PROPOSED POLICY SOLUTIONS FOR IMPROVING THE DISASTER EARLY WARNING SYSTEM IN VIETNAM TO INCREASE THE EFFICIENCY OF LOSS MITIGATION, PREVENTION

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Abstract:

The devastation of natural disaster is not only related to the danger level of phenomena but also depends on the prevention/mitigation capacity of the community. Early warning is the early recognition on disasters, an essential component of risk reduction, an important tool to protect lives and minimize material losses that may be caused by disasters. Effective operation of an early disaster warning system requires all of four interconnected components in the system, and controlled by mechanism, policies and legislation related to different management agencies from central to local level. This paper will make in-depth analysis on the position of the disaster early warning system in the legal document system relating to disaster management issued from early 1990s until the Law on Disaster Prevention officially took effect in May, 2014. The four main components of the disaster early warning systems was reviewed to see clearly the gap between policy and implementation with a view to making recommendations for improvement of the disaster early warning system and increased efficiency of the disaster risk management in Vietnam.

Keywords: *Disaster Risk Management; Early warning of natural disasters; Prevention and mitigation of natural disasters.*

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1. Position of the disaster early warning system in the policy document system on disaster prevention in Vietnam

Vietnam is one of the countries being regularly affected by natural disasters, 70% of the population faced with dangerous weather phenomena such as typhoons, heavy rains and floods. Every year, natural disasters make hundreds of people killed and wounded, material losses of up to VND thousands of billion. Natural disasters not only make losses in terms of lives and property, but also caused serious long consequences, such as many homeless people, production stoppage due to devasting infrastructure,

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adversely impact on environment, and negative socio-economic consequences. For example, only the Xangsane 2006 storm made a loss of nearly USD 1 billion for 15 central provinces. On average, each year, disasters cause losses equivalent to around 1.5% of GDP.

The devastation of disasters is not only related to the danger level of the phenomena themselves but also it depends on the human prevention, mitigation capacity. Early warning is the early recognition on disasters, an essential component of risk reduction, an important tool to protect lives and minimize material losses that may be caused by disasters. Therefore, early warning of natural disasters was especially emphasized in the Ordinance on Flood and Storm Prevention 1993 (Ordinance No. 09/L-CTN dated 20th March 1993) and in the following Ordinance 2000 to amend and revise some articles of the former Ordinance 1993 (Ordinance No. 27/2000 /PL-UBTVQH10). However, the provisions outlined in the Ordinance were simple, not focused on the issue of building a specific system, only assigning the agency responsible for providing forecasts, warnings relating to storms, floods and the agency responsible for disseminating such information to public as stipulated in Decree No 32/CP dated 20th May 1996 and Decision No.581/QD-TTg dated 25th July 1997, particularly, it did not involve the participation of community in disaster warning. In addition, various other kinds of natural disaster such as earthquakes, tsunamis, landslides,... were not mentioned in the legal documents at that time.

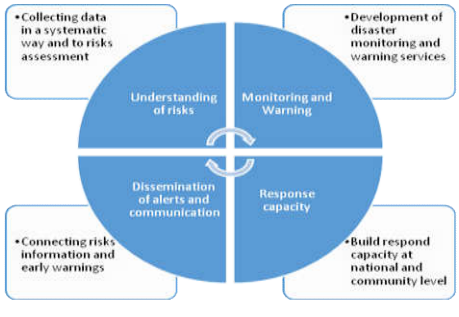
In recent years, Vietnam has made much effort to cope with natural disasters by reducing risks, promoting the improvement of physical and legal infrastructure for disaster management with the issuance of the *National strategy on disaster prevention and reduction up to 2020* approved by the Prime Minister in Decision No. 172/2007/QD-TTg and Law No. 33/2013/QH13 on disaster prevention passed by National Assembly on 19th June 2013 and effective from 01st May2014. The strategy began to emphasize the development and modernization of the natural disaster early warning system, but not including legal institutions and legal provisions on financing for the system from central to local level. Law on Disaster Prevention prescribed that community has the right to involve in disaster prevention planning at grass-root level. However, disaster risk reduction in the context of climate change is still a significant challenge, especially in respect of developing early warning capacity for all types of disaster as mentioned in the Law on Prevention so as that community can be capable of disaster preparedness and response.

