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Survey Report on 2015 Floods

မတ်လ (၂၀၁၆) ခုနှစ်　March 2016

The Project on Establishment of End-to-End Early Warning System for Natural Disaster

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Appendix

1. Introduction

1.1 Background

Torrential rains and the onset of Cyclone Komen triggered severe and widespread floods and landslides in July and August 2015 across 12 out of 14 states and regions in Myanmar. An estimated 1.6 million individuals were recorded as having been temporarily displaced from their homes by the disaster, and 132 lost their lives. Up to 5.2 million people were exposed to the floods and landslides in the 40 most heavily affected townships. Within the 40 most-affected townships, 775,810 individuals have been displaced, accounting for approximately half of the total displaced population[1].

The record and experience of the flood early warning and response of government officers and residents exposed the bottlenecks and challenges of the early warning system (EWS), human resource development (HRD) of government officers, and community-based disaster risk management (CBDRM). Currently, JICA is implementing the Technical Cooperation Project called "The Project on Establishment of End-to-End Early Warning System for Natural Disaster in the Republic of Union of Myanmar". The Project recognizes that although the major target disaster is cyclones, the methodology of the Project activities to enhance the capacity of EWS, HRD and CBDRM is also applicable to mitigate the damage of floods. By analyzing the results of a survey based on the experience of the Project activities, the Project can contribute to describe tangible lessons learned and future recommendations for the counterpart agencies and disaster management related agencies of the Government of Myanmar.

1.2 Objective of Survey

In Japan, whenever disaster occurs, the actual damage, the disaster characteristics, the actions taken for response, the issues and recommendations, etc. are summarized as a "Disaster Report" in order to utilize the experience of the disaster to better prepare for and respond to future disasters. In Myanmar also, preparation of this kind of disaster report in cooperation with related agencies is believed to reduce the damages caused by the future disasters. In order to show an example of a disaster report, this Survey on the 2015 floods was conducted in the Project.

Although the disaster report should cover the above-mentioned contents such as the actual damage, the disaster characteristics, the actions taken for response, issues and recommendations, etc., this Survey covers only the disaster characteristics and the issues and recommendations from the point of early warning and evacuation.

1.3 Outline of Survey

The Survey consists of the "Hydro-Meteorological Survey" and the "Interview Survey". The characteristics of disasters and their causes were studied in the "Hydro-Meteorological Survey" from the various available data and information such as rainfall amounts and water levels, weather charts

[1] Post Disaster Needs Assessment of Floods and Landslides July-September 2015 (Final Draft), November 2015

and satellite images, etc. owned by DMH and JMA, and the actual damage data owned by the Ministry of Social Welfare, Relief and Resettlement (MSWRR). Interviews with the government officers and the residents in the affected areas were also conducted in the "Interview Survey" on the actual situation of response activities, especially the communication and evacuation activity. Based on the result of these surveys, the issues and recommendations especially for the improvement of early warning system for the flood disaster were reported.

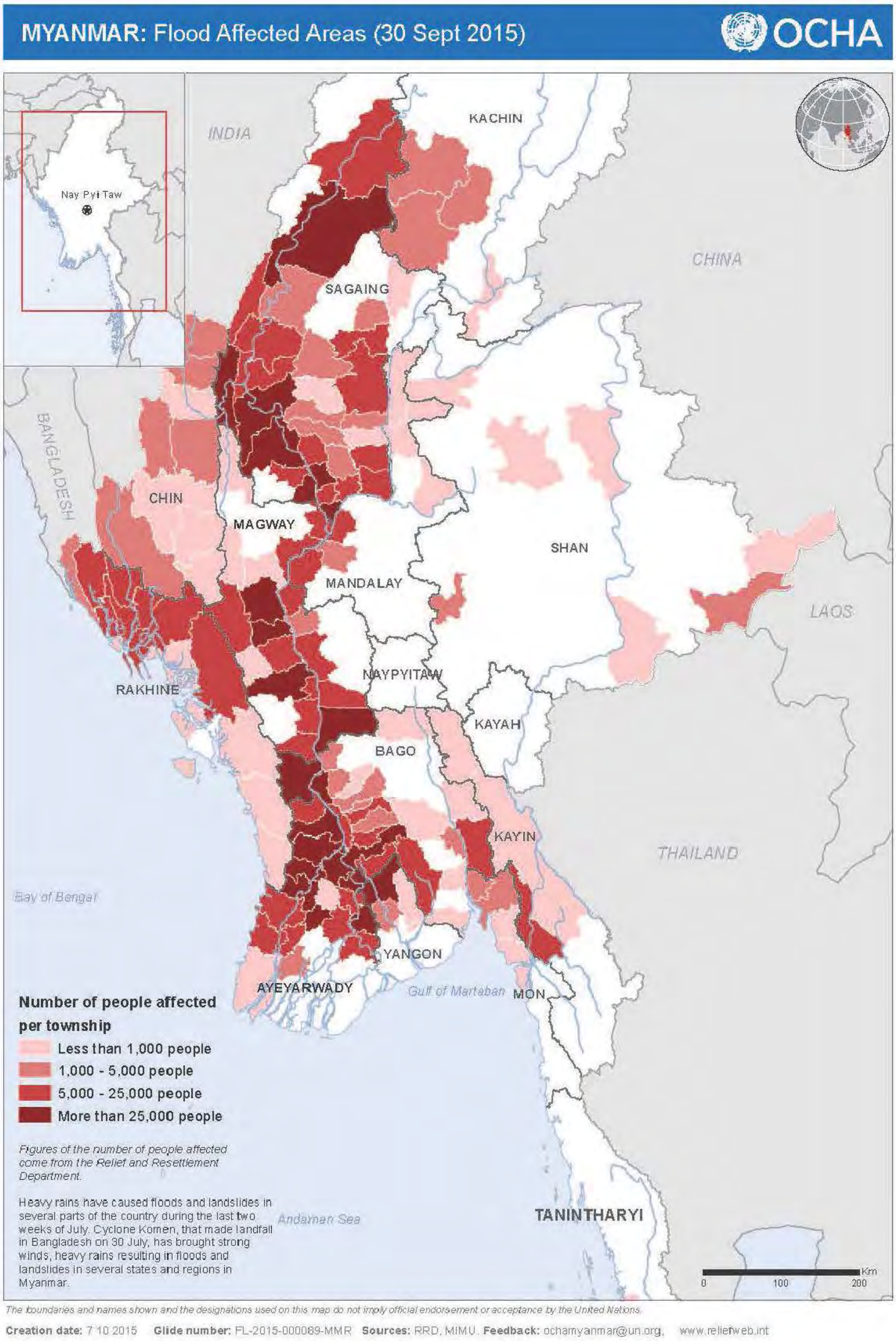
1.4 Summary of Damage

The damage situation per region/state is summarized in Table 1-1 based on the situation report prepared by MSWRR and the number of people affected by the disaster per township is shown in Figure 1-1 prepared by OCHA. As shown in this table and figure, Rakhine, Chin, Sagain, Magway and Ayeyarewaddy were heavily affected by this disaster. However, the damage condition is different for each state/region. A higher number of casualties and damaged houses but fewer affected people can be seen in Rakhine. On the other hand, there were no casualties in Ayeyarwady Region, but the number of damaged houses and affected people are the highest in the country. Therefore, it is necessary to know the differences of disaster characteristics in the affected areas in order to consider what actions should be taken for each disaster type to reduce the damage of future disasters.

Table 1-1 Summary of Damages by 2015 Floods

No.	Region/ State	No. of washed out/damaged houses	No. of Affecfed people	No. of deaths
	From 24th June to 28th June			
1	Rakhine	389	13,542	6
2	Tanintharyi	–	264	–
3	Kayin	–	389	–
4	Ayeyarwaddy	4	716	1
5	Bago	12	–	–
	Total	**405**	**14,911**	**7**
	From 16th July to 29th September			
1	Sagaing	1,963	473,329	27
2	Kachin	69	7,454	1
3	Shan	128	5,329	9
4	Mandalay	256	18,977	12
5	Chin	2,951	17,924	12
6	Rakhine	13,741	96,165	56
7	Kayin	1	7,325	–
8	Mon	45	6,632	–
9	Bago	269	177,315	5
10	Magway	414	303,694	2
11	Ayeyarwaddy	19,114	498,043	–
12	Yangon	–	63,576	1
13	Tanintharyi	3	323	–
	Total	**38,954**	**1,676,086**	**125**
Total of Jun to Sep		**39,359**	**1,690,997**	**132**

Source: Situation Report on Sep.29, 2015; Ministry of Social Welfare, Relief and Resettlement



Source: OCHA

Figure 1-1 Flood Affected Area due to 2015 Floods

Hydro-Meteorological Study

2. Outline of Hydro-Meteorological Study

2.1 Objective

The objective of this study is to know and report the characteristics of disasters, their causes and severity, etc. by utilizing the hydro-meteorological data, weather charts and satellite images owned by DMH and JMA, and the actual damage data owned by the Ministry of Social Welfare, Relief and Resettlement (MSWRR), in order to utilize the report for future disasters. Some considerations for the warning criteria will be conducted for the improvement of the early warning system.

2.2 Outline

(1) Meteorological Study

The weather conditions from June to August 2015 will be studied mainly on the rainfall distributions in the whole country. Features of tropical depressions/cyclones and various time-scale monsoon variations, which caused the widespread heavy rainfall amounts, will be also studied by utilizing the data and information from DMH and JMA.

(2) Hydrological Study

The rainfall conditions, the water level conditions and their relations with the occurrence of disasters at state/region level will be studied. The probability analysis will be conducted for the rainfall amounts and water levels in 2015 floods to evaluate the severity of disasters. In addition, the warning criteria for the flash flood, landslide and riverine flood will be considered for the improvement of early warning and evacuation system.

2.3 Collected Data and Information

The following data and information were collected for this analysis.

(1) Data

- Daily rainfall (79 stations) and daily water level (30 stations): 2015 floods (2015.06.01 – 2015.08.31), DMH
- Daily rainfall (17 stations) and daily water level (13 stations): June–August, 1986–2014, DMH
- Daily satellite image (2015.06.01–2015.08.31), GSMaP (Global Satellite Mapping of Precipitation), JAXA
- Situation report for 2015 floods, MSWRR
- Satellite image, and atmospheric circulation data and figures, JMA

(2) Report

- Early Monsoon Report of 2015, DMH
- Report for Weather Conditions during July 2015, DMH
- The report of Cyclone Komen that occurred in the Bay of Bengal, DMH

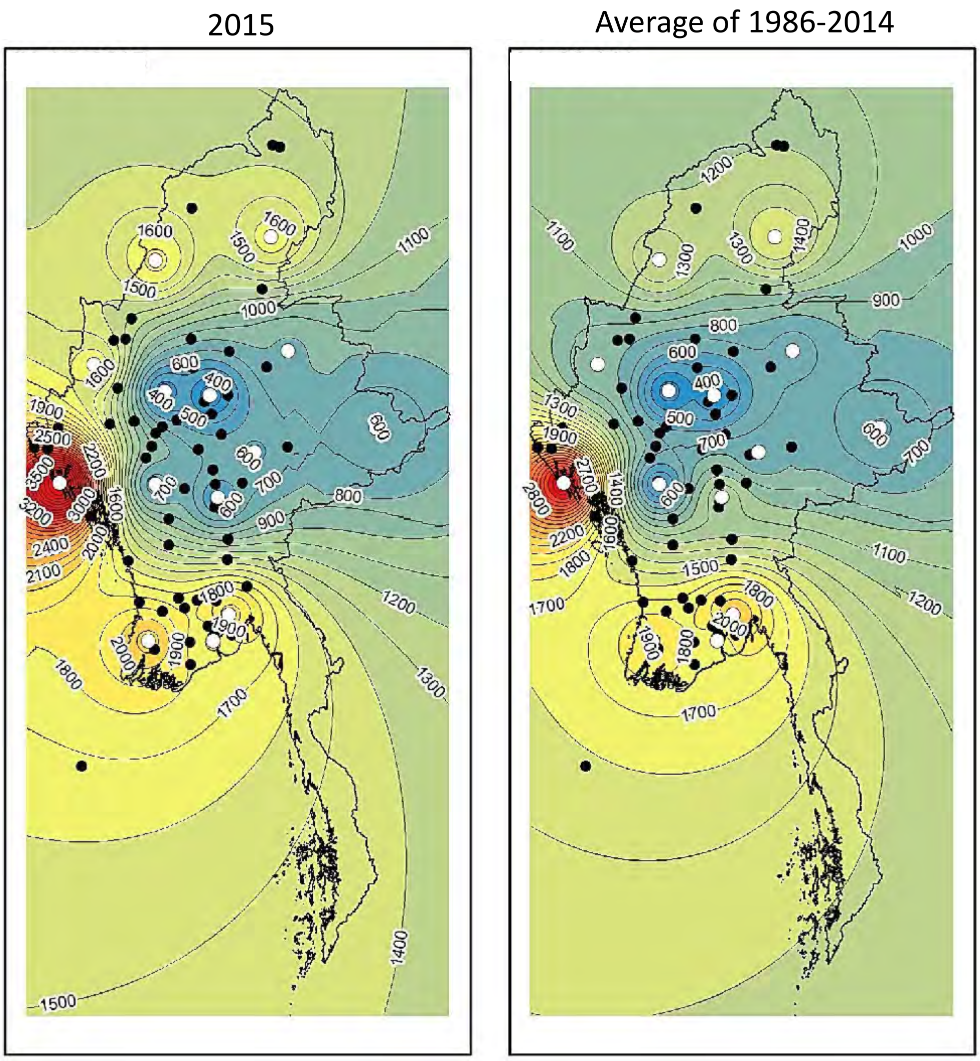
(3) Paper

- Tun Lwin, 1999: The El Nino and its Impact on the Climate of Myanmar
- Tin Mar Htay, Wittyi Soe, Chaw Su Hlaing: Climate change indices for Myanmar.
- Kyaw Moe Oo, : Climate Change, Vulnerability and Adaptation.
- Kyaw Moe Oo, 2013: Changing of annual rainfall situations in Myanmar during the decade 1991-2010.

3. Meteorological Study

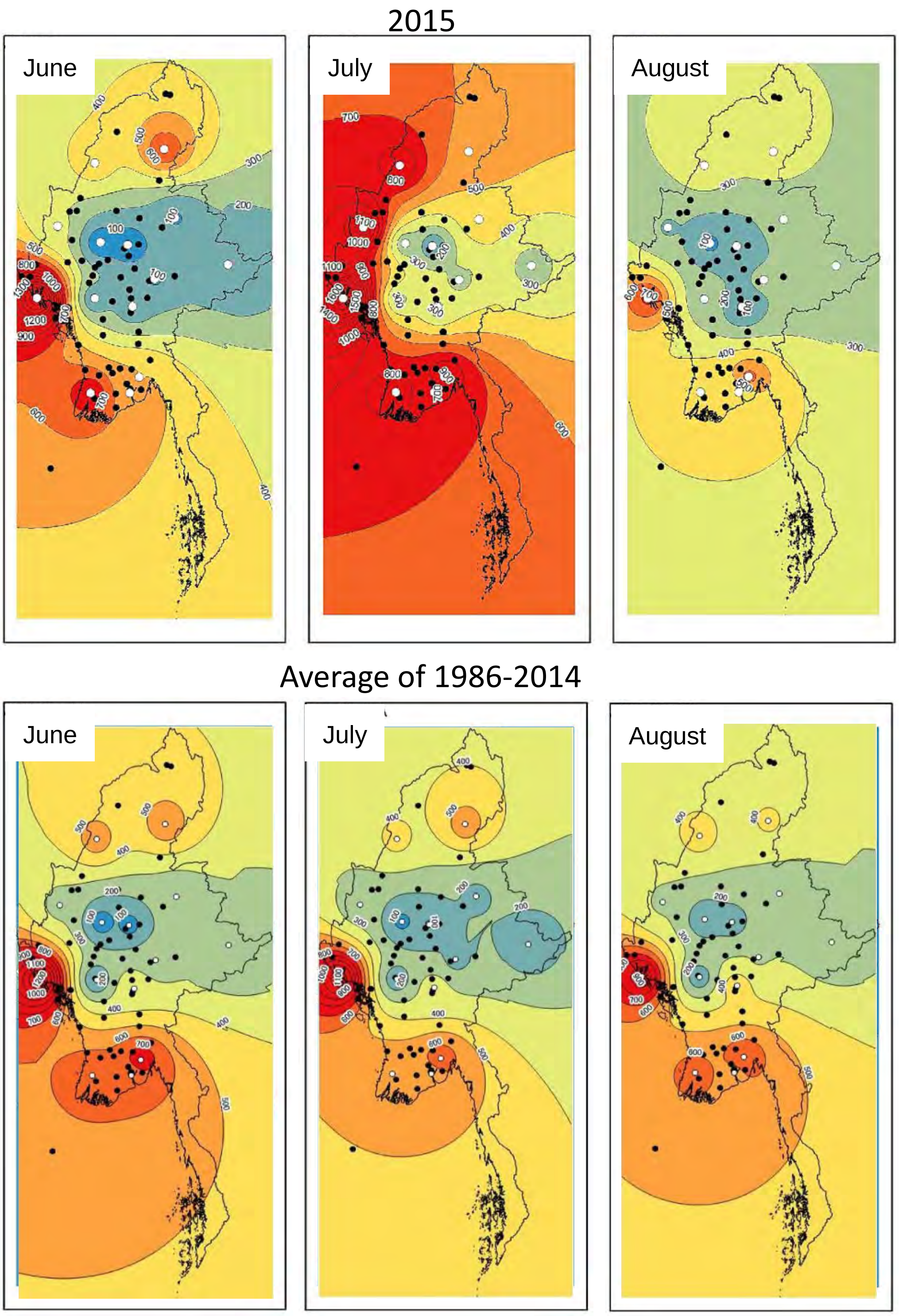
3.1 Features of Rainfall Distribution

In June 2015, the rainfall amount was above normal in the coastal and northern parts of Myanmar, while in the inland area, the rainfall amount was below normal (Figure 3-2), at about 30% to 80% of normal rainfall (Figure 3-3). From later June, heavy rainfall periods sometimes appeared, and the rainfall amount in July was above normal in most of the country (Figure 3-2 and Figure 3-3). It is noted that the rainfall amount was significantly above normal (more than 200% of normal) in some areas (Figure 3-3). In August, the rainfall amount was almost normal or below normal, while in some inland areas, the rainfall amount was above normal (Figure 3-2 and Figure 3-3). Three-month rainfall was also normal or slightly above normal in most parts of the country except in some inland areas (Figure 3-1).



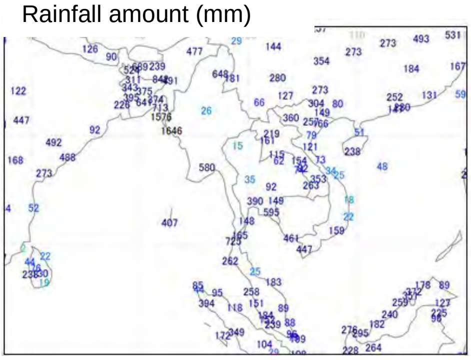
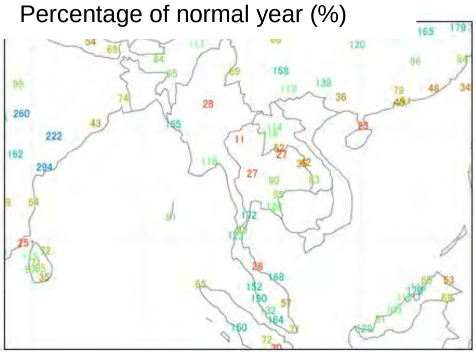
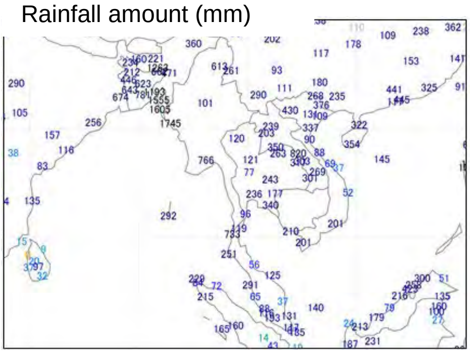
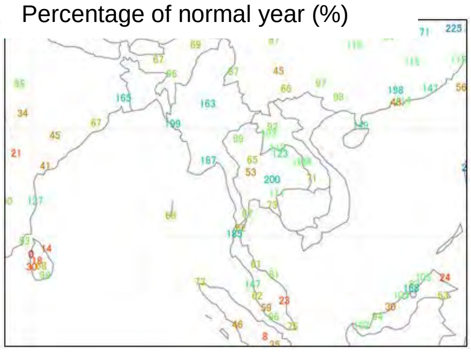
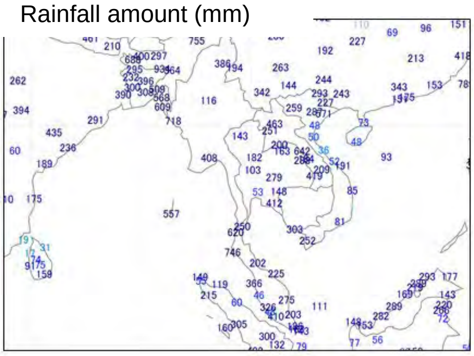
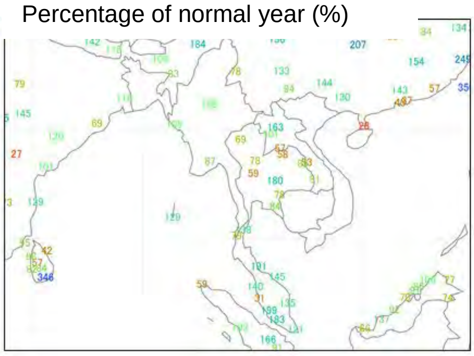
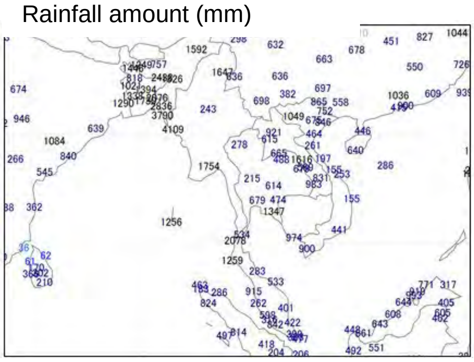
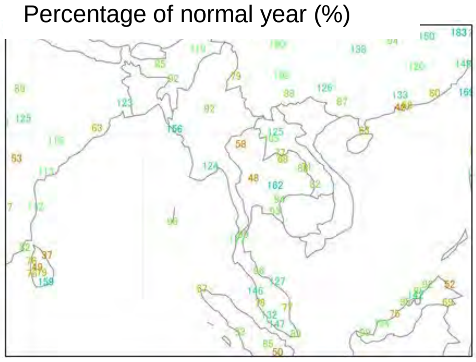
Source: Prepared by JICA Expert Team based on the data from DMH

Figure 3-1 Rainfall Distributions for Three Months (Accumulated rainfall amount from June to August)



Source: Prepared by JICA Expert Team based on the data from DMH

Figure 3-2 Monthly Rainfall Distributions

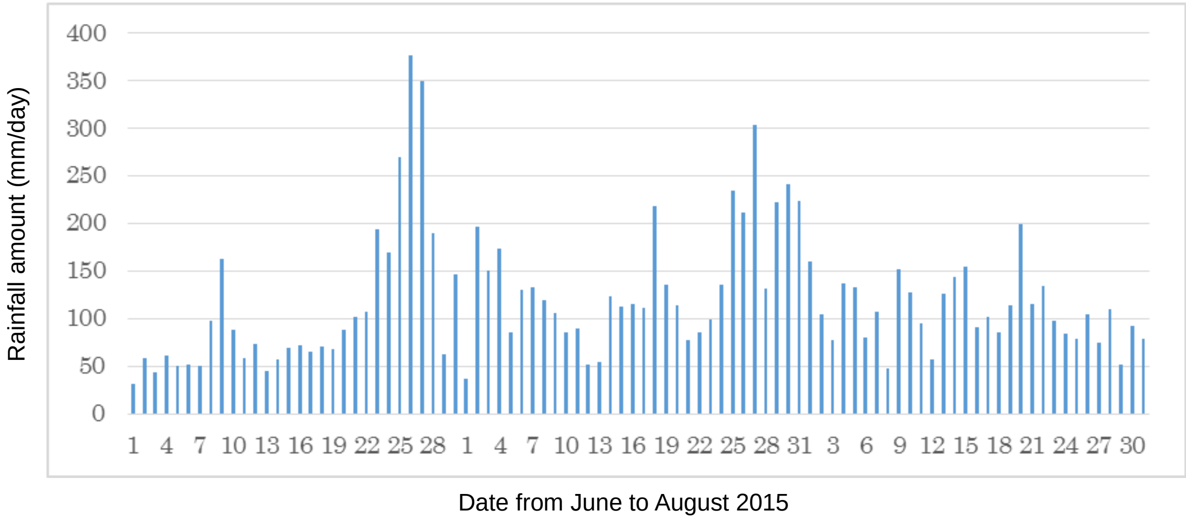
June 2015	Rainfall amount (mm) 	Percentage of normal year (%) 
July 2015	Rainfall amount (mm) 	Percentage of normal year (%) 
Aug. 2015	Rainfall amount (mm) 	Percentage of normal year (%) 
3-month (June to Aug.) 2015	Rainfall amount (mm) 	Percentage of normal year (%) 

Note Left: Monthly/three-month rainfall (mm)
Right: Monthly/three-month rainfall percentage of normal (%)

Source: CPD/JMA

Figure 3-3 Monthly/Three-month Rainfall and Percentage of Normal Amount in South/Southeast Asia

Figure 3-4 shows the time series of daily maximum rainfall amounts from 78 stations in Myanmar from June to August in 2015. It is interesting to note that daily rainfall amounts of more than 50 mm are observed at most locations in the country during the period, and in particular, rainfall amounts of more than 200 mm/day were often observed in late June and late July.

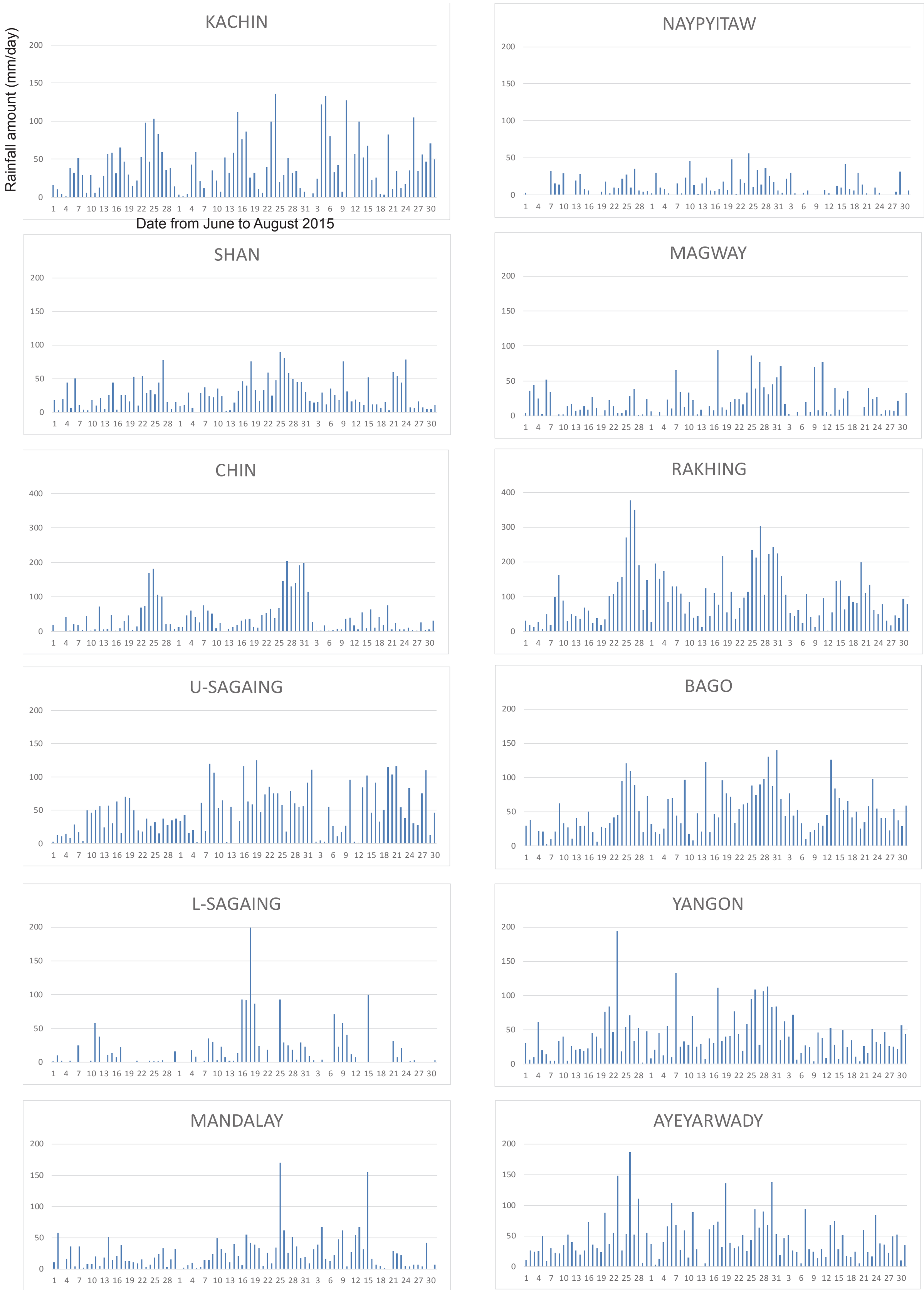


Note: The largest value is selected on each day from 78 stations.

Source: Prepared by JICA Expert Team based on the data from DMH

Figure 3-4 Time Series of Daily Maximum Rainfall (mm) at 78 Stations from June 1 to August 31 in 2015

Figure 3-5 shows the time series of daily maximum rainfall in twelve states/regions from June to August. It is evident that the daily rainfall amounts over 200 mm were observed in Chin and Rakhine, and amounts over 150 mm were recorded in Yangon and Ayeyarwady. On the other hand, heavy rain, such as daily rainfall over 100 mm, was not observed in Shan, Nay Pyi Taw or Magway throughout the period.



Source: Prepared by JICA Expert Team based on the data from DMH

Figure 3-5 Time Series of Daily Maximum Rainfall (mm) from June 1 to August 31 in 2015 (each of 12 states/regions)

Variations in rainfall amount are closely associated with southwest monsoon activities. The occurrence of high rainfall amounts in late June and late July seems to be related with intra-seasonal variations of the southwest monsoon activity, which will be discussed in a following section of the report. In addition, intensified monsoon trough and cyclonic disturbances, such as a Tropical Storm (named Kujira), which developed in the South China Sea and landed on the Indochina Peninsula in late June, and a Cyclonic Storm (named Komen), which developed in the Bay of Bengal in late July, also had important roles in the significantly heavy rainfall amounts in these periods (Report by DMH).

