Disaster Summary Sheet
Tropical Cyclones
July 2011

Document objective

This disaster summary sheet (DSS) provides a general profile of the potential impact of a tropical cyclone. The DSS helps understanding what the actual impact and priority needs after a cyclone may be, based on experience and lessons learnt from medium and large scale tropical cyclones that have occurred in the past.

This document does not intend to provide an in-depth analysis of the specific impact of tropical cyclones in different settings. It can however be used immediately after you received a cyclone alert as a framework for estimating the impact of the disaster or as a briefing package on "what do we know about the impact of a tropical cyclones on life saving sectors".

Content

1. What do I need to know?

a. General

- **Definitions**: The terms **"hurricane", "cyclones"** and **"typhoon"** are regionally specific names for a strong **"tropical cyclone"**. In North-America, the term **hurricane** is used, in the Indian ocean **cyclone** is used, while Japan and South-East Asia, tropical cyclones are called **typhoons** (NHC, 2002). *See page 13 for a full description of terms used*.

- Cyclone tracks can be forecasted up to 72 hours. However, it is difficult to accurately predict where, when and at what strength a tropical cyclone will strike. The impact of a tropical cyclone is largely determined by its wind speed, which can be accurately forecasted. However, rainfall predictions are much less reliable and storm surge prediction models are the least developed (JRC 2007).

- **Major hazards that can be produced by a tropical cyclone are:**
  - **Storm surges**: an increase in the level of the sea. When a tropical cyclone enters the coastal area, water levels can reach heights of 4 meters. Strong winds can increase these heights to 6 meters. Storm surges can produce extensive coastal flooding up to 40 kilometres from the coastline (UDC 2010). This phenomenon has great destructive potential in low-lying, densely populated coastal areas (NOAA 2011).
  - Tropical storms frequently cause **large amounts of rain**, leading to **(flash) floods** particularly more land inwards. On an average, a tropical cyclone can cause 100 mm per day of rain within 200 km of the eye, and 30-40 mm per day at distances of 200-400 km. (NHC, 2002). In mountainous areas these floods can be particularly harmful as heavy flash floods can lead to **landslides** (NHC, 2002)[1] .
  - **Wind**: Coastal regions can receive significant damage from a tropical cyclone due to strong winds, which lead to substantial property damage and loss of life. Damaging winds can start

[1] Refer to "DSS Floods", if floods result from a tropical cyclone

long before the hurricane eye makes landfall (NHC, 2002). At landfall, a tropical storm rapidly looses energy (JRC 2007) hence inland regions are relatively safe from receiving strong winds.

- More than half of the landfalling tropical cyclones produce at least one **tornado** (NHC, 2002). Tornadoes can occur at any time of the day. However, 12 hours after landfall of a tropical cyclone tornadoes tend to occur during day time (NHC, 2002) (JRC 2008). The average warning time for a tornado is about 15 minutes.

b. Physical impact

- **The loss of property from tropical cyclones has increased substantially** over recent years, because of property development in disaster prone areas (CDMP, 2001).

- Tropical cyclones often affect a **lager geographic area** than other disasters. **The area of destruction in tropical cyclones varies from about 25 km in small systems to 500 km or more in large systems** (CDMP, 2001).

- In general, the **strongest winds in a hurricane are found on the right side of the storm**. If the hurricane is moving to the west, the right side would be to the north of the storm; if the hurricane is moving to the north, the right side would be to the east of the storm, etc. **For tropical cyclones in the Southern Hemisphere, these differences are reversed: the strongest winds are on the left side of the storm** (NOAA 2011).

- Strong winds and floods caused by tropical cyclones heavily **damage infrastructure** and buildings (Bryant, 2005). **High buildings** are vulnerable to winds caused by hurricanes, especially as wind speeds tend to increase with height (NHC, 2002).

- **Crops, livestock and fisheries** in the affected area are likely to be damaged, as well as seeds and tools.

- **Disruption of communication:** Wind can disrupt telephone lines, antennae and satellite disks (IFRC, 2000).

- High voltage wires can be damaged by wind, causing **power cuts** (PAHO 1998).

- **Flying debris:** Debris such as signs, roofing materials and small items left outside can turn into small missiles in strong winds and can lead to loss of life and damage to structures (NHC, 2002).

- Winds can cause **splitting and falling of trees** (ECLAC 2003).

- Uprooted trees can lead to **damage to underground utility lines.** (NHC, 2002)

- **Storm surge**: A storm surge can lead to loss of life through drowning, inundation of low-lying coastal areas, erosion of coastline, loss of soil fertility due to intrusion by ocean saltwater and damage to buildings and transport networks (NOAA 2011).

