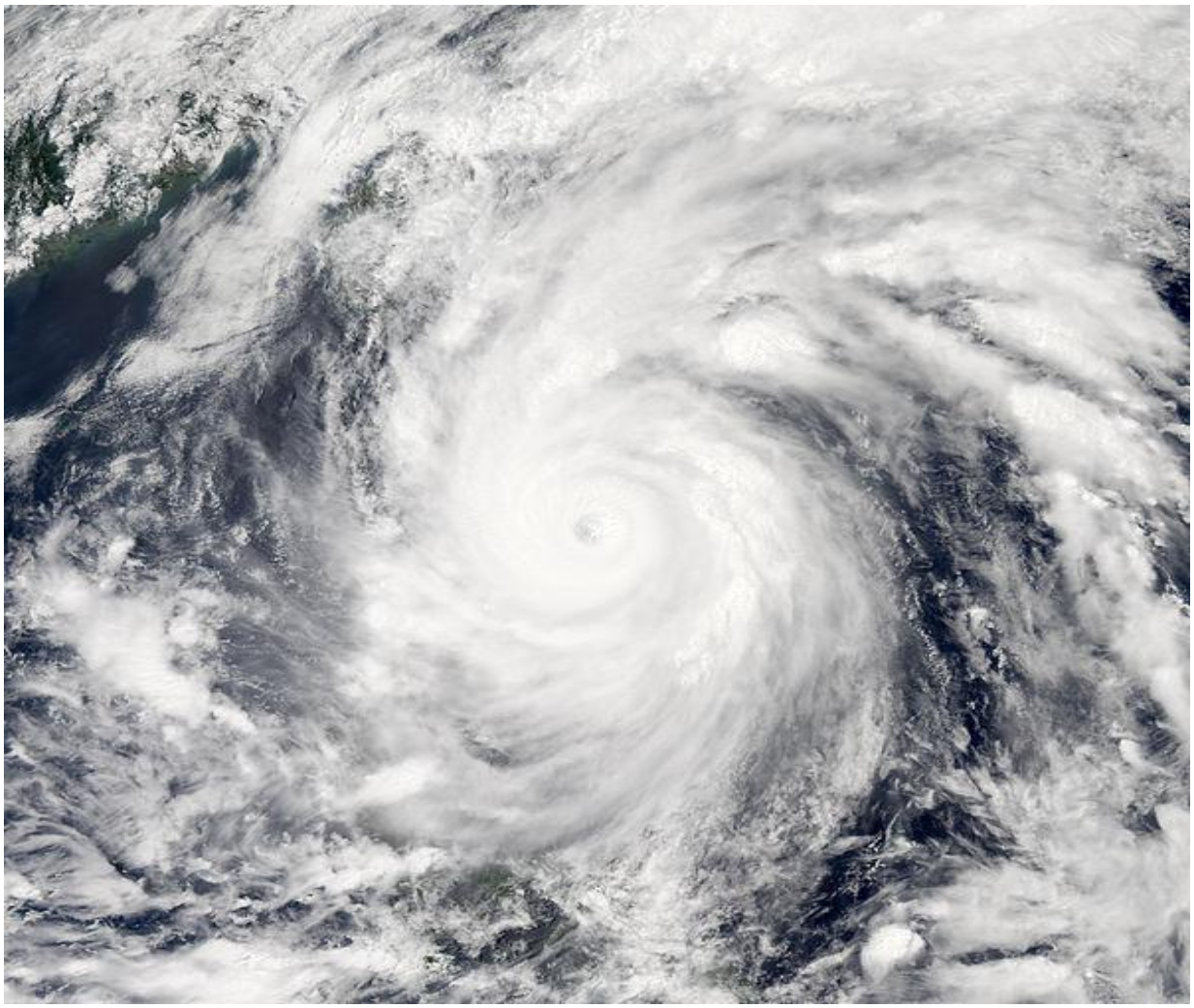
Development of Typhoon Chedeng (Songda) over the Philippines

May 19 - 29, 2011



At the end of May, 2011, the Philippines was struck by cyclone Chedeng (Songda), the fourth cyclone of the season and the second to hit the Philippines this year. After gaining strength over the open ocean since May 19 2011, it moved north-westwards along the coast, moving close to the central and north-east area of the Philippines, thereby bringing with it, large amounts of precipitation. This intense typhoon reached a minimum central pressure of 925 hPa and maximum winds of 169 km/h. As reported by the National Disaster Risk Reduction & Management Council (NDRRMC), a total of 91,767 families comprising more than 440,000 persons, were affected in 518 barangays of 53 municipalities and seven cities. Four people were confirmed dead and damage to agriculture & infrastructure amounted to PhP 14,311,499.

