

CEDIM Forensic Disaster Analysis Group (FDA)

Super Typhoon Mangkhut (Philippines: Ompong)

Information as of 26 September 2018 – Report No. 1

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SUMMARY

Official Disaster Name	Date	Landfall UTC	Local	Duration
Super Typhoon 26W Mangkhut (Ompong) – PH	14-09	18 UTC	+8	
Typhoon 26W Mangkhut – CN	16-09	09 UTC	+8	
Tropical Depression, Tropical Storm, Typhoon Cat 1 – Cat 5, Tropical Depression	07-09 – 17-09			10 days

PREFERRED HAZARD INFORMATION:

Location	Move ment	Definition (Saffir-Simpson Scale)	Min Sea Level Pressure	Wind Gusts	Time	Wind Sustained
100 km N of Rongelap Atoll, Marshall Is.	NW	Tropical Dperession	1006 hPa		07-09 00 UTC	20 kt 37 kph
120 km N of Bikini Atoll	W	Tropical Storm	998 hPa		07-09 18 UTC	35 kt 65 kph
1100 km E of Guam	W	Category 1	975 hPa		09-09 00 UTC	65 kt 120 kph
30 km NE of Rota Island	WSW	Category 2	955 hPa		10-09 06 UTC	90 kt 165 kph
90 km W of Guam	WSW	Category 3	950 hPa		10-09 12 UTC	100 kt 185 kph
2050 km E of Luzon	N	Category 4	935 hPa		11-09 00 UTC	120 kt 222 kph
1780 km E of Luzon	WNW	Super Typhoon Category 5	905 hPa		11-09 12 UTC	140 kt 260 kph

LOCATION INFORMATION:

Country	ISO	Provinces/Regions	Most Impact	Economic Exposure	HDI (2014)	Urbanity	Pop. affected
USA	US	Guam / Northern Marianas	Rota Island				
Philippines	PH	Cagayan, Ilocos Norte					
China	CN	Guangdong, Guangxi	Hongkong, Macao, Jiangmen				

1 Overview

In mid-September, the world's strongest tropical system of 2018 so far, hit the northern main island of the Philippines, Luzon, and southern China. Super Typhoon Mangkhut fell ashore on Luzon on 14 September 2018 causing landslides and flooding and claimed many lives. Mangkhut was the first typhoon of the highest category since typhoon Megi in 2010 that struck the Philippines. The typhoon raged for nearly 10 days through the tropical western Pacific Ocean, its track had a length of 6600 km. At peak intensity Mangkhut had sustained winds of 287 kph, gusts were as high as 352 kph.

As was the case in the Philippines, extensive evacuation measures were also underway in southern China, where Mangkhut made landfall two days later as category 1 or 2 typhoon in Guangdong province. The storm center barely missed Hongkong and Macau, but the storm surge created new record water levels, fallen trees and major property damage. And for the first time ever, Macau, the Asian gambling capital, closed its casinos because of Mangkhut.

