WWRP Warning Value Chain Project

Warning Value Chain Questionnaire

1. Purpose

This questionnaire (template) collects case study information on the end-to-end production and flow of information and decision making along the warning value chain during a natural hazard event. It is designed to record information about a high impact weather event but can also be used for hydrological, geohazard, or other types of events.

This template is free for anyone to use for any purpose. By completing and sharing this information with the World Weather Research Program (WWRP) Warning Value Chain Project you will:

- add to a global database of hazardous events with rich information covering the many components of the warning value chain,
- enable case studies and cross-cutting analysis of end-to-end warning value chains, from simple to complex, to understand effective practices,
- support the value cycle of review and learning from past events to identify improvements that would enhance future warnings.

More information about the WWRP Warning Value Chain Project can be found at http://hiweather.net/Lists/130.html.

2. Contents

The questionnaire has three parts. The accompanying Guide for the Warning Value Chain Questionnaire[1] gives explanations and examples of the types of information that are requested.

Part 1. Essential facts

An initial "quick look" table requests brief facts about a particular event, such as what happened, when, where, main impacts and overall responses. These short text responses help to identify and filter events. Links to this event in other databases and catalogues (EM-DAT, DesInventar, etc.) can be included here.

Part 2. Supplementary information on the warning value chain

The second part requests details about different stages in the warning value chain. This more in-depth information about the weather system/hazard source, hazards, impacts, warning communication and warning response, as well as the flow of information between these components, describe what was unique about the warning value chain for this event. Information here can be supplemented with relevant graphics, photos and videos, tables, and links to relevant external information and analyses.

The questions in Part 2 probe many aspects of the warning value chain but are not exhaustive. Each section invites additional information and analysis, including any successes, issues, or challenges experienced.

Part 3. Subjective assessment

Here contributors can rate the effectiveness of the individual elements of the end-to-end warning chain, and its overall effectiveness, on a scale of 1 (poor) to 5 (excellent). This may assist users of the database in choosing cases but should not be used for quantitative analysis. You may wish to acknowledge information providers here.

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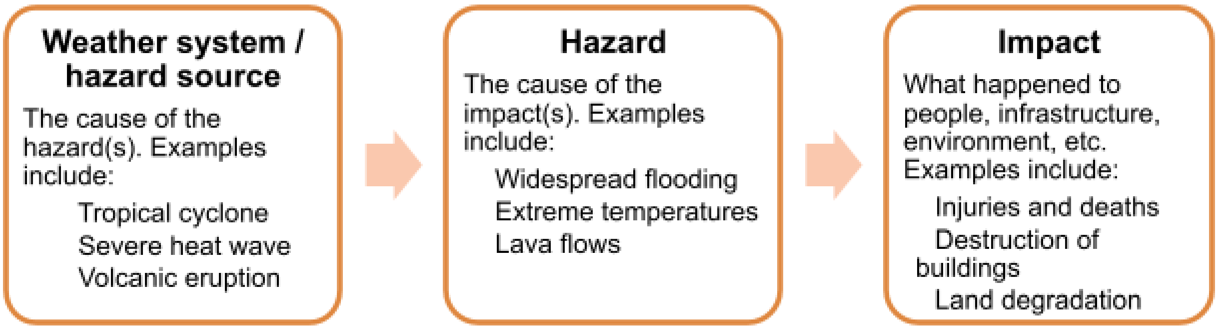
[1] https://docs.google.com/document/d/17p0G9P_u9paDGOFn21dVAgAUyTJHZnk2/edit?usp=share_link&ouid=106255653981108702821&rtpof=true&sd=true

3. Completed questionnaire

Send the completed questionnaire to valuechain@bom.gov.au. You will receive acknowledgement of your valuable contribution to the WWRP Warning Value Chain Project.

4. Tips

- In this questionnaire the terms "weather system", "hazard source", "hazard", and "impact" are used in the following way:



- A worked example of the Warning Value Chain Questionnaire is here (using a slightly earlier version of the template).
- Since it is challenging for a single person to fill in the entire template, you are encouraged to share it with colleagues who can assist with relevant information.
- While completed questionnaires are desirable, partially completed questionnaires are still very valuable contributions to the Warning Value Chain database.
- The Value Chain Glossary provides common value chain and warning chain terminology in a hydrometeorological context.
- To assist with searching the database, please try to use the names of hazard types listed in Annex 1 of this template.
- A series of prompts i in this template provide some quick information to assist with entering the requested data. Simply put your cursor over the information symbol i and text should pop up next to it (ignore the "Ctrl+click to follow link" instruction). *Note, that this feature is only available in the Microsoft Word App, not in the SharePoint or Google Drive browser page.* If this feature does not work for you, please consult the Guide for the Warning Chain Questionnaire.
- If you have further questions or suggestions on the use of this questionnaire please contact valuechain@bom.gov.au.

Information for WWRP Warning Value Chain Project team members

Opening a case

If the event does not exist yet in the library, refer to the README guide to open a new case study (project members only). If you are a project external contributor, please contact valuechain@bom.gov.au to open a new case study.

Adding resources

Resources for Part 2 (e.g., reports, graphics, data, and other information not easily accessible to the public) should be stored in the event data library of the respective case study.

1. Go to the event data library on Google Drive (open to anyone).
2. For an existing case study, locate the folder for the event for which you would like to add resources.
3. Place your resource in the folder and give an appropriate name so others know what it is about.

Embedding resources in the template

Brief resources such as forecast maps and warning graphics should be inserted directly into the corresponding section of the template. Reports and extensive graphics are not suitable to be embedded in the template but should be referred to. Please store the resources in the event data library first and then insert as a hyperlink to the template following these steps:

1. Right-click the file you want to embed/refer to and select 'Copy link' to retrieve the hyperlink pointing to the file.
2. In the template, use 'Insert Hyperlink' to paste the hyperlink in the appropriate place.

Collaborating on a case study

Many people may contribute information on an event. The shared template in the folder on the Google Drive makes it possible to work simultaneously on the same document, but other mechanisms for sharing are also fine. Where you disagree with another contributor try to provide evidence or example to support your position.

Finishing a case study

The completed questionnaire should be stored in the event data library of the respective case study, or sent to valuechain@bom.gov.au.

Part 1. Essential facts

Editors (Name & Institute)	Note: This case study was carried out in a breakout session at the WCSSP SE Asia regional workshop in Hanoi, Vietnam in May 2023 and most of the content has been provided by participants from the Philippines and Vietnam. **I've tried to list all those who presented below but do please add anyone I've missed.** **WCSSP SEA workshop breakout session participants: Do continue to add to the case study over the coming weeks if you can, and add your names and emails here if you contribute information and/or attended the breakout session and wish to continue to be kept informed on the case study.** Shirley David (PAGASA) (Breakout chair) Helen Titley (UK Met Office) (Breakout rapporteur) Email: helen.titley@metoffice.gov.uk (please contact me for more information on the HIWeather Value Chain project) Robb Prieto Gile (PAGASA) Gabriel Miro (PAGASA) Heinritz Majella Miguel (PAGASA) Jehan Fe S. Panti (PAGASA) Dr Hoang Phuc Lam (NCHMF, VNMHA) Du Duc Tien (NCHMF, VNMHA) Faye Wyatt (UK Met Office)

Hazardous event		
Unique identifier i	*(This will be added by the Project Team at a later date)*	
Name of event	Typhoon Noru	
When did it happen i?	September 21 – October 1 2022	
Where did it happen i?	Philippines and Vietnam (note that Noru also impacted wider region but we are focussing on Philippines and Vietnam)	☒ rural ☒ urban
Links/ IDs for this event in other databases	*(e.g. DesInventar, EM-DAT, GLIDE, ECMWF Catalogue of Severe Events, etc.)* *Glide: TC-2022-000318-PHL* *Glide: TC-2022-000318-VNM*	

What happened – weather, hazards, impacts, warnings, responses	
Event type/weather system that caused hazards i	Tropical Cyclone
Were any hazards forecast?	☒ yes ☐ no
Hazards that caused the main impacts i	Wind, rain, flash flood, fluvial flood

Rarity of hazard i	Around 9 TCs make landfall in Philippines each year; with 4-6 in Vietnam.
Were any impacts forecast?	☒ yes ☐ no
Main direct impacts i	Philippines: agricultural damage, infrastructure damage, > 100,000 houses damaged. Vietnam: Power outages; houses damaged/destroyed, crops flooded, school closures. Substantial flood damages.
Economic damage in USD i	$110 million (across whole region)
Fatalities	12 (and 5 missing) in Philippines; 9 in Vietnam
Were any warnings issued?	☒ yes ☐ no
Main warnings issued i	Tropical cyclone warnings (RSMC Tokyo, PAGASA, NCHMF/VNMHA), Impact-based warnings (PAGASA), Flood bulletins (PAGASA).
Who issued the warnings? i	RSMC Tokyo, PAGASA, NCHMF/VNMHA
Were there any responses to warnings?	☒ yes ☐ no
Main responses to warnings i	Philippines: Evacuations, preparations of relief goods, pre-emptive dam releases and crop harvesting, school closures. Vietnam: Ships evacuated, equipment at fish farms lowered to prevent damage at sea surface, trees cut down and electricity cut off, curfew.

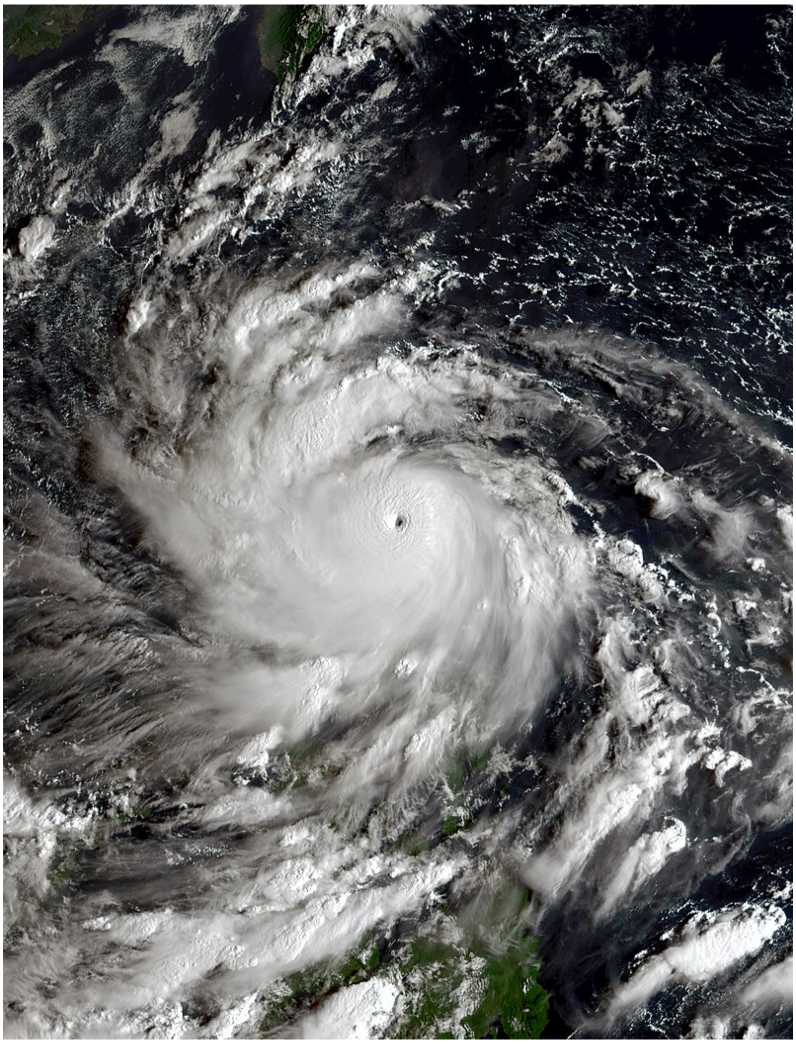
Part 2. Supplementary information on the warning value chain

This section collects more detailed information about elements of the warning value chain. It is often not possible to answer all questions, but please provide what information you can.

Information here can include:

- Free-form text (descriptions, selected extracts from reports, data analysis, tables, etc.)
- Graphics (forecast charts, analysis maps, warning graphics, photos of impacts, etc.).
- Videos (social media, weather service briefings, etc.).
- Links (external reports, media, national archives, policy documents, protocols, meeting records, etc.)

Try to keep your entries brief and include references and links (URLs) to where additional information can be found. Attribute all material that may be subject to copyright (for example, images and videos).

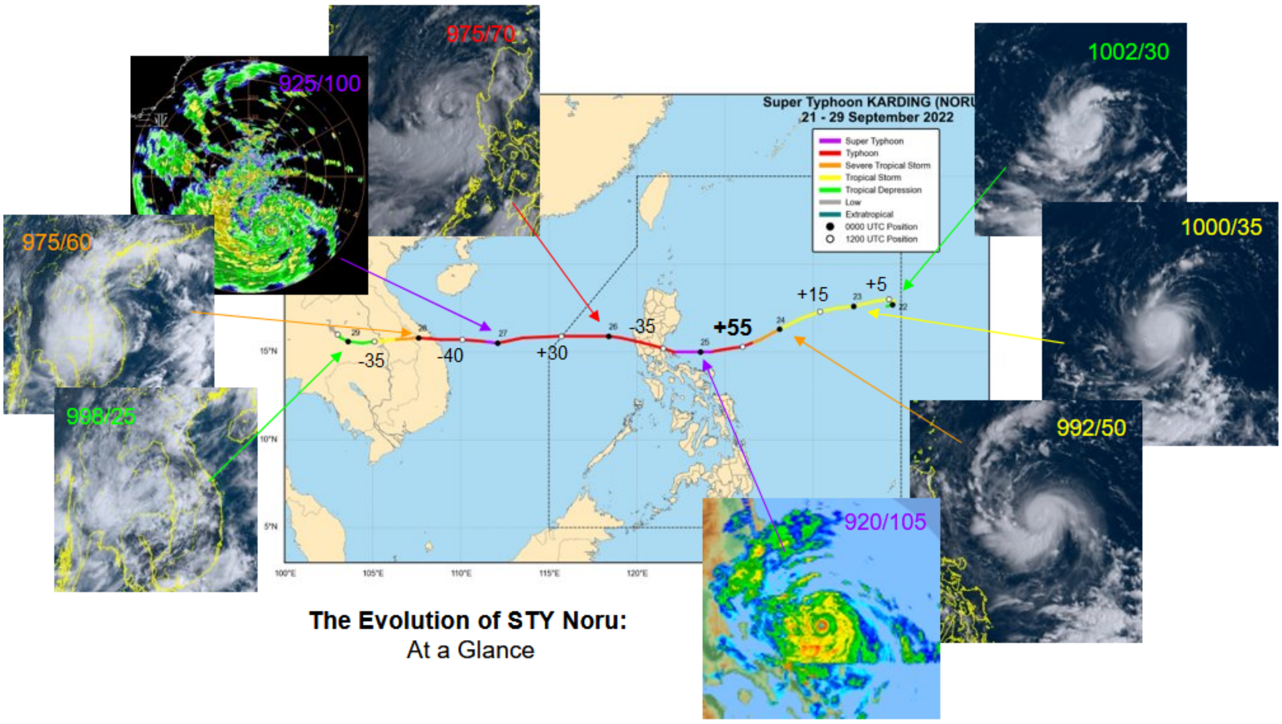


Typhoon Noru

a. Weather system / hazard source

(Adapt as required for non-meteorological events)