- **Flooding** can be caused by either **freshwater** (due to heavy rains) or **saltwater** (due to storm surges). Each presents specific problems: freshwater carries suspended solids, which leave mud and soil behind when the floodwaters recede, and saltwater can make water sources unsuitable for use, because of the salinity of the floodwaters. There are no simple treatment methods that can be used to remove salinity from salt water (WASH Cluster).

c. Impact on population

- **Loss of lives** from tropical cyclones **has significantly decreased** over recent years, primarily due to improvement in early warning systems, systems to disseminate forecasts, emergency preparedness and building of storms shelters (WHO 2002).

- **The majority of deaths during the tropical cyclone are due to high-velocity winds.** Prominent causes of death and injury are electrocutions from downed power lines, chain-saw injuries, flying debris, blunt trauma from falling trees, and motor vehicle fatalities (Shultz 2005).

- **Water, sanitation and health** are major issues after cyclones and floods, and a speedy response is crucial to prevent the spread of diseases (ALNAP 2008). Studies show the risks of disease are greatest where there is overcrowding and where standards of water and sanitation have declined (PAHO, 1981). This often happens in situations of massive population displacement away from the flooded area and prolonged stay in flood shelters without adequate water supply.

- Major population **movements are rare**, but may occur in heavily damaged urban areas, due to flooding or due to storm surges (PAHO, 2002).

2. What is the likely impact of a tropical cyclone?

a. Aggravating factors

- Lack of **early warning systems** (Bryant, 2005) and/or **systems to disseminate forecasts**. (WHO 2002).

- Lack of **emergency preparedness** and **building of storms shelters** (WHO 2002).

- **Lack of access to drinking water and sanitation.**

- **High-density settlement in low-lying areas** combined with poor housing construction amplifies risks such as in Bangladesh or Philippines, where storm surge remains the major direct cause of mortality following tropical cyclones (CDMP, 2001, Shultz 2005). **People residing in open country, seashore areas and rolling plains are most vulnerable to cyclones** (UNDP 2007).

- **Building standards**; generally those most vulnerable shelters to cyclones are light - weight structures with wood frames, especially older buildings where wood has deteriorated and weakened the walls. Houses made of unreinforced or poorly-constructed concrete block are also vulnerable (UNDP 2007). Buildings made of mud are especially vulnerable to heavy rains and flooding.

- The **type of drainage** has a significant effect on the expected discharge capacity of the system and needs special study. Closed systems, which employ pipes, are more susceptible to blockage and maintenance is more difficult. Lack of maintenance has resulted in serious flooding in urban areas.

- **Duration of the event**. A large amount of damage associated with cyclone events is caused by debris striking structures that would otherwise be able to withstand the wind. As the winds continue to blow, the amount of debris will increase leading to an escalation of damage - and

debris production (ABM 2011). The longer the tropical cyclone circulation system is sustained after landfall, the more likely that torrential rains will re-develop (CDMP, 2001).

Several factors can increase the intensity of the tropical cyclone or accompanying disasters such as floods and storm surges:

- **Topography:**
  - Gradual slopes in valleys can increase average wind velocity.
  - Deep, closed valleys offer protection against strong winds (CDMP, 2001).
  - Dense forests surrounding an installation can reduce wind force (PAHO 1998).

- Slow moving storms and tropical storms moving into mountainous regions tend to produce especially **heavy rain** (FEMA 2004).

- Potentially disastrous **surges** occur along coasts with low-lying terrain that allows inland inundation, or across inland water bodies such as bays, estuaries, lakes, and rivers leading to severe flooding (DOST 2011).

- **Floods** from tropical cyclones are dependent upon:
  - The size and speed of the system;
  - The physical characteristics of the drainage basin such as the soil type, the degree of saturation of the ground, and the vegetation which control runoff;
  - The rate and total amount of precipitation.

b. Lessons learnt

General:

- **Operational constraints**: Assessment of needs and distribution of aid may be difficult due to bad weather conditions, flooding of infrastructure and blockage of infrastructure by debris. Structures adjacent to waterways can be damaged by strong currents. These include bridges, access routes, catch basins, and pipes, among others.
- Vehicles needed to reach affected population (such as boats) are likely to be damaged (CAP 2008 Myanmar).

Food security:

- Floods and severe storms with surges are responsible for food shortages as they drown livestock and crops and damage food stocks.
- Plantation crops such as bananas and coconuts are extremely vulnerable to high winds (IFRC, 2000) (ECLAC 2003).

