MEMBER REPORT

ESCAP/WMO Typhoon Committee
4th Integrated Workshop

26-30 November 2012
China

Republic of the Philippines

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I. Overview of tropical cyclones which have affected/impacted Member's area in 2012 (January-October)

1. Meteorological Assessment (highlighting forecasting issues/impacts)

The year 2012 is not a normal year in terms of weather, climate and tropical cyclones (TC). The year started with a La Niña condition in January up to March, went on to neutral then reversed to developing El Niño up to the third quarter. From January to October 2012, fifteen (15) tropical cyclones entered the Philippine Area of responsibility (PAR), eight (8) of which are classified as typhoons, six (6) tropical storms and one (1) tropical depression. The tracks of the 15 TCs are shown in Fig.1.1. It is shown that most of the TCs did not cross the major Philippine islands except for two: TS Son-Tinh (Ofel) which crossed Central Visayas and TS Kai-Tak (Helen) which only passed the northern tip of Luzon. Likewise, it is noted that the TC activity this year is shifted more to the East of Philippine Sea (Western North Pacific Ocean). Seven (7) TCs have northward track, three (3) TCs passed over northern tip of Luzon or the Batanes group of islands while one (1) TC crossed central Philippines (Visayas and Mindoro islands) in October.

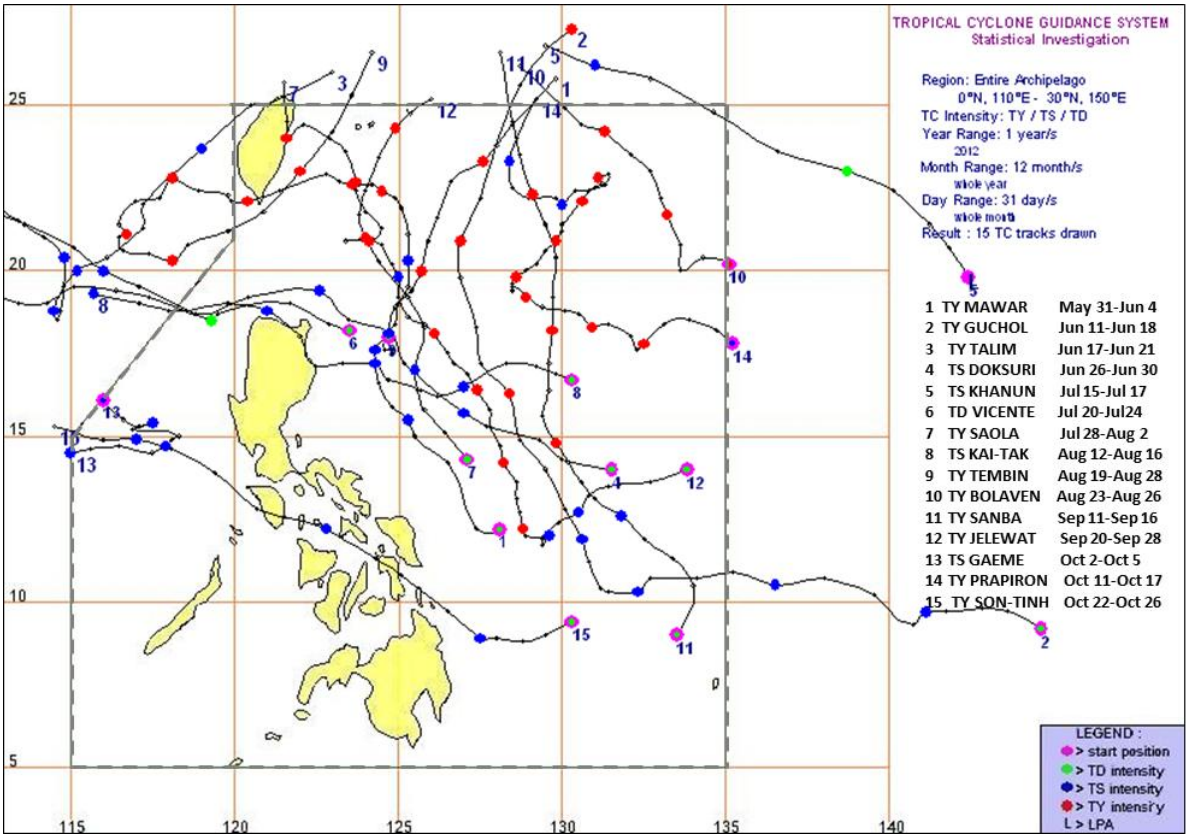


Fig. 1.1. Tracks of tropical cyclones that entered the Philippine Area of Responsibility (PAR, dashed line) for the period January-October 2012.

The characteristics and rainfall distribution associated with the 15 TCs are described and summarized as follows:

a. Typhoon "Mawar" (Ambo, 1203): May 31 – June 5, 2012

The first tropical cyclone for 2012 formed inside the PAR over East of Visayas, developed into a depression in the evening of May 31 and was named Mawar (Ambo). It intensified into a tropical storm and became a typhoon as it moved NW then to NNE going out of the PAR on June 5. Although it did not cross the islands, TY Mawar (Ambo) enhanced the southwest (SW) monsoon rainfall over the western sections of the country (Fig. 1.2). Public Storm Warning Signal (PSWS) Number 2 was raised over the Batanes Group and Calayan Islands.

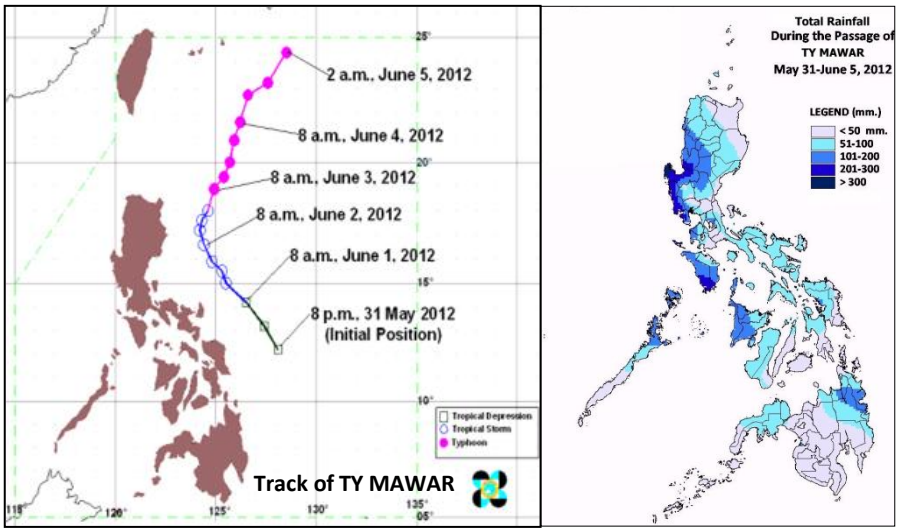


Fig. 1.2 Track of Typhoon Mawar (Ambo) (left) and the total rainfall during its passage on May 31-June 5, 2012.

b. Typhoon "Guchol" (Buchoy, 1204): June 12-18, 2012

TY Guchol formed outside the PAR in the vicinity of Caroline Islands and developed into a tropical depression on June 12. It entered the Philippine border as a tropical storm on June 14 moving west then NNW to NNE gaining strength into a typhoon with well-defined eye on June 16 moving out of the northern border PAR towards Japan on June 18.The track of TY Guchol (Fig. 1.3) is more or less similar to TY Mawar, only a little more shifted to the east. It did not cross the Philippine islands but enhanced the southwest monsoon resulting to widespread rains over the western section of Luzon. PSWS No. 1 was raised over eastern Visayas (Samar).

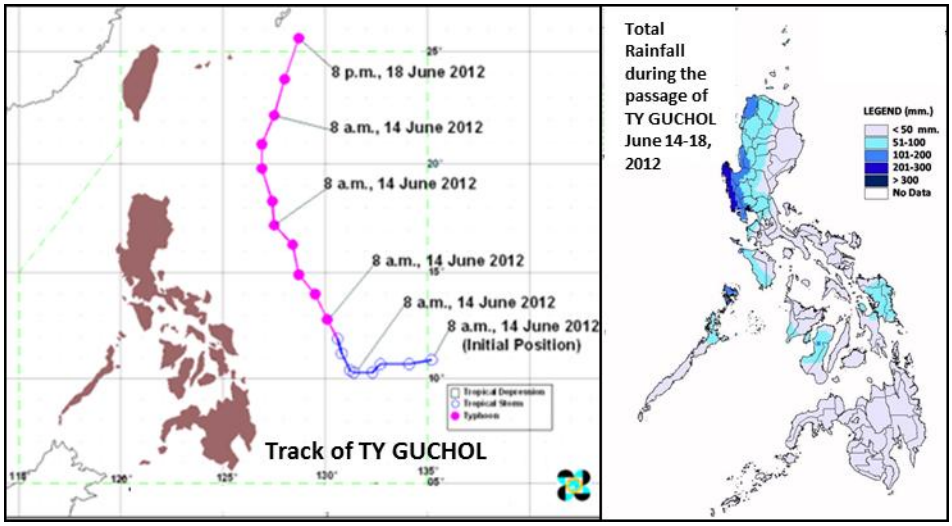


Fig. 1.3 Track of TY Guchol (Buchoy) (left) and the associated rainfall during its passage on 14-18 June 2012.

c. Tropical Storm Talim (Carina, 1205): June 20, 2012

The third TC, TS Talim, developed from the monsoon trough over Hainan extending across extreme northern Luzon. This TC developed into a tropical depression on June 17 in the vicinity of Hongkong and intensified into a storm as it moved northwestward. It briefly entered PAR over west of Taiwan for one day, June 20 then weakened as it passed the northern strait of Taiwan. TS Talim has no direct effect on the Philippines so no warning signal was raised and no rainfall is attributed to its passage.

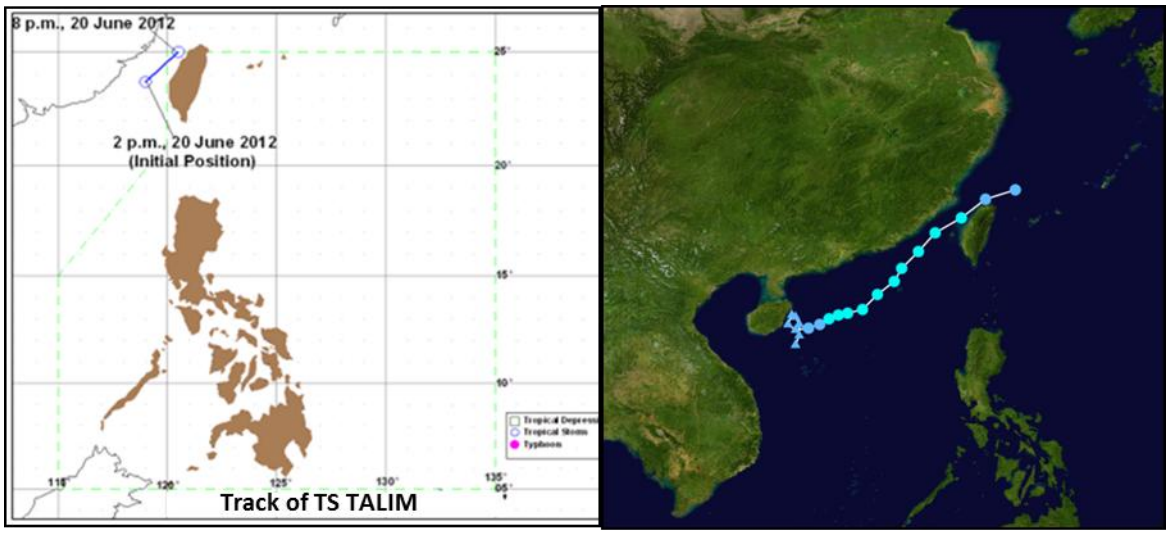


Fig. 1.4. Track of Tropical Storm (TS) Talim (Carina) within the Philippine Area of Responsibility (PAR) (left) and the complete track of TS Talim (right). *Source: Wikipedia, created by Keith Edkinsusing Wikipedia: WikiProject Tropical cyclones/Tracks. The background image is from NASA. Tracking data is from NRL).*

d. Tropical Storm Doksuri (Dindo, 1206): June 26-30, 2012

TS Doksuri (Dindo) started as a low pressure area embedded in the intertropical convergence zone (ITCZ). It developed into a tropical depression in the PAR on June 26, gaining tropical storm intensity as it moved NW towards northern Luzon. TS Doksuri crossed Balintang Channel and moved out of the Philippine border towards southern China on June 30. PSWS No. 2 was hoisted over northern Luzon and the surrounding small islands during the TCs passage. Extreme northwestern Luzon received the highest amount of rainfall (about 300 mm) for the duration of the TC.

