

# **MEMBER REPORT**

ESCAP/WMO Typhoon Committee  
11<sup>th</sup> IWS

**SOCIALIST REPUBLIC OF VIET NAM**

October 2016

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# I. Overview of tropical cyclones which have affected/impacted Member's area since the last Typhoon Committee Session

## 1. Meteorological assessment

### 1.1 Tropical cyclones

In 2016, the numbers of Tropical cyclones (TCs) and tropical depressions (TDs) over the Southeast Asian sea (SEAS) and hitting Vietnam are less than normal and as the same in 2014. Recently, there were six TCs and five TDs in the SEAS which three TCs landed in Vietnam: MIRINAE (July 2016), DIANMU (August 2016) and RAI (September 2016). The detail descriptions of the tropical storms are presented as follows:

#### 1.1.1 Tropical Storm Mirinae (1603-TS. No1)

On July 24<sup>th</sup>, 2016, a low pressure area was formed over north SEAS and it intensified a tropical depression early on July 25<sup>th</sup>, 2016. After intensification, the tropical depression moved in westward about 25-30 km/h and then the tropical depression intensified to tropical storm, named Mirinae from 03 UTC on July 26<sup>th</sup> near Paracel Islands. This is the first tropical storm in SEAS in 2016. Early on July 27<sup>th</sup>, TS No. 1 entered Bac Bo gulf with intensity of force 8-9 grade, gust 10-11 grade in Beaufort scale. After, the tropical storm No. 1 slowly moved and made landfall in Nam Dinh province at mid-night on July 27<sup>th</sup>.

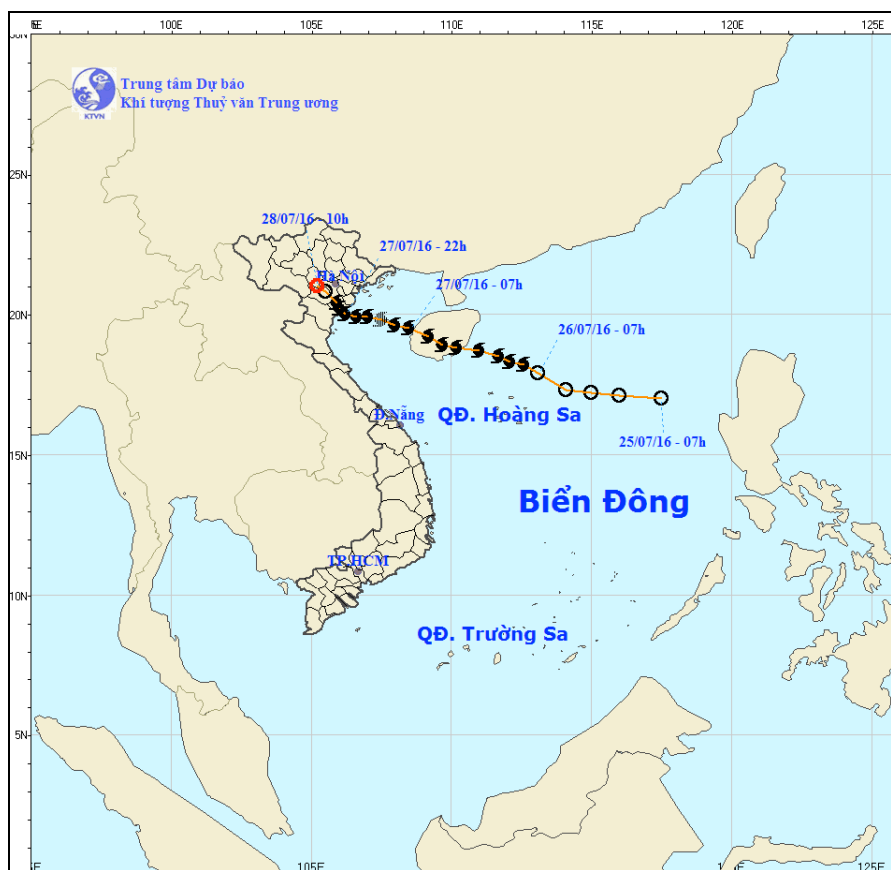


Figure 1. The best track of TS. Mirinae (NHMS of Viet Nam).

A peak gust observed at a value of 47 m/s at Ba Lat station (Thai Binh province), 41 m/s at Thai Binh station, 40 m/s at Van Ly station (Nam Dinh province) and Ninh Binh and a value of 38 m/s at Bach Long Vi stations. Minimum sea water level pressure at Van Ly (Nam Dinh) station was 985.8mb at 00.00 locations on July 28<sup>th</sup>. Total rainfall during from 12 UTC July 27<sup>th</sup> to 00 UTC July 29<sup>th</sup> was about 100 – 200mm, except in Chi Ne (Hoa Binh) 265mm, Tam Dao (Vinh Phuc) 274mm, Thai Binh 228mm and Ninh Binh 207mm.

### ***1.1.2. Tropical Storm Dianmu (1608 - TS. No3)***

A tropical disturbance formed within the monsoon trough in the SEAS on Mid-August 2016. The disturbance meandered for a few days and intensified to a tropical depression early on August 17 and then a tropical storm on the late of August 17, named Dianmu, the 3<sup>rd</sup> storm in SEAS and the 2<sup>nd</sup> tropical storm making landfall in Vietnam in 2016. TS. No. 3 moved in westward about 15km per hour and completed in Bac Bo gulf and intensified to force 9 grade, gust 11 grade in Beaufort scale. TS. No. 3 then made landfall in Hai Phong – Thai Binh provinces at noon on August 19 before dissipated in north of Vietnam, near Hoa Binh province.

TS. No. 3 caused gale wind force 8 grade, gust 9-10 grade in coastal area of Vietnam and force 6-7 grade, gust 8-9 for further inland area (e.g Lang Son, Bac Giang and Bac Ninh). TS. No. 3 caused also the storm surge (combining with a high tide) a value of 3.5m and 3-5m.



**Figure 2: The best track of TS. Dianmu (NHMS of Viet Nam).**

TS. No. 3 produced torrential rainfall in north of Vietnam with the popular precipitation from 100-200mm, especially in KM46 (Son La) 283mm, Kim Boi (Hoa Binh) 251mm, Sa Pa (Lao Cai) 286mm, Tram Tau (Yen Bai) 252mm, Tam Dao (Vinh Phuc) 350mm, Ba Vi (Ha Noi) 219mm. In Hanoi, on August 19<sup>th</sup> has observed gust wind of force 6-8 and the total precipitation about 100-200mm caused inundation in the city areas.

