Development of Cyclone Aere (Bebeng) over the Philippines

May 7-10, 2011

On May 7, 2011, the Philippines was struck by cyclone Aere (Bebeng), the second cyclone of the season and the first to hit the Philippines this year. After gaining strength over the open ocean since May 6 2011 and subsequently hitting the central eastern islands, it moved northwards along the coast. Wind speeds of Aere were comparatively low, giving the cyclone enough time to shed massive amounts of rain over the affected areas. As reported by the National Disaster Risk Reduction & Management Council (NDRRMC) Aere caused a total of 48 confirmed casualties (35 dead, 11 injured, two missing); more than 400,000 persons were affected and 9,420 houses damaged. According to NDRRMC, the estimated damages due to Aere amount to PhP 237,867,831 (agriculture-related) and PhP 1,132,536,990 (infrastructure-related).

Final Report
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Contents

1 Chronology of the Typical Cyclone Aere (Bebeng)

A Tropical Depression was detected late Friday evening (May 6, 2011), in the western Pacific Ocean east of Visayas, near the central–eastern coast of the Philippines.

On Saturday morning (May 7, 2011), the Tropical Depression was located, based on satellite and surface data, at 180 km east of Catarman, northern Samar (see track in Figure 1.1). The depression eventually developed into a more harmful Tropical Storm (on the Saffir-Simpson Tropical Cyclone scale) with maximum sustainable winds of around 55 km/h near the centre, moving north-west at around 13 km/h. Aere (Bebeng) was at this point an average-sized cyclone with a diameter of 405 km.

As of Sunday (May 8, 2011), at around 10:00am, cyclone Aere (Bebeng), made its first landfall over Northern Catanduanes, Aurora, close to the Bicol region. It then continued to move towards the area of Quezon-Aurora with maximum sustainable winds of 93 km/h and gusts of 120 km/h.

As of Monday (May 9, 2011), the Tropical Storm started to weaken after having shown maximum sustainable winds of 85 km/h near the centre of the storm with gusts of up to 100 km/h. Aere (Bebeng) then made its second landfall over northern Casiguran, Aurora.

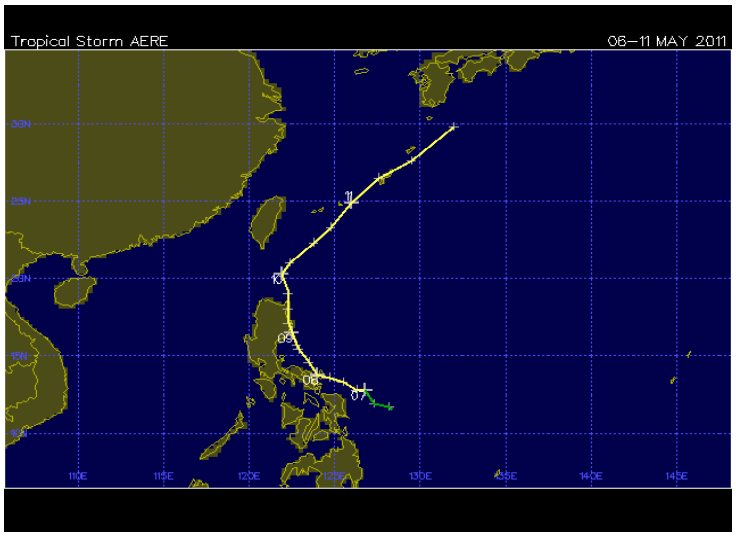

Figure 1.1 Cyclone Track, source: http://weather.unisys.com/

Due to the atmospheric pressure situation, Aere (Bebeng) continued its north-north-westward track during the night of Monday, before starting to move away from the Philippines and re-curving towards a north-north-east direction. On Tuesday morning (May 10,2011), at 4:00am, the centre of Aere (Bebeng), still classified as a Tropical Storm, was estimated at 120km south-east of Basco, Batanes – one of the northern islands of the Philippines, and moving north-north-east at increased speed (17 km/h). Aere (Bebeng) had maximum sustainable winds of 65 km/h near the centre and gustiness of up to 80 km/h.