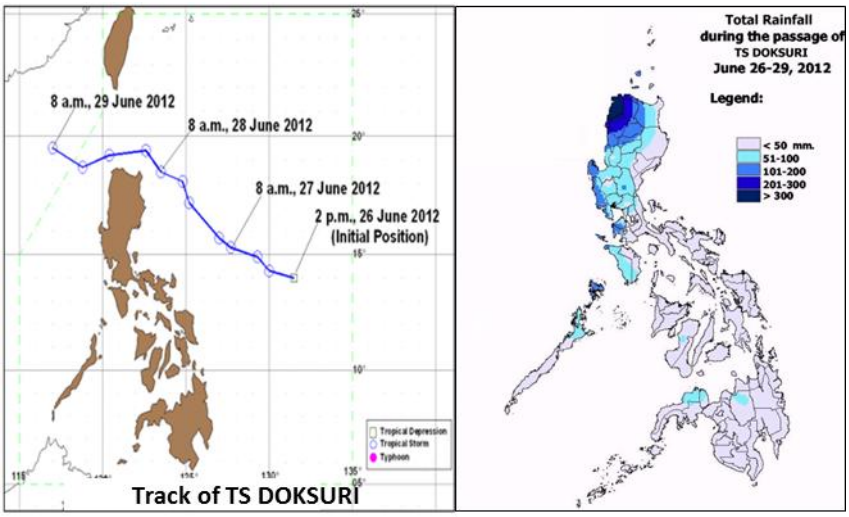


Fig. 1.5. Track of TS Doksuri (Dindo) and the associated rainfall during its passage on July 26-29, 2012.

e. Tropical Storm Khanun (Enteng, 1207): July 15 – July 17, 2012

TS Khanun originated from a low pressure area over the northwest of Guam which developed into a tropical depression (TD) on July 15. The TD gained storm intensity as it moved NW barely stepping over the northeastern border of PAR on July 16. It moved northward towards Southern Korea. TS Khanun was too far to affect the Philippine islands, hence no significant rainfall amount was recorded.

f. Tropical Depression Vicente (Ferdie, 1208): July 20-21, 2012

TD Vicente developed into a tropical depression on July 20 over east of Aparri, Cagayan, northern Luzon. The TD moved westward crossing Balintang Channel and went out of PAR towards southern China where it made landfall over Guandong. TD Vicente enhanced the southwest monsoon resulting to heavy rains over the western sections of Luzon.

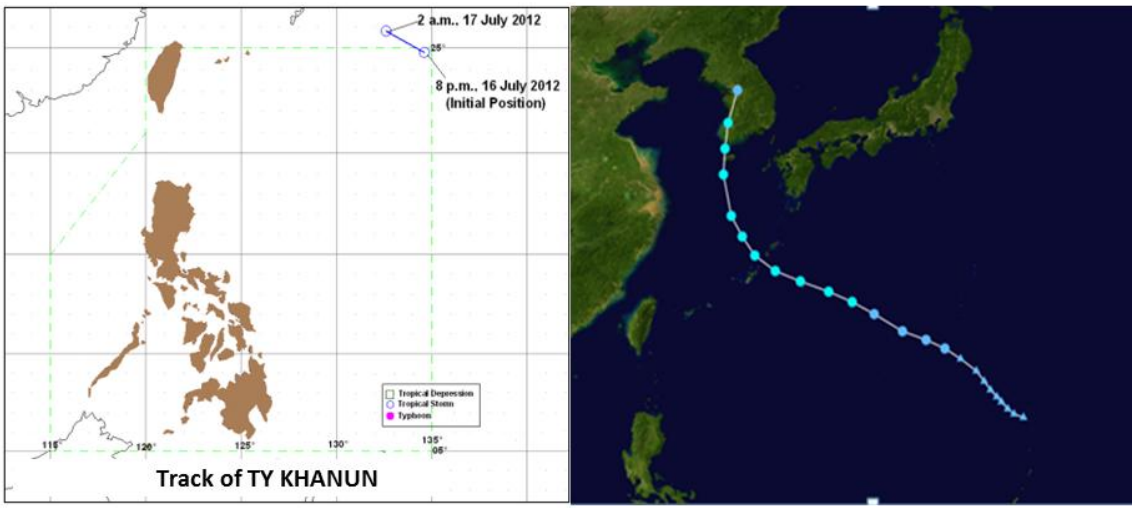


Fig. 1.6. Track of Typhoon (TY) Khanun (Enteng) during its passage within the Philippine Area of Responsibility (PAR) (left) and its complete track from Guam to Korea (right). *Source: Wikipedia, created by Keith Edkinsusing Wikipedia: WikiProject Tropical cyclones/Tracks. The background image is from NASA. Tracking data is from NRL).*

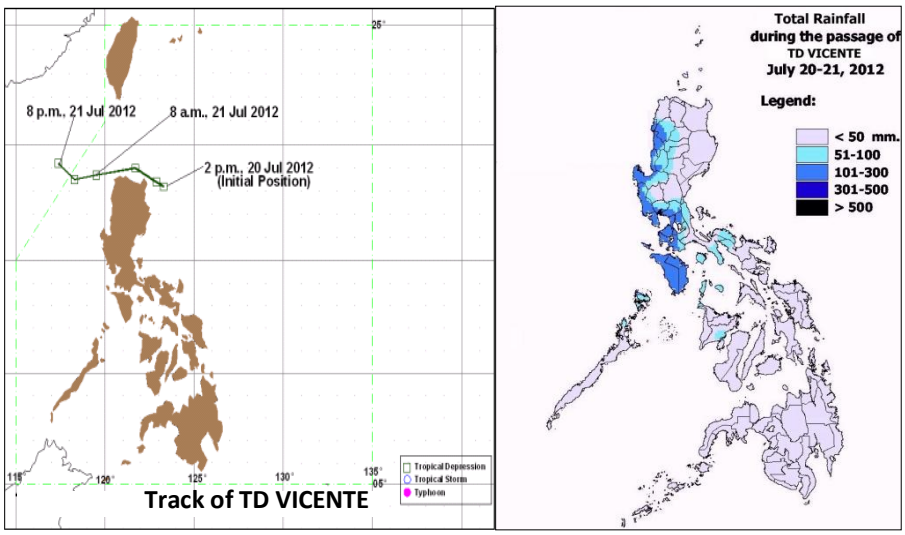


Fig. 1.7. Track of Tropical Depression (TD) Vicente (Ferdie) and the associated total rainfall during its passage on July 20-21, 2012.

g. Typhoon Saola (Gener, 1209): July 28 – August 2, 2012

Tropical depression Saola developed over about 500 km east of Bicol region on July 28. It intensified rapidly into a tropical storm as it moved northward with the eye forming as it reached typhoon intensity on July 30. It slowed down as it moved NNW and made landfall over eastern coast of Taiwan on Aug. 2. It slowly moved inland making a counter-clockwise loop then headed out towards China mainland. Although TY Saola did not come close to Philippine islands, it enhanced the southwest monsoon resulting to heavy rains over the western sections of the country. Widespread flooding was reported in Metro Manila.

While TY Saola (Gener) was over the NE of Luzon in the evening of August 29, an interesting phenomenon called mesocyclone developed over West Philippine Sea and crossed Metro Manila –Central Luzon area in about two hours. A mesocyclone is a storm scale circulation typically around 3-10 km diameter with a duration of four hours. It is not a common visually observable phenomena but can be depicted in a radar as a circulation as shown in Fig. 1.9. The heavy rains and strong winds associated with the mesocyclone and the enhanced SW monsoon due to TY Gener generated a storm surge along Manila Bay (Fig. 1.10) and widespread flooding in Metro Manila.

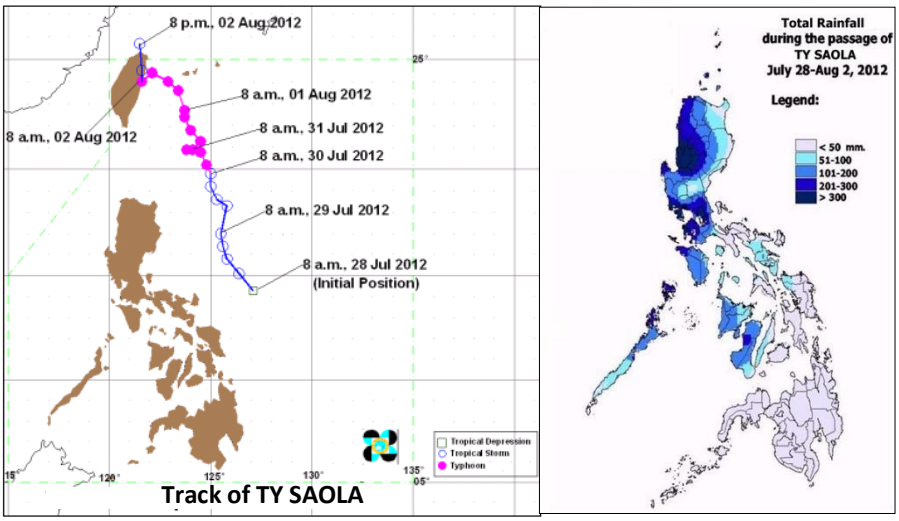


Fig. 1.8. Track of Typhoon Saola(Gener) (left) and the associated rainfall during its passage on July 28- Aug. 2, 2012.

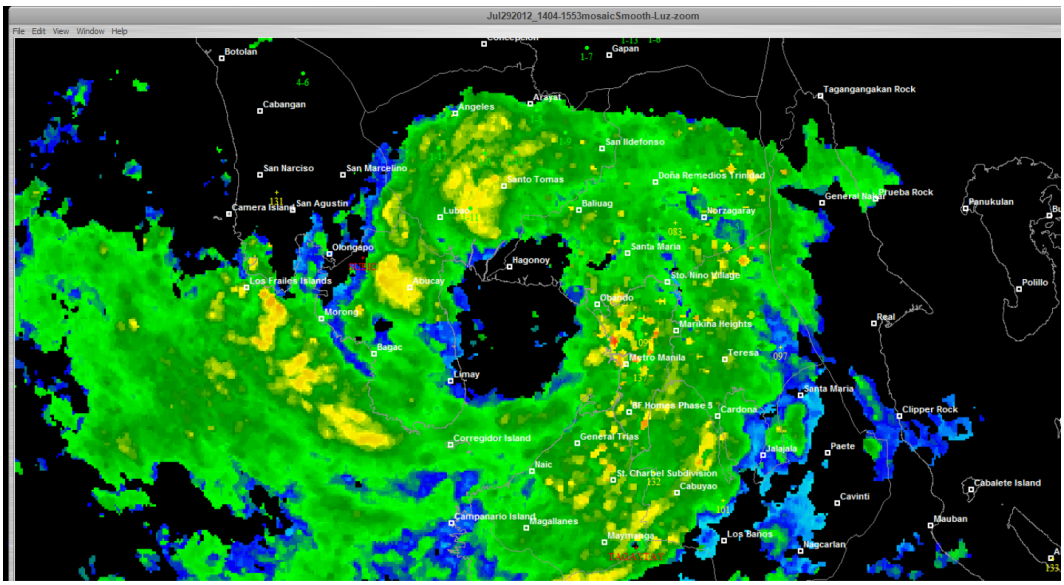


Fig. 1.9. Composite mosaic radar image of the mesocyclone taken at 9:55pm July 29, 2012. This is one of the products from the new PAGASA Hydrometeorological Decision Support System (HDSS) using the integrated High Performance Computing (IHPC) System.

Fig. 1.10. Effect of storm surge generated by the mesocyclone and TY Gener along Manila Bay on July 30, 2012

h. Enhanced SW Monsoon by TY Haikui over China: Aug. 6-8, 2012

An unusual heavy rainfall event that flooded the whole of Manila Metropolis happened on Aug. 6-8, 2012. The accumulated 3-day rainfall amount in Quezon City amounted to 1007.4 mm which is 200% of the normal monthly rainfall for the month of August. The heavy rains were due to the surge of the SW monsoon (locally known as Habagat) which was enhanced by a storm Haikui located far to the North of Luzon near China mainland.

Fig. 1.11. One of the busy streets in Manila flooded by the enhanced SW monsoon on Aug. 8, 2012.

i. Tropical Storm Kai-tak (Helen, 1213): Aug. 12–16, 2012

A low pressure area located about 700 km east of northern Luzon developed into a tropical depression on August 15 and was named Kai-tak. The TD moved generally westward as it intensified into a tropical storm making its landfall over Isabela in the morning of Aug. 15 (Fig. 1.12). TS Kai-tak shifted to a NW direction as it crossed northern Luzon then shifted to westward direction as it moved out of the western border of PAR on Aug. 16. Public Storm Warning Signal No. 2 was raised over northern Luzon and PSWS No. 1 over central Luzon provinces. As seen in the rainfall map in Fig. 10, the western sections of Luzon received the maximum rainfall.