The Second World Conference on Disaster Reduction held in January 2005 adopted the "Hyogo Framework for Action 2005-2015" with strategic approach and synthesis in disaster risk management. The framework

emphasizes the importance of early warning as the main tool to minimize risk, it encourages the development of early warning systems with focus on those audiences who could be affected, especially providing timely and understandable alert to community, including instructions on how to take action to cope with disasters *(UNISDR, 2005a)*. After 15 years of implementation of the Hyogo Framework for Action, 3rd World Conference on Disaster Reduction held in March 2015 at Sendai summarized and gave new Framework for Action with four priorities, including: (i) knowledge on disaster risks; (ii) risk management enhancement; (iii) investments to disaster risk reduction; (iv) strengthening disaster preparedness capacity for effective response. To see clearly the priority issues to focus on in the action framework 2015-2030 Sendai, please refer to Section 2 below where it analyzes the principle of an early warning system for disaster prevention.

2. Principles of a disaster early warning system

Disaster Early Warning System is a combination of tools and processes for the implementation of legal framework by the state management, not merely for forecasts and warnings. Recently, the United Nations Office for Disaster Risk Reduction (UNISDR) had emphasized an effective early warning system should include four key components, i.e: (i) knowledge on disaster risks; (ii) risk management enhancement; (iii) investments to disaster risk reduction; (iv) strengthening capacity in disaster preparedness for effective response. In this system, the four components are not only linked together in a logical sequence, but also have direct two-way relationship and interactive with each other to ensure comprehensive capacity of the system, from understanding of disasters to the preparation and response capacity. Missing one of the four components mentioned above can lead to failure of the whole system. The warning issue is of national responsibility, so roles and responsibilities of the parties involved should be clearly defined by regulations applicable in the country from local to national level.



Source: ISDR-PPEW 2005a, UN 2006

Figure 1. Four main components of a disaster early warning system

2.1. Understanding of the risks

Risk stems from a combination of natural disasters and vulnerability in specific regions. Risk assessment requires the collection and analysis about system of data inconsideration of fluctuation nature of natural disasters as well as vulnerability of the affected place due to human made activities such as urbanization, the volatility of agricultural land use, environmental destruction and climate change. The risk assessment and risk mapping should give priority to early warning systems and instructions for preparation to mitigate potential losses caused.

2.2. Monitoring and warning

Warning is the central part of the system and should be built on a solid scientific foundation to produce disaster forecasts, warnings on coming storm, rain, flooding with high accuracy, in a timely and continuous manner. Continuous supervision and monitoring on relevant parameters is a critical element for accurate warnings at appropriate time. On this basis, it can make right decision about preparedness such as evacuation, relocation and protection of people, property, works to limit losses/damages that might occur.

Although it is the most important factor, it is only a component that constitutes the system. This was an old idea of an early warning system as reality shows that even a forecasting system with technically high quality it is still insufficient to achieve the mitigation of losses/damages as expected. The human factor in early warning systems is the most important *(Basher, 2006)*. The failure of the system often occur in "Communication" and "Preparedness to respond" factors. Taking as an example, the 13 degree typhoon Xangsane in 2006, in Central provinces made 180,000 people affected, thanks to proper responses the loss from this storm was minimized, only 72 deaths compared to 110 people died in Philippines *(CCFSC)*.

2.3. Dissemination of warnings and the communication issue

Warning needs quick delivery of information to those at risk of direct and indirect impacts of disaster. Warning Newsletter should contain clear, brief but useful information for timely preparation of responses to help effectively protect people and property. Communication system among the central, provincial and community needs to be ready. The use of multiple communication channels (such as telephone, fax, internet, television, radio, loudspeakers and especially modern means of communication such as satellite) is indispensable to ensure maximum effectiveness of timely

warning to the concerned authorities and people, as well as to prevent the incidence occurred to any of the information channels.

