

MODULE 3

FLOODS AND COASTAL DISASTER

FLOODS

By definition, any land which is usually above water level is said to be flooded if it goes under water for a period arbitrarily defined as one or two hours. Flooding can be owing to many reasons. Usually this happens when the river or the stream draining the area is over balanced by a very large volume of water beyond its capacity. A river channel is formed by the forces of nature to be able to convey the flow that is found most of the time. When the volume exceeds this, the water level rises above the banks and spreads in to the adjacent lands. This area is usually called the flood plain of the river. People resident or working in the flood plains must be mindful of the fact that there is an ever present threat of floods.

TYPES OF FLOODING

Flooding can be classified into several types. Out of those riverine floods and urban floods are the most common. The flood types are explained below

Riverine floods:

Some rivers are prone to frequent floods – annually or seasonally, while others may not be affected. Riverine floods can be further classified by the rapidity of flooding or its magnitude. In the first classification, a flood can either be a flash flood or a normal flood. Flash floods occur in mountainous areas with high slopes and shallow soil depths and are caused by intense rainfall. In such conditions rivers will flood within a very short period of rainfall, not giving much notice of flooding.

In the case of normal flood, the river rises gradually and gives people ample notice of it's arrival. The type of rainfall may also be a high volume spread over a longer period rather than a short one with intense precipitation.

The same river may cause flash floods in one area and normal ones in other areas. In Sri Lanka, this is usually so with hill areas subjected to flash floods and lower reaches to normal ones. The second classification of riverine floods is based on the magnitude. The depth of inundation is a good indicator of the magnitude. The full range of the classification is given below:

- High stage flows

This is technically not a flood as the flow is still confined between the banks. Still the water may be deep and the velocities high so that normal river uses are disrupted. Bathing, boating, fishing

- Minor floods

Such a flood may affect only a small part of the riparian community. It usually inundates the low lying areas such as paddy fields, meadows etc. Economic loss is small and number of evacuations is also limited. Communications are rarely severed.

- Major Floods

A flood that affects a significant part of the riparian community and causes higher economic damage is considered a major flood. Residential and business areas as

well as public buildings may go under water. Normal services are disrupted and a major part of the community may need to be evacuated. Roads, railways and other modes of transport/communication also may be affected.

- Dangerous / critical floods

This term denotes flooding that inundates a large area of the basins and requires evacuation of most of the riparian population. The transport gets cut off and normal services are disrupted. A dangerous flood covers an extensive area of the flood plain and may remain stagnant for several days. A dangerous flood is said to reach a critical flood stage if beyond a certain threshold it causes one or more of the following events:

- i. It begins to flood strategically (or nationally) important places such as railway terminus, power stations, base hospitals etc.
 - ii. It starts entering into entirely fresh areas through saddle points.
 - iii. Flood waters overtop flood levees and breach them to inundate protected areas.
- There are other types of floods. Some of them are described below:

Urban floods / Drainage congestion

In many cases the so called floods are not caused by rivers overflowing but are caused by the inadequate drainage facilities. In urban areas this phenomenon occurs due to haphazard construction with poor planning which does not allow sufficient retention and percolation areas. In some cases people encroach drainage areas, even obstructing drainage paths and disrupting natural drainage patterns.

Floods caused by spilling of Reservoirs

When reservoirs spill, it may cause flooding downstream. The spilling may be natural or it may be caused by the reservoir operator opening the gates. In either case the reservoir owner – eg: Irrigation Department – will give advance warning.

Dam Breach

Most destructive floods are caused by the breaching of the dam of a reservoir. This will release large volumes of water stored in the reservoir. The sudden release of this water will create a rapidly moving flood wave downstream. Depending on the volume of water and the topography, it can be a catastrophic event. Fortunately, such failures are very rare and signs of failure can be usually visible to the engineers mincing the reservoirs. They will evacuate the vulnerable population to safe areas. However the possibility of sudden failure with little notice cannot be ruled out.

Minor flooding: This causes inconveniences such as closure of minor roads or low lying land.

Moderate flooding: Low-lying areas are inundated, requiring removal of stock, equipment and evacuation of isolated homes. Main traffic bridges may be covered.

Major flooding: Higher areas are inundated, with towns and properties isolated. Extensive damage is caused.

Local flooding: Intense rainfall could cause a high runoff in some areas, but would not usually lead to significant rises of water level in the main streams.

Significant river rises: This warning is issued to indicate the uncertainty of the water level and the possibility of existing flood level to increase which may be exceeded in the main stream. It lets people know that possible rises are expected within a short period.

FLOOD WARNINGS

Before a flood strikes, there is usually a good warning period. The only exception is when flash flooding occurs because it happens too quickly and unexpectedly for warnings to be issued. Warnings are usually issued by the Irrigation Department or the Disaster Management Center (DMC).