### 1.1.3. Tropical Storm RAI (1615 - TS. No4)

On September 10<sup>th</sup>, a low pressure area formed in the north of Spratly Islands and intensified to tropical depression in the next day. The TD moved in west-northwest direction and then in northwest with the wind speed about 15-20 km/h. On September 12<sup>th</sup>, the TD intensified to a tropical storm, named RAI in the coastal area of Da Nang - Binh Dinh province, this is the fourth TS in SEAS and the third making landfall TS in Vietnam (TS No. 4). The maximum wind speed observed in coastal area of central Vietnam for TS. No. 4 was 8 grades in Beaufort scale. It made landfall at Quang Nam – Quang Ngai province at midnight on September 12<sup>th</sup>, 2016 and dissipated over in south of Laos.



**Figure 3: The best track of TS. Rai (NHMS of Viet Nam).**

TS. No. 4 caused strongly wind speed at 8 grades, gust up to 9-10 grades in coastal area from Quang Tri to Quang Ngai province and force from 5-6 grades, gust to 7 grades in inland areas. It produced also torrential rainfall in Central and

Highland areas in Vietnam with popular precipitation about 150-250mm from Nghe An-Quang Binh regions, the precipitation about 250-350mm from Hue-Binh Dinh regions and the precipitation about 100-150mm in Highland areas. At some stations observed a high precipitation such as: Thuong Nhat, Nam Dong (Hue): 427mm, Song Ve (Quang Ngai): 398mm, An Chi (Quang Ngai): 380mm. TS. No. 4 has caused strongly wind with a value of 7 grades, the precipitation about 200-300mm at Da Nang city.

## **1.2 . The severe weather phenomenon from January to September 2016**

### ***1.2.1. Cold surges and extreme cold***

In the first 9 months in 2016, there are 12 cold surge event (CS) causing three freezing events (January 23-28, February 1-9 and February 15-17), concentrated during the period from at the end of January to February in 2016. Especially at the freezing event from on January 23-28, though occurring time was short, the CS intensity was very high. The minimum temperatures in some areas were recorded as historical values. Also, this freezing event caused **extensive frost in the northern provinces**, snow occurred in many areas at **elevation** of 800 meters above the sea. Particularly, in some place, snow was observed for the first time such as: BaVi (Ha Noi), Tam Dao (Vinh Phuc), Moc Chau (Hoa Binh) and Qishan (Nghe An).

### ***1.2.2. Hot spells***

Extreme hot occurred earlier than an average in south. The first event occurred at the end of January. Extreme hot continuously occurred from March to the first half of May, the peak was from the middle of April to the middle of May; at the same period, extreme hot widen to the west south and Highland areas. The maximum temperature was about 35-38<sup>0</sup>C, the highest value was recorded of 40,5<sup>0</sup>C (11/4/2016 at Ayunpa (Gia Lai province) ), 40,0<sup>0</sup>C ( 5/5/2016) at Dong Phu (Binh Phuoc province).

There was three extreme hot episodes in northwest region from April to September in 2016 (15-17/4, 5-9/5, 9-11/7); 7 events at midland and Red Delta River and Thanh Hoa province (31/5-5/6, 11/6-15/6, 9-11/7, 16-19/7, 22-26/7, 31/7-2/8 and 6-9/8); one extreme hot episode in area from Nghe An to Phu Yen (10-17/4, 24-27/4, 1/5-9/5, 28/5-5/6, 10-15/6, 9-12/7, 15-20/7, 22-26/7, 31/7-2/8, 7-11/8 and 2-4/9). The highest daily temperature was generally from 36-39<sup>0</sup>C and above 40<sup>0</sup>C in some areas. Thus, the extremely hot events in southern region where hot occurred earlier and took longer comparing with the year 2015 and other regions did not occur.

### ***1.2.3. Rainfall and extreme rainfall***

In northern and north Central areas, the rainfall was higher than the normal in January and in April. In January, since out-of-season rainfall appeared, rainfall

was excess about 200-300% comparing to the normal. Total of rainfall in February and March is lower than an average from 20-40%.

In May, extreme rainfall occurred in areas belong to Hanoi from on May 24th -25th. At Ha Dong rainfall station observed the daily rainfall with a value of 338 mm, exceeded the highest value in 1982. Huge rainfall caused several the floods at lower areas in Hanoi.

In June and July, the rainfall in North were generally about 20-60% lower than the normal. In northern coastal areas, such as: Quang Ninh, Hai Phong and Thai Binh areas, the rainfall was about 30-60% higher than an average.

In August, the rainfall was about 20-70% higher than the normal in north. In September, the rainfall in north was about 20-50% lower than normal. In north Central region, the rainfall was about 10-40% lower than the normal from on May to August. In September, the rainfall was generally about 15-45% higher than the normal.

In Middle-Central, the rainfall was about 15-40% higher than the normal from January to February. In the following months, from March to August the rainfall was about 15-60% lower than the normal. In September, the rainfall was about 20-60% higher than the normal.

In southern Central region, the rainfall was about 70-90% lower than the normal from January to May. Especially, there was not rainy during this time in Ninh Thuan and Binh Thuan provinces. In June and August, the rainfall was commonly 20-50% higher than the normal. In July, the rainfall was about 20-40% lower than the normal. In September, the rainfall was common the same as an average years.

In central highlands and Southern region, the rainfall was generally 20-50% lower than an average years in the first 4 months. Especially, there was not rainy during this time in the south. At the end of May and June, rainy was occurring more frequently in central highland and southern region. Rainfall was the same as an average in June and July. In August and September, the rainfall was about 20-40% lower than normal.

From June to August, the extreme rainfall occurred in North, most occurred in July and August. In September, torrential rains started to occur in the Central region. There are 6 remarkable episodes as following:

- Episode from July 1-7: Causing by the interaction between the northwest – southeast trough and wind convergence in upper layers, there was an extreme rainfall episode. The total amount of rainfall in the northeast, in general, was about 70-150mm, the precipitation at some places was higher such as Mong Cai (Quang Ninh): 291mm (day 1), Quang Ha (Quang Ninh): 389 (day 1) and Bai Chay (Quang Ninh): 263 mm (day 5).

- Episode from July 27-29: the first typhoon induced rainfall caused rain to heavy rain in north provinces. In the Red Delta river and some places in the north of

Central, there was heavy to torrential rainfall about 100-200mm, the precipitation at some places was higher at Ninh Binh (249mm), Thai Binh (247mm), Chi Ne (Hoa Binh): 299mm, Tam Dao (Vinh Phuc): 290mm.

- Episode from August 3-5: Typhoon No. 2 caused rainfall in north with the precipitation about 100-150mm, the rainfall at some places was higher such as Bat Xat (Lao Cai province): 210mm, Ha Giang: 190mm, Cam Son (Bac Giang): 190mm and Ninh Binh: 160mm.

- Episode from August 18-20: Typhoon No. 3 caused heavy rainfall in the north and the northern Central with the amount of rainfall ranges from 100-200mm, rain at some places was higher such as Quang Ninh 200-250mm, Hoa Binh 250-300mm, Vinh Phuc 350mm. The total of rainfall about 150-200mm caused inundation in Hanoi.

