THAILAND COUNTRY REPORT: FLOOD FORECASTING AND WARNING SYSTEMS IN THAILAND

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1. GENERAL BACKGROUND

The Lower Mekong River Basin is divided into 10 sub-areas (SA) based on the hydro-logical conditions and country boundary. The Mekong river basin's part in Thailand includes SA-2T (covering Kok and Mekong river basins in the North), SA-3T (Mekong river basin in the Northeast), SA-5T (Chi and Mun river basins), and SA-9T (Tonle Sap sub-basin). Figure 1 depicts the location and general feature of the Mekong river basin's part in Thailand. These 4 SAs covering the total area of 188,645 km^2 in 21 provinces which is 37% of the country's total area and serve 23.6 Million riparian people or approximately 38% of the country. The areas of the SA-3T, SA-5T and SA-9T constitute the whole area of the Northeast of Thailand. The Chi and Mun river basins in the SA-5T are the significant river basins having large catchment areas that constitute 23% of the total area of the country.

2. AN OVERVIEW OF THE 2005 FLOOD

The 2005 flood in the Mekong river basin of Thailand is not much distinguishable from floods in the recent years. The 2005 flood in the Northeast compared with floods in the North and the South was less severe. Large flood was not reported in the SA-3T, SA-5T and SA-9T. However in the downstream sections that close to the mouth of the Mekong river, especially in the SA-3T, the areas were suffered from inundation problems caused invasion of high backwater of the Mekong river that occur recurrently in the flood season started from August to the beginning of September. In the SA-2T large flood were re-ported due to heavy rainfall caused by storms and typhoon. Six remarkable flood events occurred in 2005 in the Mekong river basin caused by two tropical storms (Washi and Vicente), three depressions, and one typhoon (Damrey). The most severe flood event in 2005 caused by the Damrey typhoon that affects the North, Northeast, and Central regions of the country.

Flood in the SA-2T, especially in the Kok river basin, is normally classified as flash flood which is specific from flood in the areas along the Mekong river in the Northeast. High intensity and long period of rain that causes inundation in the catchments and over-bank flow on the flood plain of the rivers are the major causes of flooding in the SA-2T. Figure 2 shows inundation in Chiang Rai province resulted from flash flood. It was re-ported on Jul 31, 2005 that flood in the Chiang Rai city was 1.0 m height as a result of Washi storm.

Flooding in provinces along the Mekong river, especially in SA-3T, is normally caused by heavy rainfall in combination with invasion of backwater of the Mekong river. In 2005 five provinces along the Mekong river in the northeast namely Nong Khai province, Nakhon Phanom, Mukdahan province, Amnat Charoen, and Ubon Ratchathani province were affected by the combined flood. In particular Nakhon Phanom province and Mukdahan province were most affected. The major cause of flood in this region in 2005 was invasion of high backwater of the Mekong river resulting from excessive rainfall in the upstream basin in association with high flow in the tributaries resulting from excessive rainfall in the basin. Figure 3 show inundation in Mukdahan province and Figure 4 show satellite images of inundation in Nakhon Phanom province.