Final Report
September 2011

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1 Chronology of Typhoon Chedeng (Songda)

On May 19, 2011, the Joint Typhoon Warning Center (JTWC) reported that an area of low pressure had persisted about 510 km to the south-east of Yap, Micronesia, in the western Pacific Ocean. As it towards the north-west under the influence of a subtropical ridge of high pressure, it rapidly consolidated in an area of light to moderate vertical wind shear, a main requirement for typhoon formation and development.

On May 20, 2011, the Japanese Meteorological Agency (JMA) started to monitor the system as a Tropical Depression. By the next day, late on **May 21, 2011**, JMA reported that the depression had now become a Tropical Storm, naming it **Songda**.

After gaining strength over the open ocean for two days, Songda entered the Philippine Area of Responsibility (PAR) **on May 23, 2011**. At that moment, Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA) named it at that moment **Chedeng**.

On May 24, 2011, Chedeng (Songda) had reached maximum sustained winds of 105 km/h near the centre and gustiness of up to 135 km/h. It continued moving west-north-west (WNW) at 17 km/h. At that moment, the diameter was 480 km and presented a minimum central pressure of 978 hPa. Chedeng (Songda) continued to organize near its centre, with improved symmetrical circulation. At this time, the satellite imagery was already showing a banding eye - a sign that the system was nearing typhoon strength.

At 1,200 Coordinated Universal Time (UTC), JTWC reported that Songda had **intensified into a typhoon**. 12 hours later JMA followed suit while the system was located about 800 km to the southeast of Manila in the Philippines. Some areas of Luzon and Visayas were alerted of possible flash floods and landslides at that time.

On May 25, 2011, Chedeng (Songda) slowed down but maintained its intensity. At 5:00am, Chedeng (Songda) was situated at 365 km East of Catarman, Northern Samar (12.2°N, 128.3°E) with maximum sustained winds of 115 km/h near the center and gustiness of up to 145 km/h. Its trajectory was still WNW and a bit slower than the day before at 13 km/h. The diameter was measured at 590 km and presented a minimum central pressure of 967 hPa. PAGASA had emitted an alert for Catanduanes, Sorsogon, Albay, Camarines Sur, Camarines Norte and Samar provinces.

On May 26, 2011, Chedeng (Songda) rapidly intensified into a **Category 5 typhoon** on the Saffir-Simpson Tropical Cyclone Scale**,** passing well to the east of Bicol Region while heading on a north-north-west (NNW) track (see track in Figure 1.1).

According to the NDRRMC report, at 5:00am that morning Chedeng (Songda) was situated 270 km east-north-east (ENE) of Virac, Catanduanes (14.0°N, 127.0°E) with maximum sustained winds of 160 km/h near the centre and gustiness of up to 195 km/h. The diameter was 590 km and presented a minimum central pressure of 937 hPa.

PAGASA had emitted a Public Storm Warning Signal (PSWS) No. 2 (60 – 100 km/h winds) for the regions of Catanduanes, Sorsogon, Albay, Camarines Sur, Camarines Norte and the Samar Provinces.

