8. Conclusion and Recommendations

8.1 Weather Forecast

Most of the selected countries have been able to establish well-developed systems of data collection and sharing for short-range weather forecasting, with the support from the World Meteorological Organization and other regional and international organizations. With respect to seasonal and long-range forecasts, there is a need to enhance the technical infrastructure and capacity to produce, interpret and communicate seasonal and long-range forecasts in Cambodia, Lao PDR and Vietnam. Even though El Niño and La Niña events have a significant impact on local weather and climate related hazards, as evidenced by the catastrophic floods that affected central Vietnam in 1999, there has not been enough effort to prioritise seasonal forecasts. The absence of an intermediate mechanism that interprets ENSO forecast and converts it into locally usable information has also proved to be a formidable barrier to the decision making process.

The existing Early Warning System can be strengthened by the availability of trustworthy El Niño forecasts. Following initiatives in the Philippines, each country should have a specific ENSO task force that involves all stakeholders such as meteorology, agriculture, water resources, public health and environment authorities. Better forecasts will require application of new advances in modelling (statistical and dynamical) that enhance skill in downscaling, improve lead time, and provide training of the technical staff in forecasting and understanding the impact of disasters.

8.2 Floods

As floods cause the maximum loss to life and property in Laos, Cambodia and Vietnam, flood forecasting is their prime concern. Lately, there has been substantial investment from donors to improve the hydrometeorological network of these countries. Assisted by forecasts from the MRCS stations, these countries have been successful in documenting real time hydrometeorological data from the upstream. However, the real time data is received from few stations and accordingly the forecasts are limited to a handful of sites.

The Vietnamese government has taken substantial measures to reduce the impact of floods. The measures include: drafting policies for various flood zones, developing a comprehensive system of disaster management, implementing water resource law, ordinances and implementation provisions on dykes, and on the prevention and control of floods and storms.

In Lao PDR, Cambodia and Vietnam, flood data collection and sharing has significantly improved due to the support of Mekong River Commission. On the other hand Philippines and Indonesia have also improved on their flood forecasting and warning system. Table 8.1 highlights the hazard detection capacity in the selected countries.

Table 8.1: Hazard forecast institutions and responsibilities

Country	Forecast	Institutions and Infrastructure	Activities
Cambodia	Weather and tropical storms	Department of Meteorology (DoM), Ministry of Water Resources and Meteorology (MoWRAM) MoWRAM	Data collected from 14 synoptic stations and RSMC Issue of 24 hour forecast Warning disseminated to Minister offices, NCDM, Media, fishermen, farmers Monitor ENSO impact on the country Monthly average and minimum temperature
	Floods	Department of Hydrology and River Works (DHRW), MoWRAM 1 office for flood forecasting 15 provincial hydrometeorological offices 6 observation stations with 3 data loggers 72 newly established rain stations	Applies local models and Regression Analyses and Sogreah Model Analyses for prediction 3 days of water level prediction and warning Communication by radio, messenger Data sent to MRCS by facsimile Receive water level data of 4 countries sent by MRCS
Indonesia	Weather	Bureau of Meteorology and Geophysics (BMG) Application of Stochastic Models and ARIMA for weather prediction Assisted by the application of RAINMAN software from Australia	2 seasonal forecast and monthly forecast in the SFA, dry season forecast (before March) and wet season forecast (before Sept) Takes into account ENSO parameters for seasonal forecast
Lao PDR	Weather and Flood	Department of Meteorology and Hydrology (DMH) 74 hydro stations 86 rainfall stations 34 meteorological stations Water Administration Division (WAD) 64 hydro stations 23 rainfall stations	Hydrometeorological data collection Daily and long range forecast Provide hydrometeorological services to Ministry of Agriculture, Forestry and Environment Data transferred from local stations by messenger, post, television, internet Hydro meteorology data collection Data from WAD forwarded to MRCS by email and fed in computers
	Typhoon	World Area Forecast Center, Bracknell, Regional Specialized Meteorological Center (RSMC)	Supplies tornadoes warning Low resolution meteorological satellite receives satellite photos from GMS-5 Warning disseminated through the Bangkok node
Philippines	Weather, Typhoon	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) 60 synoptic stations that send daily weather data to central forecast office Global spectrum model used to analyse and results translated into weather forecasts	3 hourly weather observation Weather map as a tool for distribution of atmospheric pressure, wind temperature and humidity Hourly satellite images from GMS-5 and cloud coverage Data sent from synoptic stations via single band radio, telephone, email 6 hourly weather observation sent to other countries, RSMC and Global Telecommunication System (GTS)
	Flood	Flood Forecasting Bureau (FFB)	Monitoring and data collection from rain gauges and sent to Central Flood Forecasting Office. Flood forecasting models used for analyses of flood situation
Vietnam	Weather, flood	Hydrometeorological Services (HMS)	Prepares weather and flood forecast Operates a high resolution satellite image receiving system and five radar system 2 regional hydrometeorological centers Plans for flood hazard zones in under a UNDP/USAID project and a flood alert system on river basin most vulnerable to floods

8.3 Hazard Warning and Dissemination

The dissemination of weather and flood forecast needs improvement in most of the selected countries. Dissemination systems exist but require support to improve communications, which is a vital component of warning dissemination. The main constraints for warning identified in the study are: resources, cooperation and management efficiency, communication problems, limited scientific and technical understanding, and lapses in public awareness.