2.4. Responsive capacity

Important requirements to improve disaster prevention is that community must understand about the risks, timely access to warnings, and early implement responses. Plans for prevention and response to disasters must be developed, tested and regularly practiced, in which, training in relevant methods should be provided for community to ensure safety of people and property, refuge them when disasters occur at different levels.

Natural disaster early warning system includes four components to be developed, strengthened and effectively implemented, firstly, it should have a legal basis and implementation plans and policies for disaster risk management from national to local level. According to the national report on the implementation of Hyogo Framework for Action, significant progress was made over the period 2005-2009 in legislation enhancement for disaster risk management to address the shortcoming in disaster preparation and response *(Llosa, S., Zodrow, I. 2011)*. By 2011, 48 countries, out of which nearly half of them were low- or lower middle-income countries, had reported significant achievements in the development of national policies and legislation for disaster risk management and implementation of the Hyogo Framework for Action.

Based on the principles of an early warning system with specific requirements for each component in the system as recommended at the 3rd International Conference on Early Warning in Germany in 2006 *(UNEP, 2012)*, we will go into detailed in Section 3 of analysis of each component of the disaster early warning system of Vietnam with the aim of making concrete recommendations for improved performance of the system.

3. Current status of the Vietnam natural disasters early warning system compared to the requirements set out in policy documents

Vietnam is also one of the countries in the region that issued early strategies for disaster management since 1990 with the establishment of the Central Committee for Flood and Storm Control (CCFSC). The national action strategy on prevention and mitigation of natural disasters up to 2020 was approved by the Government in November 2007, with the main objective to integrate disaster risk management into socio-economic development plans. Traditionally, Vietnam used to focus on preparedness to respond to natural disasters by various measures such as construction and upgrade dyke and embankment system. Disaster risk reduction activities were mentioned in

the strategy, but the focus was placed more on responding measures by incorporating construction and non-construction works. New strategic approach to deal with disaster risk reduction now is not only responding but also improving prevention measures to reduce losses caused by natural disasters, while mitigating the natural disaster risks involved. The concept of disaster risk mitigation is a comprehensive approach to respond to natural disasters and has become the guiding principle for international join action to prevent disasters.

More recently, with the adoption by National Assembly on the Law on natural disasters prevention, the Government issued Decree No. 66/2014/ND-CP on 04th July 2014 to provide detailed guidelines for the implementation of some articles of the Law, Prime Minister issued Decision No 44/2014/QD-TTg of 15th August 2014 concerning detailed provisions on disaster risk levels, Decision No 46/2014/QD-TTg of 15th August 2014 regarding regulations on disaster forecasting, warning and communication. These documents has really improved the legal framework for disaster management in Vietnam. The principles of a disaster early warning system has been guaranteed by the country institutional, legal documents. At the national level, the first two of four components of the disaster early warning systems (*knowledge about disaster risks, strengthening risk management*) are under the responsibility of Ministry of Natural Resources and Environment and Academy of Science and Technology of Vietnam; the third component (*investment for disaster risk mitigation*) under the responsibility of various communication agencies (Voice of Vietnam, Vietnam Television, Ministry of Information and Communications); the fourth component (*strengthening disaster preparedness for effective response*) under the responsibility of the Central Steering Committee on natural disasters prevention (formerly called Central Committee for Flood and Storm Prevention) and the National Committee for victims search and rescue. These four components are vertically connected from top central down to grass-root level to ensure that in provinces there exist an unit responsible for disaster warning, communication, and steering of responses.

To analyze the performance of the disaster early warning system in Vietnam from central to local levels, a group of authors had studied the report on disaster management of local and foreign organizations, along with actual survey on disaster agencies at some central provinces frequently prone to natural disasters such as Da Nang, Quang Nam, Quang Ngai, where it shows the situation relating to the four basic components of the system compared to the following set out requirements:

3.1. For understanding of the risks

The basic issue was it should have:

- Cooperation of relevant agencies to implement disaster risk and vulnerability assessment;
- Community involvement in defining characteristics of the natural disaster, historical data based disaster mapping;
- Analysis of vulnerability of communities to all kinds of natural disasters should take into account factors of gender, disability, economic diversity, environment;
- Integration of risk assessment into risk management plans and warning information, as well as easy access to risk database.