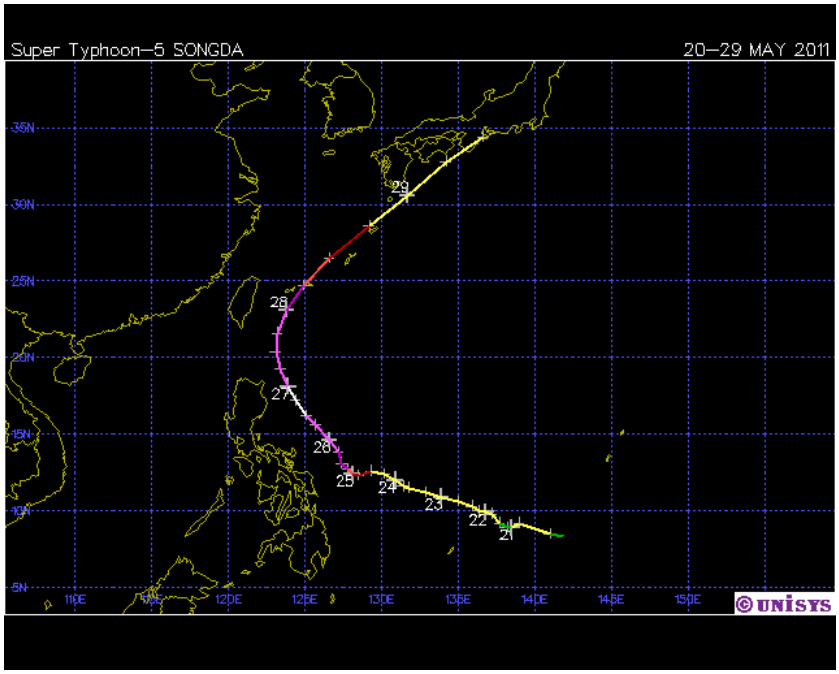

Figure 1.1 Cyclone Track, source: http://weather.unisys.com/

On May 27, 2011, Chedeng (Songda) gained more strength as it moved NNW. According to the NDRRMC report that morning (5:00am), Chedeng (Songda) was situated 250 km east of Tuguegarao City (17.2°N, 124.3°E) with maximum sustained winds of 195 km/h near the centre and gustiness of up to 230 km/h. A Public Storm Warning Signal (PSWS) No. 2 (60 – 100 km/h winds) had been emitted for the Batanes Group of Islands.

On May 28 (5:00am), Chedeng (Songda) finally started to weaken and move away from the islands. NDRRMC reported (5:00am) that Chedeng (Songda) was situated 200 km ENE of Basco, Batanes (21.9°N, 123.3°E) with maximum sustained winds of 165 km/h near the center and gustiness of up to 200 km/h. The last report from PAGASA stated that Typhoon Chedeng (Songda) accelerated rapidly as it moved away from the Philippines and the PAR. All PSWS' were lowered. However, Chedeng (Songda) continued to enhance the south-west monsoon and bring rains over Luzon and Western Visayas.

In the afternoon of **May 29, 2011**, Chedeng (Songda) became extra tropical south of Shikoku Island.

Although Chedeng (Songda) remained offshore while passing by the Philippines, heavy rains within the typhoon's outer bands impacted the Philippines, causing significant flash flooding and landslides. In the PAR, NDRRMC reported four casualties, two due to drowning and one due to a landslide. The fourth victim was a miner that got trapped inside a tunnel in Tuba, Benqet.

Flooding due to the continuous strong rains has been reported for the Provinces of Albay, Maguindanao and Lanao del Sur, affecting almost 20,500 families with sometimes waist-deep floodwaters. Another 11 incidents of flooding were reported, including three landslides. A flashflood incident in Davao del Norte, one out of eight monitored in total, affected another 16,000 persons.

A total of 91,767 families comprising more than 440,000 persons were affected in 518 barangays of 53 municipalities and seven cities, according to NDRRMC. In total, Chedeng (Songda) has caused four confirmed deaths and Chedeng's (Songda's) damage to agriculture and infrastructure amounted to PhP 14,311,499.

2 Setup of the Typhoon Trigger and Assessment of Monitored Data

2.1 Assessment of the Monitored Data

A novel insurance product aims to protect cooperatives in the Philippines from insolvency following typhoons. DHI provides online real-time monitoring of weather events all over the country, serving as the basis for the insurer's payout scheme.

Wind and rainfall were previously identified by DHI Water & Environment (S) Pte. Ltd. (DHI) as the two major causes of insurance loss and threshold values – so called triggers – set up for these two parameters. That enables DHI to categorize the severity of a weather event into a 10-year, 15-year or 20-year event.

In order to supply the most accurate information, DHI's so-called "Typhoon Trigger" integrates different kinds of independent data, thereby forming a coherent picture of the actual weather situation in the Philippines.

The Typhoon Trigger recognizes a typhoon event from the moment a tropical depression hits the PAR with maximum wind speeds superior to 30 knots (55.6 km/h).

2.1.1 Rainfall Data

The rainfall trigger is based on satellite data provided by the Tropical Rainfall Measuring Mission (TRMM), a joint mission of National Aeronautics and Space Administration (NASA) and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall. Data are available on a three-hour basis in grids of 0.25°, which are approximately squares of 27x27 km. Hence, the Philippines are covered by 852 data squares, each containing the level of rain for this area. Thereby, TRMM offers a dense coverage of the Philippines, both in time and space.

Raw data from the TRMM satellite use eight different stations to validate local data and make the necessary calibration. The closest validation station for the Philippines is located in Taiwan. After quality control operations, TRMM data are regarded as a reliable qualitative and totally independent data source useful to the hazard analysis and the development of the trigger.

It is important to keep in mind that the direct comparison between rain gauges and the TRMM rainfall data is very difficult due to the different approaches in the measurement of rainfall.