3.2 Period of Heavy Rainfall Amounts and Floods

Figure 3-6 shows the periods of heavy rainfall, which were identified in Figure 3-4 and Figure 3-5, and the timing of floods in the states/regions. The dates of the occurrence of floods are provided by MSWRR.

STATES AND DEVISIONS	JUNE			JULY			AUGUST		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
KACHIN			○		○	○	○	○	○
SHAN									
CHIN			○			●			
U-SAGAING				○	○	○		○	○
L-SAGAING					○				
MANDALAY						○		○	
NAYPYITAW									
MAGWAY									
RAKHING	○		●	○	●	●	○	○	○
BAGO			○		○	○		○	
YANGON			○	○	○	○			
AYEYARWADY			○		○	○			

Note: Floods were reported in the yellow-box periods.

Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 3-6 States/Regions with Rainfall over 200 mm/day (●) and 100 mm/day (○) Observed in Early, Middle, and Late 10-day Periods from June to August 2015

It becomes clear that:

1) Heavy rains seemed to start in late June.
2) Heavy rains with floods were observed in middle and late July in wider regions. Particularly, floods were reported in wider regions in late July.
3) In early August, heavy rains over 100 mm/day were observed only in Kachin and Rakhine, while floods were reported in these and some other regions.

With regard to 3), it should be noted that floods tend to occur due to heavy rain in certain periods, while rainfall in an upper river area may cause floods after a certain time-lag in a lower river area. In the latter case, the timing and regions of floods are not necessary consistent with those of rainfall.

3.3 Features of Accumulated Rainfall

Figure 3-7 shows accumulated rainfall starting from 1st of July to 8th of August for 2015 and for the 10-year (2001 to 2010) average (note that the 10-year average is described as “normal” in this section 2.3). Twelve stations representing each of the states/regions are selected. Features are：

1) Northwestern/western Regions (Chin, U-Sagain, Rakhine)

   Accumulated rainfall amounts are over 1,000 mm, and are more than 200% above “normal” in Hakha and Homalin, and about 120% in Sittwe, where usually a high rainfall amount is observed. They exceeded the “normal” levels after middle or late July.

2) Southern Regions (Bago, Yangon, Ayeyarwady)

   Accumulated rainfall amounts are over 800 mm, about 120% to 140% of normal rainfall amount, and exceeded the “normal” levels in late July.

3) Eastern/Northeastern Regions (Kachin, Shan)

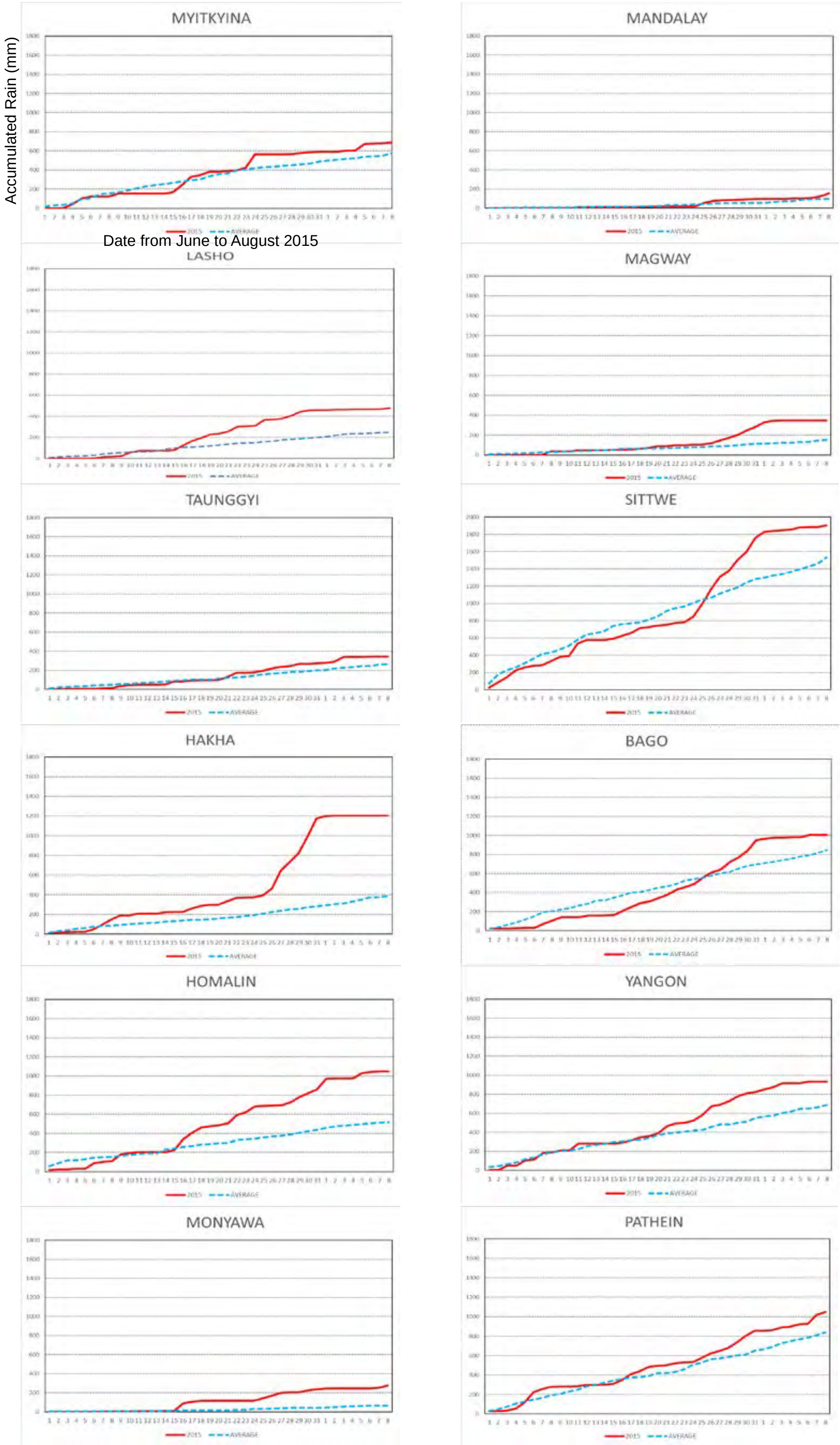
   Accumulated rainfall amounts are about 400 mm to 800 mm, about 120% in Myitkyina, about 130% in Taunggyi and about 190% of “normal” in Lasho. They exceeded the “normal” levels in late July.

4) Central Regions (L-Sagain, Magway, Mandalay)

   Accumulated rainfall amounts are about 200 mm to 400 mm, smaller than those of the above-mentioned three areas. However, they are more than 150% in Mandalay, 200% in Magway, and 300% in Monywa of “normal”.

It is summarized that:

1) Rainfall amounts were below “normal” in the early half of July, while accumulated rainfall amounts became above “normal” in or after the middle of July,
2) Rainfall amounts were much different from one area to another. They were over 1,000 mm in northwestern/western areas, while they were 200 mm to 400 mm in central areas.
3) It is noted that in most parts of northwestern areas as well as central areas, where a lot of floods were reported, accumulated rainfall amounts seemed to be about 200% to 300% of “normal”.



Note: Solid (Red) line: year 2015, Dashed (Blue) line: 10-year average (2001 to 2010)

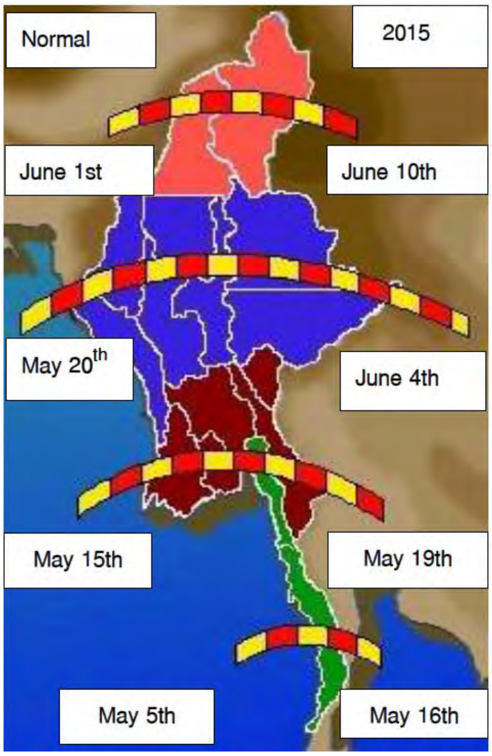
Source: Prepared by JICA Expert Team based on the data from DMH

Figure 3-7 Accumulated Rainfall (mm) Starting from July 1 to Aug. 8

3.4 Southwest Monsoon in 2015

Southwest monsoons in Myanmar usually begin in early May from southern Myanmar, while in northern parts they start in early June. (Source: DMH report

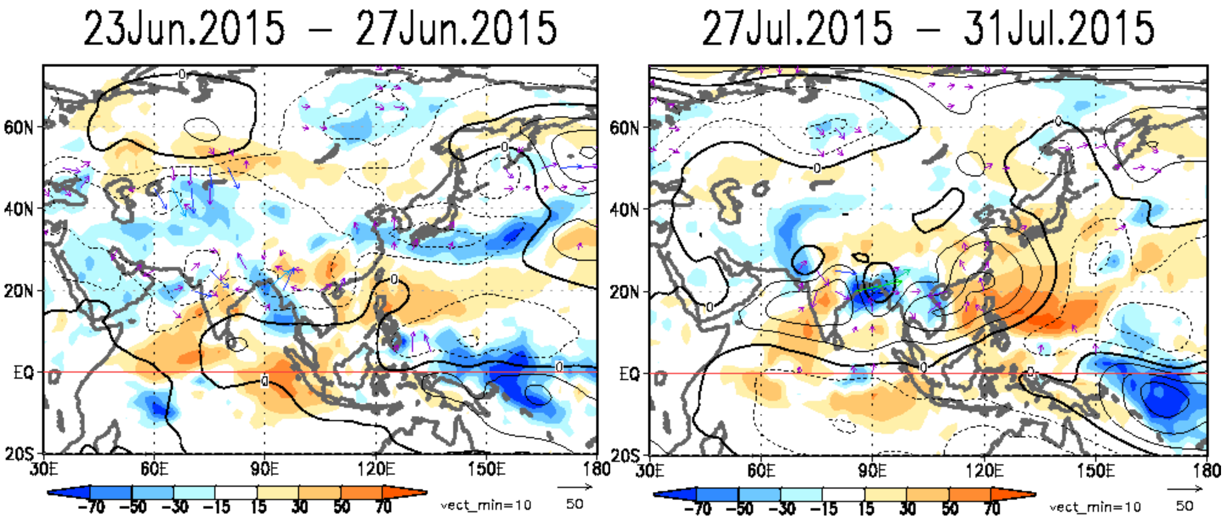
Figure 3-8). In 2015, the southwest monsoon started a little later than usual. Monsoon circulations in the Bay of Bengal became very active in late June and late July, resulting in occasional heavy rainfall of more than 100 mm/day in some areas (Figure 3-4 and Figure 2-5).



Source: DMH report

Figure 3-8 Comparison of Starting Date of Southwest Monsoon in Normal Year and in 2015

Figure 3-9 shows distribution of the "Outgoing Longwave Radiation" (OLR) anomalies and "Stream Function" anomalies at 850 hPa in late June and in late July in south/southeast Asian regions. OLR generally tends to indicate activities of tropical convection. Negative OLR anomalies correspond to stronger convective activities, while positive ones indicate weaker convective activities. The stream function distributions show the condition of circulation. For example, the negative stream function anomalies indicate stronger cyclonic circulations, while positive anomalies indicate weaker circulations. In late June (Figure 3-9 left), OLR is below normal in Myanmar and in the Bay of Bengal, and stream function anomalies are negative. In late July (Figure 3-9 right) also, the negative OLR anomalies prevail from the Indochina Peninsula to Bangladesh, indicating stronger convective activities in the area. Around the south of the area both in late June and late July, on the other hand, positive OLR anomalies are prevailing, indicating weaker convective activities. Thus, it seems evident that in these two periods, convective activities were stronger at the latitudes of northern parts of the Bay of Bengal and around Myanmar.

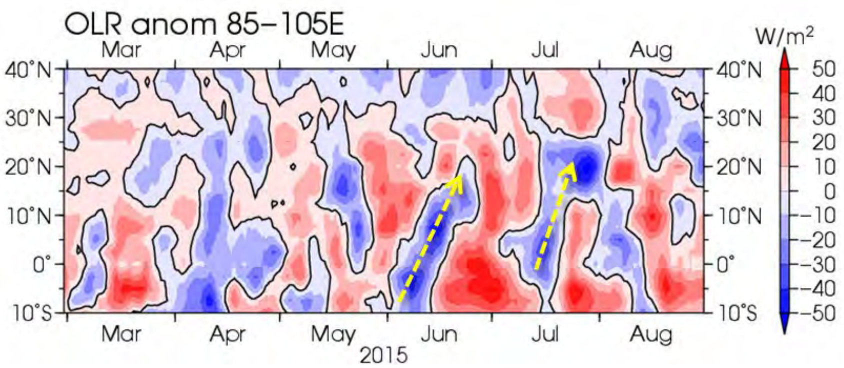


Note: Negative OLR anomalies (blue color) generally correspond to stronger convective activities, while positive anomalies (orange color) indicate weaker convective activities. Negative stream function anomalies (dashed line) generally correspond to stronger cyclonic circulation conditions, while positive ones (solid line) opposite conditions.

Source: CPD/JMA

Figure 3-9 Stream Function Anomalies at 850 hPa and OLR Anomalies in late-June (left) and late-July (right) (from CPD/JMA)

Figure 3-10 shows the latitude-time cross section of OLR anomalies averaged over the longitudes between India and the Indochina Peninsula (latitudes of 85E to 105E). It is clear that in June, negative OLR anomalies moved northward as shown by the arrow in the figure. In July, the same movement can be seen.



Note: Northward migration of active convective areas (blue areas) from around the equator to the latitude of around 20N are observed rather clearly, as shown by the arrows, during June and July 2015

Source: CPD/JMA

Figure 3-10 Time-latitude Cross-section Averaged over the Longitudes between 85E and 105E for OLR Anomalies

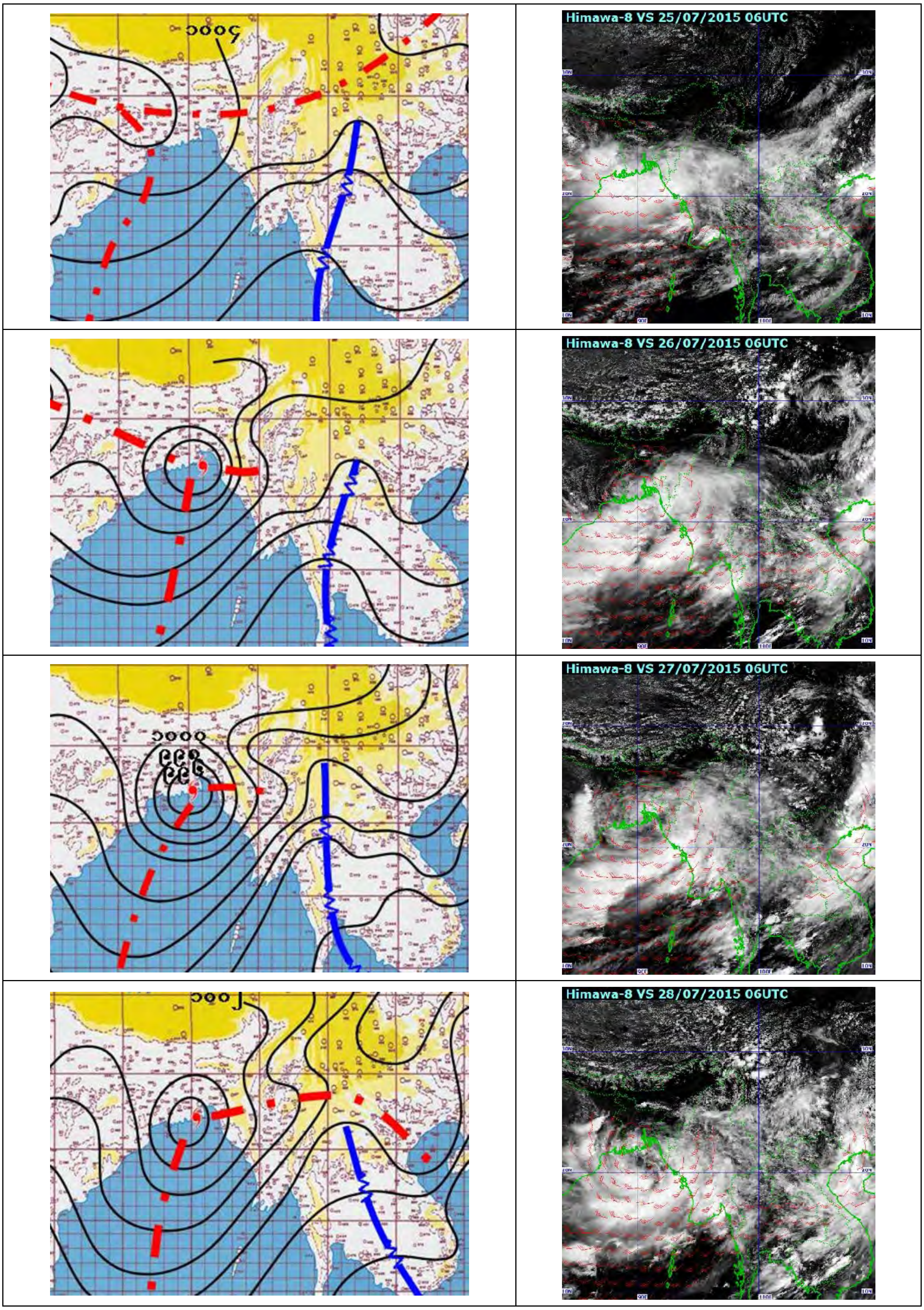
From early June to late July, the areas of active convection moved northward in about a one-month interval, and convective activities became stronger around the latitude of Myanmar and northern parts of the Bay of Bengal in late June and late July, when the heavy rainfall amounts were observed in Myanmar.

3.5 Tropical Disturbances in Late July

In late July, the monsoon trough became very evident, and a *depression* was generated on the 26th of July. In a few days, it developed into a *deep depression* on the 29th, and developed into a *cyclonic storm* on the 30th with a maximum wind speed of 50 mile/hour and a minimum air pressure of 983 hPa. The track of Cyclone Komen shown in Figure 3-11, the daily weather charts and satellite images in Figure 3-12, and the list of warnings on Cyclone Komen in Table 3-1 show how Cyclone Komen developed and how slow it moved. This was the first time that a cyclonic storm developed in the Bay of Bengal in July since 1989, based on the database by the India Meteorological Department.

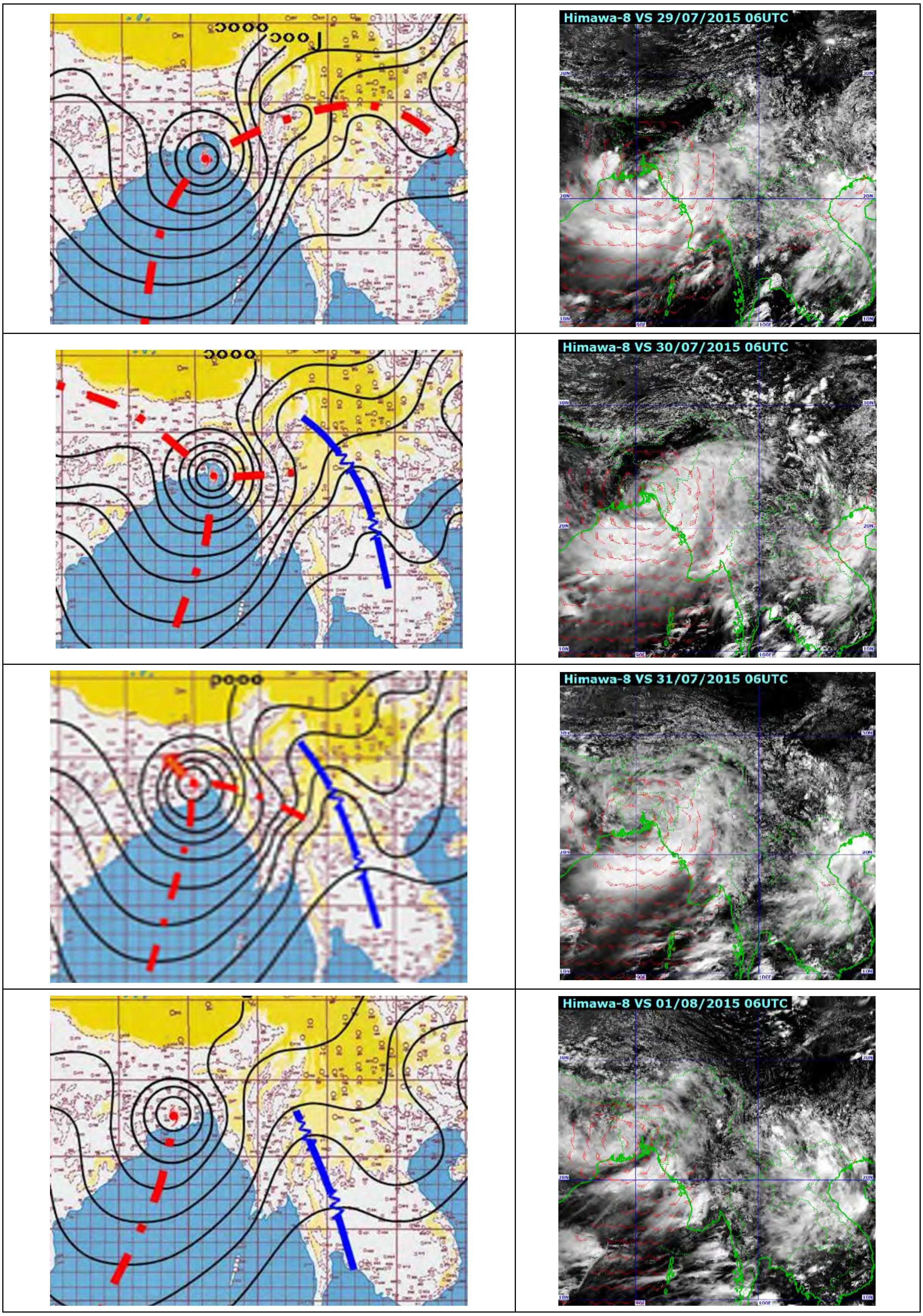
Source: DMH Report

Figure 3-11 Track of Cyclone Komen



Source: DMH and JMA

Figure 3-12 Surface Weather Chart (Left) and Satellite Image (VS, 0.64 µm) (Right) from July 25 to Aug. 1(1/2)



Source: DMH and JMA

Figure 3-12 Surface Weather Chart (Left) and Satellite Image (VS, 0.64 µm) (Right) from July 25 to Aug. 1 (2/2)

Table 3-1 Warnings and Advisories for *Cyclonic Storm Komen* issued by DMH

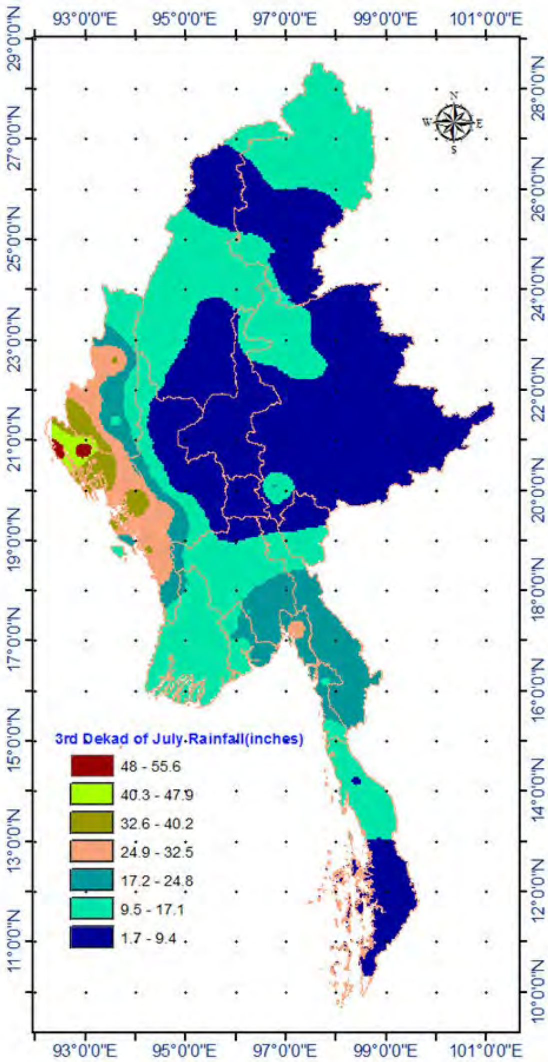
No.	Date	Time (MST)	Stage of cyclones/dipressiions		Center pressure (hPa)	Max wind (mile/h)	Forecast	Cautions and advisoris
				warning color				
1	26-Jul	16:00	Dipression	Yelow	996	45		Widespread rain, squalls,rough seas, heavy rainfalls,strong wind, flash flood.advisory to ships, etc
2		19:00						
3	27-Jul	6:00			994	40		
4		14:00						
5	28-Jul	7:00						
6		14:00						Widespread rain or thunderstorm, squalls,rough seas, heavy rainfalls,strong wind, flash flood.advisory to ships, etc
7		17:00						
8	28-Jul	7:00				45		
9	29-Jul	12:00	Deep depression	Orange			Next 36hours	Widespread rain or thunderstorm, squalls,rough seas, heavy rainfalls,strong wind, flash flood, land slide.advisory to ships, etc
10		19:00					Next 36hours	
11	30-Jul	6:00			993		Next 24hours	
12		11:00	Cyclone storm		986	50	Next 12hours	
13			Storm warning					Dangerously affected due to the banding features of the storm,etc.
14		18:30		-			Next 6hours	
15	31-Jul	7:00	Deep depression					
16		14:00						rain or thundershowers. Monsoon is strong to vigorous, etc.

Source: Prepared by JICA Expert Team based on the data from DMH

Because this depression was almost stationary or moved very slowly northward, the inflow of very warm and wet air continued in Myanmar located at the east of the depression, and brought heavy rainfall to the western parts of Myanmar, especially along the coastal regions (Figure 3-12). Heavy rainfall continued with rainfall amounts for the last 10 days of July totaling more than 1,000 mm in Sittwe (Figure 3-13). It is noted that the one-week rainfall amount (25th to 31st July) exceeded the monthly average rainfall of July in at least Magway and Chin (Report by DMH). While the depression moved north/northeastward, very warm and wet air was transferred to further inland areas, and heavy rains over 150 mm fell in the eastern regions such as Shan. Warnings and advisories were continuously issued by DMH as shown in Table 3-1.

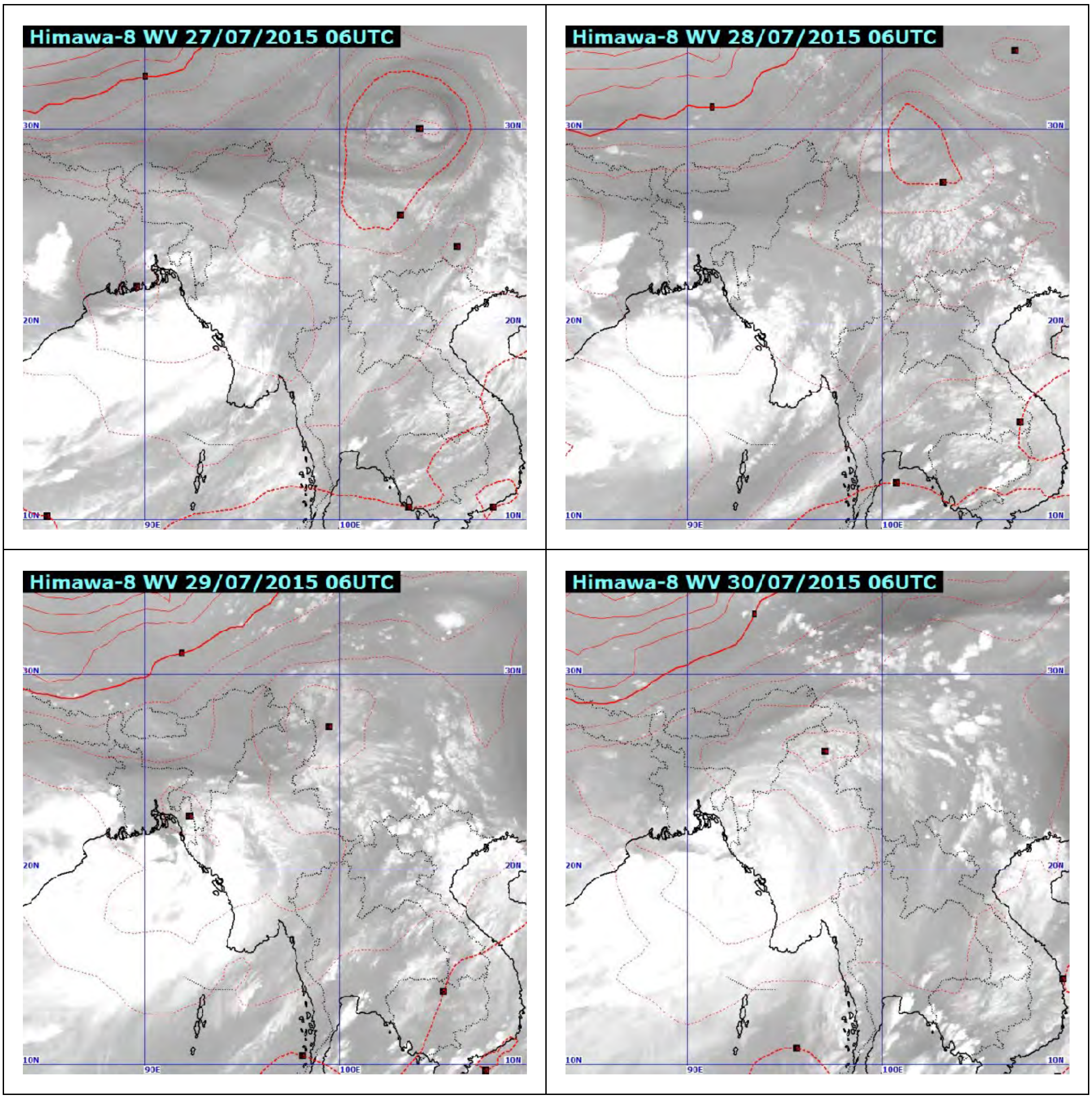
According to satellite images of water vapor by HIMAWARI-8* as shown in Figure 3-14, in which temperature distributions are superimposed, an upper cold low (UCL) was formulated around southwestern China, and moved southwestward toward over Kachin toward the end of the month. This UCL might also have contributed to rainfall in this region.

* Images of water vapor by HIMIWARI-8 are useful to monitor upper airflow and cold air.



