An overview on Flood 2006
&
Flood Hazard Mapping Related Problems in Thailand and Cambodia
Based on Field Survey, December 10-16, 2006

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PART- I

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1. Introduction

The International Centre for Water Hazard and Risk Management (UNESCO-ICHARM/PWRI), a global platform for innovations in water related disaster management, is much concerned about flood problems all over the world. The International Technical Exchange Team of ICHARM has been contributing to the goal by providing trainings and promoting flood hazard mapping practices in developing countries. In order to examine the current flood related problems thereby to conduct need assessment of flood hazard mapping, ICHARM has conducted a field survey in Thailand and Cambodia during 10-15 December, 2006. In Thailand, 32 provinces were severely attacked by floods this year (2006), leaving 164 people dead and affecting more than 2 million people. In Cambodia, flood caused not extreme damages like in the past, however prolonged turmoil paralyzed the normal life in most flood prone communities. Pursat and Kampong Cham provinces in Cambodia were among the extremely affected areas, where some people lost their lives. The main target of this field visit was to collect flood hazard mapping related information through interviews and site inspections, so that the best practicable strategy can be recommended to promote flood hazard mapping in each country. In addition, gathered information is expected to be helpful in developing flood hazard mapping manual for each country. Since the flooding season in this region especially in visited countries lasts in November, the field survey was planned accordingly to match the timing to observe the impact and to collect the damage information of the year. The survey team of ICHARM included five members including three from consulting company namely CTI Engineering Japan. In Thailand, the team interviewed some engineers in central and regional Royal Irrigation Departments (RID) and visited Sonkhla province and Hat Yai city in the south. In Cambodia, the team interviewed concerned managers at Department of Hydrology and River Works (DHRW) and visited Pre-Veng and Pursat provinces. The detail program schedule can be found in Annex I.

2. Thailand

2.1 Flood Situation-2006 in Thailand

In Thailand, the monsoon season brings heavy rainfalls from May to October, in which the country receive huge amount of its annual rainfall. Although, some studies have found that the mean annual discharge in some rivers such as Chao Phrya river in Thailand

is decreasing due to the decrease in mean annual rainfall (Tebaraki et al., 2003), the flood havoc is increasing irrespective to the annual discharge change trends. In year 2006, many parts of Thailand are attacked by severe floods likewise as it happens in the past (Annex II). Based on the survey report prepared by World Heath Organization (WHO, 2006), 32 provinces (217 districts; 1,302 sub-districts; 7,372 villages) were severely attacked by floods this year, leaving 164 people dead and affecting more than 2 million people. The total property loss was estimated at US$9.94 million excluding the damages to farmland, houses and personal belongings. The most affected provinces are Phra Nakhon Si Ayuttaya, Nakkon Sawan and Sukkothai (Fig. 1) as reported by United Nations Office for the Coordination of Humanitarian Affairs (OCHA, 2006). According to OCHA, The Thailand Meteorological Department issued a warning to the people, those who are living in very risky areas of lower central and southern Thailand especially Surat Thani, Nakhon Si Thammarat, Phatthalung, Songkhla, Pattani, Yala, and Narathiwat (Fig 1). The warning messages were issued continuously during floods 11 - 15 October, 2006. While some parts are facing flood crisis, mountainous parts were highly threatened by massive landslides and mud flows due to heavy downpour. In Chiang Rai, landslide warning was issued immediately after the observation of cracks on hill slopes. According to the Public Affairs Department under the Ministry of Culture Thailand, 75 historical

Table 1: Watershed Areas and Annual Runoff of the Major River Basin in Thailand

1	Part of Salawin	17,920.19	8,156
2	Part of Mekong	57,422.07	15,800
3	Kok	7,895.38	5,119
4	Chi	49,476.58	8,035
5	Mun	69,700.44	21,767
6	Ping	33,891.71	6,686
7	Wang	10,790.74	1,429
8	Yom	23,615.59	1,430
9	Nan	34,330.16	9,518
10	Lower Chao Phraya	20,125.25	4,925
11	Sakae Krang	5,191.43	519
12	Pasak	16,292.24	2,708
13	Tha Chin	13,681.24	2,815
14	Mae Klong	30,863.76	12,943
15	Prachinburi	10,481.32	4,502
16	Bang Pakong	7,978.15	4,900
17	Part of Tonle Sap	4,149.97	1,193
18	East Coast Gulf	13,829.72	25,960
19	Phetchaburi	5,602.91	1,140
20	West Coast-Gulf	6,745.33	1,013
21	Peninsular-East Coast	26,352.78	35,624
22	Tapi	12,224.53	17,380
23	Thale Sap Songkhla	8,494.97	7,301
24	Pattani	3,857.82	3,024
25	Peninsular-West Coast	21,172.25	9,918
Total		512,065.81	214,128

Sources: Office of the National Water Resources Committee (2000)

Table 2: Sub-basins of Chao Phraya River and Annual Runoff

Sub-basin	Catchments Area(km^2)	Total Volume(m^3)
Ping	35,535	9,073
Wang	11,084	1,624
Yom	19,516	3,684
Nan	32,854	11,936
Sakae Krang	5,020	1,096
Pasak	15,647	2,823
Tha Chin	18,105	2,449
Chao Phraya main stream	21,521	4,435
Chao Phraya basin	159,283	37,120

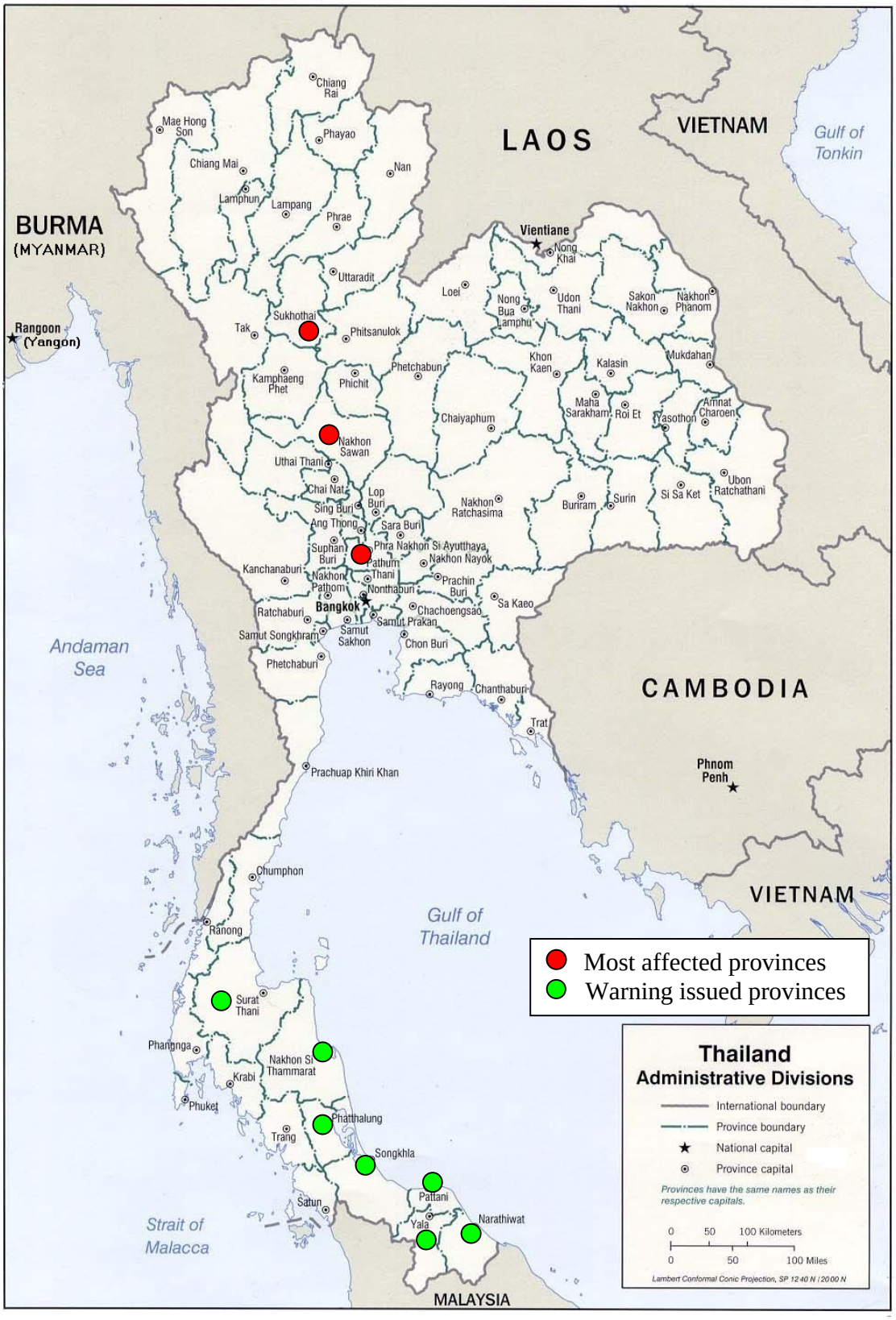


Figure 1. Most flood affected provinces in Thailand (2006)

sites were damaged by flash floods, out of which, 18 are in five different provinces in the North and the remaining 57 sites are in 10 provinces in the central region. According to the government source, government, private, and charitable organizations had sent relief bags containing necessity items to flood victims, whereas vehicles and equipment had also been sent to flood-hit areas for immediate rescue, relief and rehabilitation. The Government instructed provincial governors to reduce or exempt local development tax for affected people (Public Affairs Department, 2006) in the form of preliminary relief kit for the victims.