2.1.2 Categorisation and Triggering

In order to evaluate the rain trigger, an extreme value analysis is carried out on the 24-hour TRMM rainfall data for each municipality. Comparing the maximum 24-hour rainfall to the calculated 10-year, 15-year or 20-year rain events, the event return period is calculated for each of the municipalities. Finally, checking each of the municipalities against the trigger criteria, the triggered municipalities are sought out.

2.1.3 Tracking Chedeng (Sondga)

DHI's system was able to track Chedeng (Songda) rainfall and wind over the affected areas of the Philippines.

On May 25, Chedeng (Songda) was located at 365 km east of Catarman, Northern Samar (12.2°N, 128.3 °E). PAGASA had already emitted an alert for Catanduanes, Sorsogon, Albay, Camarines Sur, Camarines Norte and Samar provinces. During the following hours and days different regions were touched by the high precipitations as can be seen on the following figures (Figure 2.1 to Figure 2.7).

From Figure 2.1, Figure 2.2 and Figure 2.3, the monitoring system clearly shows the advancement of the heavy rains associated with the movement of the typhoon. The regions that had already been warned, such as Catanduanes, Sorsogon, Albay, Camarines Sur, Camarines Norte and Samar provinces (see close-up of Figure 2.4 and Figure 2.5), show the highest precipitation affecting more than 387,000 persons. The outer rainbands of Chedeng (Songda) were still affecting those areas on May 27, 2011 (Figure 2.1), while Cayagan and Isabela was the most affected region.

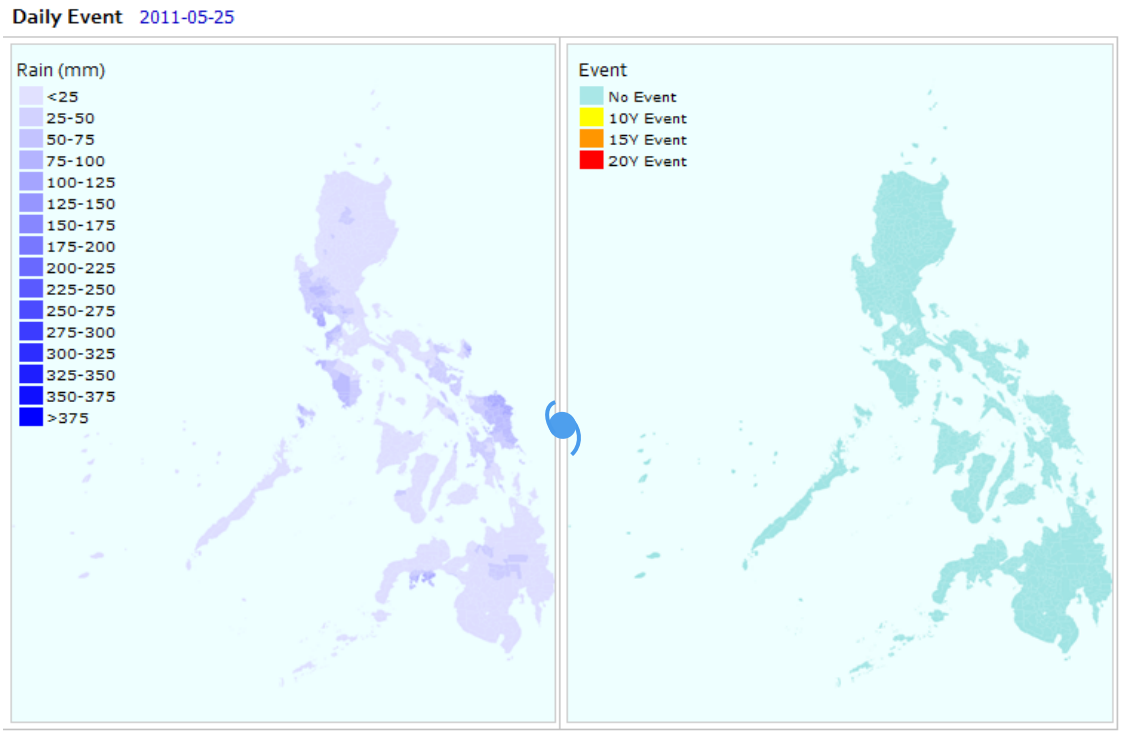

Figure 2.1 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 25, 2011. Heavy rainfall is represented as dark blue areas in the left panel. The rainfall values measured by satellite TRMM are described by the legend on top left of the first panel

