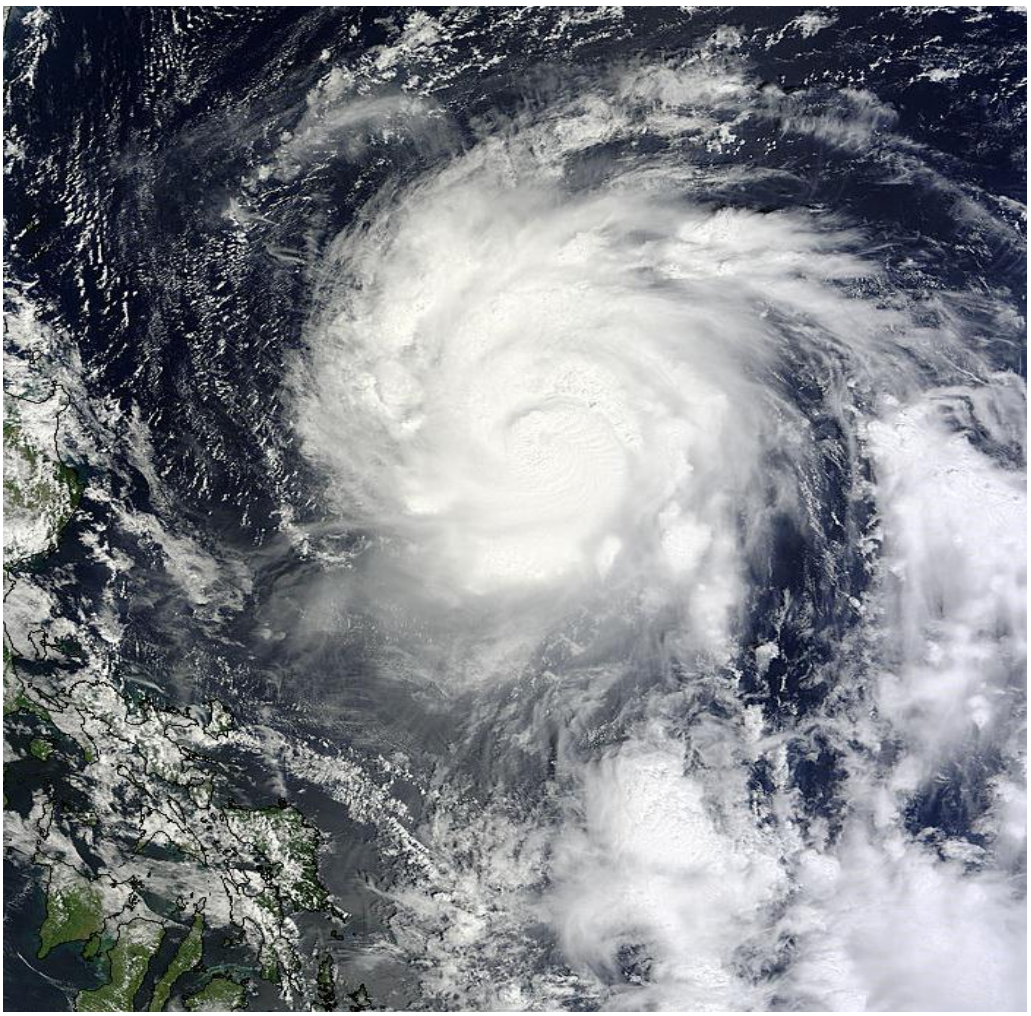
Initial Assessment on the Development of Typhoon Quiel (Nalgae) over the Philippines

September 29, 2011- October 2, 2011



Satellite image of Quiel (Nalgae) approaching the Philippines on September 30, 2011 (Source: http://rapidfire.sci.gsfc.nasa.gov/cgi-bin/imagery/single.cgi?image=Nalgae.A2011273.0215.2km.jpg

Typhoon Quiel (Nalgae) hit the Philippines less than four days after the last Typhoon Pedring (Nesat) wreaked destruction over Northern Luzon. On October 1, 2011, Quiel (Nalgae) made landfall over Dinapigue, Isabela before crossing over the mountainous lands of Northern Luzon Island where the agricultural plains were still saturated from the last typhoon's strong rains. The same municipalities affected by Pedring (Nesat) were also affected this time. Quiel (Nalgae) has caused 19 confirmed casualties and seven missing persons. More than 1 million persons have been affected in 17 provinces (135 municipalities) and 18,231 houses have been damaged as reported by the National Disaster Risk Reduction & Management Council (NDRRMC).

