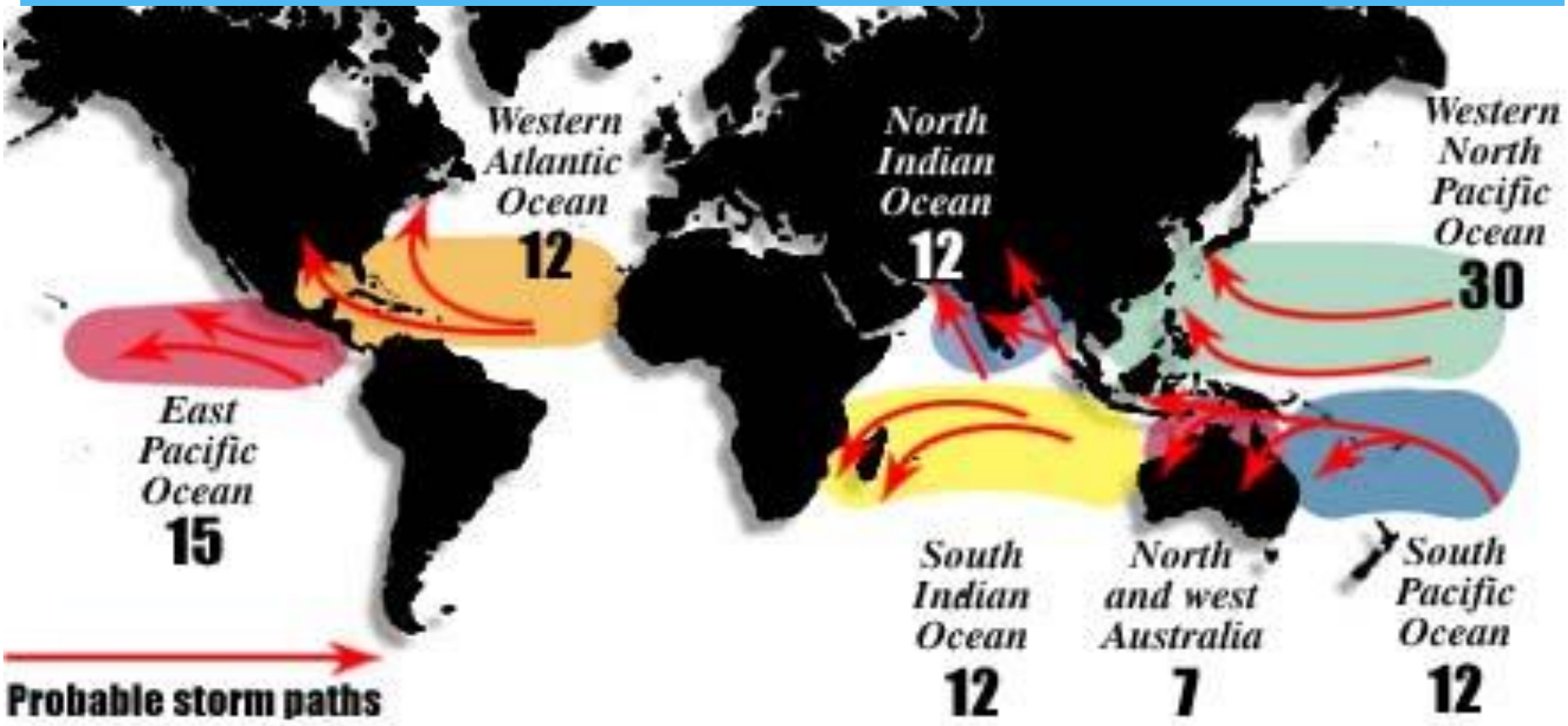
PAGASA

Philippine Atmospheric, Geophysical and Astronomical Services Administration

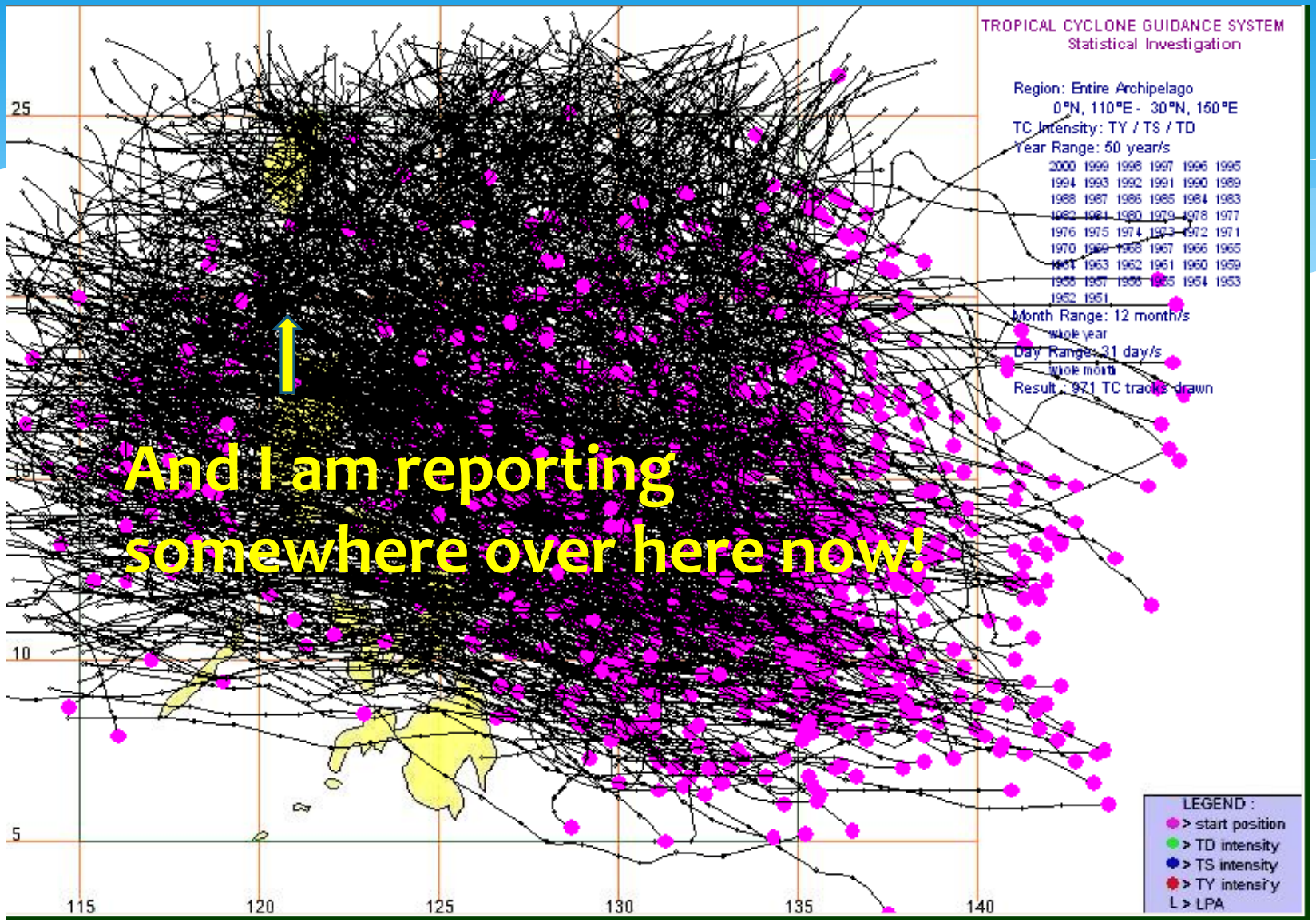
Report on TYPHOON YOLANDA (HAIYAN) Philippines

Philippine tropical cyclone climatology



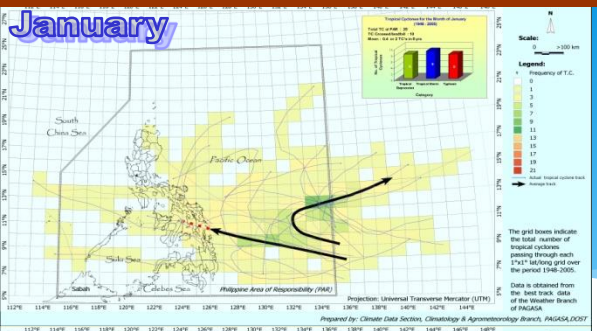
* Tropical cyclones which affect the country directly (landfalling) or indirectly usually forms over the warm waters of the Pacific Ocean on the east and at rare occasions, over the West Philippine Sea on the west.

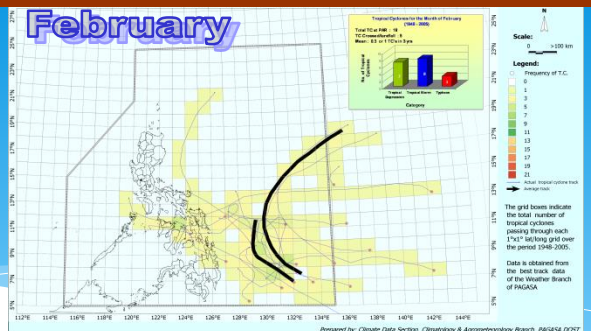
Philippine tropical cyclone climatology

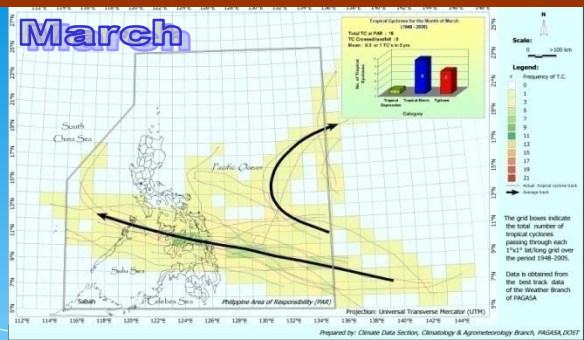


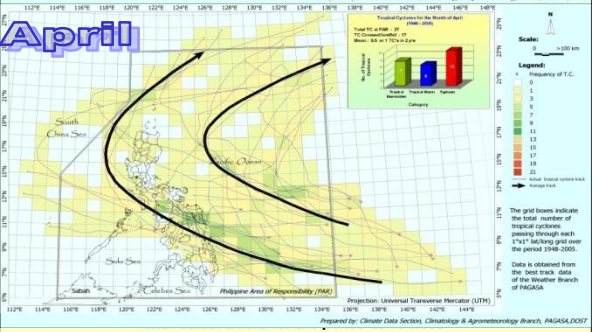
Consolidated tropical cyclone track within the PAR for the period 1951 – 2000.