Approximate location of cyclone Chedeng (Songda) on May 25, 2011

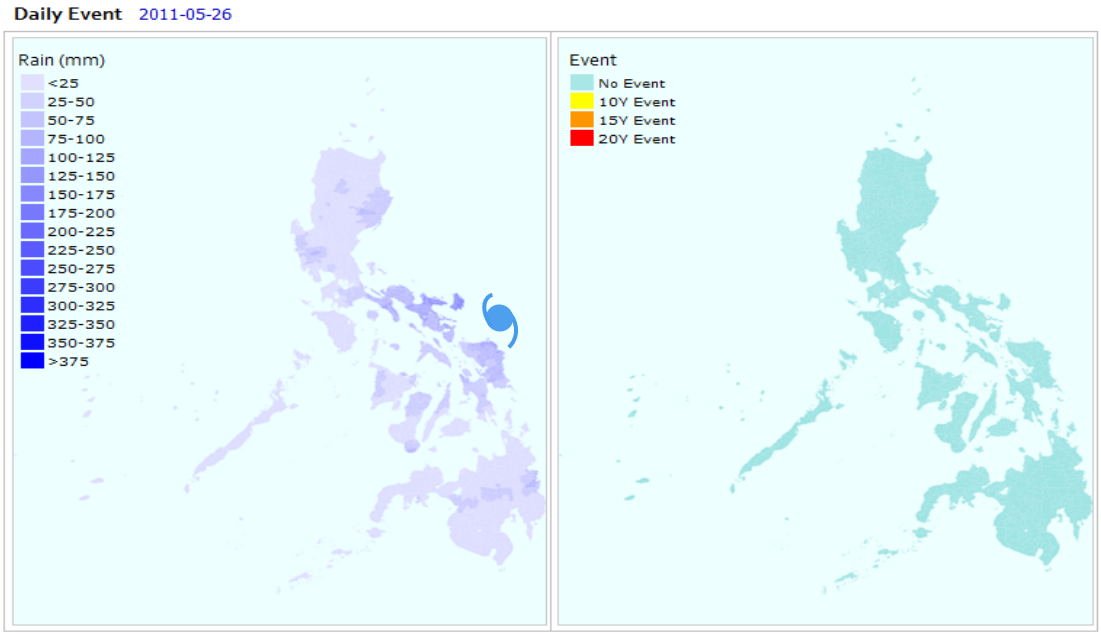

Figure 2.2 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 26, 2011. Heavy rainfall is represented as dark blue areas in the left panel.

