Integrated framework for early warning system in UAE

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Abstract

Purpose - The impacts and costs of natural disasters on people, properties and environment is often severe when they occur on a large scale and with no warning system in place. The lack of deployment of early warning system, low risk and hazard knowledge and impact of natural hazard experienced in some communities in the UAE have emphasised the need for more effective early warning systems. This work focuses on developing an integrated framework for early warning systems for communities prone to the impact of natural hazards, in order to reduce their vulnerability and improve emergency management arrangements in the UAE.

Approach - The essential elements of effective Early Warning System (EWS) were identified through literature review to develop an integrated framework for EWS. Semi-structured interviews and questionnaires were also used to identify and confirm hindering factors to deployment of effective early warning systems in Abu Dhabi and Fujairah Emirates, while areas that require further development were also identified through this means.

Findings and value - The outcome of this research revealed that the warning for natural hazards in the UAE lacked the required elements for effective early warning system, while the elements which are present are insufficient to mitigate the impacts of natural hazards. The information in this work emphasises the need to improve two elements, and to develop the other two essential elements of early warning system in the UAE.

Keywords: Community, Early Warning System (EWS), Emergency management, Natural hazards, UAE

1. Introduction

The unprecedented occurrence of natural hazards in the Gulf region and some countries in the Middle East have emphasised the devastating impact of climate change, globalisation and rapid urbanisation (Abe and Thangavelu, 2012). The impact of all these factors have been particularly evident in Asia and the Pacific region, where the occurrence of disasters have continued to increase despite various interventions from international organisations

(UNESCO, 2013). According to the report by UNESCO, there were significant increase in the occurrence of disasters in this region between 2000 and 2010 which caused wide spread disruption to source of livelihood, internal displacement and other intangible impacts. The tally of natural hazards in this region surpasses that of Africa, Northern America and Europe (Xu et al., 2014). While little can be done to prevent the occurrence of these events, Momani and Fadil, (2011) argued that their impact can be mitigated through effective preparedness measures. The investigation carried out by Momani and Fadil., (2011) using the case study of response to flood disaster in Jeddah city in 2009, emphasised the importance of having good Early Warning System (EWS) to informthe population in a timely manner.

EWS within this context, entails a combination of informing and educating the public of the imminent danger and impacts of natural hazards (CCA, 2004). Although, history account in the Middle East indicate that flooding events are uncommon in many countries, the occurrence of natural hazards in recent years have shown their occurrence in more frequencies. This increase emphasises the need for better preparedness, with a focus on effective EWS as well as an enhanced emergency management system. For example, the disaster in Jeddah left the population without water, electricity, food, and telecommunications, which further caused challenges for recovery activities, and restoration of source or livelihood in the affected community and for the people (Albreiki, 2013). While the experience in Jeddah serves as a rather remote lesson for the United Arab Emirates (UAE) to learn from, recent occurrence of natural hazards in Jordan, Oman and even in the UAE have exposed the gaps in the emergency management system in the country.

Existing literatures and researches in emergency management have identified that individuals and communities are susceptible to impacts of natural hazards when not adequately prepared or warned (Wisner, 2011). However, views vary on what should be the focus of attention; mitigation or disaster risk reduction; preparedness and response (McEntire and Myers, 2004), Dhanhani et al. (2010) states that the concerns about hazards and safety can preoccupy people to the extent that fear overwhelm them to inaction. Although Alexander (2002) linked such inaction to lack of public education, awareness and information, Sqrensen, Vedeld and Haug (2006) argued that the negative impacts of hazards should be a strong basis for embarking on and investing in effective EWS. Some of the negative impacts include, but not limited to impacts of social, economy, health, livelihood and environment (Sqrensen et al., 2006; Coppola, 2011). The potential impacts of natural hazards on development and productivity of

a country especially in the UAE has motivated a central aim for engaging all stakeholders to commit to effective implementation of EWS in the country as well as in the Gulf region.

1.1.Context of Natural Hazards in the UAE

The UAE is a popular country in the Gulf region for trade activities and its crucial location for import and export to the region. The country is also known for its peculiar tourism activities and world class architectures. Unknown to many, UAE have also been experiencing her fair share of severe natural hazards some of which include the Al Qurayah flood of 1995, the Masafi earthquake of 2002, the Al Tawaian landslide of 2005 (Abdulla, 2013), the Tropical Gonu storm of 2007 and the Sharm flood in 2009 (Dhanhani et al., 2010). For instance, intense tropical cyclones like Gonu over the Arabian Sea caused 78 fatalities, 37 missing people and a major costs of $4.4 billion (USD) spreading over Iran, Pakistan, Oman and UAE (UP International, 2007). Although some emirates in the country are more susceptible to the impacts of natural hazards than others, the emirates of Abu Dhabi which is also the capital city and Fujairah, are two of the seven emirates prone to the impacts of natural hazards (Dhanhani et al, 2010). Abu Dhabi is located with minimal proximity to Gulf of Oman and the Gulf; a location which exposes the emirate to lots of cyclones and other natural hazards during the year. The city have also experienced the impacts of some earthquakes and tremors in the past (Dhanhani et al, 2010).

The location of Abu Dhabi and a community such as Ruwais at the edge of the Gulf, exposes communities in the emirates to the cascading effects impact of climate change and rapid urbanisation. For example, the storm that hit Ruwais on 21st and 22nd November 2013 was one of the largest and most dangerous storms that have occurred in Abu Dhabi over the past years (Abu Dhabi Police reports, 2013). Nearly all streets were blocked by uprooted or displaced trees and items and the high water level made the main entrance to Ruwais and other parts of the emirates difficulty to navigate.

While the level of disruption caused by the natural hazard show the severity of the incident, the number of incidents relating to the hazard indicate the lack of EWS. Leading to this period, the impact of cyclone Phet in Fujairah emirates in 2010 should have served as a learning curve for the UAE to improve warning systems. The cyclone which hit Fujairah early morning of 4th June 2010 was the worst cyclone recorded in the country and the second strongest tropical cyclone ever recorded in the Arabian Gulf (Haggag and Badry, 2012). The

cyclone's heavy rainfall triggered flash floods causing enormous damage to the infrastructure.

Cyclone Phet also caused wide spread damage as people lost their land, their crops and their boats. The high waves of the Indian Ocean caused flooding in Fujairah emirates causing damage to about 30 houses, 2 mosques and 10 farms, and more than 10 cars were damaged (Dhanhani et al., 2010). Similar to factors which contributed to the disruption and damage in Abu Dhabi emirate, the proximity of Fujairah was the principal factor which increased the vulnerability of the emirate to the severe impact of the natural hazard. However, the impact of the cyclone in Fujairah could have been mitigated with good EWS, better preparedness measures and more effective response to the landfall of the cyclone.

According to Haggag and Badry (2012), the lack of coordination between emergency agencies for response was covert, but the lack of EWS for warning community leading to the landfall of the disaster was evident. These two case studies in the emirates of Abu Dhabi and Fujairah provide the context for the limited community awareness of hazard risks in the UAE as well as the lack of EWS deployment for natural hazards. The tangible economic, social and environmental impacts these problems present to the rapidly developing environment in the UAE has stirred major concern for the sustainability of the same should the impact of natural hazards persist. Thus, the aim of this work which is to develop an integrated framework for early warning systems for communities prone to the impact of natural hazards, in order to reduce their vulnerability and improve emergency management arrangements in the UAE.

2. Elements and Models of EWS

EWS can be described as the process for generating accurate information about possible or imminent harm in order to alert, warn and educate people who are at risk of harm or/and danger (Glantz, 2004). Within this context, EWS refers to an integrated set of elements that interact before the crisis starts, with the main goal of achieving risk reduction (Londoño, 2011). Grasso (2007) states that the importance of EWS is its appropriate use to set up measures which can enable the community at risk to avoid or reduce the impacts of hazards such as storms, cyclones, fires, floods, to mention a few. The United Nations (UN) in 2006 outlined by four interrelated elements; risk knowledge, monitoring and warning, warning

dissemination and communication, and response capability as essential for effective EWS as shown in (Fig. 1).