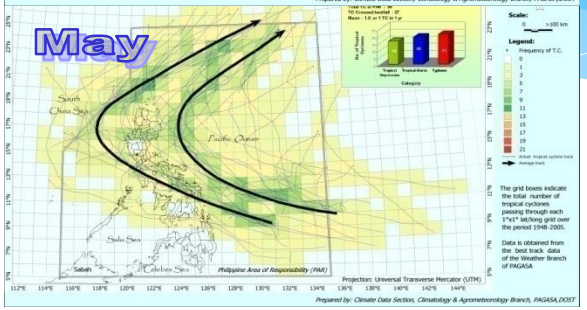
Average tropical cyclone tracks (1948-2005)

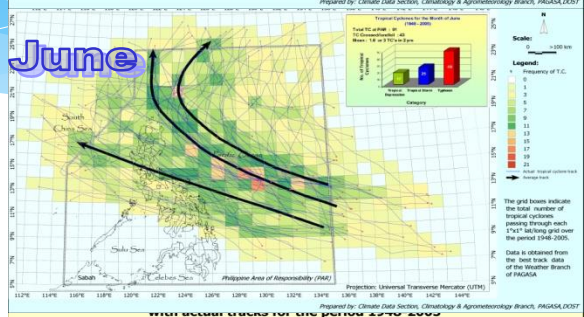


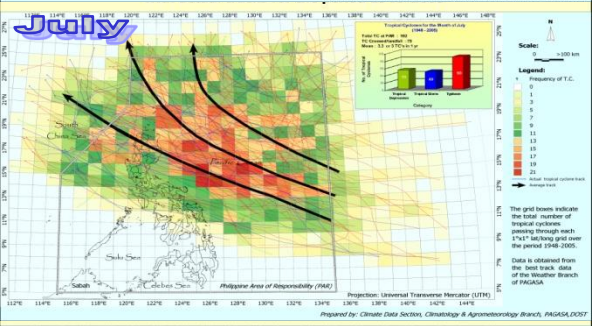


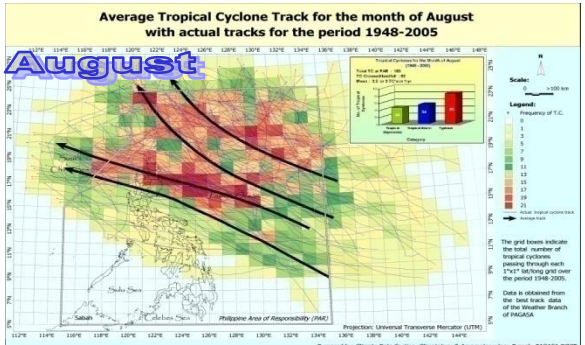


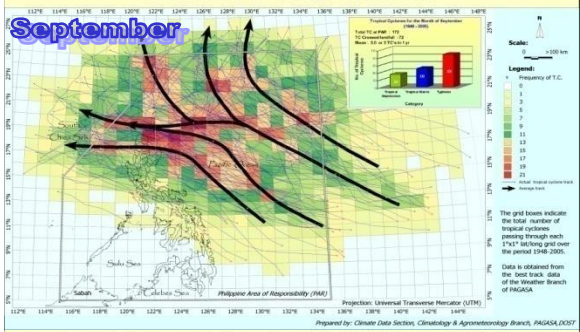


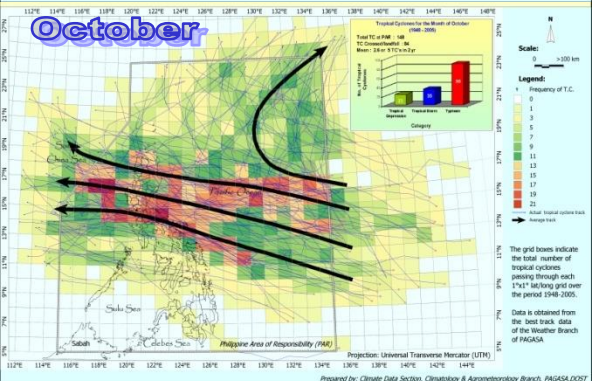


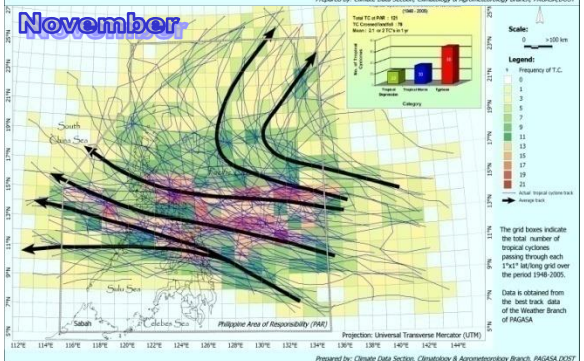


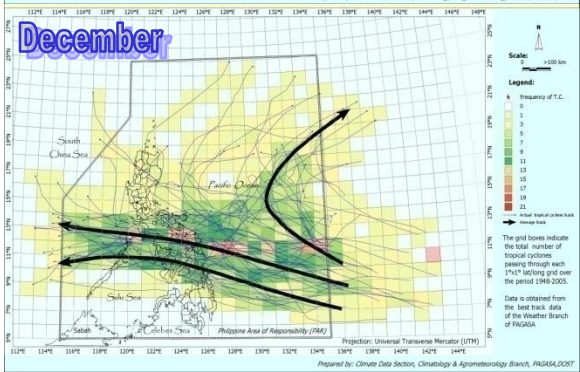




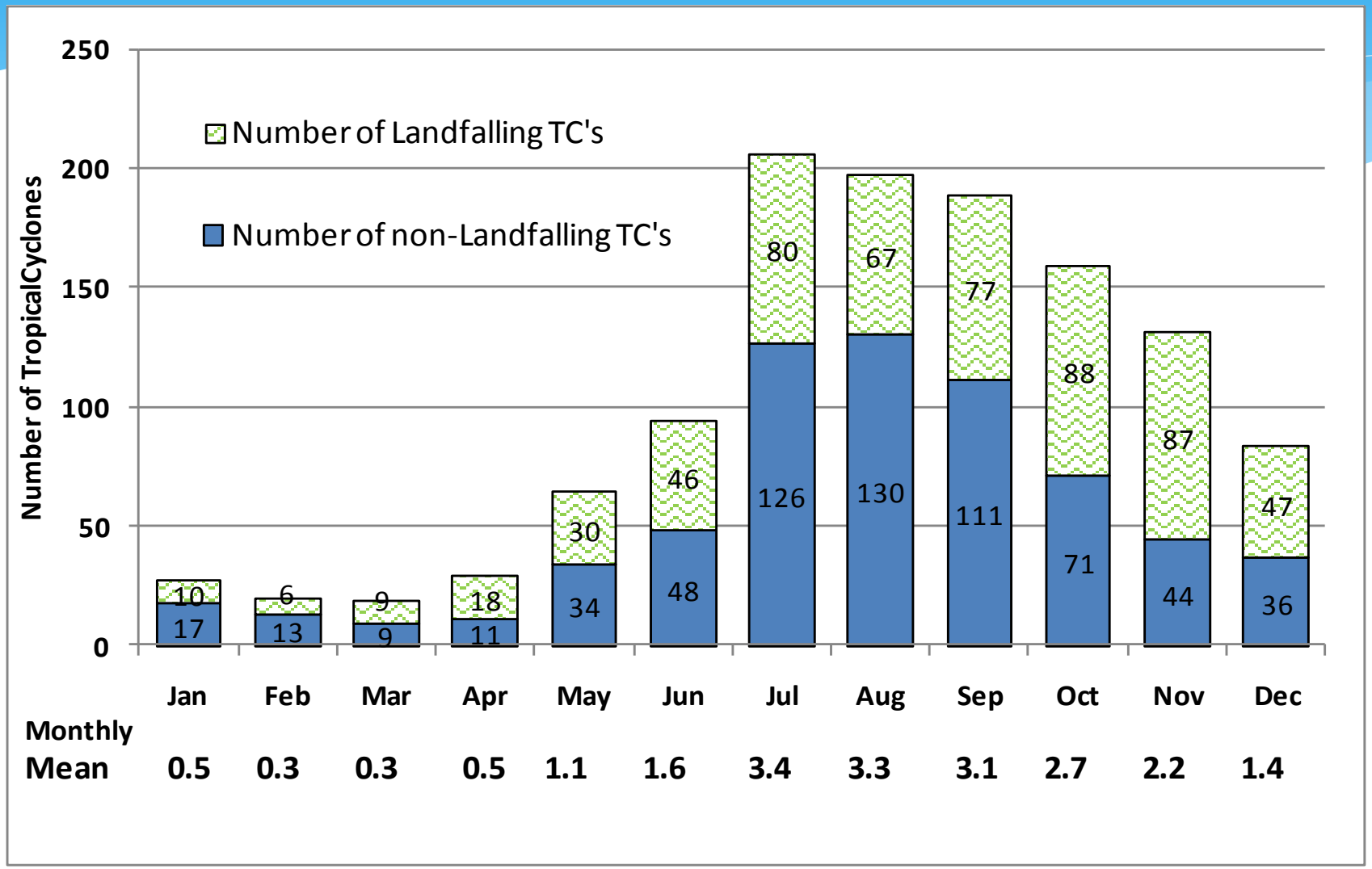




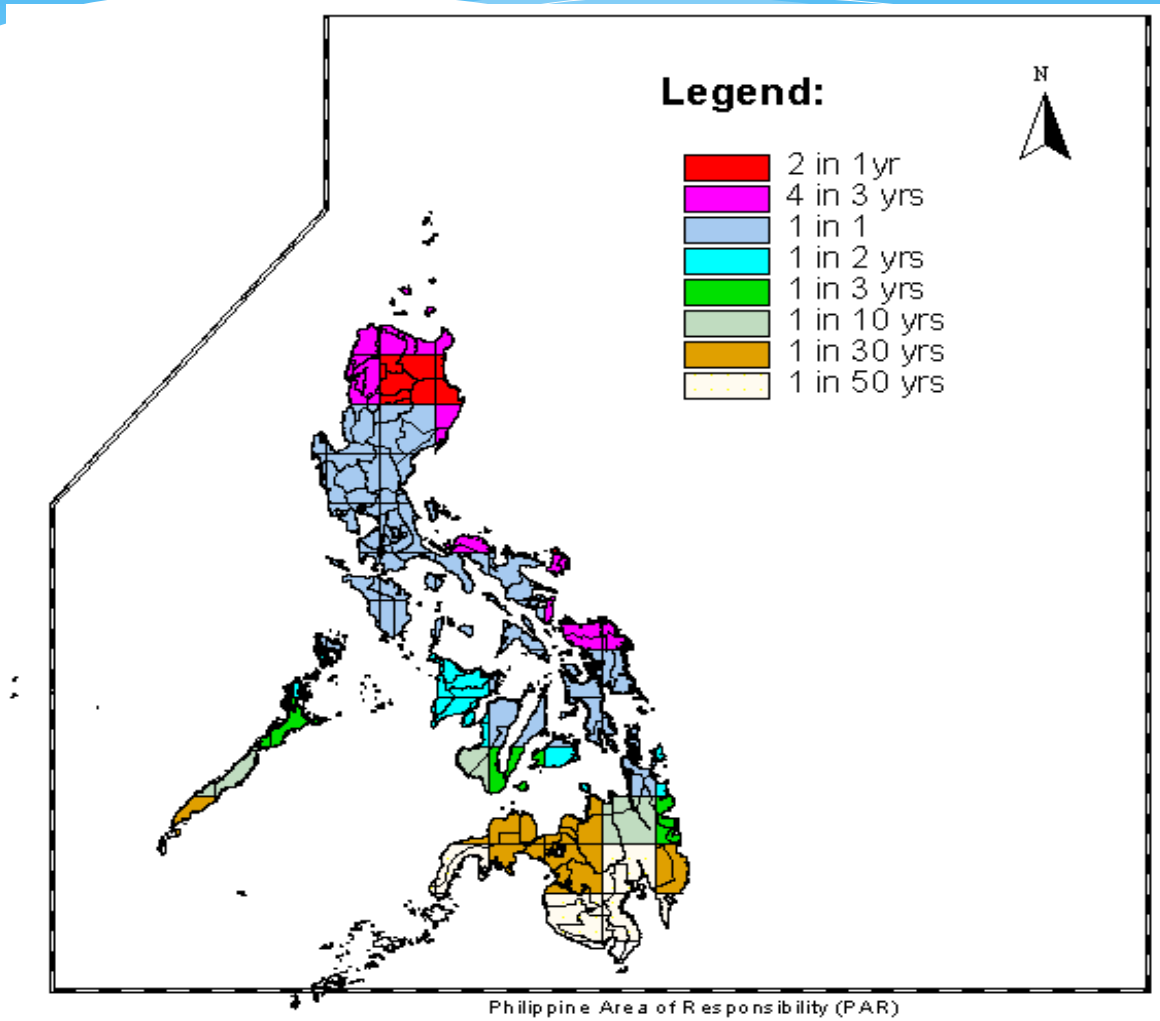




Monthly frequency of T.C. entering the PAR and crossing the Philippines (1948-2010)



Frequency of Tropical Cyclones in the Philippines (1948-2005)



Northern Luzon is most frequently hit by tropical cyclones followed by Catanduanes and Northern Samar and least in the Mindanao area.

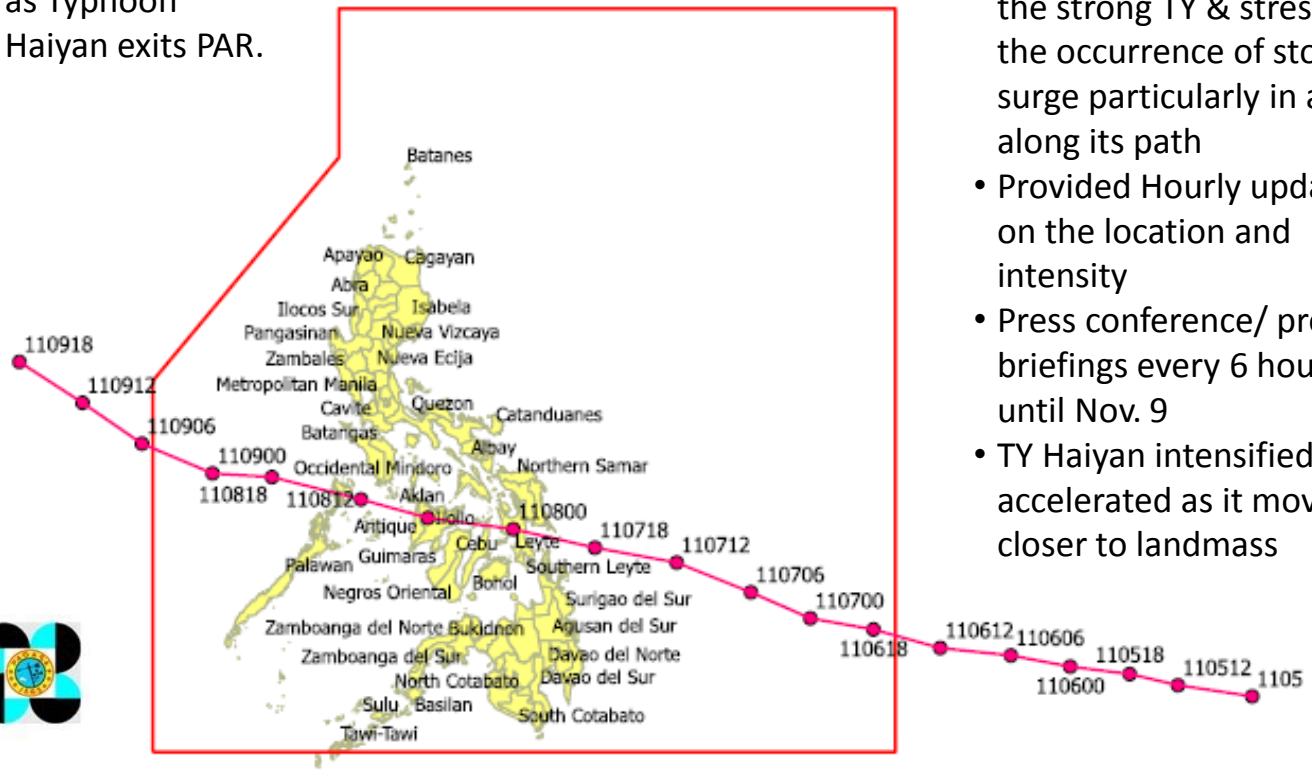
Chronology of PAGASA Activities

09 Nov 2013:

- PSWS #3 and #4 were lowered after Haiyan crossed Visayas islands and continued to move away from the country
- Final bulletin was issued at 3:30PM as Typhoon Haiyan exits PAR.

08 Nov 2013:

- Auxilliary bulletin was issued at 2AM to include other areas in Central Visayas and Southern Luzon under PSWS#4 due to acceleration of Haiyan
- 4:40AM, Haiyan made landfall over Guiuan, Eastern Samar
- 11PM, Haiyan exits the landmass of N. Palawan after crossing Central Visayas and Southern Luzon area



07 Nov 2013:

- Deployed STRIDE Team to Sorsogon
- Emphasized that a storm surge of **5-7 meters** is expected over the coastal areas in provinces of Surigao, Dinagat , **Samar and Leyte**, Sorsogon, Masbate, Northern Cebu and Bohol
- Conferred w/ the President who called for a nationwide preparation for the strong TY & stressed the occurrence of storm surge particularly in areas along its path
- Provided Hourly updates on the location and intensity
- Press conference/ press briefings every 6 hours until Nov. 9
- TY Haiyan intensified & accelerated as it moved closer to landmass