- Episode from September 11-14: Typhoon No. 4 and post-typhoon circulation caused heavy rainfall in Central and Highlands with the total amount of rainfall about 100-300mm, some places heavier such as Vinh (Nghe An): 321mm, Ha Tinh: 384mm, Huong Khe (Ha Tinh): 346mm, Tuyen Hoa (Quang Binh): 327mm, A Luoi (Hue): 323mm, Nam Dong (Hue): 437mm, Da Nang: 443mm, Tra My (Quang Nam): 371mm.

- Episode from September 20-23: a trough passing the Central and southern Central caused heavy rain in the northern and middle Central. The total amount of rainfall varied from 100-250mm, some places heavier such as: Ha Tinh: 412mm, Huong Khe (Ha Tinh): 441 mm and Hue: 468mm.

## **2. Hydrological Assessment**

### **2.1. Hydrological Assessment in North of Viet Nam**

In 2016, the flood season started more or less the same previous flood years. In general, water volume on most river systems was lack of 20-50 % in comparison with the long-term average in the main flood season duration, from June to September. There are 5 flood events occurring mostly in the upstream of the Red, the Thai Binh and the Hoang Long rivers systems with flood amplitude of 2 - 5m in the upper reach and 1.5 - 3m in the lower reach. The biggest flood event occurred in the mid of August, many locations on the Red and Thai Binh systems were recorded flood peak which are over alert level (AL) 2 and 3.

From June to July, a small flood event mostly appeared on the mountainous rivers and the upper part of the Red and Thai Binh river systems as a result of the appearance of low pressure trough with axis through northern part from the June 30 to the July 6 and the influence of tropical storm (TS) named MIRINAE during on July 27-30. Flood peaks were recorded at some positions that are below AL 1. However, during on July 2-4, inflow of Lai Chau and Son La reservoirs on Da river increased sharply as a result of heavy rain in the long duration together with a large transmission flow from China. The Lai Chau reservoir had to be operated three outlets for safety reservoir regulation during the reporting period.



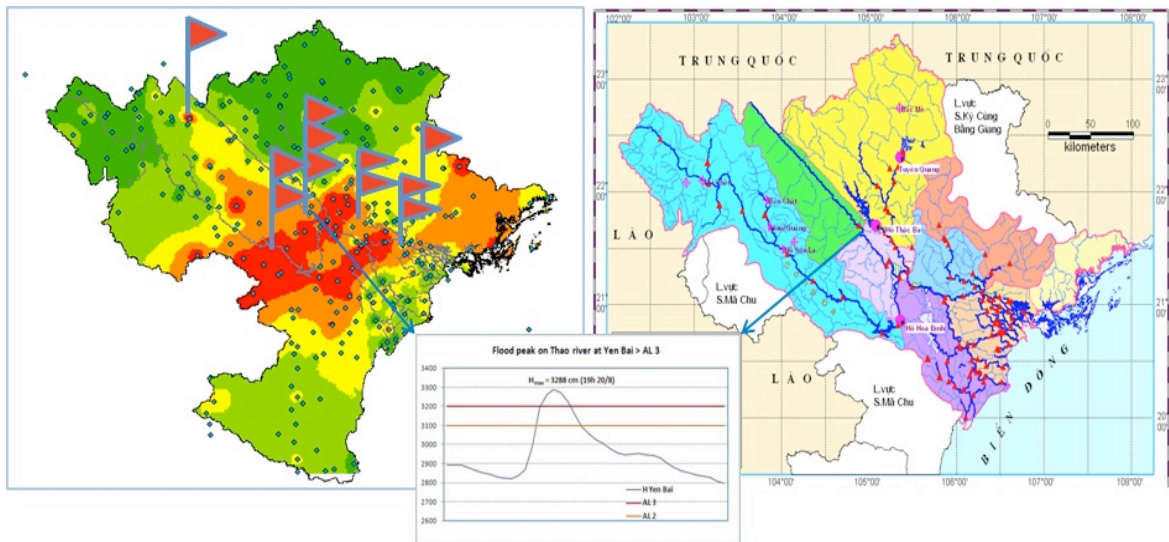
During on August 3-6, because of TS NIDA's influence, flood occurred on the Thao, Lo, Ky Cung and Chay rivers in which flood peak on Chay river at Bao Yen was recorded that is over AL 2. Flood peaks at some position on Thao, Lo and Ky Cung rivers were above AL 1.

During on August 19-21, a big flood occurred in the most rivers in the north of Vietnam with the appearance and influence of TS named DIANMU in which flood peaks at Yen Bai and Phu Tho on Thao rivers were over AL 3 and AL 2. On Da, Cau, Thuong, Luc Nam and Day rivers flood peaks were recorded that are above AL 1 and AL 2. The water levels on Mountainous Rivers such as: Nam Pan, Boi, Bui Rivers increased sharply and flood peaks on those rivers were recorded that are over AL 3. Beside, flash flood, landslide occurred in mountainous areas in Son La, Hoa Binh, Lao Cai, Yen Bai, Vinh Phuc and Bac Giang provinces. Serious flooding appeared in Yen Bai, Phu Tho and Vinh Phuc provinces and Hanoi capital.

Table 1 summarized information of flood characteristics on the river systems in the north of Vietnam during the flood season in 2016. Figure 4 illustrated the flood on the Thao River at Yen Bai where the flood peak was over AL 3 leading to serious flooding in the Yen Bai city.

**Table 1. The characteristics of flood events for main stations and Hoa Binh reservoir on the rivers in the north of Vietnam during August 19-21**