Source: DMH

Figure 3-13 Distribution of Rainfall in the last 10 days of July (21 to 31) 2015



Note: Temperatures at 500 hPa (Red lines) from the JMA/NWP are superimposed on the images. Upper cold low (UCL) indicated by red circles appears to be moving from southwestern China to northern Myanmar.

Source: JMA

Figure 3-14 Satellite Images (Water vapor, 6.2μm) from 27 0600UTC to 30 0600UTC July 2015

3.6 Consideration on Southwest Monsoon Rainfall and its Variability

During the southwest monsoon season, the rainfall variability in Myanmar is closely associated with the variability of southwest monsoon. Activity of the monsoon changes over various time scales, such as a few days to a few weeks (Intra-seasonal variations, ISV), year-to-year variations, and longer timescales. On the other hand, the convective activities in the tropics show ISV as well as inter-annual variations. An example for ISV of the tropical convective activity is the northward movement of active convective areas in the Indian Ocean and the Bay of Bengal, as discussed in section 3.1.

As described in section 3.1, the monsoon around the Bay of Bengal was stronger or more vigorous in late June and in late July as shown in the monsoon index by DMH (Repot by DMH). Northward migrations of active convective areas were clearly seen in June and July, and convective activities became stronger around the latitudes of Bangladesh and the Myanmar region in late June and late July, and heavy rainfall continued in the coastal and inland areas in Myanmar. This indicates that monitoring of southwest monsoons and convective activities in the Indian Ocean from the point of their ISVs is quite important to monitor rainfall variations during the monsoon season in Myanmar.

It is also important to note that the El Nino event continued in 2015. During this phenomenon, the southwest monsoon tends to start later than usual, and monsoon activities tend to be less active in South and Southeast Asian country regions. The onset of the monsoon season in 2015 was later than usual in Myanmar, which might indicate the influence of the current El Nino phenomenon.

As for inter-annual variations of the southwest monsoon, it may be necessary to consider other affecting factors such as the Indian Ocean Dipole mode (IOD), which mainly represents air-sea interactions between the tropical Indian Ocean and its atmosphere, and climate change issues as suggested by DMH staff at the technical meeting at DMH headquarters.

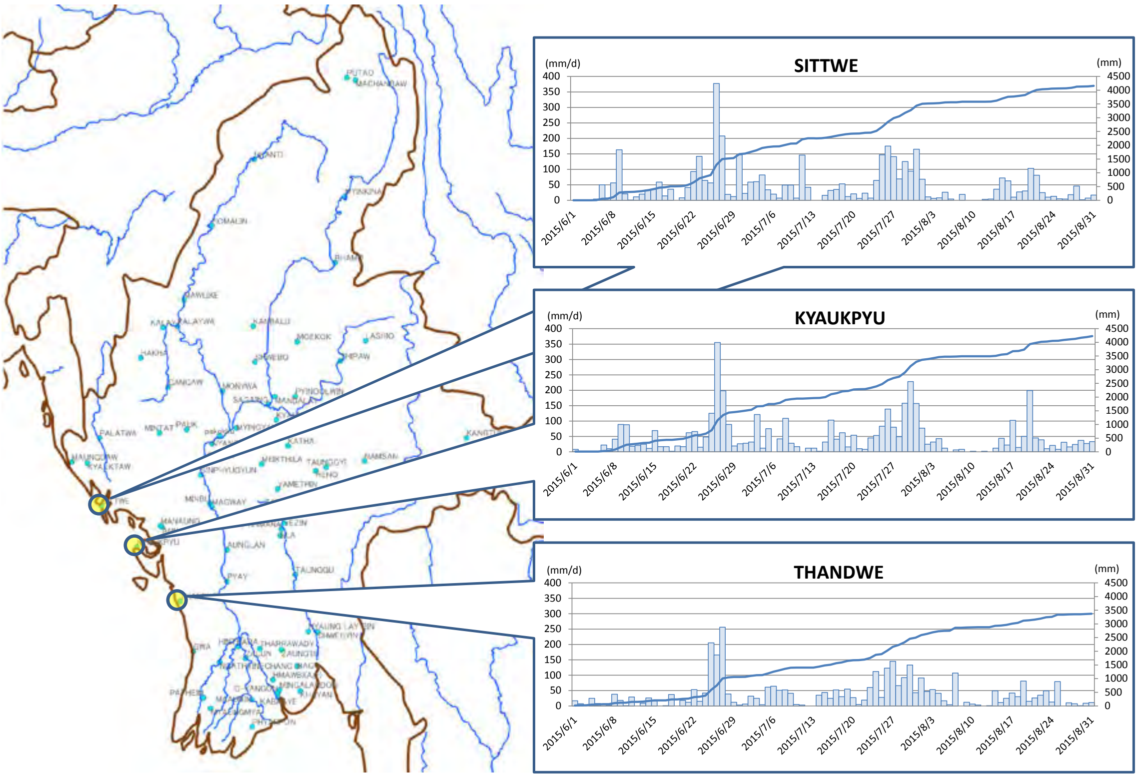
4. Hydrological Study

In general, severe disasters occurred three times in Myanmar, at the end of June, the middle of July and the end of July. In this chapter, the areas heavily affected by the disasters during this period were selected and their hydrological conditions were studied.

4.1 Rainfall Conditions

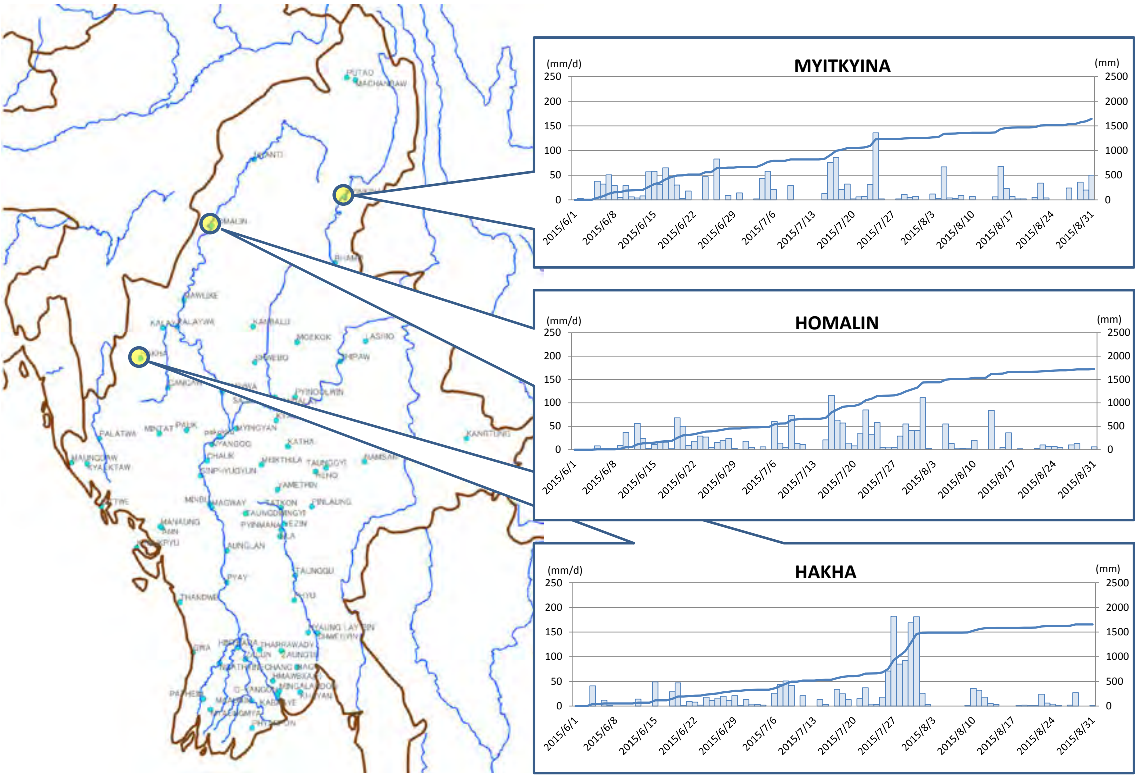
The daily rainfall amounts from June to August at the gauging stations, where the severe disasters occurred, are shown below. It can be said that the coastal areas received a much higher rainfall amount and the localized heavy rainfall that occurred in the mountainous areas.

A flood also occurred around the area shown in Figure 4-3, though the rainfall amount is very low. This is because the area was affected by a riverine flood from the upstream of the Ayeyarwady River.



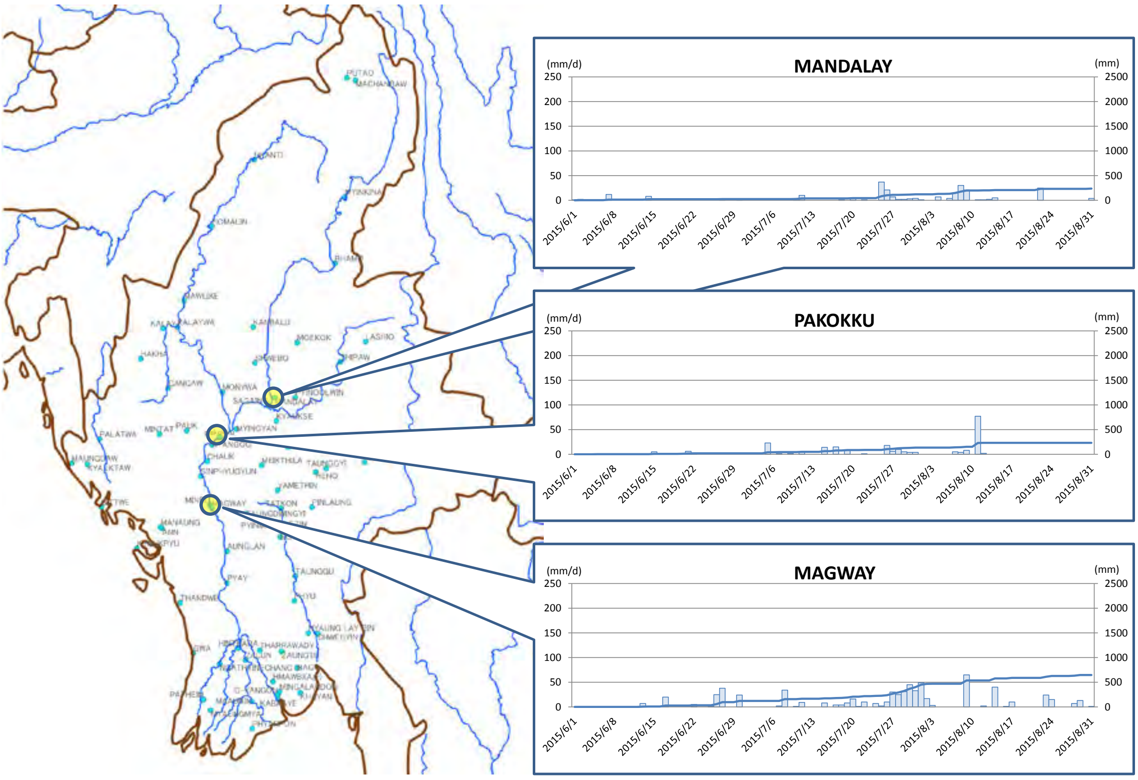
Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-1 Daily Rainfall in Coastal Areas (June to Aug, 2015)



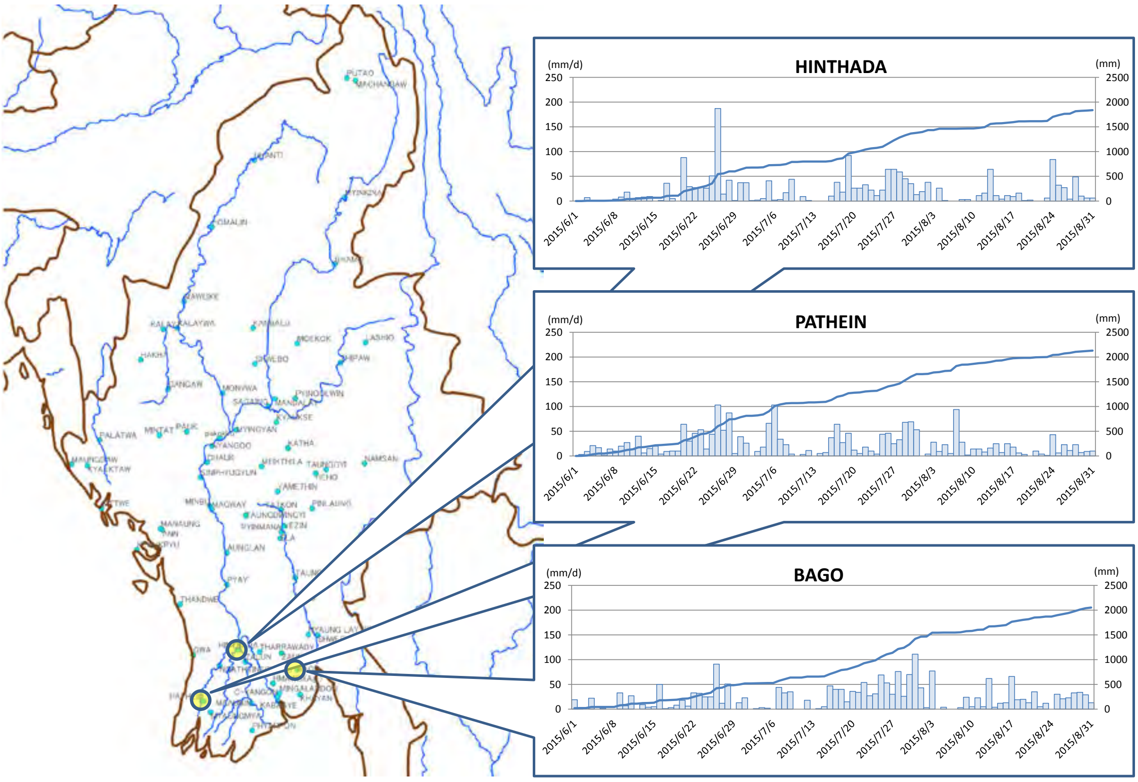
Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-2 Daily Rainfall in Mountainous Areas (June to Aug, 2015)



Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-3 Daily Rainfall in Middle Plain Areas (June to Aug, 2015)

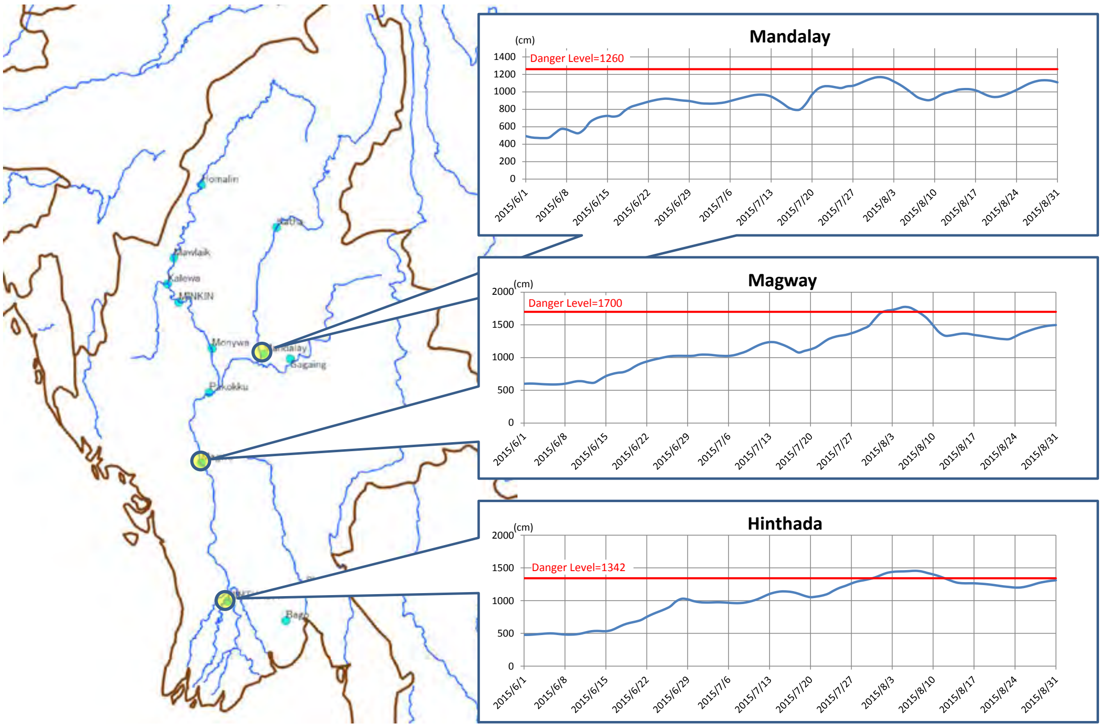


Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-4 Daily Rainfall in South Delta Areas (June to Aug, 2015)

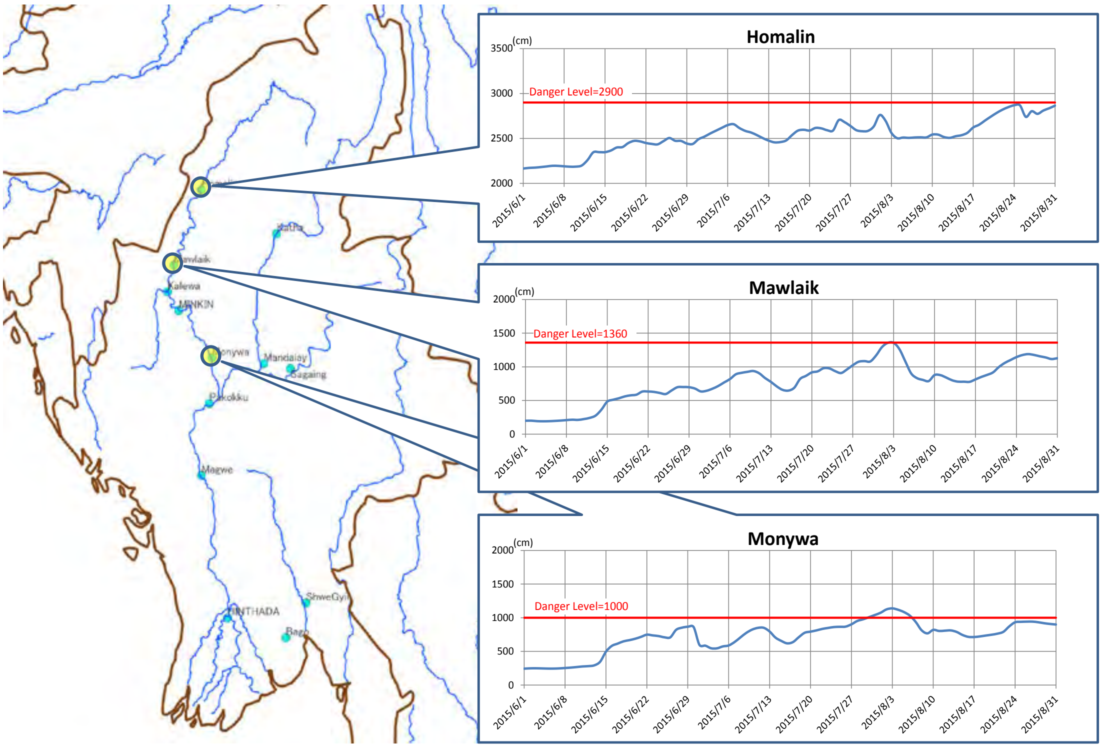
4.2 Water Level Conditions

Figure 4-5 and Figure 4-6 show the water level of the Ayeyarwady River and Chindwin River from June to August 2015. The water levels of both rivers reached the highest point at the beginning of August and the water levels exceeded the “Danger Level” defined by DMH at the mid-stream and down-stream of both rivers.



Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-5 Daily Water Level in Ayeyarwady River (June to Aug, 2015)



Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-6 Daily Water Level in Chindwin River (June to Aug, 2015)

4.3 Damage Situations

The situation report on 2015 floods was prepared by the Ministry of Social Welfare, Relief and Resettlement (MSWRR) showing the date of disaster, the number of affected people, the relief items delivered, etc. Table 4-1 is a list of affected areas where the corresponding rainfall amounts or water levels were collected based on the situation report. Noting the daily rainfall amount at the time of disasters, heavy rainfall was observed in the coastal areas, while little rainfall was recorded in inland areas. It can be said that most of the floods that occurred in the inland areas were riverine floods, though the floods also occurred due to localized heavy rainfall in some inland areas such as Hakha in Chin state.

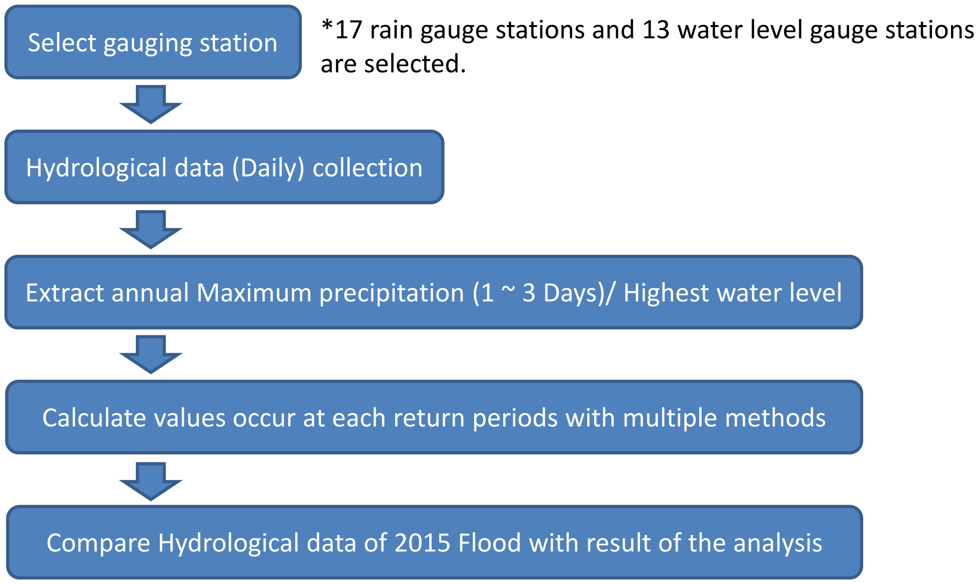
Table 4-1 List of Affected Areas with Daily Rainfall Amount

Reigion / State	Affected Areas	Disaster began Date	Number of Affected people	Total Assistant (Kyats)	Rainfall gauging station	precipitation at disaster began date (mm/d)
Sagain	Kant Ba Lu	2015/7/16	10,575	6,134,050	Kant Ba Lu	93
	Mone Ywar	2015/7/16	39,321	0	Monywa	80
	Kalaywa	2015/7/28	17,850	5,714,500	Kalaywa	23
	Kalay	2015/7/30	78,978	70,076,410	Kalay	56
Kachin	Bamaw	2015/7/24	122	0	Bhamo	103
Shan	Thibaw	2015/7/25	931	2,798,588	Thinpaw	90
Mandalay	Mogoke	2015/7/24	361	2,840,662	Moekok	34
	Nyaung Oo	2015/7/31	8,006	21,752,670	Nyangoo	19
	Myin Chan	2015/8/2	7,029	10,384,500	Myingyan	20
	Pyin Oo Lwin	2015/8/2	-	0	Pinoolwin	4
Chin	Haka	2015/7/29	4,492	55,275,348	Hakha	92
	Palatwa	2015/8/4	4,550	1,544,620	Palatwa	3
	Min Tat	2015/8/4	786	100,000	Mintat	0
Rakhine	Ann	2015/6/25	11,769	27,341,552	Ann	205
		2015/7/30	12,737	2,306,600		150
	Sittwe	2015/7/30	-	2,537,590	Sittwe	94
	Kyauk Taw	2015/6/26	290	0	Kyauktaw	170
		2015/7/30	11,342	5,616,500		172
	Maung Taw	2015/6/24	136	3,142,832	Maungdaw	96
		2015/7/30	2,579	11,017,200		242
	Kyauk Phyu	2015/8/1	-	0	Kyaupyu	77
	Thandwe	2015/6/26	244	5,755,116	Thandwe	166
		2015/8/1	-	0		91
	Gwa	2015/6/27	309	2,654,378	Gwa	181
		2015/8/1	-	0		77
Bago	Bago	2015/7/30	10,855	4,065,000	Bago	70
	Pyay	2015/8/3	4,772	1,439,010	Pyay	1
	Shwe Kyin	2015/8/3	7,130	0	Shwegyin	8
	Nyaung Lay Pin	2015/8/3	1,665	1,382,100	Nyaung lay bin	18
	Thayarwaddy	2015/8/3	5,870	2,844,000	Tharrawady	5
Magway	Pwint Phyu	2015/7/27	113,772	37,292,400	Sinphyugyun	17
	Magway	2015/7/30	5,034	5,243,850	Magway	45
	Gant Gaw	2015/7/30	382	0	Gangaw	38
	Chauk	2015/8/5	5,247	0	Chauk	-
	Min Buu	2015/8/5	12,665	0	Minbu	3
	Aung Lan	2015/8/5	31,439	0	Aunglan	-
	Pakokku	2015/8/5	19,529	0	Pakokku	-
Ayeyarwady	Hinthada	2015/7/30	44,742	6,097,300	Hinthada	35
	Myaung Mya	2015/7/30	1,084	2,113,800	Myaungmya	138
	Zalun	2015/8/2	34,896	12,775,480	Zalun	18
	Maubin	2015/8/4	10,978	2,206,600	Maaubin	4
	Pathein	2015/8/2	9,875	300,810	Pathein	4
	Nga Thine Chaung	2015/8/2	-	1,256,300	Ngathyinechang	21
Yangon	Mawbi	2015/7/31	2,695	352,320	Hmawbi	84

Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

4.4 Statistical Analysis

The probability analysis of 2015 floods was implemented according to the flowchart shown below.



Source: JICA Expert Team

Figure 4-7 Procedure for Probability Analysis

(1) Annual Maximum Rainfall / Highest Water Level

In order to evaluate the return period of rainfall amount and water level in 2015, the annual maximum daily rainfall (2-day and 3-day) for the past 30 years at the selected 17 rain gauging stations and the annual highest water level at 13 water level gauging stations were collected. The figures showing the annual maximum rainfall and highest water level are shown in the appendix.

The 2015 floods recorded the heaviest daily rainfall in the past at several stations such as Kant Ba Lu, Magway and Sittwe. The highest water level in the past was recorded at Monywa and Minkin and the second highest water level was recorded at Hinthada and Kalewa.

(2) Probability Analysis

Probability analysis was conducted for the daily rainfall data, 2-day and 3-day rainfall data in consideration of the concentration time of the rivers.

According to the results of the probability analysis of daily rainfall, the return period of 2015 floods is more than 100 years in Hakha, 50 years in Kant Ba Lu and 30 years in Sittwe. The result of probability analysis of 2-day rainfall amount indicates that the return period is more than 100 years in Hakha, 50 years in Kant Ba Lu and 80 years at Sittwe. And the result of probability analysis of 3-day rainfall evaluates that the return period is more than 100 years in Hakha and Kant Ba Lu, while it is 20 to 30 years in Sittwe. The tables for the probability analysis are shown in the appendix.

The probability analysis was also conducted for the water levels. The highest water level was observed in Monywa and Minkin for last 30 years and their return periods are 80 years in Monywa and 20 to 30 years in Minkin. The tables for the probability analysis for the water level are also shown in the appendix.

4.5 Characteristics of Disaster

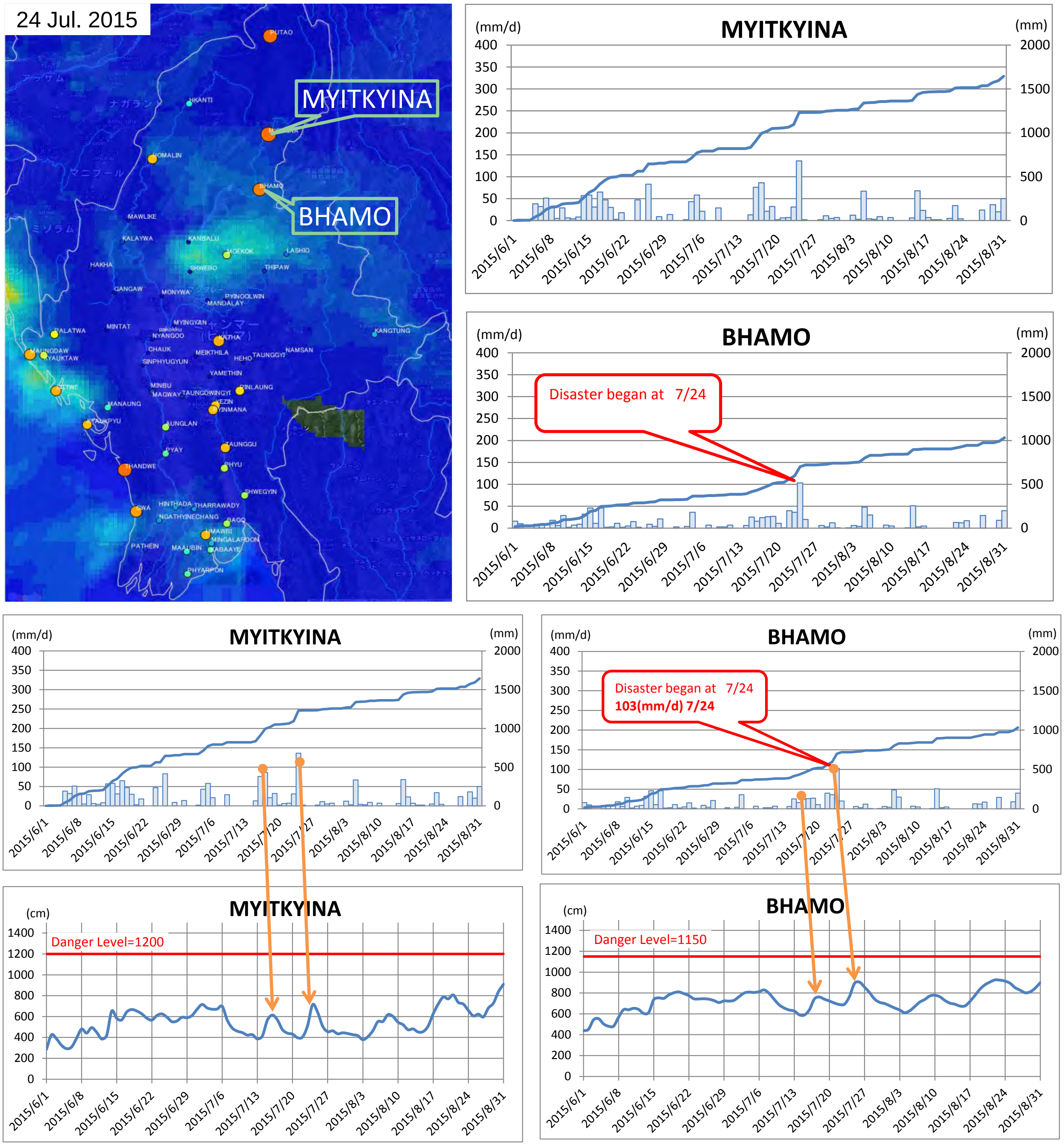
The floods in Myanmar can be classified into "Flash Floods," "Riverine Floods," and "Floods due to Storm Surge". In 2015, "Landslide" and "Debris Flow" also occurred in addition to the floods.