In Thailand, there are altogether 25 major river basins with total annual run-off capacity

Figure 2. General Map of Chao Phrya River basin, source: WWAR II

of 214 billion cubic meters as shown in Table 1 (WEPA, 2006). Three river basins mainly a) the Mun, b) Peninsular-East Coast and, c) the Chao Phraya are prominent especially for a) the largest watershed area i.e. 70,000 km^2, b) the biggest supplier of annual discharge i.e. 35 billion cubic meter and, c) demographic & economic values respectively. The first part of the field survey that conducted by ICHARM team was focused much on the Chao Phraya river basin.

According to the World Water Assessment Report I (WWAP/UNESCO, 2003), the Chao Phraya basin is the most important river basin in Thailand in terms of its contribution to national economy and its disastrous characteristics. The basin covers 30% of Thailand's land area and is home to about 40% of the country's population, out of which 50% resides in the Lower Chao Phraya basin including highly dense Bangkok Metropolitan Area BMA (Fig. 2). The total population of the Chao Phraya basin was 23.0 million in 1996. The second largest city in Thailand namely Chiang Mai is located in the upper Chao Phraya basin. About 68% of the total population of the basin is rural and majority of them are living in the upper basin. Land use within this river basin is quite diverse, however more than 90% of its territory is covered by agricultural and forest lands. The flow capacity of river sections decreases toward the downstream and maximum flow capacity of river at Bangkok is 3,600 cu. m per second (Sripong et al., 2000). The worst flood stroked the area was of 1995 triggered by storm called "Lois", which caused severe damages in several part of this basin (file Photo 1). The sub-basins of the river and annual runoff of each tributary are illustrated in Table 2.

Photo 1. People awaiting for evacuation support, File photo source: Carrefour

Photo 2. Bank of Chao Phraya River, viewed from hotel's room by R. Osti 11/12/2006

2.2 Field Observation and Interviews

2.2.1 Bangkok

The Royal Irrigation Department under the Ministry of Water Resources has long history of flood management in the country. It is an old and a central national organization that deal with national flood defense activities. Although there are other newly established organizations to look especially after the over all disaster

situations, RID has still been playing dominant role in flood disaster management in the country since its establishment in 1927. On 11 December, 2006, the survey team met some responsible officers in Royal Irrigation Department, headquarter in Bangkok. Discussion was made on several general but important topics of flood disaster management in Thailand including possibility of promoting flood hazard mapping practices in the country. Later, the discussion was focused basically on Chao Phraya river basin. It is interesting to note that there are already five flood hazard mapping practitioners, who acquired FHM training course from ICHARM in different time. It is also known that there are also some other practitioners and researchers who are actively involving in the sectors, however the pace of FHM development is very slow in the country with little or no recognition from the government. The past and present flood situations, situation of flood hazard management, flood related problems faced by public, problems in flood hazard management, recent issues, government's future plan and possibility of promoting FHM were among the topics that were discussed in the meeting. Following are the summary of the discussion.

Flood Situation in Chao Phraya River Basin

1. Most areas of Chao Phraya river basin are highly prone to flood disasters either due to flood inundation or due to flash floods. Flooding occurs almost every year (Table 3) with different magnitude and nature (especially timing) and causes fatalities and much destructions. From the view point of flood characteristics, Chao Phraye River can be sub-divided into three reaches north-upper part, middle part (including Lampang Municipality) and southern part (including BMA). While in upper part, flooding is usually caused by flash floods, the middle part is caused by over bank flows and lower part is caused by over bank flow associated with channel capacity (ref. 2.1) and tidal wave/backwater effects from the Gulf of Thailand. There are some other areas within this river basin, which are often flooded due to the accumulation of huge volume of water from the catchment slopes and triggered by heavy rain-fall. Along the downstream reach especially in BMA, little change in river water level can

Table 3. Past flood damage in the Chao Phraya river basin (million Bhat)

Year	1978	1979	1980	1981	1982	1983
Damage	21.0	3.2	1,549	314.3	224.1	1,104

Year	1984	1985	1986	1987	1988	1998
Damage	323.3	350.3	628.4	832.6	21.0	3.2

Year	1990	1991	1992	1993	1994	1995
Damage	1,549	314.3	224.1	2,181.6	45.9	11,858

Source: Siripong et al. (2000)

cause over flooding in adjacent area due to channel geometry and topography. The difference of water level and adjacent ground level was less than 1m on 11 December, on which the flood was said to be receded by large amount (Photo 2).

2. The main causes of the flooding in this river basin can be classified into three i.e natural (associated with heavy rain), semi-natural (due to the capacity of infrastructures such as irrigation canals) and man-made (uncoordinated urbanization, deforestation, destruction of embankment by residents for so-called risk reduction, ground water extraction etc.). Please refer Fig. 3 to understand the land-use change rate and associated potential damage.

3. Agriculture is the main income source of people living in rural areas. About 2 million hectors of agriculture land is situated in the flood plain area of Chao Pharya River. Usually 5 crops per 2 years is common practice and each hector of land (=6.25 rai, a Thai measurement unit) produces about 22.5 ton rice in one cropping period. Every year, large portion of rice fields is usually destroyed by floods and in many occasions the total harvest reduces significantly due to over flooding. The floating rice culture is not new for Thailand, however due to low quality product, not so many farmers plant floating rice because quality is directly related to its market price. Although they know that there is a risk of damage, people usually grow good quality rice or cash-crops, which are highly vulnerable to the flood. However, along with new agricultural development and flood defense strategy, cultivation time and types of crops are changing accordingly to fit to the natural conditions.
   Damages on agricultural land or product is not only caused by bank over flow of river but also due to the over flooding of irrigation infrastructures such as irrigation canal during heavy rainy seasons. There are some other areas i.e. upland as well as lowland agricultural fields including upland paddy fields, which are directly fed by rainfall and therefore are not depend on canal/river water, having little or no direct influence from the flood.

4. There is no clear definition or classification of flood and related risk levels in Thailand. The word “flood” is used to express the water level raise in the river even below the risk level as well as the inundation in the area.

5. Severely impacted areas in Chao Phraya river basin are mostly located in the up-stream part, where flash flood occurs along with massive landslides and debris flows. Many people were killed by

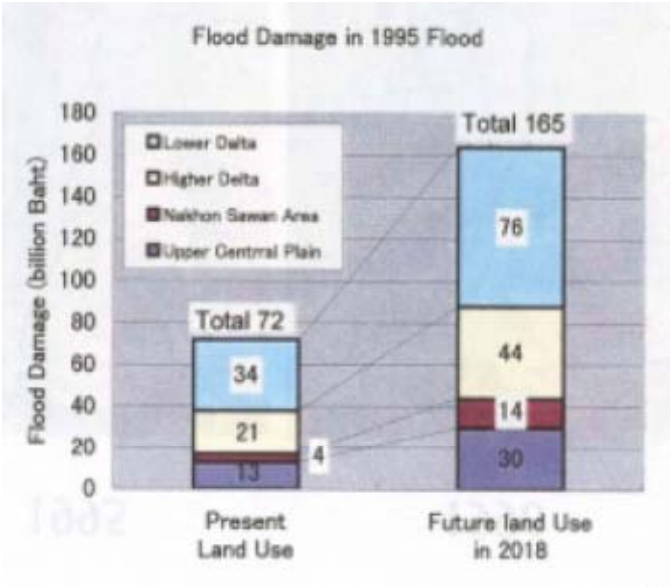


Figure 3. Flood damage in 1995 Source: Siripong et al. (2000)

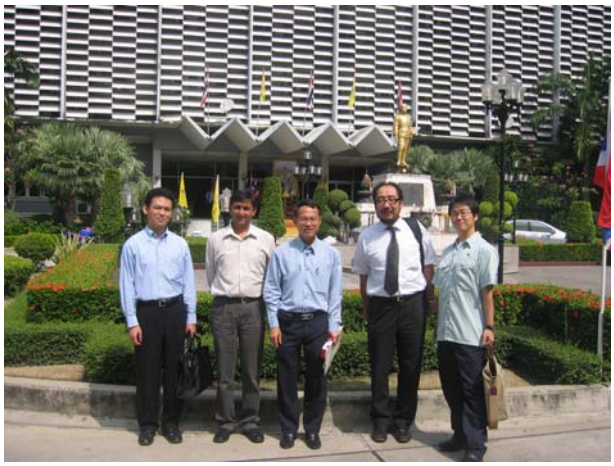
such events in the past. Mitigation measures are hardly applied because of several resource-related problems. In other hand, technique to identify the multi-risk posed by multiple hazards is still not familiar for Thai engineers and difficulty in making multi-hazard map is another challenging task.