The estimated agricultural, infrastructure and school building damage amounts to more than 115 million PhP.

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1 Chronology of the Tropical Cyclone Quiel (Nalgae)

A low pressure area (LPA) with an isolated deep depression was detected to the west of the Northern Mariana Islands on the morning of September 24, 2011. The LPA gradually drifted westwards, becoming better organized by September 26, 2011, when the Japan Meteorological Agency (JMA) started monitoring it and upgraded it to a Tropical depression. The same day, the Joint Typhoon Warning Center (JTWC) issued a Tropical Cyclone Formation Alert.

As of September 27, 2011, JMA upgraded it further to a tropical storm and named it Nalgae. Nalgae continued to drift west while it intensified gradually, developing a microeye – like feature and rainbands all around. On September 28, 2011, JMA reported that Nalgae continued to intensify with winds of over 55 knots (102km/hr). As a result, it was upgraded to a severe tropical storm. Late on that day, The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) named it Quiel as it entered the Philippine Area of Responsibility (PAR), as Pedring (Nesat) (the last typhoon heavily hitting parts of the Philippines), was leaving the PAR.

On the evening of September 29, 2011, JMA further upgraded it to a typhoon. The system rapidly intensified and seriously threatened Cagayan-Isabela according the forecasts at that moment. According to PAGASA weather bulletin, issued on October 1, 2011, Quiel (Nalgae) made landfall over Dinapigue, Isabela before crossing over the mountainous lands of Northern Luzon Island (see track in Figure 1.1), where the agricultural plains were still saturated from the last typhoon's strong rains. The same municipalities affected by Typhoon Pedring (Nesat) were also affected by Quiel (Nalgae).

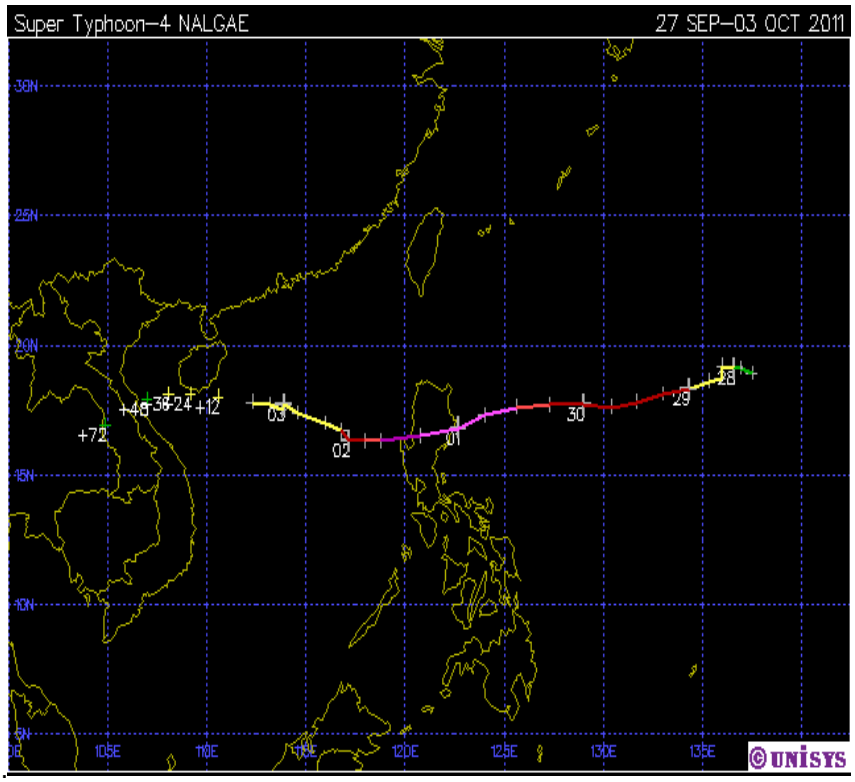

Figure 1.1 Typhoon Track (Source: http://weather.unisys.com/)

According to the PAGASA weather bulletin issued on Sunday, October 2, 2011, at 10:30 p.m., Typhoon Quiel (Nalgae) weakened into a storm and moved away from the PAR, heading towards Hainan Island.

Mild Southwest Monsoon spreading across Palawan, Visayas, Bicol Region, southwestern and southern Luzon, became intense along the western sections, where rains with thunderstorms and squalls were expected.