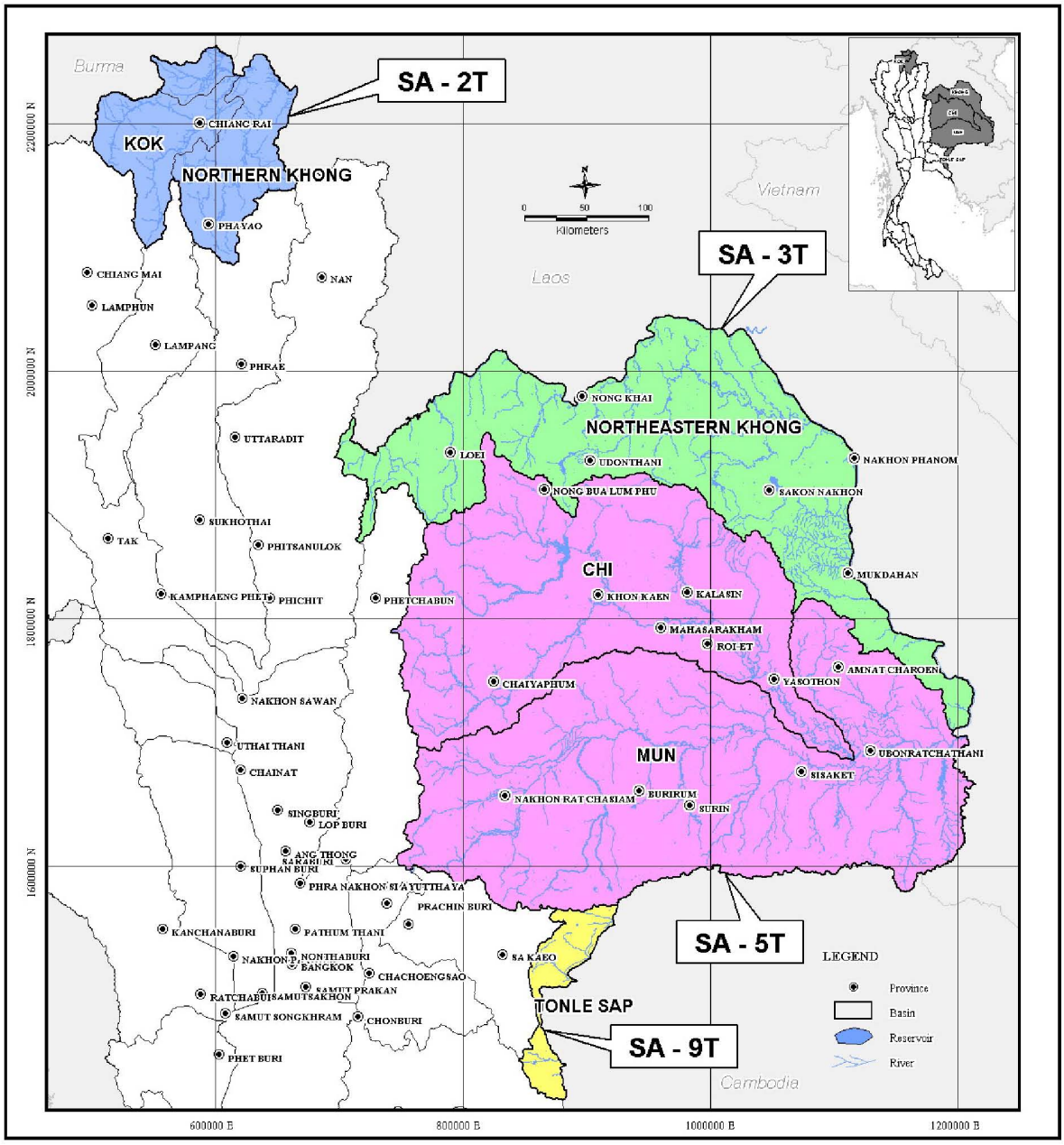


Figure 1 Location Map of Mekong River Basin in Thailand Figure 2 Inundation in Chiang Rai province in August 2005

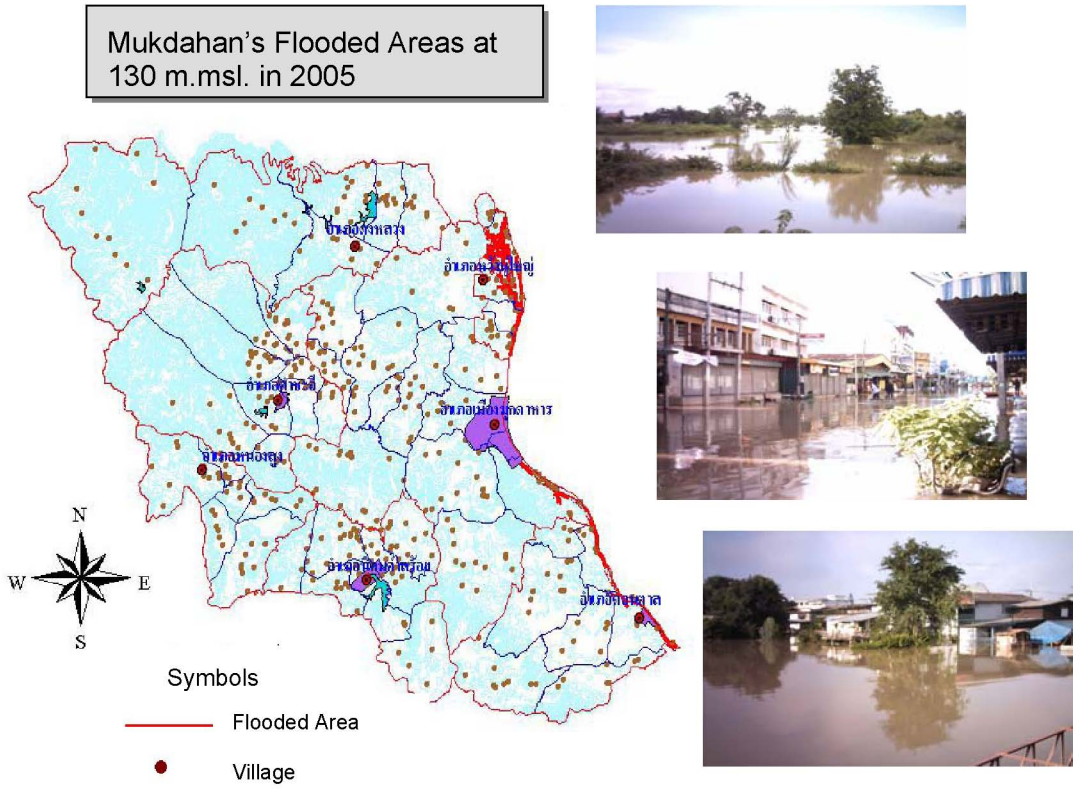
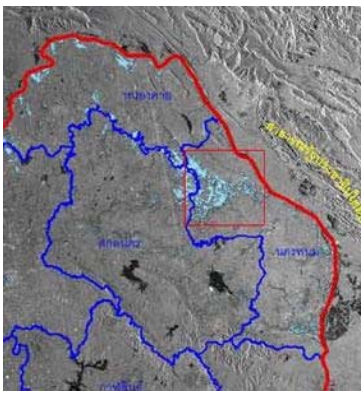


