

# Storm surge

- **Storm surge** is an abnormal rise of water generated by a storm's winds. Storm surge can reach heights well over 6 metres and can span hundreds of miles of coastline.
- A **storm surge** is a large dome of water, 50 to 100 miles wide, that sweeps across the coast near where a hurricane makes landfall, and large waves caused by the storm.
- Waves are made when wind blows over water. Storm winds and the direction the tropical cyclone is moving can add together and make waves much bigger than normal. The extreme waves arrived only shortly before the main centre of the storm
- The highest recorded death toll from a tropical cyclone occurred in November 1970; more than 300,000 persons were killed by coastal flooding when a cyclone made landfall in Bangladesh.

# Storm tide

- The **storm tide** is the water level rise during a storm due to the combination of storm surge and the astronomical (normal) tide.
- The destructive power of the **storm tide** can result in loss of life, buildings destroyed, beach and dune erosion and road and bridge damage along the coast.
- The **storm tide** can affect land even several miles inland as it travels up rivers, causing widespread flooding.

## Extreme rainfall & inland flooding

- Tropical cyclones often produce widespread, torrential rains in excess of 15cm, which may result in deadly and destructive floods.
- Flooding is the major threat from tropical cyclones for people living inland. TCs can cause flash floods, river floods, urban floods, and even landslides (if flooding destabilises a slope).
- Flash flooding, defined as a rapid rise in water levels, can occur quickly due to intense rainfall. Longer term flooding on rivers and streams can last for several days after the storm.
- Rainfall amounts are not directly related to the strength of tropical cyclones
- The amount of rainfall is affected by:
  - **Mountainous terrain.** 'Orographic enhancement' – when moist air has to go over mountains - produces more rain.
  - **Speed of movement** of the cyclone: Slower movement leads to more rain as the storm is overhead for longer.
- The severity of floods is affected by:
  - **Recent rainfall** – wet ground is more likely to flood than dry ground as it's already full of water.
  - **Speed of movement** of the cyclone - Slower movement leads to greater flooding (because of higher rainfall).
  - **Hydrology** - Narrow rivers flood faster than wide rivers as there is less space for water to get away. A confluence (where rivers join) is more likely to flood.
  - **Land use** - Urban landscapes are more prone to flash floods because of increased runoff as surfaces are impermeable. Denuded (stripped of vegetation) land moves water to rivers faster as plants would help absorb rainfall.
  - **Soil** that absorbs water and releases it slowly reduces the risk of flooding

# High winds

- Tropical storm-force winds are strong enough to be dangerous to those caught in them. For this reason, emergency managers plan on having their evacuations complete and their personnel sheltered *before* the onset of tropical storm-force winds, which come before hurricane-force winds.
- Hurricane-force winds, 74 mph or more, can destroy buildings and mobile homes.
- Debris, such as signs, roofing material, tree branches, and small items left outside become flying missiles during hurricanes. Winds can stay above hurricane strength well inland.
- Atlantic and Eastern Pacific hurricanes are classified into five categories according to the **Saffir-Simpson Hurricane Wind Scale**, which estimates potential property damage according to the hurricane's *sustained* wind speed (over several minutes).

# Tornadoes

- Extremely strong winds are generated in tornadoes that sometimes also accompany a TC.
- As a tropical cyclone makes landfall, the surface winds decrease faster than winds above - **vertical wind shear** (winds moving at different speeds and directions at different heights) - which allows for tornadoes to develop.
- Most tornadoes develop in the right-forward (left-forward) quadrant of the cyclone in the northern (southern) hemisphere, in the outer rainbands where vertical wind shear is most likely suitable to their formation.
- Tornadoes in the intense inner core are produced by small-scale spiralling winds in the eyewall (the edge of the eye at the centre of the storm)

# Lightning

- Lightning happens in the convective outer rainbands of tropical cyclones.
- The highest density of flashes is frequently on the eastern side of storms.
- The world record remains unclaimed (as of 2019) to live through a tropical cyclone, then a tornado caused by the tropical cyclone, and then survive being hit by lightning that is a part of the tropical cyclone. Eventually, though, someone will have a really bad day (but then be a record breaker!)

# Rip currents

- The strong winds of a tropical cyclone can cause dangerous waves that pose a significant hazard to mariners and coastal residents and visitors. When the waves break along the coast, they can produce deadly rip currents - even at large distances from the storm.
- Rip currents are channelled currents of water flowing away from shore, usually extending past the line of breaking waves, that can pull even the strongest swimmers away from shore.
- In 2008, despite the fact that Hurricane Bertha was more than 1,000 miles offshore, the storm resulted in rip currents that killed three people along the New Jersey coast and required 1,500 lifeguard rescues in Ocean City, Maryland, over a 1 week period.
- In 2009, all six deaths in the United States directly attributable to tropical cyclones occurred as the result of drowning from large waves or strong rip currents.