6. It seems that people are experiencing such problems since decades, however, they are less aware on how and where to evacuate in emergency. Even in the case of known evacuation centers, people simply ignore the event because they don't like to evacuate or they don't feel necessity to evacuate. Very few people have done little precisions by elevating the plinth level of their houses over the normal flood level or evacuating their cars in higher land especially over bridges during flood event.

Chao Phraya River and Flood Governance

Since the establishment of the Royal Irrigation Department (RID) in 1927, it has been looking after the water, irrigation and flood related issues all over the country through its 17 regional offices. According to interviewees, there are many other governmental bodies, which are recently formed and are rendering their services in different aspects of flood management; however they are still some misunderstandings of responsibilities and duties.

The concept of River Basin Committees (RBC) was developed along with the intervention of donor agencies. In year 2002, all temporarily established 25 RBCc in the country got full recognitions from the Government and started work on 7 allocated tasks i.e. (1) information/ data base; (2) policy and planning; (3) regulation; (4) technical; (5) public relation and coordination; (6) conflict resolution; (7) monitoring and evaluation. The history of Water Resources Department (WRD), another counterpart in flood management, is also not so old. It was established in aim of lessening the burden of RID in some aspects of water resources management. Since the establishment of WRD, RID's target area was reduced to only irrigation project areas. There is another organization namely the Department of Agricultural Extension (DOAE) under ministry of Agriculture, which is mainly responsible for organizing awareness campaigns, the evaluation of damage to the properties, compensation or rehabilitation etc. DOAE is closely working with RID as there is no overlapping in their works because RID's work is much concentrated on technical sectors only. There is also a Disaster Prevention and Mitigation Department under the Ministry of Interior, which takes care of all disaster scenarios in the countries including emergency management. Very poor coordination among these organizations and overlapping of their responsibilities has not only brought about the conflict among the



Survey team in front of RID Headquarter Bangkokk, 11/12/2006

organizations but also hampering the flood management in the country. Budget allocation for each related organization is becoming much conflicting matter.
In the case of RID, it has 17 regional offices distributing all over the country, which provide river flow information including some other hydro-meteorological information to the central department in Bangkok in a regular basis. Central department gather data and analyze the situation and give feed back to the regional offices, including the message whether the evacuation warning is essential or not. In emergency situation, the regional offices supply this information to regional governor and Mayors through consultation meetings. In need; local body announces warning messages to the local people through TVs and radios. The central department also supplies similar information to the national and international communication media including newspapers, TV, radios and on-line news etc. Usually, in rainy season, media people gather around RID headquarter to collect information on flooding and the information will be publicized but not in the form of warnings. Provincial governors are responsible in decision making on whether evacuation warning should be issued to the public or not. The issuance should be verified from provincial disaster management committee, which includes the regional irrigation office's director as a member. In municipalities, each Mayer makes decision and announces the same warning issues to the public through local radio, TV, mobile phones etc. The appearance of Governor and Mayer themselves in the media is to generate trust among public, however, negligible number of people did evacuation in the past. Flood warnings are usually issued based on real time monitoring especially water levels in different reaches of the river. However, advisory warning messages especially in the form of flood forecast information are usually sent to the public once significant rainfall is observed in the river basin.

Existing Countermeasures

Although flood occurs almost every where along the Chao Phraya river, high priority on flood management has been given to the lower part of the river basin because of high population and property density. Royal Irrigation Department (RID) has constructed 300 km long dykes along both sides of Chao Phraya River from Nakhon Sawan to Bangkok. Residential areas especially in cities along the river are also protected by polders together with a number of pumping stations. Dykes have also been constructed along the Bang Pakong River, a tributary in the east. There is another project namely "Klong Lud Po" project located at Moo 9 Tambol Songkanong, Amphoe Prapradang, Samud-prakarn Province, which was an initiative from his majesty the king of Thailand and has multifaceted benefits on the flood control and agriculture. A simple layout is shown in Fig. 4. This project aims to lower the flood risk in the vicinity of Bangkok Metropolitan by regulating flood and tidal wave in the river. It works with the principles a) when river water

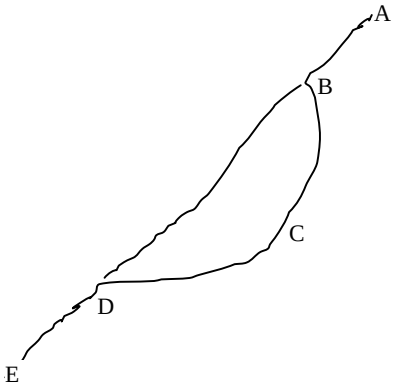


Figure 4. Layout view of Klong Lud Po project

level raises significantly, the gate at B station will be open to allow water to pass shortest way along ABDE and b) even when the river water level goes below critical level, the tidal wave might cause another disaster so elongating the river reach would be the best solution, for which the gate at station B should be closed and flood should be diverted in to ABCDE path. This canal has shortened the channel distance to bypass flood by 600 meters instead of 18 kilometers, having capacity of conveying 500 cubic meters per second from Choa Phraya River.

In some places, people have intentionally destroyed the dykes, aiming to overflow water so that their residential area will not be flooded. RID has no especial scheme to educate people, neither it has any project that deal with community participation in flood management. For the time being, DID is focusing on structural measures that might not be the sustainable solution in the region. Therefore, non-structural measures especially to educate people to raise awareness level and develop effective warning mechanism, foster better strategies and policies are of great importance. Some efforts made by the government in the past to evacuation people in crisis were failed because people ignored warning issues; instead they prefer to stay in their houses usually on the 2nd floor. Since private car is much prestigious and valued property in Thailand, many people use such warning issues to evacuate their car and other belongings to higher and safe place.

Flood Hazard Mapping

Among professionals, flood hazard map is considered as a useful tool to mitigate the impact of flood disasters. Promotion of safe and smooth evacuation in flood prone area is very important because in case if serious flood occurs, the causalities will be un-expectable. Flood hazard map can be of great help to aware people and to assist their evacuation in need. Additionally, it is useful for government and insurance company to initiate new development package against flood disaster. However, field implementation of this tool is still not in practice because of verities of reasons.

- Evacuation warnings are usually ignored by people and they prefer to live on the second floor of the building in case if inundation level rises considerably. Therefore, in addition to FHM, community awareness campaign or non-formal education should be promoted along with else FHM implementation won't get its aims. The poverty eradication schemes should be integrated into the flood hazard management and flood hazard mapping process.
- In some places, flooding is concurrently caused by several interrelated events such as inundation by heavy downpour, landslide, debris flow etc. Therefore, multi-hazard map might be the solution but uncertainty is high to implement such multi-hazard maps.
- In urban areas, people want to evacuate by cars and therefore the congested and poorly planned road may hinder the evacuation.
- There is not especially designed educational or awareness raising campaigns for the public. After the country was badly hit by Tsunami 2004, government has done much in non-formal education especially to raise awareness on tsunami impact mitigation measures. There is still much to do in flood management sector.

- Some other problems in developing flood hazard mapping in Thailand are – opposition by public due to the fear of property devaluation, opposition by politician, data and budget, lack of national policy, manpower etc.
- Flash floods often cause havoc in northern Thailand, so FHM for flash flood should be promoted, however due to the scattered population, development/production cost will be much higher.

For land-use planning, some other types of maps are already in use with little consideration on flood potential. The replacement of those maps as well as the pre-planned project based on those maps would be costlier. For evacuation, DID has been practicing some simple information boards and color flags to notify public the level of risk. Somehow this is working fine but only for certain community or group who are in proximity to these information boards. Warning signals are usually patched on the board based on real-time observation of water level.

On going projects/Future plan/Expectations

Research on Flood Hazard Mapping (FHM) by national research institute and some other water related organizations in aid from JICA Japan is undergoing. The RID (especially water allocation section and hydrological sections) are contributing to this research project. This filed based research will be conducted in Chumphon province in southern Thailand. At moment, this project is focusing on software development part. This project will also analyze the needs of awareness campaign, community participation, policy concerns etc.

Unauthorized settlements are increasing day by day in the flood plains, which should be stopped immediately by endorsing new policy and regulations. Illegal encroachment of river banks should be stopped as well. Flood insurance should be promoted in the flood prone areas, which can be done through public-private initiatives.

In order to promote safe evacuation, flood prone area should be categories according to the means of transportation such as by foot, bicycle, car, boat etc. because during heavy flooding, traffic jams especially due to evacuating cars are very usual problems. Since people are experiencing flood for centuries, convincing them in new trend of development is much difficult because they think that they know much better than anyone and they know well how to deal with floods. This problem can be analyzed closely in participation from community

Photo 3 Historical flood-depth mark (2000) at Hat Yai city centre. by:- Osti

Photo 4 Newly constructed emergency canal in Utha-pao river Hat Yai by;- Osti

members and new development plan should be fostered based on their need and interest.