"Flash Floods" usually occur in mountainous areas and the time from rainfall to the occurrence of floods is very short. "Landslide" or "Debris flow" also occurs in the same area, but these are dependent on localized heavy rainfall. "Riverine Floods" occur in the flood plains along the large rivers in association with the increase of water level. The increase in water level of large rivers is mainly caused by the accumulated rainfall over several days in the watershed rather than localized heavy rainfall. "Floods due to Storm Surge" occur in coastal areas, especially in low land areas like the Ayeyarwady delta.

In this section, the disaster characteristics at selected 7 states/regions: Kachin, Chin, U-Sagain, L-Sagin, Rakhine, Magway and Ayeyarwady were studied by using the data and information provided by MSWRR and DMH.

(1) Kachin

In Kachin State, heavy rainfall occurred at the end of July. When the floods were reported, the observed rainfall was around 100-150 (mm/d). Kachin State is located at the upper part of the Ayeyarwady River Basin, and the data from two gauging stations was used. Since the water level of each station did not reach the danger level, it can be said that the type of flood is not a riverine flood but a flash flood in this area. Figure 4-8 shows that the rainfall amount and the water level have a good correlation, indicating that the water level can be analyzed by the rainfall amount.

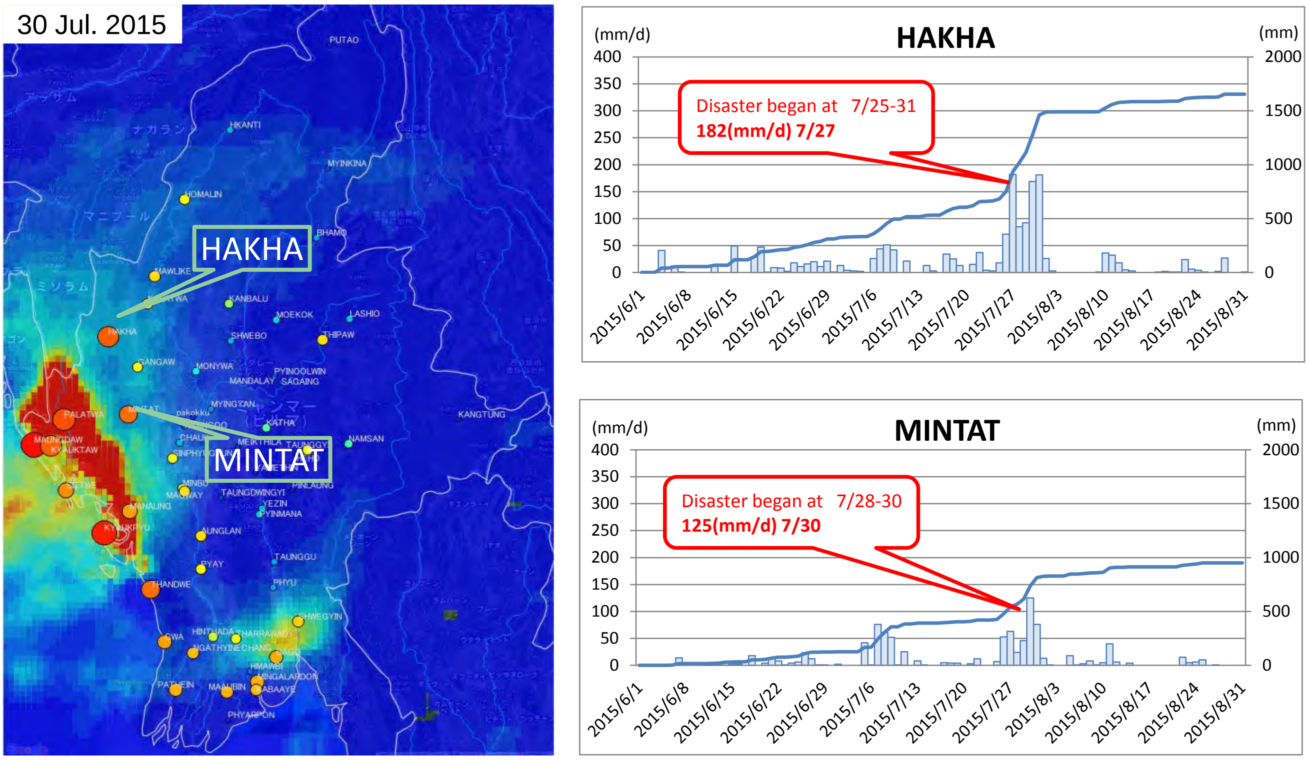


Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-8 Hydrological Situation (Kachin State)

(2) Chin

In Chin State, the heavy rainfall occurred at the end of July. When the disaster occurred, the observed rainfall amount was approximately 180 (mm/d) at Hakha located in the northern mountainous area, and approximately 120 (mm/d) at Mintat located in the inland area, which is on the east side of the mountains. The highest rainfall amount in the past was recorded at Hakha station. There were no large rivers like Ayeyarwady, nor water level gauging stations. The types of disasters were flash floods, landslides or debris flows.



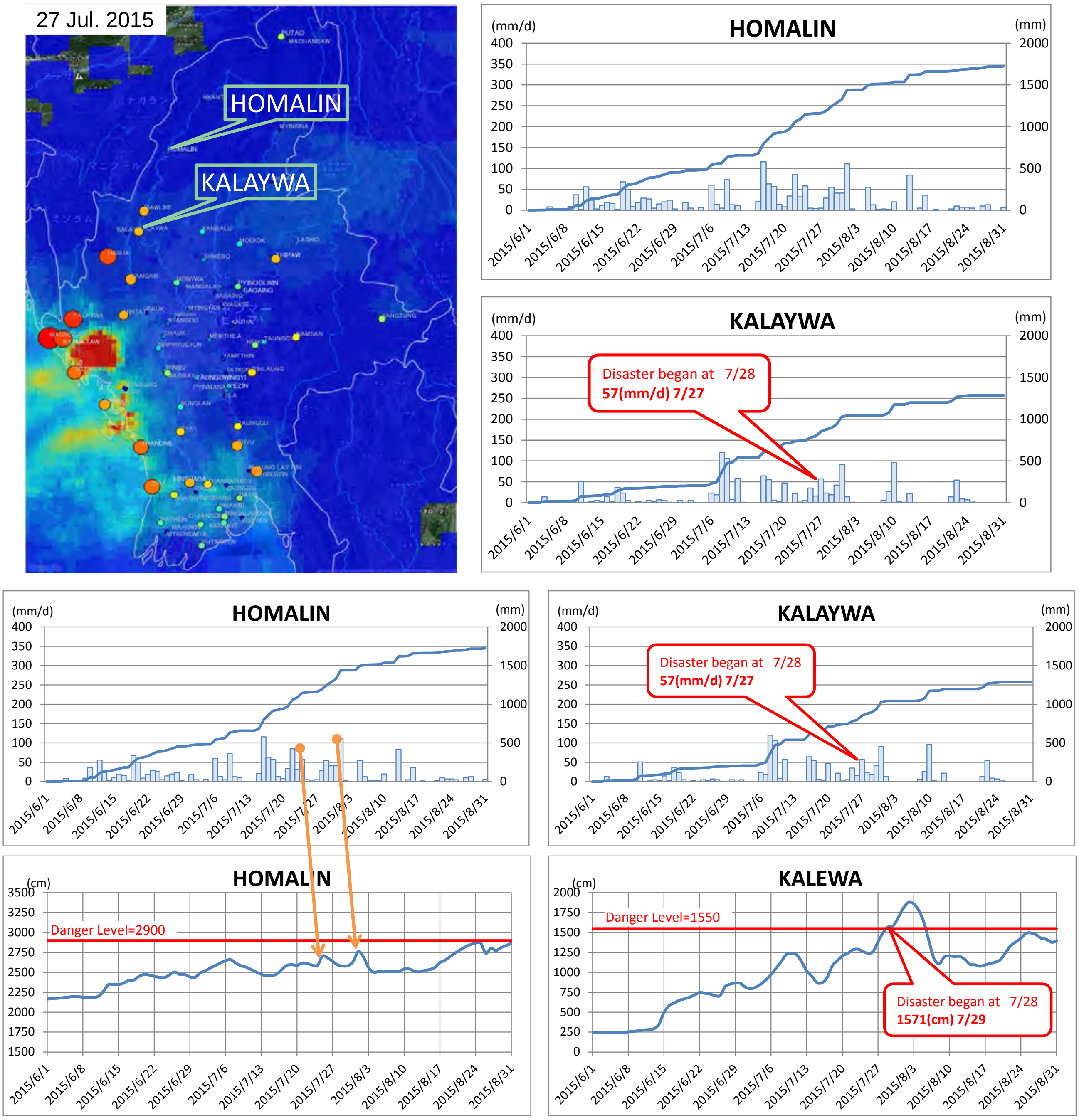
Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-9 Hydrological Situation (Chin State)

(3) U-Sagain

In U-Sagain Region, heavy rainfall occurred intermittently during July. When the disaster occurred, the observed rainfall amount was roughly 120 (mm/d). According to the precipitation data at Kalewa station, the heavy rainfall occurred two times, at the beginning and end of July, and the first heavy rainfall amount was higher than the second one, though the disaster was recorded when the second heavy rainfall occurred.

U-Sagain Region is located at the upper part of the Chindwin River Basin. The water level at Homalin station did not reach the danger level, but the water level at Kalewa station reached the danger level at almost the same time as when the disaster was reported. Figure 4-10 shows that the rainfall amount and the water level have a good correlation at Homalin station; therefore, the water level can be analyzed by the rainfall data. On the other hand, there is a weak correlation at Kalewa station, which means that the increase of water level at the end of July was greatly affected by the runoff volume from the upper watershed. The flood in Kalewa was a riverine flood.



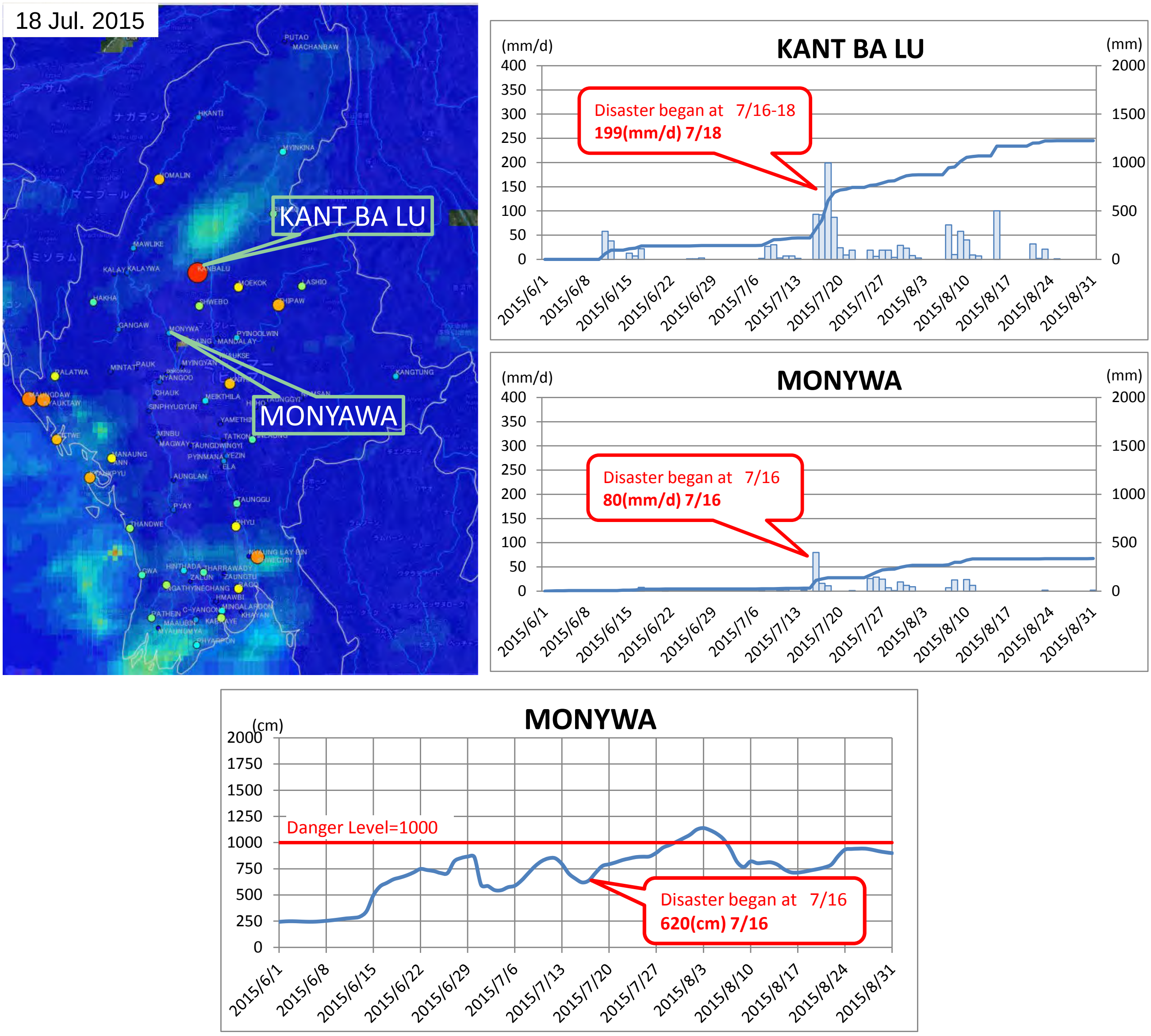
Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-10 Hydrological Situation (U-Sagain Region)

(4) L-Sagain

In L-Sagain Region, heavy rainfall occurred in the middle of July. When the disaster occurred, the observed rainfall amount was roughly 200 (mm/d) at Kant Ba Lu station.

L-Sagain Region is located downstream of the Chindwin River. Although the water level at Monywa station reached the danger level at the end of July, there is no record of disaster at that time. On the other hand, the disaster was recorded when the water level was lower than the danger level in the middle of July. Therefore, it can be said that the type of flood in this area is not a riverine flood but a flash flood. Figure 4-11 shows that the rainfall amount and the water level have no correlation at Monywa station, indicating that the water level was greatly affected by the runoff volume from the upper catchment.

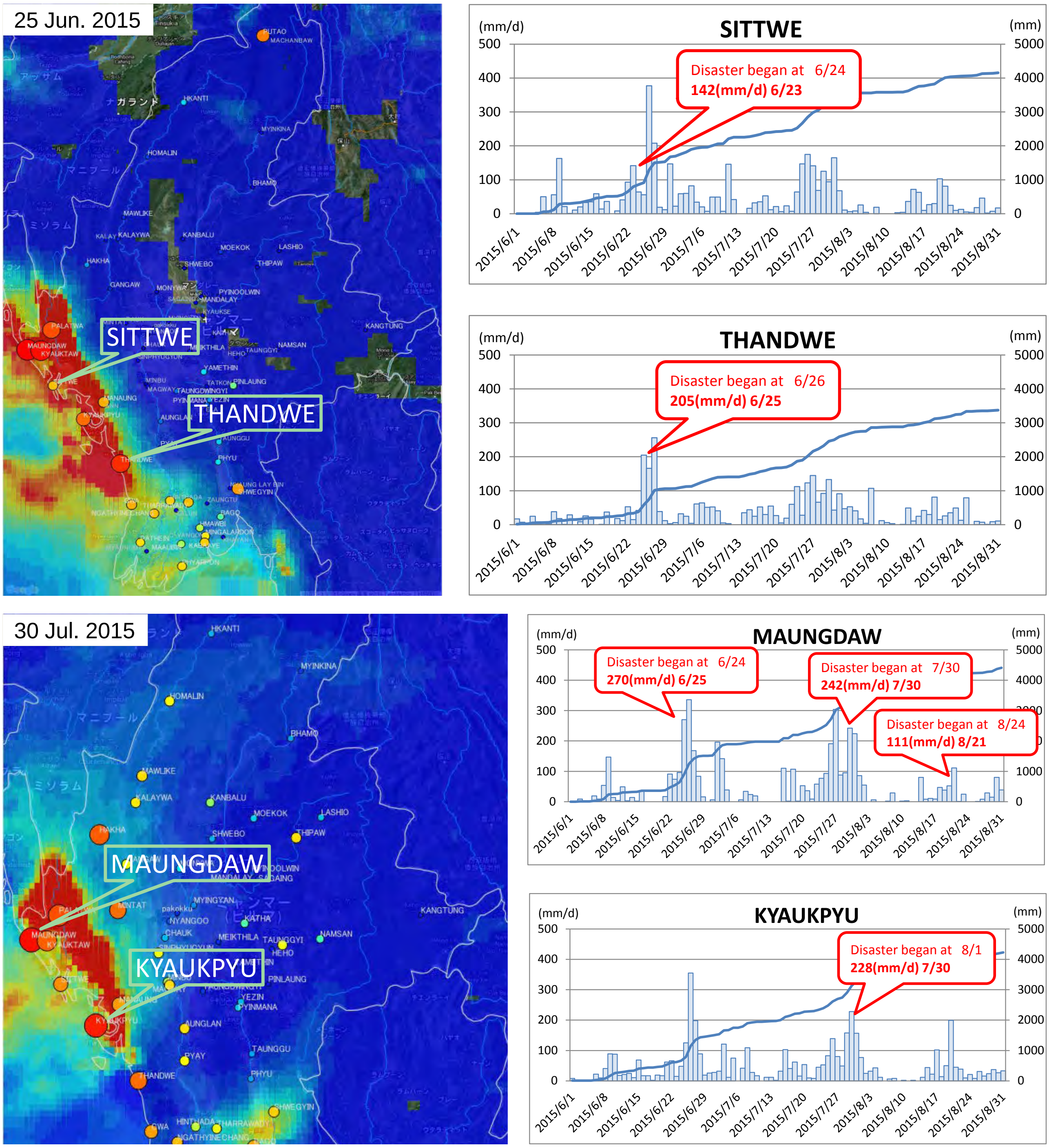


Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-11 Hydrological Situation (L-Sagain Region)

(5) Rakhine

In Rakhine State, heavy rainfall occurred three times, the end of June, the end of July, and the end of August. When the heavy rainfall occurred, the disasters were recorded. Therefore, the disaster type was flash flood in this area. The rainfall amount was roughly 100-200 (mm/d), and 377 (mm/d) was recorded at Sittwe station at the end of June. There are no large rivers like Ayeyarwady, nor water level gauging stations owned by DMH in Rakhine State.



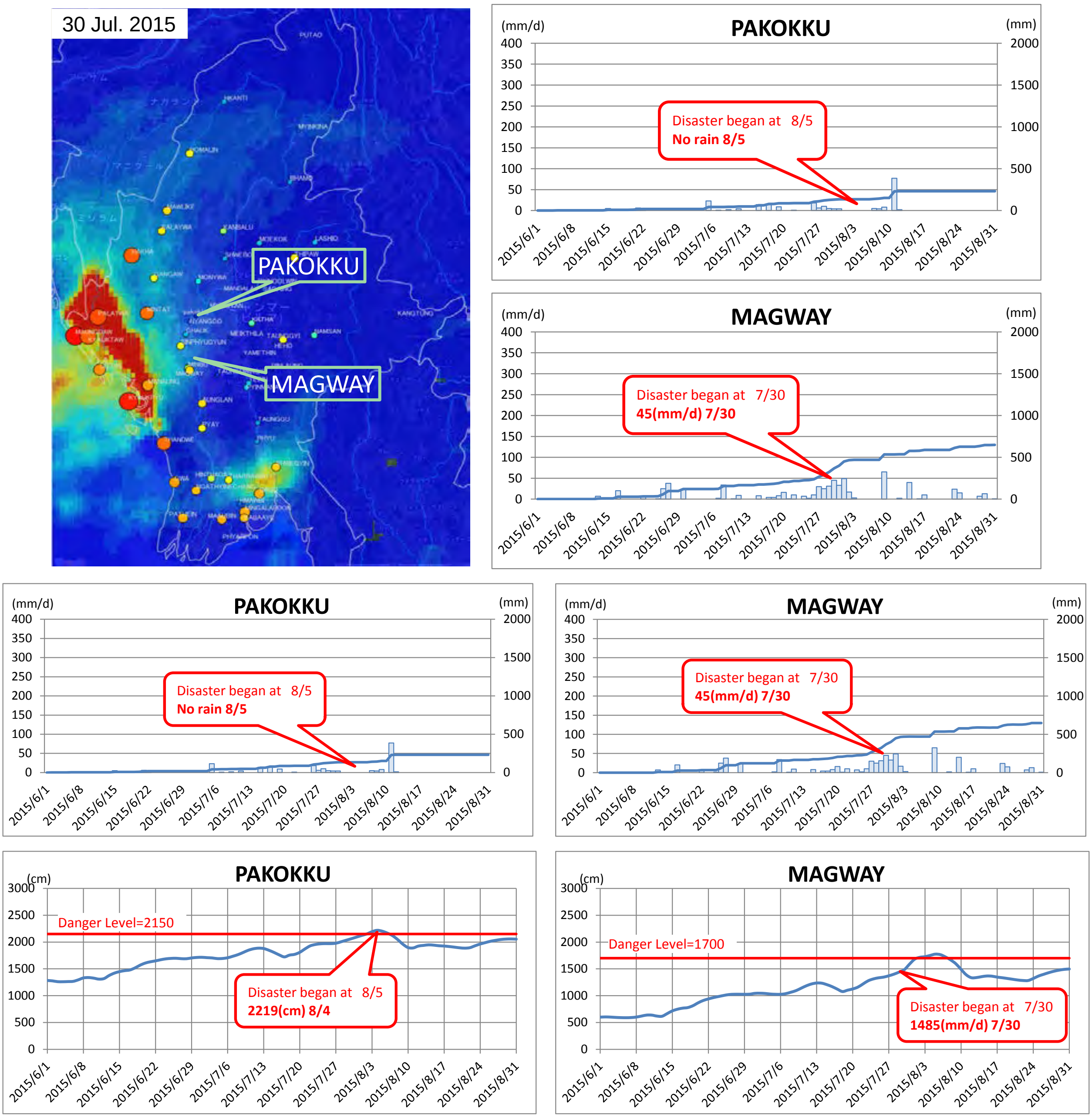
Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-12 Hydrological Situation (Rakhine State)

(6) Magway

In Magway Region, no heavy rainfall occurred from June to August. However, a disaster was recorded from the end of July to the beginning of August.

Magway Region is located in the middle part of the Ayeyarwady River Basin. The water level reached the danger level at Pakokku station and Magway station. The disaster was recorded when the water levels exceeded the danger levels. Figure 4-13 shows that the rainfall amount and the water level have no correlation, indicating that the water levels were greatly affected by the runoff volume from the upper catchment. The disaster type was riverine flood in this area.



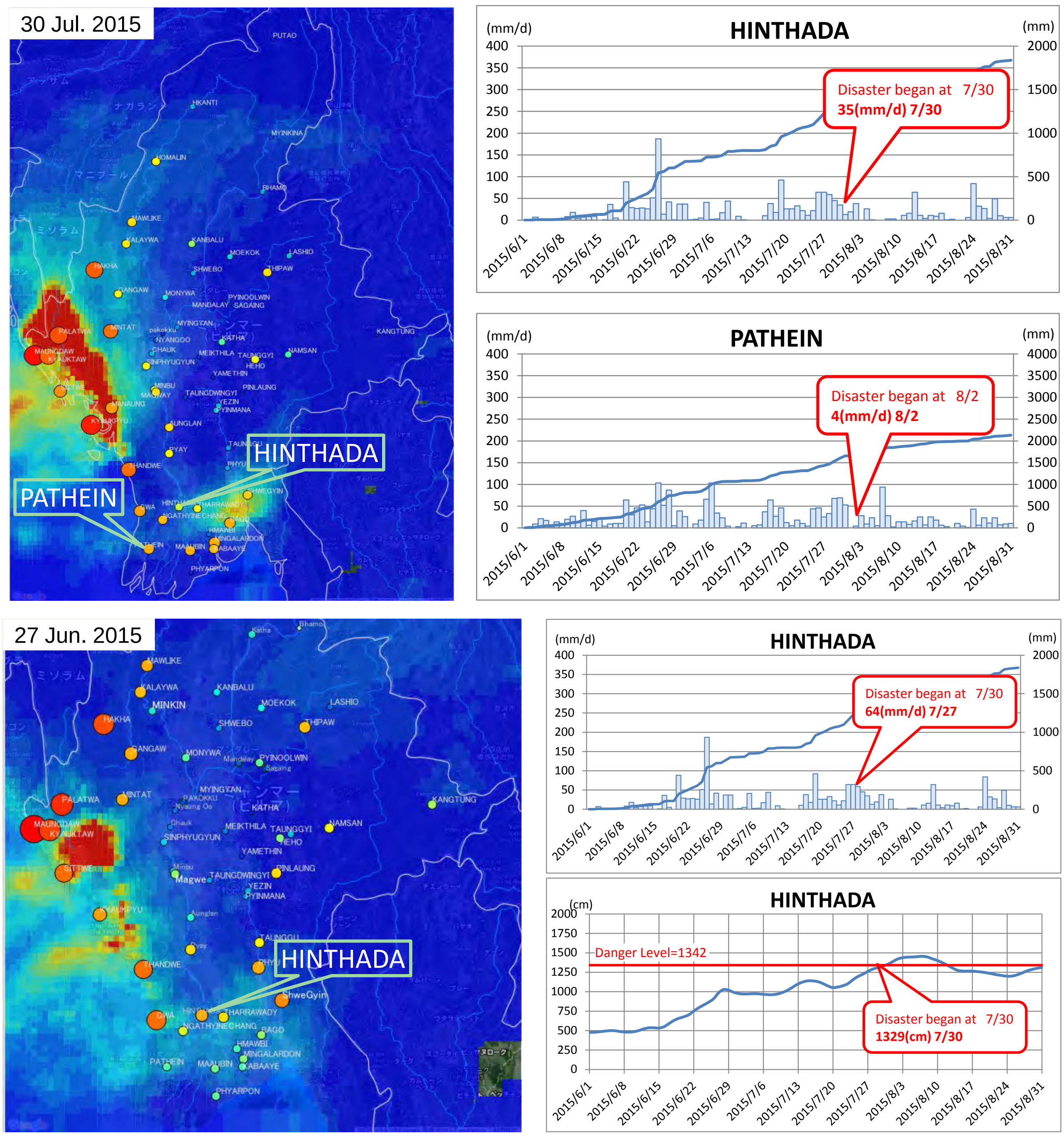
Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-13 Hydrological Situation (Magway Region)

(7) Ayeyarwady

In Ayeyarwady Region, heavy rainfall occurred at the end of June and July. The rainfall amount was roughly 100 (mm/d), and approximately 190 (mm/d) was recorded at Hinthada station at the end of June. However, the disaster was reported from the end of July to the beginning of August.

Ayeyarwady Region is located downstream of the Ayeyarwady River basin. The water level reached the danger level at the end of July at Hinthada station, and the disaster was reported almost at the same time. According to the interview survey carried out separately, the disaster was not due to the riverine flood from Ayeyarwady River, but due to the runoff from the western mountain area. It can be said that the runoff from the western mountain area could not flow into the Ayeyarwady River because of the high water level of the river. Figure 4-14 shows that the rainfall amount and the water level have no correlation, indicating that the water level was greatly affected by the runoff volume from the upper catchment.



Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure 4-14 Hydrological Situation (Ayeyarwady Region)

4.6 Consideration of Early Warning Criteria

Based on the types of disasters studied in the previous section, the warning criteria for "Flash Floods", "Landslides" and "Riverine Floods" were considered in this section at the pilot states/regions shown in Table 4-1.

Table 4-1 Pilot Areas for Considering Early Warning Criteria

Type of Disaster	State / Region
Flash Floods	Chin, Sagain, Rakhine
Landslides	Chin, Shan
Riverine Floods	Sagain, Magway, Ayeyarwady

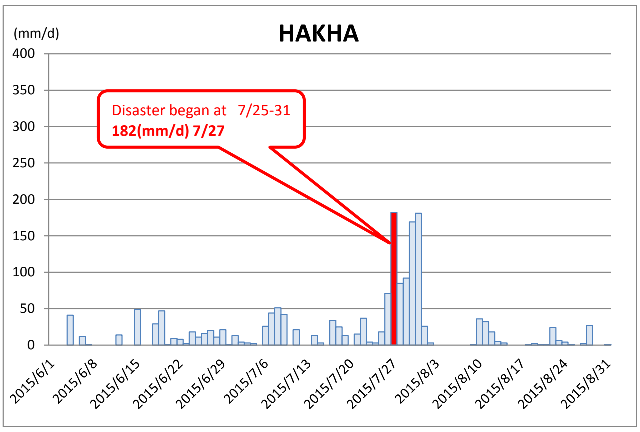
Source: Prepared by JICA Expert Team

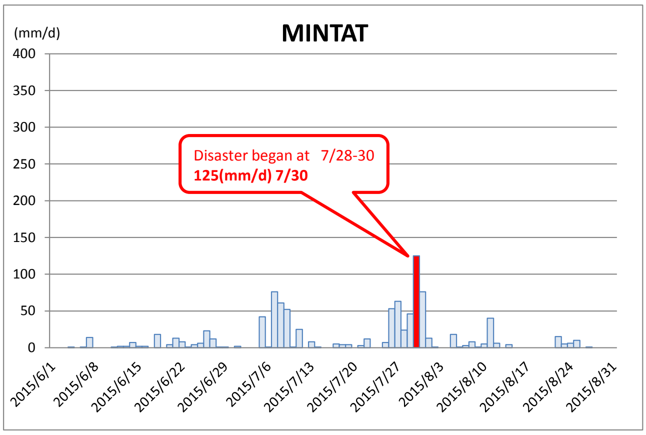
4.6.1 Early Warning Criteria for Flash Flood

The rainfall amount just before the disaster will be the criteria for the flash flood. The rainfall amount for the early warning criteria for the flash flood was considered for the areas shown in Table 4-1.

(1) Chin

Considering the rainfall data of gauging stations at the date of the disaster occurrence in Chin State, the rainfall amount for early warning can be set as less than 180 (mm/d) at Hakha station and 80-120 (mm/d) at Mintat station. The heaviest rainfall was 71 (mm/d) before 27th July when 182 (mm/d) was observed at Hakha station. According to the result of probability analysis, there is a big difference in the return period between 71 (mm/d) (return period is 3 years) and 182 (mm/d) (return period is more than 100 years). Therefore, the accuracy of criteria needs to be improved by accumulating this kind of analysis.