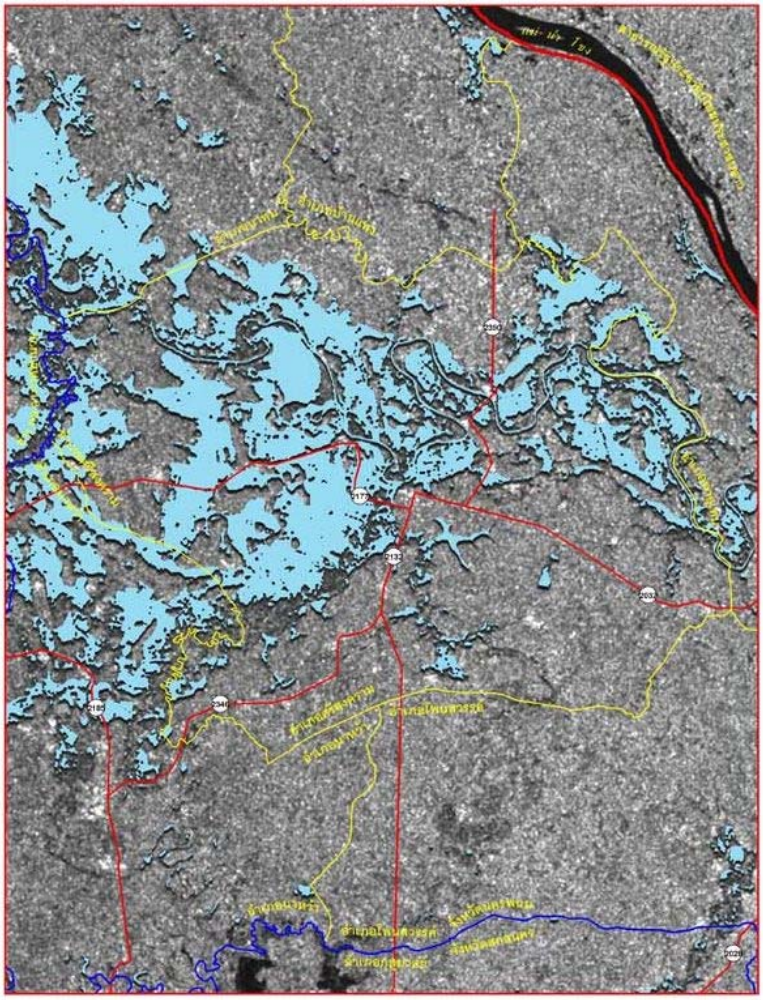
Figure 3 Inundation in Mukdahan province in August 2005

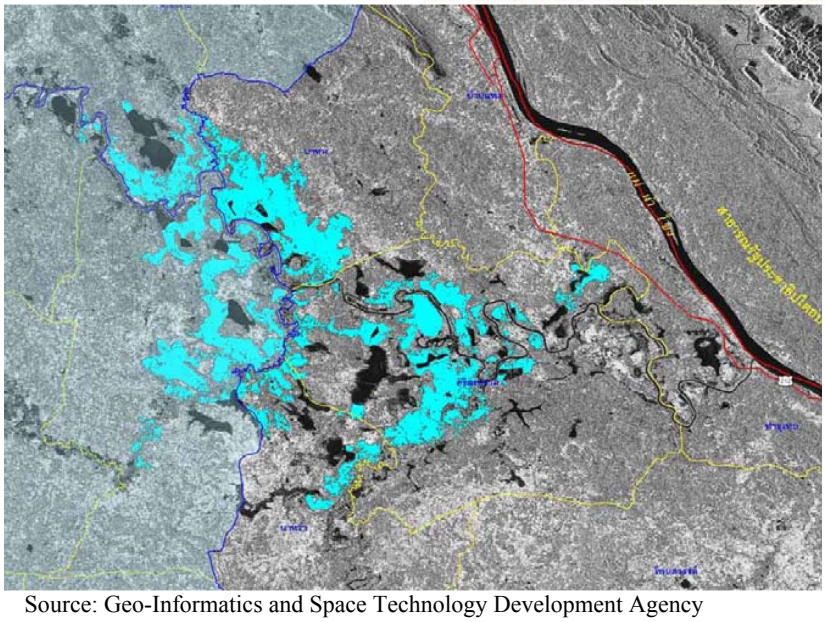
2.1. Hydro-meteorological Characteristics of the Flood

Floods in Thailand are normally caused by tropical storms and depressions, rarely by typhoons. The tropical storm season starts from May to November. During the first two months and the last month of the season, the probability of storms occurring in the country is minimal. It rises during August to September where the probability is maximal. The most common storm track is westward from the north-east of Thailand. It causes heavy rain in its passage over land. The low-lying areas of the central plains usually have the flood condition according to the intensity of heavy rain during the storm season. Figure 5 shows isohytal rainfall map and average monthly rainfall distribution in each sub river basin in the Mekong river basin. Generally, the amount of rainfall in the SA-5T is less that those in other sub-areas.



Satellite Image by RADASAT-1 Showing Flooded Area in Nakhon Phanom province on 23 August 2005