2.2.2 Hat Yai

The Utaphao river catchment lies in the southern part of Thailand, bordering Malaysia. The river often causes flooding in Hat Yai City and areas in Sonkhla provinces. A severe flood occurred in Hat Yai city following a torrential downpour of rain namely La Nina in November 2000, killed about 40 people, injured about 1700, and caused severe damage to property. Mostly the people who were killed by that event were playing, swimming or fishing in flooded river and majority of them were young boys. Water rose up to 3.5 meters high in city area (Photo 3) and almost 75% of the city area was submerged for several days. People suffered from snake and scorpion bites, drowning, dehydration, dengue fever and other diseases as water levels remained high and stagnant for couples of weeks. Losses exceeded US$ 220 million (ADPC, 2003). A comprehensive flood mitigation study of the Utaphao river catchment and Hat Yai city areas was undertaken between 2001 and 2003 by Kasetsart University and the Royal Irrigation Department (RID) of Thailand and many suitable recommendations were made to mitigate flood disasters in the area. The options suggested included numerous bypass channels, reservoir storage, land use guidance in the surrounding area of the city, and a real-time flood forecasting system (Wallingford Software, 2006). Recently, a regional irrigation office, a branch of royal irrigation department is actively involving in reducing the potential flood impact in concerned provinces and the Hat Yai city area. Under Songkhla Irrigation Project- RID No. 16 office, the Flood Warning Centre has 22 full-time staff members assigned only for flood warning related activities. This office basically monitor water levels/flow rates at different river locations and supply these all information to the Governor of Sonkhla Province and RID headquarter in regular basis. There are 13 river gauge measurement units (telemetric stations), out of them one (No 44, which is 90 km away from river mouth) at the central city is used to identify the critical level of water level in the river and to analyze critical timing for evacuation. They have recently started to use web-activated simulation model namely FloodWorks developed by Wallingford Software for

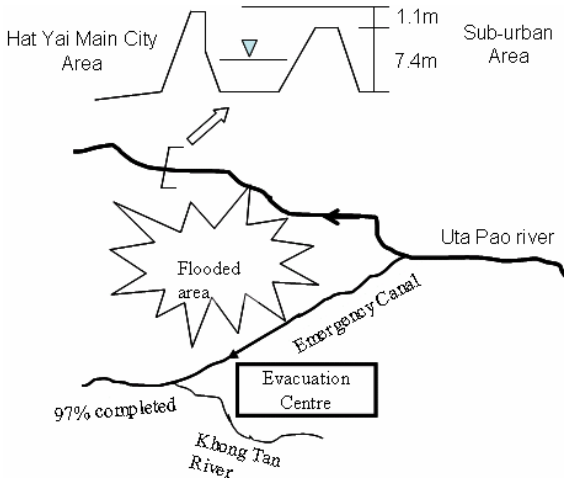


Figure 5 Lay out view of Utaphao flood prone area around Hat Yai City.

Photo 5 Levee in Uta-Pao River in Hat Yai city

real-time flood forecasting and flood warning system in the river basin, however the extent of use of this facilities and the use of simulated results is still under consideration.

The survey team visited the office, observed city area, where flooding took place and discussed with the staff members on their experience and plan. Following are the key points derived through interviews and field visits.

- Utaphao river passes through the Hat Yai city and has total 2400 km2 catchments area that composed of mountainous and flat regions. Flash flood is much frequent in the area and had often caused serious damages in the past.
- In 2005, 8 km reach of the river at Hat Yai city was fully over flooded, where the maximum flood depth observed in the city was 1.5 m. Flood entered from south west direction of Hat Yai city and flooded the Hat Yai city on its way and merged into the Sea without any human fatality.
- The worst flood in the region is said to have 13 yrs of return period. The last sever flooding happened in 2000, which was preceded by the flood disaster in 1987. Flood of 1987 was the most disastrous event experienced by the people of Hat Yai city.
- After the year 1987 (the Thai Year 2531), the government built some bypass canals in 1987. In 2000 (the Thai year 2543), the government planned to construct another large diversion canal.
- The construction of emergency diversion/bypass canal was started in 2004 (Photo 4) and is expected to be completed by the end of FY 2007. Till now, 97% of total construction is finished and the remaining earthen canal was used to bypass the flood in 2006. In many locations, sand is heavily deposited and obstructing flow, which requires immediate dredging/excavation.
- Channel capacity of Uta-Pao river at Hat Yai is about 400 m3/sec, however flood in 2005 reached 1000 cu m/sec. Emergency diversion canal was designed for 465 m3/sec only. This means the sum of channel capacity and bypass canal capacity was still deficit from total conveyance; therefore the flood was obvious in the city even after the construction of emergency canal. Surprisingly, the 100 year return period discharge should be much higher

Photo 6. Newly constructed evacuation centre

Photo 7. Warning board with flag on the top located at the bridge

than 1000cu m/sec. This type of incidences may happen repeatedly again in the future. Evacuate should be promoted in the city and flood hazard mapping is inevitable.

- Tidal waves usually affect the river flow up to Hat Yai city area therefore Hat Yai is much prone to flooding due to tidal wave propagation.
- There are already 3 functioning reservoirs built in the past, aiming to store the flood-water and to supply it to the irrigation fields during dry season. The current biggest reservoir has 53 million cu. m storage capacity. Additional 6 reservoirs are under planning and will hopefully be implemented near soon. There are already dykes in operation in some parts and few additional dykes are under planning in both upstream and downstream of Hat Yai city. Specially, city area is protected by higher levees than the levee provided in adjacent area and the slopes of levees are well protected in city side than another side (Figure 5 and Photo 5).
- In the case of severe flooding, people usually prepare to evacuate/park their cars first to some high level ground and come back home to stay overnights in the 2nd or higher floors. Car is much prestigious and therefore evacuation of car is of much importance than other goods.
- Although warning messages were transmitted in a regular basis in the case of flooding 2005 and 2006, people felt overconfidence and remain stayed in their houses. People might have known well the flood condition of the area but they don't know actually their risk level else they should have evacuated properly.
- Neither city office nor any other public authorities organize especial awareness campaigns or non-formal education for local people. The office has all kinds of data including historical flood data but these data are useless at moment. In few locations, historical flood marks are placed to remind people about the past flood havoc.
- In Hat Yai, this year 4 different evacuation centers were assigned immediately after the flooding occurred and this was the initiatives from provincial government after having meeting with committee members (which includes all concerned agencies). However, very few numbers of people were evacuated into the centers because most of the centers were not familiar and no or little facilities were made available for evacuees.
- One big evacuation centre is now constructed at the edge of the city (Photo 6). It is specially designed to accommodate about 300 evacuees at a time and it is interiorly designed in such a way that the distribution of food and clothes to the evacuees is possible in smooth and proportional manner. The new evacuation centre is located in the bank of emergency canal where the river Khong Tan merges into the canal i.e. at about 16 KM from canal mouth at the sea. However, the evacuation centre is surrounded by canal, river and swampy areas therefore smooth evacuation to the place is difficult in

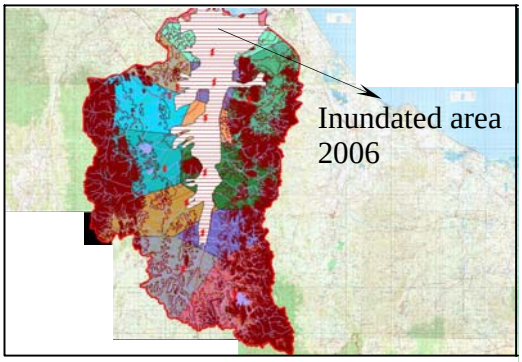


Figure 6. Inundated area map of Hat Yai

emergency. There are some additional evacuation centers under planning process. However, establishment of evacuation centers would be possible in existing public buildings and in need new buildings can also be constructed with proper planning.

- Governor himself announced the warning in TV especially to bring about the trust on their announcement. If such information are transmitted in any other form by any other people that might be ignored by people. However, even after the announcement made by Governor or Mayer, people shift their belongings to the upper floors but do not evacuate from their places.
- In heavy rain situation, few people start evacuation without having emergency warning notifications. The main propose of this kind of evacuation is basically to evacuate their cars and worthy movable goods. In general, warning information are officially provided through signals such as flags and color boards (Photo 7), however only few people, who pass through, get notice from such information board and signals.
- In 2000 flood, the office didn't have warning mechanism and had no telemetric stations; therefore warning was not issued by governmental bodies. Now, the RID regional office has such facilities including flood inundation modeling techniques so that inundation maps can be prepared and flooded area can also be figured out (Figure 6) for potential flood impact assessment. Method to develop flood hazard mapping based on inundation area mapping should be promoted for potential application of FHM.
- Now, Hat Yai is comparatively safe because emergency diversion canal is built up, dykes are also constructed, warning mechanisms are set up, flood disaster committee is formed to facilitate the process etc. However, there is still much to do as people are unaware and structural measures are incapable of controlling flood as mentioned earlier.
- Although the construction of dykes and emergency diversion canals have made Hat Yai comparatively safe, flooding in the sub-urban districts in downstream areas becomes often and much more sever than before. Districts like Bankram and Kronghong get additional 30-50 cm high flood in average due to concentrated flow from up-stream direction. People residing in these districts don't know the

Table 4.Vulnarable features in Hat Yai for various hazard level

Land use	Areas (ha)	Hazard level (ha)				
		very low	low	moderate	high	very high
Residential areas	561.4	11.8	89.7	322.5	110.5	26.9
Commercial areas	200.9	8.5	33.4	127.8	24.0	7.2
Industrial areas	24.9	3.3	2.5	9.3	7.8	2.0
Public utilities and Facilities	400.9	20.0	83.0	212.3	68.3	17.3
Preservation and Recreation areas	10.6	0.3	6.5	3.8	-	-
Agricultural land	162.7	15.3	44.1	84.8	8.5	10.0
Waterbodies	52.1	0.6	15.8	16.8	16.3	2.6
Miscellaneous	641.5	39.2	125.0	332.6	110.6	34.1
Total	**2,055**	**99.0**	**400.0**	**1,110.0**	**346.0**	**100.0**

Source: Tanavud et al. (2004)

exact reasons of over flooding especially because of the construction of structural measures in upstream areas. If they know, they might have opposed the construction or asked for better compensation. However, there are few planned activities to mitigate such problem. These planned projects include but not limited to the establishment of pumping stations and expansion of dykes in down stream areas.