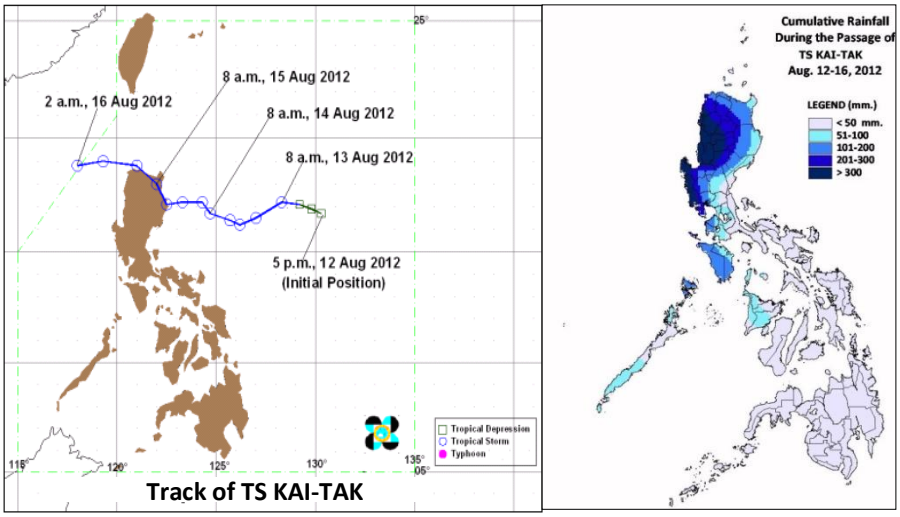


Fig. 1.12. Track of Tropical Storm Kai-tak (Helen) and the associated total rainfall during its passage on Aug. 12-16, 2012.

j. Typhoon Tembin (Igme, 1214): Aug. 19-25 and Aug 27-29, 2012

A disturbance 280 km west of northern Luzon developed into tropical depression on Aug. 19 and was named Tembin. It remained almost stationary for 24 hrs but intensified into tropical storm. It slowly moved northward and reached typhoon intensity in the morning of Aug. 21. TY Tembin gained more strength of 165 kph as it moved northwest towards southern Taiwan. On Aug. 22, TY Tembin slowed down and weakens as it moved closer until it made landfall over southern tip of Taiwan on Aug. 24. TY Tembin was downgraded to tropical storm as it continued to moved WNW and exit PAR in the morning of Aug 25 towards South China Sea. It re-intensified into a typhoon as Tembin recurved back eastward re-entering PAR on Aug. 27. Then it moved northeastward and weakened into a storm as it moved out of PAR on Aug. 29.

PSWS No. 2 was hoisted over Batanes group of islands during the passage of TY Tembin. It also enhanced the southwest monsoon rains over the western section of Luzon (Fig. 1.13).

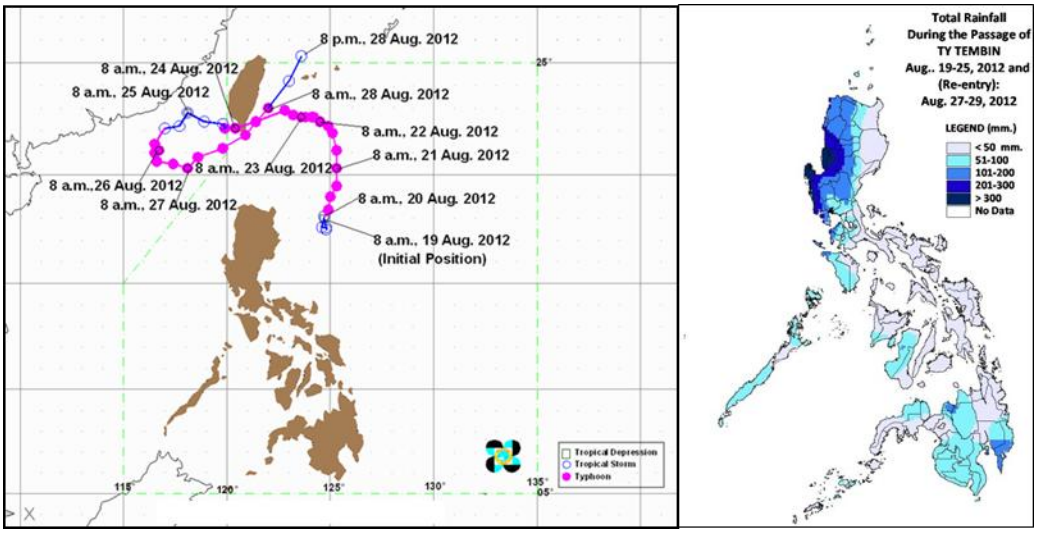


Fig. 1.13. Track of Typhoon Tembin (Igme) and the associated total rainfall during its passage on Aug. 19-25 and Aug. 27-29, 2012.

k. Typhoon Bolaven (Julian, 1215): Aug. 23-26, 2012

Bolaven developed into a depression outside PAR in the vicinity of Marianas Islands on Aug. 19. It slowly moved WNW and intensified into a storm then to a typhoon until it entered the northeastern border of PAR on Aug. 23 with maximum winds of 140 khp. It continued to move northwest intensifying further as it went out of PAR on Aug. 26. TY moved towards southern Japan, weakened slightly as it passed Okinawa then moved northward towards Korea.

The rainfall observed while TY Bolaven was within the PAR (as shown in Figure 14) was only concentrated on the western section of Luzon and this is due to SW monsoon whose peak is during the month of August. Actually, TY Bolaven has no direct effect over the Philippines but it influenced the movement of TY Tembin, a TC located farther to the east. They occurred simultaneously on Aug. 23-26 (See Fig.1.15) and interacted with each other in a Fujiwara effect. Tembin was pulled to the east after moving southwestward by Bolaven as shown in the MODIS satellite photo in Fig. 1. 16.

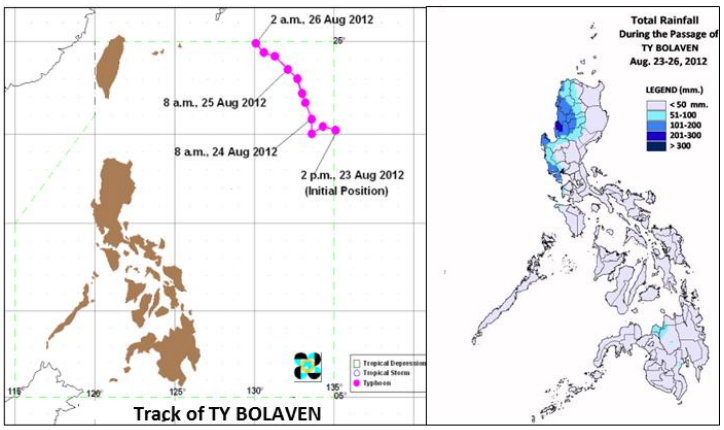


Fig. 1.14. Track of Typhoon Bolaven (Julian) within PAR and the associated total rainfall during its passage on Aug. 23-26, 2012.

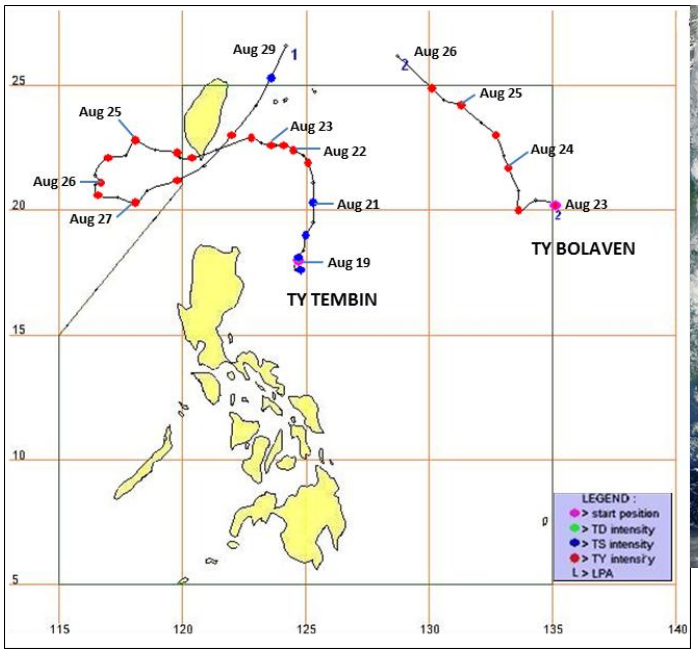


Fig. 1.15. Tracks of TY Tembin and TY Bolaven within the PAR.

Fig. 1.16. MODIS satellite photo on Aug. 27, 0240 UTC.

I. Typhoon Sanba (Karen, 1216): Sep. 11-16, 2012

In the morning of Sept. 11, a tropical depression named Sanba (Karen) developed within PAR at about 700 km east of northern Mindanao. It intensified into a storm in the afternoon as it moved northwest then northward. It continued to intensify and became a typhoon with 185 kph winds on Sept. 13. Tembin shifted to a northwest direction and made its exit out of PAR on Sep. 15 towards Japan. TY Tembin maintained a distance of about 700 km away from the Philippine islands and like the other typhoons, enhanced the southwest monsoon rains when it was located to the northeast of Luzon island. Metro Manila and Central Luzon received greater amount of rainfall from TY Sanba.

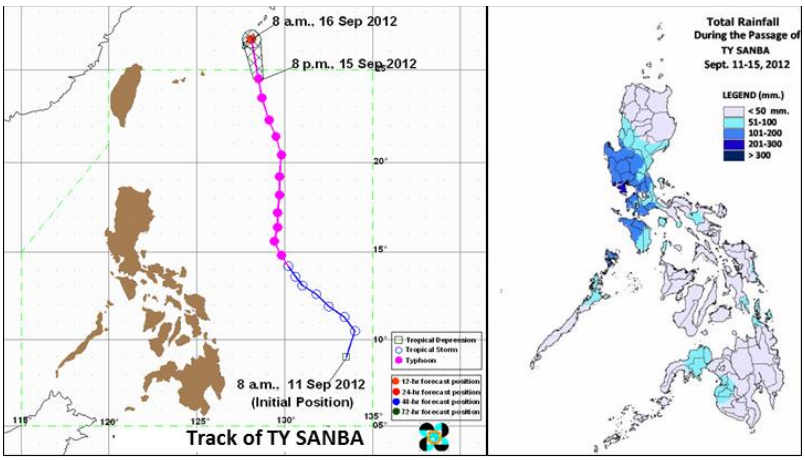


Fig. 1.17. Track of Typhoon Sanba (Karen) within PAR and the associated total rainfall during its passage on Sep. 11-15, 2012.

m. Typhoon Jelawat (Lawin, 1217): Sept. 20-29, 2012

Tropical depression Jelawat developed from a low pressure area embedded in the ITCZ east of southern Luzon on Sept. 20. It moved to the southwest gaining storm intensity the following day and became a typhoon on Sep. 23 moving closer to Visayas. Shifting to a NNW direction, TY Jelawat very slowly moved to the north but went on an explosive intensification to a wind-strength of 215 kph and a radius of 450 km on Sept. 26. At this intensity, the eye was fully developed and the Joint Typhoon Warning Center (JTWC) classified Jelawat as a super typhoon. PSWS No. 3 was then raised over Batanes group of islands. On Sept. 27, TY Jelawat recurved to a northeast direction, went out of PAR on Sept. 29 and headed towards Japan.

It is interesting to note that western Mindanao experienced southwest monsoon rainfall (Fig. 1.18) which is very unusual. The initial westerly movement of Jelawat and its very slow northward movement is the driving force of the enhanced SW monsoon over Mindanao.

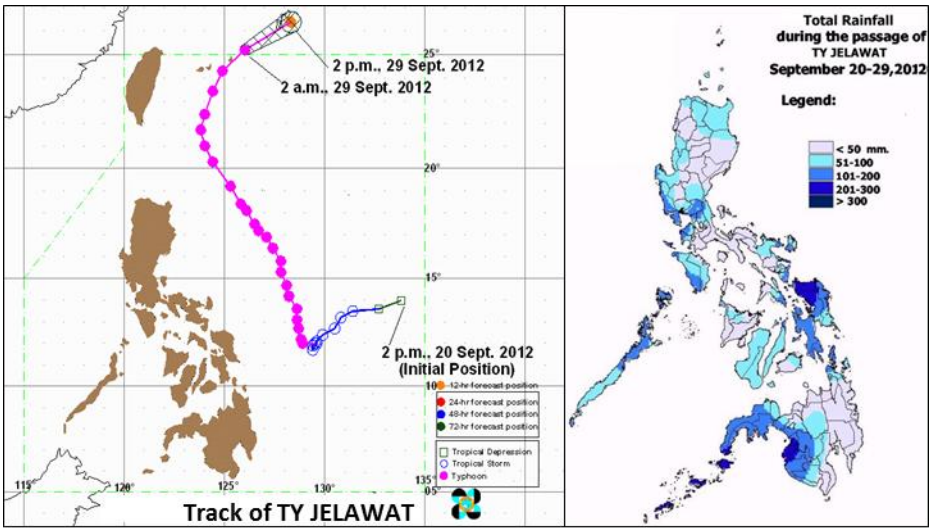


Fig. 1.18. Track of Typhoon Jelawat (Lawin) within PAR and the associated total rainfall during its passage on Sep. 20-29, 2012.

n. Tropical Storm Gaeme (Marce, 1218): Oct. 2-5,2012

Gaeme entered the western border of PAR with storm intensity in the evening of Oct. 2 and slowly moved on a southeast direction. The storm's rainbands brought rains over southern Luzon including Mindoro Island the following day, Oct. 3. Later in the evening, TS Gaeme made a clockwise turn, shifting to a WSW direction. It continued slowly westward then accelerated as it moved out of PAR on Oct. 5 headed towards southern Vietnam.