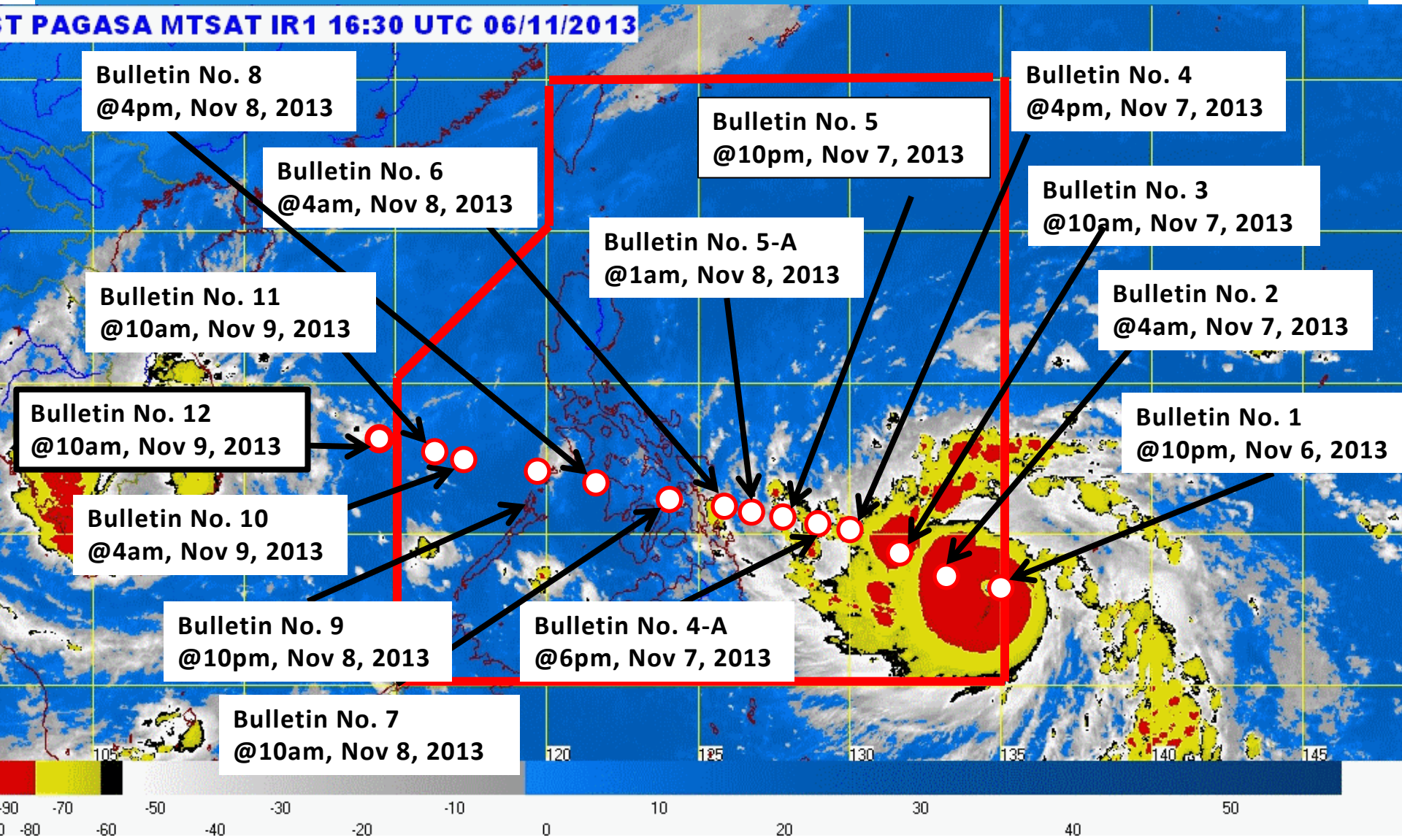
06 Nov 2013:

- Issued Regular Severe Wx. Bulletin although the TY was still outside PAR
- Presented in the NDRRMC meeting the forecast track of TY Haiyan and possible impacts
- Press conference - PAGASA emphasized that PSWS No. 4 will be issued and storm surge is expected.
- Assigned a meteorologist at the NDRRMC Operation Center
- Dispatched 2 meteorologists to Iloilo
- Dispatched 2 radar technicians to Hinatuan Radar operation.

05 Nov - Issued initial Weather Advisory
- Visayas PRSD alerted the media & Prov. Gov. of Cebu & Bohol approaching TY

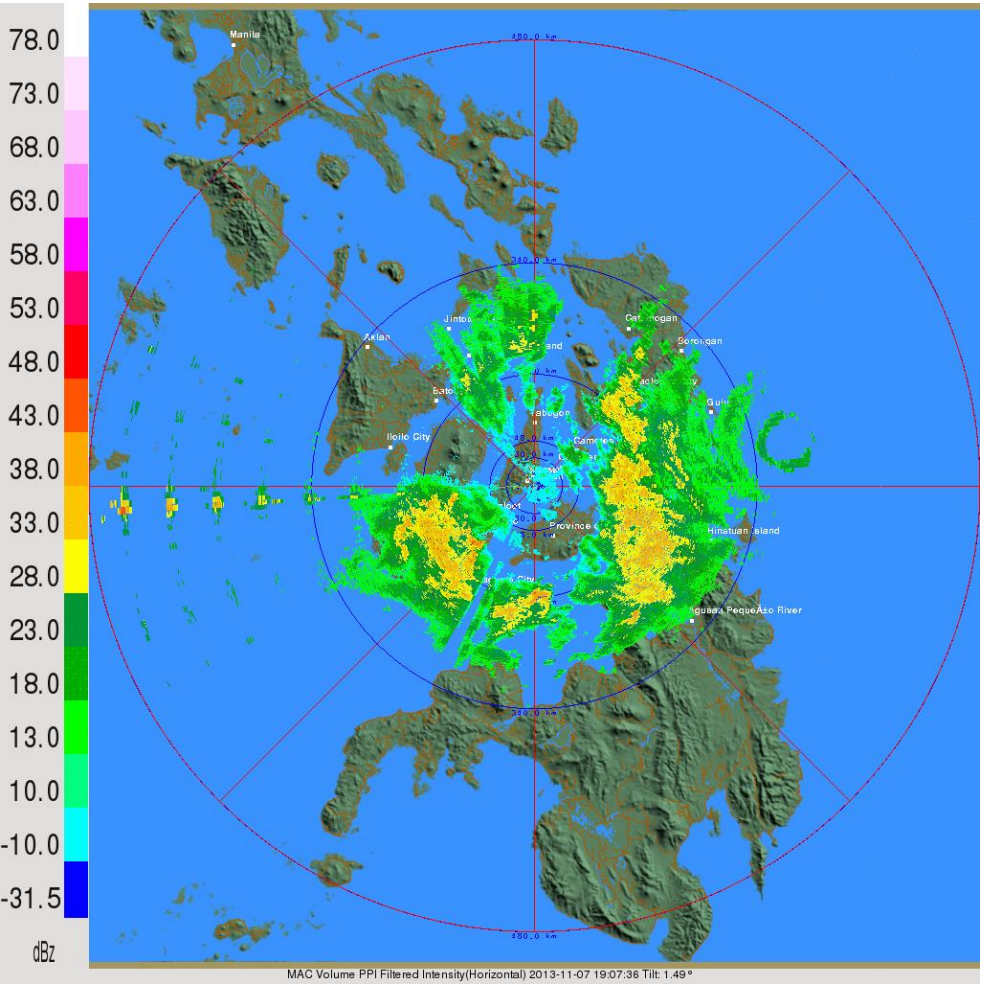
TYPHOON YOLANDA (HAIYAN)