- The authorities learnt very much from the 2000's flood event and now trying to build up their capacity to cope with potential events. Along with, increasing trend of disaster is associated with land-use changes that should be addresses. Some researches e.g. Tanavud et al. (2004) have indicated the different level of risks at different land-use patterns in Hat Yai area as of 2004 (Table 4,), which can be of help to optimize the disaster planning work in advance.
- Since the people are not aware of disasters, software type countermeasures should be promoted. In 2000 flood, people were killed because they were playing, swimming or fishing in flooded river in addition people didn't evacuate in safer place.

2.3 Conclusions

Thailand is one of the most flood disaster prone countries in the Southeast Asia region. Flooding occurs almost every year and causes many fatalities and enormous property damages. A survey team from ICHARM has recently conducted a field survey to observe the current situation of flood management in some river basins. The Chao Phraya River basin is one of the most important river basins in Thailand because it has much contribution to country's socio-economic development. However, it has also imposed serious negative impacts on societies through devastating floods each year. The Utaphao river in southern Thailand was another river basin chosen for study. The Utaphao river caused sever disaster in Hat Yai city area in the year 2000. After the panic from 2000 flood, government had started to work for the development of verities of mitigation measures, however there has little been improved because the same intensity of flooding in year 2005 and even weaker one in 2006 brought about havoc and uncertainty in the areas.

In the country, good governance thereby long term planning is lagging especially in mitigating flood problems in a long run. These problems persist because of complex bureaucratic and legislative process. Overlapping and duplication are common because of over representing organizations, which are involving to execute the same tasks and doing similar jobs with little or no coordination. Lack of duties and responsibilities of organizations are some other aspects of flood disaster management in the country. Somehow, donors are responsible to bring about this situation as they propose one way to address one thing without considering existing practices. In other hands, people are aware in the sense that they know well the problem but unaware in the sense that they don't know the way to cope with problems. Usually, the problem seems revolving around the budgetary constraint. Lack of people participation is another cause of delay. Rapid urbanization, landuse changes and climate changes are obviously responsible, however detail research is yet to be conducted to measure the degree of influences. Structural measures, which are in operation or planned to be implemented, are not

capable of mitigating flood impact in a desired level. Flood hazard Mapping is said to be useless, saying people do not like to evacuate, however why they don't evacuate and why they should evacuate are the questions to be answered by concerned agencies. The role of government is vital and it has to simplify the development approach, where donors should have facilitating roles in deed with possible technical and financial supports in need. Regional cooperation is inevitable and lesson learned from other country could be the road map for future development. Therefore, there is still much to do in the sector.

References

Asian Disaster Prevention Centre, 2005, What is the Appropriate Mitigation Mix? Structural and non-structural mitigation in Hat Yai, Thailand, Safer City 13, ADPC.

Office for the Coordination of Humanitarian Affairs, 2006, Flood Situation in Thailand - 9 October 2006, OCHA Situation Report No. 2.

Siripong H., Wirat K. and Suwit T., 2000, Flood management in Chao Phraya River basin, Proc. of Int. Conf. on Chao Phraya Delta: Historical Development, Dynamics and Challenges of Thailand's Rice Bowl, Bangkok, pp P3-I-20.

Tanavud, C., Yongchalermchai, C., Bennui, A. and Densreeserekul, O., 2004, assessment of flood risk in Hat Yai Municipality, Southern Thailand, using GIS, Journal of Natural Disaster Science, Volume 26, Number 1, 2004, pp1-14.

Tebakari, T., Yoshitani, J., Khao-Uppatum, V. and Suvanpimol, C., 2003, Trends in decreasing discharge in 1970s-1990s in the Chao Phraya river, Proceedings of the First International Conference on Hydrology and Water Resources in Asia Pacific Region (APHW), Kyoto, Vol. 1, pp. 185-190.

Wallingford Software, 2006, Hat Yai flood prevention strategy, Water & Wastewater Asia, Pabloasia Press,Singapore, pp. 24-25.

Water Environment Partnership in Asia WEPA, 2006, State of water environmental issues: Thailand, http://www.wepa-db.net/policies/state/thailand/thailand.htm.

World Health Organisation WHO, 2006, Flood situation in Thailand (as of 29 October 2006), http://www.searo.who.int/LinkFiles/EHA_Thailand-.29Oct06.pdf.

World Water Assessment Programme, 2003, The United Nations world water development report WWDR-I, UNESCO, France.

Note: This article is fully biased on field survey that was conducted within 2 days time frame and may not well represent the context. It has not precisely analyzed the data to comment or recommend. Therefore, the findings should be verified with appropriate data in future. Authors hope to make this report better in future in close consultation with local researchers/engineers with reliable data sets.

PART- II

Overview on Flood 2006
&
Flood Hazard Mapping Related Problems in Cambodia
Based on Field Survey, December 10-16, 2006

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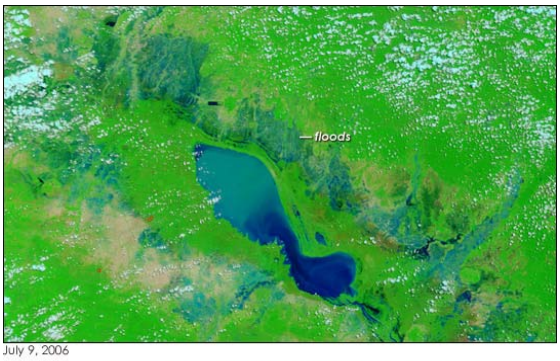
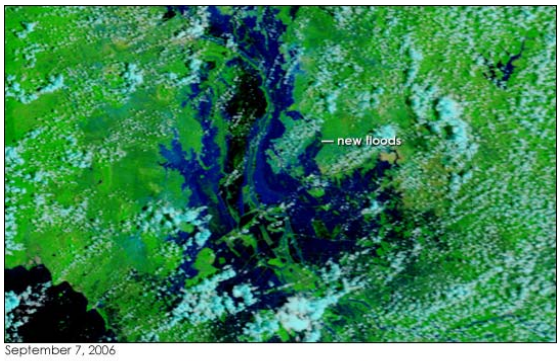
3. Cambodia

3.1 Background

Cambodia covers total land area of 181,035 square kilometers and is bordered to Thailand in the north and northwest, Laos in the north, Vietnam in the east and south-east and Gulf of Thailand in the southwest. The country can be divided in to five distinct topographical features i.e. a) the Sandstone Dangrek Range in the north, b) the Granite Cardamom Mountains of max peak 1500m, c) the Elephant mountains forming watershed boundaries for rivers flowing west direction in narrow coastal plain of Gulf of Thailand, d) the Darlac Plateu in the northeast raised up to 2700m but does not lie in the Mekong drainage basin, e) the central plains, which occupied almost 75% of total land, drains into Mekong, Tonle Sap, Bassac rivers and other tributaries. The Tonle Sap Lake drains into the Mekong rivers through Tonle Sap river, however in rainy season (starts from end of





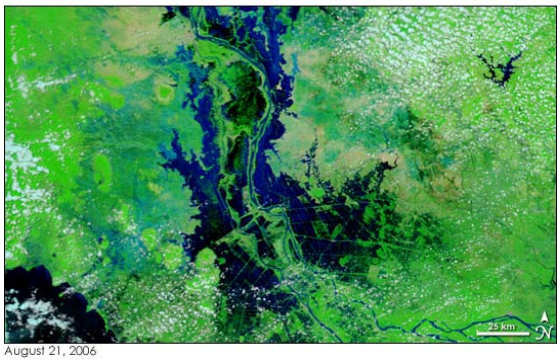


Figure 1. NASA's Terra satellite detected flooding around the Tonle Sap (source-MODIS, NASA)

Figure 2. NASA's Terra satellite detected flooding around the Tonle Sap (source-MODIS, NASA)

May) the water level in Mekong rivers raise significantly and the water level at the confluence usually raise up to about 9m due to which water starts to flow from Mekong to Tonle Sap (MS, 1994). The water level in Tonle Sap lake raises considerably in two fold manner i.e. water surface raises due to the accumulation of run-off from adjutant areas and also from Tonle Sap river. This hydrologic phenomenon causes the increment of about 10,000 square kilometer in water surface area at the lake, causing inundation in adjacent area for over five months time frame each year (Fig. 1 & 2). The mean annual temperature in the countries is about 27.8 degree celcious at Kompong Cham with mean daily minimum of 19 degree celcious. The mean monthly rainfall varies from 1,200 mm in the north western part and 4,000 mm in the south western coastal area. The distinct rainy season especially due to monsoon starts from May and lasts until October with peak in August/September.