During the following 24 hours, the Tropical Storm continued to move away from the Philippines, however maintaining its strength. On Wednesday morning (May 11, 2011), at around 2:00am, the centre (eye) of Aere (Bebeng) was estimated to be at 450 km north-east of Basco, Batanes. Aere (Bebeng) moved in the north-east direction at a speed of 24 km/h in the direction of the Okinawa Islands in Japan. Information from NDRRMC reported maximum sustainable winds of 65 km/h near the centre and gusts of up to 80 km/h. At 11:00am on the same day, Aere (Bebeng) accelerated and exited the Philippine Area of Responsibility (PAR).

2 Setup of the Typhoon Trigger and Assessment of Monitored Data

A novel insurance product aims to protect cooperatives in the Philippines from insolvency following typhoons. DHI Water & Environment (S) Pte. Ltd. (DHI) provides online real-time monitoring of weather events all over the country, serving as the basis for the insurer's pay-out scheme.

Wind and rainfall were previously identified by 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 Philippines Area of Responsibility (PAR) with maximum wind speeds superior to 30 knots (55.6 km/h).

2.1 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.

2.2 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.

2.3 Tracking Aere (Bebeng)

DHI's system was able to track Aere's (Bebeng's) precipitations over the Philippines during the whole evolution of the cyclone. Figure 2.1 to Figure 2.4 show the areas of the Philippines that have received extreme precipitation during the evolution of Aere (Bebeng) from May 7-10, 2011. Moreover, Figures 2.1 to 2.4 display the event category that has been attributed to each municipality according to the maximum 24-hour rainfall accumulation.

DHI's rainfall monitoring system emitted its first alert on Saturday, May 7, 2011 when the first municipalities where hit by high precipitations, corresponding to the arrival of the Tropical Cyclone at the Philippine's coast (Figure 2.1). On the same day, the NDRRMC emitted its first warnings and damage reports for the same region (Eastern Samar, Samar, Northern Samar, Albay and Camarines).