Quiel (Nalgae) has caused 19 confirmed casualties and 7 missing person. More than 1 million persons have been affected in 17 provinces (135 municipalities) and 12,703 houses have been damaged (as reported by the National Disaster Risk Reduction & Management Council, NDRRMC). The estimated agricultural, infrastructure and school building damage amounts to more than 115 million PhP.

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 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 PAR with maximum wind speeds superior to 30 knots (55.6km/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 27x27km. 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-hr TRMM rainfall data for each municipality. Comparing the maximum 24-hr 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 Typhoon Quiel (Nalgae)

DHI's system was able to track Quiel's (Nalgae's) precipitation and wind over the affected areas of the Philippines during the evolution of the Typhoon.

As shown in Figure 2.1, the monitoring system clearly reveals the Philippine's north-eastern areas that have been affected by the rains during the approach of Quiel (Nalgae) on September 30 and following landfall on October 1, 2011, and over Dinapigue, Isabela before crossing over the mountainous lands of Northern Luzon Island. The same areas affected by Typhoon Pedring (Nesat) (see Figure 2.2 for a close-up of the region) were again affected by Quiel (Nalgae).

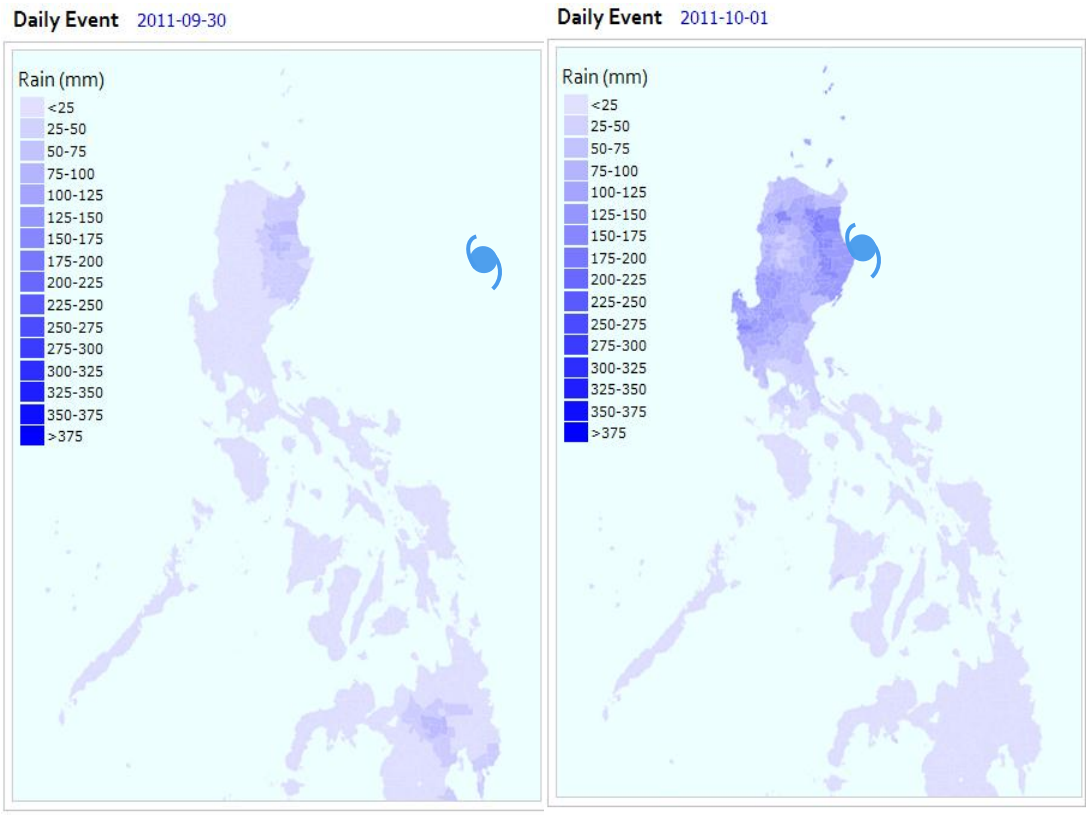

Figure 2.1 DHI's rainfall real-time monitoring system on September 30, 2011 (left panel) and October 1, 2011 (right panel). Heavy rainfall is represented in dark blue. The legend displays the maximum 24-hr rainfall values measured by satellite TRMM.

Approximate location of Quiel (Nalgae) for each day.