Terms And Their Meanings

The following are the most common terms and their meanings.

a Minor flooding

This causes inconveniences such as closure of minor roads or low lying land.

b Moderate flooding

Low-lying areas are inundated, requiring removal of stock, equipment and evacuation of isolated homes. Main traffic bridges may be covered.

c Major flooding

Higher areas are inundated, with towns and properties isolated. Extensive damage is caused.

d Local flooding

Intense rainfall could cause a high runoff in some areas, but would not usually lead to significant rises of water level in the main streams.

e Significant river rises

This warning is issued to indicate the uncertainty of the water level and the possibility of existing flood level to increase which may be exceeded in the main stream. It lets people know that possible rises are expected within a short period.

HOW TO ACT ON WARNINGS

Once a flood warning is issued, it means that the flood is anticipated. Here are key factors that contribute to flooding and signs to watch.

Unusually heavy rain over several hours or steady substantial precipitation over several days.

When a cyclone or other tropical system is affecting your area.

When water is rising rapidly in streams and rivers.

Any of these signs should prompt you to get up-to-minute reports on flood conditions. During this time, you should stay tuned to local radio weather channel that provides accurate and timely storm updates for your area and be alert to signs of flash flooding and be ready to evacuate at a short notice.

FLOOD IMPACTS

- Injury or death to people and animals.

- Damage to houses and property and important possessions such as furniture, electrical appliances, etc.,
- Livelihood of people because floods destroy crops, farmlands and livestock.
- Food shortage.
- Long-lasting floods can disturb routine cultivation pattern.
- Soil erosion can occur after floods. Lands are usually covered with debris, sand or boulders which may reduce farming areas and fertility of soil.
- Damage to infrastructure and facilities like hospitals, clinics, schools, roads, railways, telephone lines and electricity supplies.
- Disruption of clean water supplies and contamination of sources of water which can subsequently cause diseases.
- Any disaster can have a profound impact on people's emotional wellbeing affecting their feelings, thoughts, actions, and relationships.

FLOOD DANGERS

Water depth and currents: The majority of deaths caused by floods results from people attempting to swim, walk or drive through flood waters. Flood water depth and currents are easily misjudged and therefore there is a capability of sweeping away and submerging even large vehicles. In small streams, water level can rise suddenly.

Flash floods: Flash floods cannot be predicted by weather forecasting institutions unless they possess special facilities for predicting such events. Living or camping in flood plains during rainy season is very dangerous. Flash floods are fatal and they kill many people because of the sudden release of large quantities water from water sources, such as rivers or dams. Therefore, during a monsoon period, bathing or swimming in irrigation channels, storm water drains or inland rivers in mountain regions should be avoided.

Hidden dangers: Many of those who drown in floods, especially flash floods, may have actually been killed by the violent current of water or being hit by objects in the waters or in the river bed.

Simply being a good swimmer may not be enough to survive. So it is advisable not to enter or drive into flood waters when an obvious current exists. Most people are unaware that:

Most flood deaths happen when drivers make a single, fatal mistake trying to get through flood waters.

Just 6 inches of rapidly moving flood water can knock a person down.

A mere 2 feet of water can float a large vehicle such as a bus.

One third of flooded roads and bridges are damaged by water. In most cases vehicles trying to cross stand only a 50% chance of making it to the other side.

Other potential injuries:

Possibility of hypothermia, a serious medical condition in which the body temperature falls below the usual level, after staying soaked for a long time.

Risk of illness after drinking flood water or water contaminated with sewage or other hazardous waste (especially in urban areas)

Injuries due to driving into flood waters, road washouts, soft edges, damaged bridges.

Electrocution by overhead or fallen power lines. If you are on a boat, beware of power lines.

FLOOD SURVIVAL TIPS

If you are living in an area prone to floods, follow the instructions below to save your life and property.

BEFORE THE FLOOD

Flood preparedness

Ensure all communities living in flood prone areas as well as your family members, understand the danger properly.

Know the flood history of your area.

Understand the warning messages, what will be the impacts of major, moderate and minor flooding to your area, what are the areas vulnerable to different degree of flooding.

At times of adverse weather conditions, always listen to the official warnings issued by local authorities and news report on local radio or television.

Prepare a flood emergency kit.

Prepare and discuss the details of local flood hazard map with the involvement of other community members.

Indicate the flood path and possible sequences of flooding in the area in advance.

Evacuation plans should be made in advance. Each member of the family must be given specific instructions and responsibilities in case of evacuation.

If your community has boats, make sure that they are well-maintained and properly tied up to a tree or other permanent object.

Try to protect community water supply sources.

Inspect escape routes, houses etc. before floods for weaknesses. If you find any, help to protect them building up a wall of sand bags to block the flood waters.

If communities are subject to flash floods, organize groups and plan for flood level monitoring and have a discussion on how the information can be disseminated.

Organize a search and a rescue (S&R) team and identify the areas which will be isolated in case of flooding and prepare a plan for the S & R team.

EMERGENCY KIT

To survive during and after a flood, it is wise to prepare a flood emergency kit for each family member. The kit should contain:

- A portable radio and torch with fresh batteries.