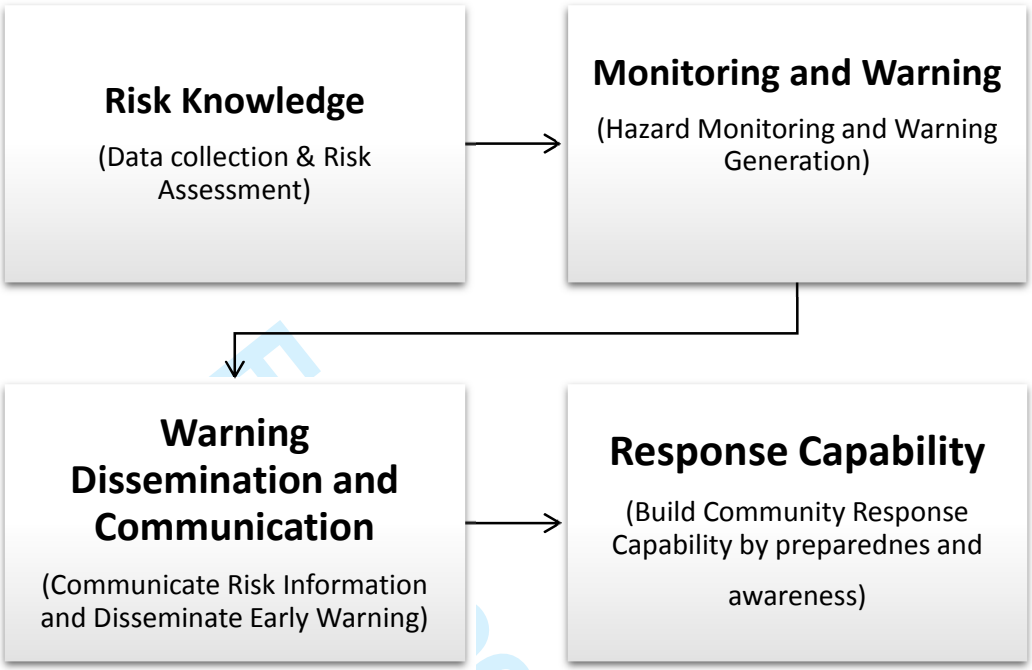

Fig. 1. Four elements for effective EWS (Adapted from UN, 2006)

This model shows that risk knowledge is important for monitoring and warning as well as warning dissemination and communication. Although these four elements have specific components, they are also interrelated elements as shown by the flow of arrows. However, Wiltshire (2006) argued that for EWS to be effective, it must include the active involvement of communities at risk, stressing the importance of community engagement for EWS.

Grasso (2007) emphasise the significance of EWS from this approach as a constant process of engagement, reviewing, creating risk awareness of hazard and monitoring of risk. This is because risk knowledge influences risk assessment which informs response capability and risk reduction measures required for mitigating the risk impacts on communities at risk (Haddow, et al. 2011). Therefore EWS which contains these essential elements are able to reduce the loss of life and economic losses through participation of community at risk (WMO, 2013).

Effective alignment of the four elements for effective EWS (Fig.3) can significantly mitigate the impact of natural hazards on community risk, however, its lack of provision for "how" the elements help to improve risk perception suggest a flaw in the UN model. The importance of

risk perception, and identification have been emphasized by Regester and Larkin (2008) as vital for ensuring effective risk mitigation, reduction and management. The lack of reference to risk perception especially in many communities prone to natural hazards indicate the gaps in existing models and theories of EWS. Many communities have norms, cultures and perception about what is considered risk or dangerous (Villangran de Leon, 2012). Perhaps this premise informed the inclusion of stakeholders and multiple linkages in the integrated model proffered by Basher (2006). According to him, stakeholders often go unrecognised as being part of the system or community at risk. As such communities and all actors including political, social, economic, institutional actors are all stakeholders both Basher (2006) and Villangran de Leon (2012) considered as important in the development and deployment of effective EWS

In addition, communities are also influenced by mitigation, education, preparedness, knowledge of hazard, prediction, system model and monitoring of risks or hazards. All these in reality determine their response behaviors when warning is issued for imminent danger, and response behaviors ultimately influence the commitments of institutions and mechanisms (Basher, 2006). EWS is a mitigation and preparedness system which is heavily reliant on communication methods and process (Villangran de Leon, 2012). But warning during critical situation can be problematic due to the impact and interruption caused by the disasters and especially in many developing countries where infrastructures are fragile (Glantz, 2004).

Therefore, overreliance on one method for communicating warning, without corresponding information to educate community can be limited and ineffective. Despite the advance in technology for disseminating warning messages, the lack of understanding, limited risk knowledge and lack of education on how to react to warning signals remain some of the biggest shortcomings of most EWS (UN, 2006; WMO, 2006). Therefore, the chain of information as well as the methods and modality for disseminating warning message make communication models or theory essential for effective EWS.

According to Coombs (2007) there are crisis communication theories and strategies which guide and help to explain how pre, during and post crisis situation can be communicated to and between all stakeholders. Coombs recommendation Situational Crisis Communication Theory (SCCT) for crisis management have been crucial in evaluating crisis type, history and relationship of crisis impacts to determine how crisis is communicated. SCCT is used to understand how stakeholders will respond to the crisis, and in turn the information is used to

communicate pre and during crisis risk or danger to stakeholders. Although SCCT has its roots in organizational crisis, the guidelines used in SCCT crisis response strategy are considered as one of the most suitable for communicating risks and crisis (Coombs, 2007). This is because Coombs classified crisis into types based on level of required responsibilities between stakeholders and victims. By so doing, SCCT clarifies expectation and responsibilities for disseminating EWS.

Communication theory such as this, shows that communication pre, during and post crisis is a shared responsibility between the victims and the organisation responsible for safety (Coombs, 2007). The systematic view this communication theory presents indicate that different messages can be created by individuals through personal subjective interpretation from which they draw conclusions (Villangran de Leon, 2012). While this possibility emphasises the need for clear, informative and educative risk communication about imminent dangers of hazards (Paton, 2008), it also emphasise the importance of ensuring that preventable hazards and risks are effectively communicated (Fearn-Banks, 2007).

Furthermore, technology EWS like, 'last mile' have potential to provide guidance that strengthens community understanding and link their participation to implementation of EWS (Thomalla et al. 2009). 'Last mile' is a phrase used for describing a portion of telecommunications network chain that reaches end-user and enable them to access information being transmitted through communication mechanisms (Thomalla et al. 2009). However, it is likely that end-users (community) are unaware of how to maximise mechanisms (telephone exchange, cell phones) for early warning to mitigate the impacts of natural hazards in their community. As such, having series of planning meetings that involve different stakeholders who are actively engaged in EWS and community activities that strengthen linkages with implementation of EWS is crucial for enhancing communication (Thomalla and Larsen, 2008).

According to Londoño (2011), EWS that focuses on community engagement should adopt a holistic strategy that utilises the multi-hazard approach based on preparedness, emergency response and recovery and rehabilitation. Preparedness within the preparedness phase that involves community establish Information Communication Technology (ICT) infrastructure that integrate ICT with EWS (Zavazava, 2008). The multi-hazard approach ensures that EWS preparedness for response to incidents that may occur consists of arrangement that utilises the most appropriate technology or communication mechanism that enable community to take

necessary safety actions (Villangran de Leon, 2012). Although 'last mile' approach are only effective when vulnerability of telecommunication networks are reduced (Thomalla et al. 2009), Zavazava (2008) argued that vulnerability of ICT are better done during recovery and rehabilitation phase, but in consultation with community.

Therefore, communication method and medium for disseminating preventive hazards, effective EWS and for ensuring response strategies ought to be carefully determined in consultation with community at risk to determine their 'fit for use' (Zavazava, 2008). Communication for effective EWS can follow the public communication timeline recommended by the CCA (2004) for ensuring better public awareness, education, public warning, informing and advising the public of imminent risks. However, the effectiveness of such timeline as well as elements of EWS examined in this section are used to evaluate the current deployment and elements of EWS in the UAE.