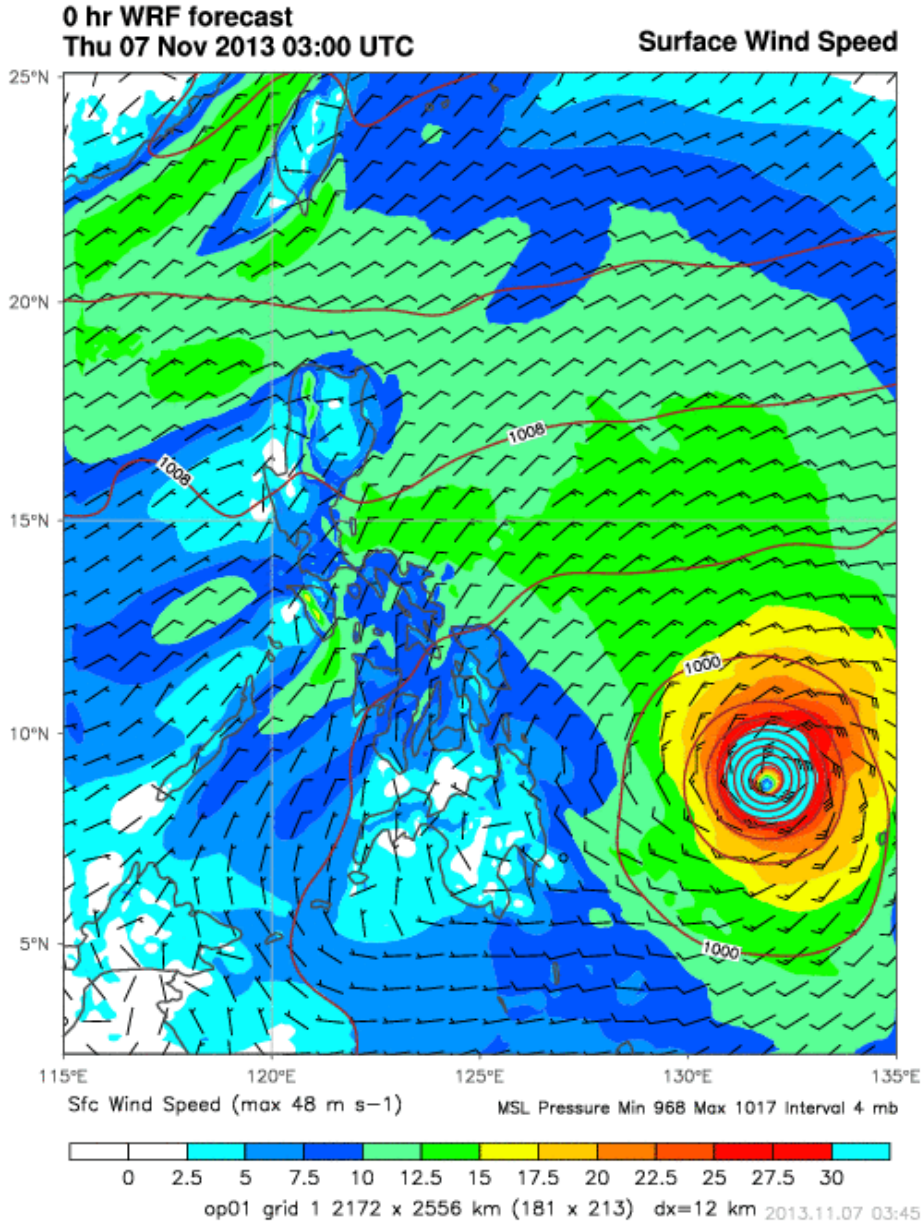
November 6 – November 10, 2013



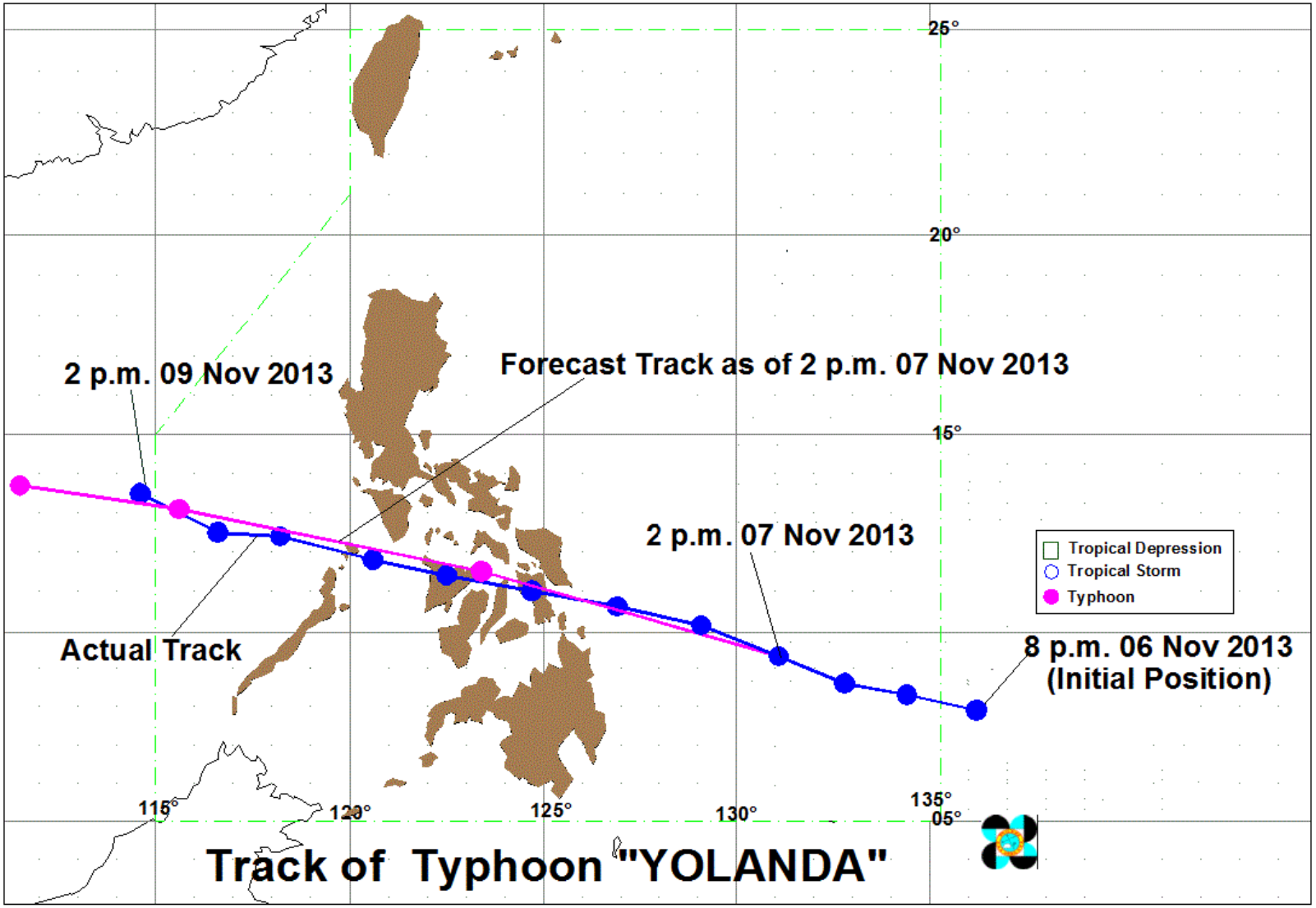
Typhoon HAIYAN "YOLANDA"

6-9 November 2013 (23rd TC in PAR in 2013)





Forecast Track vs. Actual Track

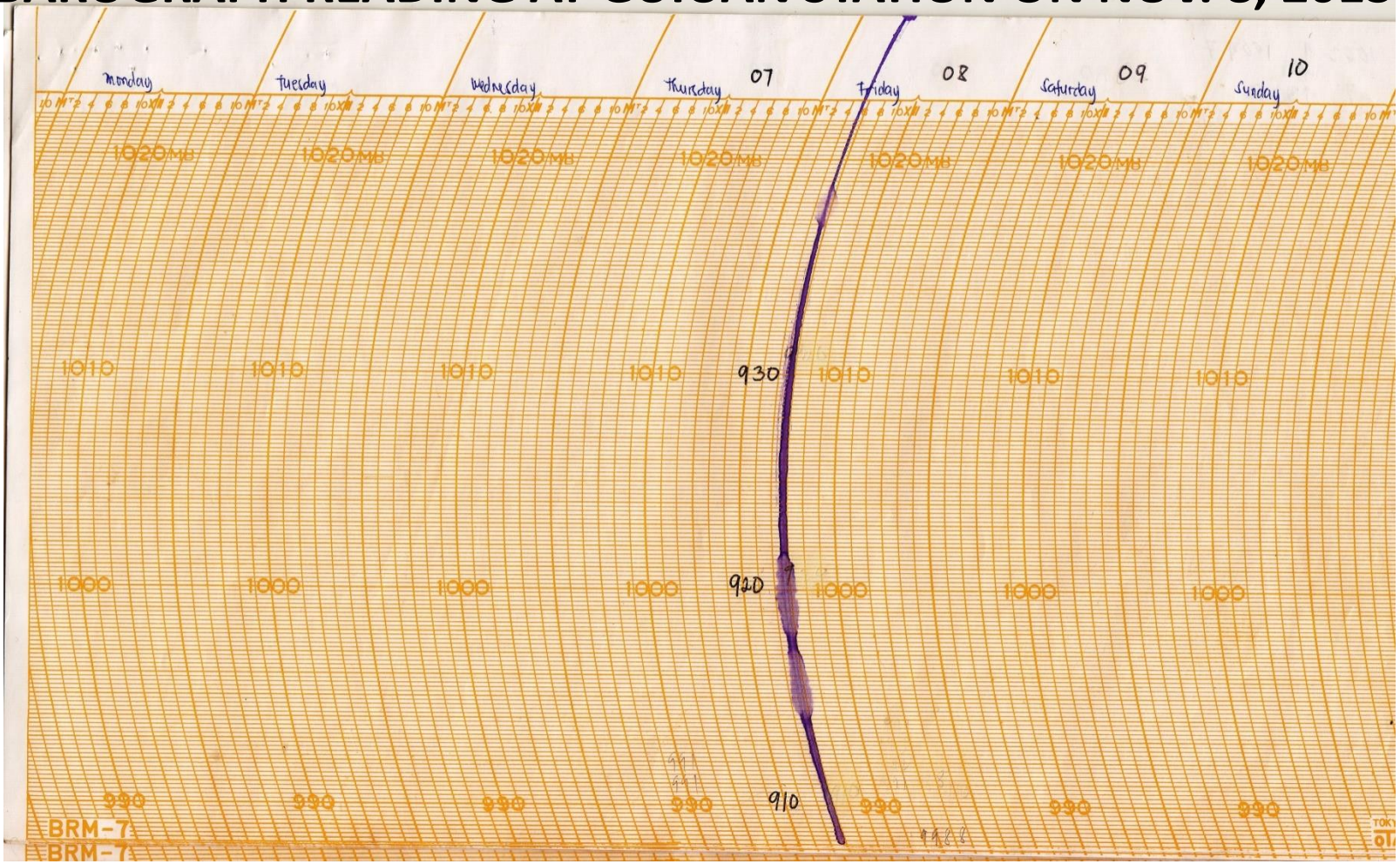


Actual track Forecast track

OBSERVED DATA

STATION	MAX SUS. WINDS	GUSTINESS
Guiuan, Eastern Samar	160 kph	195 kph
Roxas City	130 kph	205 kph
Coron, Palawan	55 kph	160 kph
San Jose, Mindoro	75 kph	120 kph

BAROGRAPH READING AT GUIUAN STATION ON NOV. 8, 2013



Lowest pressure in Guiuan Station = 910 hPa

- Observed at 5:00AM, Nov.8, 2013
- Equivalent to 240 kph max. sustained winds and 280 kph gustiness

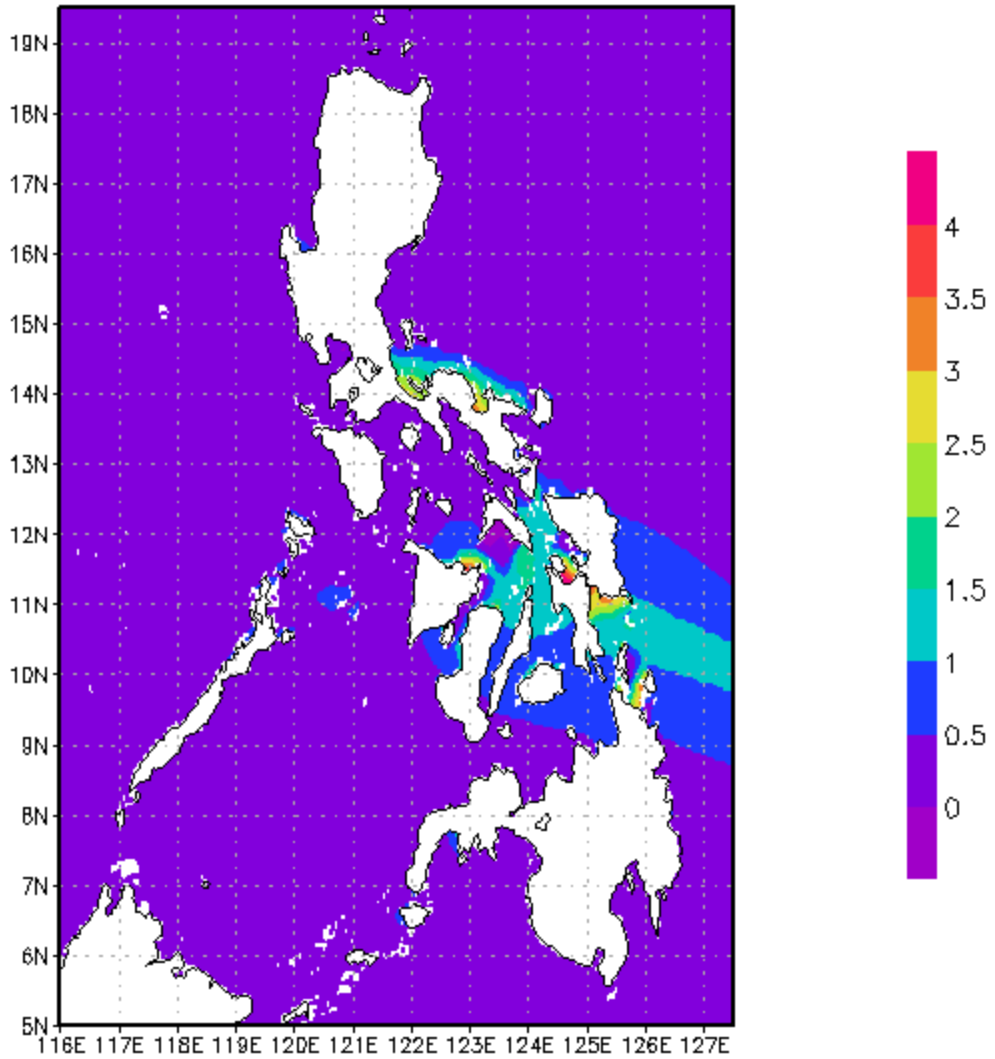
TY Yolanda vs TY Reming

Typhoon Reming: Nov. 30, 2006			
	Elevation	Max Winds	Remarks
Virac Radar	230 m	320 kph	
Virac Synop	40 m	270 kph	
Typhoon Yolanda: Nov. 8, 2013			
Guiuan Radar	60 m	280 kph	910 hPa Using barograph
	Note: Winds increases exponentially with altitude		