DIRECT IMPACT	INDIRECT IMPACT
Loss of food stock, crop yields, death and migration of animals.	Decreased access to food Decreased food access from purchase, due to loss of income Increase of prices for basic foods and Commodities Stressed animals, leading to falls in milk/egg production and weight loss
Winds and heavy rain destroy standing crops	Worsening of the food security situation in the medium and long term

Loss of tools and seeds, flooding of farmland.	Worsening of the food security situation in the medium and long term Increase of prices for basic foods and commodities Demand for labour decreases, leading to loss of income (ECLAC 2003)
Standing flood water limits replanting options or soil salinity due to storm-surge inundation	Food security situation deteriorates in the medium to long term Demand for labour in harvesting period decreases, so field workers income drops
Damage to infrastructure and transportation systems	Decreased food availability and access
Loss and injury of family members and workforce	Decreased food production

TYPICAL ASSISTANCE NEEDS

- Short term food supply
- Market support
- Cash for work, Food for work, unconditional cash transfers
- Methods for drying and preserving seed stocks
- Agriculture tools distribution
- Repair of roads and other infrastructure
- Need to restore key saline embankments to avoid further water intrusion and further damage varieties of seeds changes in soil as a result of the floodwaters
- Restoring fishing activities
- ...

Health and nutrition:

Common injuries and diseases experienced during and after tropical cyclones:

- For tropical cyclones, physical injury represents the major cause of death and the primary cause of morbidity.
- The top three cyclone-related injuries are lacerations, blunt trauma, and puncture wounds, with 80 percent of these injuries being confined to the feet and lower extremities (Shultz 2005).
- Lacerations (torn or ragged wounds) account for up to 80% of all injuries. Most occur in the post-storm clean-up phase (Shultz 2005).
- Injuries, trauma and asphyxiation due to entrapment are observed and result from building collapse and wind-strewn debris.
- An increased incidence of animal and insect bites following tropical cyclones has also been noted (CDC, 1986, 1996, 2000).
- There is also a potential for exposure to hazardous materials during the impact, as well as during the clean-up phase of the disaster.
- Chronic diseases (such as asthma and emphysema) are known to be exacerbated.
- Electrocution or drowning happen while securing property such as television antennas or boats (WHO 2011).

Communicable diseases

- The impact of tropical cyclones on the transmission of communicable diseases is limited. Outbreaks of communicable diseases are rarely observed (WHO 2011).
- Nonetheless, the risk for water borne disease and vector transmitted disease can be exacerbated. Conditions following a cyclone that increase the likelihood of infectious diseases include 1) disruption of public health services and the health-care infrastructure, 2) damage to water and sanitation networks, 3) changes in population density (especially in crowded shelters), 4)

population displacement and migration, 5) increased environmental exposure due to damage to dwellings, and 6) ecologic changes 7) High endemic rates of infectious diseases (Shultz 2005).

- Epidemics can also occur when the displaced return home in areas where water and sanitation facilities were destroyed.
- Contrary to popular belief, the presence of a large number of corpses following catastrophic natural disasters is not associated with epidemic infectious diseases. These deaths are caused by the natural disaster, not by disease, and therefore do not lead to epidemics.

DIRECT IMPACT	INDIRECT IMPACT
Storm-related mortality and injury due to for instance building collapse, storm surges/flooding mudslides or landslides	Overcrowded health structures
Damages to health facilities and disruption of public health services, personal medication lost	• Lack of access to basic healthcare • Overcrowded health structures • Deterioration of nutritional status and illness may occur if victims do not have access to appropriate health care
Disruption of water availability - consumption of unsafe drinking water	Water-borne diseases, such as diarrhoeal diseases, acute respiratory infections (ARI) and skin infections
Overcrowding due to displacement	Increased risk of transmission communicable diseases such as measles and meningitis
Psychosomatic illness, including high levels of stress	Breastfeeding can be seriously compromised, which can result in an increase in diarrhoea and pneumonia episodes
Changes in mosquito abundance	Increase in vector-borne diseases

RISKS

Risks of diseases are greatest where there is overcrowding and where standards of water and sanitation have declined (PAHO, 1981)

In case of floods, there can potentially be an increase in the transmission of the following communicable diseases:

- Water-borne diseases
- Vector-borne disease

Water-borne diseases:

- E.g. typhoid fever, cholera, leptospirosis and hepatitis A.
- There is an increased risk of infection of non-epidemic water-borne diseases contracted through direct contact with polluted waters, such as wound infections, dermatitis, conjunctivitis, and ear, nose and throat infections (WHO).
- The only epidemic-prone infection which can be transmitted directly from contaminated water is leptospirosis, a zoonotic bacterial disease (WHO).

