in high priority (UN-ESCAP, 2015b). Hence, Asia and the Pacific region demand for a regional cooperation to overcome such limitations as well as to achieve efficiency through sharing scientific knowledge & applications, sharing costs when dealing with trans-boundary hazards (UN- ESCAP, 2015).

3. Methodology

A detailed literature review was conducted to develop study's conceptual framework (Haigh et al., 2018). This is followed by a regional survey carried out among practitioners and experts in MHEW in Asia. Using an electronic questionnaire survey, data were collected. Of 199 responses, 136 questionnaires were fully completed. Questionnaire survey was consisted with closed and opened ended questions. Opened ended questions were used to identify any areas to be further developed in Asia for an effective MHEW through regional cooperation. Some questions were asked as matrix questions to reveal their preferences on given statements. They were in the forms of scale questions, ranking questions and dichotomous questions. The survey was launched during July- October 2017 as an online survey. Reliability of questions was tested using Cronbach's Alpha test. Survey data were qualitatively analysed and presented using graphs and tables.

Figure 1 presents participants' profile in terms of institutions where they represent and Figure 2 represents their years of experience. In Figure 1, other category represents people who are self-employed, or working in UNDP agency, or other international agencies, or members from scientific organizations.

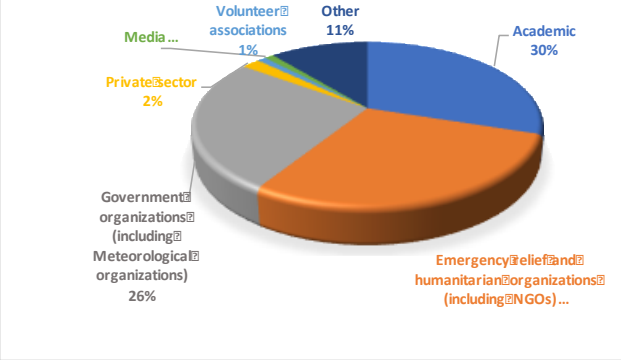

Figure 1: Sample of respondents

Figure 2: Year of experience of respondents

The above clearly shows that the selection of sample for the study is a representative sample.

4. Findings and Discussions

4.1 Importance of regional cooperation for effective MHEW in Asia

The necessity of regional cooperation has been underlined by many scholars and practitioners in disaster reduction. For example, member states of Asia and the Pacific requested the ESACAP (Economic and Social Commission for Asia and the Pacific) to provide necessary guidance on enhancing regional cooperation for effective MHEW specifically for trans-boundary and common hazards (UN-ESCAP, 2015b).

Hence, this study investigates present level of regional cooperation and its importance in the region using the survey instrument. The study found that there is some level of regional cooperation in Asia. Figure 3 presents an evaluation of existing regional cooperation towards the development of MHEW in Asia.

Accordingly, Figure 3 shows the importance of MHEW has been recognized in Asia and hence it has been prioritised among their development activities. Figure 3 further shows that, existing early warnings are not effective in reaching the most vulnerable communities in Asia. In addition, existing early warning systems are not adequate to face many types of hazards faced by Asia. The survey results also revealed that existing regional capacities are not at a satisfactory level for the development of MHEW in the region. According to survey respondents,

MHEW has not been developed to the expected level and inadequacy of regional efforts towards effective MHEW in Asia.

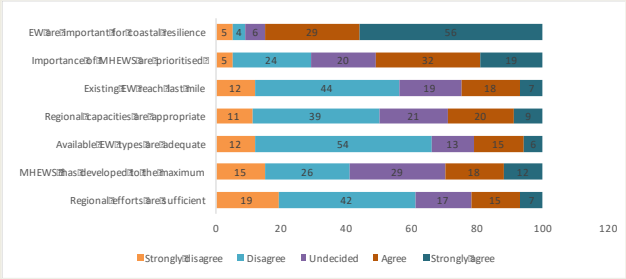

Figure 3: Evaluation of MHEW in Asia

According to Figure 4, key stakeholders are identified and partnerships are available in Asia. Nevertheless, their level of effectiveness for enhancing coastal resilience as well as regionalism approach is not at the desired level. This recall the necessity to take actions to enhance effective cooperation among key stakeholder partnerships and existing regionalism approach towards an effective system to improve MHEW in the region.