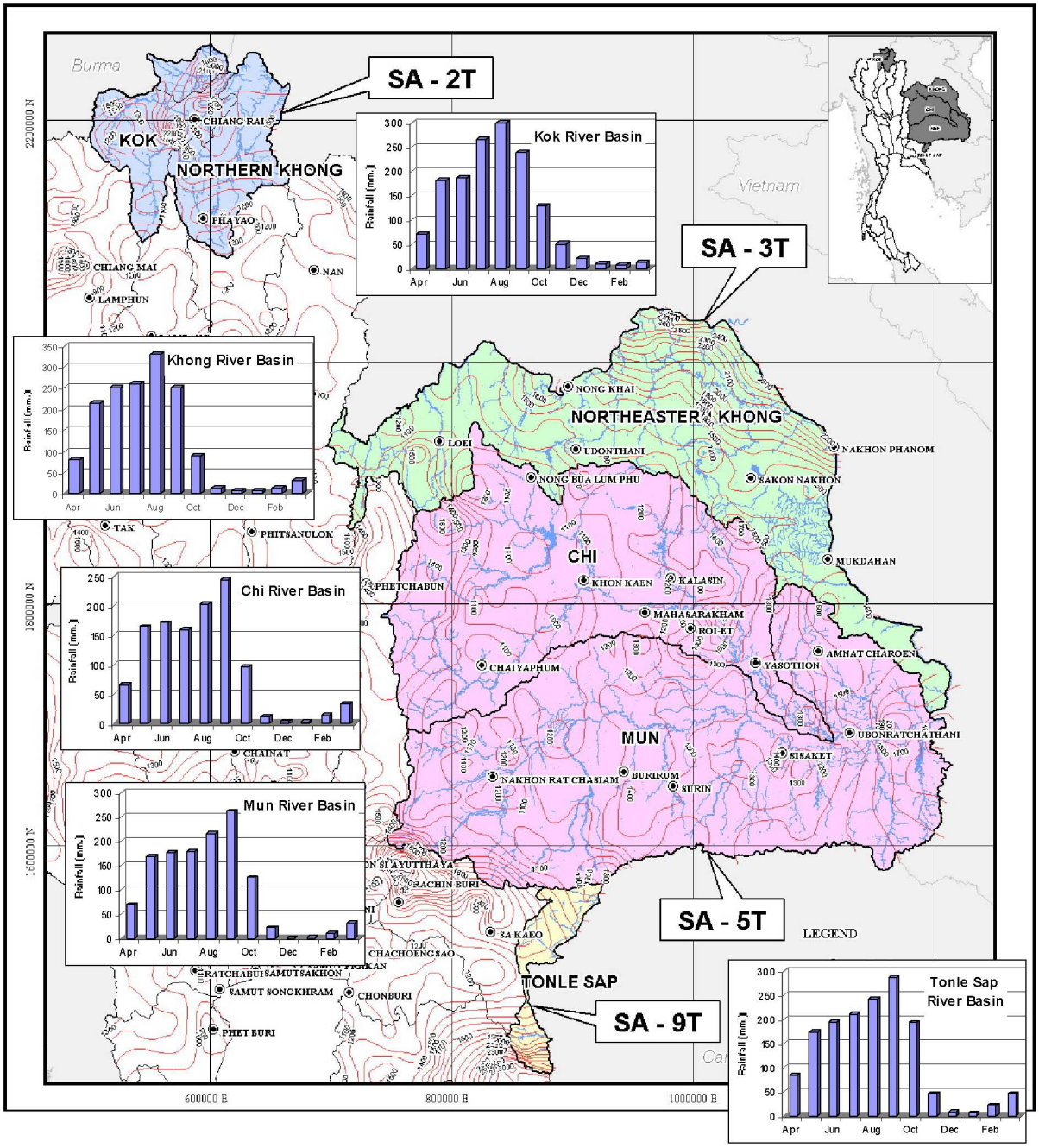




Satellite Image by RADASAT-1 Showing Flooded Area in Nakhon Phanom province on 23 September 2005

Source: Geo-Informatics and Space Technology Development Agency

Figure 4 Satellite Images showing inundation in Nakhon Phanom province in 2005 Figure 5 Isohytal Rainfall Map and Average Monthly Rainfall Distribution



In general flooding in the northeast and the tributaries of the Mekong river is a recur-rent flood event. Three kinds of flood appear in the Mekong river basin in Thailand that include:

1) Flash flood which is the result of heavy or excessive amounts of rainfall within a short period of time, causing water to rise and fall quite rapidly. The duration of flash flood is limited to a few hours to a maximum of a few days.

2) Flood caused by high water level in the Mekong main stream in which the water may overflow in lower sections of the embankment or local backwater may happen in ditches or small tributaries. The period of flood is limited to highest water level in the Mekong, generally not more than one or two weeks,

3) Combined flood that occurs in the downstream section of large tributaries, close to the mouth with the Mekong. Severe flood in the area along the Mekong river is normally the result

high flow in the tributary and high water level of the Mekong river. When the water level of the Mekong river is high, backwater flows into the tributaries preventing or slowing down the drainage of those tributaries to the Mekong river.

In addition, topographical characteristics of the basins, insufficient capacity of rivers and canals or shallowness of major and tributary rivers, and obstruction of water ways by Intrusion of man-made infrastructures and destruction of forests are other factors that speed-up the severity of the above-mentioned floods.

2.2 Summary of Positive and Negative Flood Effects

Flooding is a natural hazard which affects population's quality of life and the country's economy. The recurrent flood has become an essential element in the life of the people. People in a recurrent flooded area have learned to live with floods. However, floods of high magnitude sometimes cause loss of life and damages to cultivation, properties, infra-structures, human settlements, and essential services

Low to medium flood is beneficial to living conditions in the region. People do not feel like that they are affected by flood. In contrast, fishing activities during flooded period and subsequent fertile land after flooded are benefits for their livelihood.

Floods of higher magnitude, for instance, the flood in 1966, caused devastating dam-age to development efforts of the country. Floods in 2005, as same as floods in other years, cause damages to agricultural lands, fish ponds, livestock, and infrastructures (roads, bridges, etc). People died during flood sometimes not directly caused by flood but by any circumstances related to flood, for instances, thunderbolt, electricity shot, etc.

In Thailand, people who suffered from flood obtain different aids from various agencies, e.g. food, necessary things for living, sand bags for flood protection, pumping, etc. Losses in agricultural productions are compensated in cash or substitutions such as seeds, breeds, etc.

2.3 Lessons Learned

As mentioned above, people living in the Mekong river basin is familiar with the regular flood cycle. The recurrent flooded areas in flood plains or wetlands are acceptable. Though the recurrent flooded areas are recognized, people are still growing rice in those areas perceiving that some or all areas may be lost by the annual flood. Although compensation given for their damaged land is just about 1/4 of the total investment, people are willing to face the risk as they have no other choices to manage the land. The dramatic increase in the world's population creates the necessity to settle in risk prone areas.

Regulators at some mouths of the tributaries are requested to be constructed to pre-vent invasion of high backwater of the Mekong river. Besides, people who live just beside the bank of the Mekong river strongly request embankment protection or dike because the bank along the Mekong river is dramatically destroyed year by year by the flow current.

3 National Forecasting and Warning Centres

Early warning and forecasting is a prerequisite for efficient emergency response and contingency action planning. Structural engineering measures alone cannot completely overcome floods: no matter how high the design standards are, there is always the possibility of higher floods exceeding the standard. Flood forecasting and early warning is the most effective non-structural measure to reduce the loss of life and property in vulnerable areas, especially in the inner floodplains.