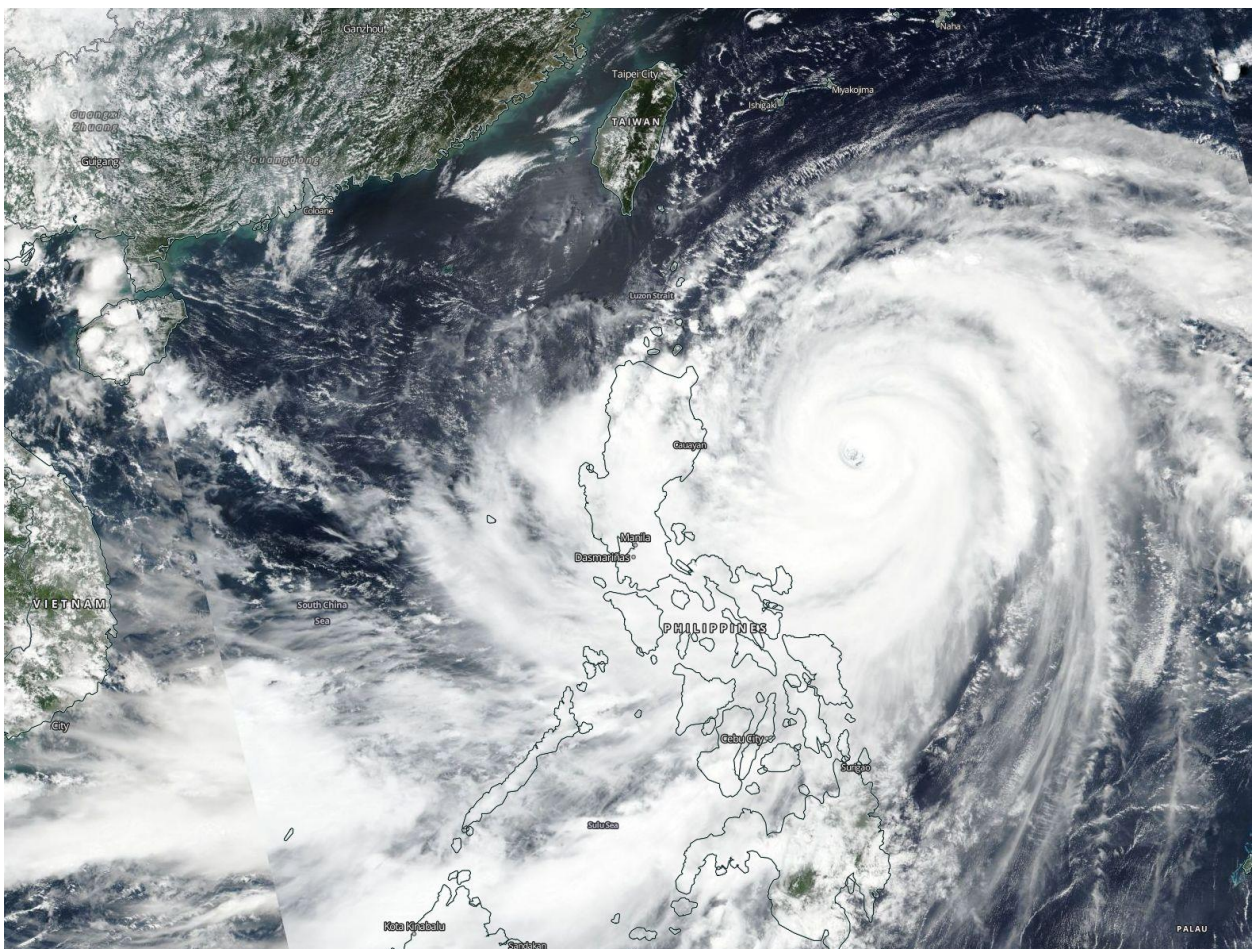


Figure 1: Satellite image showing CAT-5 Super Typhoon Mangkhut on 14 September 2018 few hours before making landfall in Luzon, PH (Image Credit: NASA Worldview).

2 Meteorological Information

2.1 Evolution of Super Typhoon Mangkhut

Mangkhut first appeared on 7 September 2018 as a tropical depression about 100 kilometers north of Rongelap Atoll (Marshall Islands). Already in the evening of the same day Mangkhut was classified as a tropical storm, 120 km north of Bikini Atoll, average wind speeds were 65 kph.

The tropical storm moved into a west northwesterly direction over open waters and on 9 September 2018, 00 UTC, Mangkhut passed the criteria to a category 1 typhoon. At that time the center of the storm was 1100 km east of Guam.

The typhoon continued to increase slowly over the next 30 hours and was already in cyclone category 2 with average wind speeds of 165 kph the next day. On the 10th, the typhoon passed through the northern Mariana Islands between Guam and Saipan, and crossed Rota Island.

Extremely favorable environmental conditions led to an explosive development and within a mere 30 hours, the category 1 typhoon had become a category 4 super-typhoon, with average winds of 220 kph. Mangkhut was still around 1500 kilometers east of the Philippines. Six hours later, on 11 September 2018, 12 UTC, the typhoon was in the highest category 5 and kept it until landfall. The development peak was reached on the evening of 13 September for 6 to 12 hours. At a surface pressure of 905 hPa, wind with an average speed of 287 kph and gusts of 352 kph raged across the waters of the Pacific Ocean.