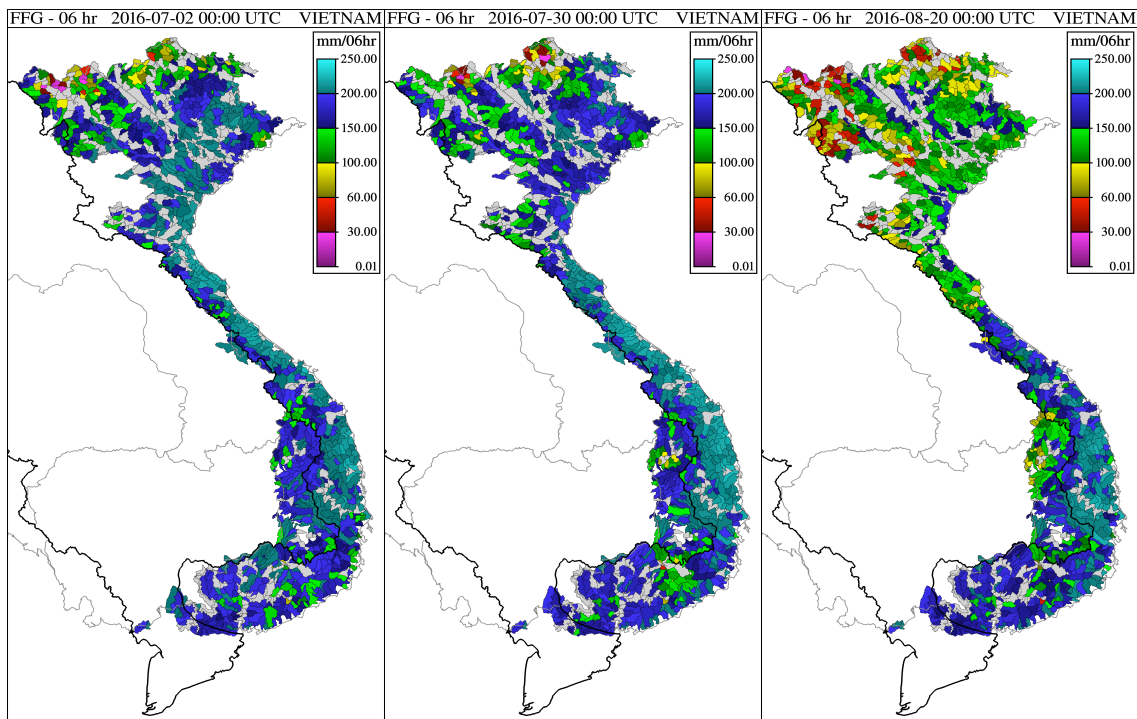
| No | Station                      | River      | Peak of flood event(cm) | Appearance time of flood peak | Flood Amplitude (cm)   | Alert Level (m)               |
|----|------------------------------|------------|-------------------------|-------------------------------|------------------------|-------------------------------|
| 1  | Lao Cai                      | Thao       | 8090                    | 08h 20/8                      | 352                    | > AL 1: 90 cm                 |
| 2  | Yen Bai                      | Thao       | 3288                    | 19h 20/8                      | 466                    | > AL 3: 88 cm                 |
| 3  | Phu Tho                      | Thao       | 1829                    | 18h 20/8                      | 272                    | AL 2                          |
| 4  | Đáp Cầu                      | Cầu        | 468                     | 10h 21/8                      | 165                    | > AL 1: 38cm                  |
| 5  | Phu Lang Thuong              | Thuong     | 490                     | 01h 21/8                      | 186                    | > AL 1: 60 cm                 |
| 6  | Luc Nam                      | Lục Nam    | 551                     | 11h 20/8                      | 300                    | > AL 2: 21 cm                 |
| 7  | Phu Ly                       | Day        | 349                     | 10h 21/8                      | 181                    | > AL 2: 19 cm                 |
| 8  | Ben De                       | Hoang Long | 347                     | 10h 20/8                      | 240                    | AL 2                          |
| 9  | Inflow to Hoa Binh reservoir | Da         | 9870 m <sup>3</sup> /s  | 01h 20/8                      | 6500 m <sup>3</sup> /s | < AL 2: 130 m <sup>3</sup> /s |



**Figure 4. Flood peaks of the year on Thao River at Yen Bai, over AL 3**

**Flash flood situation:** the flash flood occurred in the Northern part concentrated on two months, in July and August. The general situation is listed as follows:

- Thai Nguyen, Quang Ninh provinces: during the July 1- 2;
- Ha Giang, Yen Bai: on July 29<sup>th</sup>;
- Lao Cai: on August 5<sup>th</sup>;
- Son La, Hoa Binh, Lao Cai, Yen Bai, Bac Giang, Vinh Phuc: during August 19<sup>th</sup> to 20<sup>th</sup>;



**Figure 5. Warning mapping of flash flood risk as product of the Flash Flood Guidance System (FFGS) in 3 period of times: the beginning, the end of July and during DIANMU TY appearance (During August 19 to 20)**

*Source: FFGS production*

***Flooding situation:*** During July and August, serious flooding and inundation were appeared in the many cities and low-land areas as a result of extreme heavy rainfall, sharp rising of water level on stream, river as well as deterioration of drainage system. The cities and provinces faced inundation, flooding was listed as follows:

- Inundation in Thai Nguyen city (Thai Nguyen province), Cam Pha, Ha Long cities (Quang Ninh province), especially Hon Gai, Bai Chay districts on July 6<sup>th</sup>, 2016;
- Inundation in Yen Bai, Hoa Binh and Son La cities as downtown of Yen Bai, Hoa Binh and Son La provinces; inundation in Phu Tho, Vinh Phuc provinces and Ha Noi: during August 19<sup>th</sup> to 21<sup>st</sup> (figure 6).



**Figure 6. Flooding and inundation in Yen Bai, Quang Ninh and Ha Noi during DIANMU TS appearance**

## ***2.2. Hydrological Assessment in Central and Highland area***

The water level on the rivers of Central and Highland are generally low and slow change from January to Mid-May. Ma river upstream, Buoï river (Thanh Hoa province) and Cam Ly river (Lam Dong province) appeared two small flood events with the amplitude from 1-2.5m, the peak floods on the most rivers are low, a private peak flood on the Cam Ly river at Thanh Binh: 831.5m (April 28), below alert 2: 0.5m. At the last day of May, Ma River upstream appeared a small May-rain flood with the amplitude arrange from 2-4m, the peak flood at a low level.

The lowest history water level appeared on some rivers such as: Ma river at Ly Nhan station: 2.07m (7h/20/4/2016), Tra Khuc river at Tra Khuc station: 0.06m (7h/19/5/2016), Cai Nha Trang river at Dong Trang station: 2.9m (7h/13/7/2016), Ba river at Ayun Pa station: 148.81m (13h/17/5/2016), DakBla river at Kon Tum

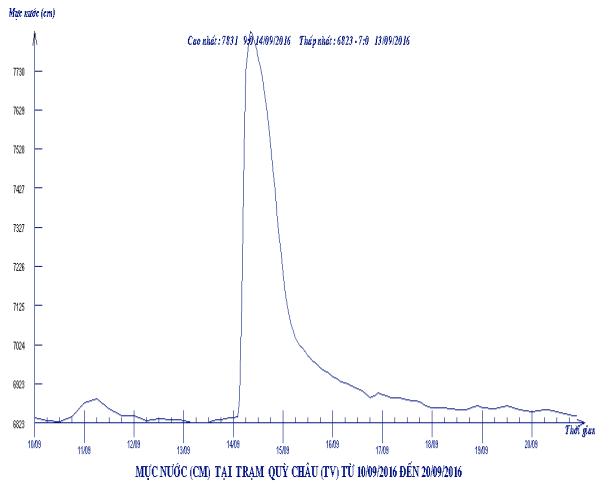
station: 514.75m (19h/17/4), Krong Ana river at Giang Son station: 414.43 (7h/14/4/2016), La Nga river at Dai Nga station: 736.49m (19h/10/4).

