Headline: Science behind Supertyphoon ‘Yolanda’

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SOMETHING big was forming around 4,500 kilometers east-southeast of the Philippines.

It was Nov. 2, 2013. Hundreds of kilometers off the Micronesian island of Pohnpei, warm and moist air had started rising from the warm ocean surface, creating a low-pressure area.

Fueled by the heat and evaporating water from the ocean, an engine of swirling cloud and wind was heading westward— in the direction of the Philippines.

In the next few days, the newly formed tropical cyclone continued to grow and gain strength, powered by the warmer-than-usual waters of the Pacific.

The Hawaii-based Joint Typhoon Warning Center (JTWC) said the tropical disturbance “intensified at an above-average rate” as it passed south of Guam, followed by “explosive deepening” as its intensity almost doubled within 24 hours.

It was given the name “Haiyan.” (Once inside the Philippine area of responsibility, or PAR, it would bear the name “Yolanda.”)

On Nov. 5, JTWC warned that Haiyan would turn into a supertyphoon with peak intensity of 241 kilometers per hour.

Yolanda entered PAR on Nov. 7. On Nov. 8, Yolanda made its first landfall, in Guiuan, Eastern Samar province.

JTWC estimated that Yolanda reached one-minute sustained winds of 315 kph just minutes before landfall, making it, at that time, the most powerful tropical cyclone to ever hit land.

Tropical cyclones form in warm waters with a temperature of at least 26.5 degrees Celsius and with a minimum distance of at least 500 km from the equator, according to the US National Oceanic and Atmospheric Administration (NOAA).

In Yolanda’s case, the above-average temperature of the Pacific Ocean and the lack of wind shear, which often prevents typhoon formation, contributed to its intensity.

In fact, NOAA reported that the combined land and sea surface temperature in November 2013 (at 0.78 degree above the 20th century average of 12.9 degrees for the month of November) was the highest in the previous 134 years.

Sea surface temperature, which NOAA refers to as the skin temperature of ocean surface water, for November that year was the third highest (tied with 2009) at 0.54 degree above the 20th century average of 15.8 degrees.

In other words, conditions for the formation of a supertyphoon like Yolanda late in the year were at among their ripest in recorded history.

JTWC's Annual Tropical Cyclone Report for 2013 supported this view, as it recorded sea surface temperature along the supertyphoon's track exceeding 29 degrees.

"Along-track ocean heat content was also very high, indicating that warm water extended fairly deep into the upper-ocean along the cyclone's path," the report noted.

Low vertical wind shear (VWS) was also observed by the University of Wisconsin Cooperative Institute for Meteorological Satellite Studies.

"Strong radial outflow, low VWS and warm ocean waters provided favorable conditions for the initial rapid intensification to typhoon strength, and subsequent explosive deepening from minimal typhoon intensity (130 kph) to supertyphoon intensity (241 kph) during the following 24 hours," the JTWC said.

Professor Jim Elsner of Florida State University and Namyoung Kang, deputy director of the National Typhoon Center in South Korea, published a study last year that found that, in the past 30 years, there were about six fewer tropical cyclones per year, but packed winds were stronger by almost 5 kph.

It is "a trade-off between frequency and intensity," Elsner told Science Daily.

Brian Caccioppoli, in his review of Elsner and Kang's study, said the most important aspect of the study was the proposed "mechanism" for the trade-off.

"The increased warmth in the surface ocean leads to more evaporation of moist air to the lower-most atmosphere, but warmer and drier conditions (strong high pressure) exist just above acting as a barrier to moisture and tropical cyclone formation," Caccioppoli said.

"This atmospheric configuration is unstable, so storms that are able to overcome the high-pressure barrier are greeted with conditions ripe for efficient intensification," he added.

In other words: Stronger storms.

Storm surges

Yolanda struck the eastern coast of Leyte province with so much force its winds obliterated houses made of light materials and generated a series of storm surges that washed out communities and coconut plantations.

Residents of Guiuan recalled being caught up in tornado-like winds.

In Hernani town, Maricel Jerusalem and her family evacuated to her cousin's house, thinking a concrete two-story structure would save them from the supertyphoon. But the tsunami-like waves crept inland and rose up to 15 feet. Clutching her 2-week-old baby, Maricel swam toward higher ground. The baby survived but not Maricel's 11-year-old brother, who was "swallowed by the waves."

Yolanda made its second landfall in Leyte.

Gerald Villamor said the surge that destroyed his village and killed thousands of people in Tacloban City consisted of “[t]hree large waves that were so high we lost sight of Samar Island.”

He watched on the roof of his house, as the coastal villages and the airport of Tacloban were submerged in water, a murky soup of debris, mud and corpses.

In a matter of hours, Yolanda struck Cebu’s Daanbantayan and Bantayan Island. It reached Concepcion, Iloilo province, in Panay Island by noon, pummeling fishing communities and damaging transmission lines.

According to the Japan Meteorological Agency, Yolanda lasted seven days before finally dissipating in the area of China.

In its passage through central Philippines, Yolanda ravaged nine regions, killing 6,300 people, displacing 3.4 million families and destroying 489,613 houses, damaging another 595,149 homes and causing P89.6 billion in damage.

In faraway Warsaw, Christiana Figueres, chief of the UN Framework Convention on Climate Change, offered a grim assessment. The supertyphoon was part of the “sobering reality” of climate change.

(Editor’s Note: The Inquirer Group is covering the climate change conference in Paris, which starts on Nov. 30. This special report, which can be read in full at inquirer.net/climatechange, is part of the Group’s Pinas to Paris campaign.)