Vector-borne diseases:

- E.g. malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever through the expansion in the number and range of vector habitats (WHO).
- Malaria epidemics in the wake of flooding are a well-known phenomenon in malaria endemic areas world-wide (WHO).

TYPICAL ASSISTANCE NEEDS

- Epidemiological surveillance and disease control
- Reconstruction of damaged or destroyed basic health services.
- Mobile health teams may need to be deployed, especially when the population has sought refuge in widely scattered areas
- Hygiene promotion
- Emergency medical care, sexual and reproductive health, mental health and child care

- Raising awareness on the risk associated with cleanup activities
- Medicines and supplies to addresses illnesses such as cholera, dysentery and other potentially deadly water-borne diseases
- Wound care supplies such as antiseptics and antibiotics
- Immunizations: Tetanus, possibly hepatitis A and typhoid
- ....

WASH:

The most common effects of tropical cyclones on the drinking water and sewerage systems include:

- Damaging to pipelines:
  - As a result of landslides and strong water currents;
  - As a result of uprooted trees due to strong winds
- Damage to elevated and ground-level tanks;
- Contamination of water in tanks, pipes and wells. Shallow wells are more prone to contamination from flooding than deep boreholes (WASH Cluster, 2009).
- Groundwater is an important source of water for many rural communities in developing countries. If the water table is within 1.5m of the bottom of a pit latrine it is almost certainly contaminated and using water from wells in the vicinity of excreta disposal facilities is not recommended after a tropical cyclone (WASH Cluster, 2009).
- The rise of water levels in sewer outfalls can cause waste water to flood the interiors of homes, lower levels of buildings, and public throughways.
- Watercourses can be affected by flooding, thereby altering expected flood levels, damaging or breaking pipes, exceeding the capacity of existing drains, and increasing turbidity in runoff.

WASH		
WATER SUPPLY	**DIRECT IMPACT**	**INDIRECT IMPACT**
	Intrusion of salt water into surface water (ECLAC 2003)	
	People may be stranded on roofs and trees, and do not have access to safe water	
	Standing water may hamper access to existing water sources	
Urban	**Disruption of water distribution systems due to** • Power cuts • Damage to water treatment plants by debris or flooding • Sedimentation, resulting in silting treatment plants **Contamination of drinking water sources by** • Human and animal corpses • Turbidity, organic or saline • Leaking of polluted water into the water supply system. • Overflowing of sewage systems • Overflowing of industrial drainage systems • Fuel flooding into water supply systems	• Consumption of contaminated water: potential risks of waterborne diseases • Insufficient quantity of water available per person and per day • Increased distance to functional water source
Rural	**Disruption of water distribution systems due to:** • Inundation of shallow (protected or unprotected) wells	• Consumption of contaminated water: potential risks of waterborne diseases • Insufficient quantity of water

	• Loss of intake points due to changes in the course of rivers • Damage to pumping equipment • Sedimentation, resulting in silting up of components of water treatment plants **Contamination of drinking water sources by:** • Human and animal corpses • Turbidity, organic or saline • Leaking of polluted water into the water supply system • Overflowing of sewage systems • Fuel flooding into water supply systems	available per person and per day • Increased distance to functional water source
SANITATION	**DIRECT IMPACT**	**INDIRECT IMPACT**
	Irrigation, drainage and storage facilities are damaged by winds or floods	
	Overflowing of pit latrines due to floods	• Contamination of the environment • Lack of latrines can lead to open defecation • Lack of available and functional latrines can force women to wait after dark to be able to use an (open air) latrine in private. This can cause constipation
	Displacement leading to overcrowding	Existing latrines/toilets are filled quickly and overflow rapidly Open defecation becomes commonplace
	High ground water table	Restricted excreta and waste disposal options
WASTE	**DIRECT IMPACT**	**INDIRECT IMPACT**
	Damaged waste facilities and restricted options for solid waste and waste-water disposal	• Increased presence of vectors • Accidental releases to ground water • Altered drainage patterns. • Existing drainage channels, canals may be clogged with waste, mud or debris
HYGIENE	**DIRECT IMPACT**	**INDIRECT IMPACT**
	Loss of basic hygiene items for personal and domestic uses, non-availability of safe drinking water and damage to sanitation infrastructure	Can cause skin problems and infections, especially among women and children

TYPICAL ASSISTANCE NEEDS

- Distribution of safe water and provision of water recipients for purification
- Rapid cleaning and disinfecting programme for affected water sources
- Raising tube-wells and boreholes above flood level to prevent contamination
- Provision of buckets and water containers in relief packages

- Provision of adequate excreta disposal facilities and promotion of good excreta disposal practices
- Hygiene promotion and distribution of sanitary kits
- Vector control, including drainage or filling of standing water pools, provision of drainage at new water points, removal of organic waste
- ….