The drought situation occurring in some provinces such as: Khanh Hoa, Ninh Thuan, Binh Thuan and Dak Lak have a great impact on agricultural production. Especially in Ninh Thuan, the flow on some small rivers and streams have depleted, the storage volume of irrigation reservoirs at the time to below 10% comparing the design volume. During the dry season, the water level at the irrigation reservoirs and hydropower is always lower than the same period of average many years, reaching from 10-50% design volume, the water level under death water level or without water.

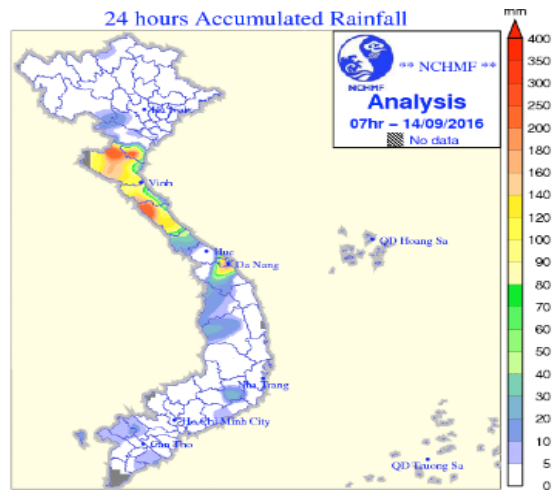
At the end of June, on the rivers in Binh Thuan and Highland appears a small flood event with the amplitude from 1 to 3m, the peak flood on the river at alert 1 to 2. In July, Buoi River (Thanh Hoa province), Cam Ly (Lam Dong province) have appeared three small flood events with the amplitude from 2 to 5m. The water level of peak flood on Cam Ly River at Thanh Binh station is at approximately alert 2.

From September 15-23, on the rivers from Ha Tinh to Binh Dinh province and Highland region occurs 3 flood events, the peak flood on the rivers at alert 1 to 2, Kien Giang River at Le Thuy station above alert 2, Cam Ly River at Thanh Binh station above alert 3.

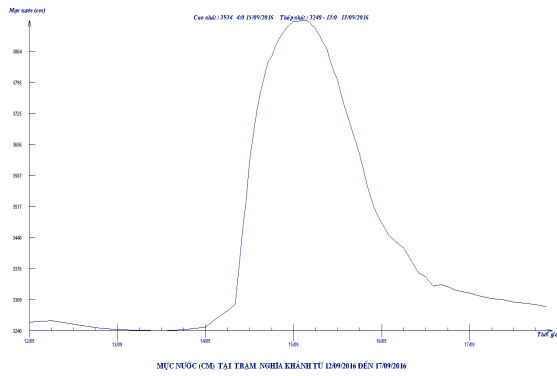
From September 12-14, on the rivers from Ha Tinh to Binh Dinh and the northern Highland region occurred a flood event. The peak flood at some observed stations on the rivers as follows: Hieu river at Nghia Khanh station: 39.34m, Ca river at Dua station: 20.65m (above alert 1: 0.15m), at Nam Dan station: 5.52m (above alert 1: 0.12m), Ngan Sau river at Hoa Duyet station: 8.52m (under alert 2: 0.48m), Ngan Pho river at Son Diem station: 12.77m (under alert 2: 0.23m), Gianh river at Dong Tam: 14.1m (above alert 2: 2.1m), Vu Gia river at Ai Nghia station: 7.26m (above alert 1: 0.76m), Tra Khuc river at Tra Khuc station: 3.81m (above alert 1: 0.3m), Tra Bong river at Chau O station: 3.03m (under alert 2: 0.43m), Poko river at Dac Mot: 585.64m (above alert 2: 0.14m), DakBla river at Kon Tum: 518.03m (at alert 1), La Nga river at Ta Pao: 119.87m (under alert 2: 0.13m).



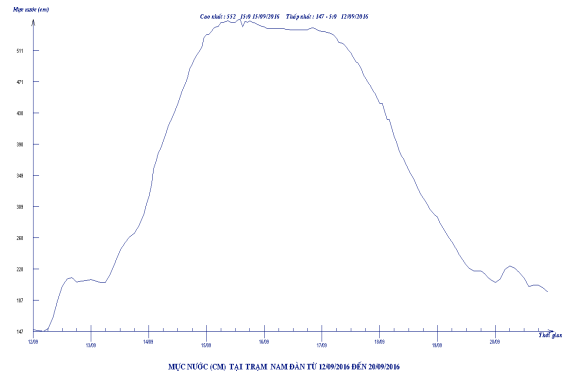
*Water level process at Quy Chau station during September 12-14, 2016*



*Accumulated rainfall during September 13-14, 2016*



*Water level process at Nghia Khanh station during September 12-14, 2016*



*Water level process at Nam Dan station during September 12-14, 2016*

Table 1. The characteristics of flood events for main stations during September 12-14/2016

| River | Station     | Peak of flood |                        | Alert Level (cm) |
|-------|-------------|---------------|------------------------|------------------|
|       |             | Time and date | H <sub>peak</sub> (cm) |                  |
| Ca    | Con Cuong   | 12h/14/09     | 2919                   |                  |
| Hieu  | Quy Chau    | 09h/14/09     | 7831                   |                  |
| Hieu  | Nghia Khanh | 04h/15/09     | 3934                   |                  |
| Ca    | Dua         | 17h/14/09     | 2065                   | > AL1: 15cm      |
| Ca    | Do Luong    | 01h/15/09     | 1385                   |                  |
| Ca    | Yen Thuong  | 08h/15/09     | 682                    |                  |
| Ca    | Nam Dan     | 10h/15/09     | 550                    | > AL1: 10cm      |
| Ca    | Chu Le      | 11h/14/09     | 1296                   | -                |
| Ca    | Hoa Duyet   | 10h/15/09     | 852                    | > AL1: 102cm     |

| River      | Station    | Peak of flood |                        | Alert Level (cm) |
|------------|------------|---------------|------------------------|------------------|
|            |            | Time and date | H <sub>peak</sub> (cm) |                  |
| Ngan Pho   | Son Diem   | 01h/14/09     | 1277                   | < AL3: 23cm      |
| La         | Linh Cam   | 16h/14/09     | 335                    |                  |
| Gianh      | Dong Tam   | 05h/14/09     | 1410                   | > AL2: 210cm     |
| Gianh      | Mai Hoa    | 07h/14/09     | 555                    | > AL2: 55cm      |
| Kien Giang | Kien Giang | 13h/13/09     | 905                    | > AL1: 105cm     |
| Kien Giang | Le Thuy    | 19h/13/09     | 91                     | < AL1: 16cm      |
| Thach Han  | Thach Han  | 19h/13/09     | 262                    | > AL1: 12cm      |
| Vu Gia     | Ai Nghia   | 16h/13/09     | 726                    | > AL1: 76cm      |
| Thu Bon    | Giao Thuy  | 16h/13/09     | 573                    | < AL1: 47cm      |
| Thu Bon    | Cau Lau    | 19h/13/09     | 168                    | < AL1: 32cm      |
| Tra Bong   | Chau O     | 07h/13/09     | 303                    | > AL1: 53cm      |
| Tra Khuc   | Tra Khuc   | 13h/13/09     | 381                    | > AL1: 31cm      |
| Song Ve    | Song Ve    | 12h/13/09     | 280                    | > AL1: 30cm      |