Situational overview i

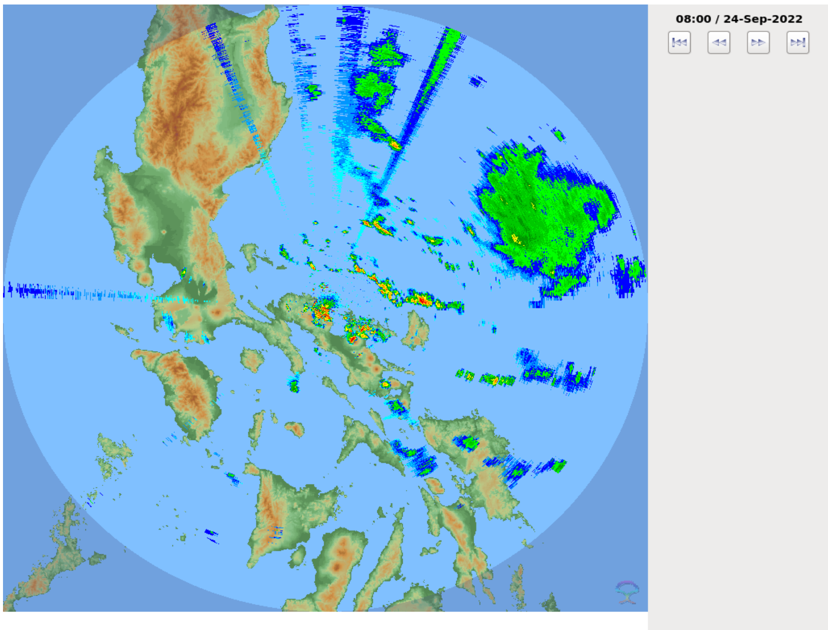


The Evolution of STY Noru:
At a Glance

Typhoon Noru, known in the Philippines as Super Typhoon Karding, was an intense tropical cyclone that affected the Philippines and Vietnam in late September 2022. Noru formed to the East of the Philippines and underwent rapid/explosive intensification as it approached landfall. Prior to landfall on 25th September it was estimated to have maximum sustained winds of 195 km/h near the center, wind gusts of up to 240 km/h, and central pressure of 920 hPa. Noru made its first landfall over the Polillo Islands at 0930UTC on September 25th with a second landfall over Central Luzon five hours later. It significantly weakened while crossing Luzon but re-intensified over the East Sea (South China Sea), before making its final landfall just south of Da Nang, Vietnam at 2100UTC on September 27th. From NCHMF: "TY NORU made landfall along Thua Thien Hue – Quang Ngai with maximum center wind speed at Cat.10-11 (98-117km/h), gust of force Cat.13 (134-149km/h)". After landfall, Noru continued westward and weakened into a low pressure over southern Laos.

Special/non-traditional observational data used in the weather forecast or assimilated into NWP i

Were the available observations adequate for forecasting the high impact weather? i
Weather radar was very useful to PAGASA in being able to observe the storm rapidly intensifying just to the East of the Philippines. See animation below:

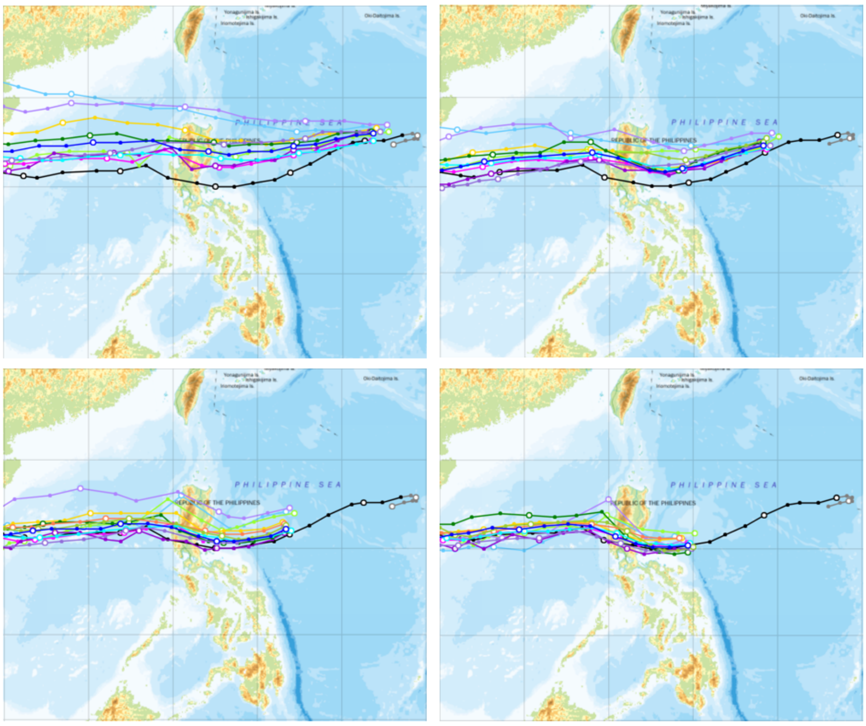


Animation of weather radar reflectivity from DAE
Roughly 15 hours ending at 00UTC 25 September 2022

Weather forecast models (long-range, medium-range and short-range) i

A wide range of models (deterministic and ensemble & global and regional) are used in both the Philippines and in Vietnam.

All models (global/regional) struggled with early predictions of TC Noru. The forecasts tracks were too far to the north, with deterministic forecasts failing to capture the observed path:



Operational track guidance failed to capture the path of Noru even hours before landfall.

Weakness: Capturing transient mid-level steering patterns

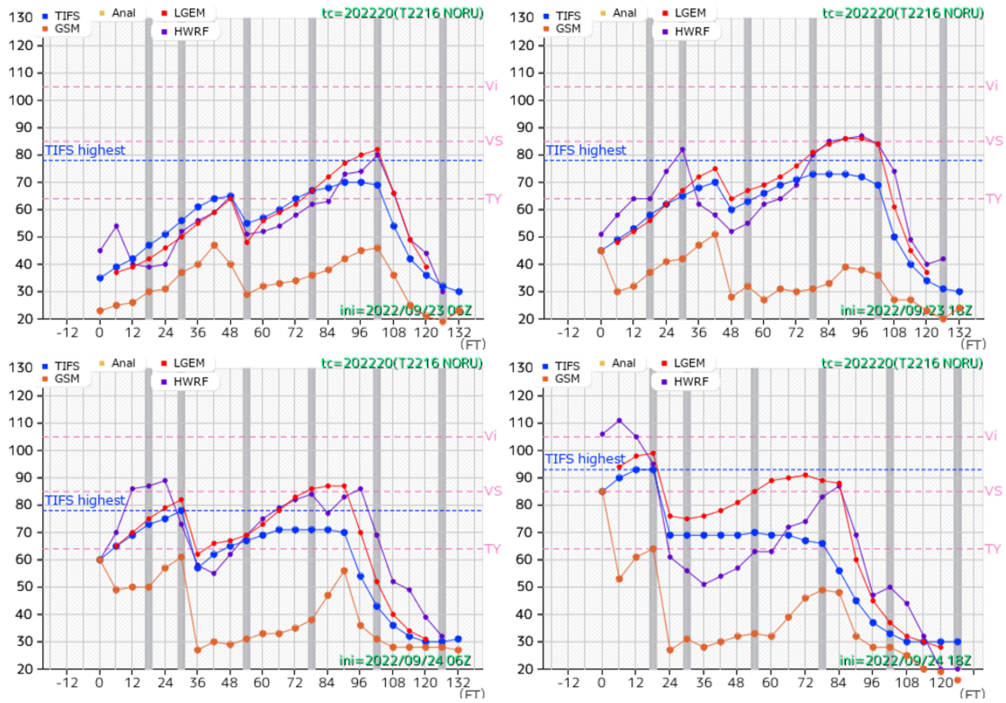
Upper left:
23/06Z guidance for 23/12Z warnings

Upper right:
23/18Z guidance for 24/00Z warnings

Lower left:
24/06Z guidance for 24/12Z warnings

Lower right:
24/18Z guidance for 25/00Z warnings

All models struggled to forecast the rapid intensification of Typhoon Noru:



Operational intensity guidance failed to capture the rate at which Noru intensified

Intensification rate too slow. Inner core not fully captured by model guidance

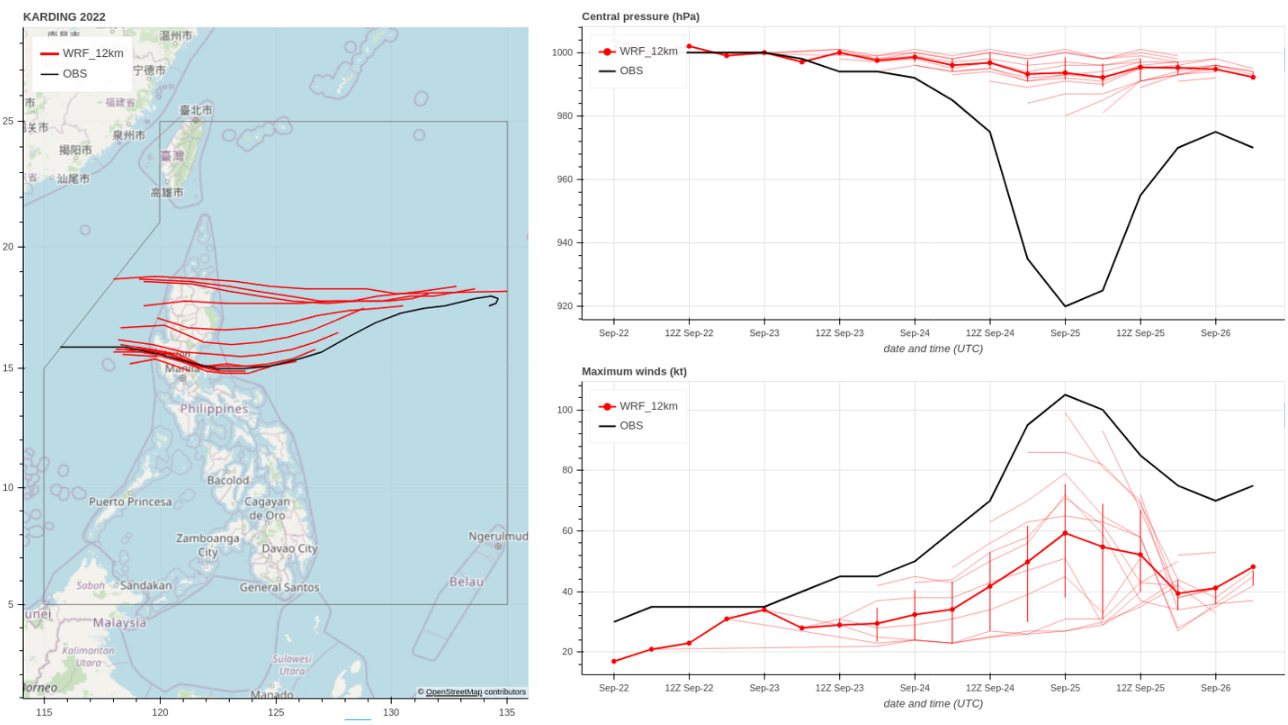
Upper left:
23/06Z guidance for 23/12Z warnings

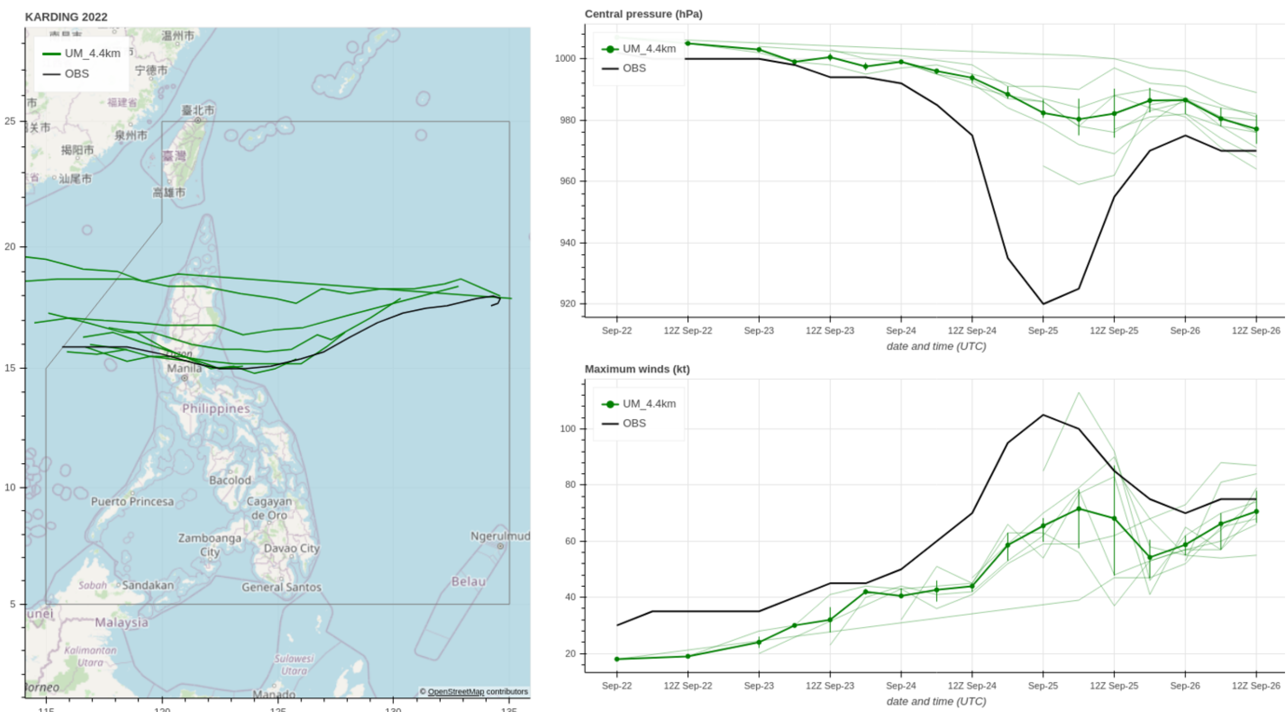
Upper right:
23/18Z guidance for 24/00Z warnings