Shelter & NFI:

- Contrary to popular belief, few houses are blown over during a cyclone. Instead, they are pulled apart by winds moving swiftly around and over the building (UNDP 2007).
- Even if an early warning system is in place, in some communities people refrain from evacuating because homes could be looted. In Bangladesh in 1970, women did not leave their houses because the cyclone struck during a month when women were forbidden by established religious convention from going outside (Bryant 2005).
- Floodwater can submerge buildings and cause various degrees of damage from staining of walls to structural collapse depending on flood depth and/ or duration and type of building (ADPC 2005).
- Land/property issues and related disputes typically emerge in the aftermath of a disaster, particularly in urban areas where there is high demand for housing.
- Land ownership after floods can pose problems as land markers can be washed away by floods (Ferris 2010).
- Debris and mud must be removed before rebuilding can take place (Brookings Institute 2010).
- The distribution of hygiene or health related NFI's should always be accompanied by information on why it is included in the distribution and on optimal use (WASH Cluster).
- Typical assistance needs are:
    - Evacuation and emergency shelter (IFRC, 2000).
    - Clean-up and debris removal (IFRC, 2000).
    - Measures reducing the individual risk of being exposed to vector-borne diseases, such as mosquito nets.
    - House cleaning kits need to be distributed to support reconstruction of damaged houses (Ferris 2010).
    - According to needs, NFI kits (Blankets, cooking set, mattresses, etc.)

Protection:

- Disasters cause more damage to vulnerable geographic areas, which are more likely to be inhabited by poor people (PAHO).
- Natural disasters do not only seriously disrupt the functioning of a community by causing widespread human, material, economic or environmental losses, but also the mechanisms established, formally or informally, to protect the lives, security and basic rights of the population.
- A breakdown of law and order can occur following a disaster. Emergency situations tend to exacerbate existing inequalities among the population, or other human rights/protection concerns (Haiti Flash Appeal 2010).

Gender:

Women are especially vulnerable to disasters (e.g. floods) for the following reasons:

- Changing role of women (from care giver to head of household) and less access to resources, social networks and decision-making.
- Lack of safety nets
- Informal and agricultural sectors are usually the most impacted by disasters. In different societies, these sectors are the main income source for women. As tropical cyclones and floods have a large impact in the agricultural sector, women become over represented among the unemployed.

- Women have less freedom and mobility to look for alternative sources of income.
- Less access to relief and information in specific cultures
- Low visibility in society and sometimes limited understanding of women's needs in post disaster situation (i.e. reproductive health). Identification and attention to their needs is most often inadequate.
- Reproductive and sexual health care are often neglected in an emergency.
- In many communities, household cleaning is traditionally the role of women/girls, while men will go out and seek immediate livelihood opportunities. Being left behind to undertake household cleaning will make them more vulnerable to diseases brought about by the extra burden of coping with household level crisis and unsanitary conditions (Flash Appeal Philippines 2009).
- Although targeting women for relief distribution can have numerous advantages in certain contexts, there is a need to address women's safety after departure from distribution sites, as well as the physical effort required by women to transport distributed relief (Haiti Revised Appeal 2010).

c. Coping mechanisms

The following table contains a list of coping mechanisms generally adopted by affected population to cope with the impact of an earthquake.

REVERSIBLE STRATEGY	IRREVERSIBLE STRATEGY	RISK SURVIVAL STRATEGY
Changes in food intake (e.g. less meals, cheaper foods)	Taking out loans which cannot be paid back	Decrease food intake
Drawing on food stores	Sale/mortgaging of productive assets (tools, and seeds)	Theft
Increased (sustainable) sale/slaughter of livestock	Mortgaging of farm land	Travel to insecure areas to work or to gather food or fuel
Collection of firewood, charcoal, building poles	Intensification of self-employment activities	Over-use of natural resources, such as excessive fishing and collection of firewood
Harvesting of reserve crops	Increased social support/gifts	Reduced expenditure on productive inputs (fertilizer, livestock drugs)
Migration for work		Child labour
Intensification of local labour activities		Reduction in expenditure on school fees and health care
Selling non-productive assets		Sale of household assets
Taking out loans or calling in debts		Prostitution and external relationships
Changes in livestock migration patterns		Engaging in illegal economy e.g. drug trafficking
Separation of families and mothers from children		
Short-term/seasonal labour migration		