In the national progress report on the implementation by Viet Nam of the Hyogo Framework for Action in the period 2009-2011 (MARD, 2010), concerning "Priorities for Action 2: Identify, assess, monitor disaster risks and enhance early warning", it admitted that Vietnam had not yet conducted any risk assessment in a systematic way for many types of disaster, there was neither a national database on disaster risk maps, furthermore, the data were relatively scattered in different management units after project implementation.

It could be seen that it was the weakest point in the system from the central to local levels. The agencies are responsible for disaster warning were hydrometeorology agencies, the steering committee of flood and storm prevention, but they had no maps of disaster risk and vulnerability level of national and local level, or if they did, these documents were too old. The establishment of such maps at the local and national levels requires big resources and the participation of experts from various fields. Moreover, the Decision No 44/2014/QD-TTg of Prime Minister promulgated on 15th August 2014 providing details on disaster risk level just focused on decentralized risks corresponding to the intensity of calamity, not taking into account the level of vulnerability of community and environment. Therefore, the implementation of other components of the system was not synchronized, confusing when planning and the integrating disaster risk into socio-economic development plans.

3.2. As for disaster monitoring and warning

The central component of the system requires:

- Mechanisms and institutions for the system operation with clear roles and responsibilities of the warning issued agencies;

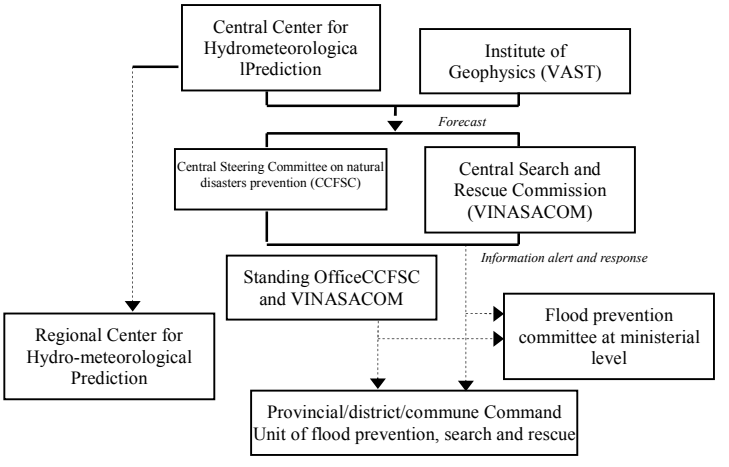
- Continuous monitoring system set up to ensure the data is acquired, processed in real-time and for long-term storage;
- Disaster forecasting and warning system can provide warnings based on the data collected by scientific and appropriate methods, simultaneously warning information is to be transmitted in a fast and most efficient manner at the requirement of users.

The hydrometeorology observation network is one of the oldest database with continuous development, in particular, investment by Government in recent years was increased. By 2012, the measuring network had 1,300 stations, including 233 hydrological, 185 meteorological, and 19 oceanographic stations, respectively, out of them 155 stations for air and water measurement, more than 700 rain gauge stations, 6 air surveillance stations, 8 high wind measuring stations, 7 radar observation stations *(WB, 2010)*. With the increase in the number of stations, the volume and quality of hydro-meteorological information was significantly enhanced, served effectively for the supervision and providing warnings of rain, storm, flood in a timely manner, with the forecast time of hurricane up to 72 hours. However, compared with other advanced countries like Japan, where it has a network of 1,300 automatic meteorological stations with an average density of 17 km^2/station, the average density in Vietnam is low, about 120 km^2/station; Moreover, the station density of our country is unevenly distributed, some station located at 1,000 km apart. This was one of the biggest difficulties for a disaster early warning system to operate effectively, because if input information were incomplete, it would be difficult to get accurate forecasts, even owning the most advanced equipment and method. The use of remote sensing data to substitute sparse measuring stations as a solution to improve the quality of alert, however, there were still many restrictions on the source of data, the ability to exploit it, especially at the local level.