3. Materials and Methods

Data were collected through secondary and primary data to provide an objective comparative parameters for determining the context of EWS in the UAE. Since emergency management in the UAE is at its infantry with limited literatures and zero academic literature on EWS, second data on EWS from a global context was necessary.

3.1.Secondary Data

Data were collected from literature review of EWS and practice context for EWS and public education model for emergency preparedness process used in the United Kingdom. The Civil Contingency Act (2004) was an important document to examine, especially the chapter on emergency preparedness and EWS, since the UAE adopted the CCA as a working guide for developing the national response plan. Information relating to natural hazards were derived from Abu Dhabi Police reports due to limited literatures or publications on past incidents in the UAE. Specific reports on 2013 storms and floods in the capital city were reviewed to identify gaps and potential areas for improving EWS in the UAE as a whole. The report from ADP also provided useful information about organisations to recruit as participants for primary data collection in Abu Dhabi and Fujairah.

3.2.Primary Data

Primary data were collected through qualitative and quantitative methods in the UAE. The qualitative data which focused on investigating the existing deployment of EWS in the UAE

involved series of semi-structured interview sessions with organisations and agencies involved in emergency preparedness and response in Abu Dhabi and Fujairah Emirates. A total of eight people were interviewed in Abu Dhabi, while total of four people were interviewed in Fujairah being a smaller emirates. Table 1 shows the description of interviewees and organisations recruited for the research.

Table 1. Demography of interviewees

Emirates	Description of Interviewees/agencies
Abu Dhabi	1. National Crisis, Emergency and Disasters Management Authority (NCEMA) 2. Abu Dhabi Civil Defence 3. Ministry of Education 4. Ministry of environment and water 5. National Media council 6. Abu Dhabi City Municipality 7. Water and Electricity Authority (ADWEA) 8. National Centre of Meteorology and Seismology (NCMS)
Fujairah	1. Fujairah Civil Defence 2. Fujairah Municipality 3. Federal Electricity and Water Authority 4. Ministry of Education

The interviewees were asked a total of eleven questions during the interview session which lasted between 45 to 90 minutes depending on the level of engagement.

The questionnaire survey focused on determining the level of risk knowledge, perception and expectations of communities at risk of natural hazards in the two emirates. A random sampling technique explained by (Kothari, 2008) was used to determine participants in the two emirates, while questionnaires were distributed randomly to members of the public who were living, working and conducting business activities close to the affected areas in the two emirates. Through this method, a total of 1,080 people within the two emirates completed the questionnaire, which is a sample size calculated using confidence level similar to the method used by (Gautam and Shivakoti, 2001). Table 2 shows the sample distribution and demographics of participants.

Table 2. Sample size and demographics of questionnaire participants

Emirate	Population	%	Sample Size	Male	Female
Abu Dhabi	404,546	83.3	845	435	410
Fujairah	80,900	17.7	235	110	125
Total	**485,446**	**100.0**	**1,080**	**545**	**535**

The questionnaire was designed to have 25 questions grouped into four main sections based on four interrelated elements or themes for effective EWS. Due to vast numbers of foreigners in the UAE especially Abu Dhabi, the questionnaires was designed in both English and Arabic were collected after 5 days of drop-off at homes, business offices, commercial centres such as malls, stations, community centres, schools and staffs of hotels and other public ministries and organisations.

3.3.Data Analysis

The interview data were analysed using content analysis which is a technique that allows valid inferences to be drawn from text data in order to provide objective context for their interpretation (Krippendorff, 2004). All qualitative data collected for the purpose of this work, including the text data from the questionnaire were analysed using the steps recommended by Leedy and Ormrod (2001). These included data categorisation in to meaningful themes, interpretation of each theme, identification of patterns and design, and generalisation to determine implication of themes as presented and discussed in Sections 4 and 5 respectively. Nvivo 10 software was also used to code, edit, classify and manage themes required for effective EWS.

Quantitative data analysis was carried out using SPSS to perform descriptive and inferential statistics (Sawalha, 2011). By using SPSS software version 16, the important data from community at risk were generated to determine the level of risk knowledge, effectiveness of EWS communication and warning as well as expectations for the deployment of EWS in the UAE. Through this process data were generated which contributed to developing the framework for effective EWS for mitigating the impacts of natural hazards in the UAE.

4. Results and Discussion

In Abu Dhabi and Fujairah emirates, a broad range of people in the communities were recruited to participate in the research. But the interview participants were strictly participants from emergency agencies with responsibilities and roles for public safety.

4.1.Risk Knowledge

The results from the two emirates show that there was minimal knowledge of risks of natural hazards. Roles and responsibilities of emergency agencies and other government sectors responsible for public safety were clear, but experts and defined organisation who understood EWS and deployment the same were lacking in the two emirates. Data from the series of interviews conducted in the two emirates shows that there is no department, organisation or people responsible for EWS before or during any imminent natural hazard. There is also no model, system or defined warning platform for natural hazards in the UAE. However, the questionnaire results show that the risk knowledge in the community vary, but low even though it covers a whole range of natural hazards in the two emirates. The questionnaire results also reveal that communities consider earthquakes as the scariest and concerning natural hazard for them.

4.2. Monitoring and Warning

Interview results reveal that, while there is minimal support for some organisations to monitor and issue warning for natural hazards, the national meteorological unit is the only one responsible for monitoring and issuing warning to emergency organisations. Although warning is also issued to the public through the media, it only takes the form of weather update and not information for mitigating impacts of hazards. The questionnaire confirmed the frequency of weather forecast usage by the community. However, none of the results showed any form of engagement with community at risk for public education, informing and to warn about identified risks of natural hazard. There is also no result which shows that the organisations interviewed or the community know of any specific EWS in the two emirates.

4.3.Warning dissemination and Communication

In terms of warning dissemination and communication, the results from the interview all echoed that all organisations responsible for public safety receive warning messages and communicate between themselves. However, only one organisation who is responsible for disseminating warning message to the public, claim that they are only responsible for issuing warning on fire, accidents and other man-made hazards and not natural hazards.

Questionnaire result reveal that, while 27.5% of community have received warning messages, they have done so via the media. The remaining 72.5% said they have never received warning message prior to or during any natural hazard before.

4.4.Response Capability

The result for this theme reveal that emergency organisations have regular exercise, to test their response procedures, carry out evacuation procedure for rescue. However, no result shows that these exercise or evacuation procedures involve the participation of community at risk. Questionnaires showed that 48.3% of the total participants from the two emirates are aware of the preparedness exercise and meetings held by emergency agencies and would like to participate in future exercise or procedures.

4.5. Discussion

The pattern of results generated in this research shows major gaps in the EWS used in the two emirates. It also reveal the specific areas where there are problems, limitations and void of best practice especially with implementation of EWS. This result has revealed the reasons for the context and impacts of natural hazards provided in section 1. Impacts of natural hazards have continuously been severe in the two emirates because there is no organisation actually responsible for disseminating warning messages, informing or educating the public on the risks of natural hazards their community is vulnerable to.

While the interview results on risk knowledge reveal the lack of expertise and understanding of EWS in the two emirates as the primary reason for this, the entire results also reveal that any preparedness activities fail to involve the community at risk. The practice of EWS in the UAE and response lacks the four interrelated elements of EWS examined in existing literatures in the field. A structured process exists for communicating warning between organisations, but the communication is not passed onto the community at risk. Such communication suggest horizontal communication without a top-down, vertical communication, revealing a limited communication process for disseminating warning messages (Fearn-Banks, 2007).

The results shows that there is no effective EWS in the UAE especially in the two emirates examined in this research. In addition, using the model proffered by the UN, by Basher (2006) and Coombs (2007) SCCT to critically examine the current practice for EWS in the UAE have proved instrumental in identifying areas which require development and the ones which require improvement.