Lower left:
24/06Z guidance for 24/12Z warnings

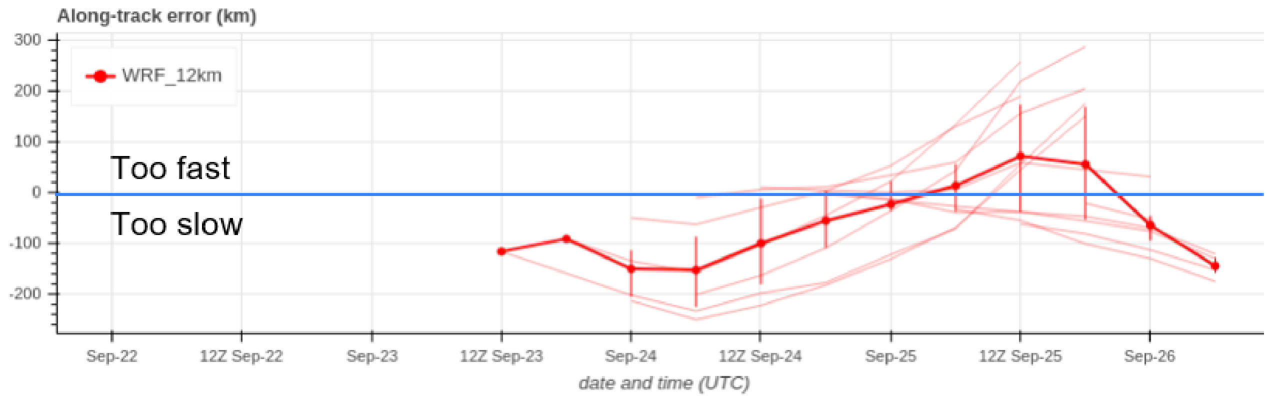
Lower right:
24/18Z guidance for 25/00Z warnings

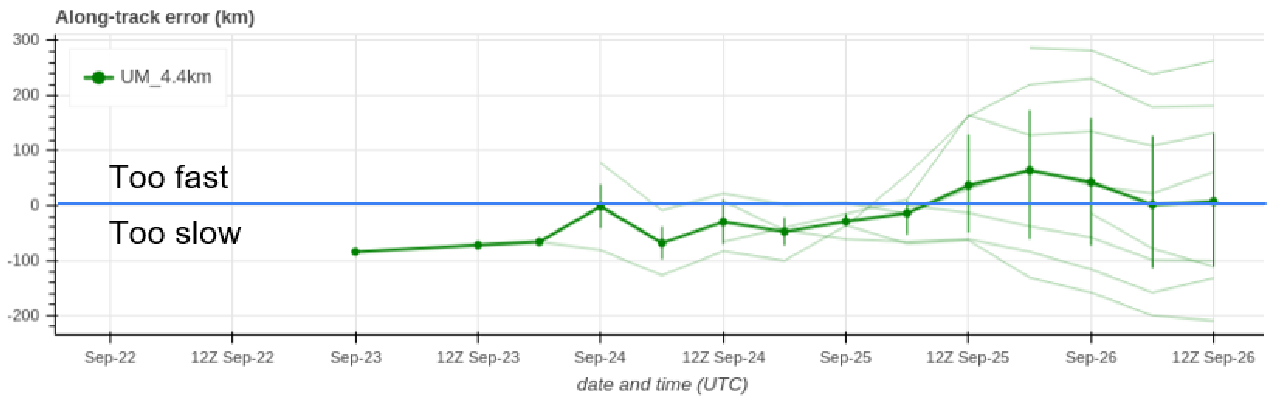
Below are the track and intensity forecasts from successive runs of the WRF 12km model and Met Office 4.4km models, both of which showed the same displacement of the track to the North and the lack of deepening of the central pressure. The winds do show some intensification, but to a much lesser degree than observed:



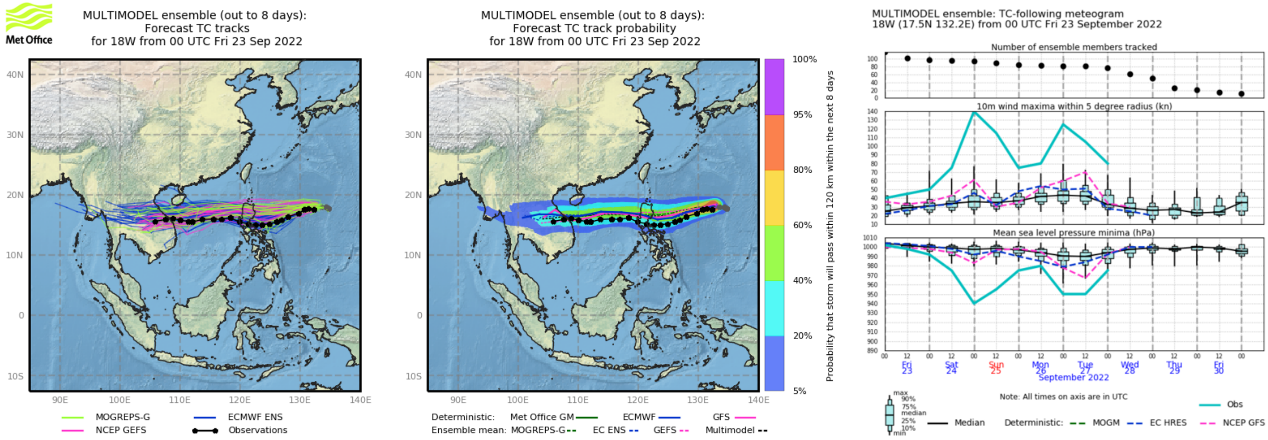


Both models had negative along track errors in the early forecast runs, which means they were forecasting the storm to be moving too slowly:

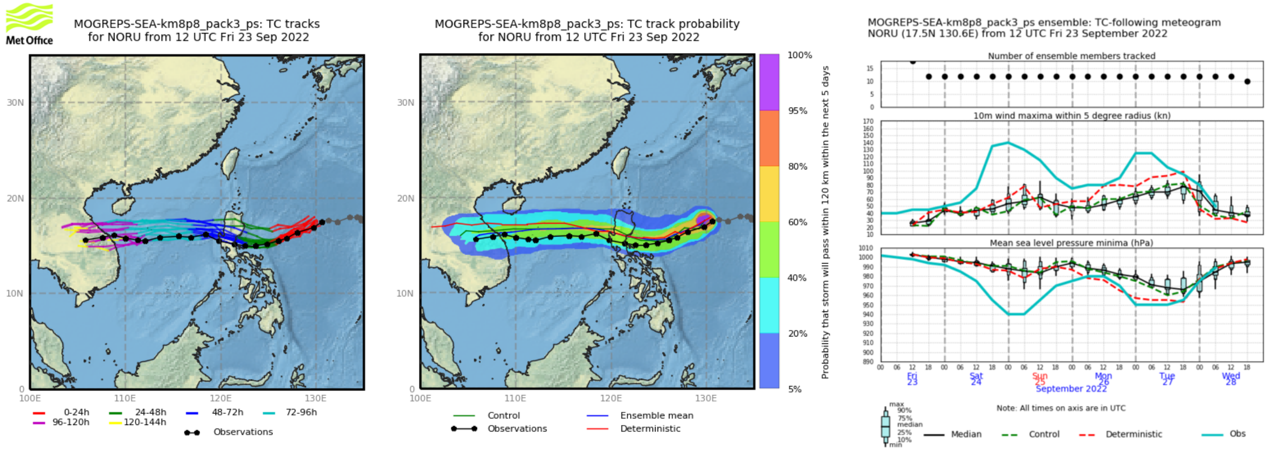




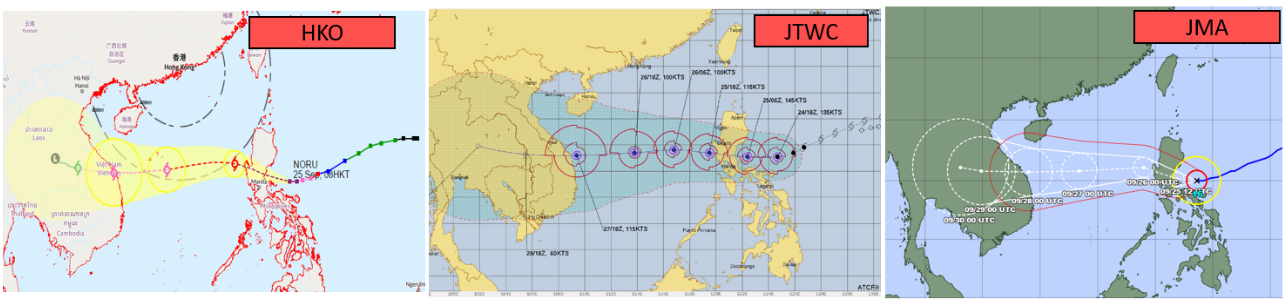
The spread in the track forecast from the global ensembles did encompass the observed track, exemplifying the benefit of using ensembles, however the observed track was towards the outer edge and most members also had the northward bias. The global ensembles failed to predict the rapid intensification (a known limitation of global model forecasts, particularly with small compact typhoons like Noru):



The Met Office regional 8.8km ensemble was also generally forecasting tracks too far to the north and struggling to predict the rapid intensification prior to the first landfall:

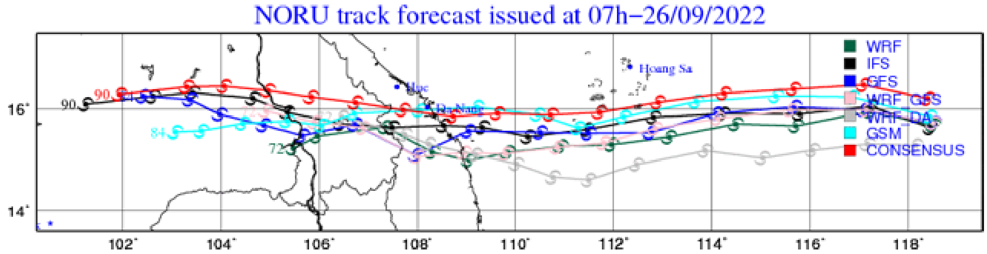


For the Vietnam landfall, the track forecasts from the NWP deterministic and ensemble models were good at even longer lead times (for example see the forecast for track and intensity above from the MOGREPS-SEA ensemble from 12 UTC 23rd September). This was used to guide the track and intensity forecasts from the main regional operational TC forecast centres that are shown below. These were similar in predicted track but had a greater variation in their intensity forecasts:

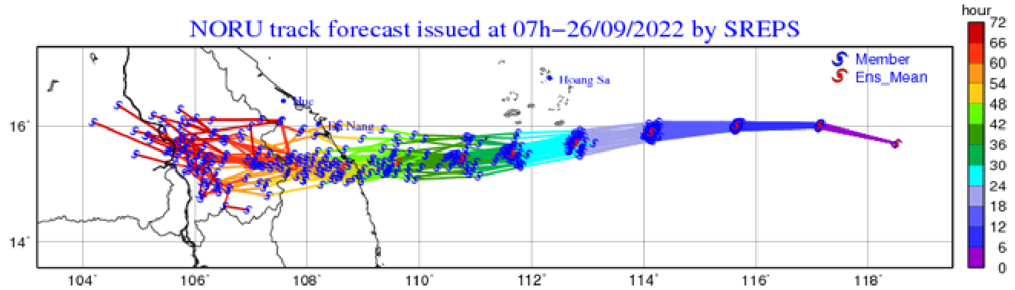


Centers	Intensity while approach land (Vietnam category)	Potential TY center landfall	Time of impact
JTWC	Cat.17 (202 – 221km/h)	ThuaThienHue–BinhDinh	In the evening of Sep. 27th
JMA	Cat.13 (134 – 149km/h)	ThuaThienHue–BinhDinh	Afternoon of Sep. 27th
HKO	Cat.14 (150 – 166km/h)	ThuaThienHue–BinhDinh	Afternoon of Sep. 27th
CMA	Cat.15 (167 – 183km/h)	ThuaThienHue–BinhDinh	Afternoon of Sep. 27th
NCHMF	Cat.14 (150 – 166km/h)	ThuaThienHue–BinhDinh	Afternoon of Sep. 27th

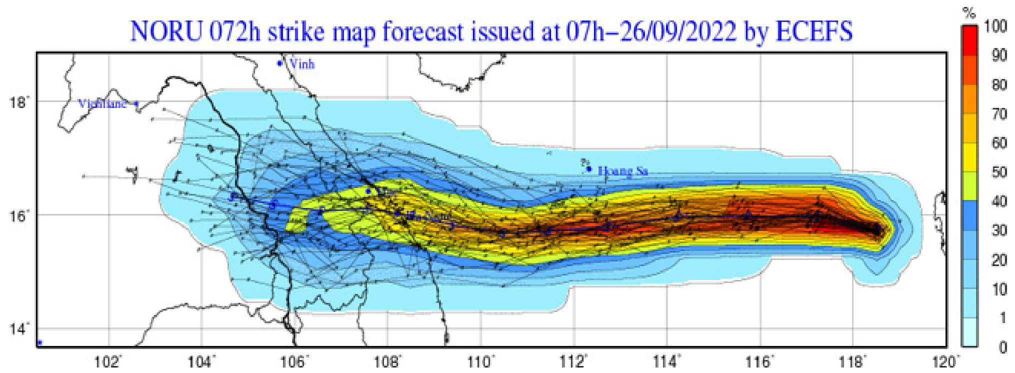
At shorter lead times (such as the examples below issued on 26th September), the track forecasts remained confident for the landfall location just to the south of De Nang from both the deterministic models and the global and regional ensemble prediction systems:



Multi TC track forecasts from deterministic models



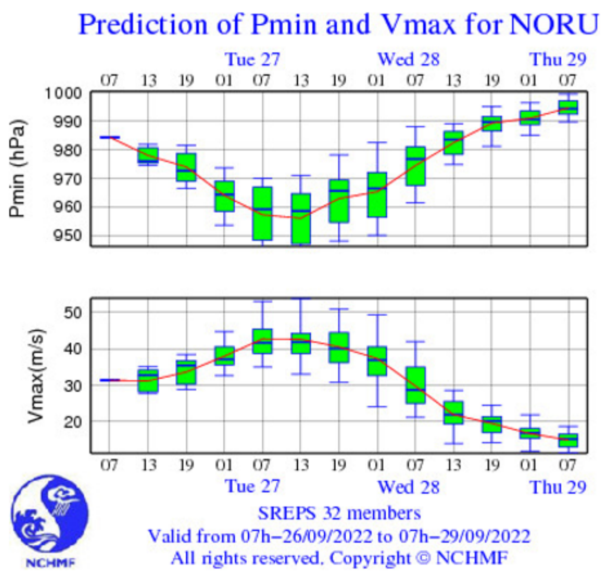
TC's tracks forecast from regional ensemble system



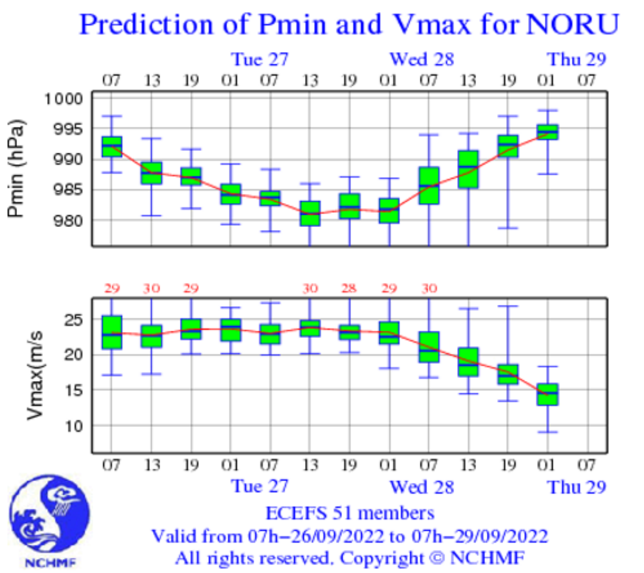
TC track probability forecast from the ECMWF ENS ensemble

The intensity was better from the regional WRF system used in Vietnam, with global model winds such as those from the ECMWF ENS shown below being too low:

TC intensity forecast from regional ensemble system



TC intensity forecast from ECMWF global ensemble system



Post-processing/calibration applied to weather model output i

Forecasters at PAGASA were monitoring the tendency of the track forecasts to shift further south and therefore were using their expert judgement to subjectively increase the track uncertainty in the forecast and communicate the potential for the storm to impact areas further to the south.