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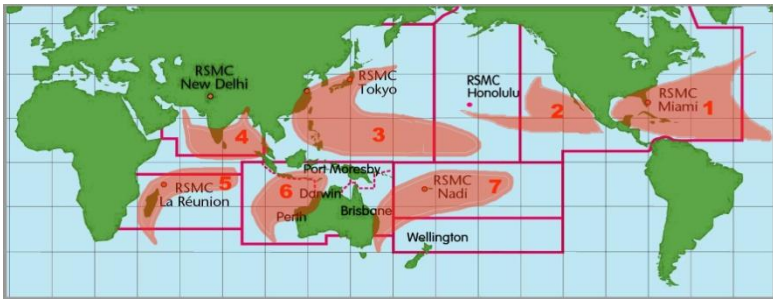
ANNEX I: General characteristics

Tropical cyclones are low-pressure weather systems that develop over the warm waters of the oceans, typically between the latitudes of 30° N and 30° S (Shultz 2005). Tropical cyclones usually originate over tropical or subtropical waters. They can continue for hours or even days, causing widespread damage to buildings and infrastructure, and considerable loss of life. The eye of a tropical cyclone is usually 30 to 50 km wide. Around the rim of the eye, or the 'eye' wall, winds may gust up to more than 300 km/hr. For the period 1968–2003, an average of 88 tropical storms developed each year, of which 48 attained tropical cyclone intensity and 21 became major tropical cyclones. (Shultz 2005). Asia has been the continent most affected by tropical cyclones, with more than 1 million people killed and 500 million people affected by tropical cyclones between 1900 and 2011 (EMDAT 2011).

There are 7 tropical basins where cyclones occur on a regular basis:



Previous Tropical Cyclones

In 2007, intense storms and a major cyclone caused severe flooding across **Pakistan**, causing flooding across large areas displacing over 300,000 people and affecting more than 2.5 million.

Cyclone Nargis struck **Myanmar** on 2 and 3 May 2008 with winds up to 200 kp. The effects of extreme winds were compounded by a sizable storm surge that destroyed an estimated 95% of housing in the delta region. The storm downed power and communications lines, and inflicted major damage to buildings.. Some 2.4 million people are thought to have been severely affected and 138,366 were killed (EM-DAT)

Tropical cyclones usually occur at predictable times of year in distinct part of the world:

- **Number 1**: Within the Atlantic/Caribbean region the hurricane season is normally from June to November
- **Number 2+3**: Within the Pacific/South East Asia region, the tropical cyclone season is normally from May to November
- **Number 6+7**: Within the Far East, South Pacific and Australia region the tropical cyclone and typhoon season is normally from November to April.
- **Number 4**: Northern India tropical cyclones usually occur from April – June and September – November
- **Number 5**: The east coast of Africa normally experiences tropical cyclones from November to April.

Six factors appear to be generally necessary to form a tropical cyclone:

1. Water temperatures of at least 26.5 °C are needed down to a depth of at least 50 m.
2. Another factor is rapid cooling with height, which allows the release of the heat of condensation that powers a tropical cyclone.
3. High humidity is needed, especially in the lower-to-mid troposphere; when there is a great deal of moisture in the atmosphere, conditions are more favourable for disturbances to develop.
4. Low amounts of wind shear are needed, as high shear is disruptive to the storm's circulation.
5. The presence of a near-surface, organized, rotating system characterized by spin (vorticity) and low-level inflow (convergence);
6. Tropical cyclones generally need to form more than 555 km (345 mi) or 5 degrees of latitude away from the equator (Shultz 2005).

Definitions

There are different names used for a tropical cyclone, depending on the geographic location. Although the categories used are not identical, the following table can be an approximate guide for comparison.