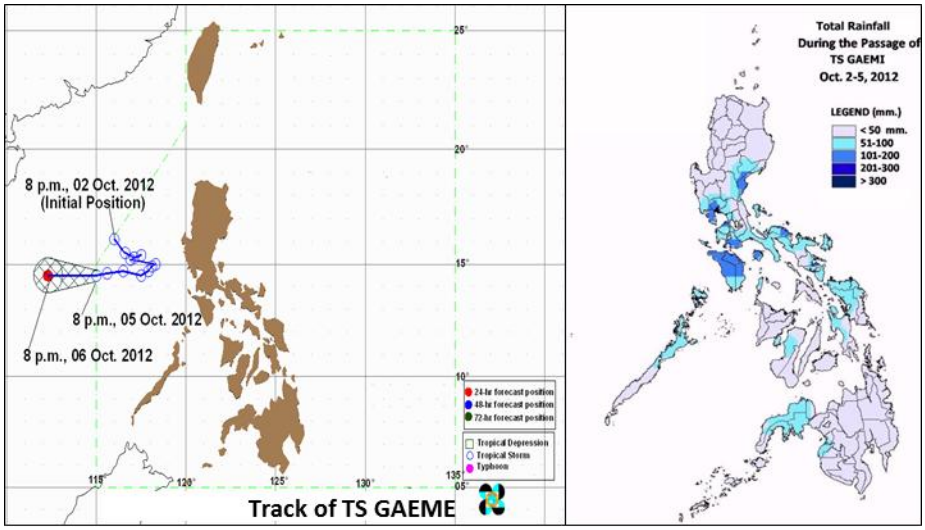


Fig. 1.19. Track of TS Gaeme (Marce) within PAR and the associated total rainfall during its passage on Oct. 2-5, 2012.

o. Typhoon Prapiroon (Nina, 12) October8-17, 2012

Prapiroon developed in the vicinity of Guam and is already a tropical storm when it entered the eastern border PAR on Oct. 8. It initially moved on a NW direction but changed to WSW as it further developed into a typhoon with 120 kph wind near the center on Oct. 9. Very slowly, TY Prapiroon shifted to a northwest direction intensifying to wind strength of 160 kph until Oct. 11. While maintaining its strength, it changed its course to northeast and remained quasi-stationary for three days. On Oct. 16, Prapiroon made a loop changing its direction to SW then recurved to NNE as it weakened to storm intensity. Storm Maria located far to the east affected the motion of Prapiroon. Finally Prapiroon made an exit out of PAR heading northeast On Oct. 17. It did not bring in excessive rainfall since southwest monsoon has weakened.

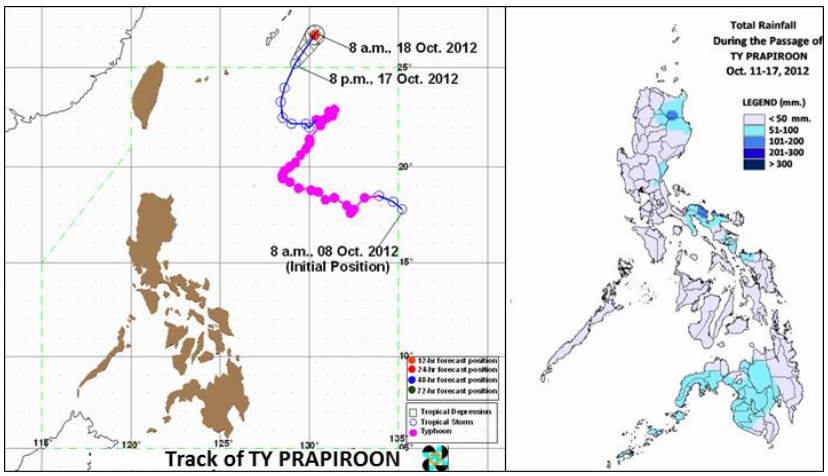


Fig. 1.20. Track of TY Prapiroon (Nina) within PAR and the associated total rainfall during its passage on Oct. 8-17, 2012.

p. Tropical Storm Son-Tihn (Ofel): October 22-26, 2012

Embedded in the ITCZ, Son-Tihn developed into tropical depression inside PAR on Oct. 22. It initially moved west at a speed of 15 kph then northwest as it intensified into a storm on Oct. 24. On that day, TS Son-Tihn passed over Dinagat Island, crossed Visayas making its landfall over Leyte province in the afternoon then accelerated towards Masbate and Mindoro on Oct. 25. Finally, it went out of PAR at West Philippine Sea towards Vietnam on Oct. 27. As Son-Tihn passed over Visayas and Mindoro Island, northeast wind flow was enhanced bringing heavy rains over the eastern sections of the Philippines (Fig. 1.21). PSWS No. 2 was raised over central Visayas, Mindoro and nearby provinces while Metro Manila was placed under PSWS No. 1.

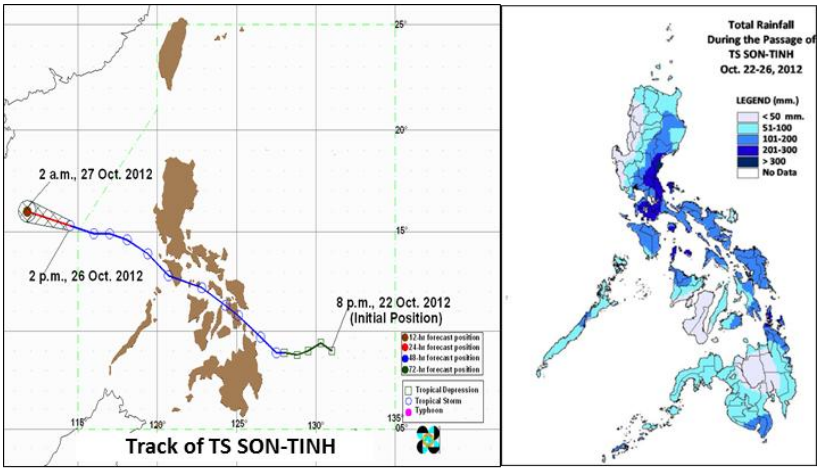


Fig. 1.21. Track of TS Son-Tihn (Ofel) within PAR and the associated total rainfall during its passage on Oct. 22-26, 2012

2. Hydrological Assessment (highlighting water-related issues/impact)

There were more than 100 cases of flooding in the Philippines due to the passages of tropical cyclones and other weather causing phenomena. Among the monitored river basins, Pampanga recorded the most number of flood bulletins issued.

	2010	2011
Monitored basin	Flood bulletins	
Pampanga	43	75
Agno	41	45
Bicol	45	32
Cagayan	71	15
Monitored major reservoirs	Flood warning information	
Angat, Pantabangan, San Roque and Magat dams	21	
	General Flood Advisories	
Non-telemetered river basins	2078	2049

Four of the monitored dams in Luzon operated their spillways: Angat, Magat, San Roque and Ipo.

It is also worth mentioning that, the enhanced Southwest monsoon resulted in devastating flooding in Metro Manila and surrounding provinces of Bataan, Bulacan, Laguna, Rizal and Batangas. Rains persisted for 24 days from July 16 to August 8, 2012.

Comparison between TS Ketsana and SW Monsoon (Habagat 2012)

	300 mm	**Max 24-hour rainfall**
TS Ketsana	Observed in 6 hours	541 mm – Sep 26, 2009
Habagat	Observed in 22 hours	391.7 mm – Aug 7, 2012

The total rainfall from August 6-8, 2012 reached 1007.4 mm (199.8% of the normal rainfall for the month of August). The 2-day maximum rainfall of August 6 and 7 amounting to 741.8 mm was the highest so far since 1948.

During the passage of Typhoon Gener in July to August 2012, San Roque dam operated its spillways when it was about 2 meters from its spilling level of 280.0 meters AMSL. Maximum outflow was 1,700 cumecs and was within the carrying capacity of the Agno river. Minor flooding was observed in low-lying areas along the Agno river while the allied river of Agno were heavily flooded. The hourly spilling record of San Roque dam is shown in Fig. 1.22.

Based on post flood investigations conducted, the worst affected provinces by flooding were Metro Manila, Bataan, Laguna, Pampanga and Bulacan.