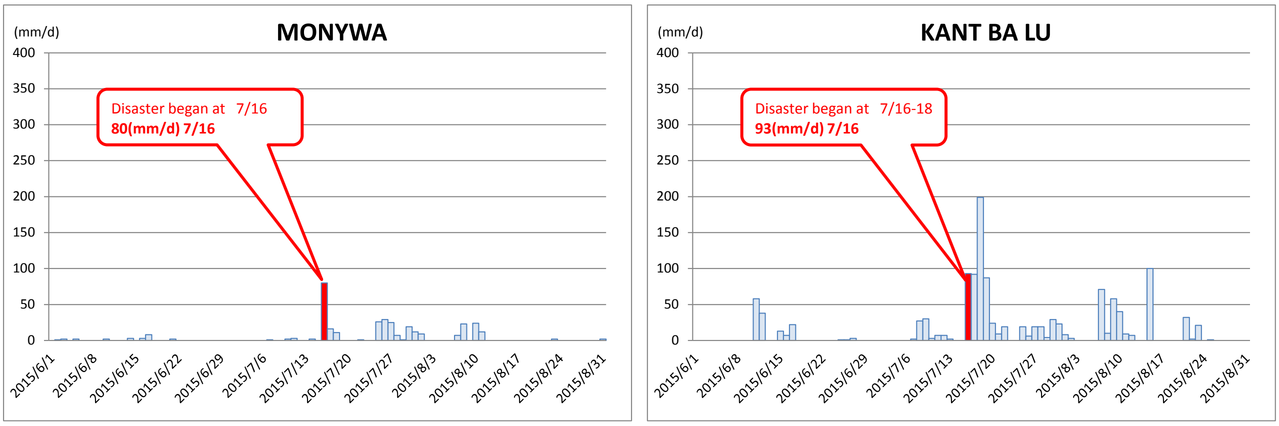


Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-15 Consideration for Warning Criteria (Chin)

(2) Sagain

Considering the rainfall data of the gauging stations at the date of disaster occurrence in Sagain Region, the rainfall amount for early warning can be stated at approximately 80 (mm/d) at Monywa station and approximately 90 (mm/d) at Kant Ba Lu station. According to the result of probability analysis, the return period of 80 (mm/d) at Monywa is 5 ~ 10 years, and 90 (mm/d) at Kant Ba Lu is approximately 3 years.



Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

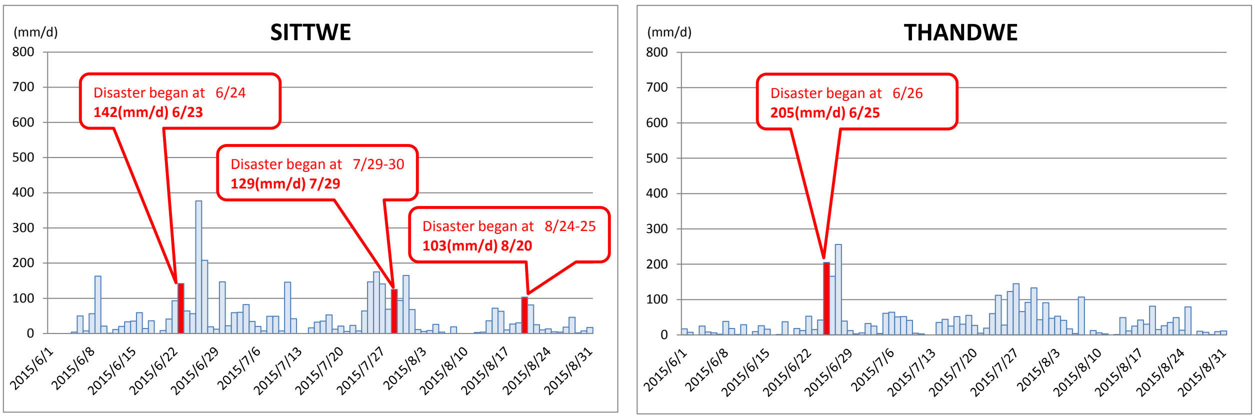
Figure 4-16 Consideration for Warning Criteria (Sagain)

(3) Rakhine

Considering the rainfall data of the gauging stations at the date of disaster occurrence in Rakhine State, the rainfall amount for early warning can be set at approximately 100 (mm/d) at Sittwe station and approximately 200 (mm/d) at Thandwe station.

According to the result of probability analysis, the return period of 100 (mm/d) at Sittwe is less than 2 years. This result seems consistent with the fact that this area is flooded almost every year.

However in Sittwe, although the occurrence of disaster was reported only three times during the 2015 floods, heavy rainfall events occurred many times during this period. It will be necessary to accumulate more data to define the warning criteria in Sittwe because the occurrence of floods might be affected by the increase of runoff ratio due to the continuous rainfall, or affected by the spring tide or storm surges.



Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-17 Consideration for Warning Criteria (Rakhine)

4.6.2 Early Warning Criteria for Landslide

In Japan, the idea of critical line with the short term rainfall and Soil Water Index (SWI) is used as the warning criteria for sediment related disasters such as debris flow, landslides, etc. SWI is calculated by using the tank model to indicate how much water is contained in the soil. SWI is calculated by using the following equations.

$S1(t+\Delta t) = (1-\beta 1\Delta t) \cdot S1(t) - q1(t) \cdot \Delta t + R$

$S2(t+\Delta t) = (1-\beta 2\Delta t) \cdot S2(t) - q2(t) \cdot \Delta t + \beta 1 \cdot S1(t) \cdot \Delta t$

$S3(t+\Delta t) = (1-\beta 3\Delta t) \cdot S3(t) - q3(t) \cdot \Delta t + \beta 2 \cdot S2(t) \cdot \Delta t$

Here, S1, S2, S3 : storage height of each tank

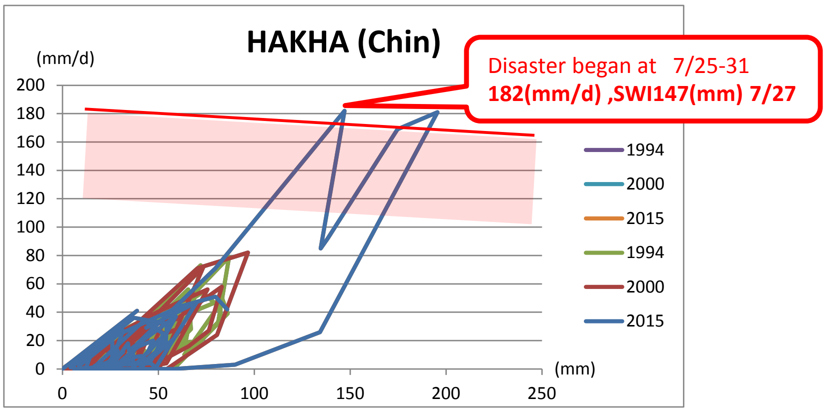
$\beta 1, \beta 2, \beta 3$: infiltration coefficient of each tank

q1, q2, q3 : runoff from each tank

Since the data is limited in Myanmar, the idea to utilize the critical line is only introduced here. The consideration for the critical line for the landslide at the areas shown in Table 4-1 was conducted. The daily rainfall data and some values used in Japan were applied for the necessary coefficients.

(1) Chin

A so-called "snake line" was calculated and drawn by utilizing the daily rainfall data at Hakha station. In addition, the critical line was estimated using the disaster record in 2015. As is shown in the probability analysis, the return period of the rainfall amount in Hakha at the time of disaster is more than 100 years. Since there is a big difference from the conditions with and without disasters, the accuracy of the critical line needs to be improved by the accumulation of disaster records.

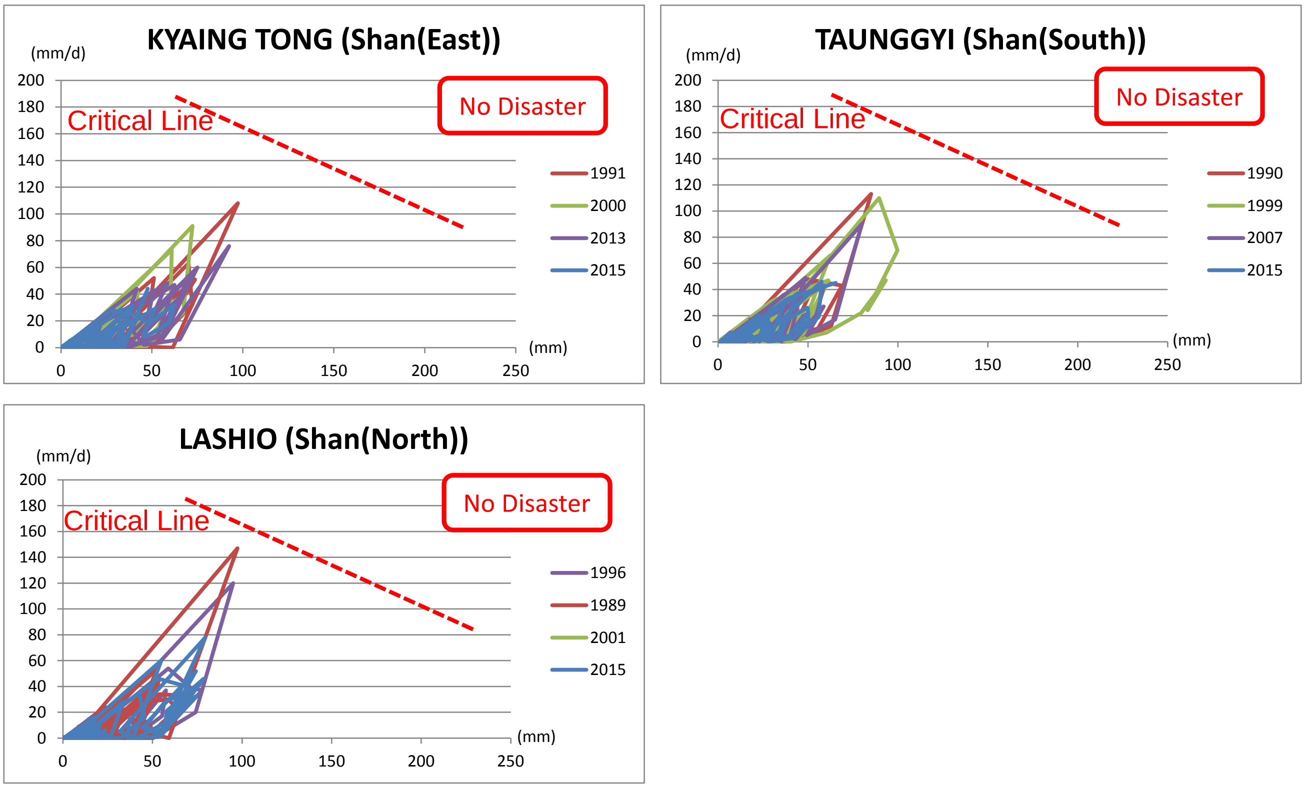


Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-18 Estimation of Critical Line (Chin)

(2) Shan

The snake line was calculated and drawn using the daily rainfall data in Shan State. Since there has been no record of landslides including the 2015 floods in Shan State, the critical line should be outside of the snake lines. More data and information is required for an estimation of the critical line.



Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-19 Estimation of Critical Line (Shan)

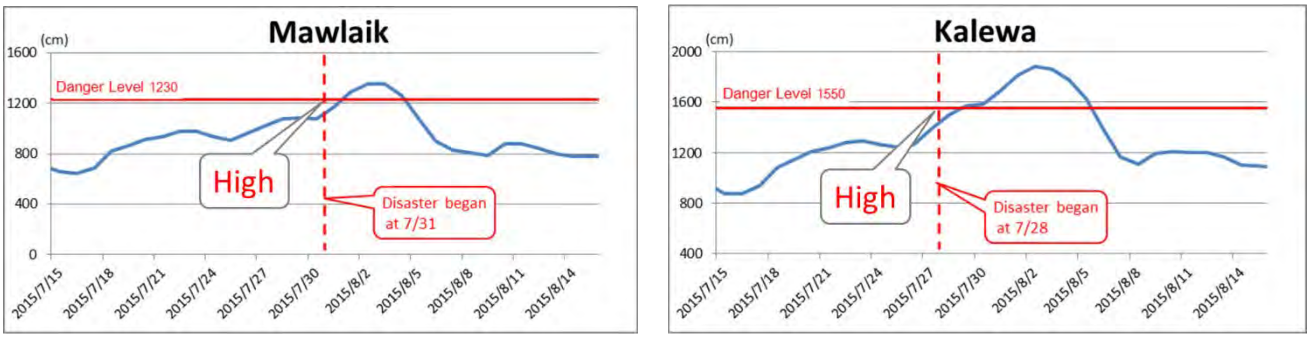
4.6.3 Early Warning Criteria for Riverine Flood

(1) Consideration for Danger Level

In Myanmar, the idea of "Danger Level" is utilized for the early warning for the riverine floods in the major rivers such as Ayeyarwady River, Chindwin River, etc. The danger level is defined for most of the major gauging stations by DMH, and a flood warning will be issued for each station when the water level at each station is forecasted to exceed the danger level.

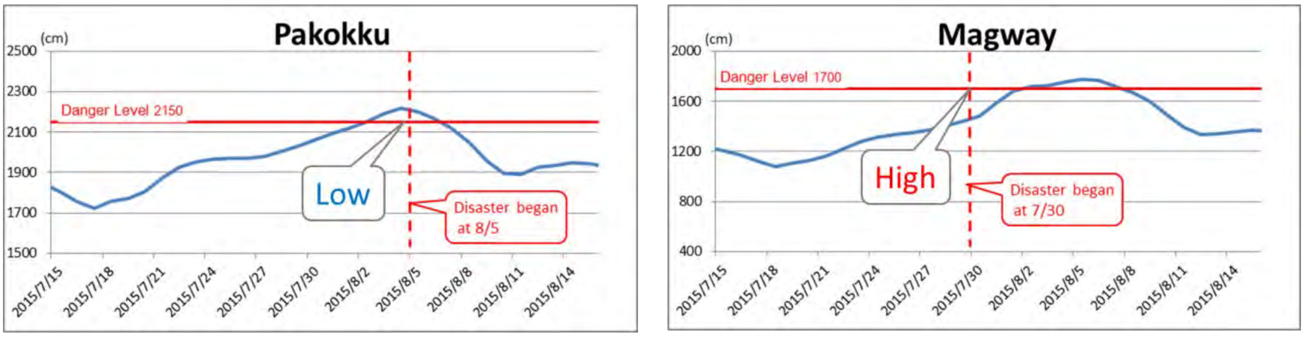
In this analysis, some of the danger levels were verified by comparing the observed water levels and the date of disaster occurrence.

According to the result of verification, some of the floods occurred before the water level reached to the danger level at Mawlaik, Kalewa and Magway. The danger levels at those stations have to be revised to lower values.



Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-20 Verification of Danger Level (Sagain)



Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-21 Verification of Danger Level (Magway)

(2) Consideration for Forecasting Water Level

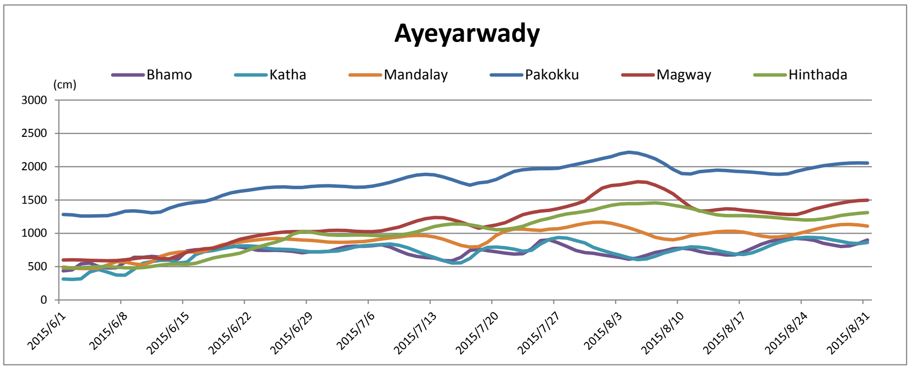
Although the danger level is properly defined, the early warning can not be issued if the water level is not forecasted properly. Riverine floods can be forecasted by using the following factors, relatively easier than flash floods and landslides.

- Correlation with the water level at the upstream gauging stations
- Local rainfall (rainfall at gauging station)
- Averaged rainfall in the upper catchment of the gauging station

DMH is forecasting the water level at gauging stations in the major rivers by correlation analysis with the water levels at the upstream gauging stations. The following tables and figures show the time difference among the water level gauging stations in Ayeyarwady and Chindwin Rivers.

Since the time difference is more than one day among the stations of Ayeyarwady River, the upstream water levels can be useful for early warning. The time difference is less than one day among the stations of the Chindwin River.

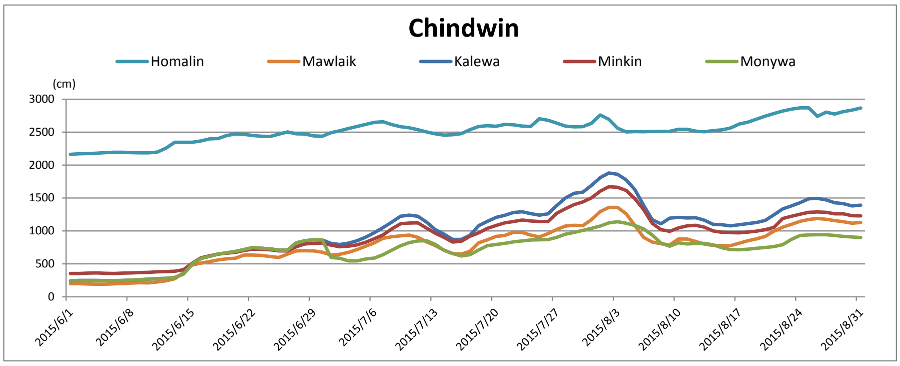
Upper Station	Lower Station	Time Difference
Bhamo	Katha	1 day
Katha	Mandalay	5 day
Mandalay	Pakokku	3 day
Pakokku	Magway	1 day
Magway	Hinthada	2 day



Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-22 Peak Time Difference among Stations of Ayeyarwady River

Upper Station	Lower Station	Time Difference
Homalin	Mawlaik	1 day
Mawlaik	Kalewa	None
Kalewa	Minkin	None
Minkin	Monywa	1 day



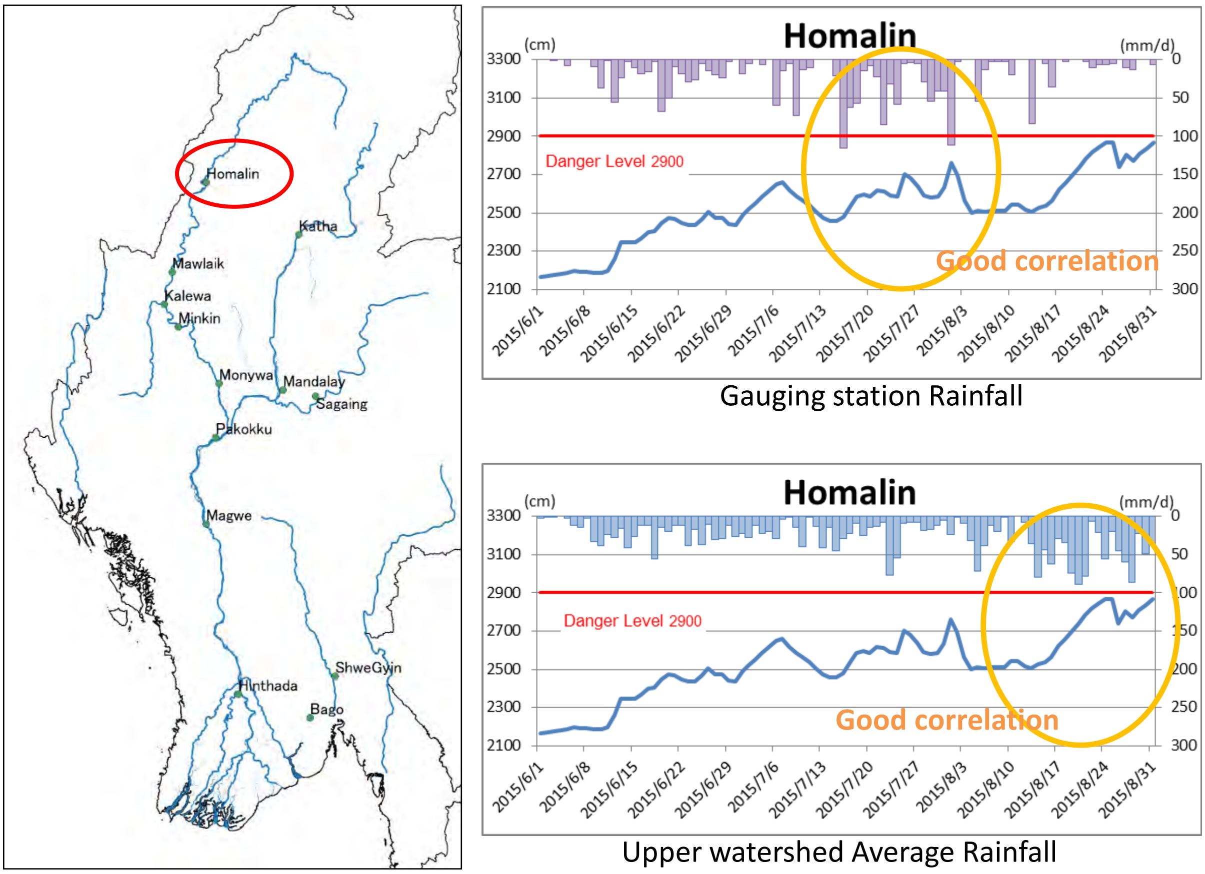
Source: Prepared by JICA Expert Team based on the data from DMH

Figure 4-23 Peak Time Difference among Stations of Chindwin River

If the correlation among the stations is good and the time difference is more than one day, it will be easy to forecast the water level. However, if the gauging station located in the upstream of the rivers, the correlation is not good, or the time difference is less than one day, it is necessary to utilize the local rainfall or the averaged rainfall in the upper catchment to forecast the water level.

Figure 4-24 shows the relation of the water level and the rainfall amount at Homalin station. Homalin station is located in the upper catchment of the Chindwin River, so the water level and the local rainfall are expected to have better correlation. The water level from the middle of July to

August corresponds to the local rainfall but the increase of water level in later August does not come from the local rainfall. It is due to the averaged rainfall in the upper catchment.

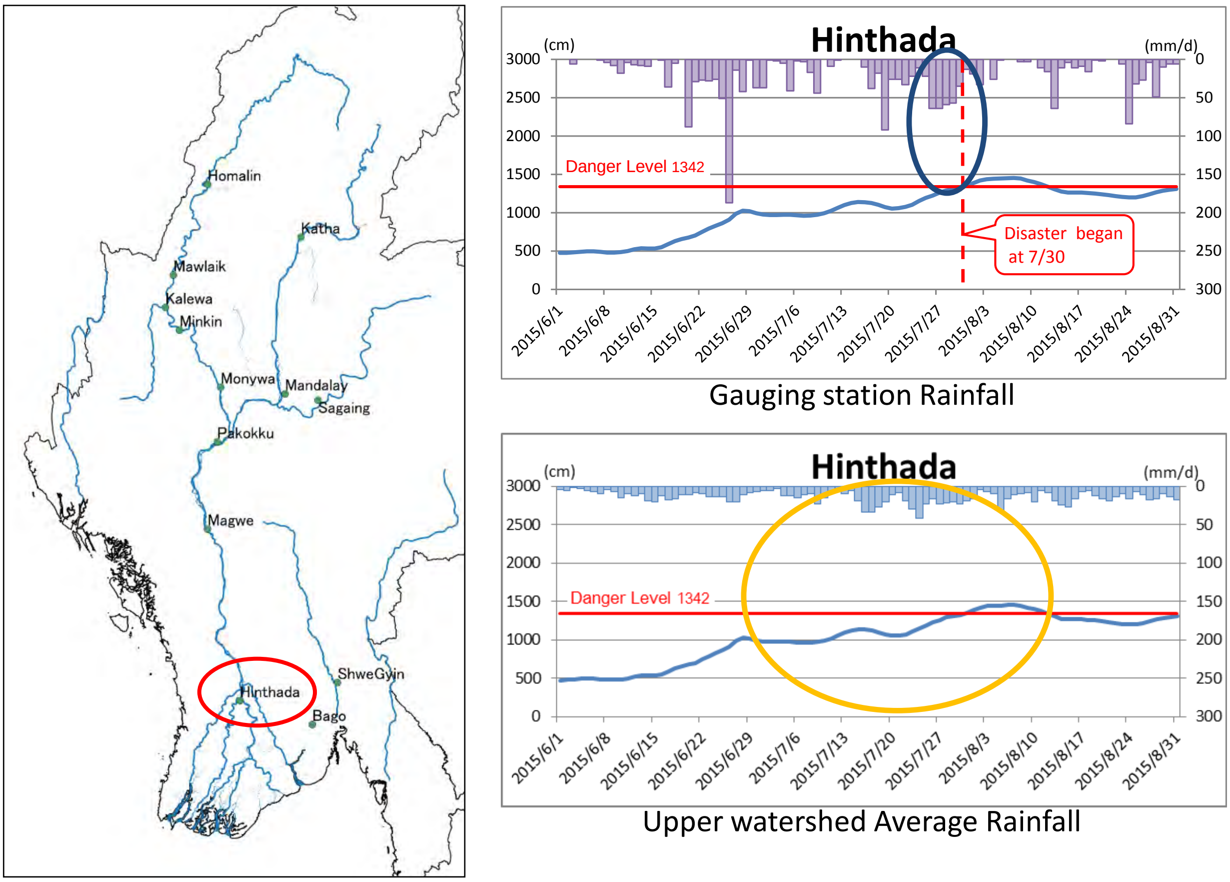


Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-24 Relation of Water Level and Rainfall at Homalin

Figure 4-24 shows the water level and the rainfall amount from June to August at Hinthada station. Hinthada station is located downstream of the Ayeyarwady River, so the water level can be forecasted from the water level of upstream gauging stations. As seen from the figures, the correlation of the averaged rainfall in the upper catchment and the water level is not good, nor is the correlation of the local rainfall and the water level.

As is shown in the previous section, it is said that the flood in Hinthada did not come from the Ayeyarwady River but from the western mountain area. Although the local rainfall did not affect the water level in the Ayeyarwady River, it might affect the floods in the Hinthada area.



Source: Prepared by JICA Expert Team based on the data from DMH and MSWRR

Figure 4-25 Relation of Water Level and Rainfall at Hinthada

5. Findings

- In the southwest monsoon season in 2015 in Myanmar, the heavy rainfall amounts were often observed after the middle of June, and the significantly heavy rains, especially in late June and late July, caused severe floods, landslides and so on in most parts of the country. More than 200% of the normal rainfall amount was observed in some of the central parts of the country, where many flood disasters were reported. These weather conditions were considered to be brought about by stronger convective activities, which are closely related with the intra-seasonal variations of southwest monsoon activities in about a one-month interval, the influence of tropical depressions and so on. Moreover, the later monsoon onset in 2015 may indicate the influences of the El Nino event on the southwest monsoon activities.
- Ability of monitoring these weather factors and timely distribution of the weather information, warnings and advisories by DMH is improving significantly. For example, because of the largest flood disaster in 2008, utilization of the advanced technologies, such as operational use of satellite-derived information (satellite images, etc.), has been introduced. To produce better weather information, it is necessary to continue these efforts and to further improve the knowledge on variability of the southeast monsoon including intra-seasonal as well as inter-annual variations, and to advance ability of monitoring/predicting the monsoon activity by introducing new techniques.
- While the ability of weather monitoring and prediction is being improved, heavy rain/flood-related disasters with more than 100 deaths occurred in 2015. In order to prevent and/or reduce these disasters, it is also important to review contents of weather information, methods of its distribution, timeliness, etc. “Was weather information useful for end-users such as local people and central/local government officers?” “Did they receive this information in time to take necessary actions?” Regarding these topics, an interview survey was also conducted by the Project, and it is expected that improvements will be planned for the contents of weather information, distribution methods, etc. based on the survey results. In addition, it is important to consider the “weather information literacy” of end-users. It is essential to know to what extent the contents of weather information are properly understood by the end-users, and how useful this information is related to their actions at the time of disasters. This will help to improve the contents of information as well as their actions when disasters occur.
- In order to improve the accuracy of forecasting and warning for floods, it is necessary to collect and accumulate data and information of not only hydro-meteorological data, but also disaster/damage information. It is also necessary to analyze the mechanism of disasters and prepare a report whenever disaster occurs. The accumulation of data, information and reports will help to improve the forecasting and warning, enhance the awareness for disasters, prepare for future disasters and improve the DRM strategy in Myanmar. The accumulation of data and information, and the preparation of reports have to be done in cooperation with RRD, DMH and other concerned government/non-government agencies.

Interview Survey

6. Outline of Interview Survey

6.1 Objectives

The objective of the interview survey is to consider the possibility to adopt the Project outputs for flood disaster.

The expected Project activities to mitigate flood disaster are as follows:

- To enhance the knowledge on disaster management for government officers and community people.
- To disseminate the necessary information such as warning and evacuation information quickly and properly (including the installation of communication equipment).
- To issue effective and understandable warning messages for residents.

6.2 Target of the survey

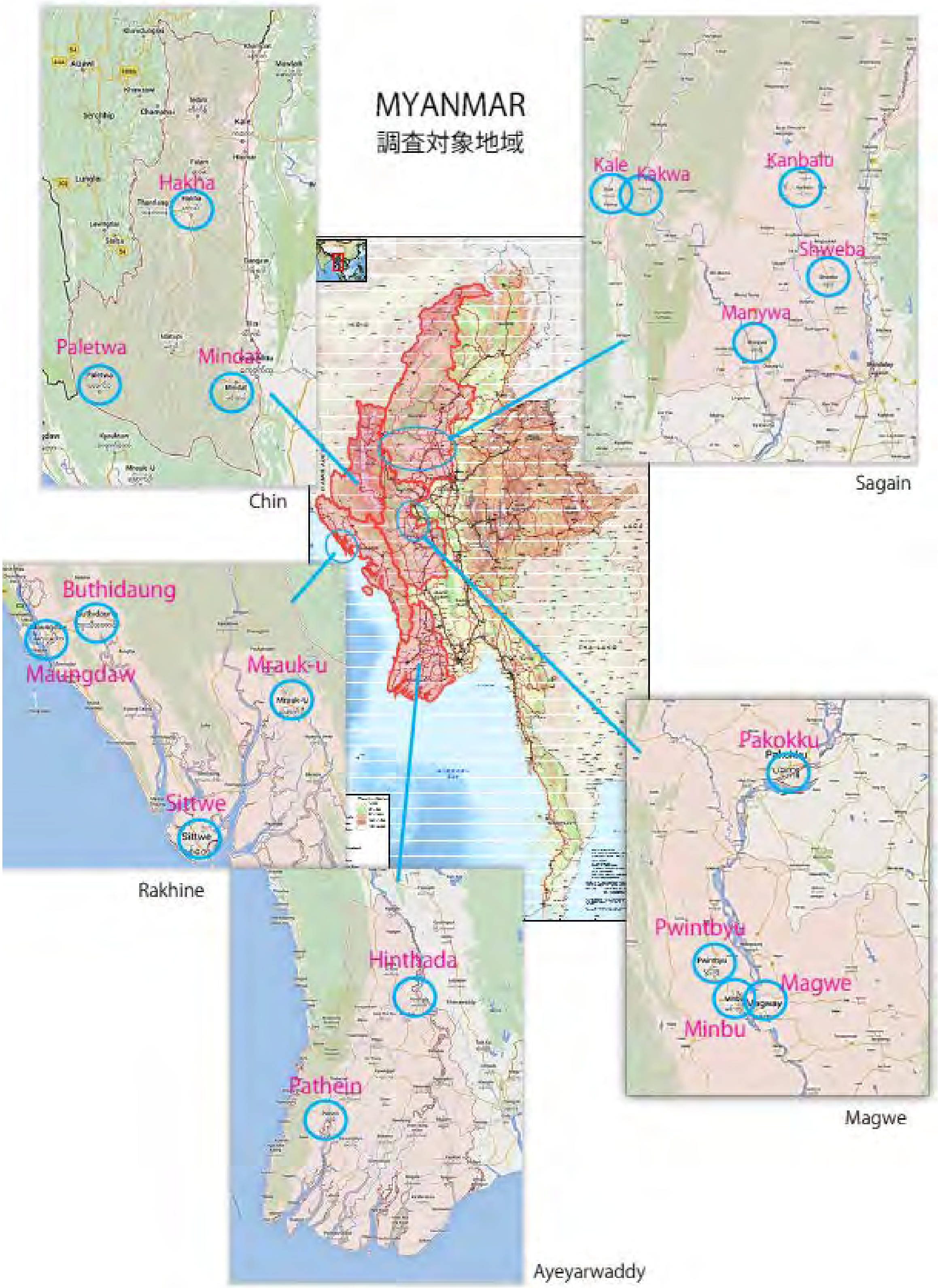
(1) Target State/Region of the survey

The target areas of the survey were selected based on the damage report issued by RRD and its selection criteria were the higher number of casualties, injuries and number of evacuees. Due to the limited time for the interview, accessibility and security were also considered. Target villages of the survey were selected based on the recommendations from the local government agencies such as regional/district levels of RRD and GAD.