If Guiuan is at a the same height of Virac radar, the wind of TY Yolanda estimated to be 20% stronger: **Max. winds = 336 kph**

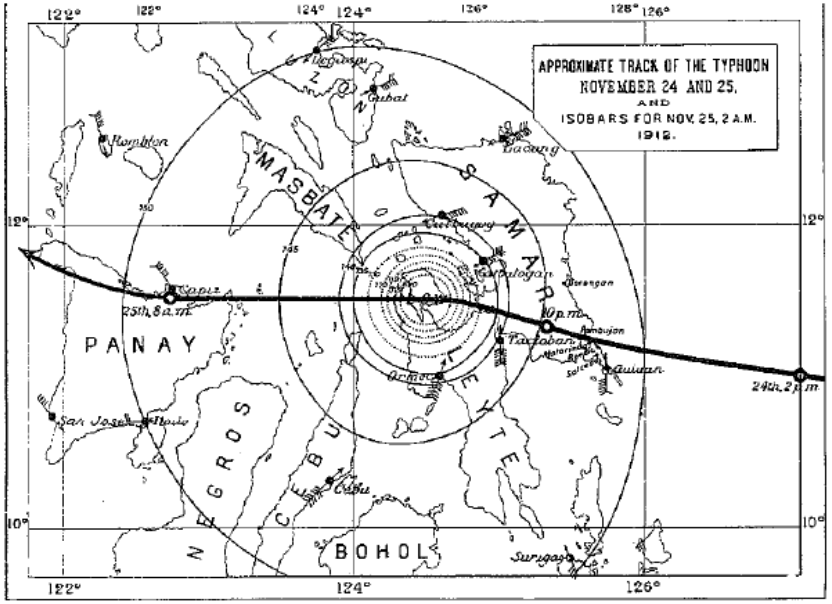
TY Yolanda is the strongest typhoon.

Highest Storm surge output of the JMA model run by PAGASA

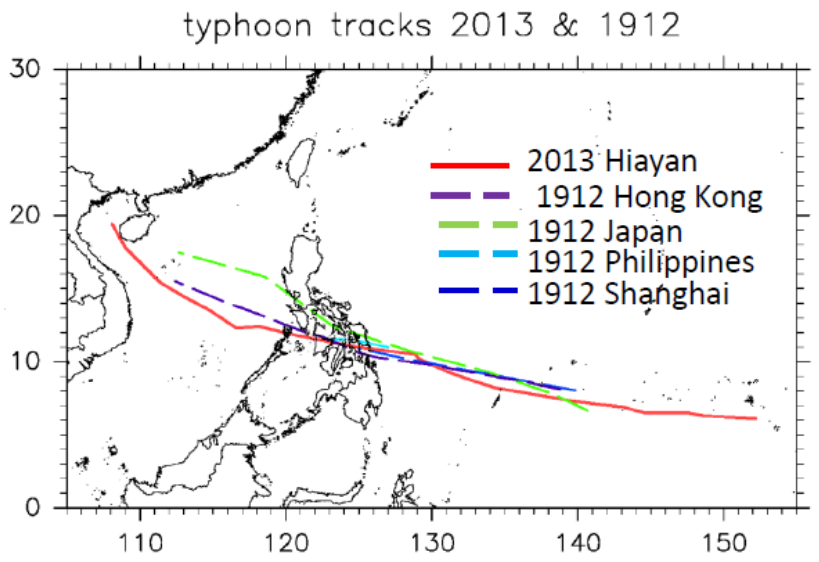


TC Tracks in November 1912 and November 2013 (Typhoon Yolanda)

TC track in Nov. 1912



Similar track to Typhoon Haiyan



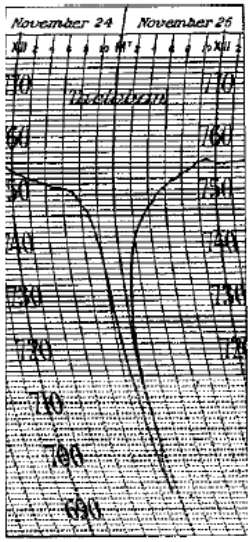
Landfall less than 920hPa

Water front, Tacloban.

EFFECTS OF THE TYPHOON IN LEYTE, NOVEMBER 24 TO 25.

Provincial Building, Tacloban.

Damage in Tacloban



Pressure measurement in Tacloban

Source : H. Kubota, 2014

Comparison between typhoon Haiyan (Yolanda) ,1912 typhoon, and 1897 typhoon

Haiyan (Yolanda) 2013	**1912 typhoon**	**1897 typhoon**
Maximum wind 240kph gust 280kph (Guiuan)	Maximum wind Beaufort scale 12 (Tacloban, Ormoc)	
Minimum station pressure 910.0 hPa (Guiuan)	Minimum station pressure 924.0 hPa (Tacloban)	Minimum station pressure 925.2hPa (Tanawan or Tanauan)
Storm surge damage Guiuan to Hernani 6-7m Tacloban to Palo 5-6m Basey 5-6m	Storm surge damage Santa Rita 7m Bobon, Tababao 6.1m Tacloban 2m Capiz 1m	Storm surge damage Hernani 7.3m Vasay 4.9m Guiuan 0.7m Tacloban 0.4m
(PAGASA)	(Monthly Bulletins of Philippines Weather Bureau 1912)	(Monthly Bulletins of Philippines Weather Bureau 1912, Some characteristics of Philippine typhoons 1939)

Source : H. Kubota, 2014

IMPACTS

PORT AREA
Several ships washed onto shore near a warehouse complex north of the city's downtown.

DOWNTOWN
People lined up for supplies in a downtown plaza, where debris from surrounding buildings littered the streets.

DEVASTATED COASTLINE
Buildings near the fish port were leveled by the storm surge, which sent water over half a mile inland in some places.

Homes all along the coast were completely destroyed. According to the Philippine census office, about one third of homes in the city have wooden exterior walls, and one in seven have grass roofs

FLOODED AREAS
Neighborhoods south of the city's downtown were inundated with water.

Sources: European Commission Copernicus Emergency Management Service; OpenStreetMap

Areas where structures were:
- Destroyed
- Heavily damaged
- Less than heavy damage or status unknown

1/2 MILE

PORT

Destroyed amphitheater

AIRPORT
The tiny peninsula where the Tacloban airport is located was devastated.

AIRPORT
All that remained of the airport was the runway. People lined up during the day hoping for fresh water, food or a flight out.

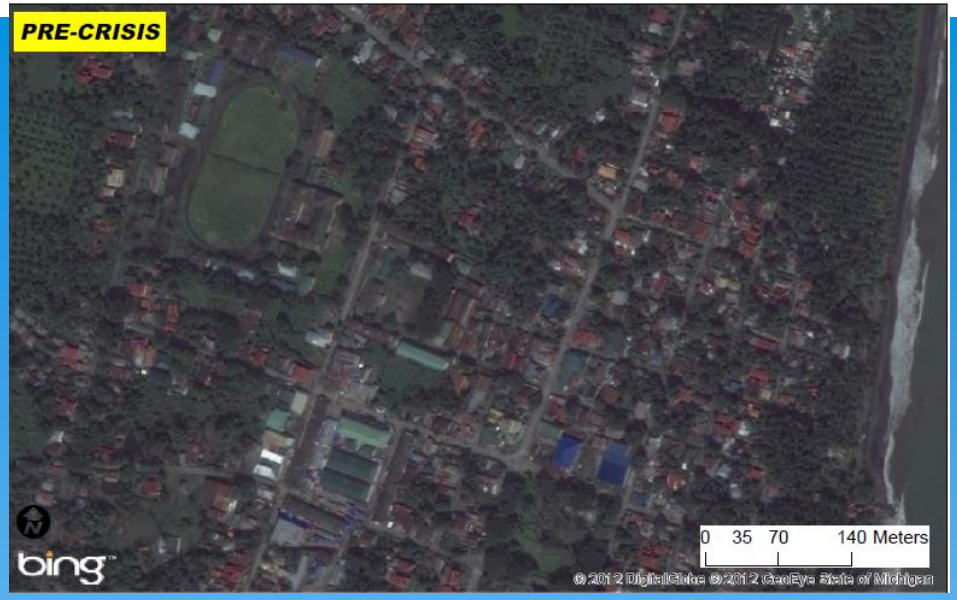
AIRPORT

Maharlika Highway

TACLOBAN

Tabuan National Highway

IMPACTS



unitar United Nations Institute for Training and Research UNOSAT

Production Date: 11/11/2013
Version 1.0
Activation Number: TC20131108PHL

DESTRUCTION IN DULAG TOWN, LEYTE PROVINCE, PHILIPPINES

As seen in WorldView-2 imagery collected 10 November 2013

UNITAR / UNOSAT
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T: +41 22 767 4020
24/7 hotline: +41 76 487 4998
www.unitar.org/unosat

Satellite Data (1): WorldView-2
Imagery Dates: 10 November 2013
Resolution: 50 cm
Copyright: DigitalGlobe
Source: USGS / HDDS
Satellite Data (2): Various
Imagery Date: Pre-Crisis
Copyright: Microsoft
Source: Bing

Road Data : Google Map Maker / OSM / ESRI
Other Data: USGS, UNCS, NASA, NGA
Analysis : UNITAR / UNOSAT
Production: UNITAR / UNOSAT
Analysis conducted with ArcGIS v10.1

Disaster coverage by the International Charter 'Space and Major Disasters'. For more information on the Charter, which is about assisting the disaster relief organizations with multi-satellite data and information, visit www.disasterscharter.org

The central portion of the town of Dulag with multiple structures and tree cover visible intact in pre-crisis image (top) collected prior to Typhoon Haiyan.