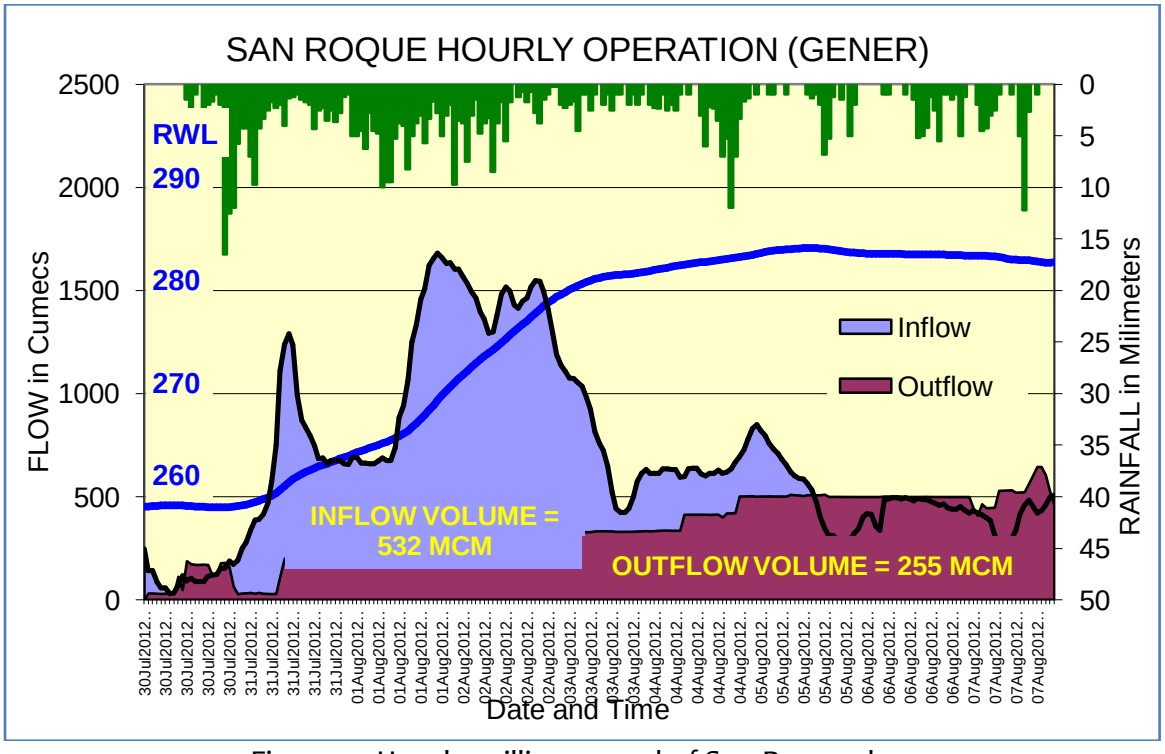


Fig. 1.22. Hourly spilling record of San Roque dam

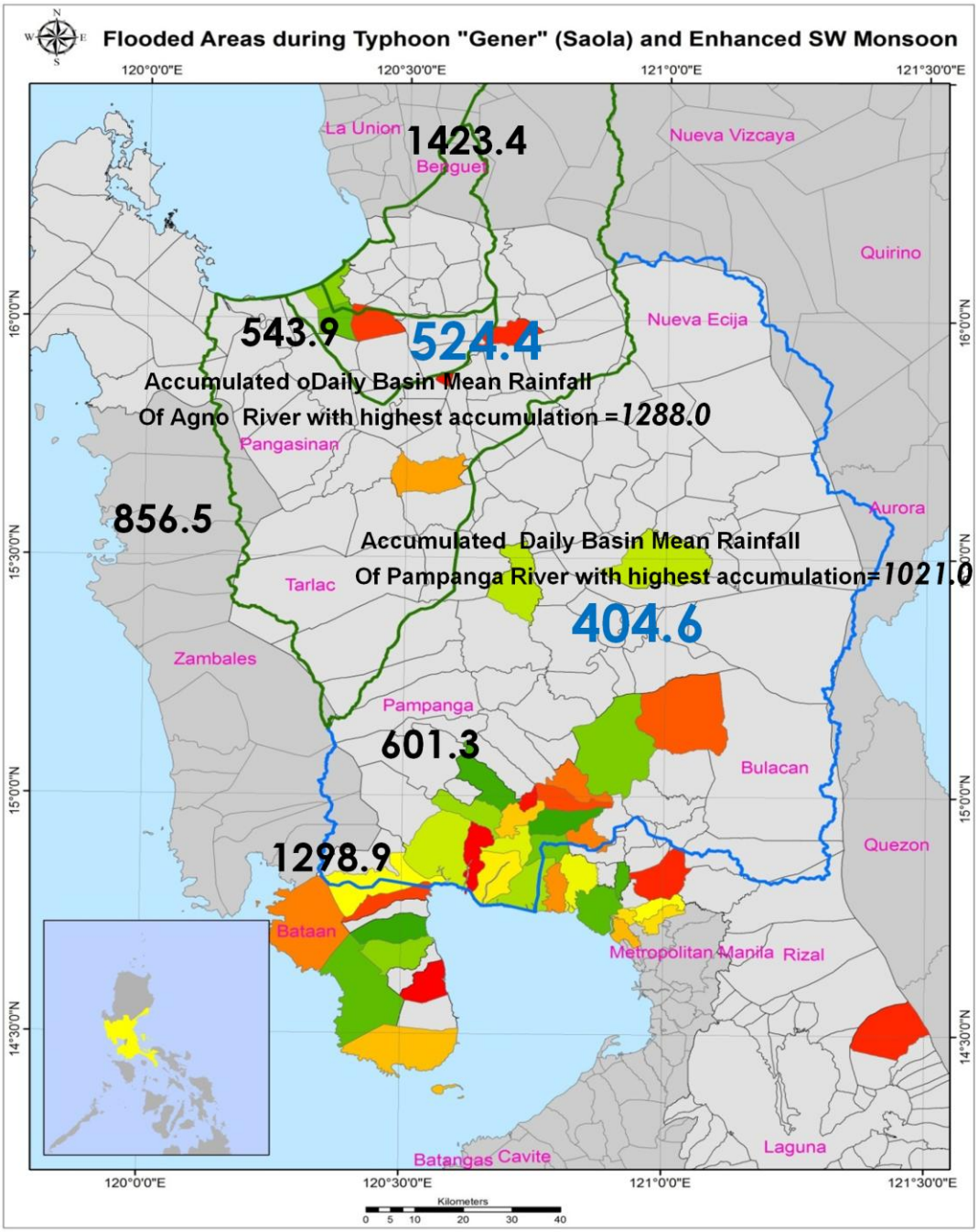


Fig. 1.23. Accumulated rainfall (mm) from August 2-9, 2012 and flooded area (shaded)

Compared with the rainfall of Tropical Storm Ketsana, the volume of rain from July 28 to Aug 8, 2012 was almost three (3) times more, but TS Ketsana was more devastating because the flood was of a flashy type.

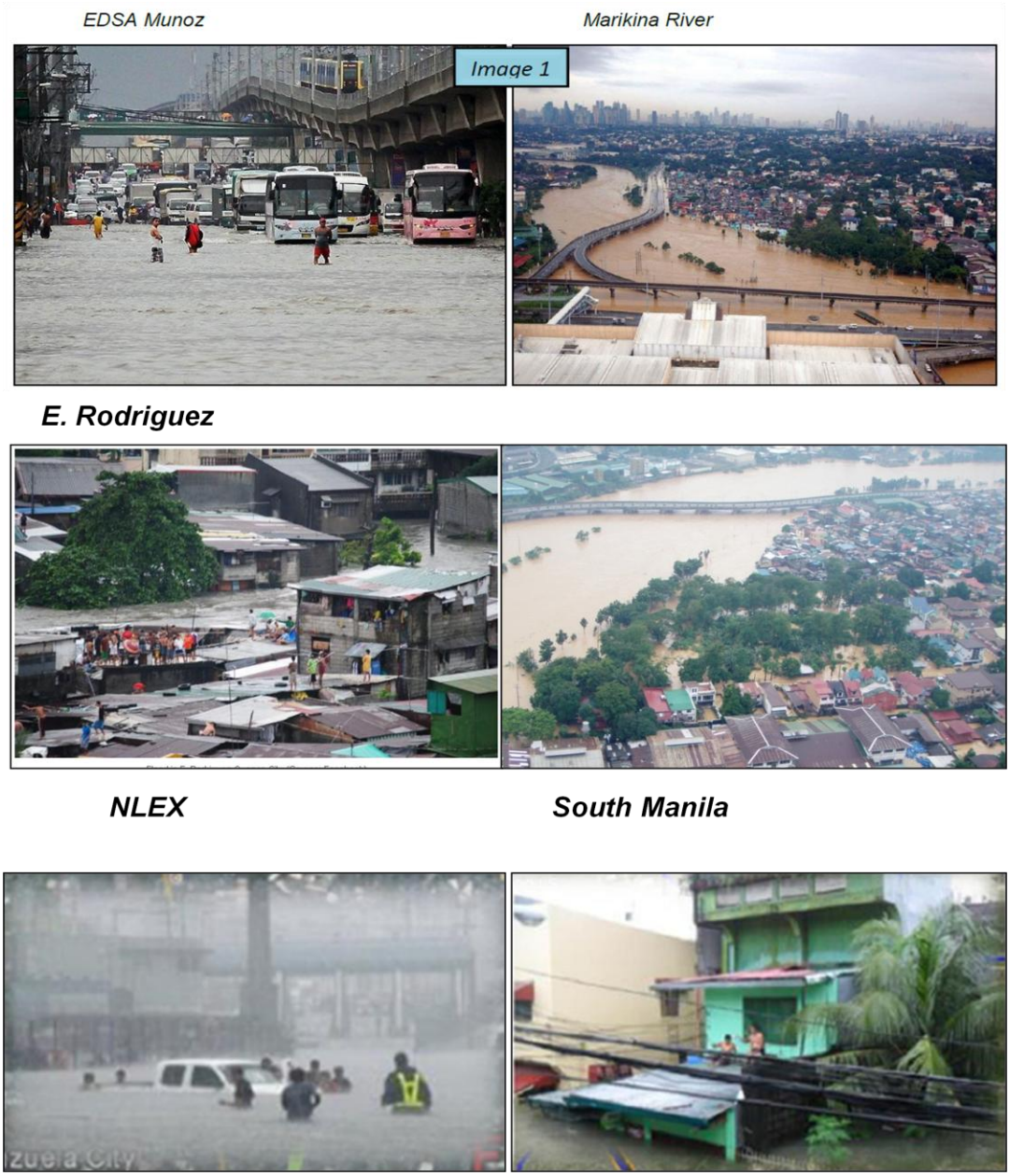


Fig. 1.24. Photos of Flooding in Metro Manila (Aug 7, 2012)

3. Socio-Economic Assessment (highlighting socio-economic and DPP issues/impacts)

The occurrence of 15 tropical cyclones from January to October 2012 incurred a considerable loss to the economy amounted toPhP1.034 billion. The toll on casualties of 211 was comparatively lower than in 2011 which was 1,257 casualties.

The most disastrous TC event this year was the TS Son-Tihn (Ofel). A toll of 52 casualties was reported as of Nov. 1, 2012.

Table 1.1 Summary of casualties and affected population due to impacts of TCs

	Casualties			Affected Population	
Tropical Cyclones	Dead	Injured	Missing	Families	Persons
15	115	78	18	297,125	1,327,184

Table 1.2 Summary of damages brought about by the impacts of TCs on Jan-Oct 2012

	Damages to Properties (Million PHP)			Damaged Houses		Total Population Served (Million)	
Tropical Cyclones	Agri	Infra	Private properties	Total	Partial	Families	Persons
15	642.82	388.15	2.6285	1,822	10,717	102,925	470,328

The extreme SW monsoon event (Habagat) on August 6-8, 2012 caused a total damage of PhP2,264 billion on infrastructure and agriculture, a toll of 95 casualties and 825,018 families affected by floods.

4. Regional Cooperation Assessment (highlighting regional cooperation successes and challenges)

Regional cooperation is highlighted by the completion and implementation of various foreign-assisted projects. New projects came in as a result of the devastation of TS Sendong (Washi) in December 2011. There were also several foreign trainings sponsored by international organizations.

II. **Summary of progress in Key Result Areas** (For achievements/results which apply to more than one Key Result Area, please describe them under the most applicable Key Result Area. Then, at the end of the description, place in parentheses ( ) the other applicable Key Result Areas)

1. Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2011 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Two (2) new Japanese Doppler radars (in Virac and Aparri) were inaugurated in 2012 making a total of 8 operational radars all over the Philippines. Five (5) radars (Subic, Tagaytay, Baguio, Cebu and Hinatuan) are now inputted in the Integrated High Power Computing System (IHPC) of PAGASA which make a composite view of all the 5 radars. On the test run is another Doppler radar in

Tampakan, Mindanao. The IHPC also run the WRF model providing hourly rainfall forecast up to 72 hours (3 days).

Figure 2.1 Radar network in the Philippines

As of October 2012, PAGASA-DOST has a total of 155 AWS and 87 automatic raingauges.

b. Hydrological Achievements/Results

b.1 Updated Flood warning protocols

The Strengthening of the Flood Forecasting and Warning System for Dam Operation (FFWSDO) funded under the Technical Cooperation (TCP) by the Japan International Cooperation Agency (JICA) which commenced in October 2009 was completed in November 2012.

The notable accomplishments of the project included: the updated dam discharge and flood warning protocols, setting up of a database management system and the development of tools for forecasting such as Inflow Forecasting model for dam operation and the Flood Forecasting model in the target areas of monitored dams. These rainfall-runoff models have already been utilized during the flood season of 2012. Drills were conducted to test the operation of these models.

It is worth mentioning that the preparation of the updated manuals were coordinated with the local government units.

b.2 Application of IFAS model in the Pampanga and Cagayan river basins

The Integrated Flood Alert System (IFAS) developed by the International Centre of Hydro-Hazards Research and Management (ICHARM) was applied in

the Pampanga (densely gauged) and Cagayan (poorly gauged) river basins through the conduct of workshops. Although further fine tuning of parameters is required, results showed that there is much potential in using the IFAS software for the basins with different characteristics.

The IFAS is 1D kinematic wave hydrologic model that makes use of DEM and land use as inputs.

	MIKE 11	HEC-RAS	IFAS
development	DHI	US Army Corps of Engineers	ICHARM
Target process	Runoff & River	River	Runoff & River
Basic Equation (River)	Continuity Eq. Saint Venant Eq.	Continuity Eq. Momentum Eq.	1D Kinematic Wave
Necessary data for model input	Topographic data, X-section, Boundary conditions	X-section, Boundary conditions	DEM, Land use All data can be downloaded
Rainfall availability	Time-series	No function	Time-series & Satellite

b.3 Flood drills in the target areas of monitored dams

Flood drills were conducted in the target areas of the Angat, Pantabangan, Magat and San Roque dams to test the timing of activities and flow of information (issuance of dam flood bulletins until these are received by the people in the target areas); communication facilities, etc. Local government units, and other stakeholders participated in the dry runs and flood drills.

b.4 Enhancement of hydro-monitoring system

There is a sustained efforts in the enhancement of hydro-meteorological monitoring system in major and principal river basins in the country resulting from the increased frequency of flood prone affected areas. The initiatives are both funded by the Philippine government and by foreign donors such as UNDP Ready for GMMA, UNDP/CIDA, LGU initiated CBFEWS, NOAH (Bataan).