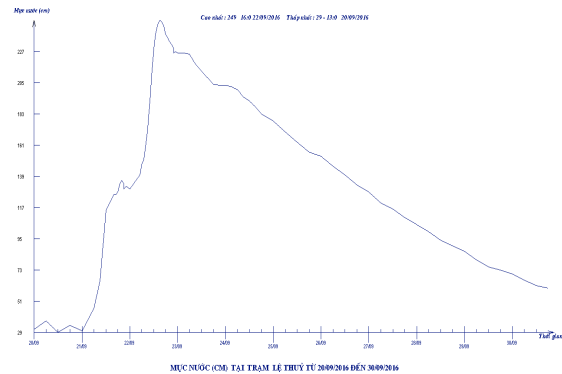
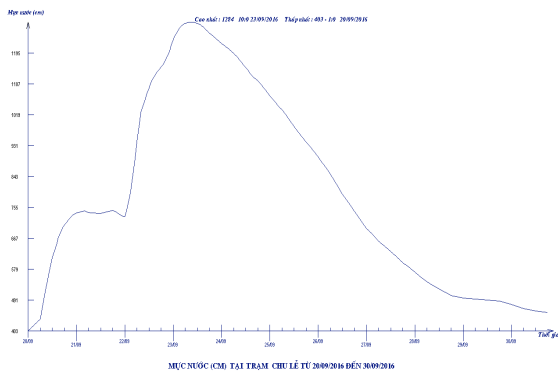
During September 21-23, on the rivers from Ha Tinh to Thua Thien Hue provinces and Cam Ly River (Lam Dong province) occurred a flood event. The peak flood at some stations are presented as follows: Ngan Sau River at Chu Le station: 12.84m (above alert 2: 0.84m), Ngan Pho river at Hoa Duyet station: 8.56m (above alert 1: 1.06m), Gianh river at Mai Hoa station: 3.41m (above alert 1: 0.41m), Kien Giang river at Le Thuy station: 2.49m (above alert 0.29m), Huong river at Kim Long station: 1.24m (above alert 1: 0.24m), Bo river at Phu Oc station: 1.86m (above alert 1: 0.36m), Cam Ly river at Thanh Binh station: 833.15m (above alert 3: 0.15m).

Table 1. The characteristics of flood events for main stations during September 20-25, 2016

| River      | Station    | Peak of flood |           | Alarm level (m) |
|------------|------------|---------------|-----------|-----------------|
|            |            | Time and Date | Peak (cm) |                 |
| Ngan Sau   | Chu Le     | 5h/21/9       | 745       |                 |
|            |            | 10h/23/9      | 1284      | > AL 2: 0,84m   |
| Ngan Pho   | Hoa Duyet  | 20h/21/9      | 502       |                 |
|            |            | 6h/24/9       | 856       | > AL 2: 1,06m   |
| La         | Linh Cam   | 12h/24/9      | 266       |                 |
| Gianh      | Dong Tam   | 9h/21/9       | 935       | > AL 1: 2,35m   |
|            |            | 10h/22/9      | 914       | > AL 1: 2,14m   |
|            | Mai Hoa    | 17h/21/9      | 341       | > AL 1: 0,41m   |
|            |            | 12h/22/9      | 319       | > AL 1: 0,19m   |
| Kien Giang | Kien Giang | 12h/21/9      | 948       | > AL 1: 1,48m   |



| River  | Station    | Peak of flood |           | Alarm level (m) |
|--------|------------|---------------|-----------|-----------------|
|        |            | Time and Date | Peak (cm) |                 |
|        |            | 13h/22/9      | 1111      |                 |
|        | Le Thuy    | 16h/22/9      | 249       | > AL 2: 0,29m   |
| Bo     | Phu Oc     | 19/22/9       | 186       | > AL 1: 0,36m   |
| Huong  | Kim Long   | 19h/21/9      | 124       | > AL 1: 0,24m   |
| Cam Ly | Thanh Binh | 9h/21/9       | 83303     | > AL 3: 0,03m   |
|        |            | 5h/22/9       | 83315     | > AL 3: 0,15m   |



*Water level process at Chu Le station during September 12-14, 2016*

*Water level process at Le Thuy station during September 12-14, 2016*

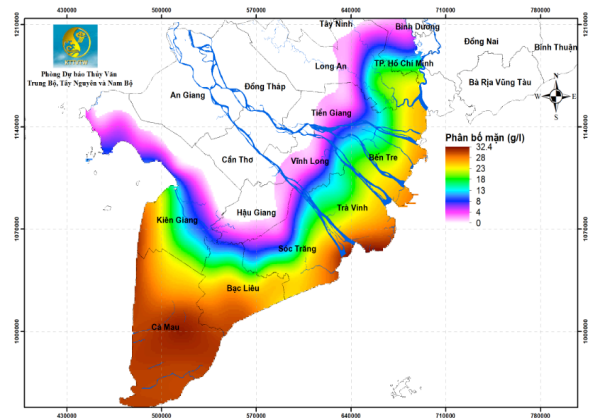
In the first nine months, the flow on the most rivers of Central and Highland region is low level, compared deficiency with an average many years from 20 to 65%; Ca River at Yen Thuong station and Cai Nha Trang river at Dong Trang station deficiencies from 75 to 95%. Particularly, an average flow of the months on the Thu Bon River at Nong Son station at approximately average many years and higher than from 20 to 40%.

### 2.3 Hydrological Assessment in the *Southern area*

The flow from the upstream of Mekong River to Mekong Delta in the early dry season in 2016 was down to the lowest levels and at the historic levels. During in the dry months, the precipitation continuous deficiency of 20-50% compared with an average many years, in the southern provinces until the end of April 2016 is almost not rain. Therefore, the water shortages and salinity intrusion has occurred soon on a large scope in the southern regions than the same period in 2015.

The salinity concentrations in the first May 2016 in the most of stations are always higher at the same period in 2015 and average many years. The highest salinity in the rivers of the southern general occurs at the end of March and greater than from 1-7g/l compared with the same period in 2015. Particularly in Vam Co

River system and Ca Mau-Kien Giang regions, the highest salinity appeared in the first-half of May.



*Drought in Southern VietNam*

*Highest salinity in Southern VietNam*

Beginning of the flood season in 2016 until now, there are four flood events in the Mekong River, the water level at the stations on the main stream of Mekong river are lower than an average many years from 1-4m. An average flow in three months June, July and August 2016 at the main stations are at a lower average many years from 15-50%. Compared in 2015, the volume of flow in June, July and August 2016 at the stations is at a higher and approximate levels. However, the flow in August 2016 was lower than the same period in 2015 and belongs to the low in the chain of the same period years.