Approximate location of cyclone Chedeng (Songda) on May 26, 2011

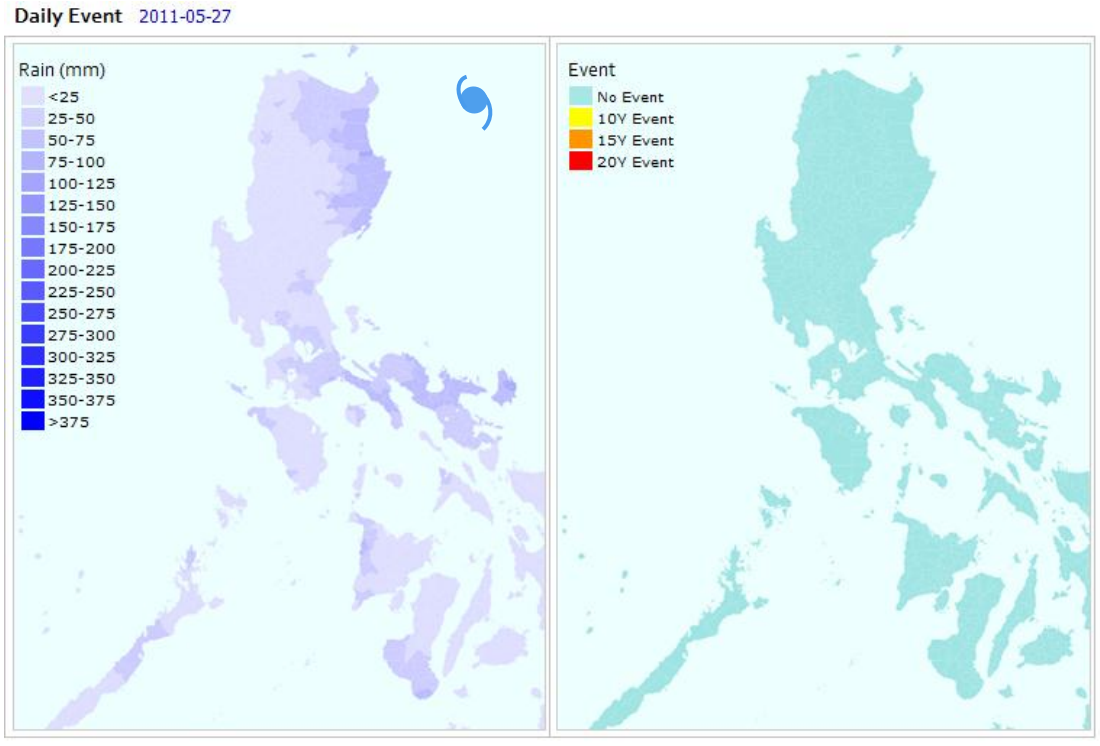

Figure 2.3 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 27, 2011. Heavy rainfall is represented as dark blue areas in the left panel. The rainfall values measured by satellite TRMM are described by the legend on top left of the first panel.

Approximate location of cyclone Chedeng (Songda) on May 27, 2011The outer rainbands of Chedeng (Songda) were still affecting those areas on May 27, 2011 (Figure 2.3), while the most affected region was Cayagan and Isabela.

Figure 2.5 depicts a close-up of the Isabela area, showing that the municipality of Maconacon had suffered the highest amounts of precipitation. As follows from the NDRRMC rapport, 31 families were affected in Maconacon. The monitoring system didn't trigger any extreme event because the precipitation value for a 10-year event is around 350mm and the measured accumulated precipitation over Maconacon was around 100 mm.

Flooding due to the continuous strong rains was reported for the Provinces of Maguindanao and Lanao del Sur, in the south of the Philippines affecting almost 20,500 families with sometimes waist-deep floodwaters. DHI's monitoring system measured amounts around100 mm for these places; however no municipalities were triggered as the threshold value for a 10-year event is around 160 mm.

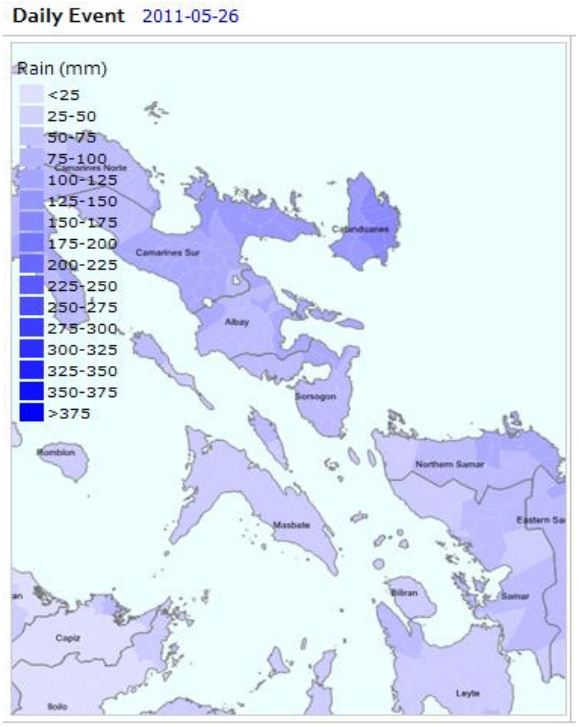

Figure 2.4 Close-up of Bicol Region

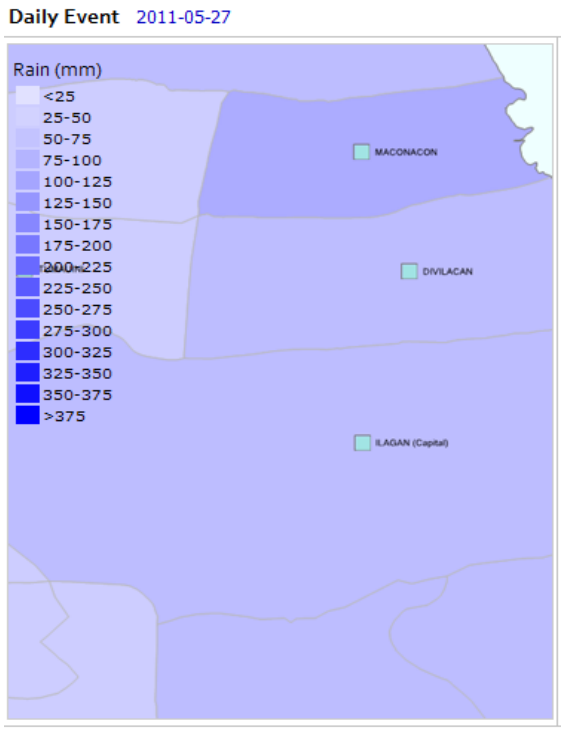

Figure 2.5 Close-up of Maconacon, Isabela (Cagayan Valley)