In Philippines, with respect to warning and communication system, not all communities (LDCC) have access to public warning, and communication hardware and the quality of audibility is poor. Table 8.2 provides an overview of hazard warning and dissemination capacity in the selected countries.

Table 8.2 Hazard warning and dissemination

Country	Hazard/ Responsibility	Warning	Dissemination
Cambodia	Flood National Center for Disaster Management (NCDM)	Two level of flood warning. flood advisory and flood warning	NCDM transmits information on flood situation, through a sub-national committee on disaster management Up till the village level Tools commonly used are fax, messenger, and telephones Hand held radio used by district offices but not maintained
Indonesia	Floods Disaster Coordination Center (POSKO)	POSKO issues the warning with information on type of flood, time and place of occurrence, effect of the flood, steps to be taken, and maps of flood prone areas BMG is responsible for seasonal forecast	POSKO relies on media to disseminate information (extensive briefing on radio, TV and newspapers) on existing conditions and river heights Informal and community networks also serves as an important medium for warning dissemination Provides a published document on total rainfall intensity for wet and dry season, and also seasonal forecast for the Seasonal Forecast Areas (SFA)
Lao PDR	Weather, Tropical Storms NDMO	For rainy season forecast issued twice a day During inclement weather forecast is issued 3 times a day Typhoon warning contains the typhoon characteristics, risk on people, recommended action to prevent and mitigate	Warning sent to a number of media (for further dissemination), all levels of government, ministries and private companies Mobile phones and high frequency radio receivers
Philippines	Tropical Cyclone PAGASA	3 categories of tropical cyclone warning: Weather advisory, Tropical cyclone alert, and Tropical cyclone warning 3 categories of flood bulletin: flood outlook, flood advisory and flood warning	Multi-pronged dissemination scheme Public receives information directly by PAGASA or TV broadcast, regional warning centers and dam offices
Vietnam	Flood Provincial Dyke Management, Flood Control and Strom Preparedness (PDMFCSP)	NA	Village radio communications Loud speakers in communities

Effective communication channels between local meteorology and climatological agencies, other relevant agencies and stakeholders in potentially affected sectors needs to be set up with some urgency in order to facilitate appropriate means of dissemination of warnings and other information

8.4 Community Response

Public awareness programs exist at varying levels in the all the selected countries but are insufficient to create a significant impact at the community level. There is good amount of awareness, though people are unable to quantify the would-be impact of the disaster due to lack of technical knowledge and low priority to disaster. The ability to assess impacts is essential to the formulation of effective and appropriate response strategies. Therefore, there is a need for a public awareness program that takes into consideration the most effective means to reach the public.

Communities show a high level of resilience and act from experience or on instinct to survive. In the study conducted, there were cases where communities hesitated to evacuate to safer places due to their reluctance to leave their personal properties. The case study from Indonesia is a good model of how the community can be a part of an early warning system.

8.5 Recommendations

Early warning can be an effective tool for mitigating the negative impacts of climate related hazards. However, mitigation should be viewed as one part of an integrated disaster management system that includes sustained attention to risk management and mapping of vulnerable communities.

There is an urgent need to promote community-based early warning systems based on maps of the vulnerable areas of villages, provinces and districts.

Effective disaster management also requires coordination and cooperation between responsible agencies, institutions, officials, the media, political leaders and other players at local, national and international levels.

With the improved capacity of most countries in establishing the early warning system, there is need to move towards a proactive approach and development of effective national and regional frameworks to facilitate prompt action. This can be realized through improved communications, mobilizing government support, raising awareness (impacts, safety measures, mitigation options and EWS) and building on existing knowledge and institutional structures and programs.

With growing international attention to climate change and climate related hazards, the public has become more aware of the importance of disaster mitigation, but sustained political will is the most essential ingredient to establishing effective early warning capacity. Substantial progress may be achieved by capitalizing on momentum generated by international, regional and national level projects.

With respect to seasonal and long-range forecasts, there is a need to enhance the technical infrastructure and capacity to produce, interpret and communicate seasonal and long-range

forecasts. This need is most urgent in Cambodia, Lao PDR and Vietnam but the Philippines and Indonesia can benefit greatly from additional technical support as well.

One way to strengthen existing Early Warning Systems is through ensuring the availability of trustworthy El Niño forecasts. Better forecasts will require application of new advances in modelling (statistical and dynamical) that enhance skill in downscaling, improve lead time, establish a community of trained technical personnel capable of forecasting, understanding the impacts of disasters and communicating this critical information to decision makers.

In most countries the dissemination systems exist but are not maintained, in part because the sporadic incidence of hazards can lull decision makers into a false sense of security. Though in most countries the dissemination structure extends to the local level, the communication infrastructure is not effectively used. The reasons for the breakdown in communications need to be examined more closely and specific gaps need to be identified and bridged.

As warning for hydrometeorological hazards is limited to the capacity of the existing infrastructure to forecast potential disasters, the mutual exchange and cooperation between the five countries would serve as an important tool for efficient early warning.

Finally, effective communication channels between local meteorology and climatological agencies, other relevant agencies and stakeholders in potentially affected sectors need to be set up with some urgency in order to facilitate appropriate means of dissemination of warnings and other information.