Weather forecast outputs and examples i
See track/intensity forecasts above.

Forecast interpretation/guidance for non-experts i

How well did different forecasts agree? i
All forecasts agreed that the track would be further north than it was and wouldn't significantly intensify ahead of landfall, but this was incorrect and therefore gave false confidence in these forecasts.

How reliable and accurate were weather forecasts at different lead times? i
At shorter lead times the models began to more accurately predict the landfall location and timing e.g. from 00UTC 25th September.

When was the potential event first detected in the forecast models? i

Weather observations and analyses i

How did the observed weather relate to climatology and/or previous extreme events? i

Additional analysis i

Successes/issues/challenges experienced in weather forecasting and observation i
Idea for improvement: It may be of benefit to formalise bilateral discussions between PAGASA and Vietnam when a typhoon is travelling between the two countries, perhaps using the mechanism of the Typhoon Committee.

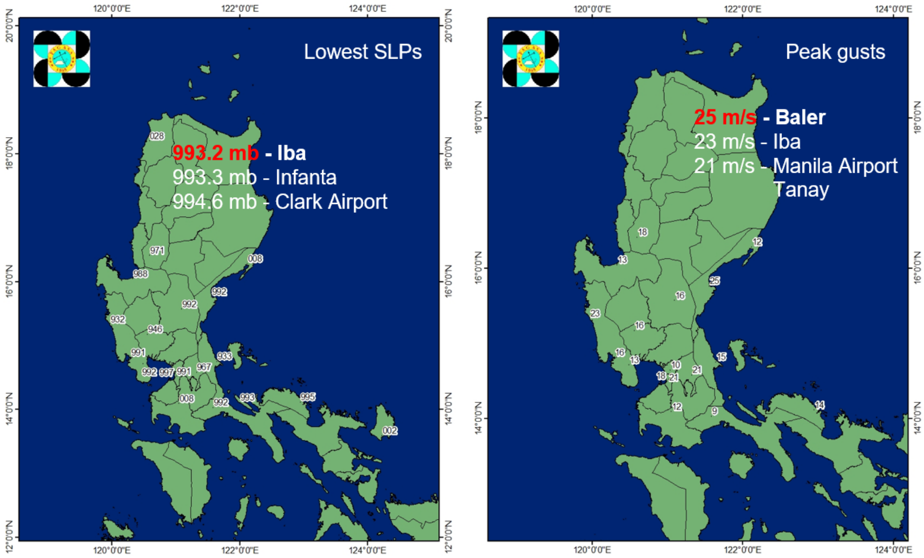
b. Hazards i

Brief overview of the hazard(s) i

The main hazards were from very strong winds and flooding from heavy and prolonged rainfall.

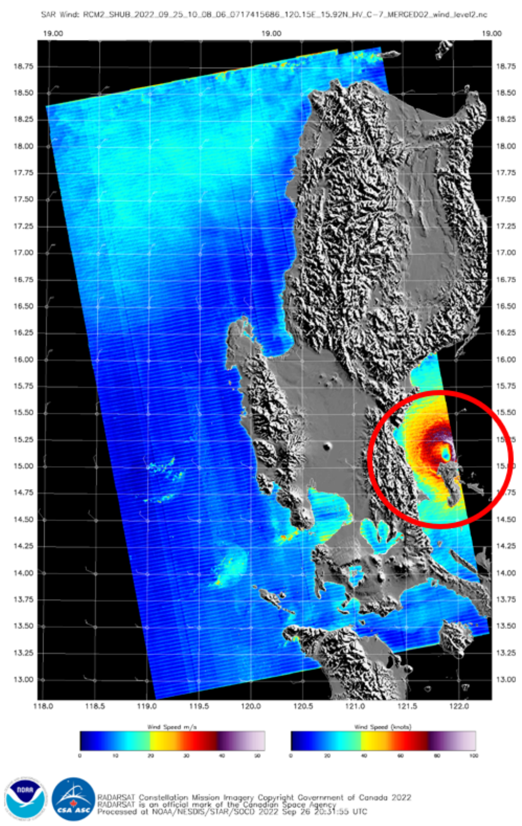
Philippines

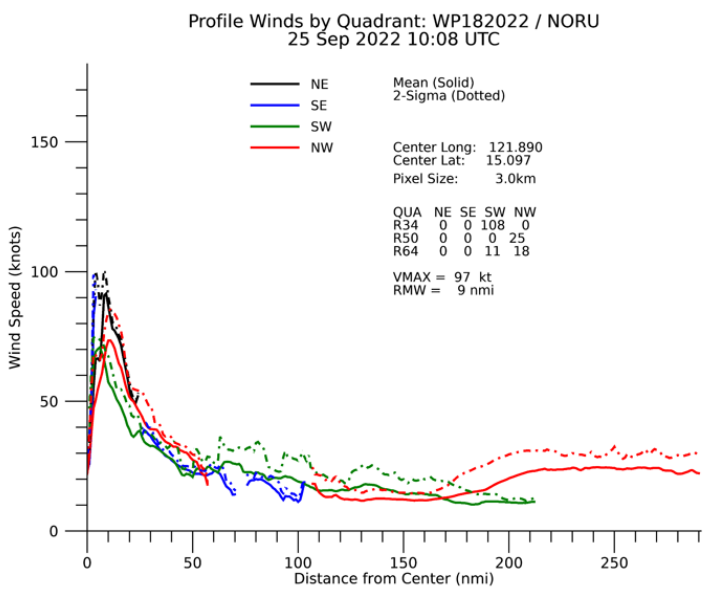
Typhoon Noru was a small storm with a very small inner core, so the area impacted by the strongest winds over the Philippines was quite small and sourcing wind/pressure observations over land was difficult and thus the values below do not represent the minimum pressure or maximum wind gust:



YouTube videos are useful to validate that violent typhoon conditions were experienced within the small inner core of Noru at the height of its initial landfall in Polillo Islands, Quezon e.g.: http://www.youtube.com/watch?v=vAQDClfasUM

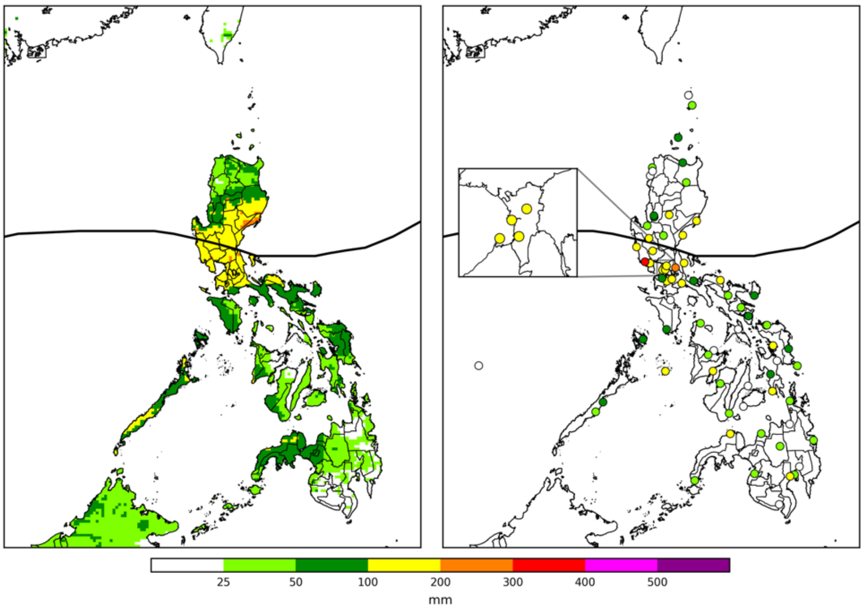
SAR data also gave useful information of the winds in different quadrants after the initial landfall (post-real time):





SAR overpass (post-real time data) showing wind swatch and profile winds of Noru post-initial landfall

Storm total rainfall accumulations were highest across a swath of central Luzon as shown below:



Satellite-derived, gauge-corrected estimates (left) and gauge observations (right) of storm duration rainfall (21-26 September 2022)

Vietnam

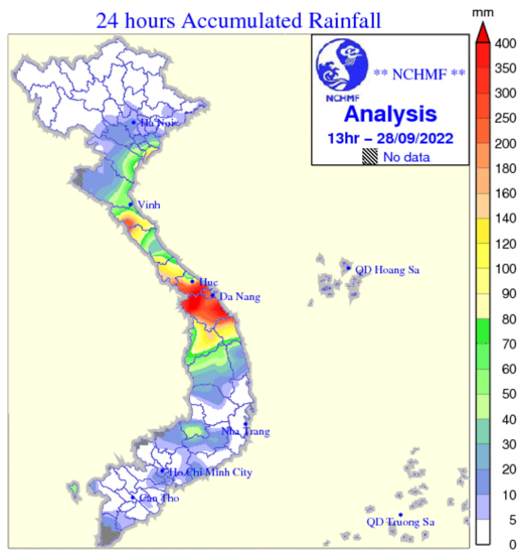
Strong wind information from NCHMF:

- Cham Island had wind speed at Cat.11 (103-117km/h), gust of force Cat.14 (150-166km/h); Ly Son Island had wind speed at Cat.10 (89-102km/h), gust of force Cat.12 (118-133km/h).
- On the land of Da Nang – Quang Nam area had wind speed at Cat.7-9 (50-88km/h), gusts of force Cat.11-13 (103-149km/h).
- The area from Quang Binh to Thua Thien Hue province, from Quang Ngai to Phu Yen province, Kon Tum and Gia Lai province has strong wind at Cat.5-6 (29-49km/h), gusts of Cat.7-8 (50-74km/h).
- The minimum center pressure is 968.9mb at 03h20 in Sep.28th in Tam Ky station (Quang Nam province)

Heavy rainfall information from NCHMF:

- There was heavy rainfall and thunderstorm from the morning of Sep.27th to the day of Sep.28th.
- From 07h00 Sep.27th to 13h00 Sep.28th: Thua Thien Hue to Quang Nam province 200-400mm, some places over 450mm; Quang Binh, Quang Tri, Quang Ngai province and North Highland 100-200mm, some places over 250mm.

Province/ctiy	Station	Precipitation (mm)
Quang Tri	A Bung	293
	Ta Rut	291
Thua Thien Hue	Bach Ma	597
	Nam Đong	481
Đa Nang	Ba Na	394
Quang Nam	Nui Thanh	485
Quang Ngai	Tien Phuoc	465
	Tam Ky	460
	Tra Phu	419
Kon Tum	Đak Choong	322
	Đak Na	299



24 hours accumulated rainfall at 06UTC Sep.28th 2022

Observational data used in the hazard prediction or assimilated into the hazard model i

Were the available observations adequate for predicting the hazard? i

Hazard prediction models/tools i

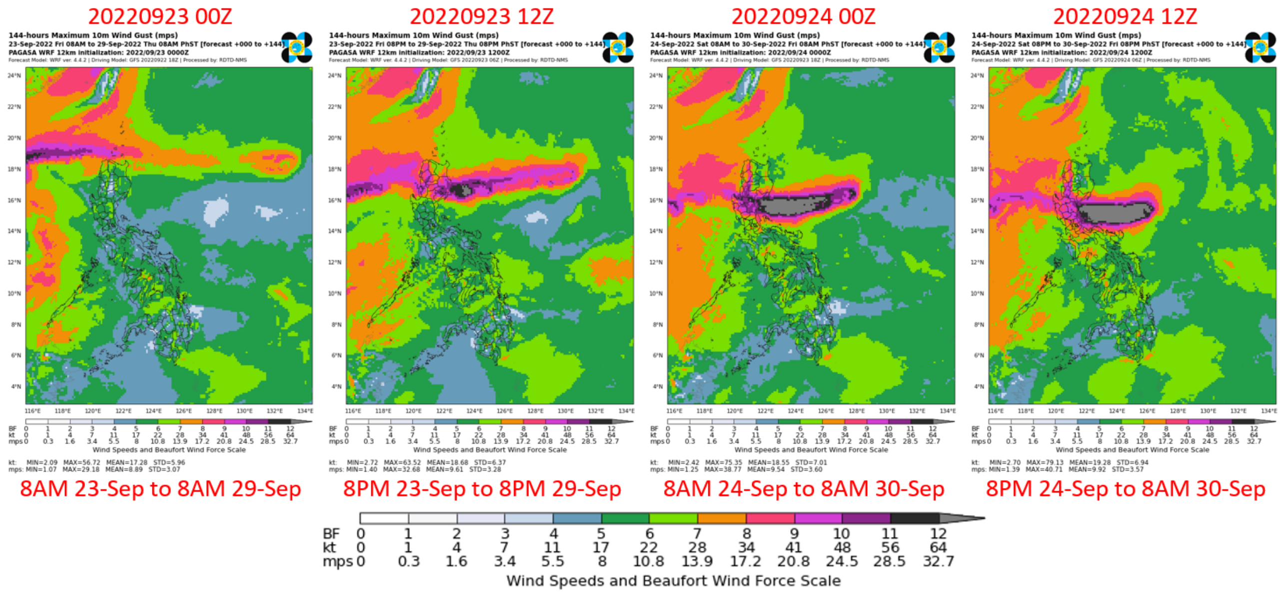
Models used by PAGASA include the PAGASA-WRF 12km and 3km models, the Met Office 4.4km SEA model and 8.8km MOGREPS-SEA regional ensemble, and other global deterministic and ensemble models.