Despite the lapses in deployment of EWS, the established responsibilities and horizontal communication between agencies and organisations responsible for public safety can be used to further improve the practice of and the development of effective EWS based on the four interrelated elements of EWS. Developing an effective EWS is possible in the UAE, since the questionnaire results indicate the willingness of communities at risk to be involved in future preparedness activities in their respective emirates. Such positive indication can be resourcefully used for engaging community at risk for preparedness and risk reduction activities (McEntire and Myers, 2004). This indication also suggest that, needs and situation assessment might be required in the two emirates in order to determine the most effective approach for engagement given the wide range of diversity of occupation, religion and nationalities in the country especially in Abu Dhabi.

5. Recommendations

Two main recommendations have emerged from this results in order to mitigate and reduce the impacts of imminent natural hazards in the two emirates. These are; (1) Development of an effective EWS using the four interrelated elements and (2) Improvement of preparedness activities for EWS. The development of an effective EWS which includes community at risk must imbibe all the issues identified through the investigation of this research in order to ensure that risk knowledge is improved, while monitoring and warning, dissemination and communication and response capability are all developed in equal capacity.

The four interrelated elements for effective EWS are essential to improving and developing all preparedness activities including the involvement of community at risk for EWS deployment in the UAE. According to Paton (2008), dissemination and communication can be more effective by understanding the community and ensuring that warning message and warning dissemination mechanism are vertical, horizontal and clearly define actions to be taken by the community.

The continued occurrence and the potential impact of climate change in the Gulf region also means that response capability needs to be strengthened through regular training based on risk assessment and integration of risk information. In a developing country such as the UAE, a feedback mechanism will be crucial to ensure that level of improvement necessary for effective EWS takes place. The four interrelated elements for effective EWS have been used

to develop the framework which entails other associated components necessary for effective EWS in the UAE as shown in Fig. 2.

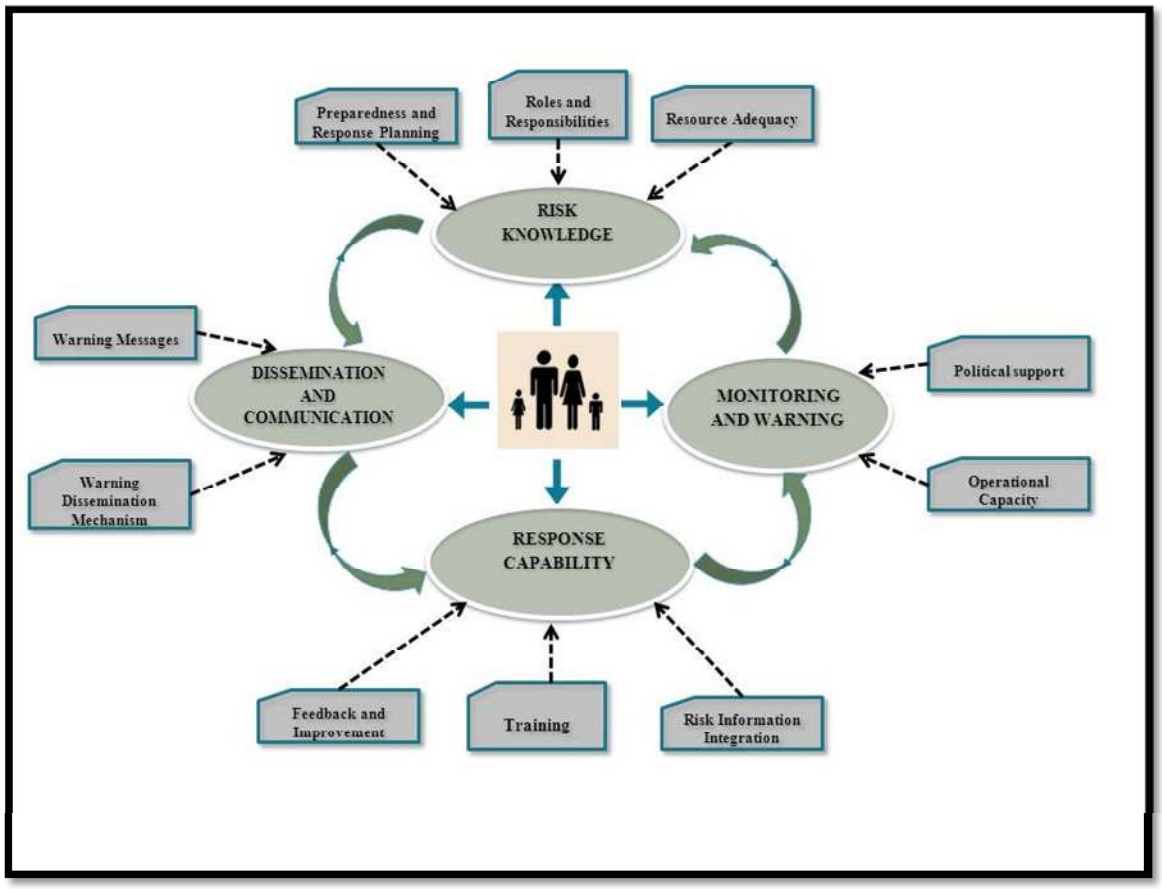

Fig. 2. Framework for effective EWS in the UAE

This framework for developing and improving the EWS in the UAE shows various associated components and activities which can potentially attract the involvement of communities at risk as well as other necessary stakeholders in the UAE. The framework is targeted at stakeholders such as emergency service organisations in the UAE (Police, Civil Defence, NCEMA), non-governmental organisations such as the Red Crescent, SANID volunteer organisation to mention a few. Ensuring that all these stakeholders understand their roles and responsibilities for risk knowledge, monitoring and warning, response capability, and dissemination and communication as identified in this research is crucial to the effective implementation of the EWS framework. It also given that by establishing an effective EWS which involve communities at risk in Abu Dhabi, all the other six emirates will benefit from such reform since Abu Dhabi is the capital of the UAE.

6. Conclusion

The scale of natural hazards when they occur still remains unpredictable, which at times influence the level of impacts they have on affected community (Selby, 2012). While the occurrence of natural hazards know no boundaries, global efforts in emergency and disaster management have identified good and timely early warning system as crucial in mitigating the impact of natural hazards. This work have identified elements of effective EWS and used them to critically examine the existing practice of EWS in the UAE for mitigating the impacts of natural hazards. Using the case study of two emirates; Abu Dhabi and Fujairah as communities most prone to the occurrence of natural hazards in the country, it was discovered that the practice of EWS in the country lacks the essential elements in an interrelated manner. The elements of effective EWS provided by the UN and Basher (2006) were instrumental in developing a framework to facilitate effective EWS which involves communities at risk. By so doing, it is envisaged that the level of vulnerability of these communities, and impact of natural hazards in UAE as a whole will be reduced, while also improving the emergency management practice in the UAE.

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Integrated framework for Early Warning System in UAE

Abstract

Purpose - The impacts and costs of natural disasters on people, properties and environment is often severe when they occur on a large scale and with no warning system in place. The lack of deployment of early warning system, low risk and hazard knowledge and impact of natural hazard experienced in some communities in the UAE have emphasised the need for more effective early warning systems. This work focuses on developing an integrated framework for early warning systems for communities prone to the impact of natural hazards, in order to reduce their vulnerability and improve emergency management arrangements in the UAE.

Approach - The essential elements of effective Early Warning System (EWS) were identified through literature review to develop an integrated framework for EWS. Semi-structured interviews and questionnaires were also used to identify and confirm hindering factors to deployment of effective early warning systems in Abu Dhabi and Fujairah Emirates, while areas that require further development were also identified through this means.

Findings and value - The outcome of this research revealed that the warning for natural hazards in the UAE lacked the required elements for effective early warning system, while the elements which are present are insufficient to mitigate the impacts of natural hazards. The information in this work emphasises the need to improve two elements, and to develop the other two essential elements of early warning system in the UAE.