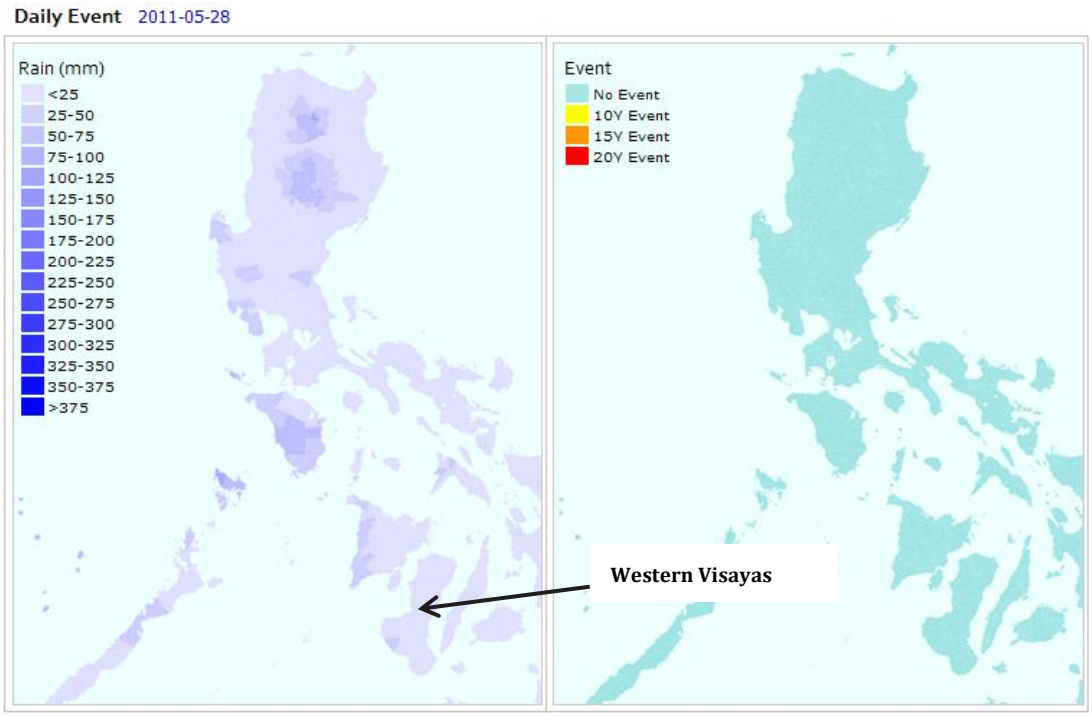

Figure 2.6 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 28, 2011. Heavy rainfall is represented as dark blue areas in the left panel. The rainfall values measured by satellite TRMM are described by the legend on top left of the first panel.