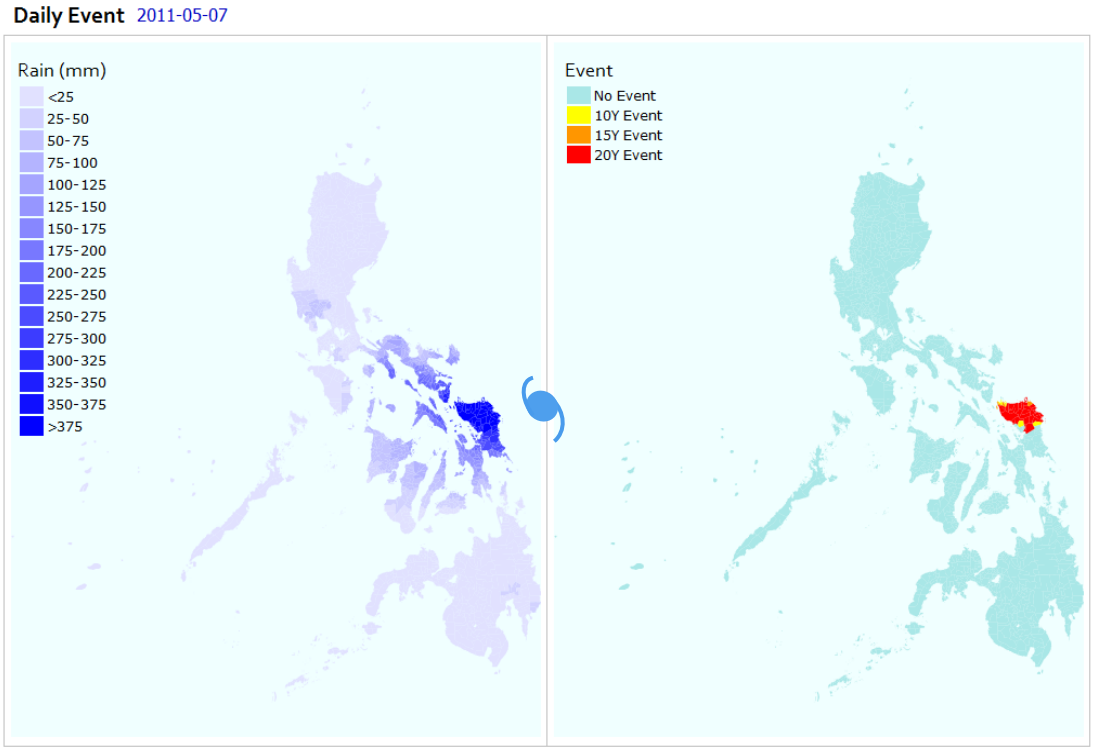

Figure 2.1 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 7, 2011. Heavy rainfall (dark blue areas in the left panel) is classified as an extreme 20-year event (red areas on the right panel. Approximate location of cyclone Aere on May 7, 2011

Figure 2.2 shows the situation on May 8, 2011, after Aere's (Bebeng's) position had moved towards the north-west. Subsequently, Aere (Bebeng) changed its direction to some degrees, continuing its displacement towards the north-north-west, with the maximum precipitation remaining in the region of Northern and Eastern Samar. That corresponds to the right posterior cyclone's rain bands, usually considered the most dangerous part of the storm (National Oceanic and Atmospheric Administration (1999), Hurricane Basics, retrieved on 2011-05-20).

Figure 2.3 displays the situation on May 9, 2011. By then, the region most affected by the high rains is further north close to Bicol, corresponding to the cyclone's displacement in the last 24 hours. No extreme event was triggered on that day.

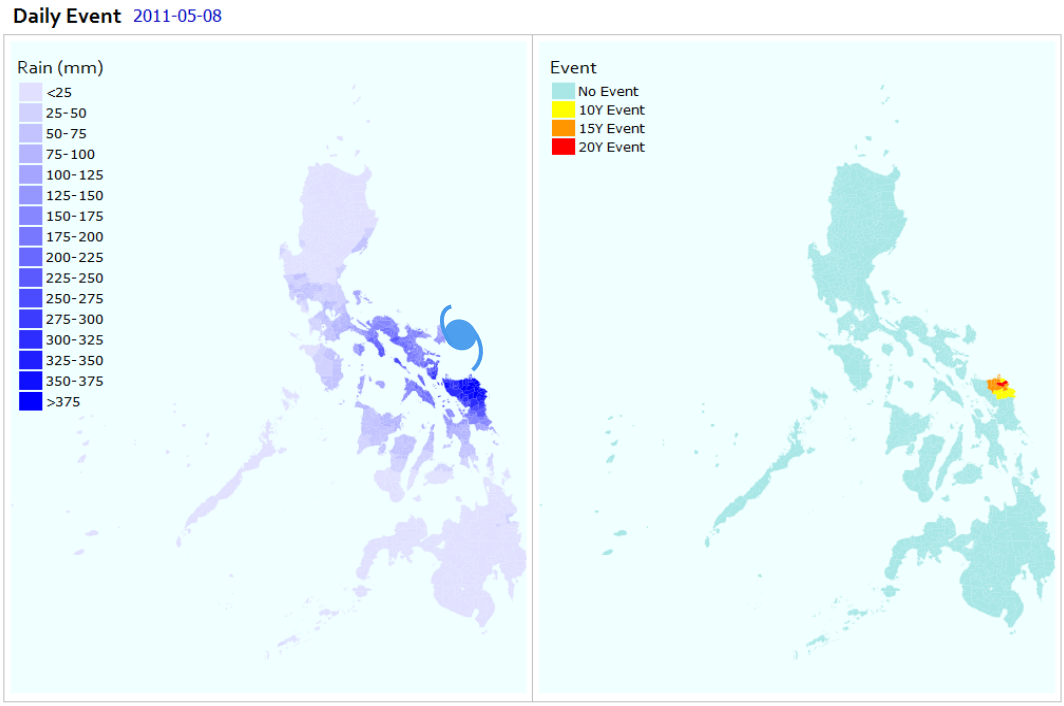

Figure 2.2 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 8, 2011.
Approximate location of cyclone Aere (Bebeng) on May 8, 2011