Keywords: Community, Early Warning System (EWS), Emergency management, Natural hazards, UAE

1. Introduction

The unprecedented occurrence of natural hazards in the Gulf region and some countries in the Middle East have emphasised the devastating impact of climate change, globalisation and rapid urbanisation (Abe and Thangavelu, 2012). The impact of all these factors have been particularly evident in Asia and the Pacific region, where the occurrence of disasters have

continued to increase despite various interventions from international organisations (UNESCO, 2013). According to the report by UNESCO, there were significant increase in the occurrence of disasters in this region between 2000 and 2010 which caused wide spread disruption to source of livelihood, internal displacement and other intangible impacts. The tally of natural hazards in this region surpasses that of Africa, Northern America and Europe (Xu et al., 2014). While little can be done to prevent the occurrence of these events, Momani and Fadil, (2011) argued that their impact can be mitigated through effective preparedness measures. The investigation carried out by Momani and Fadil., (2011) using the case study of response to flood disaster in Jeddah city in 2009, emphasised the importance of having good Early Warning System (EWS) to informthe population in a timely manner.

EWS within this context, entails a combination of informing and educating the public of the imminent danger and impacts of natural hazards (CCA, 2004). Although, history account in the Middle East indicate that flooding events are uncommon in many countries, the occurrence of natural hazards in recent years have shown their occurrence in more frequencies. This increase emphasises the need for better preparedness, with a focus on effective EWS as well as an enhanced emergency management system. For example, the disaster in Jeddah left the population without water, electricity, food, and telecommunications, which further caused challenges for recovery activities, and restoration of source or livelihood in the affected community and for the people (Albreiki, 2013). While the experience in Jeddah serves as a rather remote lesson for the United Arab Emirates (UAE) to learn from, recent occurrence of natural hazards in Jordan, Oman and even in the UAE have exposed the gaps in the emergency management system in the country.

Existing literatures and researches in emergency management have identified that individuals and communities are susceptible to impacts of natural hazards when not adequately prepared or warned (Wisner, 2011). However, views vary on what should be the focus of attention; mitigation or disaster risk reduction; preparedness and response (McEntire and Myers, 2004), Dhanhani et al. (2010) states that the concerns about hazards and safety can preoccupy people to the extent that fear overwhelm them to inaction. Although Alexander (2002) linked such inaction to lack of public education, awareness and information, Sqrensen, Vedeld and Haug (2006) argued that the negative impacts of hazards should be a strong basis for embarking on and investing in effective EWS. Some of the negative impacts include, but not limited to impacts of social, economy, health, livelihood and environment (Sqrensen et al., 2006; Coppola, 2011). The potential impacts of natural hazards on development and productivity of

a country especially in the UAE has motivated a central aim for engaging all stakeholders to commit to effective implementation of EWS in the country as well as in the Gulf region.

1.1.Context of Natural Hazards in the UAE

The UAE is a popular country in the Gulf region for trade activities and its crucial location for import and export to the region. The country is also known for its peculiar tourism activities and world class architectures. Unknown to many, UAE have also been experiencing her fair share of severe natural hazards some of which include the Al Qurayah flood of 1995, the Masafi earthquake of 2002, the Al Tawaian landslide of 2005 (Abdulla, 2013), the Tropical Gonu storm of 2007 and the Sharm flood in 2009 (Dhanhani et al., 2010). For instance, intense tropical cyclones like Gonu over the Arabian Sea caused 78 fatalities, 37 missing people and a major costs of $4.4 billion (USD) spreading over Iran, Pakistan, Oman and UAE (UP International, 2007). Although some emirates in the country are more susceptible to the impacts of natural hazards than others, the emirates of Abu Dhabi which is also the capital city and Fujairah, are two of the seven emirates prone to the impacts of natural hazards (Dhanhani et al, 2010). Abu Dhabi is located with minimal proximity to Gulf of Oman and the Gulf; a location which exposes the emirate to lots of cyclones and other natural hazards during the year. The city have also experienced the impacts of some earthquakes and tremors in the past (Dhanhani et al, 2010).

The location of Abu Dhabi and a community such as Ruwais at the edge of the Gulf, exposes communities in the emirates to the cascading effects impact of climate change and rapid urbanisation. For example, the storm that hit Ruwais on 21st and 22nd November 2013 was one of the largest and most dangerous storms that have occurred in Abu Dhabi over the past years (Abu Dhabi Police reports, 2013). Nearly all streets were blocked by uprooted or displaced trees and items and the high water level made the main entrance to Ruwais and other parts of the emirates difficulty to navigate (Fig. 1).

Fig.1: Disruption caused by the storm in Ruwais (Abu Dhabi Police reports, 2013)

While these pictures show the level of disruption caused by the natural hazard, the number of incidents relating to the hazard indicate the lack of EWS. Leading to this period, the impact of cyclone Phet in Fujairah emirates in 2010 should have served as a learning curve for the UAE to improve warning systems. The cyclone which hit Fujairah early morning of 4th June 2010 was the worst cyclone recorded in the country and the second strongest tropical cyclone ever recorded in the Arabian Gulf (Haggag and Badry, 2012). The cyclone's heavy rainfall triggered flash floods causing enormous damage to the infrastructure (Fig. 2).

Fig. 2. Impact of cyclone Phet in Fujairah caused considerable material damage (Haggag and Badry, 2012)

Cyclone Phet also caused wide spread damage as people lost their land, their crops and their boats. The high waves of the Indian Ocean caused flooding in Fujairah emirates causing damage to about 30 houses, 2 mosques and 10 farms, and more than 10 cars were damaged (Dhanhani et al., 2010). Similar to factors which contributed to the disruption and damage in Abu Dhabi emirate, the proximity of Fujairah was the principal factor which increased the vulnerability of the emirate to the severe impact of the natural hazard. However, the impact of the cyclone in Fujairah could have been mitigated with good EWS, better preparedness measures and more effective response to the landfall of the cyclone.

According to Haggag and Badry (2012), the lack of coordination between emergency agencies for response was covert, but the lack of EWS for warning community leading to the landfall of the disaster was evident. These two case studies in the emirates of Abu Dhabi and Fujairah provide the context for the limited community awareness of hazard risks in the UAE as well as the lack of EWS deployment for natural hazards. The tangible economic, social and environmental impacts these problems present to the rapidly developing environment in the UAE has stirred major concern for the sustainability of the same should the impact of natural hazards persist. Thus, the aim of this work which is to develop an integrated framework for early warning systems for communities prone to the impact of natural hazards, in order to reduce their vulnerability and improve emergency management arrangements in the UAE.

2. Elements and Models of EWS

EWS can be described as the process for generating accurate information about possible or imminent harm in order to alert, warn and educate people who are at risk of harm or/and danger (Glantz, 2004). Within this context, EWS refers to an integrated set of elements that interact before the crisis starts, with the main goal of achieving risk reduction (Londoño, 2011). Grasso (2007) states that the importance of EWS is its appropriate use to set up measures which can enable the community at risk to avoid or reduce the impacts of hazards such as storms, cyclones, fires, floods, to mention a few. The United Nations (UN) in 2006 outlined by four interrelated elements; risk knowledge, monitoring and warning, warning dissemination and communication, and response capability as essential for effective EWS as shown in (Fig. 3).