3.1 Current Status of National Centers

At present a center that legally performs both forecasting and warning at national level does not exist. However, National hydrological monitoring, forecasting and warnings have been developed by many national agencies. The Thai Meteorological Department (TMD) undertakes country meteorological investigation and weather forecasts and warnings. The Electricity Generating Authority of Thailand (EGAT) undertakes hydrological investigation on specific sub-basins where large reservoirs are situated. The Royal Irrigation Department (RID) undertakes hydrological investigation on major rivers and mainstreams as well as operates irrigation water utilities and flood control operations in cultivated areas. The Bangkok Metropolitan Administration (BMA) undertakes hydrological investigation in the lower Chao Phraya river nearby Bangkok as well as implement flood forecast in eastern Bangkok. The Naval Hydrographic Department (NHD) undertakes hydrographic and oceanographic investigation as well as meteorological investigation at the estuaries. Normally monitoring and forecasting products including warnings by above-mentioned agencies are published on the websites.

Furthermore, the flood forecasting and river monitoring system has been established recently by the MRC that provide river forecast to its member countries and that the fore-cast products are published on the MRC website and disseminated to the National Mekong Committees and other concerned agencies. Linkage to the MRC website is established on the RID's webpage.

In addition to the hydrological forecasts, there are also flood preparedness plans and mitigation measures in the basins. The above-mentioned agencies including the Department of Disaster Prevention and Mitigation (DDPM), the Department of Mineral Resources (DMR), the Land Development Department (LDD), are involved in hydrological investigations for flood preparedness mitigation purposes.

After October 2, 2002 Thai government has enacted the Bureaucrat Reform Act 2002, Department of Disaster Prevention and Mitigation (DDPM) has been established under the umbrella of Ministry of Interior (MOI) to shoulder the responsibility of disaster management of the country. Moreover, under the Civil Defence Act 1979 and Prime Minister Office Regulations on National Safety 1995, DDPM is in charge of the office of National Civil Defence Committee Secretariat and National Safety Committee Secretariat.

As the principal agency for disaster management coordination among all agencies concerned at all levels. As regards disaster risk reduction, DDPM shall conduct activities in coordination with other agencies such as: the TMD, the RID, and the DWR.

Moreover, the Thailand's National Disaster Warning Center (NDWC) was officially inaugurated on May 31, 2005 to launch a natural disaster early warning system after the catastrophic tsunami disaster of December 26, 2004 that caused heavy social and economic damages in six southern provinces of Thailand on the Andaman coast those had been affected by the massive waves.

More details regarding duties and responsibilities of major agencies are described hereinafter.

3.1.1 Department of Disaster Prevention and Mitigation

The DDPM is obliged to draft Master Plan, set up measures, promote and support disaster prevention, mitigation and rehabilitation. Disaster prevention and mitigation activities are carried out through establishment of safety policy, prevention and warning system, rehabilitation of disaster devastated area, and the follow-up and evaluation, so as to secure the safety of life and property of the people. Authorities and duties of the Department under the Ministerial Statute 2002 are as follows:

1 Formulate policy, guideline and set up criteria for disaster management.

2 Study, analyze, research and develop the prevention, warning systems and disaster mitigation.

3 Develop information technology system for disaster prevention, warning and mitigation.

4 Mobilize people's participation in establishing disaster prevention and mitigation.

5 Create people's awareness and preparedness in disaster prevention and mitigation.

6 Among the training and exercise in disaster prevention and mitigation, rehabilitation devastated area and in assisting the victims as stated by law.

7 Promote, support and carry out disaster prevention and mitigation activities, provide assistance to the victims and rehabilitate devastated areas.

8 Direct and coordinate the operation of assisting the victim and rehabilitate devastated.

9 Coordinate the assistance with the organizations both internal and international in disaster prevention relief mitigation and rehabilitation.