Mekong river is the largest river in Cambodia and almost 18% of its total basin area lies in Cambodia. Mekong delta begins in Phom Penh, a capital of Cambodia, where the river divides into its two main distributaries i.e. Mekong and Bassac. The flood in the Cambodian flood plain is characterized by lateral flows of Mekong from Kratie to the confluence with Tonle Sap. Up to 4 million ha of lowland areas in Cambodia are inundated annually (MRC, 2005). Although flood is the main contributor to the biodiversity, fisheries, soil fertility and navigation along-with it is helpful to maintain ground water reservoir and killing vermin such as rats, substantial preparedness is required to reduce the damage caused by excess flood. The years 2000, 2001 and 2002 were successively damageable. In 2000, sever flooding affected 22 out of 24 provinces

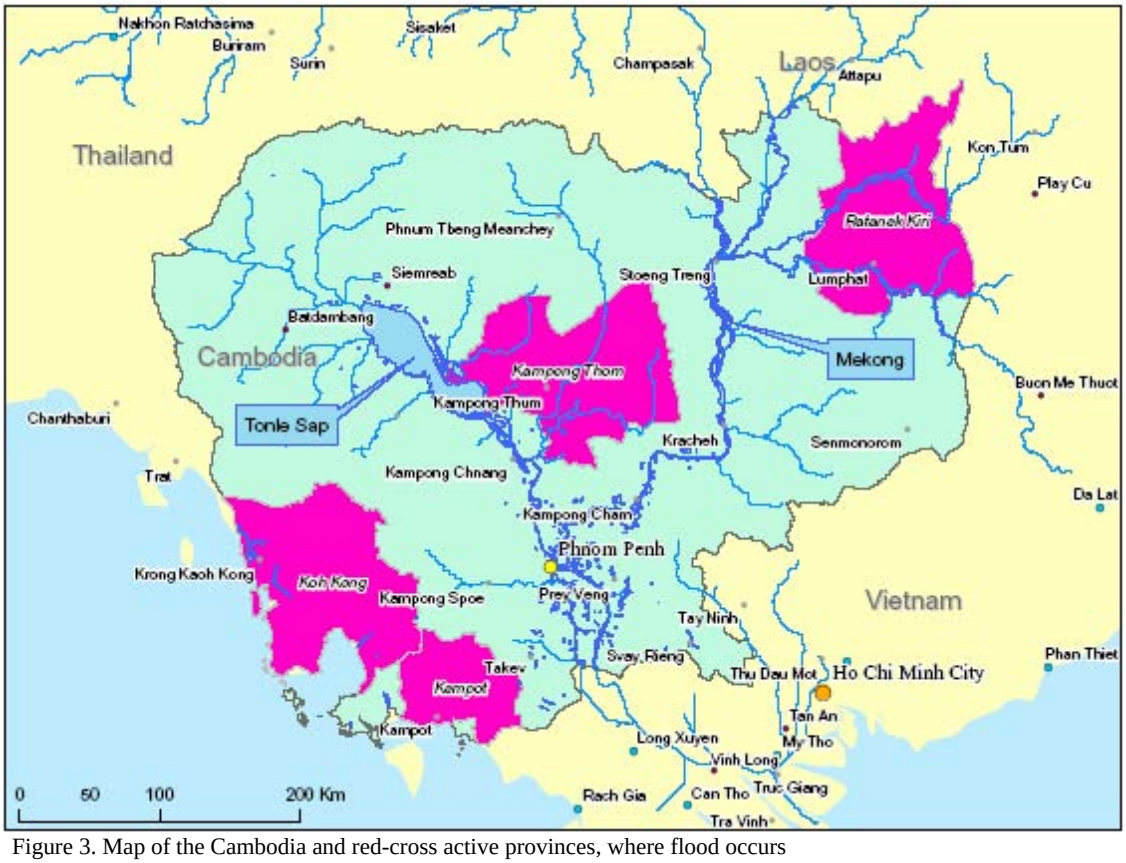


Figure 3. Map of the Cambodia and red-cross active provinces, where flood occurs

in Cambodia and death toll reached 347 people, out of which 80% were children. Physical damaged reached at top US$ 161 million in the history. Flood in 2001 also killed 29 people and caused physical damaged of US$ 12 million. In year 2003 and 2004, floodings were comparatively soft but in the same year people faced draught. Year 2005 was again the worst especially in four provinces Stung Treng, Kratie, Kompong Cham and Kandal (Fig. 3), where 20 people died, majority of them were children especially male children, who are often most vulnerable in Cambodia. In these provinces, more than 275,000 people were affected and total number of evacuees in Kratie and Kompong Cham were 361 and 429 respectively (MRC, 2005). Some of the major historical floods enlisted in EM-DAT are illustrated in Table 1 & Table 2, however some of them mismatch with MRC data.

Table 1. Top 10 natural disaster based on number of people killed (source: EM DAT)

Disaster type	Date	No. Killed
Flood	31-Jul-1994	506
Flood	11-Jul-2000	347
Flood	22-Aug-1991	100
Flood	30-Sep-1996	59
Epidemic	16-Apr-1999	56
Flood	15-Aug-2001	56
Epidemic	Jun-1992	50
Flood	18-Aug-2002	29
Flood	8-Sep-2005	16
Epidemic	14-Jun-1998	15

Table 2. Top 10 natural disaster based on number of affected people (source: EM DAT)

Disaster type	Date	No. Affected
Drought	Jun-1994	5,000,000
Flood	11-Jul-2000	3,448,053
Flood	15-Aug-2001	1,669,182
Flood	18-Aug-2002	1,470,000
Flood	30-Sep-1996	1,310,000
Flood	22-Aug-1991	900,000
Drought	Jan-2002	650,000
Drought	Apr-2005	600,000
Flood	2-Aug-1999	535,904
Epidemic	Mar-1992	380,000

3.2 Flood Situation 2006 in Cambodia

Very scarce country level information on flood damage is available for the year 2006. There is no official disclosure of any report neither from Cambodian government nor from Mekong River Commission. Several relief organizations have been reporting their activities and reports indicate that the flood impact is significant this year as well. Usually, Mekong flood can be divided into 4 levels, referring to the water level at the Bassac-Chaktomuk station,

Small Flood Annual Maximum WL ≤ 9.00 m
Medium Flood 9.00 m < Annual Maximum WL ≤ 10.00 m
Large Flood 10.00 m< Annual Maximum WL ≤ 11.00 m
Largest Flood Annual Maximum WL > 11.00 m

It is not known that which level of flood occurred in 2006 and what extent of damages is prevailed so that deriving any conclusion is much difficult task at present. It was known that the Kingdom of Cambodia has been affected by China typhoon since 13/08/06. The rainfall was continuing for some days, which has caused dramatic flash flood in costal and mountainous provinces such as Battambang, Pursat and Kampong Thom. Some reported events and corresponding damages are shown in table 3.

Table 3. Flood affected provinces and districts in Cambodia, 2006 (source: various)

Province or District or City	Coverage	Date	Deaths	Damages
Kg. Speu	-	13-14/08	-	Few domestic animals were killed
Kampot	5 districts, 92 communes, 482 villages	16/08 -	-	-
Battambang, Pursat and Kg. Thom	Sangke River, Pursat River and Stung Sen River banks	16/08/06	-	-
Kep City	Affected 2 district and 10 communes	-	-	One dam was damaged
Koh Kong	National Road Nº 4 around Stung Samrong area was flooded	-	-	flood level 2.6m
Phnom Sruoch	some communes and villages, Prek Thnot River area, Makara dam in Kandal Stung district	-	-	Banghear Peam Poul dam was 80% damaged (in Chambak)
Kandal	3 districts and 25 communes by Prek Thnot River	-	-	Damaged to rice crops, livestock and houses
Rattanakiri	caused by rain fall and Hydro electricity dam household and other crop/. Two districts: Kon Mum and Lumphat were severely affected	-	-	-
Pursat	Sampov Meas district caused	21/08 at 15 :00	2	9 houses totally destroyed
Kampong Cham	-	21st August 2006	1	5 houses totally destroyed

Field survey team has visited some concerned organizations as well as flood affected areas and collected some basic information concerning general flood management and flood 2006 in Cambodia.