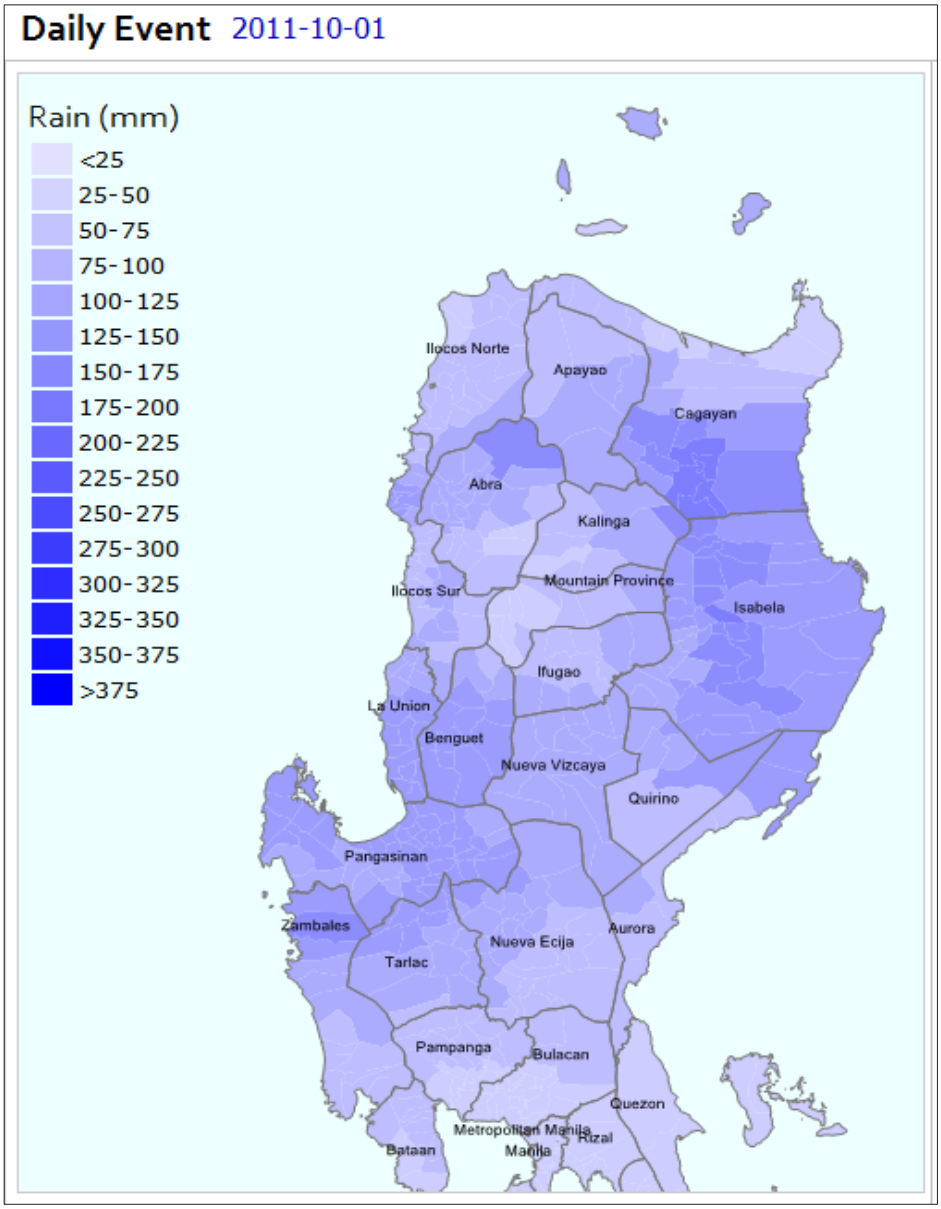

Figure 2.2 DHI's rainfall real-time monitoring system on October 1, 2011. Heavy rainfall is represented as dark blue areas. The legend displays the maximum 24-hr rainfall values measured by satellite TRMM.

3 Linking Damage to Triggered Municipalities / Provinces

During October 1 & 2, 2011, the areas of Cagayan, Isabela, Quirino, Nueva Vizcaya, Benguet, Pangasinan and Zambales received 120-200mm of rain over 24 hours, experiencing several types of flood and landslide casualties as reported by NDRRMC (see Figure 2.2 for a close-up on the region).

No rain events have been triggered during the passage of typhoon Quiel (Nalgae), as no municipality overpassed the amounts of around 260mm and higher precipitation necessary to trigger a 10-year precipitation event. However, high amounts of precipitation have been measured by TRMM in several municipalities, reaching amounts of 162.3mm/24 hrs in Tuguegarao City, 159.7mm/24 hrs in Enrile or Iguid in Cagayan province, 151.9mm/24 hrs in Gamu and 149.3mm/24hrs in Reina-Mercedes or Naguilias in Isabela province.