10 Perform any other functions as assigned by the Ministry of Interior or the cabinet.

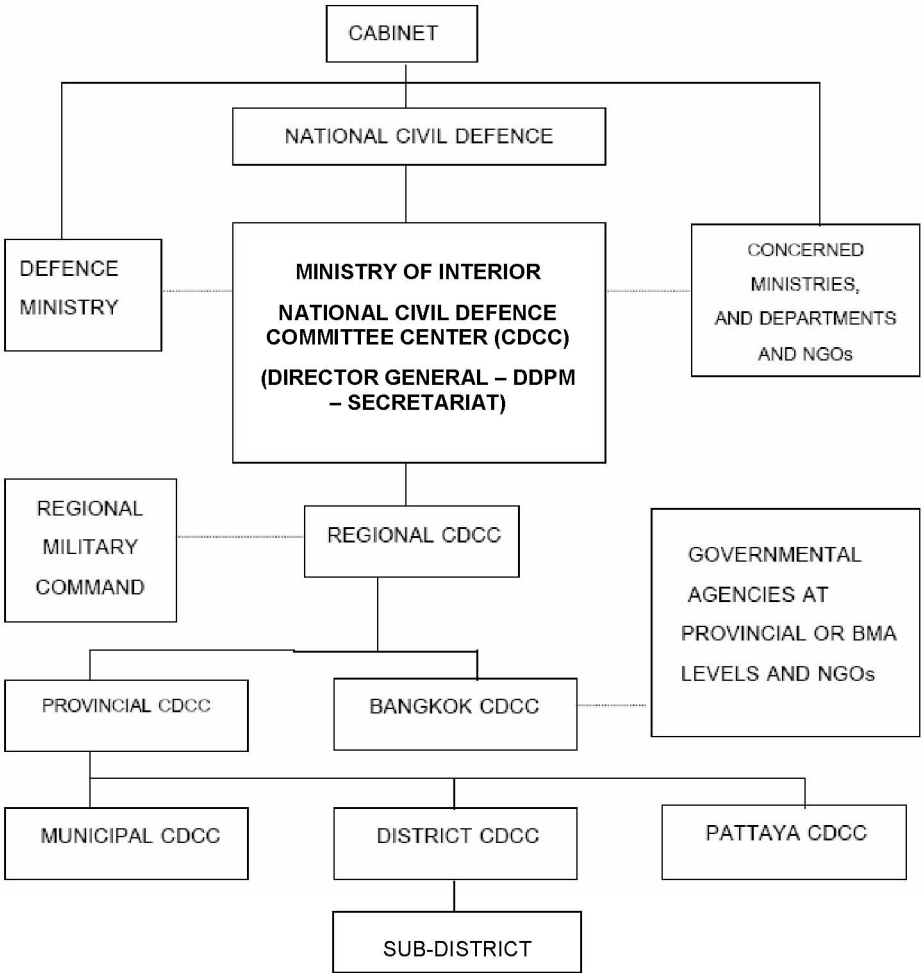


Figure 6 Legal Structure of Disaster Management according to the Civil Defence Act 1979

The legal structure of disaster management according to the Civil Defence Act 1979 which is followed by line authority of warning activity is shown in Figure 6. This disaster management system comprises 3 levels: national level, regional level and local level:

3.1.2 Thailand's National Disaster Warning Center

The NDWC is responsible for planning, coordinating, controlling, implementing and preparing the national warning systems and equipment including studying the technical expertise to disseminate knowledge to public and related agencies for reducing disaster impacts and mitigation disasters effectively.

With staff on duty 24 hours, the newly-established NDWC functions as a centralized information centre receiving, monitoring, processing and relaying critical information on impending natural disasters round the clock.

To facilitate timely data exchanges and updates, Thailand's Early Warning System information network is linked into the information networks of the TMD, the DMR and the NHD and receives data on seismic activity from these agencies. It is also linked into the information networks of other state agencies comprising the DDPM, the Department of Fisheries (DOF), the RID, the Department of Maritime Transport and Commerce and the EGAT.

The NDWC is also linked into international information networks such as those of disaster prevention and mitigation agencies like the Pacific Tsunami Warning Centre in Hawaii, the US Geological Survey and the Japan Meteorological Agency.

In the event that there is a high probability of a tsunami incident occurring, a warning for high risk areas around Thailand will be issued. Data will be relayed immediately via satellite. Once a warning has been issued by the center, television and radio stations will immediately cease broadcasts of on-air programmes and commence their broadcast of the disaster warning. The diagram of early warning system at NDWC is illustrated in Figure 7.

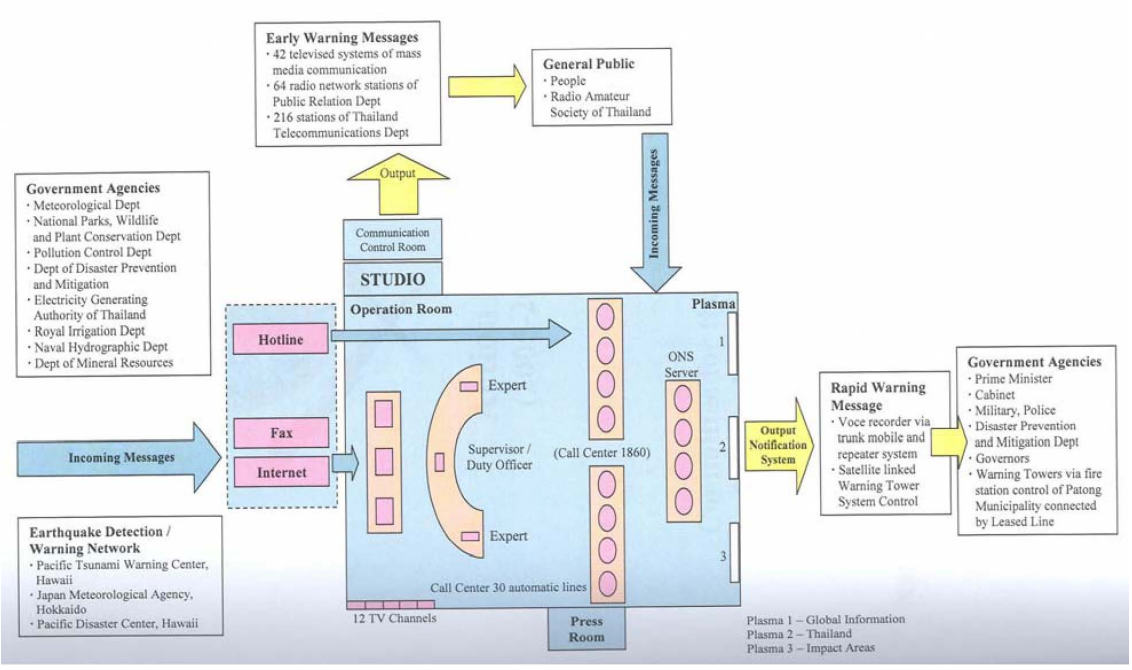


Figure 7 Early Warning System at National Disaster Warning Center, Thailand

To achieve the widest coverage within the shortest possible time, warnings for high risk areas will also be transmitted simultaneously via the nationwide radio network, Channel 5 army television network, the state-operated television pool, as well as via SMS to some 20 million cellular phone users.

While the NDWC will initially focus exclusively on monitoring earthquakes and tsunamis, it is also equipped to handle, at a later stage, a variety of natural disasters such as to monitor and issue warnings for storms brewing in the Gulf of Thailand, forest fires, floods and air pollution.

3.1.3 Water Crisis Prevention Center

To prevent and control the water crisis, the DWR has established the Water Crisis Prevention Center in 2003 for an effective remedy by undertaking the following work plans and activities.