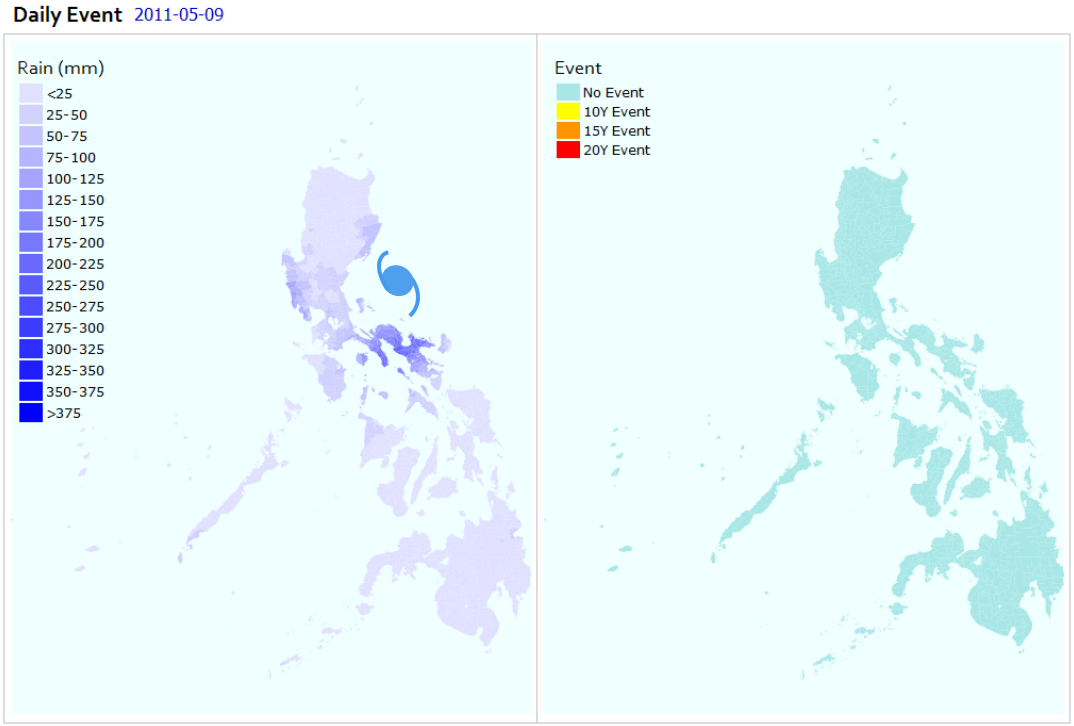

Figure 2.3 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 9, 2011.
Approximate location of cyclone Aere (Bebeng) on May 9, 2011