In addition, there were restrictions on data sharing within and outside the network. It also led to challenges for the operation of other components in the system, especially for historic data on disasters to build the risk map, to raise awareness about the risks and take active responses to disasters.

3.3. Concerning warnings and communications to public: it needs to ensure: (i) an organized decision-making process be institutionalized with full authority and responsibility; (ii) systems and equipment for effective communication to whole community by all form, in two-way, with preventive measures; (iii) the warning information understandable and realizable.

Law on Natural Disasters Prevention in 2013 and the Prime Minister Decision No. 46/2014/QD-TTg dated 15th August 2014 issuing regulations on disaster forecasting, warning and transmission has ensured this third components of system completely institutionalized, with the mobilization of the communication network of TV, radio, newspapers, telecommunications, military safe guard agencies, and other internal units. In addition to general warning information on the phenomenon, direct specific information on preparedness to respond also been transmitted to community. This was a major effort in the system being implemented for years to cope with disaster. Especially, in the village, loudspeakers have long been very effective in conveying information in response to storms, floods. However, the mode of transmission still needs to be more diversified with new technology updates such as satellite communications in order to ensure uninterrupted communication during natural disasters. The warning by SMS has recently been applied, but no specific mechanism issued for the event of disasters, so localities thought that was costly to send out information to multiple objects. In particular, the information was just one way dimension (Figure 2), from forecasting agencies to community, not vice versa way on the development of natural disasters, in order to help the issuing and steering agencies know better about the actual facts happened for timely update of changes in forecasts and response steering. This was a necessary direction for the system to get the ability to minimize losses.



Source: CCFSC website

Figure 2. Process of disaster warning management

Moreover, it should be focused on the improvement of the "timeliness" of the alerts and the forecast time limit. Currently, the process of collecting and processing data for making the warning messages take about 3-4 hours,

on an average, before transferring to the central disaster management agency, then the steering information for response takes about 0.5 - 1 hour before it can be disseminated to subordinate units. Thus, it may take 3 hours from issuing a warning message to the people effected by the disaster. A study on the benefits of early warning of Schroeter & nnk (2008) showed a correlation between the preparation time and the damage caused by flash flood as follows: predicting time before 12 hours shall likely reduce up to 60% of damages, while with predicting time before 1 hour it was only 20% damage reduction.

3.4. For response capacity: (i) Responsible competent authority should have trust on the warning; (ii) There should be plans to prepare and respond to each type of disaster, in which the mapping of disaster risk and vulnerability levels should be used for planning; (iii) Capability of response of communities must be evaluated and strengthened; (iv) Community awareness and education must be regularly enhanced on all matters including disaster risks, the contents of disaster warning, reliability, damage prevention and mitigation measures.

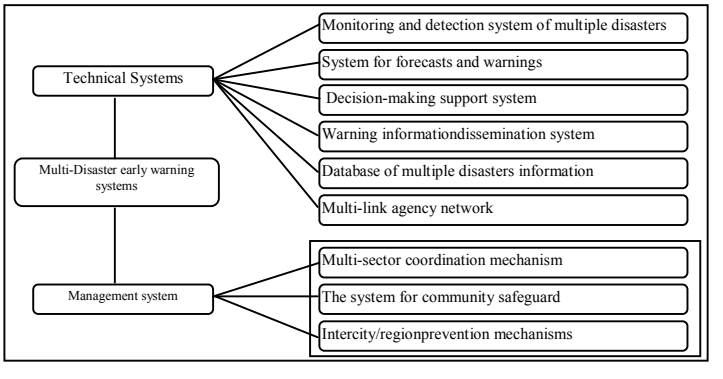
The assessment on the National progress report on implementation of the Hyogo Framework for Vietnam Action during 2009-2011 *(MARD, 2010)* said that the level of achievement was low (index 2 on the scale of 5) in respect of community response capacity improvement, it was due to limited ability in risk management at all levels, especially the low autonomy of community. In recent years, building capacity to cope with natural disasters is one of the priorities of ODA projects and programs and interventions of non-governmental organizations for Vietnam focusing on communities at district, commune level. But in general, the results of these programs and projects implementation were only in the area of raising awareness on calamity hazards and regulations compliance.