Table 6-1 Target State/Region of the Interview Survey

No	State/Region	District	Township	Village
1	Chin	Hakha	Hakha	1
2		Mindat	Paletwa	1
3	Sagaing	Kalay	Kalay	1
4		Mon Ywar	Kan Ba Ru	1
5	Rakhine	Myauk U	Myauk U	1
6		Maundaw	Buthidaung	1
7	Magway	Minbu	Pwint Phyu	1
8		Pakokku	Pakokku	1
9	Ayeyarwady	Hinthada	Hinthada	1
10		Pathein	Pathein	1
Total	5	10	10	10

Source: JICA Expert Team



Source: MIMU and JICA Expert Team edited

Figure 6-1 Location Map of the Interview Survey

(2) Target organization of the survey

In order to analyze the response of various level and agencies, the following organizations were selected as the target of the interview survey. The target organizations and their major roles are as follows:

- **GAD (State/Region, District, Township)**
  GAD covers the entire policy for local government level, and early warning transmission to residents is designed to be transmitted by GAD administrative line. In each level of local government, the head of the disaster management committee is an administrator of GAD. Therefore, GAD leads the policy-making of disaster response.

- **RRD (State/Region, District)**
  RRD is responsible for disaster relief and developing an HRD program for government officers and residents in terms of Disaster Risk Reduction (DRR).

- **DMH (State/Region, District)**
  DMH is responsible for providing meteorological and hydrological information and issuing warning messages through administrative lines and media.

- **Villagers (Village leaders)**
  Among villagers, village tract administrators play important roles to disseminate the instruction from township to residents, and lead its member villages during disaster response.

6.3 Methodology of survey

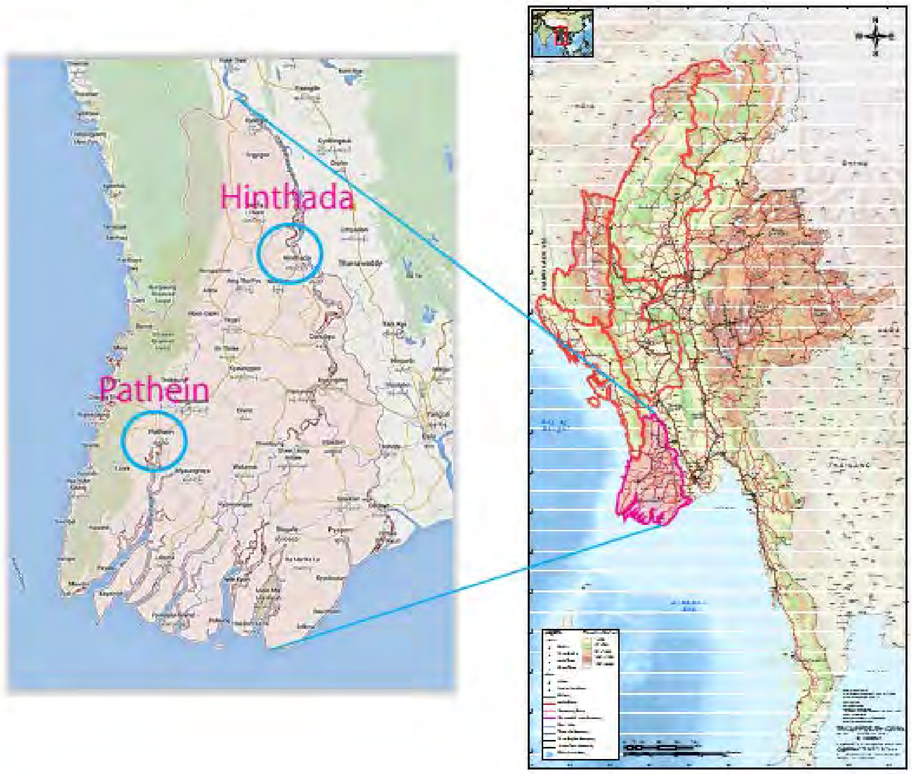
The detailed methodologies of the interview survey are as follows. The questionnaire forms for government officers and residents are in Appendix 1 Questionnaire of the survey.

1) Interviews were conducted based on questionnaires designed for government officers and villagers.
2) For region/state level and district level, RRD, DMH and GAD officers gathered at the same place for interviews if the government offices were located in the same township.
3) For township level, the township administrator or an equivalent person from GAD township was the target of the interview.
4) For village level, Focus Group Discussion (FGD) was conducted including the VT administrators, elderly persons, teachers, etc. If specific groups such as women were not included in the FGD, they were interviewed separately.

7. Results of the survey

7.1 Ayeyarwady Region

(1) Location of the survey



Source: MIMU

Figure 7-1 Survey Location of Ayeyarwady Region

(2) Response of local government

In Ayeyarwady Region, a Disaster Management Committee led by GAD was convened and necessary actions were confirmed within the members of the committee. Since Pathein District and Pathien Township are located in the same city as Ayeyarwady Regional Government, no communication problems were observed from region level to township level. For the monitoring of water level, the Irrigation Department and its volunteers monitored water levels and reported to GAD every hour. Regarding training, since Ayeyarwady Region experienced Cyclone Nargis in 2008, most of the interviewed government officers have experience in disaster management training; thus, the capacity of the government officers is higher than other states/regions.

In Hinthada District, capacity of the local government in regards to disaster response is limited compared to that of Pathein District. When the survey team inquired about the data for relief distribution, GAD revealed that they did not keep the records of relief from donors, individual and private companies due to the chaotic situation during the early response phase of the disaster. The township recorded the amount of disaster relief fund from the Ayeyarwady Regional Government.

When the survey team inquired about the document of the disaster management plan, an officer misunderstood it as disaster management law. It is probable that the designated actions and roles in the disaster management plan are not fully understood by the local government officers. As for training of government officers, the Disaster Management Training Center (DMTC), operated by RRD, just opened in Hinthada District, so RRD, DMH, and GAD officers participated in the training and will participate in the training in DMTC.

Hinthada Township GAD had trouble with instructing villagers at risk to evacuate to safe places. According to GAD officers, a few villagers refused to evacuate because they were worried about cattle. For better response including instructing and persuading villagers to evacuate, during the interview, GAD Township suggested that DMH issue more accurate and detailed information, especially forecasts of wind speed, tornadoes, and earthquakes, which local government and villagers cannot expect based on their experience.

(3) Response of local residents

The target village, Shwe Myin Tin Village, is located one and half hours from Pathein and the village experiences minor floods every year. Therefore, villagers thought the flood was normal and did not trust the information from the news; thus, they did not evacuate until the water level reached two meters. As for evacuation, some villagers did not want to evacuate because of the poor environment of evacuation places, such as food, water and toilets, and they were worried about their cattle.

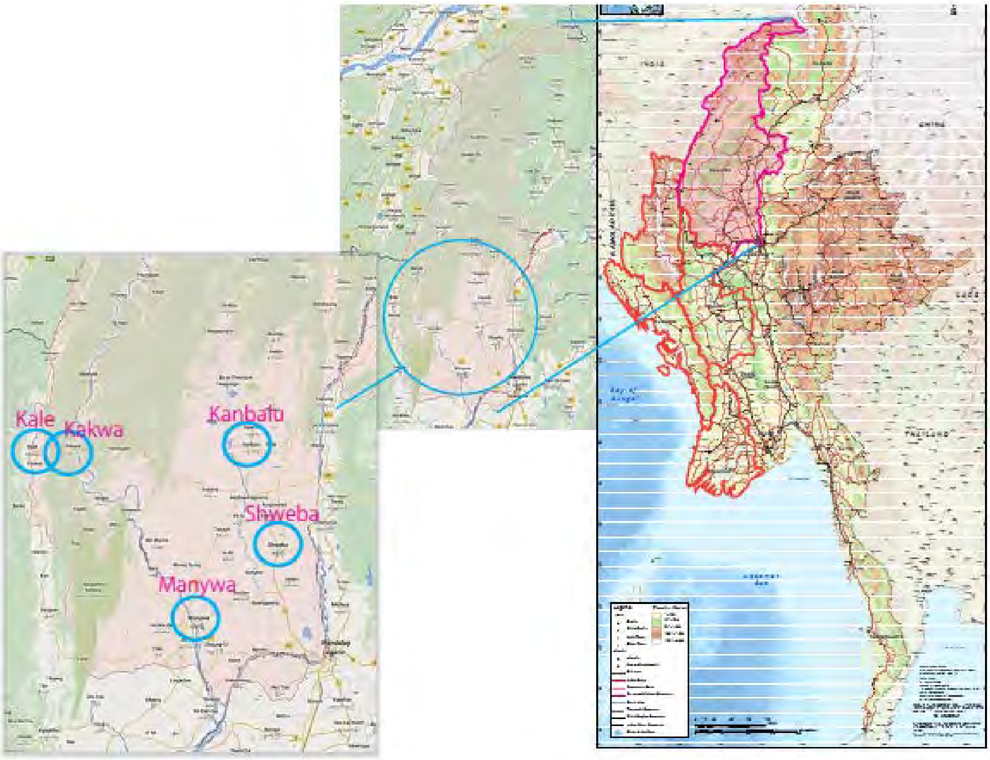
Because the villagers are not wealthy enough to store supplies for several days in their houses and did not have enough time to prepare for evacuation, villagers were able to evacuate with food for only one day. They suffered from food shortage for three days until donors came to the village. As for water, because water ponds and wells in the village were covered with floodwater, villagers also suffered from water shortage. It was reported that some of the villages even could not receive relief from donors because of transportation problems.

The villagers in Pay Gyi Kyun Village located in Hinthada District evacuated when the water level reached one meter after recognizing the difference from a regular flood. GAD Hinthada Township instructed village tract administrators to issue evacuation orders when the water level reached one meter lower than the danger level. Villagers also recognized the flood because MRTV broadcast the flood in Rakhine and the possibility of occurrence in Hinthada. However, according to the interview, villagers started to evacuate when they heard the news that the water level of Hinthada had exceeded the danger level. At this time, the water level and waves were too high and it was dangerous for villagers to evacuate to high land by crossing the river.

Because the villagers evacuated at the last minute and the village does not have warehouse that is resistant to flood, they suffered from food and water shortage until donors came to donate rice. The geographical condition in the village, which is flat and surrounded by river, made it difficult for villagers to secure safe evacuation places and a place for storing food and water. In the remote area of the village tract, phone communication was unstable during the disaster. In this case, these areas are likely to be isolated because boats cannot reach them due to high water levels.

7.2 Sagaing Region

(1) Location of the survey



Source: MIMU

Figure 7-2 Survey Location of Sagaing Region

(2) Response of local government

In Sagaing Region, floods occurred twice in July and the middle of August. Kalay Township was most heavily affected by the flash flood. It was reported that the maximum level of inundation was 11 m. Among the affected states/regions in Myanmar, Saging Region was one of the most damaged. The administrative structure of Sagaing State is different from that of Ayeyarwady Region. Sagain State GAD does not exist and the Region Minister directly oversees the district level of GAD.

For Mon Ywar District, villagers living near a dam evacuated early based on the information and instruction from GAD. Mon Ywar District does not have experience in responding to floods, so evacuation camps were not prepared before the disaster. Regarding communication, because all the communication facilities for mobile phones were inundated in Mon Ywar District, phone lines were cut off for six days. Infrastructure such as roads and bridges were also inundated, so GAD could not reach affected villages for several days even though the village leaders requested rescue.

Kalay District was the most heavily damaged by the flood. Twenty persons died from drowning and six persons are still missing. GAD instructed all villagers in Kalay Township to evacuate, and Myanmar NGO, MRCS and WFP supported the evacuation and relief activities. The DMH office in Kalay District was damaged by the flood and all records and documents were spoiled. Infrastructure in Kalay District was severely damaged and it took one month to recover mobile phone communications. Roads and bridges were also destroyed by flash flood, resulting in hindering the rescue activities in remote villages.

(3) Response of local residents

An elderly women from Chat Thin Village commented she had never experienced a flood in 50 years. Villagers did not know about the mechanism and characteristic of floods and only knew that it would rain for few days. Therefore, the villagers did not prepare anything before the disaster. Without knowing the characteristic of floods, villagers did not evacuate until the water level reached two meters. Then, they started to evacuate to a monastery using ropes and mangers because they do not own boats. Because of the above-mentioned conditions, villagers could not prepare enough food, and they suffered from hunger and a shortage of drinking water until donors and GAD delivered food after several days.

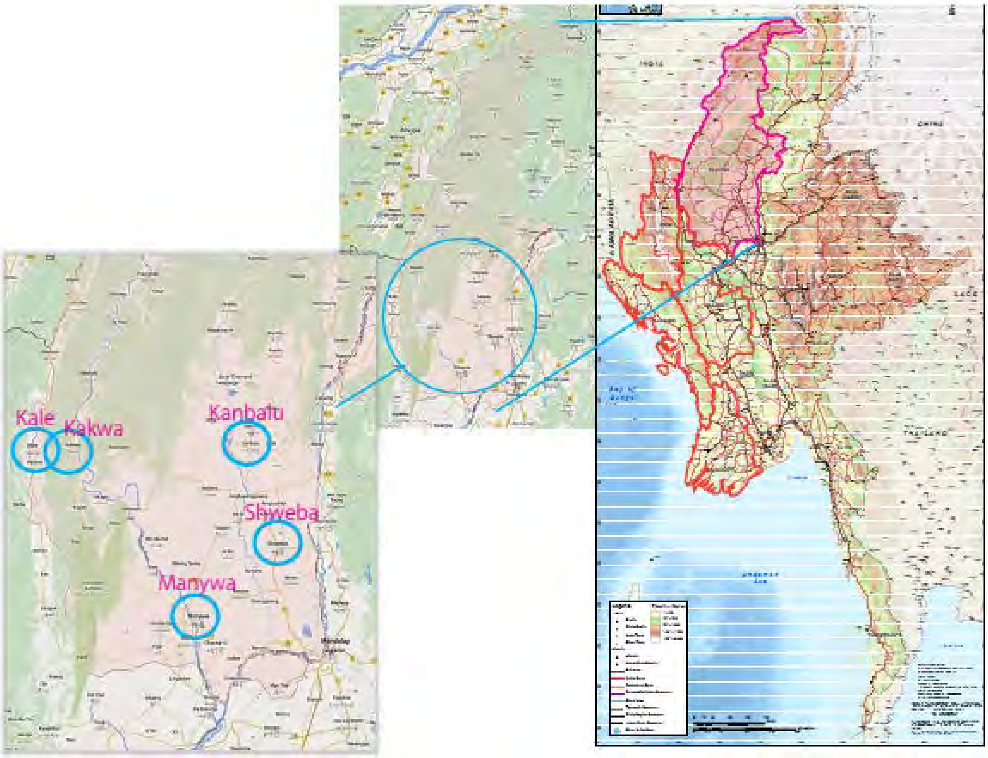
Regarding knowledge and training for disasters, they had never heard about training for disaster management, but the villagers now understand the importance of obtaining knowledge and wished they could have obtained the information from TV, radios and mobile phone messages.

Villagers in Kyaw Zin Village located in Kalay District had never experienced floods and did not know the procedure for evacuation even though some villagers received information from GAD. Villagers started to evacuate when the water level reached two meters, but they still thought they did not want to evacuate because they were concerned about their property. In this village, the water level reached ten meters within 48 hours, and villagers did not have time to prepare food while evacuating. Since the villagers had to stay at the evacuation site for 12 days, they suffered from hunger and water shortage until donors and the government distributed relief materials.

Like the villagers in Mon Ywar, villagers in Kalay are eager to learn disaster management and recognized the necessity of good communication, a well-established early warning system and multiple channels of information such as TV, radio and loud speakers.

7.3 Magway Region

(1) Location of the survey



Source: MIMU

Figure 7-3 Survey Location of Magway Region

(2) Response of local government

Min Bu District was one of the most damaged areas in Magway Region. During the flood, mobile phone lines were cut off for two days and electricity was also disrupted. Because of this, GAD could not communicate with village tracts by either landline or mobile phone about warning information. In Magway Region, RRD is only available at regional level; it is not available to coordinate at district level. When the survey team inquired about the records of disasters in GAD, it took time to find the documents such as damage lists because data and records were not well organized.

Government facilities of Min Bu District were affected by the flood. The DMH office in Min Bu District reported that the water level measure ruler was flushed away by the flood, and electricity and mobile phones were cut off, so the officers could not send the report by fax or mobile phone for a few days. At this time, only landline phones were available as a means of communication, but the phone line communication was not stable. The office of GAD Pwint Phyu, Min Bu District was flooded and could not start rescue activities at the time the damage was reported.

As for the Pakokku District, once the GAD received information from the upper river stream region, GAD assisted with evacuating all villagers at risk to higher land that is owned by department of land transport. GAD also opened 12 evacuation camps and accepted evacuees. Because the local government received information earlier and mobilized villagers promptly, no major damage was observed in Pakkoku District. It is probable that Pakokku District experienced a flood in 2011, so the government learned to respond to the flood properly.

(3) Response of local residents

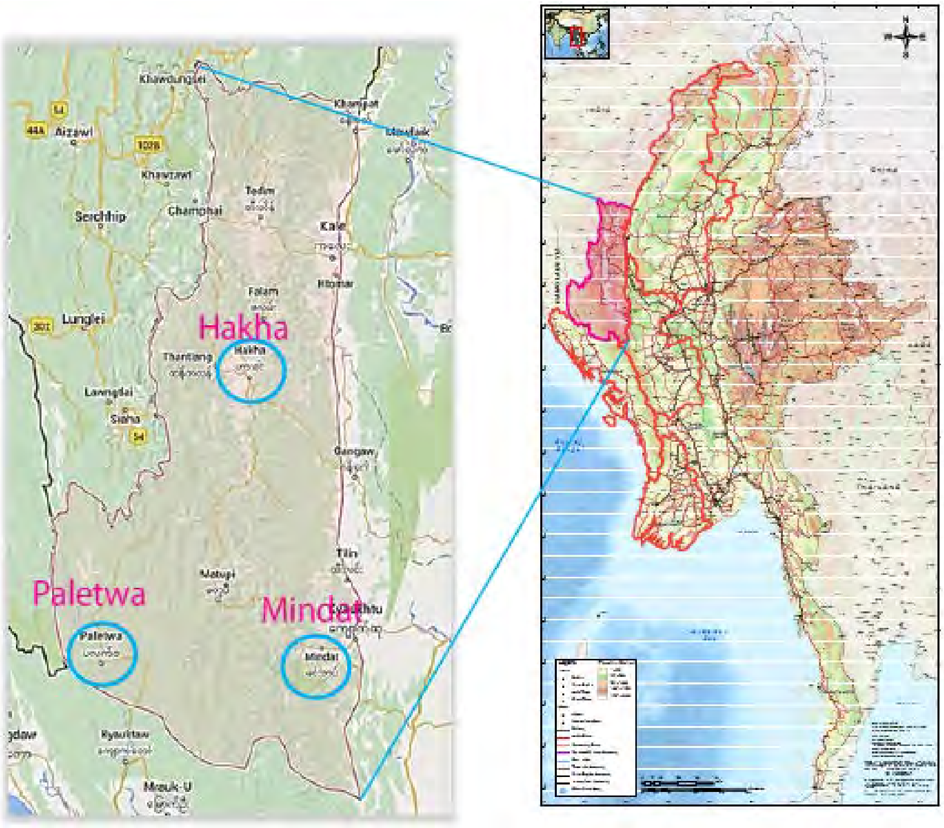
Nyaung Pin Village, located in Pwint Phyu Township, experiences minor floods every year and villagers are used to handling floods with a water level of less than one meter. Because of their experience, they did not trust the information from the government and radio information thinking that it was a normal flood and did not evacuate until the water level reached one meter. Because of such late timing, the villagers needed to evacuate by walking in mud for three hours and could not afford to prepare enough food while evacuating. Due to the cut off of mobile phone lines and electricity, villagers did not receive any information from GAD during the early phase of the flood. Villagers never heard about CBDRM but they commented on the necessity of information dissemination through loud speakers by the village tract administrator.

In Aye Kyun Village, located in Pakkoku Township, villagers living near the river have experience with floods. They always listen to the radio and watch TV to collect information, so they had enough time to prepare for evacuation unlike other interviewed target villages. They were able to bring valuable items from their houses as well as a certain amount of food. The only trouble they faced was an insufficient number of boats while evacuating. As for training, even though they have never heard about CBDRM, they commented that they wanted to be trained in the future.

Even in the same region, the responses of the two villages were totally different probably because of their past experiences with floods. Comparing their attitudes toward CBDRM training, villagers in Pakkoku District understood the importance of training while villagers in Min Bu District answered that only information from a loudspeaker is necessary. Results of pilot activities of the Project in Ayeyarwady Region, which experienced Cyclone Nargis, indicated that villagers who have experienced damage from disasters understood the necessity for training in disaster response.

7.4 Chin State

(1) Location of the survey



Source: MIMU

Figure 7-4 Survey location of Chin State

(2) Response of local government

Hakha District experiences minor landslides every year because of the mountainous topographic features. Yet, Hakha District has never experienced such a large-scale landslide and government officers did not expect the extensive damage. A survey conducted by the Disaster Risk Reduction Working Group (DRR WG) investigated the contents of the disaster management plan of Hakha Township, and found out that landslides were not included in the hazards in the plan[2].

As for communication, mobile phone coverage amounts to only 60% of Hakha city even in the normal period, so Township GAD could not contact village tracts that are located far from Hakha. Because the roads of Chin State are narrow, especially in mountainous areas, road transportation was also blocked. Land transportation is underdeveloped in Chin State so communication between government agencies was also difficult. Due to limited accessibility to other areas, disaster data collected by GAD was not complete.

Although physical damage by the landslide in Min Dat was less than Hakha District, Pa Lat Wa Township had difficulty communicating with upper organizations because there is no transportation

[2] DRR Working Group "Post Flood and Landslide Township Level Assessment ", October 2015

channel between the two cities. Pa Lat Wa Township is dependent on information transmission from Sittwe, Rakhine State because of its isolated location from other cities in Chin State.

During the disaster, all telephone communication was cut off for more than week so conditions could not be reported to village tracts. Because of high waves and strong winds, rescue teams could not arrive at Pa Lat Wa Township for three days.

(3) Response of local residents

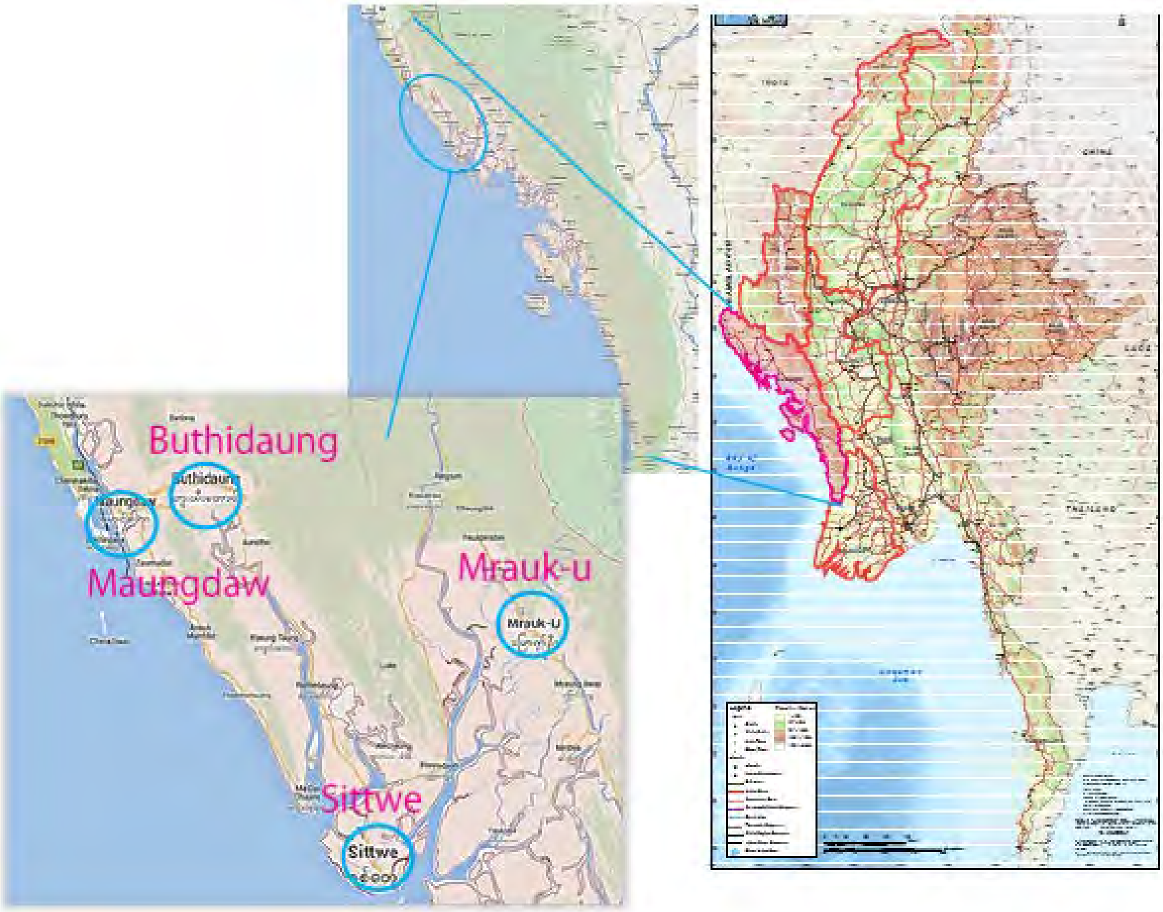
According to an elderly woman in Myoet Ma Ward in Hakha, this kind of landslide was the first experience of her life over 70 years. Because they lack experience in disasters, the villagers did not prepare food for evacuation. Villagers could not receive any information from Township GAD and evacuated to the church using their own judgment. The major issue of villagers in Chin State was that Chin people tend not to follow the instruction of the Burmese government because the head of the local governments were occupied by Burmese officers and Chin people were not likely to be promoted in the local government. Therefore, collaboration between the government and residents was weak.

In Hakha District, most of the residents use the Chin language and they refused to learn the Burmese Language. Because of this language barrier, RRD Chin State cannot provide training for the residents. Currently, RRD only prepares brochures about disasters in the Burmese Language. Chin State is a scarcely populated area and many of the residents are living in mountainous areas, so physical accessibility was also a hindrance of training by RRD.

For Moet Ma Village in Min Dat District, evacuation from the flood was not critical because of the mountainous landscape. Villagers could climb up the hill while carrying important items. Since villagers did not expect a long duration of evacuation, they did not bring enough food during the evacuation. It was fortunate that because the affected areas were relatively small and WFP stored some food in this area, people did not suffer from food shortage. Because of its remote location, government officers commented that they cannot reach the village to provide CBDRM training and the villagers have never heard of CBDRM.

7.5 Rakhine State

(1) Location of the survey



Source: MIMU

Figure 7-5 Survey Location of Rakhine State

(2) Response of local government

Myauk U District has experienced the response to cyclones but has never experienced handling heavy flooding in city areas. The general response for disasters, such as information transmission to village tracts and relief distribution, was conducted smoothly. Even though GAD Myauk U Township informed the villagers about flood warning, villagers did not trust the information since the areas only experienced a minor flood, which inundated 50 cm. DMH Myauk U reported that the road to go to the water level monitoring station was inundated and thus, they could not go to obtain the data during the flood. As for reporting to upper organizations, communication is poor and the monthly budget for communication is insufficient in case of disaster.

Mobile phone communication was cut off in Myauk U District for three days and the electric supply was also disrupted during the flood. Therefore, after the water level became lower, village administrators needed to walk to GAD Myauk U Township office to report the damage.

In Maungdaw District, International Organizations and NGOs such as IOM, ICRC, CARE and WFP became involved in an emergency meeting organized by the disaster management committee and arranged for early evacuation actions at the village tract level based on their frequent experience with cyclones. Two townships in Maungdaw District are accessible only by water transport, so the above-mentioned donors assisted with response such as relief distribution. Because of strong winds and water flow, communication facilities such as mobile phone towers were damaged and the SSB antenna had fallen down in DMH. They were disconnected from communication for several days.

In Maungdaw District, most of the interviewed government officers have experience in training from RRD or international organizations but government officers cannot provide training to residents due to security reasons. The conflict among the Muslim and Buddhist populations in this area also caused trouble in evacuation. Residents refused to evacuate to a designated camp if there were evacuees from a different ethnic group or religious group and voluntarily evacuated to further camps.

(3) Response of local residents

Since the villagers in Nan Kyarr Village, Myauk U District are so-called "Living with Flood", they did not trust the information from the government and did not evacuate until the water level reached one meter. At that time, because of strong winds caused by Cyclone Komen, there were many floating pieces of wood and branches in the water and these materials hit the evacuation boats and people. In Myauk U District, 13 people died during evacuation and most of them were women and children.