3.2.1 Department of Hydrology and River Works, Phom Phen

On 12 December 2006, a team visited the Department of Hydrology and River Works in Phom Phen. Mr. Mao Hak, a director of the department briefed the recent flood situation. Some important points from his talk are summarized below.

- One third of the country's area has flooding problems with different degree of potential inundation and damages. There are basically two types of floods a) Floods due to over-bank flow including flash flood in some northern provinces. b) Flood due to the accumulation of rain-fall. Statistic shows that the trend of devastating flood in Cambodia occurs in each 70 year interval.
- In principle, Department of Hydrology and River Works (DHRW) is responsible to arrange and analyze hydrological data and to issue warning to the communities and meantime supply information to rescue related organizations. Decision making is in hand of National Disaster Prevention Committee, which is chaired by prime-minister and includes many ministers and Mekong River Commission as well.
- Cambodian government is much concerned about flood management in the country and has initiated verities of structural and non-structural measures. It has recognized the importance of evacuation (in response to our question on the importance of warning and evacuation), however lack of volunteers always hinders the operation. Therefore, our department usually requests Cambodian Red-Cross to supply volunteers and also send information to Cambodian corps and national army for possible help. Cambodian Red-Cross is so far the most active agency involving in flood warning, rescue and rehabilitation.
- Cambodian government organizes annual forum each year and many foreign representatives are usually invited to take part in it. This year also the annual forum was successfully held. Many representatives from disaster prone countries shared their ideas and Cambodian government has learned much from them. This time, we are particularly interested in the technique developed by Bangaladesh to warn people in crisis period. They use very tall red flags, which can be seen from very far distance and is better then our information board, which is limited to only specific group or people.
- Now, we have recognized the importance of flood hazard mapping. Since flood in Cambodia has enough lead time, FHM would of great help if it can be implemented properly. If we can develop, it will definitely work but we are facing budgetary constraint to lunch FHM programmes. In response to team's question i.e. at least you can start from simple test scale project, which may not take much budget and few practitioners those you have already are enough to initiate (quoting FHM training course at ICHARM), Mr. Hok showed his argument and expressed that he never thought from that prospect. In response, he insisted that his department will try to initiate a simple FHM project soonest possible.
- There are some under-going flood management related projects, which are considering FHM approach as well. In Pre-ven province, Asian Institute of Technology (AIT) and Department of Hydrology and River Works (DHRW) are cooperating to develop effective inundation map and that will hopefully extended to FHM.
- For the time being, as an initiative, government in cooperation with NGOs & INGOs has provided at least 1 boat for 4-5 households in most flood prone areas, aiming to facilitate evacuation process.

- In order to reduce the damages to the crops, we are trying to practice shifting of cultivation with improved seeds, however it is not easy as we think because traditionally practiced system has strong hold every where. Around Tonle Sap lake, people are practicing floating rice culture.
- We are trying to adopt some structural measures against flood. These measures are not only dams and levee structures but are some kinds of simple inland low earthen barriers to reduce the flood wave propagation time. In Pursat, because of newly constructed barriers the flood propagation time was delayed (Fig. 4) so there was enough time to prepare for warning and evacuation.
- However, flood problems in Mountain regions such as Kravan or Cardamom mountain areas in northern provinces are still challenging because they are flash floods with short lead time and we can not easily control them. Some mountain ranges are close to Tonle Sap so local people sometimes experience both types of floods at the same time or different time in the same year. Usually Tonle Sap floods during June to September and flash floods occur during October to November.
- Some other sorts of problem to prepare FHM are lack of data especially topographical which at moment available at 5m contour difference and also mapping techniques are not familiar with us.

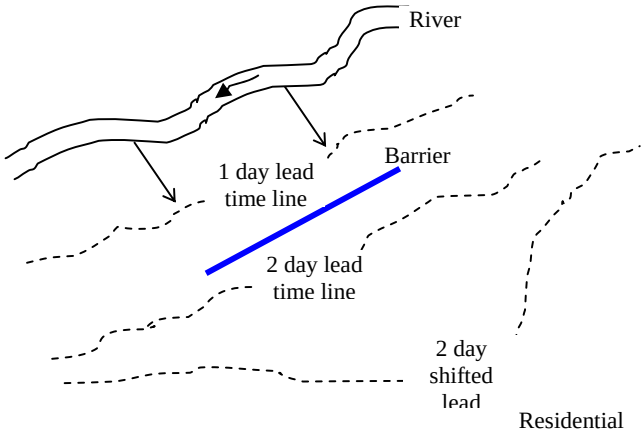


Figure 4. In-land barrier

3.2.2 Pre-Veng

Next day, the team visited Pre-Veng district in Pre Veng province, south-east from Phom Phen (Fig. 5). Pre-Veng is one of the most flood affected province in Cambodia with population 1,025,331 as or 2001 (Wikipidia, 2007). Prey Veng, which has 12 districts, 116 Communes and 1,138 Villages, covers an area of about 4,883 square km. This province can be sub-divided into two categories in terms of water availability i.e. flood plain and central plain. Flood-plain area experiences floods every year by the Mekong river and it has enormous small perennial streams available for irrigation in dry season. Central-plain which occupies with rain fed agricultural field is often experienced drought with few or no irrigation facilities. On the way to Pre Veng district's headquarter, we observed

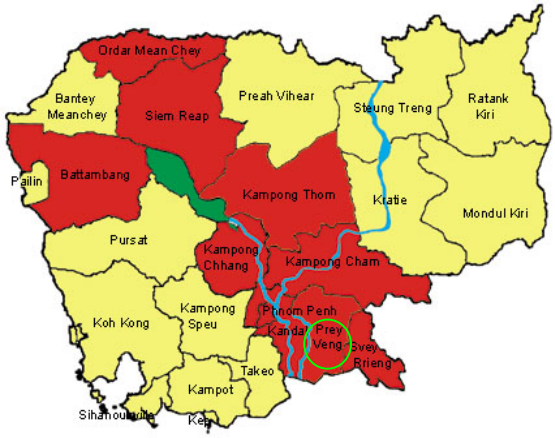
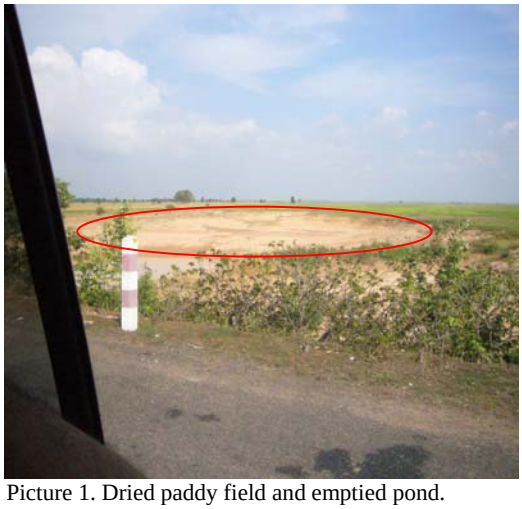


Figure 5. Pre-Veng province in Cambodia

and realized many things that how Cambodian people are experiencing the natural disasters with both much and little water.

- It was a 13 December 2006, we saw very dry paddy fields and matured rice plats were dying without water.
- Many small ponds are dog out by farmers close to their paddy fields probably for the provision of storing water for irrigation but amount of stored water was already consumed or lost by evaporation or infiltration. Ponds were almost dried and filled up with silts (Pic. 1). Far a way, Mekong with flooded banks and swampy areas were seen.



Picture 1. Dried paddy field and emptied pond.

- National road is elevated through out the route, which helps the flood preparedness in multi faceted manner i.e. a) it acts as a barrier/dam to control flood entering into the another side, b) it provides a space to evacuate people and animal during crisis, c) it maintains access and communication to other part of the country to facilitate rescue and relief operation during crisis. Japanese government has provided financial support to elevate and widen the road and it was under rehabilitation. In certain places, road elevation is lowered to function spill way to drain the water (Pic. 2). There are many small water gates to facilitate irrigation.

Picture 2. Spill way provided on the national road

- Although banana plants are not tolerant to the flood, wide range of banana plantation was surprisingly seen through out the journey. Probably there might have some other benefits additional to its economic value that question will be answered in the next filed survey. In some places especially in South Asia, banana tree's trunk is used to make fishing boat and such technique may help to facilitate immediate evacuation.
- First floors of school buildings are raised to considerable height so that it

Picture 3. Tube wells for drinking water

will not be affected by flood and the school children can go to school even during flood, however it is not sure that how do they go school. To provide safe drinking water, numbers of tube wells are constructed closely in elevated ground (Pic. 3). It takes few months to completely drain the flood water so that there is a big problem of water contamination and risk of water related diseases.