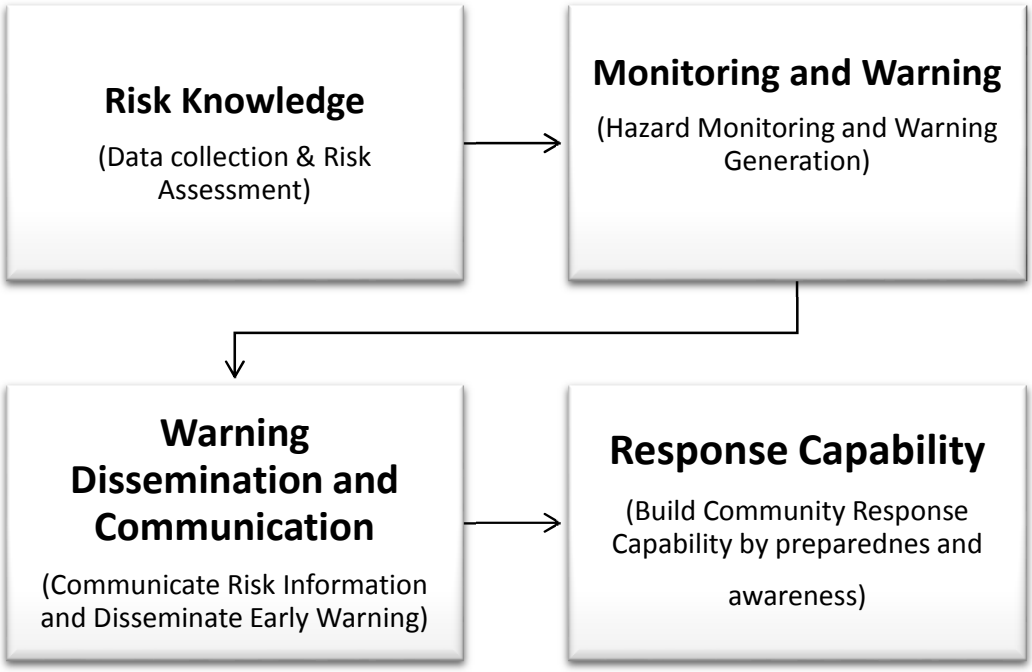

Fig. 3. Four elements for effective EWS (Adapted from UN, 2006)

This model shows that risk knowledge is important for monitoring and warning as well as warning dissemination and communication. Although these four elements have specific components, they are also interrelated elements as shown by the flow of arrows. However, Wiltshire (2006) argued that for EWS to be effective, it must include the active involvement of communities at risk, stressing the importance of community engagement for EWS.

Grasso (2007) emphasise the significance of EWS from this approach as a constant process of engagement, reviewing, creating risk awareness of hazard and monitoring of risk. This is because risk knowledge influences risk assessment which informs response capability and risk reduction measures required for mitigating the risk impacts on communities at risk (Haddow, et al. 2011). Therefore EWS which contains these essential elements are able to reduce the loss of life and economic losses through participation of community at risk (WMO, 2013).

Effective alignment of the four elements for effective EWS (Fig.3) can significantly mitigate the impact of natural hazards on community risk, however, its lack of provision for "how" the elements help to improve risk perception suggest a flaw in the UN model. The importance of risk perception, and identification have been emphasized by Regester and Larkin (2008) as vital for ensuring effective risk mitigation, reduction and management. The lack of reference

to risk perception especially in many communities prone to natural hazards indicate the gaps in existing models and theories of EWS. Many communities have norms, cultures and perception about what is considered risk or dangerous (Villangran de Leon, 2012). Perhaps this premise informed the inclusion of stakeholders and multiple linkages in the integrated model proffered by Basher (2006). According to him, stakeholders often go unrecognised as being part of the system or community at risk. As such communities and all actors including political, social, economic, institutional actors are all stakeholders both Basher (2006) and Villangran de Leon (2012) considered as important in the development and deployment of effective EWS

In addition, communities are also influenced by mitigation, education, preparedness, knowledge of hazard, prediction, system model and monitoring of risks or hazards. All these in reality determine their response behaviors when warning is issued for imminent danger, and response behaviors ultimately influence the commitments of institutions and mechanisms (Basher, 2006). EWS is a mitigation and preparedness system which is heavily reliant on communication methods and process (Villangran de Leon, 2012). But warning during critical situation can be problematic due to the impact and interruption caused by the disasters and especially in many developing countries where infrastructures are fragile (Glantz, 2004).

Therefore, overreliance on one method for communicating warning, without corresponding information to educate community can be limited and ineffective. Despite the advance in technology for disseminating warning messages, the lack of understanding, limited risk knowledge and lack of education on how to react to warning signals remain some of the biggest shortcomings of most EWS (UN, 2006; WMO, 2006). Therefore, the chain of information as well as the methods and modality for disseminating warning message make communication models or theory essential for effective EWS.

According to Coombs (2007) there are crisis communication theories and strategies which guide and help to explain how pre, during and post crisis situation can be communicated to and between all stakeholders. Coombs recommendation Situational Crisis Communication Theory (SCCT) for crisis management have been crucial in evaluating crisis type, history and relationship of crisis impacts to determine how crisis is communicated. SCCT is used to understand how stakeholders will respond to the crisis, and in turn the information is used to communicate pre and during crisis risk or danger to stakeholders. Although SCCT has its roots in organizational crisis, the guidelines used in SCCT crisis response strategy are

considered as one of the most suitable for communicating risks and crisis (Coombs, 2007). This is because Coombs classified crisis into types based on level of required responsibilities between stakeholders and victims. By so doing, SCCT clarifies expectation and responsibilities for disseminating EWS.

Communication theory such as this, shows that communication pre, during and post crisis is a shared responsibility between the victims and the organisation responsible for safety (Coombs, 2007). The systematic view this communication theory presents indicate that different messages can be created by individuals through personal subjective interpretation from which they draw conclusions (Villangran de Leon, 2012). While this possibility emphasises the need for clear, informative and educative risk communication about imminent dangers of hazards (Paton, 2008), it also emphasise the importance of ensuring that preventable hazards and risks are effectively communicated (Fearn-Banks, 2007).

Therefore, communication method and medium for disseminating preventive hazards, effective EWS and for ensuring response strategies ought to be carefully determined in consultation with community at risk. Communication for effective EWS can follow the public communication timeline recommended by the CCA (2004) for ensuring better public awareness, education, public warning, informing and advising the public of imminent risks. However, the effectiveness of such timeline as well as elements of EWS examined in this section are used to evaluate the current deployment and elements of EWS in the UAE.

3. Materials and Methods

Data were collected through secondary and primary data to provide an objective comparative parameters for determining the context of EWS in the UAE. Since emergency management in the UAE is at its infantry with limited literatures and zero academic literature on EWS, second data on EWS from a global context was necessary.

3.1.Secondary Data

Data were collected from literature review of EWS and practice context for EWS and public education model for emergency preparedness process used in the United Kingdom. The Civil Contingency Act (2004) was an important document to examine, especially the chapter on emergency preparedness and EWS, since the UAE adopted the CCA as a working guide for developing the national response plan. Information relating to natural hazards were derived from Abu Dhabi Police reports due to limited literatures or publications on past incidents in

the UAE. Specific reports on 2013 storms and floods in the capital city were reviewed to identify gaps and potential areas for improving EWS in the UAE as a whole. The report from ADP also provided useful information about organisations to recruit as participants for primary data collection in Abu Dhabi and Fujairah.

3.2.Primary Data

Primary data were collected through qualitative and quantitative methods in the UAE. The qualitative data which focused on investigating the existing deployment of EWS in the UAE involved series of semi-structured interview sessions with organisations and agencies involved in emergency preparedness and response in Abu Dhabi and Fujairah Emirates. A total of eight people were interviewed in Abu Dhabi, while total of four people were interviewed in Fujairah being a smaller emirates. Table 1 shows the description of interviewees and organisations recruited for the research.

Table 1. Demography of interviewees

Emirates	Description of Interviewees/agencies
Abu Dhabi	1. National Crisis, Emergency and Disasters Management Authority (NCEMA) 2. Abu Dhabi Civil Defence 3. Ministry of Education 4. Ministry of environment and water 5. National Media council 6. Abu Dhabi City Municipality 7. Water and Electricity Authority (ADWEA) 8. National Centre of Meteorology and Seismology (NCMS)
Fujairah	1. Fujairah Civil Defence 2. Fujairah Municipality 3. Federal Electricity and Water Authority 4. Ministry of Education

The interviewees were asked a total of eleven questions during the interview session which lasted between 45 to 90 minutes depending on the level of engagement.

The questionnaire survey focused on determining the level of risk knowledge, perception and expectations of communities at risk of natural hazards in the two emirates. A random sampling technique explained by (Kothari, 2008) was used to determine participants in the two emirates, while questionnaires were distributed randomly to members of the public who were living, working and conducting business activities close to the affected areas in the two emirates. Through this method, a total of 1,080 people within the two emirates completed the questionnaire, which is a sample size calculated using confidence level similar to the method used by (Gautam and Shivakoti, 2001). Table 2 shows the sample distribution and demographics of participants.