In support to these activities, the PAGASA has been provided by the national government to put up Flood Forecasting and Warning Centers in the 13 ungauged major river basins starting 2013.

b.5 UNESCAP/ WMO/TC: Urban Flood Risk Management (UFRM)

Submission of draft "Introduction" and "Way Forward" for the UFRM guidelines.

b.6 Foreign and Local Trainings/Workshops/Fellowships

A. Foreign-Assisted Trainings/ Workshops/Fellowships

Title of Training/ Workshop	Place	Personnel	Sponsor
Training on Risk Assessment using HEC-RAS – Jan 2012	Canberra, Australia	R. A. Badilla & A. T. Castillo	GA
Knowledge Sharing Workshop on Water Related Disaster Management - Jan 2012	Kathmandu, Nepal	S. R. Espinueva	ICHARM
44th Session of the TC/UNESCAP/WMO – Feb 2012	Hangzhou, China	Susan R. Espinueva, et al	GoP
Drafting of UFRM Guidelines – Feb 2012	Nanjing, China	Susan R. Espinueva	GoP
Seminar on the Application of Satellite Based Technology – Feb-Mar 2012	Macau, China	Susan R. Espinueva & Socrates F. Paat, Jr.	TC/ UNESCAP
Flood Risk Modeling – Mar 2012	Brisbane & Canberra	Roy A. Badilla	GA
Toward Effective Flood Management by Utilizing Satellite Based Information – Mar 2012	Marseille, France	Susan R. Espinueva	JAXA/ Restec
Training Course in Early Warning & Monitoring System for Disaster Mitigation – Mar – Apr 2	Seoul, Korea	Mario I. Dungca, Max F. Peralta, Elmer S. Caringal, Berlin V. Mercado & Edgar A. Dela Cruz	KOICA
Workshop on Flood Risk Modeling – April to May 2012	Canberra, Australia	Roy A. Badilla & Adelaida T. Duran	GA
Workshop for JICA Project – May 2012	Jakarta, Indonesia	Rosalie C. Pagulayan	JICA

TC Mission on WGH Project on Extraordinary Flood – June 2012	Thailand	Nivagine. C. Nievares	KICT, Korea
Training of ICHARM – 8 July to 7 August 2012	Tsukuba, Japan	Socrates F. Paat, Jr. and Shiela S. Schneider	JICA / ICHARM
Training on Remote Sensing using radar – 14-21 Sep 2012	Taiwan	Nivagine C. Nievares	NUIST, Taiwan
UFRM Training Course on Xinanjiang Model – 24-26 Sep 2012	Guangzhou, China	Shiela S. Schneider	UNESCAP/ WMO/TC
1st TC-WGH Meeting – 8-10 Oct 2012	Seoul, Korea	Susan R. Espinueva & Nivagine C. Nievares	MLTM & KICT, Korea
ASEAN JICA AHA Project Workshop	Jakarta, Inodesia	Rosalie C. Pagulayan	JICA
Training Program on Flood Inundation Analysis - 12 – 22 Nov 2012	Tsukuba, Japan	Hilario G. Esperanza & Hilton T. Hernando	ADB
4th TRMM and GPM International Science Conference, Nov 13-16, 2012	Tokyo, Japan	Susan R. Espinueva, vice Dr. Esperanza Cayanan	JAXA
7th Integrated Workshop of TC – 26 to 30 Nov 2012	Nanjing, China	Susan R. Espinueva, et al	UNESCAP/ WMO/TC

c. Disaster Prevention and Preparedness Achievements/Results

Please refer to Report of Working Group on DRR.

d. Research, Training, and Other Achievements/Results

<u>Research activities in 2012:</u>

- Enhancing Risk Analysis Capacities for Flood, Tropical Cyclone Severe Wind and Earthquake for GMMA (Taguig City – Pilot Area) – 2011-2013:
  - Prepared a preliminary local severe wind hazard map for Taguig at different return periods
  - Preliminary flood hazard map for Pasig-Marikina River basin
- Enhancement of the Automatic Weather Station (AWS)

- The Impacts of Climate Variability on Entomological Activity in Central Luzon – Draft report submitted
- A Study of Thunderstorm Forecasting in Metro Manila – On-going
- Validation of Subic Radar Rainfall Estimates for Agno and Pampanga River Basins – On-going
- Intercomparison and Validation of Radar Rainfall Estimates using Raingauge data for Hinatuan and Cebu Radars
- Development of Rainstorm Warning System for Metro Manila (in collaboration with WD, HMD, CAD, ETSD, PRSD-NCR) – Developed Rainfall Warning System for Metro Manila was launched in June 2012
- 25 Personnel from CSCAND agencies attended the Communication Planning Conference and so with the Gender Mainstreaming Seminar on DRR. A gender-responsive DRRM Training for LGU for Cainta, Marikina City and Pasig City was also attended by 300 Local government employees involve in DRR activities. A total of 250 participants attended also the 2-day National Conference on Multi Hazard Mapping and Assessment for Effective Community-based Disaster Risk Management.

Training courses for 2012

	Course Title	Participants	Training Hrs
1	Meteorologists Training Course (MTC) 09 November 2011 – 31 October 2012	34	1,670
2	Seminar on Government Radio Operator's Certification for Northern Luzon PAGASA Regional Services Division 21 – 24 March 2012	30	40
3	Orientation Seminar/Workshop on Operational Hydrology for Mindanao PRSD Personnel 09 – 13 April 2012	22	40
4	Orientation Seminar/Workshop on Operational Hydrology Northern Luzon PRSD Personnel 16 – 20 April 2012	22	40
5	Orientation Seminar/Workshop on Operational Hydrology for NCR PRSD Personnel 07 – 11 May	20	40
6	Orientation Seminar/Workshop on Operational Hydrology for Visayas PRSD Personnel 14 – 18 May 2012	22	40
7	Orientation Seminar/Workshop on Operational Hydrology for Southern Luzon PRSD Personnel 28 May – 01 June 2012	18	40

An international training, the APEC Training Course on Quantitative Precipitation Estimation/Forecasting (QPE/QPF) was conducted at the Crowne Plaza Galleria Manila on March 27-30, 2012. This was sponsored by APEC.

Other related training activities are as follows:

- Participated in the APEC Workshop on Facing the Abnormal Flood Disaster: New Vision for APEC Member Countries; APEC-ACTS 2nd Workshop "Typhoon and Landslide Disaster Prevention, Mitigation and Social Resilience Capacity Building"
- Assisted 2 full scholars (2 foreign Fellows), 1 partial scholar (monthly stipends, tuition fees, book allowances), 6 MTC foreign students (stipend) and 22 local (transportation allowance)
- 16 international meetings/conferences attended 28 PAGASA officials and personnel
- 3 scholars for Australian government through PAHRODF
- 49 foreign trainings/seminars/workshops attended by 79 PAGASA personnel

e. Regional Cooperation Achievements/Results

Please refer to Key Result Area 1(c).

f. Identified Opportunities/Challenges for Future Achievements/Results

Promotion and implementation of the National Disaster Risk Reduction and Management Framework and Plan; Establishment of DRRM Training Institutes including the development of DRRM Modules; Intensify Public Information Campaign on DRRM; Intensify disaster risk reduction capacity development and operational readiness of national/local level disaster manager and responders.

2. **Progress on Key Result Area 2:** Minimized Typhoon-related Social and Economic Impacts. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2011 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Please refer to Key Result Area 1(a).

b. Hydrological Achievements/Results

Please refer to Key Result Area 1(b).

c. Disaster Prevention and Preparedness Achievements/Results

Please refer to Key Result Area 1(c).

d. Research, Training, and Other Achievements/Results

For January-October 2012, more than 35,000 students, teachers, government personnel, local government units, media, etc. were benefitted from the lectures on hydro-meteorological hazards, climatic trends and climate change by PAGASA personnel and officials.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

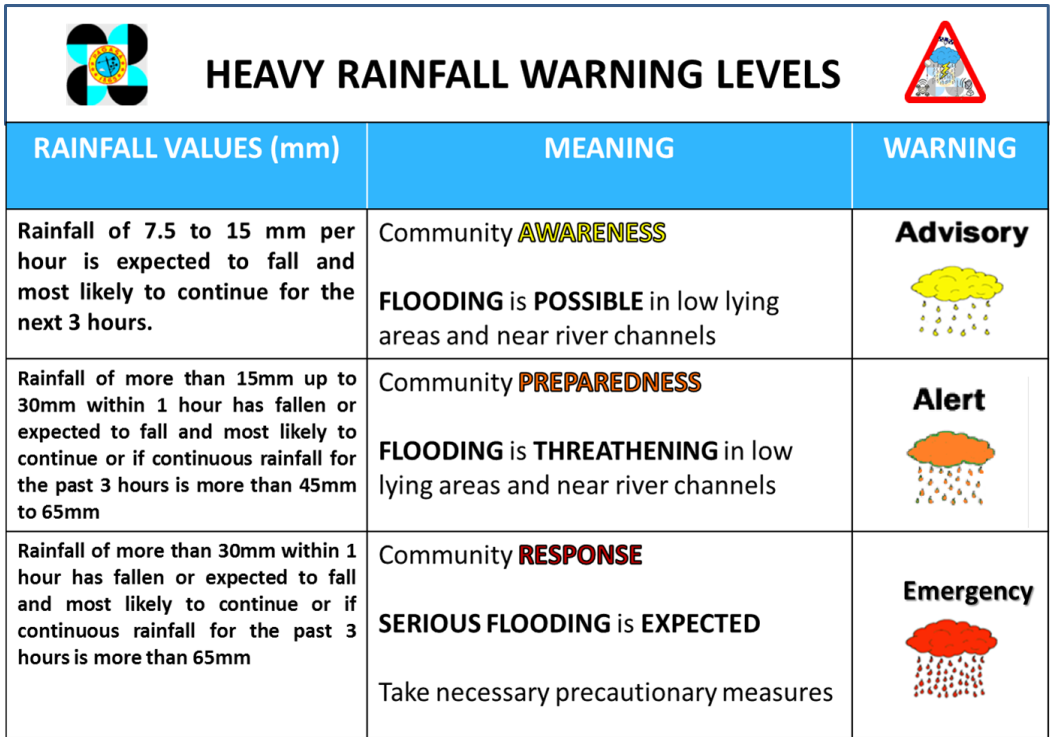
Nil.

3. **Progress on Key Result Area 3:** Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

The Rainfall Warning Decision Support System (RWDSS), or simply "RWS", for Metro Manila was established and became operational since June 2012. RWS is an end-to-end decision support tool designed to provide meaningful information to decision-makers, stakeholders and communities to protect lives, livelihood and property about heavy rainfall events that would cause or aggravate flooding. This is through the provision of an easy to interpret information that empowers people to take action when disaster is about to happen. RWS has two components: the Heavy Rainfall Warning System (HRWS) and the Thunderstorm Rainfall Warning System (TSTMWS).

The HRWS is implemented whenever large-scale (synoptic-scale) weather systems (i.e., low pressure areas, Monsoon, tail-end of a cold front, etc.) are expected to promote widespread or long duration heavy rainfall over an extensive area (e.g. Metro Manila). Three color-coded levels are used for warning: Yellow, Orange Advisories and Red Warning shown in Fig. 3.1. These are issued to the public based on the observed and forecast amount and duration of rainfall from radars, raingauages, automatic weather stations (AWS) and output of numerical prediction models. These color-coded levels are used to provide information about its associated effects and what actions to take by the public.

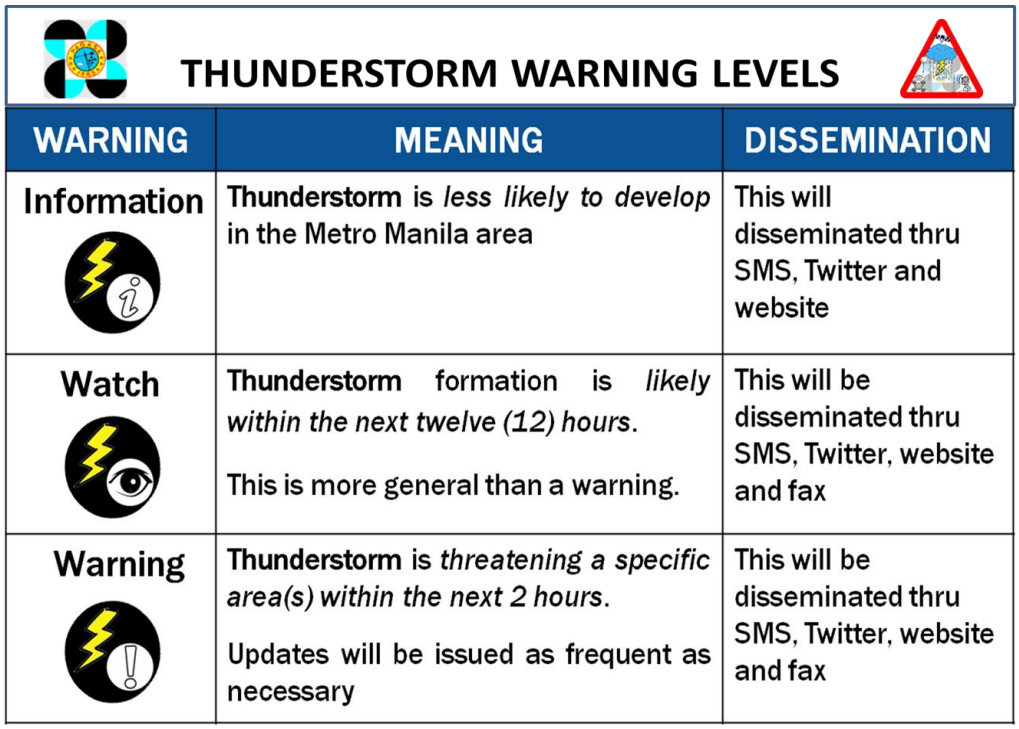


HEAVY RAINFALL WARNING LEVELS

RAINFALL VALUES (mm)	MEANING	WARNING
Rainfall of 7.5 to 15 mm per hour is expected to fall and most likely to continue for the next 3 hours.	Community **AWARENESS** **FLOODING** is **POSSIBLE** in low lying areas and near river channels	**Advisory**
Rainfall of more than 15mm up to 30mm within 1 hour has fallen or expected to fall and most likely to continue or if continuous rainfall for the past 3 hours is more than 45mm to 65mm	Community **PREPAREDNESS** **FLOODING** is **THREATHENING** in low lying areas and near river channels	**Alert**
Rainfall of more than 30mm within 1 hour has fallen or expected to fall and most likely to continue or if continuous rainfall for the past 3 hours is more than 65mm	Community **RESPONSE** **SERIOUS FLOODING** is **EXPECTED** Take necessary precautionary measures	**Emergency**

Fig. 3.1 Color-coded warning levels used in the Heavy Rainfall Warning System

The TSTMWS is utilized in situations when local conditions favor the formation of thunderstorms. This system consists of three levels: Thunderstorm Information, Thunderstorm Watch and Thunderstorm Advisory (Fig. 3.2). These are issued to the public based on available data (e.g. upper-air observations, model output, wind profiler etc) to provide information on the likelihood of thunderstorm formation and its associated hazards.