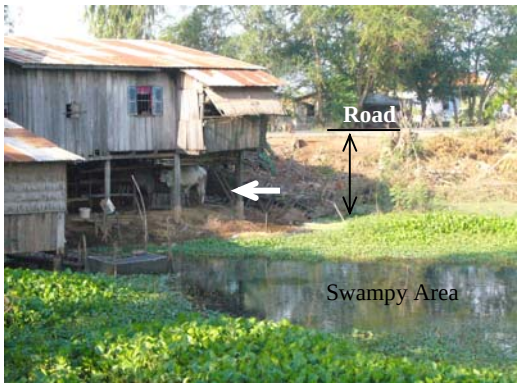
- Most houses are constructed close to the highway, making their first floor almost at the same level of the road level or higher (Pic. 4) and many of them are connected directly to the road by means of simple wooden bridge. Domestic animals such as cow, bullock, buffalos and goats are common, which are usually kept on the ground floor (Pic. 5). Such techniques based on thumb rules are accustomed in Cambodian flood prone societies and are initiatives from local people, who are experienced in living with flood.

Department of Hydrology and River Works, Pre Ven province

In this regional office of DHRW, we took an interview with some engineers, who are involving in flood management. Some key issues that we noticed during our visit in this regional department are summarized below.

- This department is responsible for the most components of water resources management in the province. It has 80 staffs and each of them is looking after certain sector such as flood management, water supply or irrigation.
- In this province, there are 12 districts, out of which 11 are usually flooded every year and four of them are badly affected by floods in 2002 and later. Mekong river is responsible for flooding in mentioned districts except one, which is flooded usually by heavy rain.
- Office has well maintained 48 historical flood marks, which can help people to alert and aware on possible consequences. JICA is running some flood management projects in this province.
- 'Local Agencies' (formed by group of people and field staffs) collect data in regular basis and send it to local department office, which is then collected and sent to the central department in Phom Phen, where data analysis including predictions and forecasts are made. These data are usually sent to Red Cross as well as to the local department offices. Therefore, Red-Cross can cooperate promptly with local staffs for warnings and evacuation.
- Asia Disaster Preparedness Centre (ADPC) is also active in this area

Picture 4. Elevated houses in flood plain



Picture 5. Ground floor is a shed for domestic animal

especially in Peam Chor district, providing training, facilitating community development and so on,

- Tentative flood inundation maps based on observed flood marks in different places are often prepared after each flood event; however there is limited use of it. Flood in 2002 was one of the worst events in history.
- Though people know well the scenarios, they do not like to evacuate. Domestic animals in this region are very precious and people do keep their animals together with them during flood and sometimes on the same room. Collapsing river banks causes high speed flood which is much difficult to manage than usual flood. Many people in the past were killed by such events but many events also due to boat sink, house collapse or drowned by flood.
- Warning can be done in several ways but here many people do not have TV, radio, mobile or internet so there is no alternative to the announcement through loud speakers in the street and each residential area. In addition, we usually inform village leader of each commune so he/she informs and advices about the potential danger to each and every household.
- In our question of current need and future plan concerning warning and evacuation, one of engineers expects to have separate evacuation centers for people and animal. In addition, he emphasizes the need of non-formal education to the people so they can initiate self evacuation in need. Moreover, information provided from the office or even

Picture 6. Red-cross made tube-well for flood prone community

Picture 7. Red-cross made public toilet for flood prone community

Picture 8. Community based flood warning system and awareness campaign (community based FHM in insight)

from Red-Cross may not trustworthy for local people therefore best person or agency should be selected to convey warning messages to the public. Another engineer insisted to build dykes and levees in help from donor agencies so that the risk level can be lowered significantly. He further explained that people participation is inevitable. Local people can contribute to this goal in several ways. Another technician explained the requirement of flood related subject in school curricula because most vulnerable groups of people are school children. Majority of victims in the past were school children basically because of their negligence.

- In this area, school children have long vacation in rainy season because rainy season is also a rice cultivation time and school children are expected to help their parents in the farm. In the meantime, parents take care of their children so they are out of risk that posed by flood while coming and playing in school. Although there is no special disaster related subject or topic to be taught, school teacher advices regularly their students about dangers and possible countermeasures to save life. Similar teachings are provided by Buddhist monks in pagodas.
- This office is cooperating well with provincial government. Provincial government has provided many supports in the past such as boats for communes. Therefore, flood hazard map can also be developed and promoted in this area in support from provincial government, however at moment they are lacking of budget and appropriate instrument (technology). Since Cambodian Red-Cross is actively involving in non-structural countermeasures against flood in the province, collaboration with such partner would be helpful. Red Cross is establishing several important facilities for disaster preparedness in the province. Some of the works that has been done by Red-Cross are illustrated in pictures 6, 7 & 8.
- Community based early warning system and preparedness (Pic. 8) have been adopted in many villages in supports from different national and international donor agencies. This project has covered only a tiny part of the flood prone community and is still under test phase. In connection to this development, survey team visited a site and talked to village leader. Information boards are erected, which consist of warning level indicators, risk map prepared by community itself and flood marks. This type of warning method can help only few households and there are very few such information boards in the village. Village leaders are well trained on how to instruct local residents to evacuate or aware community members.

3.2.3 Pursat

On 15 December 2006, we headed to Pursat provience, which covers 12,692 square km area in the northwest part of Cambodia. This province has 6 districts and Pursat is its capital. The town of Pursat is situated on the road from Phnom Penh to Batambang at 187 kilometres. The town centre is situated in the bank of Stoeung Sen river. This province has two folds of problem, often there is drought and sometimes flooding so farmer rarely receive a very good yield from their field. Pursat, a district capital is one of the flood prone areas. Flooding is often caused by heavy rainfall as well as by over bank flow from Stoeung Sen river. This year (2006) in October, the area was again flooded. Some notes on field observation are as follows.

- In October 2006, flow in the river was 1,300 cum/sec. Since the total flow capacity of the river in the down stream portion is about 600 cum/sec, about 700 cu m/sec was excess amount that caused flooding in the city.
- Flood level in the city was increased at the rate of 2 m/day (1 m/12 hrs) in an average rate. Therefore, time for evacuation was enough at the beginning but very few people evacuated.
- There are 7 existing automatic rain gauge stations, 8 manual rain gauge stations and 9 water gauge stations installed in different locations. Data recorded by automatic stations are incessantly available to view/download at internet site.
- During a site inspection, survey team observed flood marks along the bank of the river. River is meandering a lot with massive bank erosion. Traditional bank protection measures can be seen along the bank (Pic. 9).
- Probably river bed aggradation is one of the major causes of increasing flood damages. Recently, local farmers are interested to extract sand from the river bed using their irrigation pump. Sand has taken a good price in construction market so some of the farmers have shifted their traditional farming job into sand wholesaler. This illegal sand extraction may have direct or indirect and positive or negative impact on flood control. Extracted sand dunes can be seen in picture 10.
- Some paddy fields are in higher grounds so getting irrigation water from river is usually impossible. Since irrigation and flood timing are coincided, people can use small gates to regulate flood water at the embankment (Pic. 11). Some previously used irrigation pump

Picture 9 Wooden structures to protect bank from erosion

Picture 10 Sand extracted from the river bed (pump-inset)

Picture 11 Flood-irrigation regulating gate

stations are no more in function due to the lack of proper maintenance.

- A barrage is recently constructed to serve irrigation in the area. It has no function to control flood. Since the area is also a flood prone, such measures would better to be multi purpose rather than single use.

Picture 12 Barrage constructed for irrigation use

3.3 Conclusion and Recommendation

In year 2006, flood has not caused extreme damages like in the past, however prolonged turmoil paralyzed the normal life in most flood prone communities. Pursat and Kampong Cham provinces in Cambodia were among the extremely affected areas, where some people lost their lives. Cambodia has been facing serious flood problems since decades and there is little improvement in structural as well as non-structural countermeasures against flood in the country. Though country's legislative mechanism and flood governance is not complex as of Thailand, Cambodian government is not progressing in mitigating flood in good pace. Probably, the main hindrance is the budget but meantime lack of human resources, aged technology, unaware communities and rapid urbanization are some other problems. In other hand, lack of vision and poor planning as well as ineffective policies could have additional impact. For an example, efforts have been made to mitigate flood damage in the Chao Phraya River Basin through the construction of dams, reservoirs, dikes and pump stations but flooding problem still persists due to the increase of flood discharge as a result of deforestation, expansion of farmlands and urban areas etc. Flood management should not be treated separately rather it should be the part of community development and poverty eradication thereby main stream development. The community based disaster management practices has been taken into account by some donor agencies but the effectiveness of such project should be tested and if possible such programmes should be expanded to other communities. Flood hazard mapping could be the best working tool in community based disaster management practice; however it would not be effective unless agencies and communities are fully aware of its use and benefits. There is still a lot to do in flood management sector in Cambodia.

References

Mekong Secretariat (MS), 1994, Irrigation rehabilitation study in Cambodia, Final Report, Sir William Halcrow & Partners Limited, UK

Mekong River Commission (MRC), 2005, Annual flood report 2005, Flood Management and Mitigation Programme MRC, Vientiane, Lao PDR

Wikipadia a free Encyclopedia, 2007, Pre Veng province in Cambodia, http://en.wikipedia.org/wiki/Prey_Veng_Province

Note: This article is fully biased on field survey that was conducted within 3 days time frame and may not well represent the context. It has not precisely analyzed the data to comment or recommend. Therefore, the findings should be verified with appropriate data in future. Authors hope to make this report better in future in close consultation with local researchers/engineers with reliable data sets.