Australian name	Australian category	US*	US Saffir-Simpson category scale*	NW Pacific	Arabian Sea /Bay of Bengal	SW Indian Ocean	South Pacific (East of 160E)
Tropical low	-	Tropical depression	-	Tropical depression	Depression or severe depression	Tropical depression	Tropical depression
Tropical cyclone	1	Tropical storm	-	Tropical storm	Cyclonic storm	Moderate tropical storm	Tropical cyclone (Gale)
Tropical cyclone	2	Tropical storm	-	Severe tropical storm	Severe cyclonic storm	Severe tropical storm	Tropical cyclone (Storm)
Severe tropical Cyclone	3	Hurricane	1	Typhoon	Very severe cyclonic storm	Tropical cyclone	Tropical cyclone (Hurricane)
Severe tropical cyclone	4	Hurricane	2 - 3	Typhoon	Very severe cyclonic storm	Intense tropical cyclone	Tropical cyclone (Hurricane)
Severe tropical cyclone	5	Hurricane	4 - 5	Typhoon	Super cyclonic storm	Very intense tropical cyclone	Tropical cyclone (Hurricane)

Related disasters:

- **Storm surge**: water is physically piled up along a coastline. This lead to loss of life through drowning, inundation of low-lying coastal areas, erosion of coastline, loss of soil fertility due to intrusion by ocean saltwater and damage to buildings and transport networks.
- **Wind:** can lead to substantial property damage and loss of life and constitute the main agent for crop destruction. Can exacerbate the spread of fires in urban and forested areas.
- **Rain**: On an average, a tropical cyclone can dump 100 mm per day of rain within 200 km of the eye, and 30-40 mm per day at distances of 200-400 km. These rates can vary tremendously depending upon local topography, cyclone motion and the availability of moisture. Rainfall leads to loss of life, property damage and crop destruction from flooding (Nalivkin, 1983).
- **Tornadoes:** more than half of the landfalling tropical cyclones produce at least one tornado (NHC, 2002). Tornadoes can occur at any time of the day. However, 12 hours after landfall of a tropical cyclone, tornadoes tend to occur during day time (NHC, 2002) (JRC 2008).
- **Landslides**: heavy rain in hilly or mountainous areas is responsible for landslides or mudflows where intensity of rainfall can lead to slope instability.

Severity classification

There are several scales available to measure the intensity of tropical cyclones, depending on the geographic region of the cyclone. The most familiar scale is the Saffir-Simpson scale. The scale has five categories and applies only to hurricanes. *See annex II for complete Saffir-Simpson scale.*

Scale Number	Sustained Winds (MPH)	Damage	Storm Surge
1	• 74 - 95 mph • 64 - 82 kt • 119 - 153 km/hr	Minimal: Unanchored mobile homes, vegetation and signs.	• 4-5 feet • 1,2 - 1,5 m
2	• 96 -110 mph • 83 - 95 kt • 154 - 177 km/hr	Moderate: All mobile homes, roofs, small crafts, flooding.	• 6-8 feet • 1,8 - 2,4m
3	• 111 - 130 mph • 96 - 113 kt • 178 - 209 km/hr	Extensive: Small buildings, low-lying roads cut off.	• 9-12 feet • 2,7 - 3,6m
4	• 131 - 155 mph • 114 - 135 kt • 210 - 249 km/hr	Extreme: Roofs destroyed, trees down, roads cut off, mobile homes destroyed.	• 13-18 feet • 3,9 - 5,4m
5	• > 155 mph • > 135 kt • > 249 km/hr	Catastrophic: Most buildings destroyed. Vegetation destroyed. Major roads cut off. Homes flooded.	• > 18 feet • >5,4m

Terminology

Post-tropical Cyclone:
A former tropical cyclone. This generic term describes a cyclone that no longer possesses sufficient tropical characteristics to be considered a tropical cyclone. Post-tropical cyclones can continue carrying heavy rains and high winds.

Storm surges: piling up of water, primarily caused by wind. The exact amount of water piled up depends upon the speed of the wind, its duration and its location relative to the centre of a cyclone. (Bryant 2005). If a storm moves in the direction of its wind speed, then it will tend to drive a wall of water ahead of it. This wall behaves as a wave and travels with a speed similar to that of the storm. As the cyclone approaches land, the surge height increases. The probability of occurrence of a surge height is highly dependent upon the physical characteristics of a coastal site. To define this probability, knowledge of the size of past events and how often they have occurred over time (magnitude – frequency) is also required.

Tropical cyclones: A large-scale vortex of rising air hundreds of kilometres in diameter that forms over the tropical oceans. It is characterised by copious rain and a central area of calm surrounded by rotating winds blowing at speeds in excess of 200-250 km/hr.

Tornadoes: Range from just a few metres across to over a kilometre, and can last up to an hour or more. Tornadoes are primarily an over-land phenomena as solar heating of the land surface usually contributes toward the development of the thunderstorm that spawns the vortex (though over-water tornadoes have occurred). Tropical cyclones at landfall often provide the conditions necessary for tornado formation (NOAA 2011).