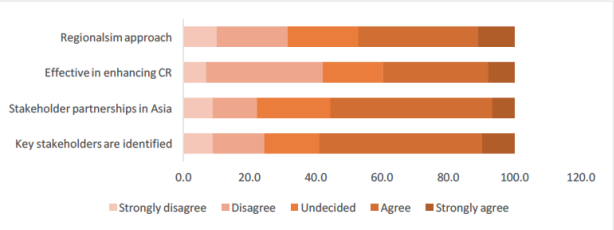

Figure 4: Evaluation of regional cooperation on MHEW in Asia

4.2 Critical needs for developing MHEW in Asia

As per the second objective of the study, questionnaire survey examined the critical needs to be further developed in Asia for enhancing effectiveness of MHEW. According to Figure 5, 82.4% confirms that training needs as the top priority in the region, followed by (78.3%) capacity development needs and (70.7%) innovation needs for the development of effective MHEW in Asia.

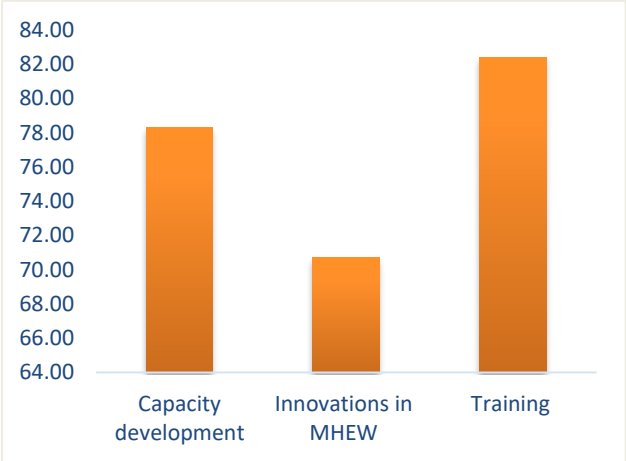

Figure 5: Critical needs for developing MHEW in Asia

In addition to capacity development needs, innovations and training needs in the region, following aspects have been proposed by respondents to an open-ended question.

1. Integration of local people as stakeholders,
2. Development of mechanisms for regional cooperation,
3. Knowledge sharing and networking,
4. Use of ICT and computer modelling,
5. Mainstreaming MHEW into development planning,
6. Availability of emergency information systems for the public,
7. Linkage between government disaster management units and universities and
8. Disaster education and awareness building.

4.3 Availability of policies

One of the main criticism for effective operation of MHEW is the division science and policy (UN- ESCAP, 2015). Supportive policy and legislative background are vital elements for successful risk reduction and resilience strategies. Hence, the survey examined the availability of policies on MHEW in Asia. According to survey results, 71% agrees that there are related policies, legislations, guidelines and plans for improving MHEW for coastal resilience in Asia. Further examination on their

effectiveness, the level of implementation and level of success is having significant gaps as shown in Figure 6.

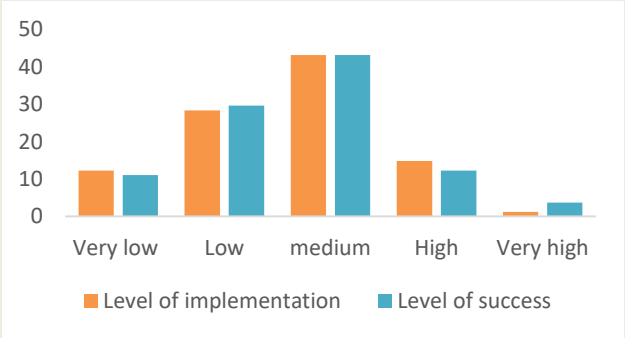

Figure 6: Evaluation of existing policy implementation and its success in Asia

Figure 6 clearly indicates that level of implementation of existing policies, legislations, guidelines and plans for MHEW in the region is not operating at the expected level. Similarly, its level of success is not at the expected level in Asia.

5. Conclusions

Coastal hazards are much prevalent in Asia when compared to other regions. Hence, the importance of MHEW has been identified never as before to strengthen resilience among coastal communities. The Sendai Framework for Disaster Risk Reduction, Paris agreement and Sustainable Development Goals emphasize the necessity of effective regional cooperation within MHEW. Regional cooperation has shown benefits via sharing information, technology and overcoming duplication of resources and nature of transboundary disaster impacts.

Hence, Asia has started some level of regional cooperation in terms of policies and procedures. The study found that there are policies, legislations, guidelines and plans are available in Asia for regional cooperation towards effective MHEW. However, there are many gaps during their implementation and success.

Training needs, capacity development needs and innovation needs have been identified by the survey results as the critical areas for further development of existing MHEW in Asia.

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