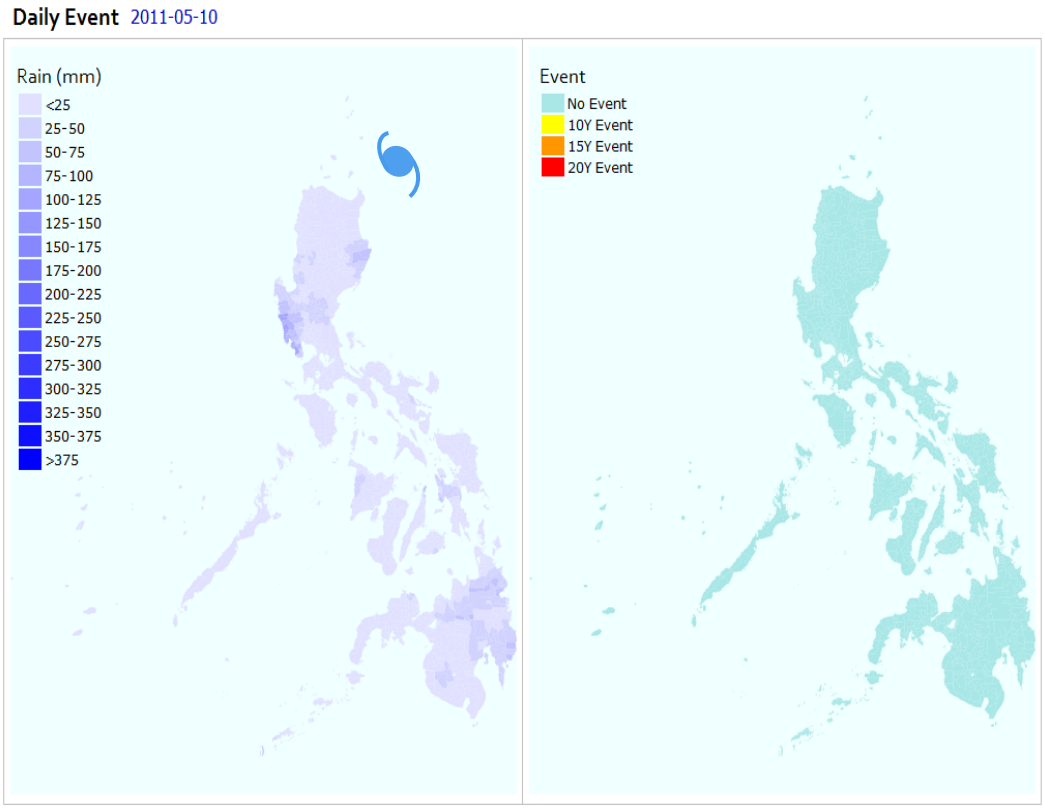

Figure 2.4 DHI's rainfall (left panel) and event (right panel) real-time monitoring system on May 10, 2011. Approximate location of cyclone Aere (Bebeng) on May 10, 2011

DHI's monitoring system did not measure sufficient amounts of rain to be categorized as an extreme event (Figure 2.3 and Figure 2.4, right panel) either on May 9, 2011 or on May 10, 2011.

The wind intensities that developed during cyclone Aere (Bebeng) 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 2.5 shows that the wind values estimated for this event do not exceed 40 km/h. As a result, the wind values did not have any influence on the event category, which was solely determined by Aere's (Bebeng's) rainfall.