THUNDERSTORM WARNING LEVELS

WARNING	MEANING	DISSEMINATION
Information	**Thunderstorm** is *less likely to develop* in the Metro Manila area	This will disseminated thru SMS, Twitter and website
Watch	**Thunderstorm** formation is *likely within the next twelve (12) hours.* This is more general than a warning.	This will be disseminated thru SMS, Twitter, website and fax
Warning	**Thunderstorm** is *threatening a specific area(s) within the next 2 hours.* Updates will be issued as frequent as necessary	This will be disseminated thru SMS, Twitter, website and fax

Fig. 3.2 Warning levels used in the Thunderstorm Warning System

b. Hydrological Achievements/Results

The Joint Operation and Management Committee (JOMC) of the FFWSDO, an interagency committee that oversees the operational and maintenance activities of monitored major river basins and reservoirs in the Philippines conducted 2 regular meetings. The Sub-Committee on Hydrology convened its members once in October 2012. However, 3 emergency meetings of the Committee were carried out during the passage of tropical cyclones to decide on the spilling operations of the monitored dams.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Nil.

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

Nil.

4. **Progress on Key Result Area 4:** Improved Typhoon-related Disaster Risk Management in Various Sectors. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

- The PAGASA Special Tropical Weather Disturbance Reconnaissance, Information Dissemination and Damage Evaluation (STRIDE) or the PAGASA Quick Response Team was dispatched to assess and conduct filed investigation and extend assistance in the mitigation of meteorological hazards and disaster reduction in areas affected tropical cyclones Gener.

  In parallel to these activities, other members of the STRIDE team were assigned at the NDCC office to brief concerned officials and the media on the status of tropical cyclone.

- The PAGASA conducted regular press conferences/briefings during the occurrence of a tropical cyclone inside PAR, simultaneously these warning

bulletins and advisories are being sent to the different sectors of the society either through SMS or emails particularly to the affected areas.

b. Hydrological Achievements/Results

b.1 Flood hazard mapping activities

Using 1:10K base maps, flood hazard mapping activities were conducted under the AusAID/UNDP Ready Project covering the selected municipalities of the provinces Rizal and Laguna. In addition similar activities were conducted in Siargao and Palawan Islands under the Ecotown Framework Project funded by the Global Green Growth Institute (GGGI) of Korea and with the Climate Change Commission (CCC) as the responsible partner agency in the Philippines. Some of the outputs are shown below.

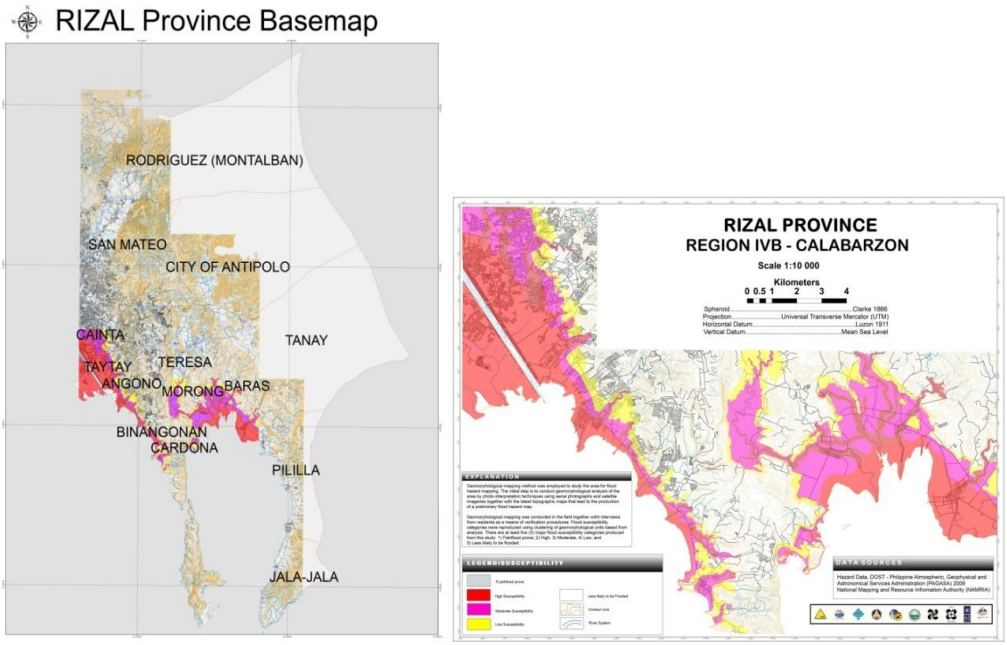


Fig. 4.1 Rizal province base map (left) and the flood hazard map (right)

For CY 2012, flood hazard maps using 1:10K scale maps were completed in the provinces of Abra, Isabela and Cagayan. The hazard maps were provided to concerned local government units (LGUs) as inputs in updating their comprehensive land use plans (CLUPs).

Post flood investigations were conducted in Metro Manila, Bataan province and Ilocos region 2012 due to passages of tropical cyclones and intensification of Southwest Monsoon that brought again devastating flooding in Metro Manila and surrounding provinces.

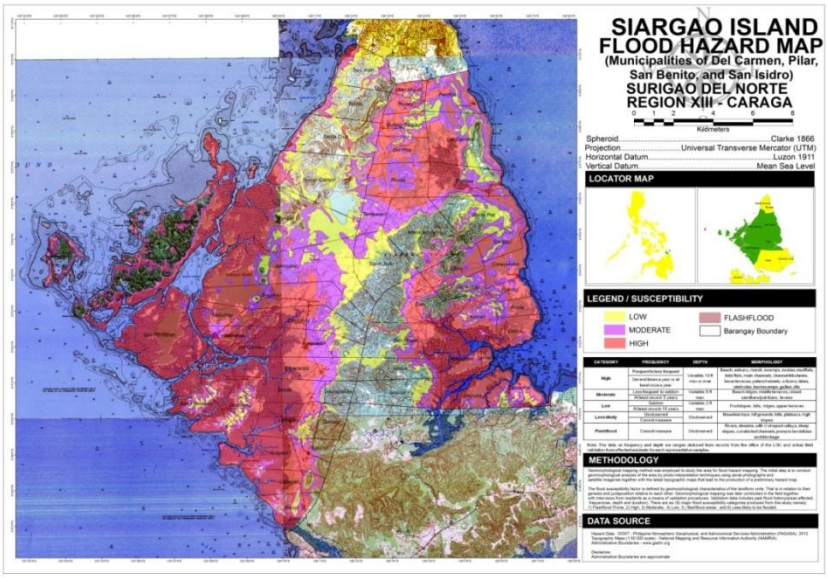


Fig. 4.2 Flood hazard map of Siargao Island (using a 1:50k base map)

c. Disaster Prevention and Preparedness Achievements/Results

Please refer to Key Result Area 1(c).

d. Research, Training, and Other Achievements/Results

Please refer to Key Result Area 1(d).

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

Major private telecommunication service providers such as SMART have developed a server for PAGASA to upload all its information and enhance PAGASA's dissemination of its products to the public for free.

5. **<u>Progress on Key Result Area 5:</u>** Strengthened Resilience of Communities to Typhoon-related Disasters. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2011 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

- The PAGASA-DOST has implemented the conduct of press conferences/briefing every issuance of a Weather Bulletin and Warning four (4) times a day, every 5AM, 11AM, 5PM and 11PM.

- Weather Forecasters/Meteorologist also joined the PAGASA IEC group as regular lecturers to the communities concerning hydro-meteorological hazards.

b. Hydrological Achievements/Results

- The PAGASA provided technical assistance to government and non-government organizations, private institutions in the installation of rainfall and water level gauges for community based flood early warning system (CBFEWS).

c. Disaster Prevention and Preparedness Achievements/Results

d. Research, Training, and Other Achievements/Results

Please also refer to Key Result Area 2(d).

e. Regional Cooperation Achievements/Results

Key officials from the disaster agencies of Bangladesh visited the flood forecasting and warning facilities of PAGASA to gain insights on the best practices of the Philippines in flood disaster risk mitigation.

In addition, key officials from the Government of Afghanistan also visited PAGASA's flood forecasting and warning facilities.

f. Identified Opportunities/Challenges for Future Achievements/Results

1. **Applying Remote Sensing Technology in River Basin Management – ADB/JAXA**

The implementation of the project has started with the conduct of site survey to locate additional rain gauges for GSMaP calibration. Along with this activity, an Inception Workshop was held last 20 November 2012 to introduce the benefits of having a satellite in the Philippines as well as its application in the pilot river basin of Cagayan – all activities of which will be implemented in 2013.

2. **Supporting Investments in Water-Related Disaster Management – ADB/ICHARM**

The application of the Integrated Flood Alert System (IFAS) project in Pampanga and Cagayan river basins was completed in October 2012 with the conduct of Training/Seminar for Pampanga river basin and Cagayan river basin where participants had actual hands-on in running the IFAS model. Experts from ICHARM presented their analyses on both river basins.

As a result of its successful implementation, a new project will be developed to include the following components:

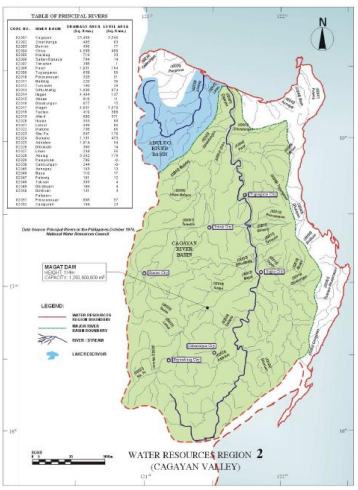
3. **The "Project Climate Twin Phoenix":** Enabling the Cities of Cagayan de Oro and Iligan to Cope with Climate Change **– AusAID/UNDP**

   The Project aims to assess the disaster vulnerabilities of the cities of Cagayan de Oro and Iligan and the municipalities surrounding the CDO & Mandulog river basins in Mindanao, Philippines, to geological, meteorological and meteorologically-induced hazards due to climate change. The results will provide the basis for priority mitigation actions like community based and managed early warning systems and integrated contingency planning and mobilization.

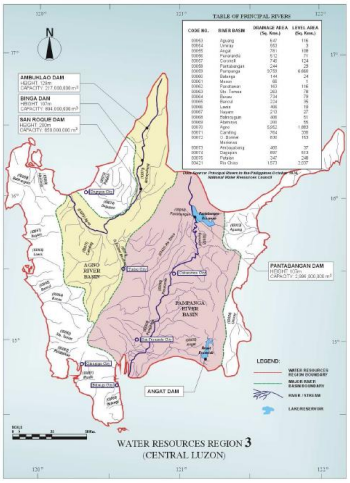
   The project will also conduct massive information, education and communications campaign to raise the awareness of the general public on climate change and its impacts, as well as, enhance the competencies of the concerned local government units on mainstreaming climate/disaster risk management into local land use and development planning and regulatory processes. To increase the resilience of vulnerable communities, the Project will support the development of climate resilient livelihoods and risk sharing/transfer models. The Project will also help cull and organize knowledge on climate/disaster risk management for vulnerable communities. The Programme Period: 2012-2014.

4. **Project ReBUILD:** Resilience Capacity Building for Cities and Municipalities to Reduce Disaster Risks from Climate Change and Natural Hazards, Phase I **– NZAP/UNDP**

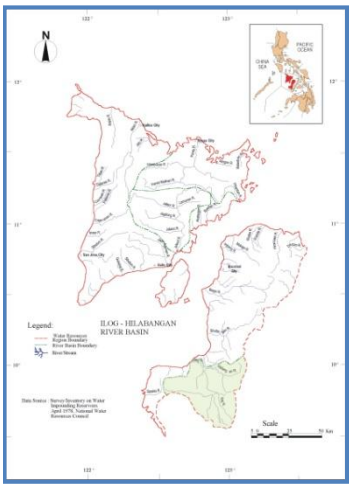
   The Project will address the institutional capacity and individual competency gaps on climate/disaster risk management of key players in the cities and municipalities surrounding the target river basins in Regions 2, 3 & 6 (See **Figures below**). These regions face geological (earthquakes, landslides), meteorological and meteorologically induced (typhoons, flooding, and rain-induced landslides) hazards/risks. The Project will attempt to cover all major risks, but will prioritize the meteorological and meteorologically induced hazards.



Region 2



Region 3



Region 6

The project is expected to be implemented over a period of three (3) years.