As mentioned above, the gap in the first component "risk perception" of the system lead to inadequacies in the three other components. Through surveys, disaster preparedness plans at local level was largely dependent on the knowledge and experience of the authorities concerned. Historical data of local were not scientifically stored, evaluated to serve disaster prevention. A significant limitation was local staff worked only part-time for disaster prevention, even without a national training programme for them on technology and management skills in mitigation of damages.

4. Some policy recommendations to improve the disaster early warning system in Vietnam

Through actual analysis, the process of natural disasters early warning in Vietnam is at present not yet complete in all sectors, in particular, the linkage between the four components need to be strengthened not only on technical aspect, which is important, but also management aspect to create systems of multi-sectorial, multi-disaster, multi-stage response character, comprehensive so as to enhance community education, increase awareness on disaster risk, conduct effective warning transmission to community for them to ensure preparedness to respond. Such a system will ensure economic efficiency as well as proactive responses to natural disasters which are becoming more and more brutal, unusual in the context of the current climate change. Pattern of a successful early warning system as above was mentioned in the recent global assessment report on disaster reduction *(Rogers and Tsirkunov, 2011)*, it was a multiple disaster early warning system of Shanghai developed by the Chinese meteorological agency in conjunction with the Shanghai Government with the support of the World Meteorological Organization.

The disaster early warning system of Shanghai is fully in compliance with the principle of four basic components, but different in terms of form, the system consists of two technical and management aspects as shown in Figure 3. Thus, technically speaking, outside the system is the platform of monitoring and detection, forecasting and information dissemination system, the need for multiple disaster database, especially the support system for decision making for responding work with multi-agency link network, so the data can be easily shared, information can be consulted before providing warnings for people. The management aspect of the system ensures shorter preparation time for an earlier response.



Source: Rogers & Tsirkunov, 2011

Figure 3. Model of a multiple disaster early warning system

Clearly, for a disaster early warning system to be effective it needs to realize a series of regulations in respect of cross-sectorial coordination, monitoring and alerting, risk analysis, planning for emergencies and preparing response measures. Through analysis of the current situation of the disaster warning system in Vietnam, in comparison with the other effective system as assessed by international community, and in reference to the latest recommendations of UNISDR, the study team launched some policy recommendations for better management of the natural disasters early warning system in Vietnam, as follows:

- Natural disaster early warning system of Vietnam needs to have a shift towards a multi-disaster system with multi-sector involvement in the development and operation of the system from the central to local levels;
- It should change the approach of assessing disaster risk and impact on communities so it can strengthen the involvement of community in all stages of disaster management including preparation, prevention, response and recovery.

In order to develop a multi-disaster system with approach of community based assessment of disaster risk and impact, management policies should promote both aspects: technical platform and operational mechanism, specifically:

a) As for technical platform

- Mobilize all necessary financial and professional resources to build a national database on disaster information; Conduct risk assessment and establish extended disaster, vulnerable maps, to multi-natural disasters by remote sensing and GIS technologies and, including storms, floods, heavy rains, landslides, drought, rising water,…; Regularly update of other risk factors and their impacts;
- Improving the quality of information of forecast and warning systems:
  + Improved surveillance and detection by strengthening and improving the network of disaster observation stations: To step up to automation technology and increase the density of ground monitoring networks, diversify sources of data, especially remote sensing data;
  + Developing mechanisms to promote the use of geospatial data in disaster management;
  + Strengthening specialized information systems: Enhanced speed for data collection from local to central level and vice versa;

+ Improving equipment of the forecasting system: Upgrade and improve forecasting models appropriate for regional conditions, strengthening input data, especially remote sensing data, developing forecasts combined with statistical models;
+ Improved content of alerts for different objects, e.g: agencies relating to production and business, newspapers, radios, various sectors such as agriculture, transport, health, and community;
+ Integrating disaster risk and impact information on the warning message.