Models used by Vietnam include a WRF-based regional ensemble, and global deterministic and ensemble forecast models.

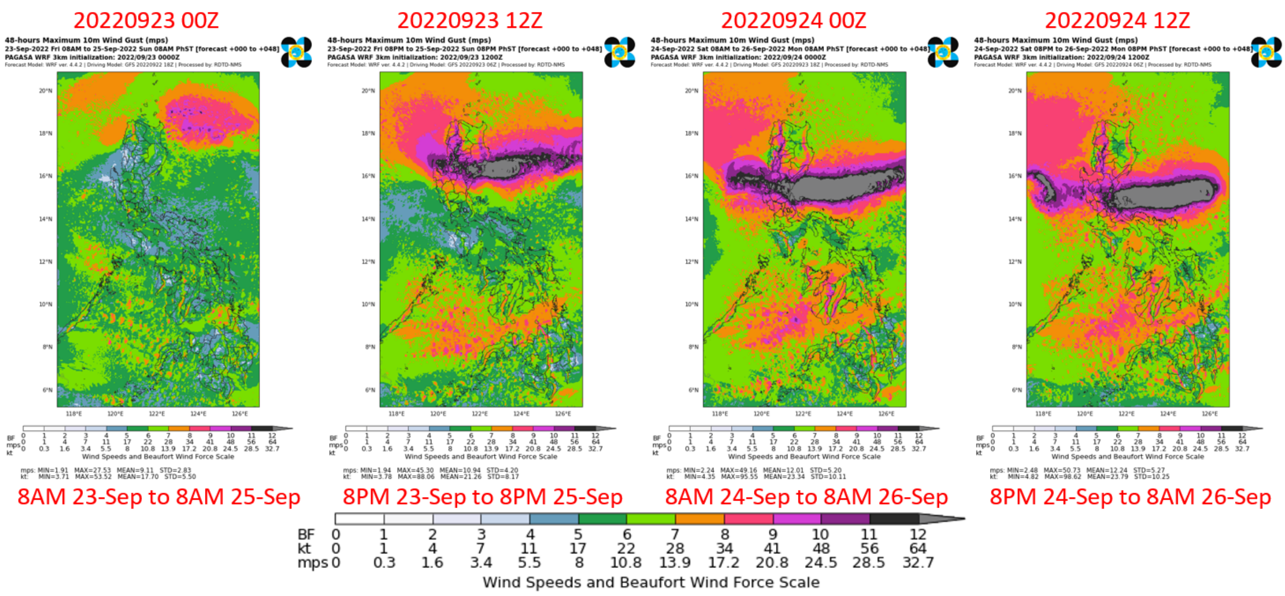
Hazard prediction outputs and examples i

Examples from Philippines

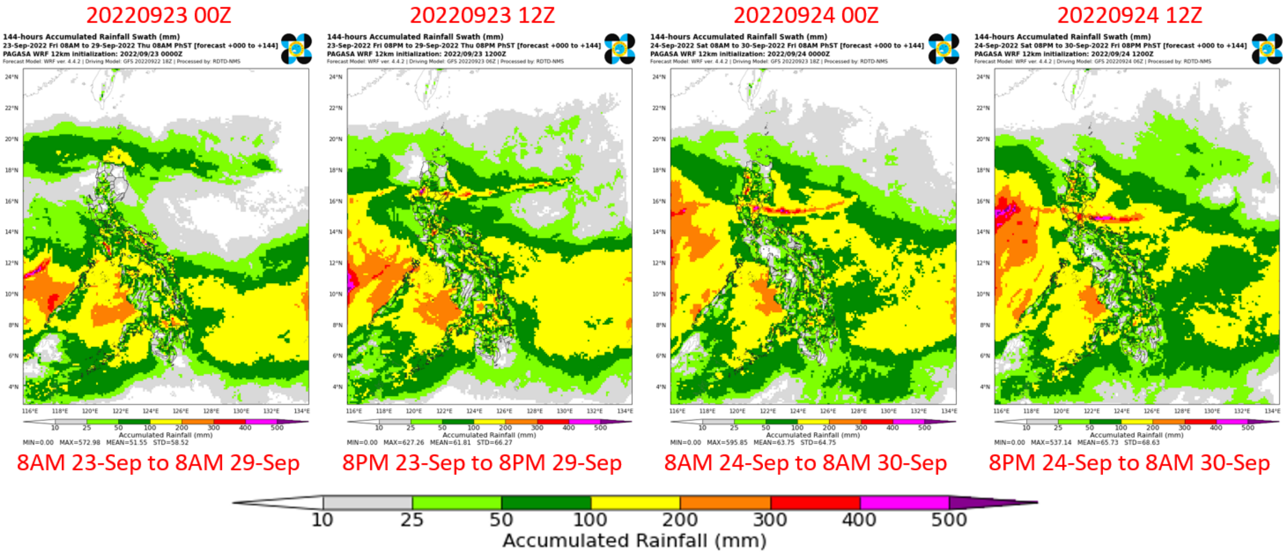
PAGASA-WRF 12km 144-hours Maximum 10m Wind Gust



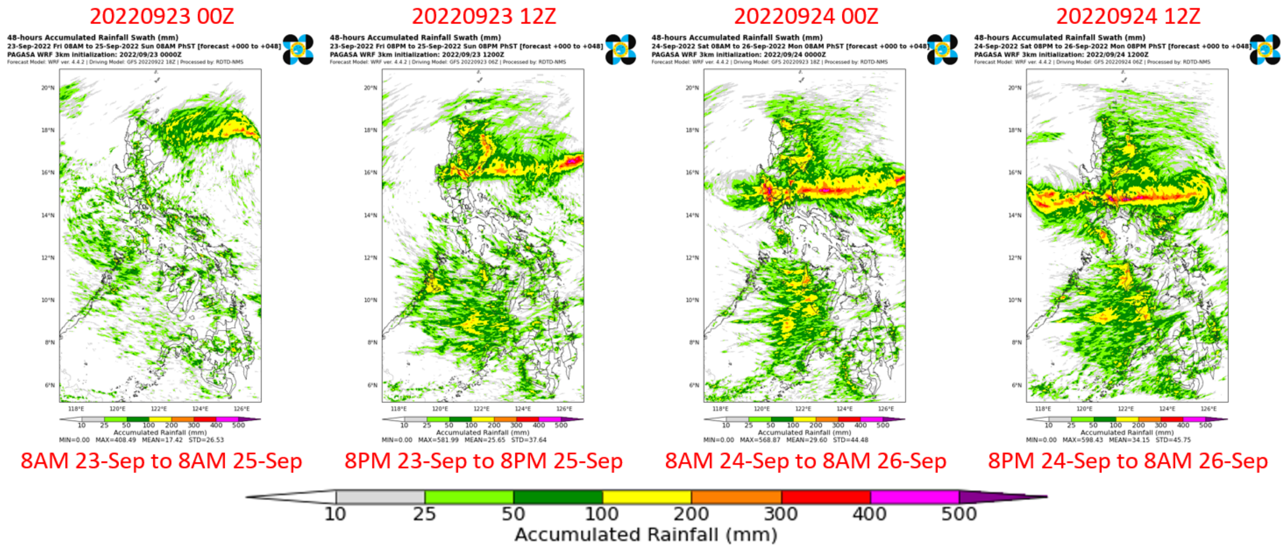
PAGASA-WRF 3km 48-hours Maximum 10m Wind Gust



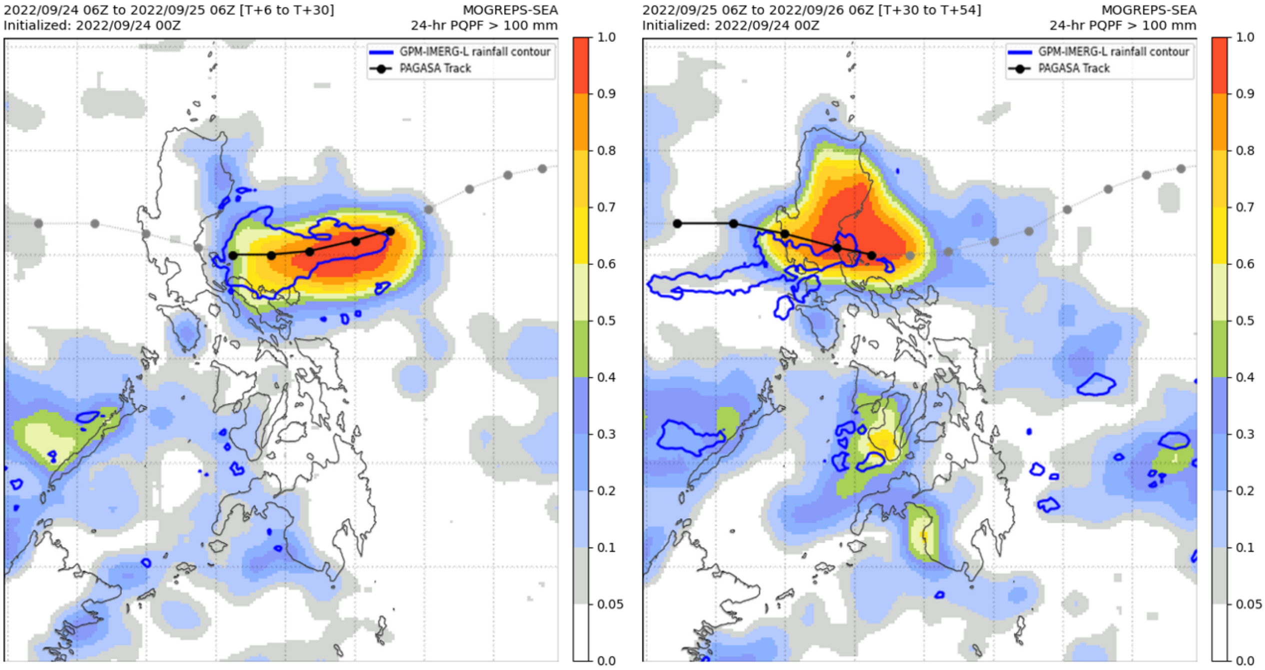
PAGASA-WRF 12km 144-hours Rainfall Swath



PAGASA-WRF 3km 48-hours Rainfall Swath

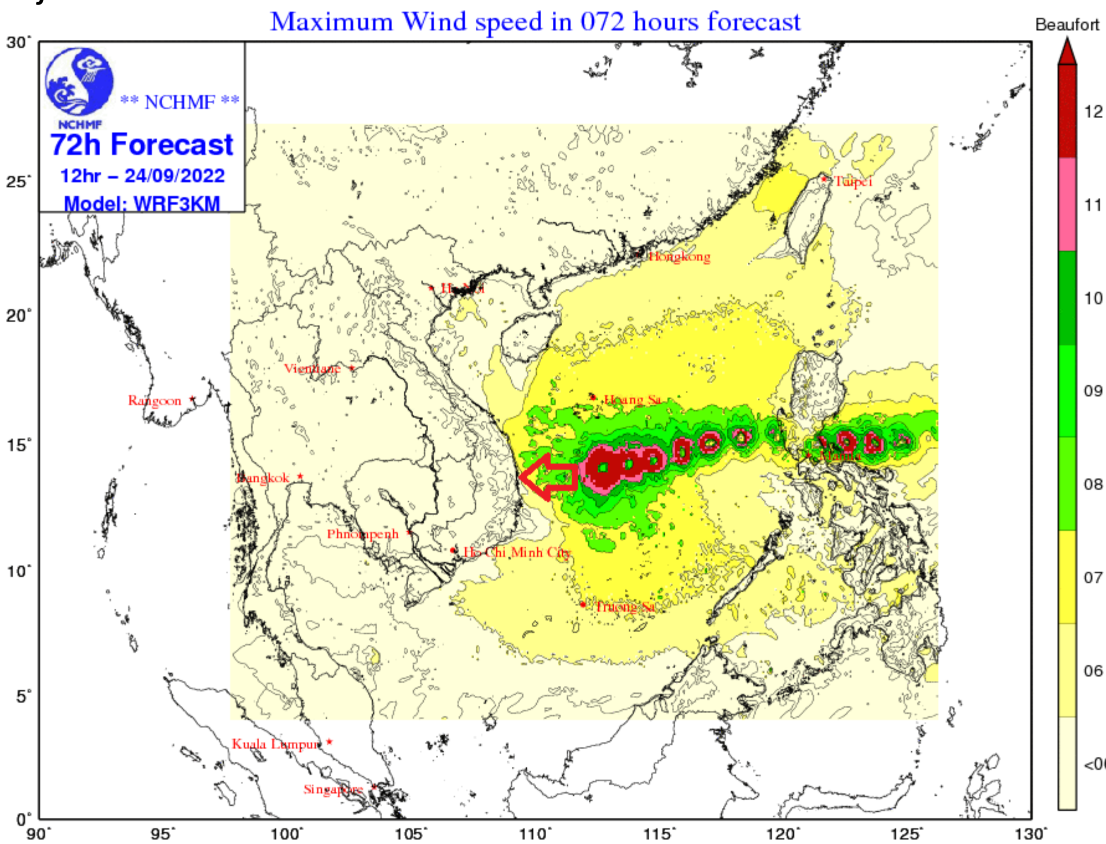


MOGREPS-SEA 24-hr PQPF > 100mm (Initialized 00Z Sep-24) GPM 100mm contour in blue