Annex II: The Saffir-Simpson Table

Category	Winds (1 min sustained winds)	People, Livestock, and Pets	High-Rise Windows and Glass	Trees	Power and Water
1	**74-95 mph** **64-82 kt** **119-153 km/hr**	People, livestock, and pets struck by flying or falling debris could be injured or killed.	Windows in high- rise buildings can be broken by flying debris. Falling and broken glass will pose a significant danger even after the storm.	Large branches of trees will snap and shallow rooted trees can be toppled.	Extensive damage to power lines and poles will likely result in power outages that could last a few to several days.
2	**96-110 mph** **83-95 kt** **154-177 km/hr**	There is a substantial risk of injury or death to people, livestock, and pets due to flying and falling debris.	Windows in high-rise buildings can be broken by flying debris. Falling and broken glass will pose a significant danger even after the storm.	Many shallowly rooted trees will be snapped or uprooted and block numerous roads.	Near-total power loss is expected with outages that could last from several days to weeks. Potable water could become scarce as filtration systems begin to fail.
3	**111-130 mph** **96-113 kt** **178-209 km/hr**	There is a high risk of injury or death to people, livestock, and pets due to flying and falling debris.	Numerous windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm.	Many trees will be snapped or uprooted, blocking numerous roads.	Electricity and water will be unavailable for several days to a few weeks after the storm passes.
4	**131-155 mph** **114-135 kt** **210-249 km/hr**	There is a very high risk of injury or death to people, livestock, and pets due to flying and falling debris.	Most windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm.	Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas.	Power outages will last for weeks to possibly months. Long-term water shortages will increase human suffering. Most of the area will be uninhabitable for weeks or months.
5	**155 mph** **135 kt** **249 km/hr**	People, livestock, and pets are at very high risk of injury or death from flying or falling debris, even if indoors in mobile homes or framed homes.	Nearly all windows will be blown out of high-rise buildings resulting in falling glass, which will pose a threat for days to weeks after the storm.	Nearly all trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas.	Power outages will last for weeks to possibly months. Long-term water shortages will increase human suffering. Most of the area will be uninhabitable for weeks or months.

Annex III: Safety recommendations

Minimising the risk

If you are in a cyclone region during the tropical cyclone season:

- Make sure that you and all your team members are in a safe location well before the cyclone hits, and make sure the structure is in good condition.
- Be aware of the cyclone warning system that exists in your area.
- Have a grab bag ready.
- Make plans to secure your property. Permanent storm shutters offer the best protection for windows. A second option is to board up windows with 5/8" marine plywood, cut to fit and ready to install. Tape does not prevent windows from breaking.
- Install straps or additional clips to securely fasten your roof to the frame structure. This will reduce roof damage.
- Be sure trees and shrubs around your home are well trimmed.
- Clear loose and clogged rain gutters and downspouts.
- Determine how and where to secure your boat.
- Consider building a safe room.

What to do during a tropical cyclone

- Once a cyclone warning is issued, secure the doors and board up and tape over the windows to prevent flying glass and other objects from coming in.
- Remain indoors- away from windows, skylights and glass doors – and remain in the strongest part of the building.
- In flood-prone areas do not use the cellar or basement: these areas can be extremely dangerous because of the addition risk of flooding.
- Avoid using naked flames, such as candles and paraffin lamps, as a source of light, in case of gas leaks.
- If the building you are in starts to break up or fall apart, then the only option is to protect yourself with a mattress, rugs, blankets or tarpaulin and to hold on to any strong fixtures (such as water pipes), or get under a strong, heavy table or bed.
- Beware the eye of the storm. As the cyclone eye passes over there is a sudden lull in winds, which may last up to two hours. When the other side of the cyclone then hits, winds will resume with equal strength but blowing from the other direction. It is vitally important to remain in shelter during and after the eye passes.
- If you are stuck outdoors during a cyclone, seek solid and enclosed shelter, but avoid trees.
- If you are driving, stop (handbrake on and in gear), park well clear of trees, power lines and streams, and stay in the vehicle.

What to do after a tropical cyclone

- Drive only when necessary. The streets will be filled with debris. Roads may be blocked or weakened. When driving, you must be careful to avoid damaged power lines, bridges, buildings, trees and any flood waters.
- Stay away from beach fronts, river banks and streams until potential flooding has passed.

Source: FEMA 2004 and Save the Children 2010