Table 2. Sample size and demographics of questionnaire participants

Emirate	Population	%	Sample Size	Male	Female
Abu Dhabi	404,546	83.3	845	435	410
Fujairah	80,900	17.7	235	110	125
Total	**485,446**	**100.0**	**1,080**	**545**	**535**

The questionnaire was designed to have 25 questions grouped into four main sections based on four interrelated elements or themes for effective EWS. Due to vast numbers of foreigners in the UAE especially Abu Dhabi, the questionnaires was designed in both English and Arabic were collected after 5 days of drop-off at homes, business offices, commercial centres such as malls, stations, community centres, schools and staffs of hotels and other public ministries and organisations.

3.3.Data Analysis

The interview data were analysed using content analysis which is a technique that allows valid inferences to be drawn from text data in order to provide objective context for their interpretation (Krippendorff, 2004). All qualitative data collected for the purpose of this work, including the text data from the questionnaire were analysed using the steps recommended by Leedy and Ormrod (2001). These included data categorisation in to meaningful themes, interpretation of each theme, identification of patterns and design, and generalisation to determine implication of themes as presented and discussed in Sections 4

and 5 respectively. Nvivo 10 software was also used to code, edit, classify and manage themes required for effective EWS.

Quantitative data analysis was carried out using SPSS to perform descriptive and inferential statistics (Sawalha, 2011). By using SPSS software version 16, the important data from community at risk were generated to determine the level of risk knowledge, effectiveness of EWS communication and warning as well as expectations for the deployment of EWS in the UAE. Through this process data were generated which contributed to developing the framework for effective EWS for mitigating the impacts of natural hazards in the UAE.

4. Results and Discussion

In Abu Dhabi and Fujairah emirates, a broad range of people in the communities were recruited to participate in the research. But the interview participants were strictly participants from emergency agencies with responsibilities and roles for public safety.

4.1.Risk Knowledge

The results from the two emirates show that there was minimal knowledge of risks of natural hazards. Roles and responsibilities of emergency agencies and other government sectors responsible for public safety were clear, but experts and defined organisation who understood EWS and deployment the same were lacking in the two emirates. Data from the series of interviews conducted in the two emirates shows that there is no department, organisation or people responsible for EWS before or during any imminent natural hazard. There is also no model, system or defined warning platform for natural hazards in the UAE. However, the questionnaire results show that the risk knowledge in the community vary, but low even though it covers a whole range of natural hazards in the two emirates (Fig. 4).

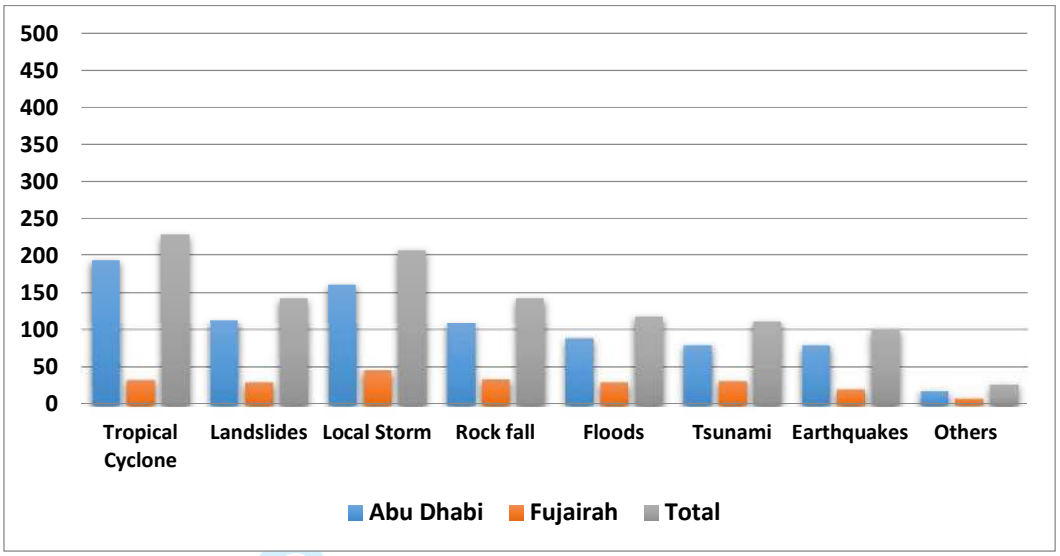

Fig. 4. Risk knowledge of natural hazards in Abu Dhabi and Fujairah

The questionnaire results also reveal that communities consider earthquakes as the scariest and concerning natural hazard for them.

4.2. Monitoring and Warning

Interview results reveal that, while there is minimal support for some organisations to monitor and issue warning for natural hazards, the national meteorological unit is the only one responsible for monitoring and issuing warning to emergency organisations. Although warning is also issued to the public through the media, it only takes the form of weather update and not information for mitigating impacts of hazards. The questionnaire confirmed the frequency of weather forecast usage by the community (Fig. 5).

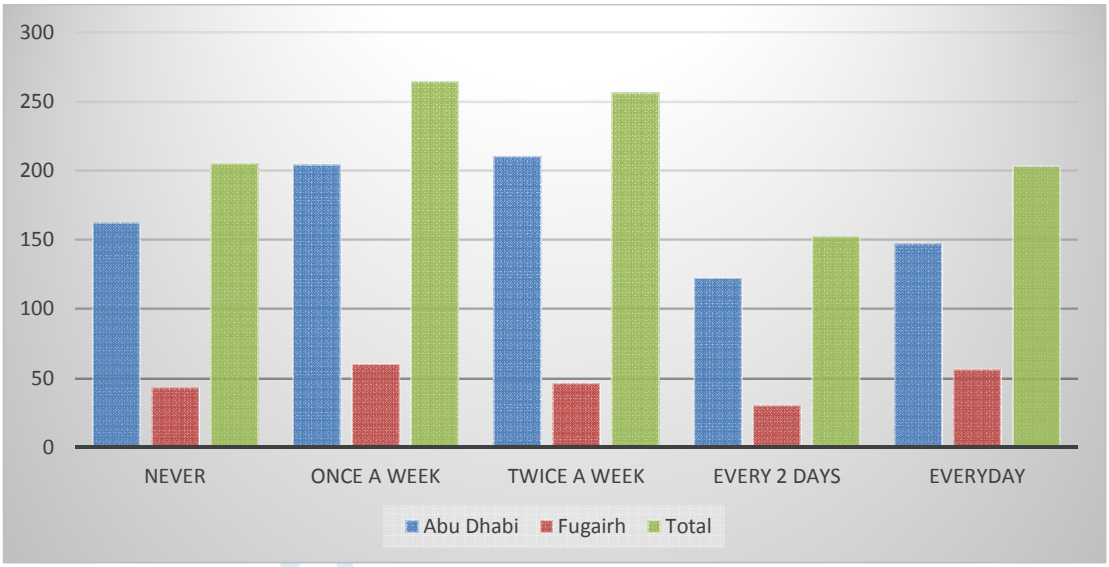

Fig. 5. Frequency of weather forecast usage by community at risk

However, none of the results showed any form of engagement with community at risk for public education, informing and to warn about identified risks of natural hazard. There is also no result which shows that the organisations interviewed or the community know of any specific EWS in the two emirates.

4.3.Warning dissemination and Communication

In terms of warning dissemination and communication, the results from the interview all echoed that all organisations responsible for public safety receive warning messages and communicate between themselves. However, only one organisation who is responsible for disseminating warning message to the public, claim that they are only responsible for issuing warning on fire, accidents and other man-made hazards and not natural hazards. Questionnaire result reveal that, while 27.5% of community have received warning messages, they have done so via the media. The remaining 72.5% said they have never received warning message prior to or during any natural hazard before.