The Table 3.1 shows several municipalities mentioned in the NDRRMC rapport where casualties has been reported. The table also shows, for better comparison, the maximum values estimated by DHI's monitoring system, from TRMM satellite over 24 hours, and the corresponding trigger for a 10-year event (values estimated on October 1, 2011).

Table 3.1 List of affected municipalities (as reported by NDRRMC) and corresponding rainfall and 10-year event trigger values.

Municipality (Province)	Measured Rainfall (mm/24 hrs)	Trigger Value for a 10-year Rainfall Event (mm/24 hrs)
Tuguerao City (Cagayan)	162.3	316
Dagupan City (Pangasinan)	108.0	443
Reina Mercedes (Isabela)	149.3	316

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.

Typhoon Quiel (Nalgae) manifested with strong winds at the surface, triggering several municipalities. Figure 3.1 displays DHI's wind surface estimation for the passage of typhoon Quiel (Nalgae). It clearly shows the area where the typhoon made landfall and entered the Philippines, becoming weaker as the typhoon lost energy, crossing west over land. Comparing the wind pattern with the triggered areas (see Figure 3.2), it can be easily understood that even if the highest wind values were estimated close to the landfall area, these areas are generally more exposed to typhoons and therefore the event return period is smaller, leading to triggered events of only 10 years or 15 years on this side of the country. On the contrary, the west part of the affected area, less exposed to the damage of typhoons, were triggered with winds exceeding the trigger values of a 15-year and 20-year event.

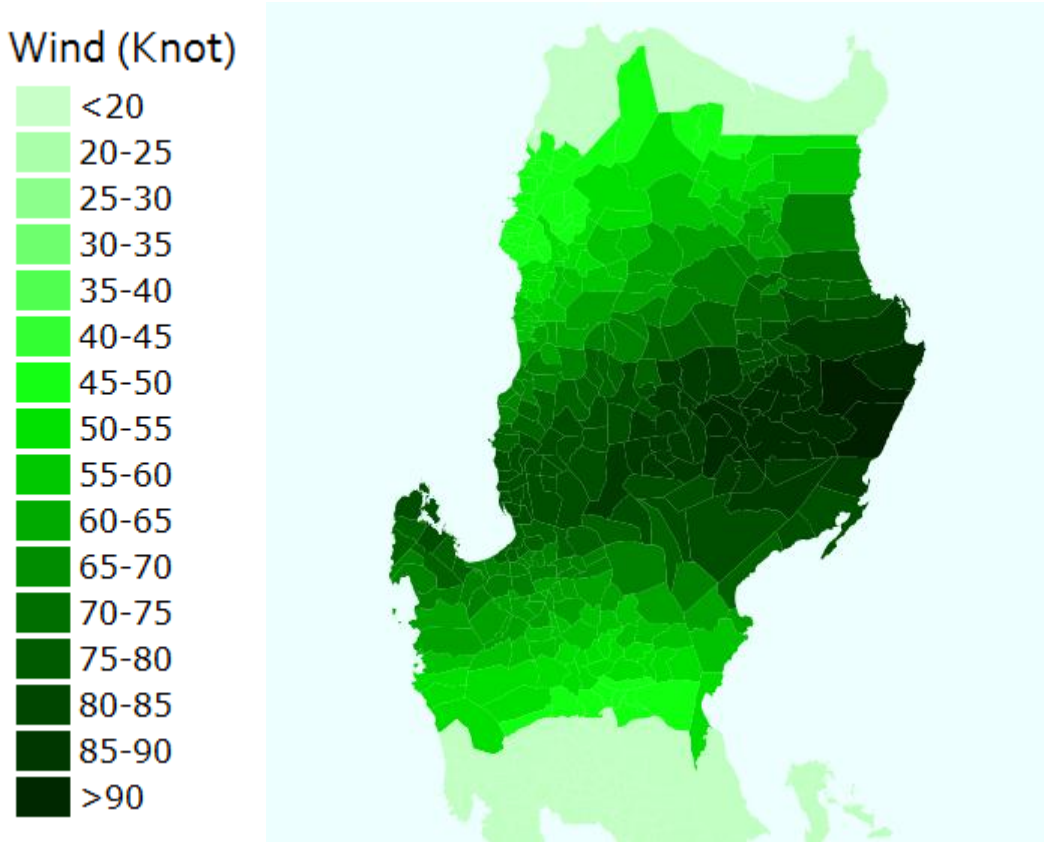

Figure 3.1 DHI's surface wind monitoring system after the passage of Quiel (Nalgae). Strong surface winds, represented as dark areas (left panel, intensity described in the legend), and the corresponding triggered areas (right panel).