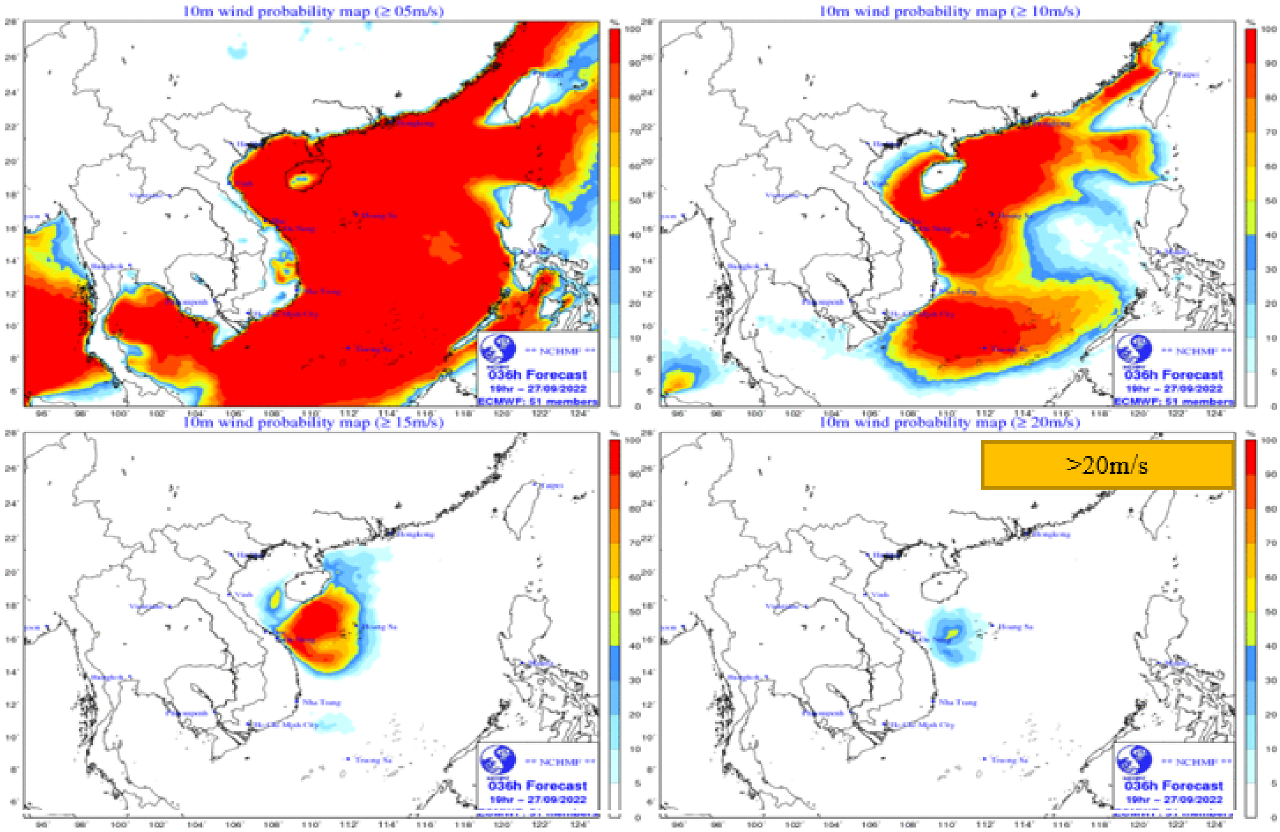


The figure above shows that MOGREPS-SEA (the 8.8km regional ensemble) is forecasting the rainfall to occur later than it was observed (due to the slow track bias still present on the 00UTC Sep 24th run). The heavy rainfall area is also forecast to extend too far to the north over Luzon.

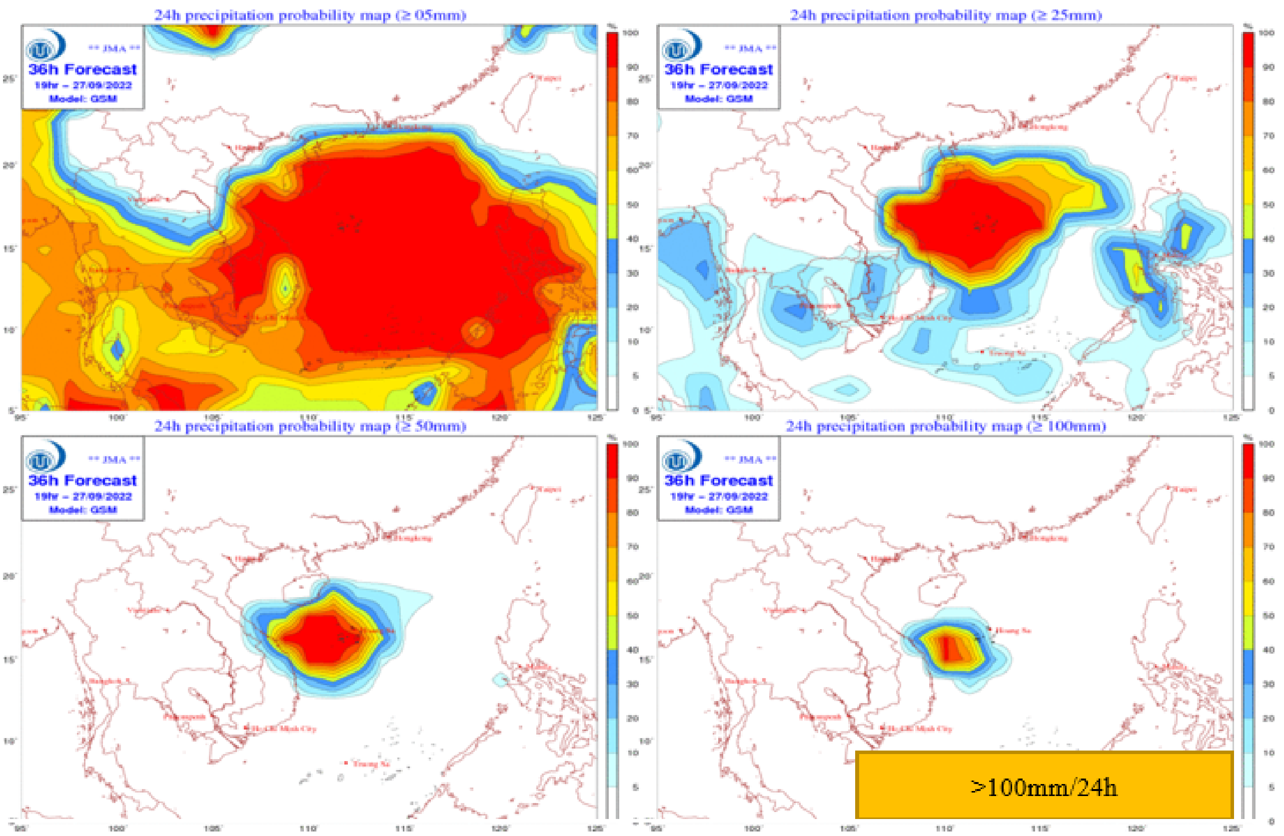
Examples from Vietnam



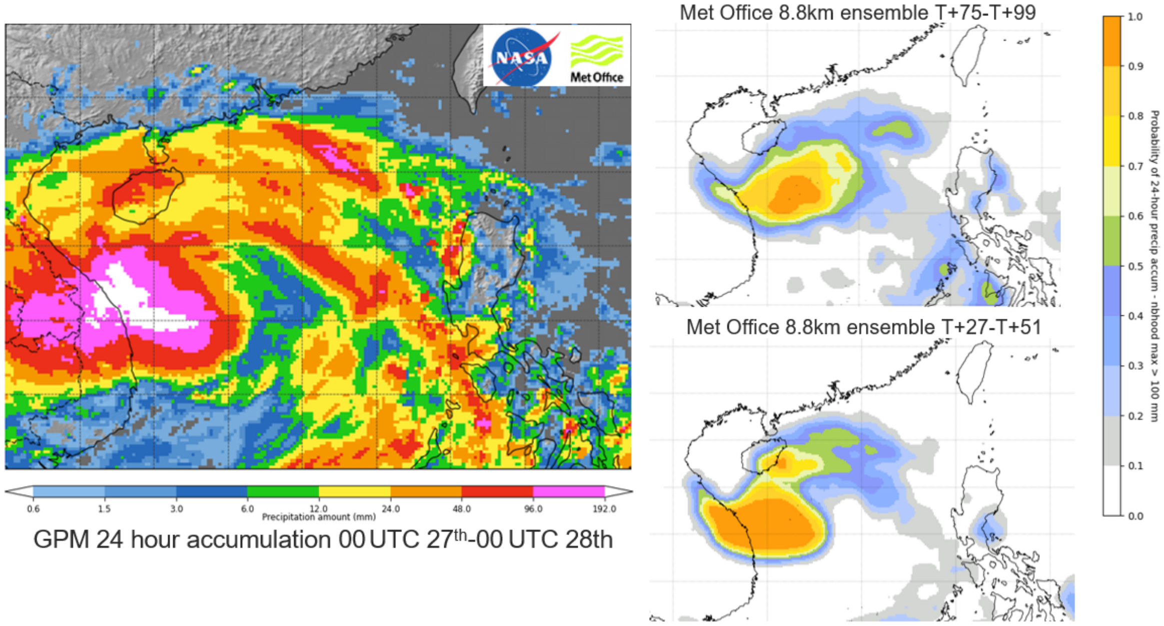
Wind forecast from the high resolution 3km WRF model



Probability maps for strong wind from the ensemble system of ECMWF



Probability maps for 24-hour rainfall accumulation from the ensemble system of ECMWF



Probability of rainfall accumulation > 100mm from MOGREPS-SEA ensemble

How reliable and accurate were the hazard predictions? i

The forecasts for strong winds and heavy rainfall for the Philippines were impacted by the poor track and intensity forecasts detailed in the previous section, with the heavy rainfall and strongest winds only being forecast in the correct locations at short lead times (around 36 hours ahead of landfall - see above for the PAGASA-WRF 12km and 3km output).

The forecasts for the wind and rain were more reliable for Vietnam, with the winds being better forecast by the high-resolution regional models. The area of heavy rain was well highlighted in ensemble guidance up to 4 days ahead.

What process or trigger(s) identified the event as hazardous and started the warning process? i

Hazard observations and analyses i

What crowdsourcing/citizen science was used for observing the hazard(s)? i

How did the observed hazard(s) relate to climatology and/or previous extreme events? i

How was the observed hazard(s) made worse by pre-existing conditions? i

Additional analysis i

Successes/issues/challenges experienced in hazard prediction and observation i

Accessibility (due to bandwidth and/or access policy issues) means the WCSSP SEA model products provided to PAGASA and the VNMHA were difficult to use in real time.

c. Impacts i

Brief overview of the impact(s) i

Total damages: $110 million (across whole region)

Fatalities: 12 (and 5 missing) in Philippines; 9 in Vietnam

Philippines

Severe agricultural damage, infrastructure damage, > 100,000 houses damaged.

Information from an official National Disaster Risk Reduction and Management Council Situational Report, also stored in the "Response" directory of this case study:

- A total of 382,737 families or 1,451,649 persons were affected
- A total of 12 dead, 68 injured, and 5missing persons were reported
- A total of 45 road sections and 18 bridges were affected
- A total of 72 domestic flights and 12 international flights were cancelled
- A total of 108,916 damaged houses are reported
- Total agricultural damages of $54 million USD
- $5.4 million USD damage to infrastructure

Vietnam

Power outages; houses damaged/destroyed, crops flooded, school closures. Substantial flood damages.

Information from an official Vietnamese government document available online and also stored in the "Response" directory of this case study:

> "Concerning people: 04 injured people (Quang Tri); concerning houses: 03 collapsed houses (Quang Tri: 02, Thua Thien Hue: 01), 157 damaged and unroofed houses (Quang Tri 118); concerning vessels: 03 small boats sank (Da Nang 02, Quang Nam 01); concerning electricity: power outage in 9.427 substations (Quang Nam: 4369, Da Nang: 3340, Quang Ngai: 1718) and power outage in 15 communes (Kon Tum: 09 communes, Gia Lai: 06 communes). Currently, 535 substations have been repaired (Quang Nam: 372, Da Nang: 163). Other damage: 01 fallen antenna post of Hoi An City Communication Center (Quang Nam); 02 damaged border guard posts (Quang Nam), etc. Many fallen trees in the provinces including Quang Tri, Da Nang, Quang Ngai and Gia Lai."

Input data used in the impact prediction or model i

Impact prediction models/tools (if used) i

Informal approaches used to predict impacts i

Impact prediction outputs and examples i

PAGASA has an ongoing experiment of implementing impact-based forecasting in Manila and Cebu. In Typhoon Noru, IBF warnings for rainfall and winds were issued for Metro Manila with a medium likelihood of significant impacts. These forecasts were disseminated through messenger groups, which were also used to feed back observations of any impacts in real time. Due to the IBF forecasts, disaster managers went to a blue alert level. In practice fewer impacts were observed than expected in the Metro Manila area, with the main impacts being damage to agriculture in the surrounding area. But it was a good experience for all involved in the IBF trial, increasing awareness of the warnings. Further information is given below:

ISSUANCES

Observed health and social impacts i:

Observed property and business impacts i:

Observed critical infrastructure damage and service disruption i:

Image compilation created by the PAGASA IBF team:

Observed environmental damage i:

Comparison of predicted/expected and actual impacts i
See the following table compiled by the PAGASA IBF team:

Subjective Assessment of Impacts

For Q3 (July-September 2022)

Severe Weather Event	Number of Issuances	Warning Levels	Highlights of Impact (from Impact Table)	Impacts (from feedback reports)
③ Super Typhoon "Karding" (Noru) 24-26 September 2022	5 (Heavy Rainfall) 2 (Severe Wind)	Heavy Rainfall highest: Medium Likelihood of Severe Impacts (Orange) Severe Wind highest: Medium Likelihood of Significant Impacts (Orange)	Severe impacts • Widespread damages to all infrastructures • Widespread blockings to main and auxiliary passage ways due to toppled/uprooted trees, electric posts • Danger to life Significant impacts • Class interruption • Possible cases of blown-out roofs, downed power lines • Isolated cases of road blockage due to toppled/uprooted trees, electric posts • Some uprooted trees and broken branches	Makati • Flooding Malabon • No flooding • Evacuated people Mandaluyong • Moderate rains • Fallen tree • Strong winds

What crowdsourcing/citizen science was used to observe the impacts? i

Who and what were exposed to the hazards, when, for how long? i

Of those exposed, who and what were vulnerable to the hazards and why? i

Additional analysis i

Successes/issues/challenges experienced in impact prediction and observation i

d. Warning communication

Brief overview of the warning communication i

PAGASA issued 26 tropical cyclone bulletins, many of which are contained in the "Warnings" subdirectory of this case study. Flood Advisories were also output by PAGASA for several river basins.