As of 10 November 2013 (bottom) most structures are gone with proximate debris indicative of complete destruction, and most tree cover likewise destroyed.

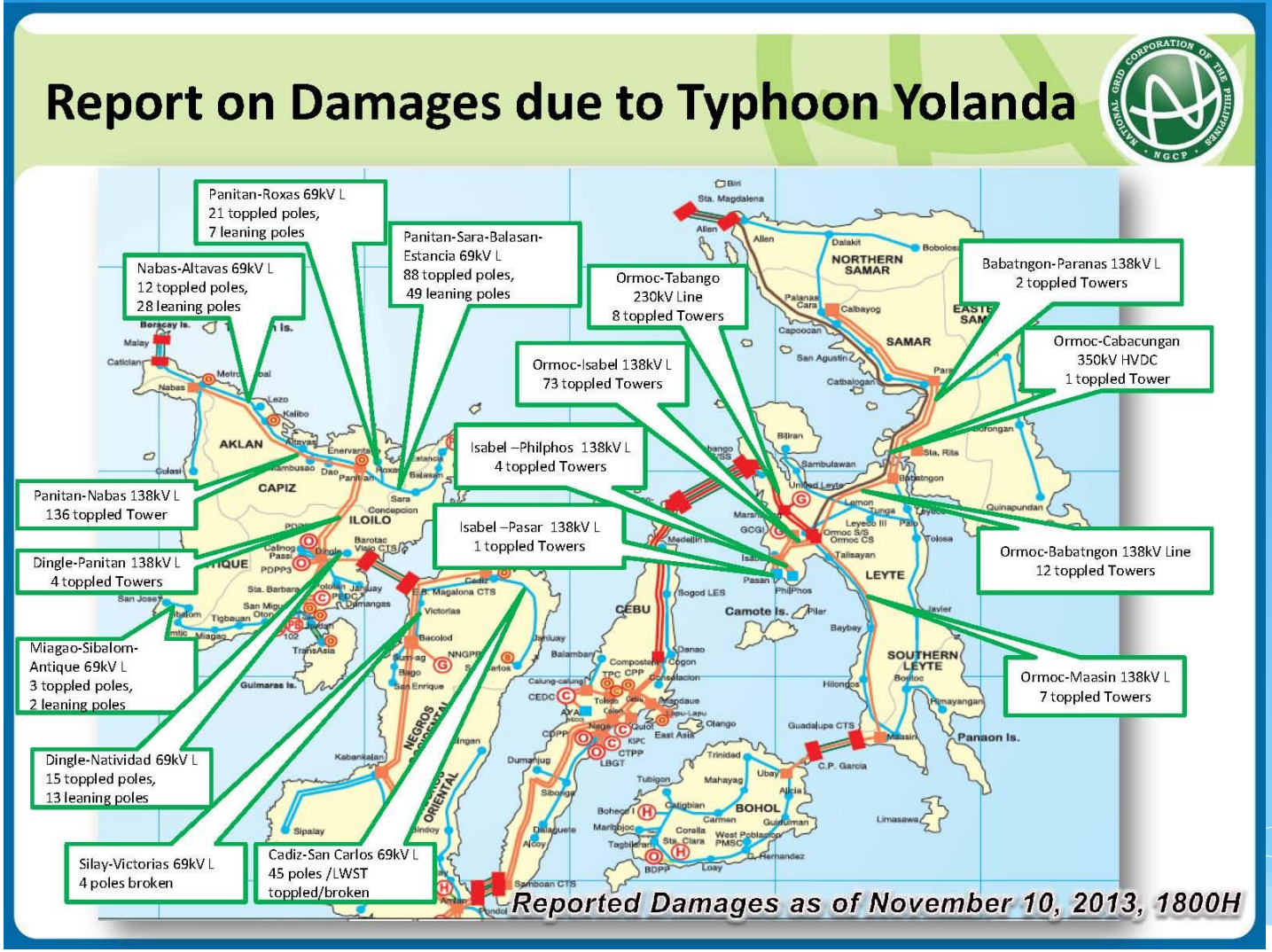
A portion of central Dulag town almost completely eradicated by Typhoon Haiyan. See Figure 1 (next page) for pre-disaster comparison.

Center Coordinates: 125°5'28.12"E 10°59'3.94"N

Tacloban City

IMPACTS

Impacts: Toppled towers of National Grid Corporation of the PH



Toppled:

- 40 transmission towers
- 2000 poles

Estimated cost of damage:

- PhP5 billion (USD119 M)

Source: NGCP

Impacts: Damaged PAGASA Doppler radar in Guiuan, Eastern Samar

photo - credit: AFP Central Command from their Facebook page: https://www.facebook.com/media/set/?set=a.356701284467306.1073741835.323973651073403&type=1

Impacts: Damaged PAGASA synoptic stations

(source: PAGASA Storm Chasers)

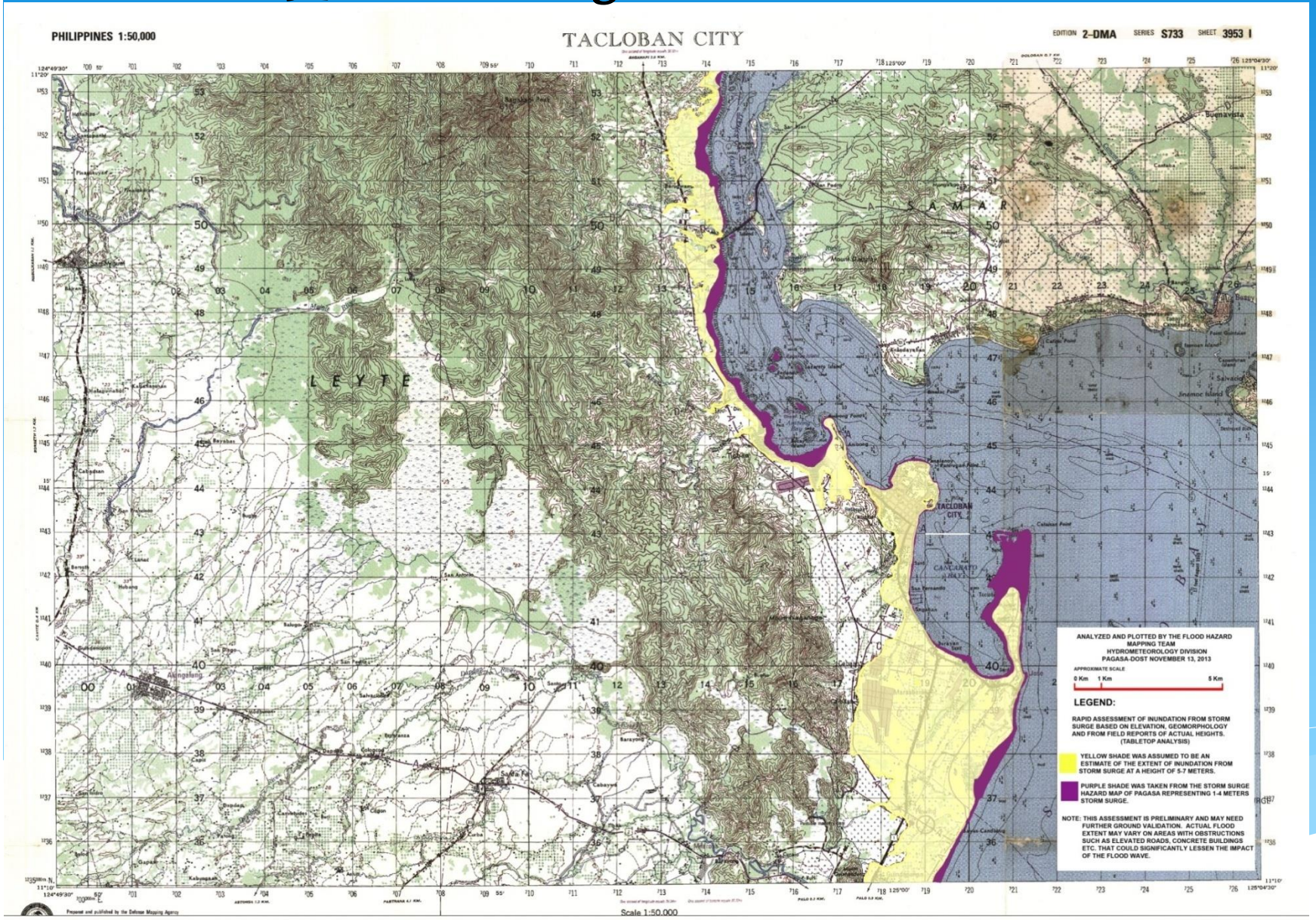
PAGASA Tacloban synoptic station

PAGASA Guiuan synoptic & radar station

List of Damaged PAGASA stations & facilities (P74.24M=44.24(bldg&eqpt) +30M(bouy))