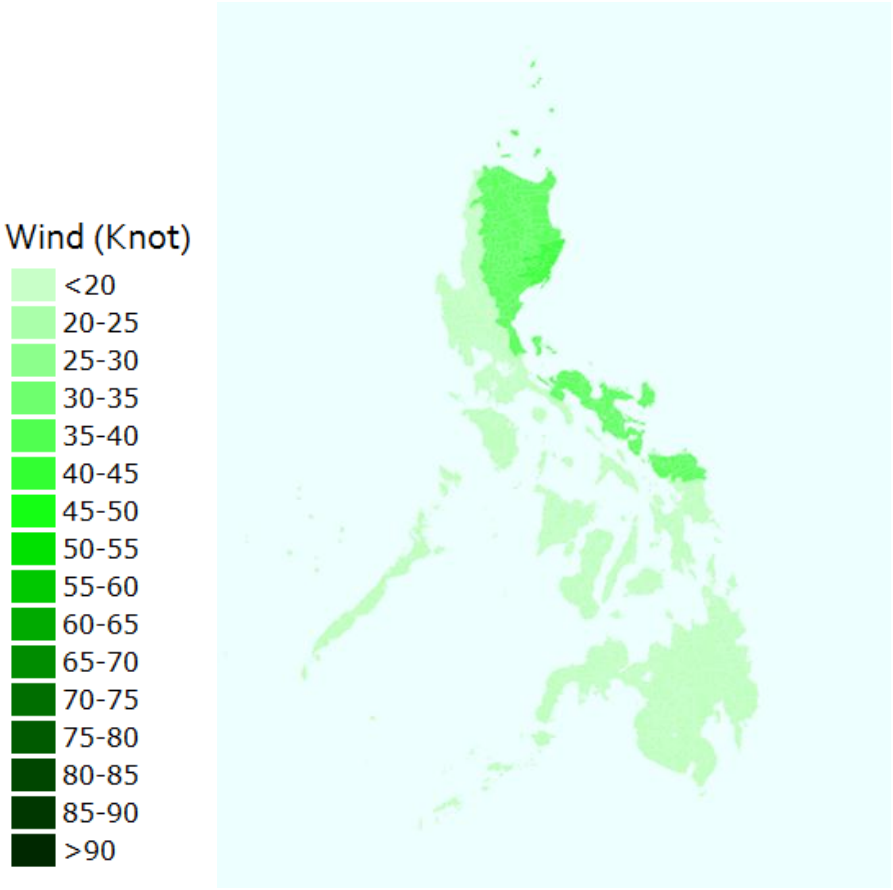

Figure 2.5 DHI's wind monitoring system for the whole event. The legend on the left show the corresponding wind values.

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. Table 3.1 and Table 3.2 list the municipalities triggered by DHI's system for May 7, 2011 and May 8, 2011 due to rainfall.

Table 3.1 List of triggered municipalities on May 7, 2011

Municipality Name	Province	Event (Return Period in Years)
Calbayog City	Samar	20Y
Santa Margarita	Samar	20Y
Gandara	Samar	20Y
Motiong	Samar	20Y
Paranas (Wright)	Samar	20Y
Matuguinao	Samar	20Y
San Jorge	Samar	10Y
San Jose De Buan	Samar	20Y
Catarman (Capital)	Northern Samar	20Y
Victoria	Northern Samar	20Y
San Antonio	Northern Samar	15Y
Lope De Vega	Northern Samar	20Y
San Isidro	Northern Samar	20Y
Bobon	Northern Samar	20Y
Lavezares	Northern Samar	10Y
Allen	Northern Samar	15Y
Rosario	Northern Samar	15Y
San Jose	Northern Samar	10Y
Lapinig	Northern Samar	20Y
Silvino Lobos	Northern Samar	20Y
Mondragon	Northern Samar	20Y
Las Navas	Northern Samar	20Y
Catubig	Northern Samar	20Y
San Roque	Northern Samar	20Y
Pambujan	Northern Samar	20Y
Laoang	Northern Samar	20Y
Mapanas	Northern Samar	20Y
Gamay	Northern Samar	20Y
Palapag	Northern Samar	15Y
Can-avid	Eastern Samar	10Y
Dolores	Eastern Samar	20Y
Maslog	Eastern Samar	20Y
Jipapad	Eastern Samar	20Y
Arteche	Eastern Samar	20Y
Oras	Eastern Samar	20Y
San Policarpo	Eastern Samar	20Y

Table 3.2 List of triggered municipalities on May 8, 2011

Municipality Name	Province	Event (Return Period in Years)
Matuguinao	Samar	10Y
San Jose De Buan	Samar	10Y
Lapinig	Northern Samar	10Y
Silvino Lobos	Northern Samar	15Y
Mondragon	Northern Samar	15Y
Las Navas	Northern Samar	15Y
Catubig	Northern Samar	20Y
San Roque	Northern Samar	15Y
Pambujan	Northern Samar	15Y
Laoang	Northern Samar	15Y
Mapanas	Northern Samar	20Y
Gamay	Northern Samar	15Y
Palapag	Northern Samar	10Y
Dolores	Eastern Samar	10Y
Maslog	Eastern Samar	10Y
Jipapad	Eastern Samar	15Y
Arteche	Eastern Samar	10Y
Oras	Eastern Samar	10Y
San Policarpo	Eastern Samar	10Y

Following the last NDRRMC Summary-report (No.14, May 16, 2011), 10 flooding incidents were reported during the passage of Tropical Cyclone Aere (Bebeng). Many of the affected municipalities are to be found in the tables above, e.g. San Jorge, Catarman, Lope de Vega, Las Navas, Catubig and Mondragon.

4 State of Calamity reported by NDRRMC

The NDRRMC did not report any state of calamity during cyclone Aere (Bebeng).