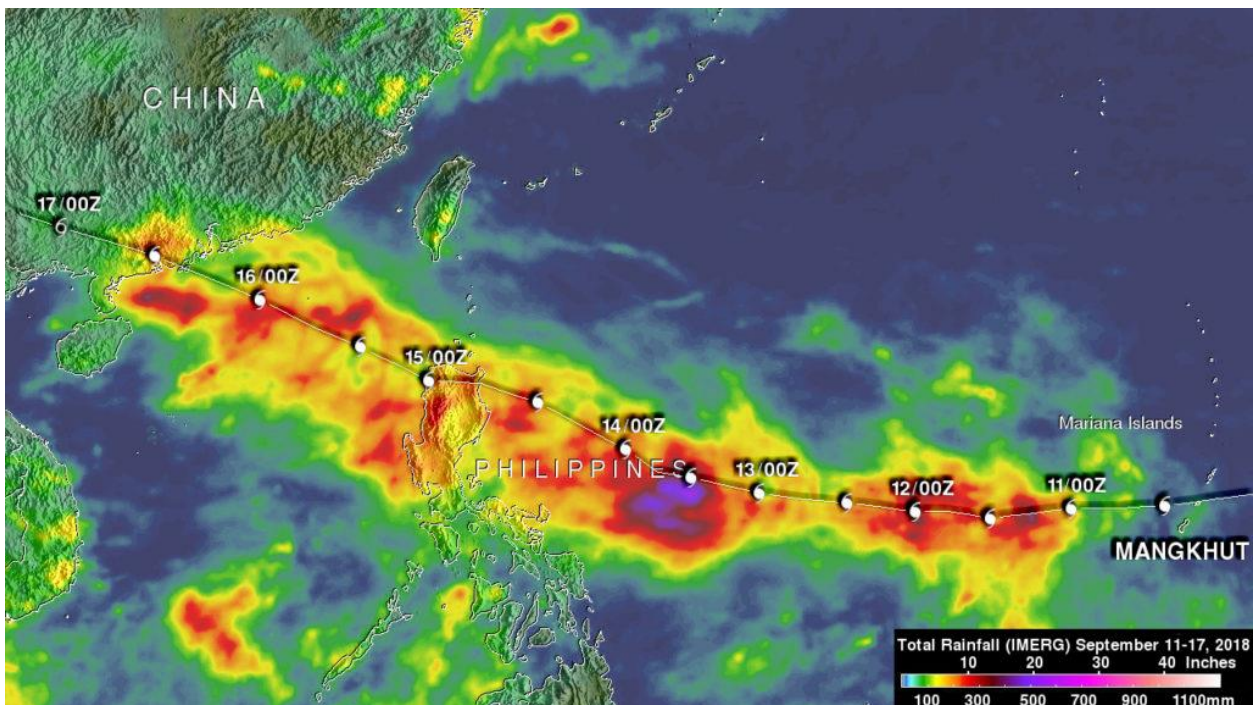


Figure 2: Rain estimates along the track of Mangkhut based on satellite data. Duration 11-17 September 2018 (Image credit: NASA Goddard Institute for Space Studies).

With average winds of 265 kph, the center of the typhoon crossed the coastline of Luzon near Baggao in the province of Cagayan on 14 September 2018 at around 18 UTC. Only about 8 hours later, Mangkhut had travelled across entire Luzon while the mountainous island caused a significant weakening of the circulation due to friction. The eyewall collapsed and Mangkhut entered the South China Sea as a category 3 typhoon near Laoag City.

For the next 39 hours and while weakening slowly, Mangkhut moved to the northwest across the South China Sea. The final landfall took place on 16 September 2018 at 09 UTC near Jiangmen City in the southern Chinese province of Guangdong. According to the Joint Typhoon Warning Center (JTWC) the average wind speeds were 145 kph three hours before reaching the coast,

making Mangkhut a category 1 typhoon. According to the China Meteorological Agency (CMA), one-minute sustained winds were 177 – 185 kph (Cat2 to Cat3) and the Japanese Meteorological Agency called ten-minute average wind speeds of 137 kph which would be about 153 kph for the one-minute average.

Mangkhut quickly lost strength over land and was downgraded to a tropical storm on the afternoon of 16 September 2018.

2.2 Precipitation, wind and storm surge

Mangkhut brought enormous rain along its track amounting several hundred mm (Figure 2). At peak development as much as 700 mm were observed over the Philippine Sea, but only fell over water.

On the Philippines, the rains caused flooding and landslides that buried many people. In the northwest of Luzon, Baguio reported a rainfall of more than 660 mm. Hong Kong Observatory dropped to 167.5 mm in 24 hours.

Mangkhut's cloud bands covered a huge area when the typhoon came ashore, and destructive winds extended far from the center. Hurricane force wind speeds occurred at a distance of 160 km from the center, tropical storm force winds even at a distance of 500 kilometers.