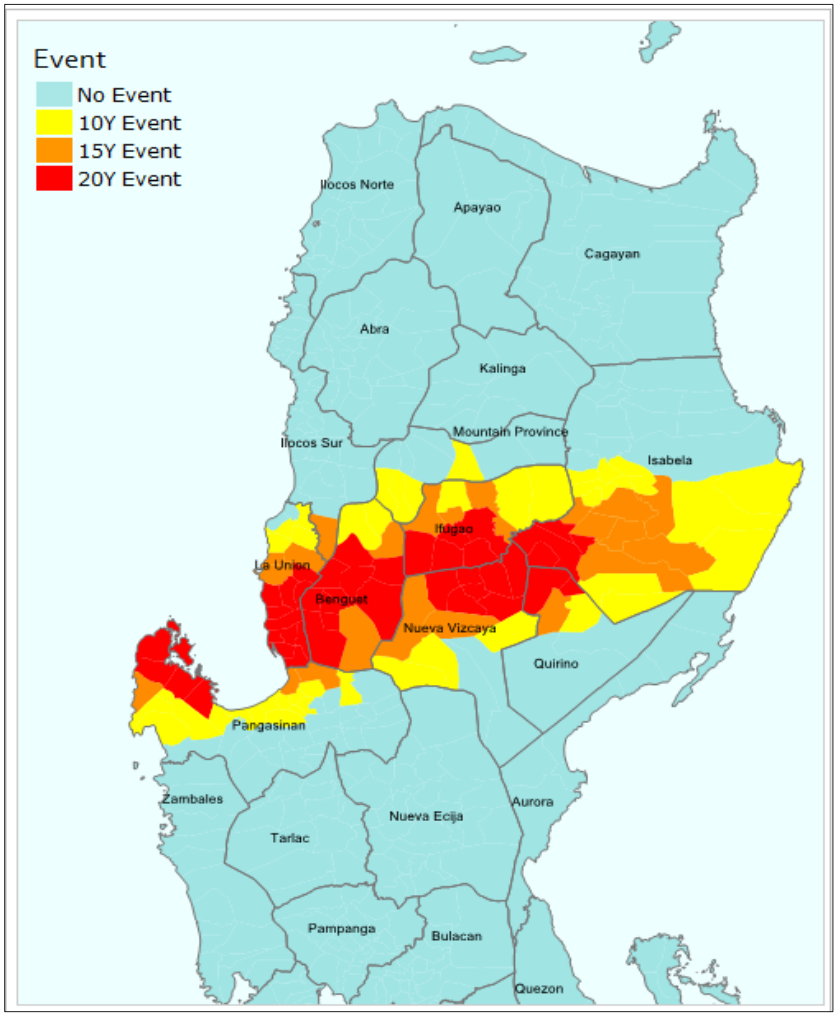

Figure 3.2 DHI's rainfall real-time monitoring system on October 1, 2011 showing the triggered areas. The legend displays the wind event expressed in years, according to their return period estimated by DHI's analysis.

Table 3.2 lists some of the 111 municipalities triggered by DHI's system due to the passage of typhoon Quiel (Nalgae) on October 2, 2011. They have been triggered by 10-year, 15-year and even 20-year events.

Table 3.2 List of triggered municipalities with their corresponding estimated surface wind values and type of event with the according trigger wind values

Municipality (Province)	Estimated Surface Winds (knots)	Event- Return Period in Years (Trigger Value)
AGOO (La Union)	79	20 (75)
AMBAGUIO (Nueva Vizcaya)	82	20 (81.3)
AGNO (Pangasinan)	71	15(69.7)
BAGUIO CITY(Benguet)	79	20 (75.8)
TUBA (Benguet)	79	20 (78.4)

4 State of Calamity Reported by NDRRMC

The NDRRMC did not report any state of calamity during the passage of Typhoon Quiel (Nalgae) following the last report (Sitrep No. 12) issued on October 10, 2011, at 6:00 a.m.

However, the Provincial Disaster Risk Reduction & Management Council, PDRRMC of Tarlac declared the whole province of Tarlac Under State of Calamity on October 6, 2011.