Due to the upstream flow at low level during the beginning in 2016 until now, the water level in the Mekong River appears only a small five oscillations. The water level at Tan Chau and Chau Doc is strongly influenced by the tides and always at a lower level compared with average many years.

**3. Socio-Economic Assessment**

**3.1. Damage Situation in 2015**

In 2015, the natural disasters happened in Vietnam with lower frequency, but with some at record high magnitude of impacts such as: five storms and two tropical depressions in the East Sea (with the first and the third storms hitting in Vietnam directly). From January to March, unseasonal big rains and floods happened in three central provinces, with the flood peaks in the some rivers reaching alarm 3. On the other hand, extreme heat also happened during record long durations (first time in 60 years), and droughts spread from northern region to south of central region.

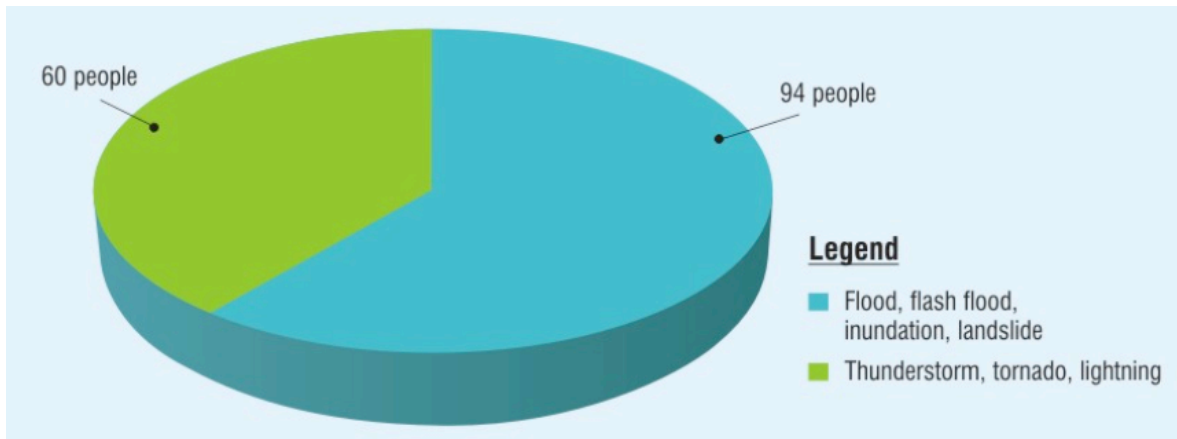
In many areas, serious lack of rainfalls happened even during the rainy season, while especially heavy rained occurred in Quang Ninh for as long as 10 days (during July 24 to August 4) with total rainfall reaching over 1,557mm in Cua Ong (highest over the last 50 years). Land, riverbank and coastal erosion happened in many places, and saltwater intrusion occurred earlier and deeper inside the inlands. Depletion of water in rivers is increasingly becoming a common sight (with



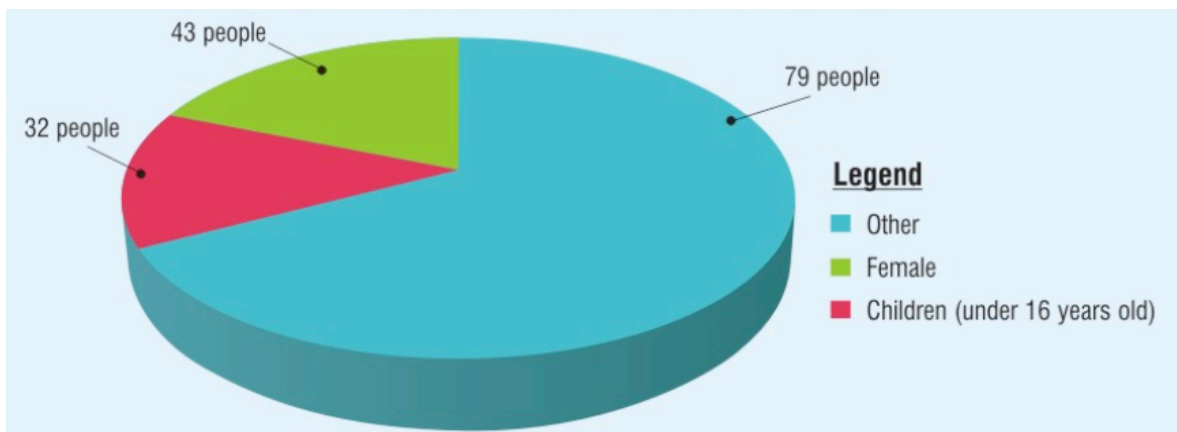
Mekong river water level decreasing to its 100 years' lowest); posing negative influences people's lives.

Natural disasters in 2015 caused serious human and assets losses, including:

- Human losses: 154 were killed and/or reported missing (94 by floods, flash floods, land erosion and post-storm rains and floods, 60 by tornados and thunderbolts, none by storm); 127 were injured.



**Figure 7: Total human damages**



**Figure 8: Total human damages (by gender and age)**

- Houses: 1,242 houses were down and/or swept away; 35,233 houses were flooded, damaged, and/or unroofed.

- Agriculture: 443,292ha of rice and crops and 51,230 ha of industrial and fruit crops were damaged, 2,642 cattles and 63,448 livestocks were killed.

- Irrigation: 3,026m dykes of grade 3 and special grades and 5,313m dykes below grade 4, 9,514m of embankments, 115,287m of canals, and 179 small lakes and dams were damaged.

- Transportation: 2,107,247m<sup>3</sup> of soil and rocks were caused to erode from national, provincial and rural transport roads, 136 bridges and drains were damaged.

- Agriculture: 5,488 ha of aquaculture area and 2,583 cages of fish culture were damaged

- Industry: 300,000 tons of coal were lost, various mines of Mong Duong and Quang Hanh Coal Mining Companies were flooded, and a dam accident happened in Mong Duong Coal Mining Company (Dam 790).

Total asset damages were estimated about 8,167 billion.

### **3.2. Damage Situation in 2016 (During January to September 01<sup>st</sup>)**

Since early 2016, the disaster situation in our country is complicated, unusual and extreme for various types of natural disasters such as cold weather in the Northern region; severe drought occurred in the South Central region, the Central Highlands and the Mekong Delta; storms, heavy rainfall caused floods and landslides in the northern provinces. Disaster has caused heavy losses of lives and property on a large scale as follows:

- Human losses: 96 people dead or missing (including storms, floods, flash floods: 60 people; tornado, lightning and other natural disasters: 36 people); 215 people were injured;

- Houses: 3,931 houses collapsed and washed away; 101,727 houses were unroofed and destroyed, 2918 houses were flooded;

1,341 ships were sunk or damaged;

- Agriculture: 436,756 hectares of rice; 205,671 ha of industrial crops, fruit trees, perennial crops damaged; 56,491 cattle and 577,645 birds are killed; 94,789 ha of aquatic and 353 damaged cages; 32,097 electric poles were broken, pouring.