1 Study, analysis, identification of risk areas to natural and man-made water disaster.

2 Recommendations on setting up master plan for water crisis prevention and mitigation together with the implementation study, for instance,

3 Surveillance and warning system: flood, drought and water pollution forecasts, together with quantitative and qualitative managements, for instances,

- Establishment of War Room to cope with the water crisis. Focusing on the flood, drought and water pollution monitoring and assessment, the Owner-Custodian-User operation system is implemented and shared by water related agencies, for example the RID, BMA, etc., as information owner responsible for data updating while the DWR, as custodian responsible for identifying 4 user levels: internal user, commercial user, institute and academic user, and public user.

- Study and detailed design of the telemetry warning system to be installed in some urgent areas.

- Preparedness for public relations and press release in both normal and emergency situations. The officials in charge are trained in simulated floods in order to be able to efficiently and accurately report real time incidents.

- Study on the water crisis mitigation project in other basins such as Chi-Mun river basins.

3.2 Flood forecasting and warning system

A flood forecasting and warning system (FFWS) integrates the data collection system, data communication system, data management system, and computer modeling system to accurately forecast the amount of flooding that may occur in an area. The FFWS consists of real-time rainfall and water level data collection (through telemetry system) at the selected stations in the river basin. The data is transmitted to the central computer at the master station over radio links, lease line, GPRS, or satellite. In addition to rainfall and water level data, the communication system is also used for transmitting alarms, system status, diagnostics, and error logging information from the remote stations to the control center and vice versa. The information collected at the control center computer is then in-put into a modeling software system capable of predicting flood elevations and inundation extents.

In the area of flood forecasting there is extensive cooperation between various concerned departments. Presently, there are five main agencies undertaking the flood fore-casting (including rainfall forecasting) in the major river basins where the flood damages are frequently occurred.

These five agencies consist of the RID, the TMD, the EGAT, the DWR, and the BMA.

3.2.1 Telemetry and Flood forecasting systems in the Mekong river basin (Thailand)

Up to present only two telemetry systems have been installed in the Mekong river basin of Thailand. Both systems are located in the SA-5T and operated by the EGAT. The location of these present telemetry stations are shown in Figure 8.

The telemetry system in the lower Mun basin (Pak Mun dam) was completely established in 1995 after the accomplishment of the Pak Mun dam in 1994. The purpose of the system is to monitor the amount of rainfall and water level in the Mun river at the upstream part of the Pak Mun dam and nearby locations for real-time inflow forecasting and reservoir operation in order to avoid potential adverse environmental impacts of the new dam.