Villagers in Ta Pauk Chang, Maungdaw District have experience with cyclones but have never experienced severe floods, so they did not trust the information from the government and evacuation was delayed. At the time of evacuation, the waves and winds had already become strong enough to endanger the safety of the villagers. In Bu Thee Thaung Township, 18 persons died during evacuation. Because villagers only own small boats, several boats capsized when evacuating in the strong winds and high waves. Because of the late timing of the evacuation, not all villagers prepared food for evacuation. Even though donors such as WFP assisted with food distribution to affected people, relief could not reach remote villages.

8. Bottlenecks and challenges

8.1 Early warning system

The major challenges of early warning are physical infrastructure and contents of the early warning messages, which urge the villagers at risk to evacuate.

(1) Infrastructure

Landslide-affected areas required a longer time for recovery of communication because communication infrastructure was destroyed by the landslide. For flood areas, the mobile phone service was cut off for three days on average. Due to the disruption of mobile phone communication, GAD could not disseminate messages to village tracts that were not accessible by land.

(2) Perception of Danger Level

In the case of Pay Gyi Kyun Village in Hinthada District, GAD previously informed the village tract administrator that evacuation is required when the water level rises to one meter below the danger level. However, this instruction was not fully understood by the villagers and they actually evacuated when the MRTV broadcast water level exceeded the danger level. The possible reasons for this action are the difficulty for the villagers to understand the definition of danger level, and to know when the water level rises to one meter below danger level. Villagers tend to think that it is time for them to evacuate when the water level rises above the danger level.

(3) Contents of the message

Most of the residents who were interviewed either watched TV or listened to the radio during the bad weather conditions. However, except for Pakokku Township, which experienced flood damage in 2011, villagers of flood-affected areas did not evacuate until the water level rose more than one meter, which is dangerous for evacuation. It is probable that the villagers could not fully understand the contents of the warning, so that they thought it was not necessary to evacuate.

One of the Township GADs requested DMH to disseminate more accurate and detailed information, especially to fisherman or residents who cannot expect the extent of the dangers based on their experiences. If GAD receives more understandable information from DMH, the township level can respond more properly.

8.2 Capacity of local government

Major challenges and bottlenecks of the government are the phases of instruction of evacuation to the residents in the areas at risk and relief distribution. In order to improve the response capacity, proper record taking and learning from past experiences are indispensable.

(1) Lack of practice for recording and reviewing past experience

Three GAD offices refused to answer the interview survey even though the Expert Team requested RRD to endorse the survey by explaining the purpose. A possible reason for refusing the interview is the government officers did not understand the importance of recording the damage and responses for the lessons for other regions and successors.

(2) Unfamiliar to disaster response

In relation to the above-mentioned bottleneck, some local government offices did not keep the records of disaster response due to chaotic situations during the response phase without recognizing the importance of recording and learning from past disasters. Inadequate recording of the disaster may result in repeating the same misconduct and avoidable loss and damage.

It was observed that local level government officers were not used to respond to disasters with low frequency, such as heavy floods in Rakhine State and Sagain Region. For example, timing of response for floods and cyclones is different because they are different meteorological phenomena.

This challenge is especially applicable to GAD. Due to the frequent transfer of employees, newly assigned officers are not familiar with the knowledge of disasters in the region. The Expert Team observed that some GAD officers in Rakhine State did not know the meaning of the color code for cyclones because they were transferred from other regions.

(3) Difficulty with persuading/instructing villagers to evacuate

GAD officers pointed out that they had trouble with evacuation of residents because residents did not trust the information and refused to evacuate. In the flood response, a certain number of losses and injuries would have been avoidable if the residents started to evacuate earlier. According to U Soe Thein, the former township administrator of Bogalay Township during Cyclone Nargis, GAD instructed villagers in coastal areas to evacuate, but villagers did not follow the instructions resulting in an increase of damage from the cyclone[3]. Due to the lack of knowledge and underestimation of the risk of disaster at the resident level, it is a challenge to persuade them to evacuate earlier.

(4) Coordination among agencies about relief distribution

Results of the interview survey indicated that relief distribution of disaster stricken areas has room for improvement. RRD has stockpiles of family kits, yet the number of family kits was insufficient and the urgent needs of the residents were not family kits but food and water. In Hinthada District, GAD did not have record of donations or relief distribution but only listed the amount of the disaster relief fund from the Ayeyarwady Regional Government. If there is no record of relief distribution, GAD and RRD cannot make proper plans for emergency stockpiles and relief distribution based on past experience. This could result in a deficiency of relief material again. It is also essential to review the contents of emergency stockpiles reflecting the needs of the residents.

[3] Lectures of TOT workshop in Kyauk Phyu Township on 2nd of March 2015.

(5) Capacity for information transmission

Township GAD is responsible for transmitting the warning messages during disasters and needs to take on necessary response actions. However, human resources at the GAD Township level are not sufficient to cover all village tracts. For example, Ayeyarwady Region has 26 Townships and 1,939 village tracts. That means one township should cover approximately 75 village tracts on average. At the township level GAD, there are no specialized sections for disaster management and no specialized staff for disaster management. Making phone calls to a large number of village tracts with poor communication is time consuming and burdensome for this kind of organizational structure. Due to the heavy burden, messages from GAD tend to be delayed. The limited number of transportation means such as vehicles and boats is also a bottleneck for the Township GAD to disseminate the warning information and instruct villagers to evacuate. Since the village tract level usually does not have simultaneous communication equipment such as SSB, or walkie-talkies that can be used to communicate while mobile phones are out of service, Township GAD has trouble communicating with village tracts.

8.3 Capacity of residents

Except for Pakkoku and Magway, major bottlenecks among target villagers derive from a lack of knowledge of disasters and preparedness and response. The low level of education also affects the level of understanding of the warning messages and instructions from the government.

(1) Insufficient knowledge of DRR

Among the target villages, only village tracts in Hinthada District, Ayeyarwady Region had experience on the training of DRR. Because of the devastating damage of Cyclone Nargis in 2008, a large number of awareness-raising projects were implemented in Ayeyarwady Region by the government and aid agencies. Disaster stricken areas of Rakhine State, where Cyclone Giri hit in 2010, also have experience in CBDRM training.

According to the interview, villagers answered that it was the first time for them to experience such a disaster and they did not know how to respond. In this case, villagers were unable to imagine the speed of inundation or the time frame for evacuation and ended up not having enough time to prepare.

Except for Pakokku, all of the interviewed villages experienced food and water shortages for several days until donors or government agencies arrived. The possible reasons for food and water shortages are 1) timing of evacuation was too late, 2) villagers do not know how to prepare for evacuation site, and 3) logistic and relief distribution at the local level was insufficient.

The timing of evacuation was the most critical bottleneck at the village level since some of the deaths and injuries could have been avoided if evacuation had commenced earlier. According to the interview with villagers, there are two main reasons for delayed evacuation. For the areas that do not have experience of disasters, villagers could not efficiently respond. On the other hand, in the areas that frequently experience minor floods, villagers underestimated the scale of the flood based on previous experience and did not follow the news or instruction from the government.

(2) Imbalanced support from donor and government to coastal regions

RRD pointed out that CBDRM training and other DRR activities are concentrating on Ayeyarwady Region and Rakhine States, which have experienced devastating damage of cyclones[4]. According to RRD, the response of two states/regions is relatively efficient compared to other affected areas. Providing balanced opportunities for training all over Myanmar as well as training on other types of disasters are the challenges for CBDRM activities.

8.4 Regional specific issues

(1) Security issues

The survey team reported that due to the security conditions in Maungdaw District in Rakhine State, GAD had trouble handling the evacuation of residents. Villagers refused to evacuate to the designated evacuation camps because they did not want to stay with the Muslim population who they are in conflict with. Due to the conflict between the Buddhist and Muslim populations, government officers cannot reach the communities to provide training and donors and NGOs cannot provide relief. This condition may continue to deprive the residents from the opportunity to learn CBDRM activities and receive relief distribution from donors.

(2) Language barriers

Among the target areas of the interview survey, Chin State had trouble with response because of language barriers. Most of the people in Chin State cannot understand the Burmese language especially in the remote areas. Those who cannot read the Burmese language are especially vulnerable since they cannot understand the information broadcast on TV or IEC material for DRR.

(3) Anti-sentiment against the local government

It was reported that even though the local governments disseminate proper messages, some residents, especially in states, do not follow the directions. Since this kind of anti-sentiment is generally deep-rooted in a complex background, it is a big challenge for local governments to instruct the residents.

[4] The comment was made on 5th February 2016 during JCC meeting

9. Recommendation

9.1 Early warning communication

(1) Provide more effective EW information for residents

It is necessary to provide pertinent information to residents so that people can feel safe to evacuate. Information about food and water in shelters, care of cattle, and an estimated duration of evacuation are the major concerns of residents for evacuating. It is recommended to provide the information on public services such as care of cattle during the evacuation to residents as a part of the warning advisory. In addition, it is desirable to provide information such as providing disaster relief and subsidies for affected housing to increase the credibility of the government for the villagers.

(2) Strengthen Regional/District level DMH as local resource for better EW actions

Even though district-level DMH does not conduct weather forecast activities, local government agencies and residents ask DMH district-level offices about weather conditions. Typical questions to DMH officers at district levels are related to the direction of cyclones, the meaning of the color code for cyclone warning, and advice on shipping activities during bad weather[5]. Therefore, DMH officers at the region/district level have to understand the concerns and necessary information of local government officers and residents. It is effective to utilize the knowledge and experience of local government officers to improve warning messages including the danger level of the water levels in each area.

In Japan, JMA and its regional branches provide lectures about disasters to the public such as students, civil society organizations and self-help disaster management group at the municipality level[6]. JMA states that its purposes for providing lectures to the public are to 1) enhance the knowledge and awareness of meteorology, earthquake, volcano and climate change, and 2) listen to the opinions and voice from the public. These activities contribute to raise the awareness of the public and improve the contents of weather news to meet the needs of the public.

(3) Secure redundancy of communication during disaster

It is recommended to secure a source of information transmission other than mobile phone and fax considering the possible disruption of mobile phone lines and electric supply. For communication, SSB and walkie-talkies can be considered as secondary communication devices. For areas where landlines are available, additional electric sources such as generators and solar panels are necessary to mitigate blackouts.

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[5] Interview with U Than Zin Oo, DMH Labutta District on May 22, 2014
Interview with U Than Tun Win, DMH Kyauk Phyu District on May 30, 2014

[6] http://www.jma.go.jp/jma/en/Activities/pws.html
http://www.jma.go.jp/jma/kishou/intro/demae.html

9.2 Human Resource Development

(1) Include training of CBDRM to Disaster Management Training Center (DMTC)

Considering the lack of knowledge of DRR at the resident level, capacity development of residents is critical to mitigate the damage of disasters. As of December 2015, the curriculum of DMTC did not include lectures on CBDRM[7]. CBDRM training to understand the characteristics of residents and necessary actions at the village level is necessary for local government officers who directly provide services to the public as well as villagers.

(2) Sharing the past disaster experience among government officers

It is observed that damage and response of the disaster is different even within the same region such as Magway Region. Results of the survey indicated that the actual experience of disaster response is the best teacher for better response. Counterpart officers of the Project who experienced the response of Cyclone Nargis showed high awareness and knowledge of disasters compared to other officers. Sharing the experience of disasters among such government officers is effective. Record and lessons learned should be shared with other areas that have low frequency of disasters.

9.3 Community-based Disaster Risk Reduction

The response of the pilot villages in Rakhine State verified that CBDRM training was effective for villagers to respond properly[8]. However, the risk and damage of the disaster adversely affected the marginalized people living in remote areas. Countermeasures for these populations should be considered.

(1) Applicability of CBDRM activities for Cyclone

Even though the characteristics of cyclones and floods are different, core knowledge such as the importance of early evacuation, emergency stockpiles at individual and community levels, safe evacuation routes, reports on damage and loss, and shelter management are applicable to both disasters. The methodology of CBDRM activities conducted by the Project can be extended to other regions by adjusting the contents of the knowledge of disasters.

(2) Awareness raising for people living in remote areas

In general, vulnerability of disaster has a strong correlation with the distance from city center due to communication, transportation, education, etc. RRD also recognized that they are currently

[7] Training courses of DMTC were obtained from Daw Phyu Lai Lai Htun, Director of RRD Training Section on 14 December, 2015

[8] Apart from the interview survey, JICA Expert Team conducted interview with the villagers in pilot villages in Rakhine State about the response of flood in the end of July. The villages which conducted evacuation drill evacuated before the instruction of township and even though the water level raised to 2m, no major damage were reported. On the other hand, the pilot villages which did not start CBDRM training did not evacuate even though the location of these villages are close.

unable to reach remote areas in Chin State due to transportation and language barriers[9]. Possible measures to reach the remote community are to develop TV or radio programs to disseminate proper knowledge and lessons learned from past disasters. Community FM radio in the local language is a possible source to access ethnic minorities who do not understand the Burmese language.

9 Comment was made when the Expert Team made a brief presentation about the result of the survey at JCC on 5th of February, 2016

10. Conclusion and Recommendations

- More than six months have passed since the 2015 disaster occurred. There have been no similar reports up to now. As a “Disaster Report,” the contents of this report do not include damage analysis or the actions taken for response activity, etc., and the issues raised are mainly on the early warning and evacuation system, not for the overall DRM. Therefore, this report is not sufficient as a disaster report to be utilized effectively for the future disasters. The actions taken by related organizations for the response activity including donor agencies were presented in “the Lessons Learned Workshop for 2015 Floods and Landslides” held on February 9, 2016, and the findings, issues and recommendations were shared among the participants in the workshop. However, in order to avoid forgetting the results of the workshop, it is highly recommended that the Myanmar side prepare a report on the actions taken by the related agencies.
- The Project activities, such as improvement of the early warning system, and capacity enhancement of government officers and residents, have been conducted mainly for the cyclone disasters along the coastal areas for the last three years. It was found that these experiences and the lessons learned are basically applicable to the flood disasters as well. However, it must be noted that it is not easy to forecast floods, to communicate with remote areas, or to enhance the capacity of government officers and residents on flood disasters, compared to cyclone disasters, because floods may occur anywhere in Myanmar and they sometimes occur in a restricted local area.
- This kind of report can be prepared by observing the rainfall amount and water levels continuously, and by conducting surveys to report the disaster records and damage situations whenever disaster occurs. Through accumulating a disaster report, a reduction in the damage by future disasters can be achieved.

Appendix

(1) Observed rainfall amount at the gauging stations and the rainfall distribution by the satellite image at the end of June, the middle of July and the end of July 1

(2) Annual Maximum Daily Rainfall... 3

(3) Annual Highest Water Level 6

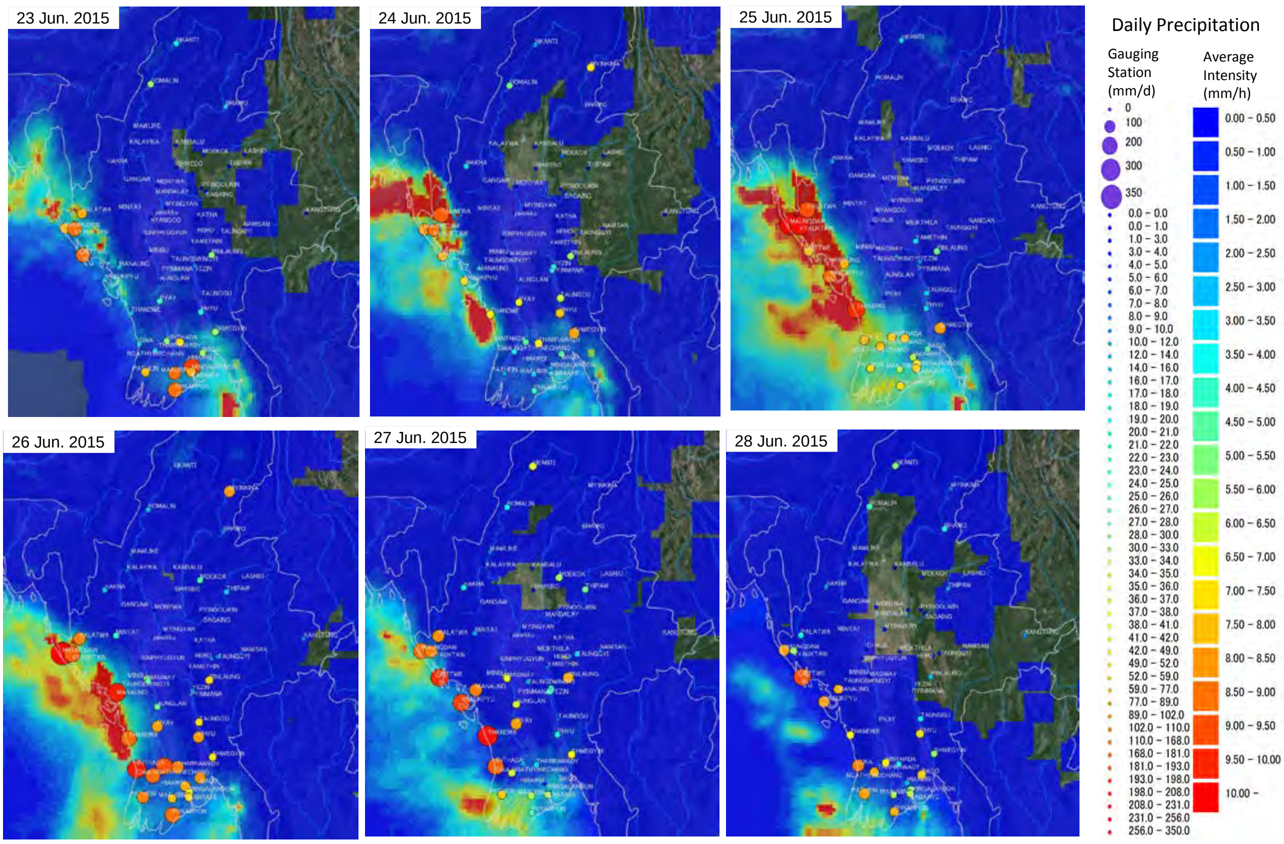
(4) Result of Probability Analysis 7

(5) Pictures of Survey 11

(6) Questionnaire Form for Government Officer and Residents.............................. 15

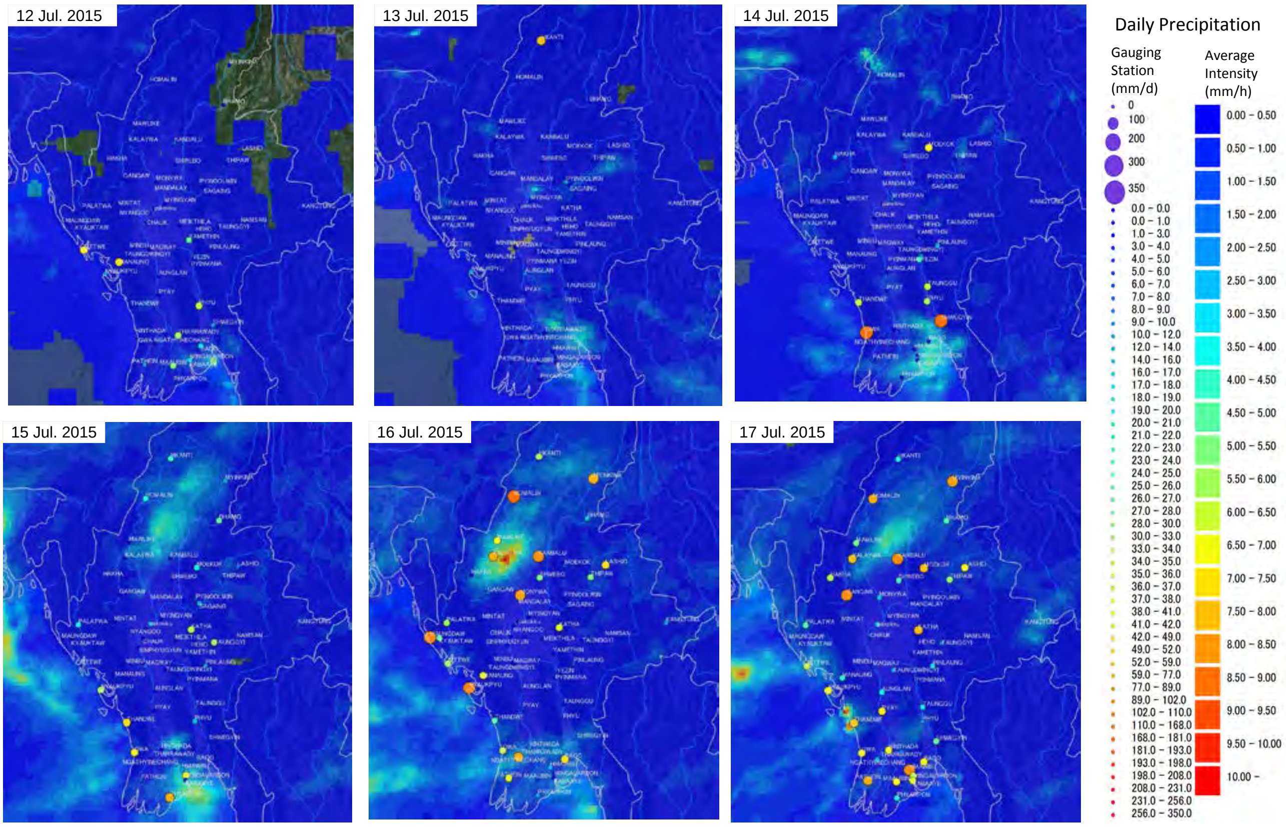
(1) Observed rainfall amount at the gauging stations and the rainfall distribution by the satellite image at the end of June, the middle of July and the end of July

It is useful to utilize satellite images for weather forecasting and warning. However it is necessary to know the characteristics of the satellite image. As shown in the figure below, the observed rainfall amount at the gauging stations and satellite image are mostly corresponding. However, the satellite image sometimes cannot grasp the localized rainfall eg. at the north-west part, around the border of India, particularly during the rainfall event from the end of July to the beginning of August.



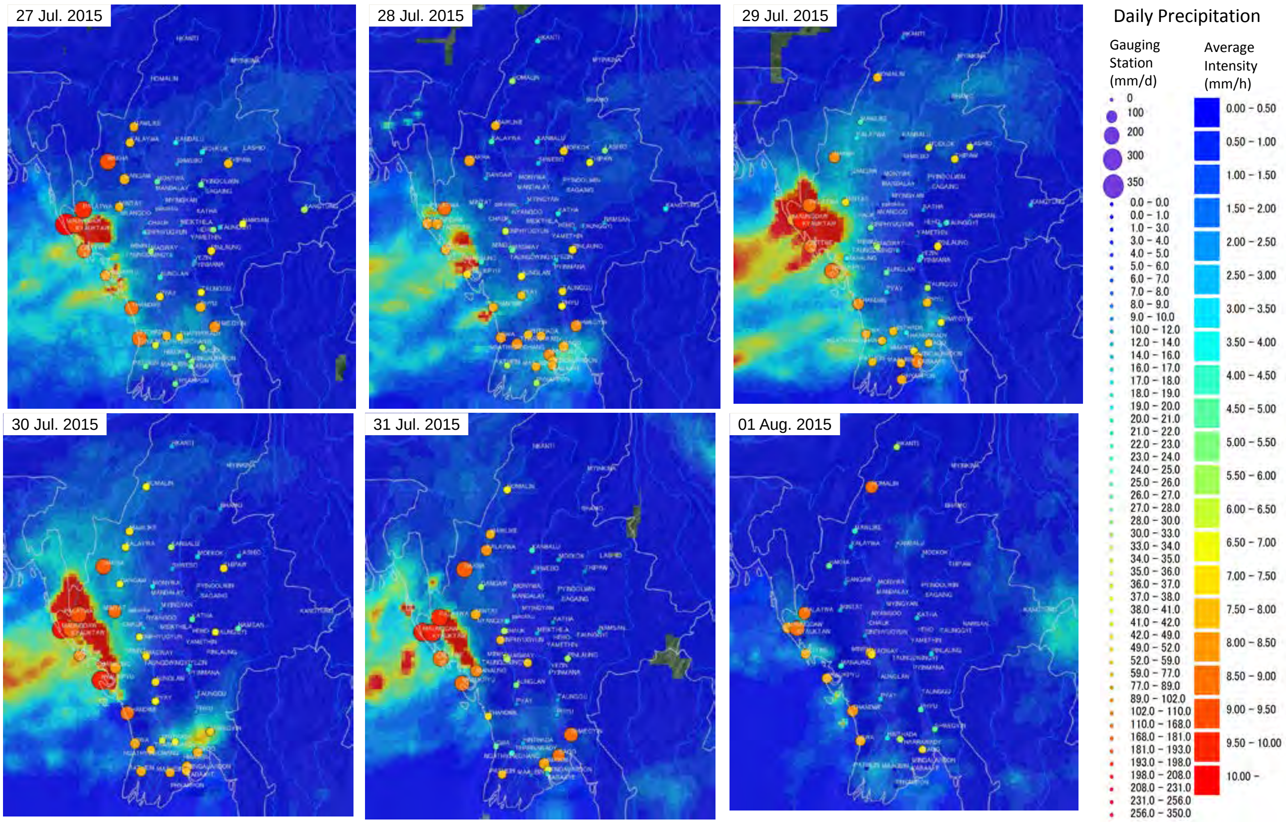
Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure A-1 Rainfall Condition (23 - 28 Jun, 2015)



Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

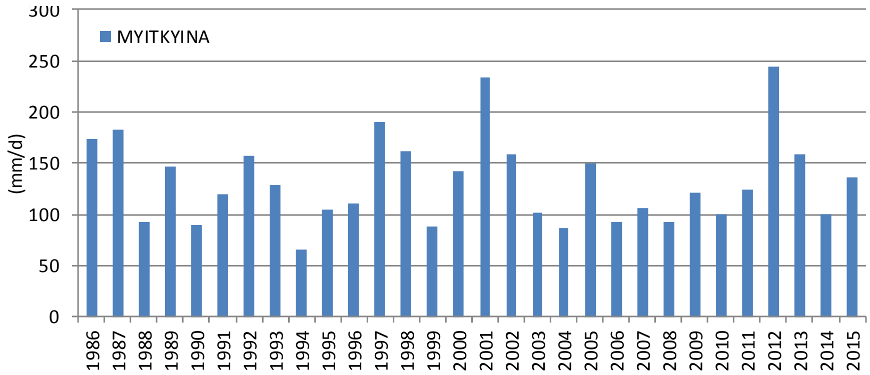
Figure A-2 Rainfall Condition (12 - 17 Jul, 2015)



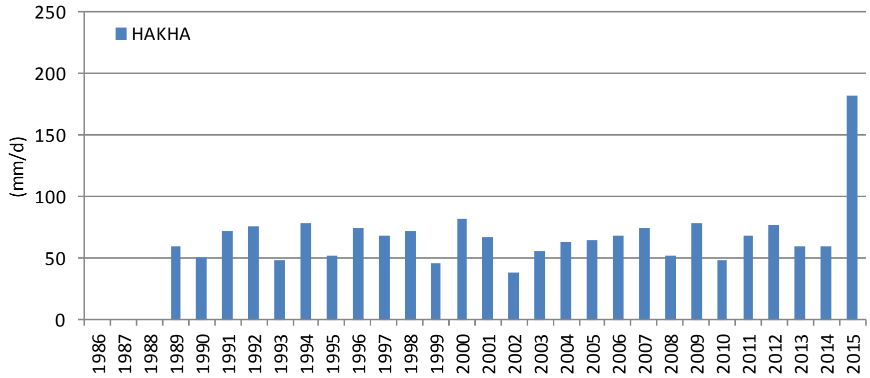
Source: Prepared by JICA Expert Team based on the data from JAXA, DMH and MSWRR

Figure A-3 Rainfall Condition (27 Jul - 1 Aug, 2015)