In Macao, which was missed by the eye of Mangkhut by only 65 kilometers, a storm surge of 1.9 meters occurred. In Hong Kong wind gusts reached 163 kph, additionally, a record breaking storm surge did occur. In Quarry Bay, the storm surge had a level of 2.35 m, the previous record level was 1.77 m (typhoon Wanda 1962). And also in Tai Po Kau there was a new record with 3.38 m, typhoon Hope (1979) was responsible for the previous record of 3.23 m.

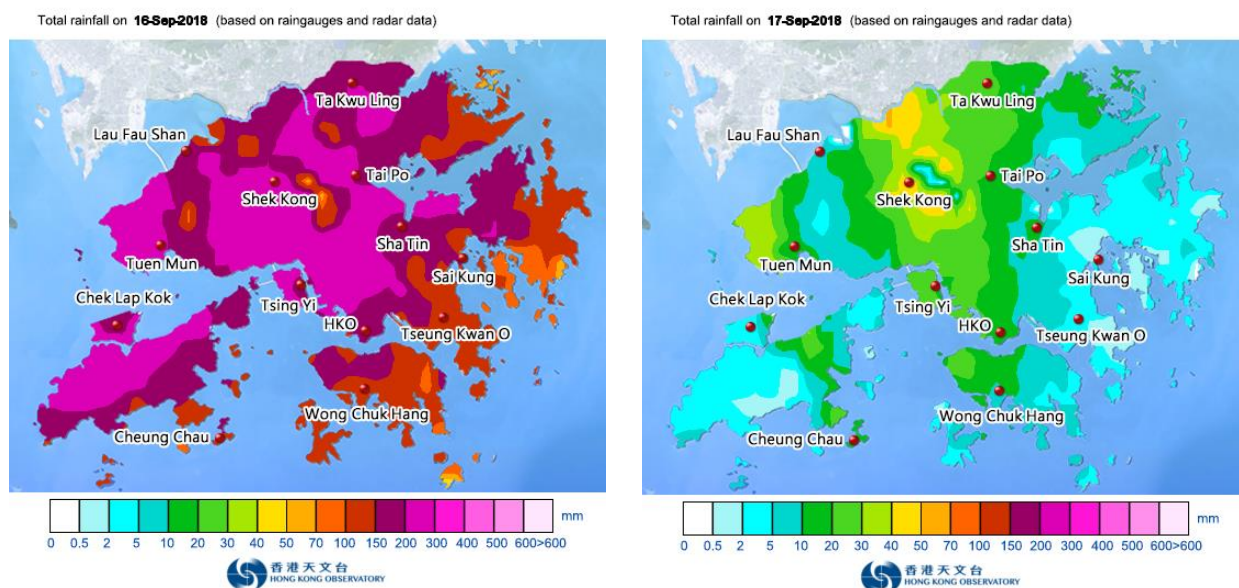


Figure 3: Observed daily rain amounts in Hongkong on 16 September 2018 (left) and 17 September 2018 (right; Image credit: Hongkong Observatory).

3 Impacts

Mangkhut affected millions of people, especially on Luzon (Philippines) and in the Chinese provinces of Guangdong and Guangxi. About 61 million people were exposed to Mangkhut of category 1 strength or higher.

The estuary of the Pearl River is one of the world's most important manufacturing hubs and the large metropolitan areas of Hongkong, Shenzhen or Guangzhou are home to tens of millions of people. Hundreds of thousands of people had to move to safer ground. The news agency Xinhua, citing government reports, said that nearly 2.5 million people in the province had been affected in some way.

3.1 Overview of the impacts of Mangkhut

Micronesia (Marshall Islands, Mariana Islands – Rota, Guam):

- Flooding, stewn debris and downed power poles in Guam [1]
- 600 people sheltered in evacuation centres overnight [1]
- In Rota & Guam: hundreds of people homeless, widespread outages, flooded areas, knocked down power lines and trees, and cancellation of dozens of flights [2]

Philippines (mainly north of country – Itogon, Luzon):