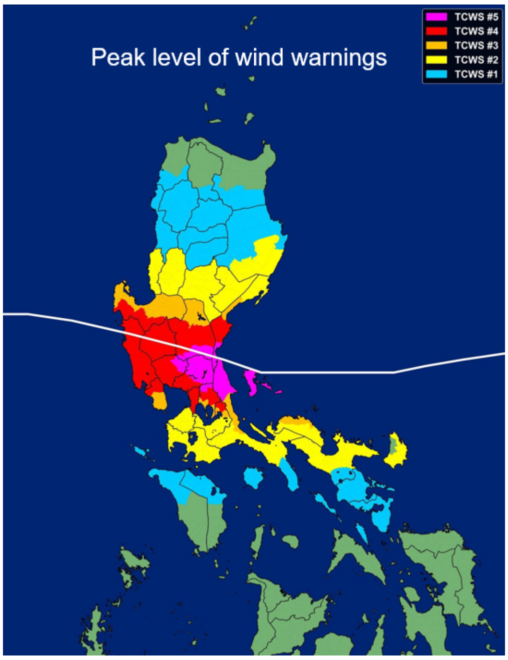
NCHMF issued a total of 76 bulletins, of which 41 were hourly reports.

What information was provided to emergency responders, government and other stakeholders about the hazard and its possible impact(s), and by whom? i

Philippines

The following information is taken from https://en.wikipedia.org/wiki/Typhoon_Noru and from the information contained in the official National Disaster Risk Reduction and Management Council Situational Report (this detailed document is also stored in the "Response" directory of this case study):

- PAGASA began releasing bulletins on the storm on September 22, initially expected to remain a tropical depression. PAGASA began raising Signal No. 1 as early as September 23. The Flood Forecasting and Warning Section of the PAGASA (PAGASA-FFWS) issued advisories for the Magat River.
- PAGASA also began raising Signal No. 2 in parts of Isabela, Aurora, and the Polillo Islands on Sep 24. The agency warned of the possibility of raising Signal No. 4 as the storm neared.
- On the evening of Sep 24, Signal No. 3 was raised in the Polillo Islands and in parts of Camarines Norte.
- In the morning of Sep 25, following a sustained period of rapid intensification, the PAGASA assessed the storm's development into a super typhoon and began raising Signal No. 4, starting with the Polillo Islands.
- At 11:00 PHT (03:00 UTC) on Sep 25th, Signal No. 5 was raised in the Polillo Islands and the extreme northern portion of Quezon. Later on 25th this signal no. 5 was extended to the extreme southern portion of Aurora, the eastern and central portions of Bulacan, the extreme southern portion of Nueva Ecija, the eastern portion of Pampanga, and the extreme northern portion of Rizal. Coastal areas were warned of storm surges.
- Wider areas were placed under lower signals (1-4) – the map below shows the peak level of wind warning issued by PAGASA for each area:



- The Pampanga, Agno, Cagayan, and Pasig–Marikina river basins, including the Magat sub-basin, were placed under a flood watch by the PAGASA-FFWS.
- By 5:00 PM on 26th all TCWS raised due to Typhoon Noru were lifted as the typhoon passed into the West Philippine Sea. However, heavy rainfall and severe winds were still forecast to be experienced as the storm slightly intensified while moving over the West Philippine Sea.

Vietnam

On Sep.23th 2022, NCHMF sent an official dispatch to the Permanent office, National Steering Committee for Natural Disaster Prevention stating that:

- A Tropical Depression over the East of Philippines Sea could strengthen into a Tropical Storm with a probability of over 80%.
- From the evening of Sep.25th, the TS would move into the East Sea, causing strong wind, significant wave height and heavy rainfall for the North and Middle of East Sea (Including Hoang Sa Island).
- The TS was predicted to keep moving westward, to the mainland of Vietnam.

On the night of Sep.23rd, NCHMF published the early warning for the TS near the East Sea, forecast that the TS would move into the East Sea in the next 48 hours.

From the early morning of Sep.26th, when TY. NORU moved into the East Sea, NCHMF published emergency TY warnings, cautions for strong wind, significant wave height over the sea, strong wind and heavy rainfall on land. At the same time, hourly analysis information on the intensity and direction of TY. NORU was updated.

Public warnings i

Type of warning i	Issued by i	Warning name i	Warning area i	Lead time	Frequency	Scaled i	Icon / colour	Included safety advice?	Channels i

How was warning information communicated by other organizations including media? i

Philippines

- The National Disaster Risk Reduction and Management Operations Center (NDRRMOC):
  - Facilitated the conduct of Weather Updating, PDRA Analyst Group, and PDRA Core Group Meetings on 22 and 23 September 2022.
  - Raised the NDRRMOC Alert Status to RED effective 23 September 2022, 6:00 PM and activated NDRRMC
  - EOC Management Team effective 24 September 2022
  - Conducted EOC Briefing with DOST-PAGASA, DENR-MGB, and concerned regions on 24 September 2022
  - Issued Public warnings:

  a. 39 Emergency Alert and Warning Message (EAWM)

  b. 222 NDRRMC Advisories

  - Issued the following Memorandum:

  a. No. 144 Preparations for Tropical Depression "KARDING", dated 22 Sept 2022.

  b. No. 145 Preparations for Tropical Depression "KARDING" and Southwest Monsoon dated 22 Sept 2022.

  c. No. 146 Raising of Alert Status to RED of the NDRRMOC effective 23 Sept 2022, 6:00 PM ICOW

  d. No. 149 Upgrading of Emergency Preparedness and Response Protocols ICOW

- The Mines and Geosciences Bureau warned of landslides and flooding in parts of Nueva Vizcaya, Quirino, and Cagayan.
- The Philippine Institute of Volcanology and Seismology also raised lahar advisories for Mount Pinatubo and the Taal Volcano.

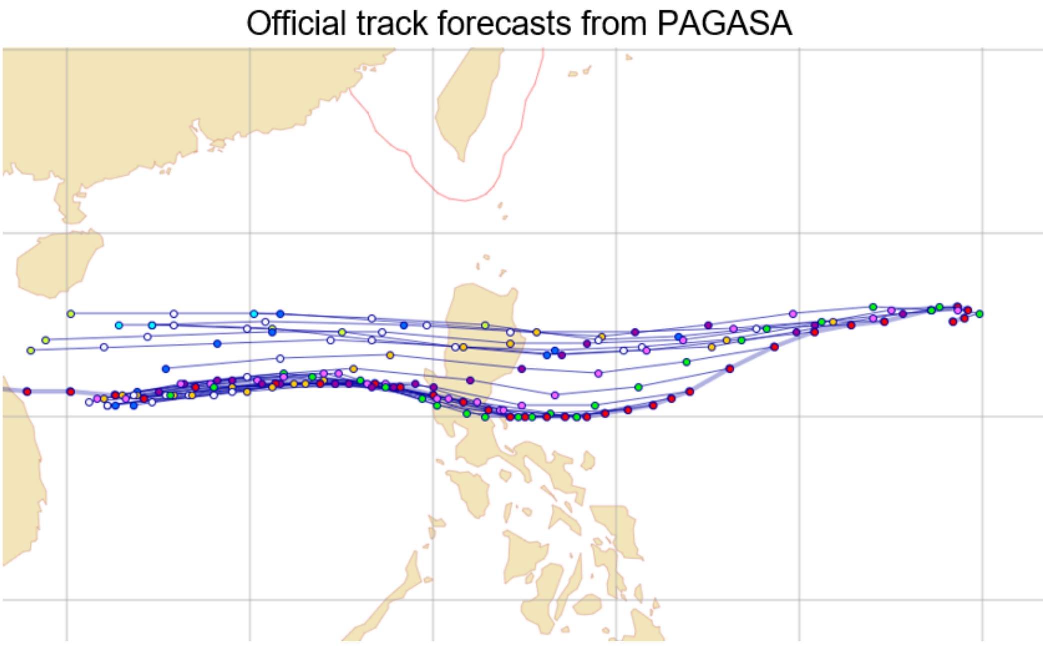
Vietnam

All the forecast and warning information was provided to the National Steering Committee for Natural Disaster Prevention, and the National Committee for Search and Rescue at national level and localities (Highlands, Middle and Southern Central regions). The News Agencies updated the newest information to the local people as soon as possible, which contributed to minimizing the loss of life and property.

Warning outputs and examples i

Philippines

The official track forecasts from PAGASA shared the same northward track error as the NWP guidance:



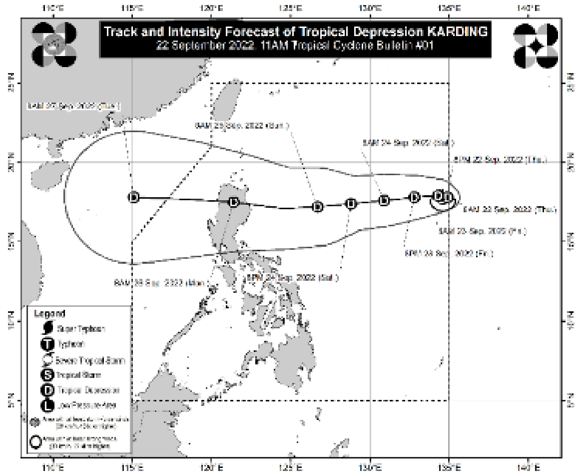
Two examples of the tropical cyclone bulletins issued by PAGASA are given below (the earliest one on 22nd September and a later one on 25th September where a level 5 wind signal being raised for the Polillo islands):

Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)
Weather Division

Management System ISO 9001:2015
TÜVRheinland CERTIFIED
www.tuv.com ID 9105085309

MMSS-07 Rev.2 / 03-01-22

TROPICAL CYCLONE BULLETIN NO. 1
Tropical Depression KARDING
Issued at 11:00 AM, 22 September 2022
Valid for broadcast until the next bulletin at 5:00 PM today

THE LOW PRESSURE AREA EAST OF CENTRAL LUZON DEVELOPS INTO TROPICAL DEPRESSION "KARDING"	
Location of Center (10:00 AM)	
The center of Tropical Depression "KARDING" was estimated based on all available data at **1,350 km East of Central Luzon or 1,370 km East of Northern Luzon (17.7°N, 134.7°E)**	
Intensity	
Maximum sustained winds of **45 km/h** near the center, gustiness of up to **55 km/h**, and central pressure of **1002 hPa**	
Present Movement	
Eastward at 10 km/h	
Extent of Tropical Cyclone Winds	
Strong winds extend outwards up to **90 km** from the center	

Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)
Weather Division

Management System ISO 9001:2015
TÜVRheinland CERTIFIED
www.tuv.com ID 9105085339

MMSS-07 Rev.2 / 03-01-22

TROPICAL CYCLONE BULLETIN NO. 16
Super Typhoon KARDING (NORU)
Issued at 11:00 AM, 25 September 2022
Valid for broadcast until the next bulletin at 2:00 PM today

SUPER TYPHOON "KARDING" INTENSIFIES FURTHER AS IT MOVES WESTWARD TOWARDS THE NORTHERN PORTION OF QUEZON – SOUTHERN PORTION OF AURORA

Location of Center (10:00 AM)

The center of the eye of Super Typhoon KARDING was estimated based on all available data including those from Daet and Baler Doppler Weather Radars at **175 km East of Infanta, Quezon (15.0°N, 123.3°E)**

Intensity

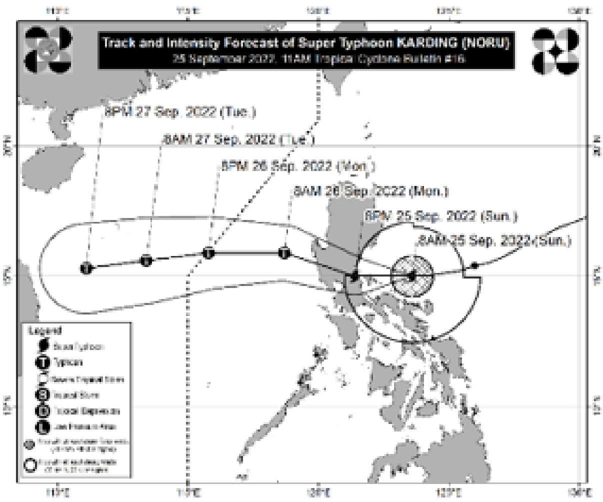
Maximum sustained winds of **195 km/h** near the center, gustiness of up to **240 km/h**, and central pressure of **920 hPa**

Present Movement

Westward at **20 km/h**

Extent of Tropical Cyclone Winds

Strong to typhoon-force winds extend outwards up to **290 km** from the center

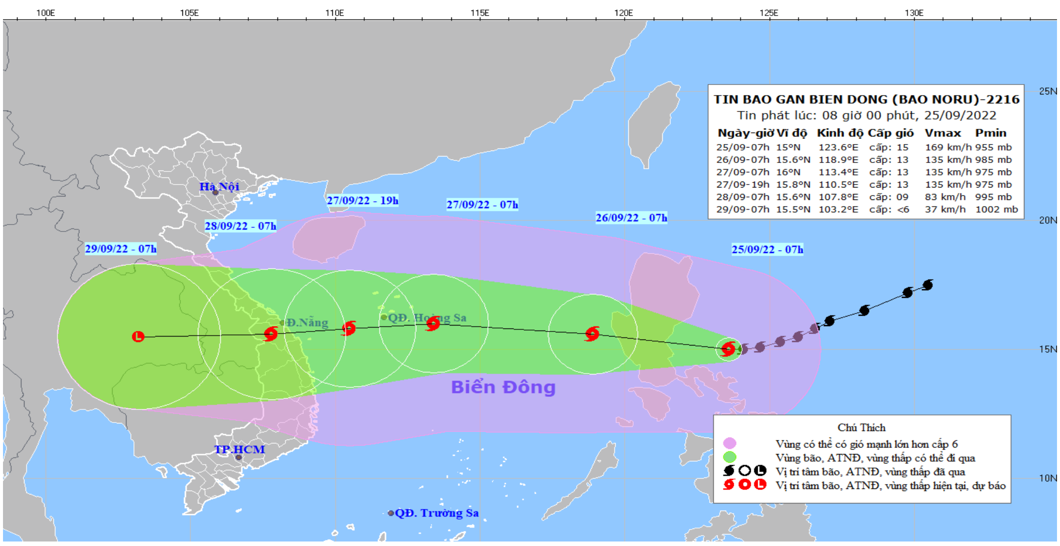


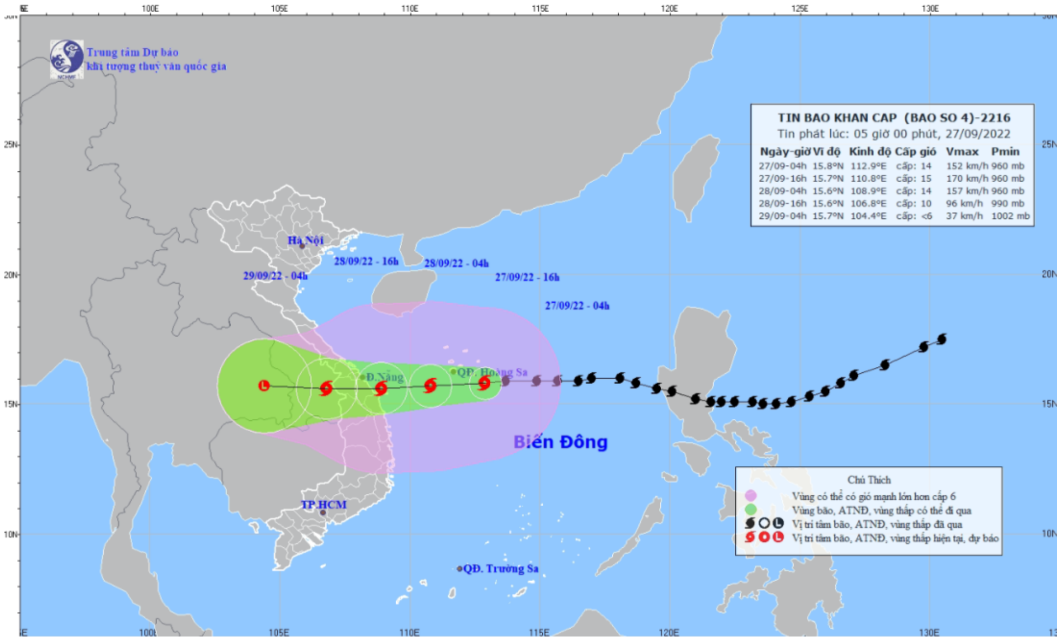
TROPICAL CYCLONE WIND SIGNALS (TCWS) IN EFFECT			
TCWS No.	**Luzon**	**Visayas**	**Mindanao**
5 Wind threat: **Typhoon-force winds**	**Polillo Islands** and **the extreme northern portion of Quezon** (the northern and central portions of General Nakar, and the northeastern portion of Infanta**)**	-	-
	Warning lead time: **12 hours** Potential impacts of winds: **Extreme threat to life and property**		

Further PAGASA TC bulletins (and flood bulletins) are contained in a sub-directory of this case study.