5. **Data Collection Survey on Situation of Nationwide Flood Forecasting and Warning System - JICA**

The Survey objective is to collect and study basic information on FFWS in the Philippines in terms of the issues of equipment, organisation/ institutional arrangements/ capacity (FFWS itself as well as O&M of equipment).

The study will cover the 18 major river basins in the Philippines and the principal river basin of Mandulog, which was affected by flashflood in December 2011 due to the passage of Tropical Storm Washi. The project will commence in January 2013 and ends in July 2013.

6. **Disaster Preparedness and Response Project – UNWFP**

The United Nations World Food Programme has recently approved its pilot community based flood early warning system (CBFEWS) in 4 provinces, namely: Beguet, Cagayan, Laguna and Sorsogon. With the active participation as well as financial support of the local government units, the project will take off in 2013, with the technical assistance of PAGASA.

7. **Establishment of a Pilot Automatic Warning System (AWS) in Cagayan de Oro (CDO) river basin – NDMI/MOPAS, Korea**

This initiative of the National Disaster Management Institute (NDMI) of the Ministry of Public Administration and Safety of the Republic of South Korea was a result of the Expert Mission conducted in March 2012 by the UNESCAP/WMO/TC to assess the needs of the areas devastated by the flood/flashflood brought about by Tropical Storm Washi. Following the

assessment and discussions with the national and local government units in Cagayan de Oro and Iligan cities, the NDMI came up with a plan to pilot the installation of an automatic warning system in Cagayan de Oro City.

6. **Progress on Key Result Area 6:** Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2008 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Currently, the Doppler radars in Subic, Tagaytay, Hinatuan and Cebu are now operational and integrated in the Integrated High Power Computing System (IHPC) of PAGASA. Two (2) of the three (3) Doppler radars provided by the Japan International Cooperation project installed in Virac, Catanduanes are now operational.

The PAGASA with the assistance of DOST has also started the project: Enhancement of Doppler Radar Network for National Weather Watch, Accurate Forecasting and Flood Early Warning (3 Doppler's for Antique, Zamboanga & Palawan).

b. Hydrological Achievements/Results

b.1 Risk Assessment for GMMA

The Risk Assessment Project (RAP) for Greater Metro Manila Area (GMMA) is among the numerous projects that were implemented after the devastation of GMMA and fringed provinces during the passage of Tropical Storm on 26 September 2009. The project was funded by AusAID (Geoscience Australia) and the United Nations Development Programme (UNDP) which aimed to conduct risk assessment in Metro Manila by applying ID and 2D modeling using Lidar data to derive the flood depths of various return periods in Taguig City. In addition, the project also aims to derive flood fragility curves in Metro Manila using 14 types of building topology.

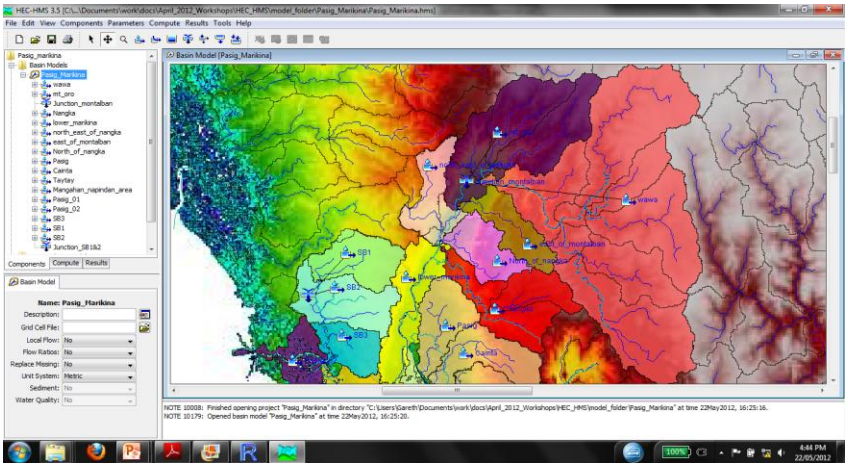


Fig. 6.1 HECRAS Model Development

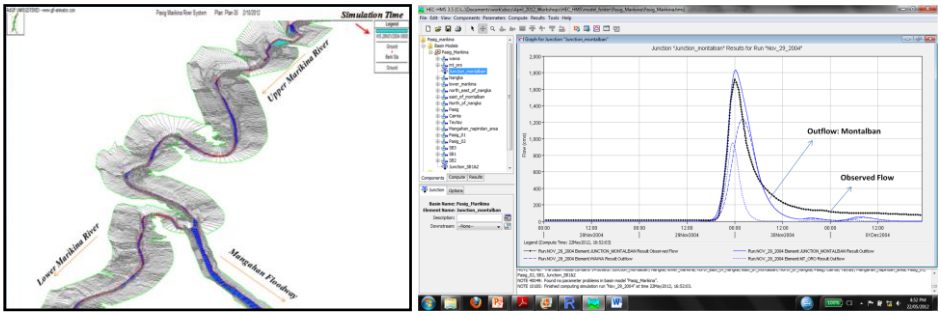


Fig. 6.2 Simulation of outflow in Marikina river in Nov 2004 flood event

b.2 The National Operational Assessment of multi-Hazards (NOAH) Project – GoP/DOST

A big effort of the national government through initiative of the Department of Science and Technology (DOST) is the NOAH project. The project components include: river basin management, rainfall-runoff modeling with inundation mapping, LIDAR mapping of the entire country and enhancement of delivery of PAGASA products in coordination with the government TV station.

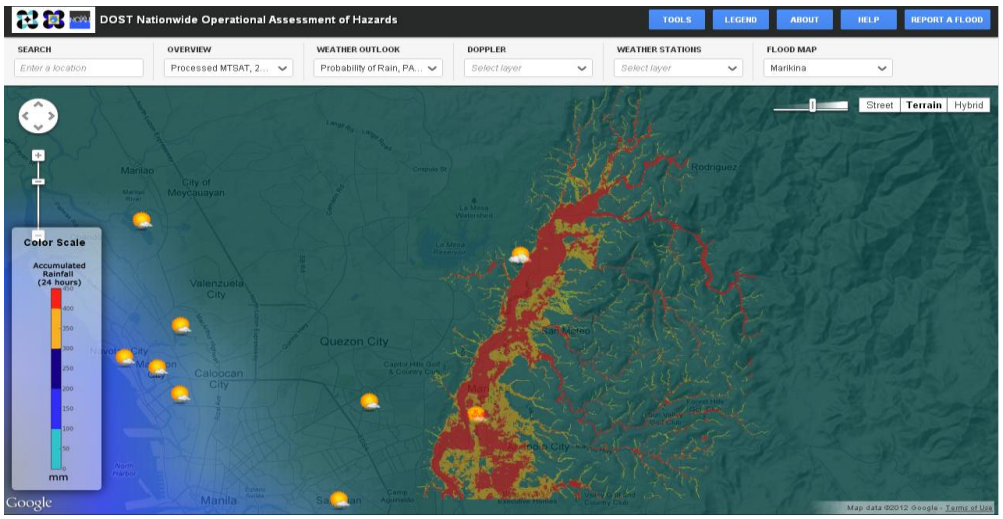


Fig. 6.3 Inundation map of Marikina river – output of the NOAH project

The NOAH website can be accessed and linked with the PAGASA website. An example of its output (inundation map) is shown above.

c. Disaster Prevention and Preparedness Achievements/Results

Please refer to Key Result Area 1(c).

d. Research, Training, and Other Achievements/Results

Please refer to Key Result Area 1(d).

e. Regional Cooperation Achievements/Results

Nil.

f. Identified Opportunities/Challenges for Future Achievements/Results

7. **Progress on Key Result Area 7:** Enhanced Typhoon Committee's Effectiveness and International Collaboration. (List progress on the Strategic Goals and Associated Activities in the Strategic Plan and progress on the 2009 Typhoon Committee Annual Operating Plan goals)

a. Meteorological Achievements/Results

Nil.

b. Hydrological Achievements/Results

- **40 Years of Flood Forecasting and Warning Service in the Philippines**

Flooding is not a new hazard in the Philippines. As a matter of fact, the **Archives of the Manila Observatory** chronicles major floods that occurred between 1691 and 1911 in connection with the passage of tropical cyclones. From the archive and the floods after 1911, the country experienced great floods in 1911, 1943 and 1972 in the country.

This year, 2012, the Philippines is celebrating the 40 years of Flood Forecasting and Warning Service, one of the operational services of the PAGASA-DOST.

It is worth nothing that, the early stages in putting up the pilot Flood Forecasting and Warning System (FFWS) in the Pampanga River Basin was initiated by the Economic Commission for Asia and the Far East (ECAFE) and the World Meteorological Organization (WMO) which sponsored the dispatched of a Preparatory Survey Mission on Typhoons (December 1966-January 1967) in the

Philippines headed by Dr. Toshio Takenouchi, then Director of River Department, Public Works and Research Institute of the Ministry of Construction of the Government of Japan, a Hydrology Expert. The Mission recommended the development of comprehensive plan for a pilot flood forecasting and warning system for the Pampanga River Basin.

In its inaugural session in 1968, the Typhoon Committee (TC) called attention to the need of members to embark on the development of their flood forecasting and warning capability. The Philippines was especially cited because of the destructive and extensive floods that had been affecting the country every few years. Dr. Takenouchi was a member of the First Survey Mission comprising of Japanese experts that conducted a survey of the Pampanga River Basin in November-December 1969. This was considered as the initial feasibility study for the pilot flood forecasting and warning system for the Pampanga River Basin.

In 1971, the Weather Bureau (now PAGASA) and the Bureau of Public Works (now DPWH) formalized a MOA for the establishment and operation of the proposed flood forecasting system. In Sep 1971**,** a flood forecasting center was established in the Weather Bureau in cooperation with the Bureau of Public Works. Trial computation was undertaken by the Center on the basis of the Japanese Survey team's report and with the assistance of the Typhoon Committee Secretariat.

As a result of the preparatory activities, the Diet of Japan approved the appropriation of US $260,000 (Grant) for the provision of equipment and training of personnel for the Pampanga Flood Forecasting System, the first big-scale development program in PAGASA.

The Pampanga FFWS became operational on 13 Sep 1973. Shortly after its establishment, two typhoons caused extensive damage over the Pampanga area in October 1973. Timely dissemination of flood warnings on those occasions proved extremely helpful. Farmers interviewed had stated that radio broadcast of flood advisories enabled them to harvest *Palay* (rice) before the flood waters rose to destructive level. The inhabitants of the towns in the flood affected areas too, were thankful for the effectiveness of the flood warnings.

The immediate success of the Pampanga FFWS led into development of the Agno, Bicol and Cagayan (ABC) FFWS, the first among the Overseas Economic Cooperation Fund (OECF) support.

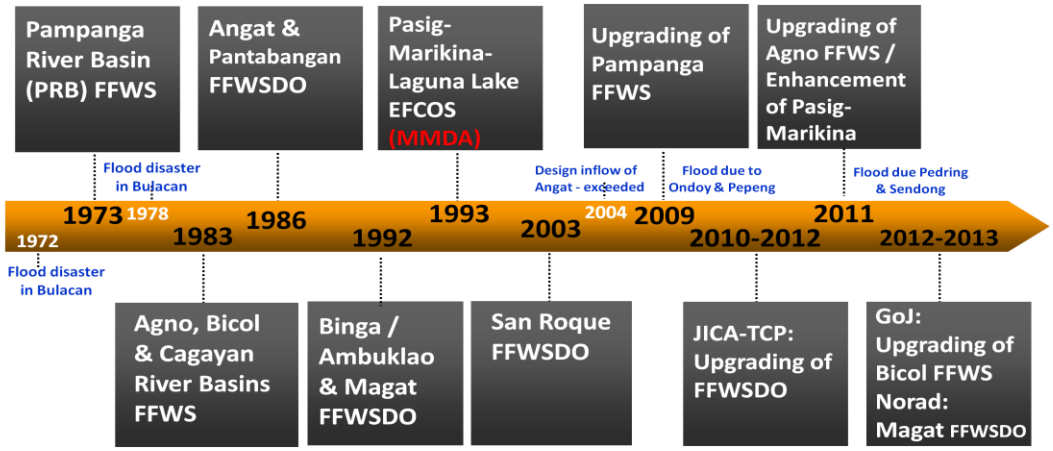


Fig. 7.1 Evolution of flood forecasting and warning service (hydrometeorological service) in the Philippines

Through the Typhoon Committee's initiatives and the subsequent activities to improve and enhance flood forecasting and warning service under the WGH, the Philippines through PAGASA was able to sustain its hydrometeorological service for the past 40 years.

c. Disaster Prevention and Preparedness Achievements/Results

Nil.

d. Research, Training, and Other Achievements/Results

Related training in meteorology:

Related training in Hydrology:

Related training in climate change:

Related training in Disaster Risk Reduction

e. Regional Cooperation Achievements/Results

f. Identified Opportunities/Challenges for Future Achievements/Results

III. Resource Mobilization Activities

Nil.

IV. Update of Members' Working Groups representatives

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