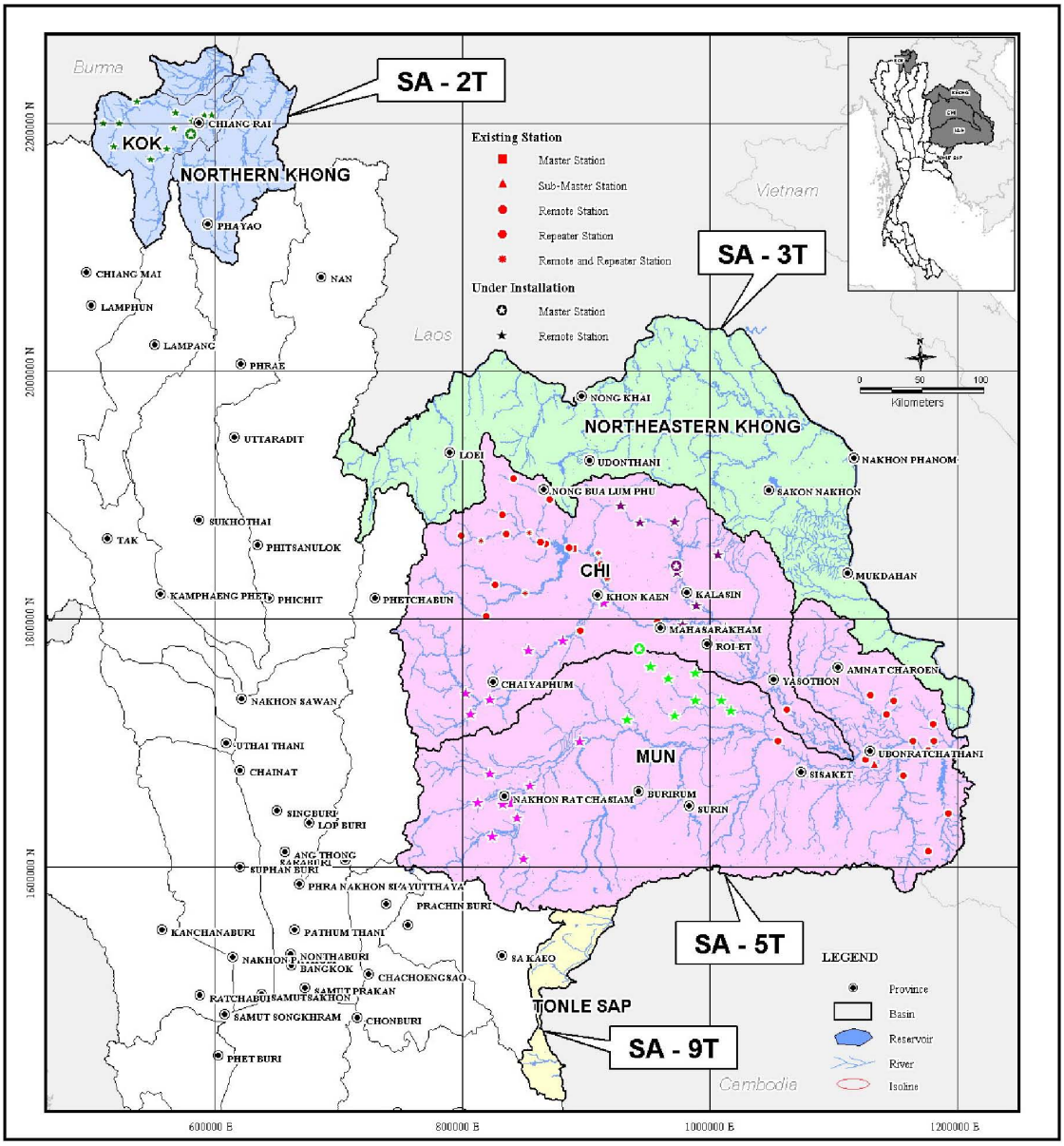


Figure 8 Location Map of Telemetry Systems in the Mekong River Basin

The telemetry system of the Ubon Ratana dam, Khon Kaen province was completely

established in 2005. The purposes of the system are to 1) manage water resources at up-stream and downstream parts of the Ubon Ratana dam, 2) monitor the amount of rainfall and water level, and 3) operate the reservoir in order to avoid flooding at the edge of the reservoir together with control over bank flow of the Nam Pong river at downstream part of the dam.

Currently there are three agencies undertaking installation of telemetry and flood fore-casting systems in the Mekong river basin (see Figure 8)

In the SA-5T, the DWR is installing telemetry systems in the upper Chi and upper Mun river basins (with regional information centers). The RID is installing a telemetry system at Lam Pao river basin (in Chi river basin) for real-time flood forecasting and water management in the basin. In the SA-2T, a flood forecasting and warning system is being developed by the TMD in the Kok basin. The system comprises a master station in Chiang Rai province and other 11 remote stations.

In addition, in the SA-5T the RID has already studied and planned to install telemetry systems in the Chi-Mun basin and Sieo Yai river basin (in Mun river basin).

3.3 Unmet needs for forecast and warning product dissemination to flood-at-risk communities

Though flood forecast and warning product have been developed by many agencies including the MRC and published on websites, access to this information is limited only to the concerned agencies and people who are able to reach internet connection. People who are not able to access to internet or living in remote areas receive information from their leaders of sub-district/village according to the local line agencies of warning activity. Unfortunately dissemination of those information warning does not cover all vulnerable areas yet. However, information regarding flood and warnings can be obtained via television and radio networks. In addition, since some people become familiar with the Mekong river's behavior, they are able to prepare themselves, at some level, for the incoming flood by investigating variation of the Mekong water level and/or surrounding environments.

3.4 Aspect of the centre-community relationship that must be strengthened

As yet the relationship between national centers and communities are quite far directly related. Continued efforts by the concerned agencies to educate the public regarding the occurrences and destructive force of floods are essential. Community monitoring, detection, and warning programs with emphasis on individual warning responses are advantageous. Real-time feedback from local designated persons or authorities to the center offices as to the hydrological and meteorological aspects of flood development will make a more effective warning system. Furthermore, coordinated dissemination and preparedness programs that involve community and center initiatives will remain essential for effective flood hazard mitigation.

However lack of accessibility to timely information is still great obstacle to local communities. Establishment of a community communication center together with capacity building to community should be enhanced. A working group specific on flood issue can be possibly nominated to carry out any related flood works e.g. dissemination of flood forecasting and warning information, claiming damages to property to concerned agencies, present opinion on policy, plan, and resolution of flood problem, coordinate, follow up and monitor the operation of the centre, etc.

4 RECOMMENDATION PRAGMATIC WORKING ARRANGEMENTS BETWEEN NATIONAL CENTRES AND THE MRC RFMMC

Although there have been frequent floods of great magnitude affecting millions of people and causing immense damage to public properties and infrastructures, in the absence of any existing agreement among the riparian countries regarding sharing of meteorological and hydrological

information, the efforts made so far in individual countries in the area of flood forecasting and warning have been only partially successful and less than effective.

Sharing of technology, knowledge and experiences in flood forecasting, risk assessment, preparedness, emergency response, policy, plans and resolutions of flood problems among riparian countries and MRCs should be further strengthened as well as communication/sharing of real-time hydro-meteorological data and forecasting products among riparian countries and MRCs should be enhanced.

More efficient and wider dissemination of information in regard to flood disaster management is a matter of great urgency where the attention of concerned national governments and international agencies should be further focused.

5 OTHER NATIONAL SUGGESTIONS ON FORECASTING AND WARNING

- Technology should be shared among all agencies involved in flood forecasting and risk assessment both in national and basin levels.

- As several agencies are involved in developing and operating flood forecasting and warning, a national network of flood forecasting and warning system which provide information of a consistent quality, which are regularly updated and transmitted in real time to authorities and public using internet and other modern data transmission technologies must be established. The national hydro-meteorological information system will be coordinated with existing information networks and databases at national, regional and international levels.

- Several mathematic models are presently commercially available in flood fore-casting and management models those have been already using in different basins as well as different formats and types of database, integration of the flood forecasting systems and database into a national system in future must be care-fully considered.

- Further improvement of flood forecasts for more precise and reliable information is needed.

- As different telemetry systems are developed in different locations by different agencies, linkage of the existing systems and the incoming systems to the adjacent systems in the same basin should be further focused.

- Training in the use of the newly introduced technology is essential, but the opportunity can also be taken to provide refresher training in more conventional hydro-logical skills, as well as in non-technical areas such as administration, public relations, marketing and customer service.

- Capacity building to the operational staffs to achieve effective operation and maintenance and avoid the difficulties as well as assure long-term sustainability should be strengthened. In addition, encouragement of persons in charge of monitoring is recommended.

- An effective flood forecasting and warning service needs good cooperation among concerned agencies and public, information technology must be supplemented with an effective communication system to reach remote communities, which are vulnerable to flood.

- Dissemination of flood warnings must be improved, largely in response to the enhanced coverage and attention of the local commercial media. Public response to warning will be

improved if individual streams are identified in the warning messages.

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