4.4.Response Capability

The result for this theme reveal that emergency organisations have regular exercise, to test their response procedures, carry out evacuation procedure for rescue. However, no result shows that these exercise or evacuation procedures involve the participation of community at risk. Questionnaires showed that 48.3% of the total participants from the two emirates are

aware of the preparedness exercise and meetings held by emergency agencies and would like to participate in future exercise or procedures.

4.5. Discussion

The pattern of results generated in this research shows major gaps in the EWS used in the two emirates. It also reveal the specific areas where there are problems, limitations and void of best practice especially with implementation of EWS. This result has revealed the reasons for the context and impacts of natural hazards provided in section 1. Impacts of natural hazards have continuously been severe in the two emirates because there is no organisation actually responsible for disseminating warning messages, informing or educating the public on the risks of natural hazards their community is vulnerable to.

While the interview results on risk knowledge reveal the lack of expertise and understanding of EWS in the two emirates as the primary reason for this, the entire results also reveal that any preparedness activities fail to involve the community at risk. The practice of EWS in the UAE and response lacks the four interrelated elements of EWS examined in existing literatures in the field. A structured process exists for communicating warning between organisations, but the communication is not passed onto the community at risk. Such communication suggest horizontal communication without a top-down, vertical communication, revealing a limited communication process for disseminating warning messages (Fearn-Banks, 2007).

The results shows that there is no effective EWS in the UAE especially in the two emirates examined in this research. In addition, using the model proffered by the UN, by Basher (2006) and Coombs (2007) SCCT to critically examine the current practice for EWS in the UAE have proved instrumental in identifying areas which require development and the ones which require improvement.

Despite the lapses in deployment of EWS, the established responsibilities and horizontal communication between agencies and organisations responsible for public safety can be used to further improve the practice of and the development of effective EWS based on the four interrelated elements of EWS. Developing an effective EWS is possible in the UAE, since the questionnaire results indicate the willingness of communities at risk to be involved in future preparedness activities in their respective emirates. Such positive indication can be resourcefully used for engaging community at risk for preparedness and risk reduction activities (McEntire and Myers, 2004). This indication also suggest that, needs and situation

assessment might be required in the two emirates in order to determine the most effective approach for engagement given the wide range of diversity of occupation, religion and nationalities in the country especially in Abu Dhabi.

5. Recommendations

Two main recommendations have emerged from this results in order to mitigate and reduce the impacts of imminent natural hazards in the two emirates. These are; (1) Development of an effective EWS using the four interrelated elements and (2) Improvement of preparedness activities for EWS. The development of an effective EWS which includes community at risk must imbibe all the issues identified through the investigation of this research in order to ensure that risk knowledge is improved, while monitoring and warning, dissemination and communication and response capability are all developed in equal capacity.

The four interrelated elements for effective EWS are essential to improving and developing all preparedness activities including the involvement of community at risk for EWS deployment in the UAE. According to Paton (2008), dissemination and communication can be more effective by understanding the community and ensuring that warning message and warning dissemination mechanism are vertical, horizontal and clearly define actions to be taken by the community.

The continued occurrence and the potential impact of climate change in the Gulf region also means that response capability needs to be strengthened through regular training based on risk assessment and integration of risk information. In a developing country such as the UAE, a feedback mechanism will be crucial to ensure that level of improvement necessary for effective EWS takes place. The four interrelated elements for effective EWS have been used to develop the framework which entails other associated components necessary for effective EWS in the UAE as shown in Fig. 6.

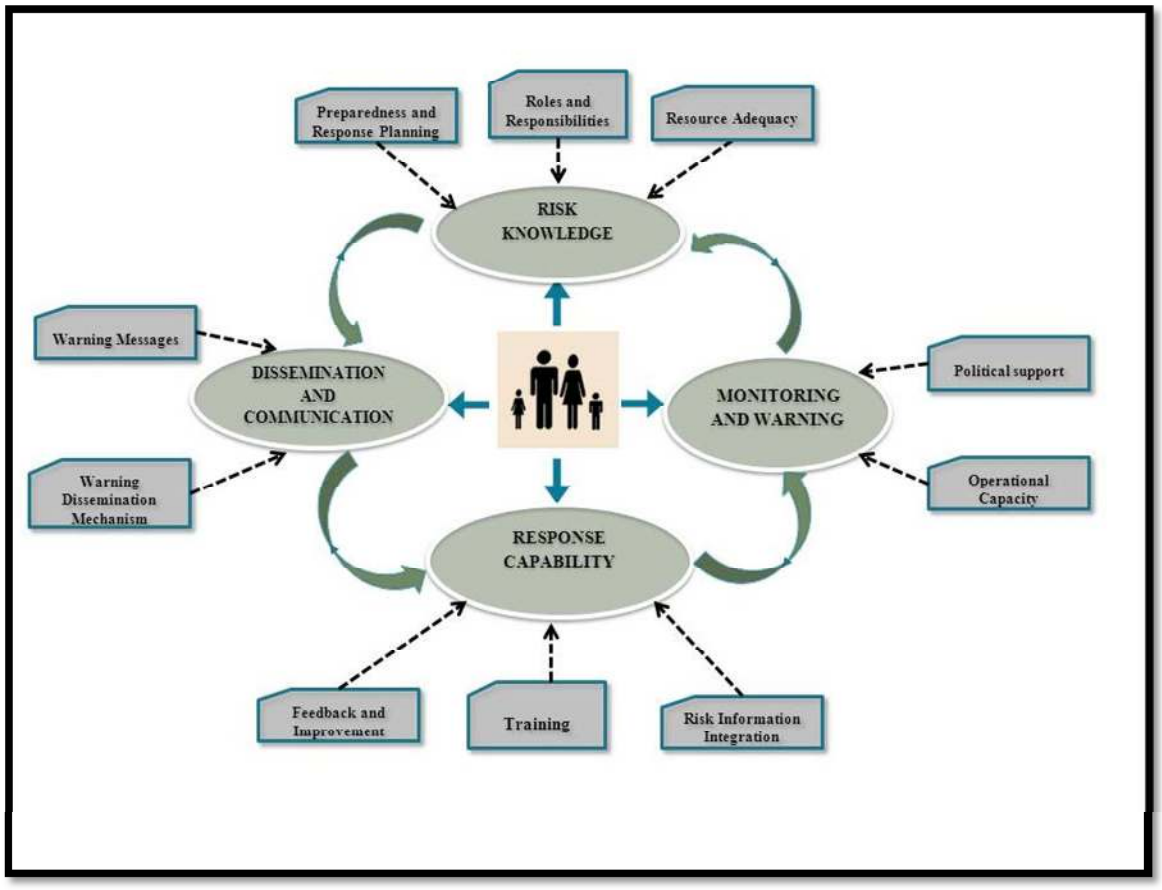

Fig. 6. Framework for effective EWS in the UAE

This framework for developing and improving the EWS in the UAE shows various associated components and activities which can potentially attract the involvement of communities at risk as well as other necessary stakeholders in the UAE. It also given that by establishing an effective EWS which involve communities at risk in Abu Dhabi, all the other six emirates will benefit from such reform since Abu Dhabi is the capital of the UAE.

6. Conclusion

The scale of natural hazards when they occur still remains unpredictable, which at times influence the level of impacts they have on affected community (Selby, 2012). While the occurrence of natural hazards know no boundaries, global efforts in emergency and disaster management have identified good and timely early warning system as crucial in mitigating the impact of natural hazards. This work have identified elements of effective EWS and used them to critically examine the existing practice of EWS in the UAE for mitigating the

impacts of natural hazards. Using the case study of two emirates; Abu Dhabi and Fujairah as communities most prone to the occurrence of natural hazards in the country, it was discovered that the practice of EWS in the country lacks the essential elements in an interrelated manner. The elements of effective EWS provided by the UN and Basher (2006) were instrumental in developing a framework to facilitate effective EWS which involves communities at risk. By so doing, it is envisaged that the level of vulnerability of these communities, and impact of natural hazards in UAE as a whole will be reduced, while also improving the emergency management practice in the UAE.

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