Station/facility	Damage	Remarks
1. Tacloban Synoptic	Building and Equipment totally damaged	Operation suspended
2. Coron Synoptic	Building and Equipment totally damaged	Operation suspended
3. Guiuan Radar and Synoptic	Old and new radar equipment totally damaged while buildings were partially/totally damaged; all basic meteorological instruments were totally damaged except standard 8" raingauge	Operation suspended for 1 week. Operation resumed for rainfall and visual observation. Installed solar panel for temporary lighting system and radio communication
4. Catbalogan Synoptic	Building partially damaged	Installed solar panel for temporary lighting system and radio communication. Repaired genset.
5. Borongan synoptic	Broken glass windows	
6. Maasin synoptic	No communication	Restore communication after a week
7. Roxas synoptic	Observer quarter and station unroofed; power line and PLDT (telephone) connection cut down; thermometer shelter unroofed, antennae connection and wirings were lost.	
8. Cuyo synoptic	Radio antennae mast bent down	
9. San Jose (Occidental Mindoro) synoptic	Thermometer shelter unroofed	
10. Mambusao Agromet	Perimeter shelter of station and thermometer shelter damaged, outside gutter fell down	
11. Visca Agromet	Thermometer shelter blown down, rain gauge damaged; sunshine instrument realigned.	
12. Met Buoy (Madridejos,	Totally damaged	All sensors were retrieved and

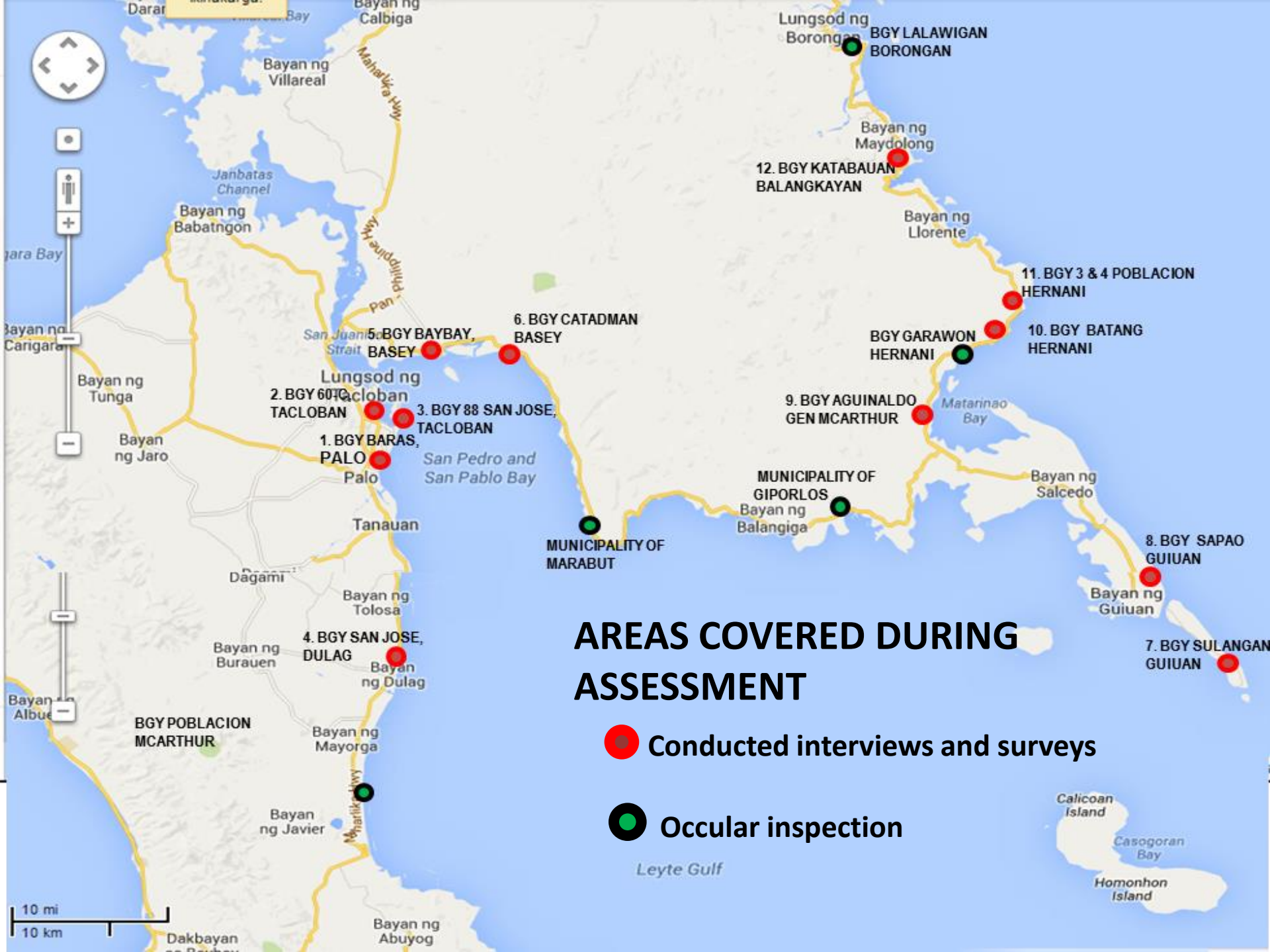
Estimated extent of inundation resulting from the forecast 5-7m storm surge



Assessment Report

(PAGASA STORM CHASER Team)

1. Typhoon Haiyan made landfall in Guiuan Eastern Samar specifically over Homonhon & Suluan Islands. The last recorded pressure before landfall at Guiuan station was 910.0 hPa. At this pressure, the equivalent **maximum sustained wind is 240kph** near the center and **gustiness up to 280kph.**
2. Based on interviews and actual observations in the area, the eye of Typhoon Haiyan passed between municipalities of Dulag and Tolosa, Leyte between 5am to 6am of Nov 8, 2013.
3. The provinces of Leyte and Eastern Samar were devastated by Typhoon Haiyan and the associated **storm surge.**
   - ***Tacloban to Palo Leyte 5 to 6 meters*** *with inundation of* ***600 to 800 meters.***
   - ***Basey Samar 5 to 6 meters*** *with inundation of* ***600 to 800 meters.***
   - ***Guiuan to Hernani Eastern Samar 6 to 7 meters*** *with inundation* ***of 800 to 1000 meters.***
   - *In Tacloban PAGASA station, 2 container vans which were intended as temporary shelter for PAGASA staff were carried by the storm surge 100 meters away.*


Lungsod ng Borongan
BGY LALAWIGAN BORONGAN
Bayan ng Villareal
Bayan ng Calbiga
Bayan ng Maydolong
12. BGY KATABAUAN BALANGKAYAN
Bayan ng Llorente
11. BGY 3 & 4 POBLACION HERNANI
10. BGY BATANG HERNANI
BGY GARAWON HERNANI
6. BGY CATADMAN BASEY
5. BGY BAYBAY, BASEY
Lungsod ng Tacloban
2. BGY 60 TACLOBAN
3. BGY 88 SAN JOSE, TACLOBAN
1. BGY BARAS, PALO
Palo
Bayan ng Tunga
Bayan ng Jaro
Janbatas Channel
Bayan ng Babatngon
San Juanico Strait
San Pedro and San Pablo Bay
Matarinao Bay
9. BGY AGUINALDO GEN MCARTHUR
MUNICIPALITY OF GIPORLOS
Bayan ng Balangiga
Bayan ng Salcedo
MUNICIPALITY OF MARABUT
Tanauan
Dagami
Bayan ng Tolosa
8. BGY SAPAO GUIUAN
Bayan ng Guiuan
7. BGY SULANGAN GUIUAN
4. BGY SAN JOSE, DULAG
Bayan ng Burauen
Bayan ng Dulag
BGY POBLACION MCARTHUR
Bayan ng Mayorga
Bayan ng Javier
Leyte Gulf
Calicoan Island
Casogoran Bay
Homonhon Island
Bayan ng Abuyog
Dakbayan
10 mi
10 km
AREAS COVERED DURING ASSESSMENT
Conducted interviews and surveys
Occular inspection

- **Check/validate the reported height of the storm surge**

ACTUAL SURGE HEIGHT= 6.4M

BGY. BARAS, PALO LEYTE

Actual Storm Surge Height (above msl)

	BGY/MUNICIPALITY	LAT	LON	H (msl)	INUNDATION
1	Bgy. Baras, Palo, LEYTE	11° 09.848'	125° 00.510'	6.39	800
2	Bgy 60C Old Rd Sagcahan, TACLOBAN	11° 13.556'	125° 00.242'	5.75	600
3	Bgy 88 San Jose, TACLOBAN	11° 12.656'	125° 01.604'	6.27	500
4	Bgy San Jose, Dulag, LEYTE	10° 59.108'	125° 02.347'	2.85	200
5	Bgy Baybay, Basey E. Samar	11° 17.021'	125° 04.277'	5.53	500
6	Bgy Catadman, Basey E. SAMAR	11° 16.290'	125° 09.164'	5.39	800
7	Bgy. Sulangan, Guiuan, E. SAMAR	10° 57.820'	125° 49.724'	7.14	800
8	Bgy Sapao, Guiuan, E. SAMAR	11° 02.835'	125° 45.524'	3.94	300
9	Bgy Aguinaldo Gen McArthur, E. SAMAR	11° 13.279'	125° 32.028'	2.26	80
10	Bgy. Batang, Hernani, E. SAMAR	11° 17.958'	125° 36.162'	6.61	800
11	Bgy 4 & 3 Poblacion Hernani, E. SAMAR	11° 19.384'	125° 37.040'	6.77	1000
12	Bgy 3 Katabauan, Balangkayan, E. SAMAR	11° 28.048'	125° 30.428'	6.96	800

Activities of the PAGASA Response Teams

- Basic instruments from destroyed Tacloban station were installed at the DOST Region 8 Office in Palo, Leyte
- Three (3) solar panels were put up for temporary lighting system and radio communication (SSB) at DOST R8 in Palo, Leyte, in Catbalogan and Guiuan stations.
- Repaired water line at Guiuan station
- Repaired the generator sets of Tacloban, Catbalogan and Catarman stations
- Repaired and re-installed all basic instruments in all affected PAGASA stations

TACLOBAN STATION

Basic met instruments are installed at a new site, at DOST Region 8 Office in Palo, Leyte

GUIUAN

THANK YOU!

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