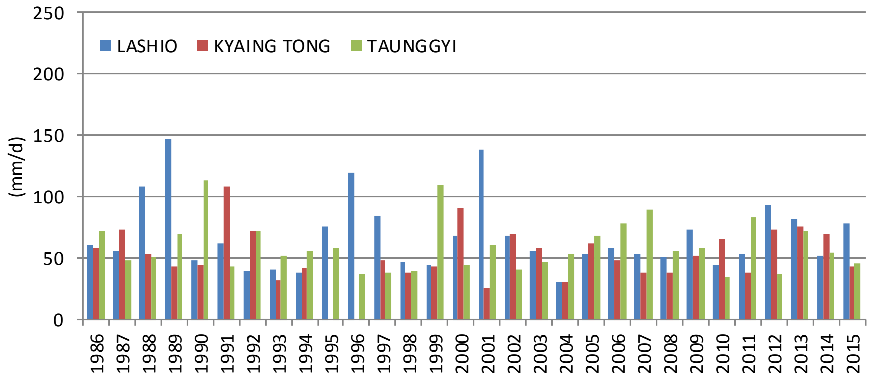
(2) Annual Maximum Daily Rainfall



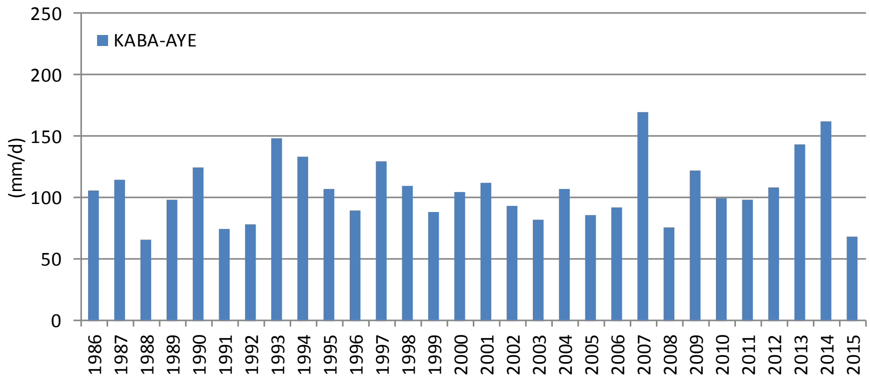
Chin



Shan

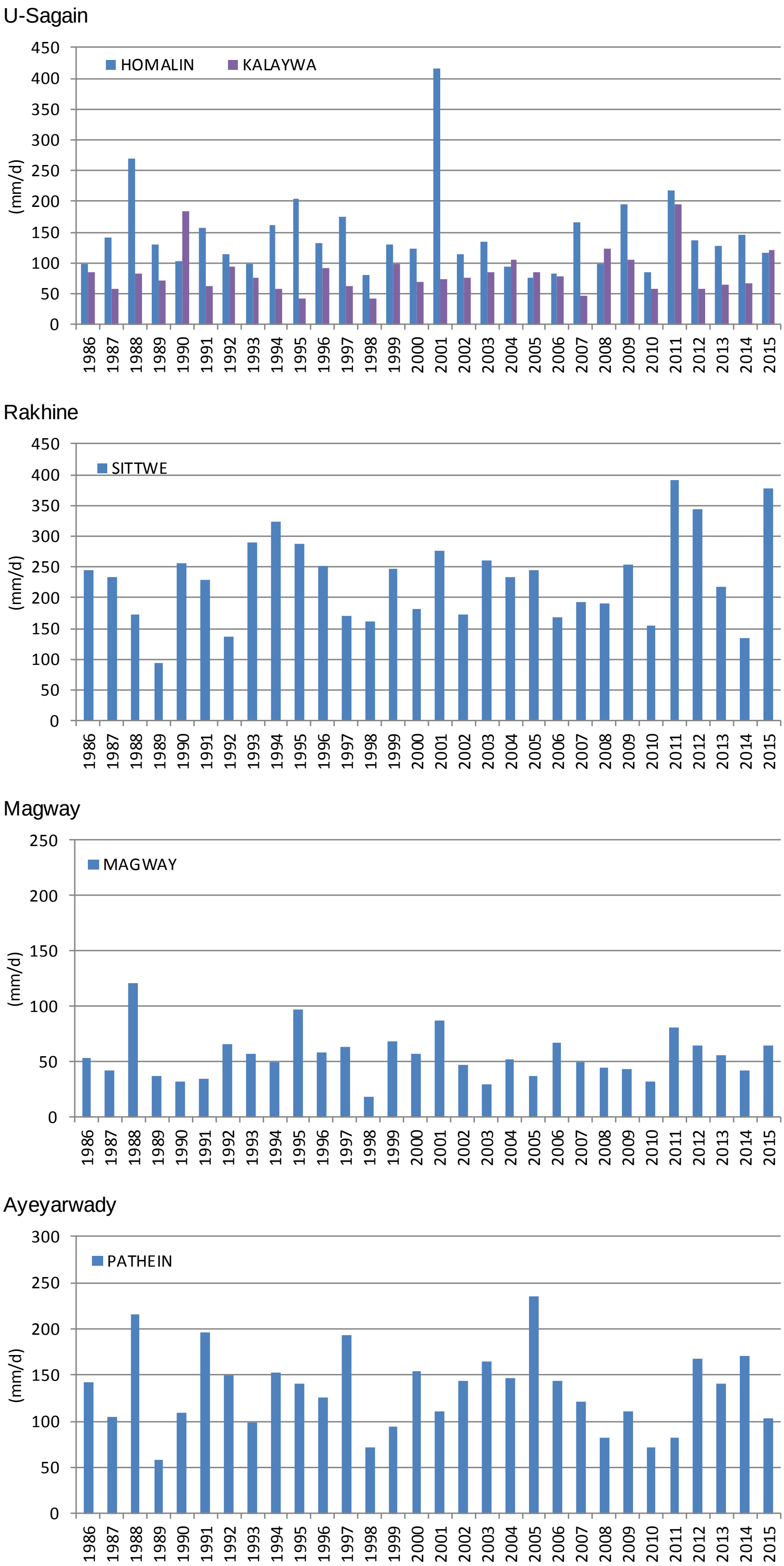


Yangon



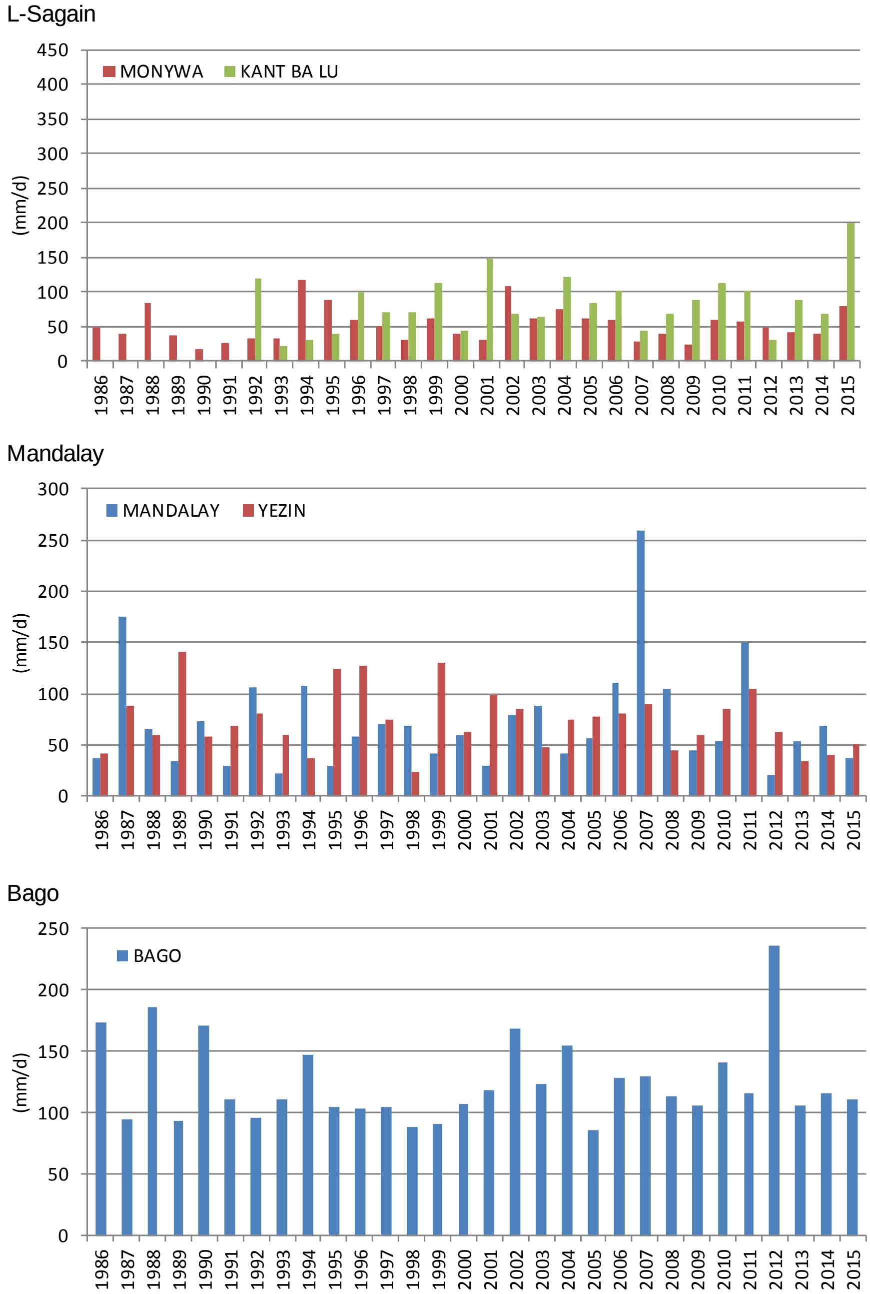
Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-4 Annual Maximum Daily Rainfall (1/3)



Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-5 Annual Maximum Daily Rainfall (2/3)

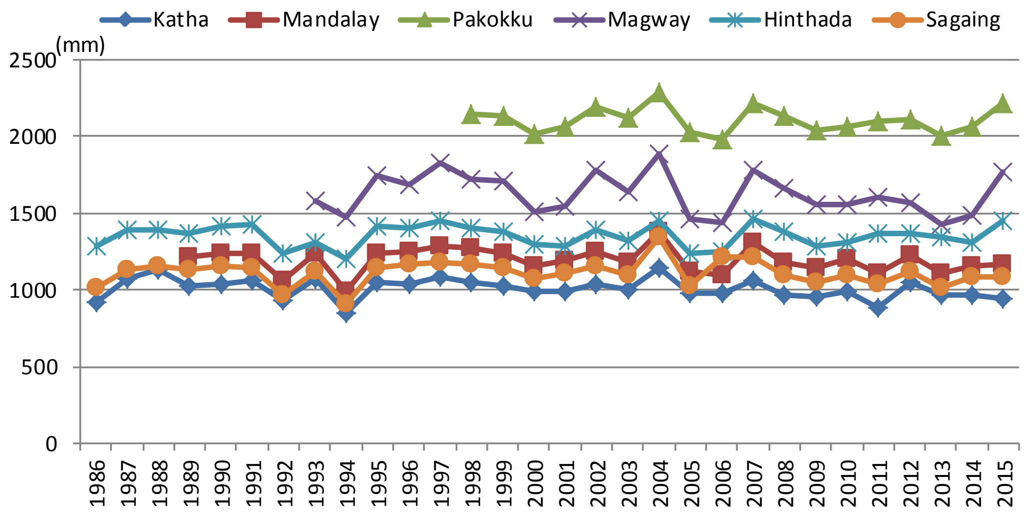


Source: Prepared by JICA Expert Team based on the data from DMH

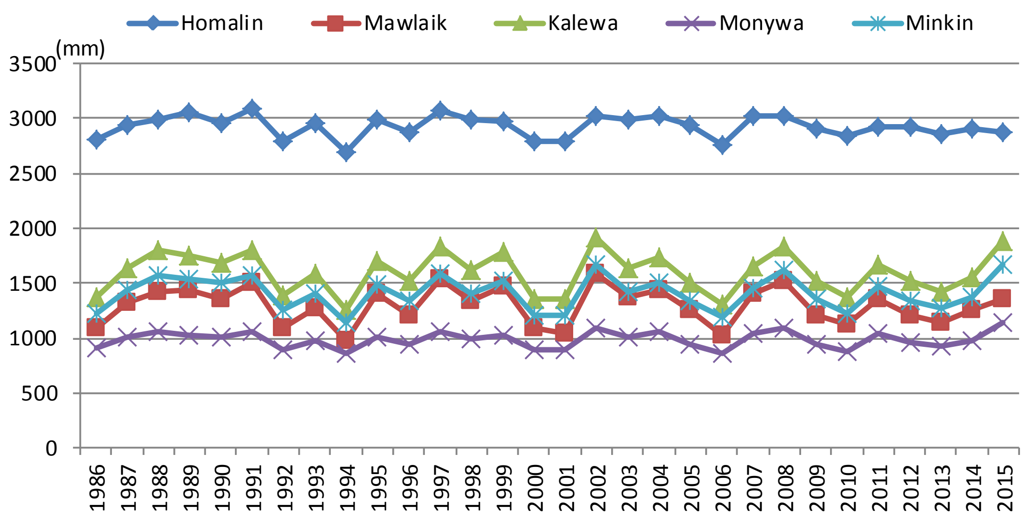
Figure A-6 Annual Maximum Daily Rainfall (3/3)

(3) Annual Highest Water Level

Ayeyarwady



Chindwin



Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-7 Annual Highest Water Level

(4) Result of Probability Analysis

State / Region		Kachin	Sagain				Shan			Chin
							North	East	South	
Station		MYITKYINA	HOMALIN	MONYWA	KANT BA LU	KALAYWA	LASHIO	KYAING TONG	TAUNGGYI	HAKHA
Return Period (yr)	2	122.8	124.4	47.8	77.0	74.3	60.3	52.0	55.2	62.2
	3	141.2	146.3	58.4	94.7	87.1	71.6	60.4	63.6	71.3
	5	162.6	175.3	70.7	114.4	103.3	85.3	69.7	73.2	82.5
	10	190.4	219.6	86.6	139.2	126.8	104.4	81.3	85.8	97.5
	20	218.0	271.2	102.4	162.9	152.8	124.6	92.3	98.3	111.7
	30	234.1	305.2	111.7	176.6	169.4	137.1	98.5	105.7	119.4
	50	254.3	352.7	123.6	193.7	191.9	153.7	106.3	115.0	128.3
	80	273.0	401.1	134.7	209.3	214.3	169.8	113.5	123.8	135.3
	100	281.8	425.7	140.0	216.7	225.5	177.7	116.9	128.0	138.1
2015 Flood		136	116	80	199	120	78	44	46	182
Return Period (yr)		2~3 (yr)	2 (yr)	5~10 (yr)	50 (yr)	10 (yr)	3~5 (yr)	2 (yr)	2 (yr)	100 (yr)

State / Region		Rakhine	Mandalay		Magway	Bago East	Yangon	Ayeyarwady	
Station		SITTWE	MANDALAY	YEZIN	MAGWAY	BAGO	KABA-AYE	PATHEIN	HINTHADA
Return Period (yr)	2	222.9	57.2	69.5	51.6	113.6	102.5	129.9	97.1
	3	255.5	74.9	83.4	60.7	128.2	114.3	149.9	116.4
	5	289.1	98.2	98.2	70.7	146.5	127.1	170.2	140.9
	10	327.5	132.8	115.5	83.4	171.3	142.9	192.9	174.0
	20	360.4	171.6	130.6	95.5	196.1	157.5	211.8	207.1
	30	377.5	196.4	138.7	102.5	210.7	165.6	221.6	226.5
	50	397.2	230.0	148.2	111.2	229.0	175.6	232.6	250.9
	80	413.6	263.1	156.3	119.2	245.8	184.4	241.7	273.3
	100	420.8	279.5	159.9	123.0	253.8	188.4	245.7	284.0
2015 Flood		377	37	50	65	111	69	103	187
Return Period (yr)		30 (yr)	2 (yr)	2 (yr)	3~5 (yr)	2 (yr)	2 (yr)	2 (yr)	10~20 (yr)

Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-8 Probability Anaysis of Daily Rainfall

State / Region		Kachin	Sagain				Shan			Chin
							North	East	South	
Station		MYITKYINA	HOMALIN	MONYWA	KANT BA LU	KALAYWA	LASHIO	KYAING TONG	TAUNGGYI	HAKHA
Return Period (yr)	2	161.5	170.0	57.3	91.9	107.0	80.7	72.6	81.1	84.8
	3	180.9	195.9	70.3	115.5	127.7	94.3	84.0	93.1	97.0
	5	204.9	228.5	84.4	144.4	154.6	111.1	96.6	107.1	115.5
	10	238.6	275.0	101.5	184.6	195.0	134.7	112.1	125.4	147.9
	20	275.0	325.5	116.8	227.2	241.6	160.0	126.7	143.2	190.8
	30	297.7	357.1	125.1	253.4	272.3	175.6	134.9	153.5	221.8
	50	328.2	399.1	135.0	288.0	314.9	196.1	145.0	166.4	268.2
	80	358.1	439.8	143.6	321.4	358.5	215.9	154.1	178.2	318.9
	100	372.9	459.8	147.5	337.8	380.8	225.5	158.4	183.8	345.9
2015 Flood		167	179	96	291	226	86	52	78	350
Return Period (yr)		2 (yr)	2 (yr)	5~10 (yr)	50 (yr)	10~20 (yr)	2~3 (yr)	2 (yr)	2 (yr)	100 (yr)

State / Region		Rakhine	Mandalay		Magway	Bago East	Yangon	Ayeyarwady	
Station		SITTWE	MANDALAY	YEZIN	MAGWAY	BAGO	KABA-AYE	PATHEIN	HINTHADA
Return Period (yr)	2	328.2	69.1	89.8	65.1	171.1	144.5	189.5	136.9
	3	374.6	89.3	106.9	76.9	188.2	158.9	220.2	159.4
	5	421.7	115.0	126.1	90.5	206.8	175.3	254.3	189.9
	10	474.3	152.5	150.5	108.0	229.2	195.8	297.2	236.3
	20	518.2	194.5	174.2	124.9	249.6	215.3	338.4	289.4
	30	540.7	221.6	187.9	134.6	260.7	226.3	362.1	323.9
	50	566.0	258.5	205.1	146.7	274.1	240.0	391.7	371.2
	80	586.7	295.5	221.1	157.5	285.7	252.3	418.8	418.7
	100	595.7	314.0	228.7	162.5	291.0	258.1	431.6	442.7
2015 Flood		585	58	57	82	181	131	169	238
Return Period (yr)		80 (yr)	2 (yr)	2 (yr)	3 ~ 5 (yr)	2~3 (yr)	2 (yr)	2 (yr)	10 (yr)

Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-9 Probability Analysis of 2 Days Rainfall

State / Region		Kachin	Sagain				Shan			Chin
							North	East	South	
Station		MYITKYINA	HOMALIN	MONYWA	KANT BA LU	KALAYWA	LASHIO	KYAING TONG	TAUNGGYI	HAKHA
Return Period (yr)	2	192.7	207.8	65.7	106.9	133.0	96.3	86.1	98.1	103.8
	3	222.0	245.2	80.7	138.1	157.9	109.9	97.8	110.9	117.4
	5	260.5	289.9	97.7	175.0	187.7	127.0	110.4	125.7	138.6
	10	317.3	350.7	119.2	222.5	228.4	151.4	125.4	144.8	177.1
	20	380.5	413.7	139.7	267.7	270.8	177.7	139.2	163.6	230.4
	30	420.7	452.1	151.5	292.9	296.6	194.2	146.8	174.6	270.1
	50	475.2	502.3	166.1	323.5	330.4	216.1	156.1	188.5	331.1
	80	529.2	550.2	179.3	350.3	362.8	237.2	164.4	201.4	399.6
	100	556.2	573.7	185.5	362.4	378.6	247.6	168.3	207.6	436.9
2015 Flood		183	236	107	384	245	115	72	79	442
Return Period (yr)		2 (yr)	3~5 (yr)	5~10 (yr)	100 (yr)	10~20 (yr)	3~5 (yr)	2 (yr)	2 (yr)	100 (yr)

State / Region		Rakhine	Mandalay		Magway	Bago East	Yangon	Ayeyarwady	
Station		SITTWE	MANDALAY	YEZIN	MAGWAY	BAGO	KABA-AYE	PATHEIN	HINTHADA
Return Period (yr)	2	429.2	77.9	105.0	73.7	206.6	181.3	237.0	166.9
	3	484.5	101.1	123.6	87.1	223.0	199.1	274.1	189.5
	5	537.5	129.4	144.3	102.1	239.9	219.7	313.4	222.3
	10	592.8	168.4	170.3	121.0	259.3	247.0	359.4	276.0
	20	635.6	209.2	195.3	138.8	276.5	274.6	400.1	341.6
	30	656.3	234.2	209.7	148.9	285.9	291.0	422.0	386.2
	50	678.6	266.9	227.7	161.2	297.2	312.2	448.0	449.4
	80	695.8	298.3	244.1	172.1	307.2	332.2	470.5	515.1
	100	703.1	313.7	251.9	177.1	311.9	341.9	480.7	549.0
2015 Flood		641	66	77	127	224	184	242	264
Return Period (yr)		20~30 (yr)	2 (yr)	2 (yr)	10~20 (yr)	3 (yr)	2 (yr)	2~3 (yr)	10 (yr)

Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-10 Probability Analysis of 3 Days Rainfall

River system		Ayeyarwady					
Station		Katha	Mandalay	Pakokku	Magway	Hinthada	Sagaing
Danger Level		1040	1260	2150	1700	1342	1150
Return Period (yr)	2	1011	1202	2097	1619	1358	1114
	3	1041	1238	2135	1684	1388	1153
	5	1068	1271	2176	1748	1416	1190
	10	1095	1302	2225	1819	1444	1227
	20	1117	1326	2267	1877	1466	1255
	30	1128	1337	2290	1906	1476	1269
	50	1140	1349	2317	1938	1488	1284
	80	1150	1358	2339	1963	1498	1295
	100	1154	1362	2349	1974	1502	1300
2015 Flood		940	1168	2219	1775	1456	1085
Return Period (yr)		2 (yr)	2 (yr)	10 (yr)	5 (yr)	10~20 (yr)	2 (yr)

River system		Chindwin					Bago	Shwegyin
Station		Homalin	Mawlaik	Kalewa	Monywa	Minkin	Bago	Shwegyin
Danger Level		2900	1360	1550	1000	1350	910	700
Return Period (yr)	2	2940	1303	1607	987	1414	899	731
	3	2984	1380	1693	1021	1484	914	772
	5	3021	1449	1772	1053	1550	929	807
	10	3052	1515	1849	1084	1615	943	839
	20	3072	1563	1905	1107	1664	955	860
	30	3080	1584	1930	1118	1686	962	868
	50	3088	1606	1956	1129	1710	969	877
	80	3094	1622	1976	1137	1728	974	882
	100	3096	1628	1984	1140	1735	977	884
2015 Flood		2869	1357	1879	1139	1672	908	749
Return Period (yr)		2 (yr)	2~3 (yr)	10~20 (yr)	80 (yr)	20~30 (yr)	2~3 (yr)	2~3 (yr)

Source: Prepared by JICA Expert Team based on the data from DMH

Figure A-11 Probability Analysis on Water Level

(5) Pictures of Survey

CHIN	
	
When landslide occurred in Hakha Township	
	
One way road when landslide occurred	Broke by flash waters in Pa LatWa
	
Support from NGO's	Evacuation camp
Rakhine	
	
The monastery, which is evacuated during	Flooded school in Nan Kyarr Village

disaster	
Rakhine	
	
The monastery, which is evacuated during disaster	Showing water level witch was reach in disaster
Ayeyarwaddy	
	
Water level mark	Interview at War Yar Chaung Village in Pathein
	
The board for raising awareness of climate change	Road situation of Pe` KyiKyun Village
Magwe	

	
Evacuation team during disaster	1.2m from Ground
Magwe	
	
Villager receive the foods from rescue team	Interviewing with GAD Pakokku
Sagain	
	
Meeting interview with Chat Thin Villagers	Flood situation and after flood
	
Collapsed bridges in Main way to KaLay Township	Muds in Kalay Township

	
Collapsed bridges in Main way to KaLay Township	KYAW ZIN Village

(6) Questionnaire Form for Government Officer and Residents

Questionnaire for Government Officers

[Flood Condition]

1. When did the flood occur? If the flood occurs more than once, please describe the major ones

   Date:____________________, Duration:________________________________

   Date:____________________, Duration:________________________________

   Date:____________________, Duration:________________________________

2. What kind of flood occurred?

   ☐ Rapid □ Slow □ Strong □ Weak

   Note: If more than one characteristic were observed, please describe all.

   ____

   ____

3. How much was the maximum inundation depth in your area? Please specify the areas which were severely damaged.

________________________(Feet or Meter)

Note: ____

____

____

____

[Evacuation Condition]

4. Did you receive any information on flood or evacuation before flood?

   □ Yes □ No

   If Yes,

   When: ___________________________________

   From whom: ______________________________

   Contents: ____

   ____

   ____

   ____

How: □ Tel □ FAX □ TV □ Radio

☐ Others : ________________________________

5. Did you convene Disaster Management Committee in your coordinate jurisdiction?

□ Yes □ No

□ Yes (When:_______________) □ No

If Yes,

What was the trigger to convene the committee?

____

____

What was discussed in the committee meeting?

____

____

If No, Why: ____

6. Did you instruct your staff to arrange evacuation?

□ Yes (When:_______________) □ No

If Yes, What was the trigger to instruct people to evacuate?

□ Warning message

Contents/ From whom: _____________________________________

____

____

□ Inundation depth

Depth:_______________________(Feet or Meter)

□ Recommendation (Instruction) to evacuate

From whom: ____

How: □ Tel □ FAX □ The other: _______________________

□ Result of Disaster Management Committee

If No, Why: ____

7. How much was the inundation depth when you instructed evacuation?

Depth:___________________________(Feet or Meter)

8. Was the timing of instruction to evacuate appropriate?

□ Yes □ No

If No, Why: （Ex. Residents already became panic before issuing evacuation instruction）

9. Did people evacuate smoothly based on your instruction?

   □ Yes □ No

   If No, please describe the reason of not evacuating and conditions of villagers: (Ex. People did not want to leave their houses, People became panic and believed the rumors etc.) ____________________

   ____

10. Did you instruct people to evacuate earlier, if you had received any information on flood or evacuation earlier? What kind of information would be useful to make prompt decisions to arrange the evacuation of residents?

    □ Yes □ No

    Contents/ From whom: ______________________________

    ____

    ____

11. Did you have any difficulties for the communication?

    □ No problem □ Blackout □ No/Poor Telephone line

    □ Others: ______________________________

    With whom/How long: ______________________________

12. Did you prepare (instruct to prepare) enough foods and necessary items in the evacuation center before instructing people to evacuate?

    □ Yes □ No

    Note: ______________________________

    ____

[Other Information]

13. Does flood occur every year in your area? How much is the averaged inundation depth?

    □ Yes □ No ____________________(Feet or Meter)

14. When was the heaviest flood during recent years? How much was the maximum inundation depth?

    ____

    ____

____

15. Are there any heavy floods like this year in the past? When was it?

☐ Yes ☐ No

____

____

16. Do you instruct people to evacuate every year?

□ Yes □ No

17. When did you instruct people to evacuate last time?

____

18. Do you think village people know the timing and place to evacuate (capacity to evacuate)?

☐ Yes ☐ No

Note: ____

____

19. Have you (and your staff) taken DRM course before?

☐ Yes ☐ No

Note: ____

____

20. Have you conducted CBDRM activity for village people?

☐ Yes ☐ No

Note: ____

____

21. Are there any problems related to early warning and evacuation?

____

____

Questionnaire for Village People

[Flood Condition]

22. When did the flood occur? If it occurred more than once, please describe the major ones. (Date and length of flood)

Date:____________________, Duration: Ex.9 am to 3 pm, 2hours

Date:____________________, Duration:________________________________

Date:____________________, Duration:________________________________

23. Please describe the stream of flood water (intensity, etc.).

☐ Rapid ◻ Slow ◻ Strong ◻ Weak

Note: Ex. The stream was too fast and could not walk

____

____

24. How much was the maximum inundation depth?

________________________(Feet or Meter)

Note: ____

____

[Evacuation Condition]

25. Did you, your family, and villagers evacuate to other places?

◻ Yes ◻ No

If No, Why: (Ex. Somebody should watch the property of house. Did not feel necessity of evacuation)

Note: ____

____

26. When and how long did you evacuate?

When: Ex. Date, time and duration of evacuation

____

27. What was the trigger to decide evacuation?

◻ Warning message

Contents/ From whom: _______________________________________

____

☐ Inundation depth

Depth:______________________(Feet or Meter)

□ Recommendation to evacuate

From whom: ____

Others: (Ex. Seeing cloud on the sky, wave of the river/sea)

____

28. How much was the inundation depth when you started to evacuate?
    Depth:__________________________(Feet or Meter)

29. How did you evacuate?

    □ Walk □ Boat □ Others: ___________________

30. Was the timing of evacuation appropriate?

    □ Yes □ No

    If No, Why: Ex. Did not have time to evacuate the cattle.__________

    ____

31. Have you received any information on flood or evacuation in advance?

    □ Yes □ No

    If Yes,

    When: ________________________________

    From whom: ___________________________

    Contents: ____

    ____

    How: □ Tel □ FAX □ Radio □Others: _____________________

32. Would you evacuate earlier, if you had received any information on flood or evacuation in advance? What kind of information would be useful to make decisions for evacuation?

    □ Yes □ No

    Contents/ From whom: ____________________________________

    ____

33. Did you have any difficulties for the communication regarding to flood?

□ No problem □ Blackout □ No/Poor signal of telephone line □ Unclear message

□ Others: ____

With whom/How long: _____________________________________

34. Were you informed about the timing and place to evacuate in advance?

☐ Yes ☐ No

If Yes, Timing to evacuate: ____

____

If Yes, Place to evacuate: ____

____

35. Were there enough foods/water and necessary items in the evacuation site?

□ Yes □ No

Note: ____

____

36. Did you receive any relief distribution to evacuation site or your village while you were suffering from the flood?

□ Yes □ No

If yes, when and from whom__________________________________

37. Did you or your village prepare foods/water and items necessary in the evacuation site in advance?

☐ Yes ☐ No

If yes , please describe who and what kind of item

____

If no, please describe why ____

[Other Information]

38. Please describe the frequency of the flood in your village. How much is the average inundation depth?

☐ Every year ☐ Once in a few years ☐Less frequent(Approx. every years)

____________________________(Feet or Meter)

39. Do you usually evacuate when flood occurs?

☐ Yes ☐ No ☐Depend on the conditions_________________________

40. When did you evacuate last time and why did you evacuate?

____

41. When was the heaviest flood during recent years? How much was the maximum inundation depth?

____

____

____

42. Are there any heavy floods like this year in the past? When was it?

☐ Yes ☐ No

____

____

43. Are there any problems related to early warning and evacuation?

Facility(Ex. Mobile phone connection, speakers, evacuation shelter)

____

Training and education (Ex. Timing of evacuation, knowledge of disaster, emergency response, no reliable information)

44. Have you (or your village) taken any CBDRM trainings before?

☐ Yes ☐ No

If yes, from whom, duration (one day, 1 week), target of the training, and contents of the training (Ex. 1 day training from MRCS about first aid targeting to women group)

____

Risk Report

Five elements	Items	Expected Risk	Risk Factor	Measures to be avoided the risk
Law and organizations	Role and responsibility	Role is not Cleary defined	Detailed role which can be utilized for actual disasters is not	・Consideration through introduntion of timeline
		The organization for issue the evacuation advice and order is not determined	No understanding the importance of the position	・Explanation of example and lessons learned inside and outside of the country and promote understanding of the importance
	Expansion plan	The expansion plan prepraed in the project is not implemented	Budget is not secured	・Preparation of realizable plan from the viewpoint of budget through enough discussion with CP
Perception of risk	Damage by disaster type	It is not understood the phenomena	No imagination because of lack of disaster	・Explanation by video and simulation
			No accurate hazard map	
		Incorrect response	Not understanding the difference of phenomena	・Explanation by video
	Understanding of risk area	No safe place	No strong building for shelter and evacuation place	・Evacuation facility construction by easy method ・Evacuation plan for near by evacuation facility in early stage
Observation and warning services	Observation equipment and	Tidal gage is not properly maintained	Not understanding of the purpose and importance	・Explanation how to utilize the tide observation and analysis
	Warning issue and chancel standard	No clear standard	Degree of accuracy of forecast is not enough to determine the standard	・Clarification of warning level by existing capacity
	Warning message	Action is not clear by residents	Degree of accuracy of forecast is not enough to determine the action	・Clarification of warning level by existing capacity ・Understanding of needs of receiver through interview and workshop
	Evacuation order and advice issue determination	No appropriate decision	Degree of accuracy of forecast is not enough to determine the decision	・Clarification of warning level by existing capacity
			Importance of evacuation order and advise is not understood	Explanation of example and lessons learned inside and outside of the country and promote understaning of the importance
Information and communication	Information and communication route and methods	Information is not communicated as planed	Communication equipment can not be used in case of emergency	・Establishment of system which take into account of disaster situations ・Preparation of easy to understand manuals use it in normal time, guide the periodical check
	Training and drill	Just for event	Trainings and drills are not understood	・Clarification of the purpose of event, and implementation of review meeting after the event
		No continuity after the project finished	Trainings and drills are not understood	・Explanation of example and lessons learned inside and outside of the country and promote understaning of the importance
			Lack of capacity to conduct training and drill	・Preparation of easy to understand manuals

Response capacity	Community disaster management activity	Plan is not implemented(risk has not improved)	Cannot secure budget	･Consider to secure the budget when developing a plan ･Develop a plan feasible for villagers
			Plan is beyond capacity of community	･Preparation of realizable plan from viewpoint of budget and capacity through enough discussion with CP and residents ･Reflection of contents of disaster management plan for development of village
		Activities are not expanded	Cannot recognize importance of CBDRM	･Explanation of example and lessons learned inside and outside of the country and promote understaning of the importance ･Explanation of importance of self/mutual help ･Explanation of importance of CBDRM to related government agencies