- Deaths and impact on people
 - 54 people died, 42 missing, 32 injured [3]
 - Impact on 5.7 million people in the Philippines [4]
 - As of Saturday, 15 September 2018, the storm had caused 51 landslides in the country's north [3]
 - Most of the deaths due to landslides, mainly in the Cordillera Administrative Region in northern Luzon [3]
 - Most missing people are believed to be miners operating in small villages in the municipality of Itogon [3]
 - More than 250,000 people were affected by the storm across the country with around half of those seeking shelter in evacuation centers in the country's north [3]
 - Two of people killed were rescue workers [3]
- Other impacts on buildings and economy)
 - Landslides, strong winds, heavy rain, mountain torrents and floods [5]
 - Collapsed houses (particularly in coastal areas), broken windows, tore off roofs, cut-off roads, downed power lines [5]
 - Farms across Luzon, which produce a large portion of the nation's rice and corn were flooded, their crops ruined just a month before harvest [5]
 - Worst case scenario - Damage to crops: 157,000 tonnes of paddy rice, about 257,000 tonnes of corn (250 million \$) [5]
 - Tightness in the domestic supplies of rice at a time when retail prices are already high which would compound worries about inflation [5]
 - Tuguegaro airport in norther Luzonk, a vital transportation hub was damaged forcing the cancellation of more than 100 local and international flights [3]
 - Manila (more than 340 km from the eye of the storm experienced heavy rains that caused flooding in urban areas [3]
- Comparison with former events:
 - Not as much destruction as due to other recent, less powerful storms (6000 people died, 4 million displaced from Super Typhoon Yolanda in 2013) [3]

Hongkong:

- People:
 - No reported deaths as the city was well prepared for tropical cyclones [3]
 - 400 people had sought medical treatment and more than 1,500 sought refuge in 48 temporary shelters [6]
- Damages:
 - Torrential rain flooded roads and buildings [3]
 - Broken windows, torn off roofs, fallen trees and damaged streets [3,6]
 - More than 3.4 meter surges of seawater [6], 3.9 meters in Hongkongs Victoria Harbour [3]
 - 600 roads blocked in Hongkong by debris, fallen trees and fallen power poles [7]
- Economy:
 - Gambling enclave of Macaou closed all its casinos [3]
 - More than 550 flight cancelled at airports in Hongkong, Shenzhen and Guangzhou [3]
 - Most of public transport suspended [3]
 - Schools and university remained closed the day after [7]

Southern China (Province Guangdong):

- 4 people died in Guangdong [4]
- More than 2.45 million evacuated in Guangdong province [3]
- Xinhua reports 18,327 emergency shelters have been activated and 632 tourism and 29,611 construction sites have been shut down [3]
- All fishing boats called into port [3]
- Raging storms and heavy rainfall flooded roads in Guangdong's coastal cities [8]
- More than 13,300 hectares of farmland have been damaged [9]

Sources:

- [1] <https://www.radionz.co.nz/international/pacific-news/366146/typhoon-hit-cnmi-asks-us-for-emergency-declaration>
- [2] <https://www.dvidshub.net/news/293410/us-coast-guard-cutter-sequoia-recovery-after-typhoon-mangkhut>
- [3] <https://edition.cnn.com/2018/09/16/asia/typhoon-mangkhut-china-hong-kong-intl/index.html>
- [4] <https://www.globalgiving.org/learn/listicle/typhoon-mangkhut-fast-facts/>
- [5] <https://www.iloveqatar.net/news/general/latest-updates-tropical-storm-makhuts-swathe-of-destruction-in-southeast-asia>
- [6] <https://www.nytimes.com/2018/09/17/world/asia/typhoon-mangkhut-hong-kong.html>
- [7] <https://www.tagesschau.de/ausland/taifun-mangkhut-109.html>
- [8] <http://www.chinadaily.com.cn/a/201809/16/WS5b9dc425a31033b4f4656442.html>
- [9] <https://www.cnn.com/2018/09/17/hong-kong-southern-china-clean-up-after-super-typhoonmangkhut-.html>

3.2 Economic Losses and Costs

Despite extremely high estimates like \$16 to 20 billion damage for Philippines from private firms such as *Enki Research* with the current storm track, total losses across Philippines are likely less than \$1 billion including private housing, given the fact that this typhoon had 20 times less damage than Typhoon Yolanda which caused at most \$9 billion. Similarly high estimates were given for Hong Kong from *Enki Research* being likely around 20 to 30 times too high (<http://www.thinkhk.com/article/2018-09/20/29675.html>), at \$26 billion. \$50 billion was estimated for China. A total loss estimate from *Enki Research* was at **\$120 billion** for all Asian countries as published in Bloomberg and other news outlets.