- System of dissemination warning information:
  + Maximum mobilization of all means of communication and dissemination of information, to ensure that information reach all subjects at risk of to be affected;
  + Setting up feedback information channels from the field of disaster to any level of agencies concerned: Update disaster information before, during and after the incident.
- In respect of decision-making support system:
  + To develop tools to support decision-making of concerned authorities to direct disaster prevention: Integration of historical information, statistic data on disasters, such as frequency, maximum, minimum effects…;
  + To develop information-sharing mechanism between technical and management agencies.

b) With regard to mechanism of operation:

- Multi-sectorial coordination mechanism: implementation of all components of the system, with the exchange of feedback among the parties involved, namely, Hydrometeorology agencies need to know about the process of decision-making of steering bodies to provide warnings more consistent with management requirements; feedback quality warnings, forecasts for users;
- The system should work to ensure community benefits: the design and operation of disaster early warning systems needs to be based on commitments of cooperation and exchange of information for the benefit of the community; develop plans of preparedness to protect community taking into account vulnerable subjects such as the elderly, disabled persons, young children;

- Inter-city/inter-region prevention mechanism: ensuring the coordination to mobilize resources to respond to disasters around the affected area./.

REFERENCES

Vietnamese:

1. Law on Natural Disasters Prevention, number 33/2013/QH13 by the National Assembly ratified on 19th June 2013.
2. Decision No 172/2007/QD-TTg dated 16th November 2007 of Prime Minister approving the "National Strategy for natural disasters prevention and mitigation up to 2020".
3. Decision No 44/2014/QD-TTg dated 15th August 2014 of Prime Minister giving detailed provisions on disaster risk levels.
4. Decision No 46/2014/QD-TTg dated 15th August 2014 of Prime Minister providing issues relating to disaster forecasting, warning and communications.
5. MARD - Ministry of Agriculture and Rural Development. (2010) *Vietnam National progress report on the implementation of the Hyogo Framework for Action (2009-2011) - interim*. http://www.preventionweb.net/english/countries/asia/vnm/.

English:

6. ADPC. (2003) *Disaster management in Southeast Asia, an overview*. Compiled and written by Ms. Lolita Bildan, Information Manager, PDR-SEA1.
7. UNISDR - United Nations International Strategy for Disaster Reduction. (2005) *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters.* http://www.unisdr.org/eng/hfa/hfa.htm
8. United Nations. (2006) *United Nations, Global Survey of Early Warning Systems - An assessment of capacities, gaps and opportunities toward building a comprehensive global early warning system for all natural hazards*. A report prepared at the request of the Secretary-General of the United Nations. http://www.unisdr.org/2006/ppew/info-resources/ewc3/Global-Survey-of-Early-Warning-Systems.pdf
9. WB. (2010) *Weathering the Storm: Options for Disaster Risk Financing in Vietnam.*
10. WMO - World Meteorological Organization. (2010) *Guidelines on Early Warning Systems and Application of Now casting and Warning Operations*. PWS-21, WMO/TD No. 1559, 22pp. http://www.wmo.int/pages/prog/amp/pwsp/documents/PWS-21.pdf
11. UNEP. (2012) *Early Warning Systems: A State of the Art Analysis and Future Directions*. Division of Early Warning and Assessment (DEWA), United Nations Environment Programme (UNEP), Nairobi. https://na.unep.net/siouxfalls/publications/Early_Warning.pdf.
12. Basher R. (2006) *Global early warning systems for natural hazards: systematic and people-centred*. Phil. Trans. R. Soc., 364, pp. 2167-2182

13. Schroeter, K. and nnk. (2008) *Effectiveness and Efficiency of Early Warning Systems for Flash-Floods (EWASE)*. First CRUE ERA-Net Common Call - Effectiveness and Efficiency of Non-structural Flood Risk Management Measures, 132pp.

14. Llosa, S., Zodrow, I. (2011) *Disaster risk reduction legislation as a basis for effective adaptation - (UNISDR): Revealing Risk.* Redefining Development.

15. Rogers, D., Tsirkunov, V. (2011) *Implementing Hazard Early Warning System*. Global Facility for Disaster Reduction and Recovery (GFDRR). 48pp.