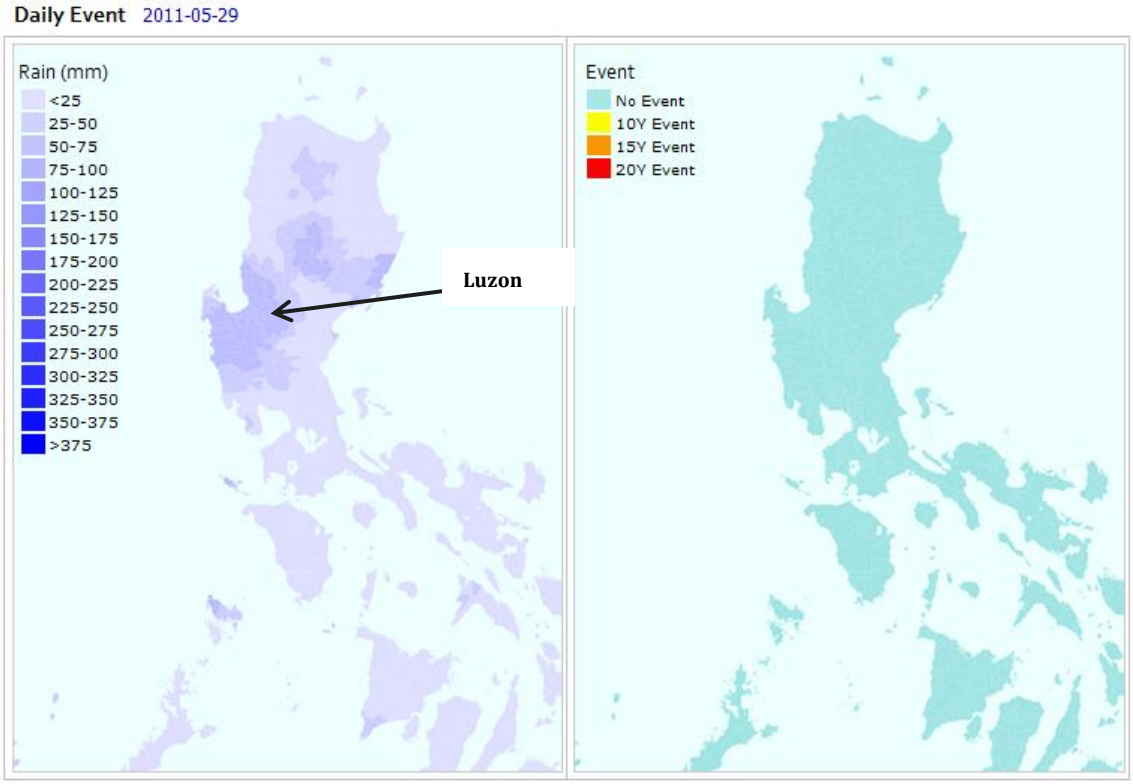

Figure 2.7 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 28, 2011. Heavy rainfall is represented as dark blue areas in the left panel. The rainfall values measured by satellite TRMM are described by the legend on top left of the first panel. On May 28, 2011 and May 29, 2011, Chedeng (Songda) continued to enhance the south-west monsoon and to bring rains over Luzon and Western Visayas.

3 Linking Damage to Triggered Municipalities/Provinces

The Typhoon Trigger covers the Philippines at municipal level based on the probability of both rain and wind exposures during a typhoon event. The real-time monitoring system updates the data every three hours, at the same time adjusting the affected municipalities and well as the event category for each of them.

During the passage of Chedeng (Songda), DHI's monitoring system didn't measure sufficient amounts of rain to categorize the rain over the municipalities as an extreme event.

The wind intensities that developed during cyclone Chedeng (Songda) were not strong enough to exceed the trigger values that were estimated, on the affected areas, to values between 65 km/h to 80 km/h. Figure 3.1 shows the wind values estimated for this event.

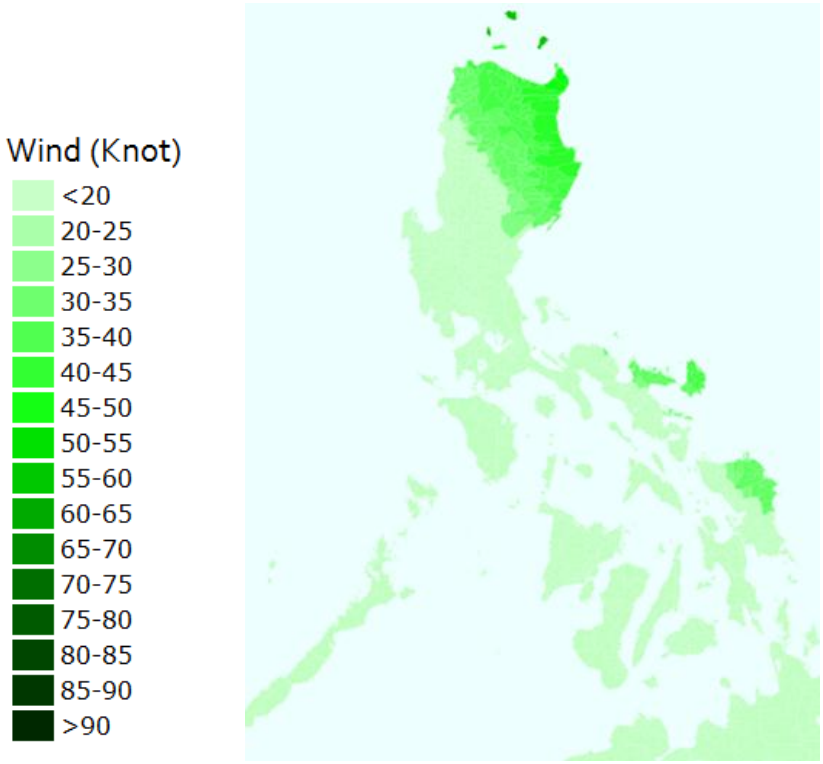

Figure 3.1 DHI's wind monitoring system for the whole event. The legend on the left show the corresponding wind values.

4 State of Calamity Reported by NDRRMC

The NDRRMC did not report any state of calamity during cyclone Chedeng (Songda).

However, the Government Provincial Disaster Risk Reduction and Management Council (PDRRMC), Albay, declared **Albay Province** under a State of Calamity through SP Resolution No. 38-2011.