Vietnam

Examples of the official track forecasts are given below:





The landfall location was well predicted by the forecasters in Vietnam, with their track being more accurate than those from the other international centres.

How was uncertainty conveyed in the warning? i

To what extent were communication systems in place and operating effectively? i

How were warning messages received by the public? i

How well were warning messages understood by the public? i

How were the needs of specific communities and populations addressed? i

Additional analysis i

Success/issues/challenges experienced in warning communication i

For the Philippines the main forecast issues were the rapid intensification, the north bias, and the issue of whether it would hit the metro Manila area.

The model forecasts were also too slow, being problematic for disaster risk managers who were trying to communicate the potential timings of the impacts.

In risk assessment meetings, “disaster imagination” was used to aid communication. This involves communicating information that helps people to imagine the expected impacts e.g. using example of Vamco (2020) as analog.

In Vietnam, this idea of using analog storms to help communicate the likely impacts from the storm was also used, with warning communication referring back to Damrey (2016) which also made landfall in Da Nang.

e. Responses

Brief overview of the response to the hazard by emergency services and other partners i

Philippines:

From information given at our breakout session:

- PAGASA experimental IBF warning was issued over metro Manila for wind and rain and disseminated to stakeholders through messenger groups.
- Disaster managers went to blue alerts. In this case were less impacts to Manila than anticipated (main damages to agriculture).
- Useful online resource summarising stakeholder responses to the event including lessons learned.

Additional information from https://en.wikipedia.org/wiki/Typhoon_Noru:

- By Sep 23, the National Telecommunications Commission began to prepare to ensure sufficient resources in areas forecast to be affected by the storm.
- On Sep 24, the Magat Dam began discharging excess water in preparation for the storm.
- In Cagayan and Isabela, farmers harvested their crops early in preparation.
- Bans on sailing and fishing were imposed on the region.
- The Department of Social Welfare and Development (DSWD) secured funds for immediate response and prepared food packs and personnel.
- The National Disaster Risk Reduction and Management Council (NDRRMC) was also put on red alert as it activated its Emergency Operations Center teams.
- The Department of Public Works and Highways (DPWH) closed Kennon Road, a major yet hazardous road that connects La Union and Baguio in Benguet, citing public safety reasons. DPWH began preparing quick response teams consisting of maintenance personnel and equipment which will oversee the possibility of roads in affected areas.
- The Philippine Red Cross prepared its volunteers, which included operations staff and on-the-ground personnel.
- Quezon, Bicol, and Baguio's local disaster agencies were placed on red alert.
- In Metro Manila and Central Luzon, school classes suspended for next day (September 26).
- Courts in Metro Manila, Central Luzon, Calabarzon, and Bicol were ordered closed by the Supreme Court on September 26.
- On the evening of September 25, the Office of the President released a memorandum suspending work in government offices and classes in all levels of public schools in affected regions.

Information from the official National Disaster Risk Reduction and Management Council Situational Report, also stored in the “Response” directory of this case study (please note there is a huge amount of detailed information on response activities in this document, only a summary is included here):

- A total of 23,151 families or 91,169 persons were pre-emptively evacuated.
- Php68,372,574 worth of food and non-food items assistance provided to affected families.
- Search, rescue and retrieval (SRR): 117 teams deployed, with 11,980 individuals rescued and assisted by the SRR teams.
- Medical Logistics Provided: Php 8,649,159 in 10 deployed teams.

Vietnam:

From information given at our breakout session:

- 2 days ahead of landfall issued emergency warning, initiating meeting of National Steering Committee

- Identify current status e.g. ships, tourist activities, likely dangers and actions needed to make sure everyone is safe
- Government took higher actions because of learning from Philippines (in the media)
- Committee formed on-site in Da Nang where forecast to make landfall
- Ships evacuated, equipment at fish farms lowered to prevent damage at sea surface
- Trees cut down and electricity cut off

Information from https://en.wikipedia.org/wiki/Typhoon_Noru:

- 400,000 people were evacuated as Noru neared.
- Approximately 270,000 military personnel were placed on standby.
- Hundreds of flights were cancelled.

Information from an official Vietnamese government document available online and also stored in the "Response" directory of this case study:

- From September 25 to 27, the Frontline Steering Committee organized 03 working groups to directly inspect, urge and direct the response to the typhoon Noru. On the night of September 27, the Frontline Steering Committee held an overnight work to continuously monitor and meet online with the Chairpersons of the People's Committees of provinces and cities to understand the situation in each province/city and promptly direct the implementation of the response.
- Before Noru made landfall, local authorities and forces had called and guided 57.840 vessels (299.678 people) to move to shelter and anchor safely; on September 27, 2022, more than 108.441 households (340.863 people) were evacuated to safety. People in 20.712h hectares and 4.571 aquaculture cages and rafts had been informed and evacuated ashore in order to ensure their safety when typhoon Noru made landfall. Dikes, dams, infrastructure works were reinforced; the people were instructed to reinforce their houses and property; traffic was restricted when the Noru made landfall.

What were the main response actions by the public to the warnings? i

Responses by institutions (governments, hospitals, etc.) i

Response actions	Taken by whom	When taken	On the basis of what information?	Benefit (if any)	Cost

How did the overall response to this event compare to similar previous events? i

Comment on the existence and use of disaster preparedness and response plans i

How did the key decision makers and institutions interact before, during and after the event? i

How knowledgeable was the community about the hazard and its associated risks? i

What capacity did the community have to respond to warnings? i

Additional analysis i

Success/issues/challenges experienced in warning response i

f. Analysis of the warning value chain

Issues with information flow through the warning value chain i

Warning value chain component	Was the necessary input information available? (yes/partially/no)	If not or partially available, what input information was missing?	Who should have provided the missing information?
Weather, etc. forecast	Philippines: Partially	Philippines: Prior to Philippine landfall: Poorly forecast rapid intensification and track too far north. Lack of operationally available probabilistic guidance for track and intensity guidance.	Philippines: Need improved model forecasts for rapid intensification.
	Vietnam:	Vietnam:	Vietnam:
Hazard forecast	Philippines: Partially	Philippines: Lack of probabilistic guidance that could have captured the southward shift in the areas that would be affected by wind, rain and storm surge hazards.	Philippines: Needs operational access to raw probabilistic model guidance for wind, rain and storm surge hazards.
	Vietnam:	Vietnam:	Vietnam:
Impacts forecast	Philippines:	Philippines:	Philippines:
	Vietnam:	Vietnam:	Vietnam:
Warning communication	Philippines: Partially	Philippines: Lack of reasonable work case and set of alternate scenarios derived from probabilistic model guidance.	Philippines: Needs operational access to raw probabilistic model guidance for systematically establishing reasonable worst case and multiple alternative scenarios.
	Vietnam:	Vietnam:	Vietnam:
Response	Philippines: Yes	Philippines: N/A	Philippines: N/A
	Vietnam:	Vietnam:	Vietnam:

Tools and operational workflows for sharing information between partners i

Philippines: The PH National Disaster Risk Reduction and Management Council convenes the so-called Pre-Disaster Risk Assessment (PRDA) Meetings upon the recommendation of the hazard warning agencies like PAGASA. These meetings are convened at both national and local levels. Through PDRA, the forecast weather and hazard scenario is presented, along with possible reasonable worst case and alternative scenarios. Based on the assessment of the threat of hazard, both in magnitude and extent, emergency preparedness and response (EPR) levels are set for each local government unit (LGU) of the country. Each EPR level has a predetermined set of early action protocols for LGUs to follow (e.g., evacuations, prepositioning of relief goods and response assets)

How useful were social media/crowdsourcing/citizen science in the warning value chain? i

Philippines: Social media was very useful in the warning value chain. Majority of Filipinos turn to social media for news and public safety related information. Using the social media reach of PAGASA, aside from posting of the latest warning, social media was used to broadcast live weather updates that are made every 6 hours. Posts from PAGASA social media channels are then shared widely by other government agencies through their respective social media platforms.

Evidence that warning was effective in reducing fatalities, injuries, damage, and/or disruption i

Philippines: Considering that the most affected region was one of the main agricultural areas of the country, damage to agriculture and infrastructure was considerably high. However, the number of fatalities (12) and injuries (68) were fairly limited. The bulk of the fatalities were related to the deaths of emergency responders who drowned during a rescue operation.

What were the strongest links (information flow) in the warning value chain? i

Philippines: The strongest link was the communication of the weather and hazard information to the decision makers responsible for triggering emergency response and early action (which may fall under warning communication in the value chain).

What were the weakest links (information flow) in the warning value chain? i

Philippines: The portions on weather and hazard forecasts were seen as the weakest link in the value chain for this event. The lack of probabilistic model guidance in the operational setting was evident during the warning communication to decision makers. However, this weakness was overcome by the expertise of PAGASA forecasters in utilizing available deterministic guidance and integrating them with similar analog cases and potential reasonable worst-case scenarios to provide decision makers with enough information to make informed decisions during PDRA meetings.

What procedures were used to identify lessons learned from the event? i

Philippines: After the event, the NDRRMC undertook an after-action review to determine issues that were experienced or reported, analyze the root cause of the issues noted, and determine potential course of action to address these issues and their root causes. Internally, potential improvements in operations based on the experiences from the event were brought up in a forecaster meeting.

Comment on lessons learnt from previous events and their contributions to greater warning success for this event i

Philippines: The experience during STY Goni and their similarities (e.g., the southward shifting paths,) helped us not only in performing subjective adjustments to model guidance based on observations, but also in explaining the uncertainty in the track, intensity, and hazard forecasts for the event.

Additional analysis i

Part 3. Subjective assessment

a. Level of expertise with high impact events

The purpose of this question is to assist the WWRP Warning Value Chain project team to understand more about the contributors to the warning value chain database. If multiple contributors have assessed the same event, this information may be useful in interpreting variations in the subjective ratings. The intent is not to judge the quality of the information provided in this report.

Your profession:

Please rate your level of expertise on a scale of 1 (no expertise) to 5 (established expert) for:

Hazard source (e.g., weather) ______

Hazard ______

Impact ______

Warning/communication ______

Response ______

High-impact event evaluation ______

b. Performance of the warning value chain

Please rate each part of the warning value chain on a scale of 1 (poor) to 5 (excellent). Briefly note the reason for your rating.

How well do you think the event was observed? ______

Reason for this rating

How well do you think the source of the hazard (e.g., weather) was forecast? ______

Reason for this rating

How well do you think the hazards were forecast? ______

Reason for this rating

How well do you think the impacts were predicted? ______

Reason for this rating

How well do you think the warnings were communicated? ______

Reason for this rating

How well do you think the warnings were used? ______

Reason for this rating

How well do you think the entire warning chain performed overall? ______

Thank you very much for contributing to the WWRP Warning Value Chain Project database! Please send the completed questionnaire to valuechain@bom.gov.au.

Acknowledgements of information providers

(optional)

Annex 1: List of hazards

Adapted from the *UNDRR-ISC Hazard Information Profiles*. * = not in UNDRR-ISC list of hazardous events

1. Convective-related
- Downburst
- Lightning (Electrical Storm) Thunderstorm

2. Flood
- Coastal Flood
- Estuarine (Coastal) Flood
- Flash Flood
- Fluvial (Riverine) Flood
- Groundwater Flood
- Ice-Jam Flood Including Debris Ponding (Drainage)
- Snowmelt Flood
- Surface Water Flooding
- Glacial Lake Outburst Flood

3. Lithometeors
- Black Carbon (Brown Clouds)
- Dust storm or Sandstorm
- Fog
- Haze
- Polluted Air
- Sand haze
- Smoke
- Volcanic gases and aerosols

4. Marine
- Ocean Acidification
- Rogue Wave
- Sea Water Intrusion
- Sea Ice (Ice Bergs)
- Ice Flow
- Seiche
- Storm Surge
- Storm Tides
- Tsunami
- Pumice*

5. Pressure-related
- Depression or Cyclone (Low Pressure Area)
- Extra-tropical Cyclone
- Sub-Tropical Cyclone

6. Precipitation-related
- Acid Rain
- Rain*
- Blizzard
- Drought
- Hail
- Ice Storm
- Snow
- Snow Storm
- Ash/Tephra Fall

7. Temperature-related
- Cold Wave
- Dzud
- Freeze
- Frost (Hoar Frost)
- Freezing Rain (Supercooled Rain)
- Glaze
- Ground Frost
- Heatwave
- Icing (Including Ice)
- Thaw

8. Terrestrial
- Avalanche
- Mud Flow
- Rockslide
- Landslide
- Lahar
- Lava Flows
- Ballistics
- Pyroclastic Density Current
- Ground Shaking

9. Wind-related
- Derecho
- Gale (Strong Gale)
- Squall
- Subtropical Storm
- Tropical Cyclone (Cyclonic Wind, Rain [Storm] Surge)
- Tropical Storm
- Tornado
- Wind

10. Environmental
- Wildfires
- Crown fire*
- Surface fire*
- Ground fire*
- Coastal Erosion