In the following table, the losses seem to **be below \$5 billion** for all affected countries (summary of official statements from local governments):

	Economic Losses	Damaged/Destroyed Buildings	Other Comments
Philippines	18.8 billion PHP (\$350 million) for infrastructure and productive sectors; an estimated \$750 million for private buildings is estimated = \$1100 million	10338 totally damaged; 107,399 partially damaged; 25 road sections and 2 bridges still damaged	This will likely increase to 200,000 damaged or destroyed buildings (mostly partially)
Guangdong Province	4.2 billion CNY (\$612.4 million). Could rise to around \$1bn.	1200 rooms destroyed, 800 rooms severely damaged, 3500 rooms damaged	Significant losses to agriculture (174000ha affected); Car insurance expecting ca. 784 mn CNY in losses.
Rest of Mainland China	1.1 billion CNY (\$160.4 million)		
Guangxi Autonomous	183 million CNY (\$26 million)	653 rooms destroyed, 446 rooms severely damaged, 2766 damaged	
Macao	1.1 billion patacas (\$186 million) for the casino business. Likely less than TY Hato in 2017 – ca. \$400-600mn.		Lost Income and Shutdown Costs
Hong Kong	Estimates between 3 and 9 billion CNY (\$400mn-\$1.4bn USD)		Including horseracing activities, downtime, loss of vessels.
Total	\$2.5 billion to \$4.1 billion		

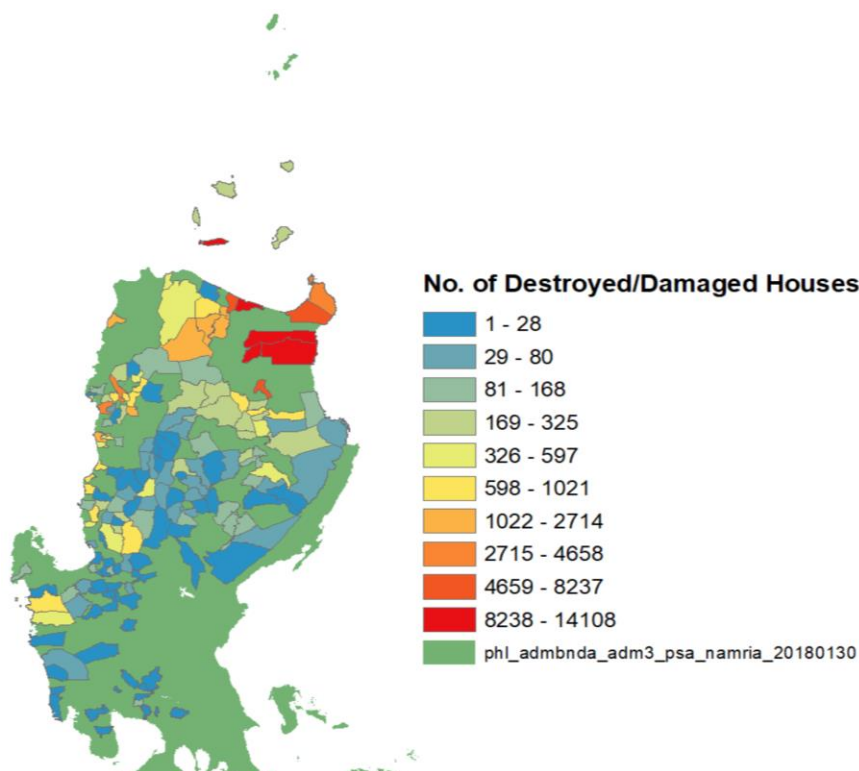


Figure 4: Number of damaged and destroyed buildings on North Luzon island visualised from the NDRRMC reports showing that.

3.3 Social Issues

Table 1: Number of people dead, injured, homeless, evacuated and affected Mangkhut in countries struck by super typhoon Mangkhut (summary of official statements from local governments).

Country	Deaths	Injuries	Homeless	Evacuated	Affected
Philippines	23 dead and 2 missing*	134	56352		2140185
Guangdong Province and the rest of Mainland China	5 dead and 1 missing		10000	2450000	3500000
Guangxi Autonomous	1 missing				497000
Macao	0	40		5900	
Taiwan	1 dead				
Hong Kong	2	362			
Total	35				

*values as high as 88 have been quoted (also including landslide etc.)

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