- Transportation: 455,338m<sup>3</sup> rocks eroded roads;

- Irrigation: 163 lakes, small dams were damaged, 80,176 m of canals damaged; 20,001m embankments were eroded;

Total damage is estimated at 25,974 billion (drought, saltwater intrusion: 15,701 billion; cold weather damage: 1,533 billion; storms, floods, flash floods: 8,560 billion; other natural disasters: 181 billion).

## **II. Summary of progress in Key Result Areas**

**Title of item:** Progress in interpreting Regional Forecasting Support Center - Ha Noi in SWFDP of WMO at South-East Asia

The SWFDP-SeA webpage is developed and taken into operationally since June 2012 under the link of <http://www.swfdp-sea.com.vn> for NHMSs of Lao PDR, Cambodia, Thailand and Philippine (Myanmar as an observer) to access and use available products. At present, the following products are operationally provided through the SWFDP-SeA portal:

+ Sharing global forecast from international centers and regional forecast running from Viet Nam (both deterministic and ensemble forecasts)

+ Providing guidance for short range (1-2 days) and medium range (3-5 days) based on NWP products for strong wind (over 30 kts and 50 kts) and heavy rainfall (over

50mm/24h and 100mm/24h). These guidance were created by forecasters from NHMS of Viet Nam

+ NHMs joined to the SWFDP-SeA project (Laos, Cambodia, Thailand, Philippine and Myanmar as an observer) can use the SWFDP-SeA guidance to enhance their forecasts

- All products have been sharing on website [swfdp-sea.com.vn](http://swfdp-sea.com.vn). The guidance has been providing operationally every day since 1/1/2016 (the third phase or demonstration phase of this project) for short range guidance and medium range.

- Expanding guidance domain for covering Myanmar.

- Global Satellite Mapping of Precipitation (GSMAP) is global rainfall estimates by the retrieval algorithm for brightness temperatures from satellite-born microwave radiometers. The horizontal resolution is 0.25 x 0.25 deg, 24 pictures per day, update every 1 hour. The delayed time is about 4 hours

- The precipitation products from the framework of the Sustained, Co-Ordinated Processing of Environmental Satellite Data for Nowcasting (SCOPE-NWC): <http://sigma.cptec.inpe.br/scope>

- Storm tracks: this product is developed by NHMS of Vietnam in order to issue warning the direction and speed of the movements of deep convective systems of up to 3 hours. The algorithms are based on 3 steps: motion vector fields are derived two successive images using multi-scale variation method; deep convective clouds are simply recognized by multi-threshold method from Himawari-8/9 data (infrared channels); and convective systems are separated by deep first searching (DFS) algorithm

- ASCAT: this product provides a measure of wind speed and direction near the sea surface. The measurements are obtained through the processing of scatter meter data originating from the ASCAT instrument on EUMETSAT's Metop-A satellite.

- Global deterministic NWP products from GSM model of JMA, GFS of NCEP and ICON (updated of GME) of DWD. The products of GSM and GFS have resolution of 0.5 x 0.5deg, ICON product has resolution of 0.125 x 0.125deg. All of global model products is updated every 6 hours at 00UTC, 06UTC, 12UTC and 18UTC. The available surface forecasting products include charts for precipitation, pressure of mean sea level, temperature at 2 meters, wind at 10 meters, 1000-500mb thickness. For upper levels (850, 700, 500 and 300mb), the forecasting charts of wind and geo-potential height, relative humidity, relative vortices and vertical velocity is also provided.

- Regional deterministic NWP products from WRF and COSMO have been updated (twice per day for WRF at 15km resolution and once per day for COSMO at 7km resolution)

- Global Ensemble Prediction Products based on 21 ensemble members of GFS ensemble system (NAEPS) for forecasting 5-10 day ahead: these products have resolution of 1.0 x 1.0 deg and are updated every 12 hours at 00UTC and 12UTC. The available EPS products include charts for ensemble mean (i.e. pressure of mean sea level, wind and geo-potential height at 850mb and temperature at 850mb), stamp map of 24-hours accumulated precipitation, and probabilistic maps (i.e. 24-hours precipitation quartile, 24-hours precipitation probability, 24-hours maximum wind-gust probability, 24-hours maximum CAPE probability, etc). In addition, the EPS-diagram for the 22 locations of Cambodia, 17 locations of Lao PDR and 16 locations of Thailand are also provided.

- Regional Ensemble Prediction Products based on two operational EPS of NHMS of Vietnam, namely is SREPS and LEPS. The SREPS (Short Range Ensemble Prediction System) is multi-model multi analysis EPS in which running HRM (High resolution Regional Model of DWD) and WRF (with two dynamic cores ARW and NMM) with initial and boundary conditions separately from 5 global models including GSM, GFS, GEM and NOGAPS. The SREPS has 15 members with resolution of 0.15 x 0.15 deg and is updated every 6 hours at 00UTC, 06UTC, 12UTC and 18UTC. The main aim of SREPS is in order to provide ensemble products for forecasting 1-3 days ahead. The LEPS is developed to provide ensemble products from 3 to 5 days ahead by running HRM model with initial and boundary conditions separately from 21 members of global EPS of GFS model. The LEPS has 15 members with resolution of 0.2 x 0.2 deg and is updated every 12 hours at 00UTC, and 12UTC. All available ensemble mean and probabilistic products of SREPS and LEPS are the same as with NAEFS.

**Identified opportunities/challenges, if any, for further development or collaboration:**

Based on the Meeting of the Regional Subproject Management Team (RSMT) of the Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia from 11-14 August 2015 in Hanoi, NHMS has some future activities:

+ Under the third phase - demonstration phase, (tentatively Jan 2016) in which the guidance had been providing 24/7 and all participating members have to evaluate the guidance based on their observation system. Now, Hanoi RFSC is in the second phase (Pilot Phase).

+ Expanding guidance domain for covering Myanmar.

+ Collaborating with RMSC Tokyo to release the guidance in case of having tropical storm (TS) or tropical cyclone (TC) over the Southeast Asia domain.

+ Under the helps of WMO and JMA, the HimawariCast Receiving and Processing Systems was installed in NHMS of Vietnam in 2015.

+ Adding the link of forecasts for SWFDP-SeA by ECMWF

Summary Table of relevant KRAs and components:

| <b>KRA =</b>                                    | 1                                   | 2                                   | 3                        | 4                                   | 5                                   | 6                                   | 7                                   |
|---|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Meteorology                                     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Hydrology                                       | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| DRR   | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Training and research                           | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |
| Resource mobilization or regional collaboration | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            |

|            |                      |                                |                              |
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