- Fresh batteries.

- Candles and water-proof matches.

- Reasonable stocks of drinking water, canned food and food items such as instant noodles.

- A first aid kit.

- A supply of essential medicine for cold, cough, diarrhea, headache, fever etc.

- Strong shoes and if possible, a pair of rubber gloves.

- A water proof bag for clothing, documents and valuables.

- A plastic bucket to collect fresh water until you get water supplies.

Emergency flood-proofing

The most readily available material is sand. Sandbags stacked to form a barrier against rising water levels are the most common emergency flood proofing technique. The bags must be strong enough to hold sand or other filling material and withstand the contact with water indefinitely because the water exerts on the sandbags, if possible, a trench may be dug (along the centre of the levee or embankment), to prevent the levee from moving.

The bags should not be too full with sand. This allows one to overlap another, which locks bags together. Bags should be placed in a way that bags on each layer are at right angles to the layers above and below to add stability. To prevent the seepage, a durable plastic sheet can be placed to cover the side exposed to flood water (waterfront).

River Bank Erosion Management

River and stream bank erosion involves loss of vegetation, valuable agricultural and recreational land along the waterways. As the banks collapse or erode into the flowing water, the sediment and nutrient loads increase and water quality (particular for human consumptive purposes) is reduced, adversely affecting the aquatic life forms. In addition the debris carried by the water can be a threat to roads, bridges and buildings in the downstream areas, resulting in accelerated erosion along the way.

Management options for such hazard include:

- Maintaining the vegetation (trees, shrubs, grasses, seeds, etc.) along the river and stream banks, especially the kind of vegetation with fine, deep roots. The key advantages of such practice include:

- Installing fence along the river to prevent livestock from trampling on the vegetation and eating them, which result in leaving only short grass to hold the bank together

- Conduct a thorough survey (by a mandated and capable national agency) of

the river/stream process to understand more about the flow regime in a particular water way before any heavy structural measures are undertaken, to avoid increasing the flood risks in the downstream area.

Encouraging and restricting proper land use planning practices on the river bank.

DURING THE FLOOD

Surviving a flood

Keep your emergency kit safe and dry.

Do not eat food which has been in contact with flood water

Collect rainwater until you get fresh water supplies. Boil all water before drinking it.

Do not use water from dug wells during such time until it is declared safe by authorities.

Do not use gas, electricity or other electrical appliances which have been flood effected, until they are safety checked.

Watch for your children. Do not allow them to play or swim in flood waters.

Beware of poisonous animals such as snakes, spiders which may move to drier areas in your premises.

Check with police or local authorities safe routes before driving anywhere and do not enter flood water without checking depth, current, etc.

If on foot, do not attempt to walk through flood waters, turn around and go directly to higher ground.

Keep away from river banks in the flooded area as these may be undermined and may be subjected to collapse.

Listen to your local radio and TV stations and follow all advice and warnings.

Stay where there are people around you, give and receive assurance and comfort for each other.

If evacuation is advised

You may be advised to evacuate by village leaders or other local authorities, please follow the earlier plan agreed upon by the community. Before leaving take the following actions.

Collect all your valuables, papers, certificates, and mementos. etc.

Stake your furniture and possessions above likely flood level.

Turn off electricity, gas supply and water and close windows and doors of the house.

Take care of all electrical appliances.

Empty the freezers, refrigerators and leave the doors open, unplug them.

Do not forget your emergency kit.

Be sure to follow the recommended evacuation routes.

AFTER THE FLOOD

Your home has been flooded. Although flood waters may be down in some areas, many dangers may still exist. These are things to remember after floods.

Inform your village leaders or your neighbours that you are returning home and obtain advice before making a decision.

Roads may be still closed because they have been damaged or are still covered by water. If you happens to come across such roads with stop signs please avoid that road and find another way.

Keep listening to radio for news. Additional flooding or flash floods may occur.

Emergency workers may be assisting people in flooded areas. You may be able to help them.

Try to avoid walking through the flooded area.

If you must walk through flooded area, stay on firm ground. Standing water may be electrically charged from underground or downed power lines.

Use nets when you sleep to prevent mosquito and insect bites.

Do not go near river banks or where there are signs about landslides or to areas where people have been evacuated.

Do not allow children to enter the houses / buildings that have been flooded unless they are checked by an adult.

Do not touch any damp electrical sockets or turn on the electricity if the house was subject to floods until it has been checked and has dried out for some time.

Returning to normal life

It is important to understand that you and your family may react to this emotional distress in many ways. Feeling exhausted, sad and low in mood, hopeless about the future, easily angered, constant quarrelling, unable to sleep, constant body aches may be just some ways your body and mind will react to what has happened.

You need to look after your physical and emotional wellbeing and that of your family during the transition period. These are ways that can help you and your family return to normal life:

Get good rest and eat before commencing cleaning up. Having meals as far as possible at regular times and getting the right amount of sleep is very important to staying strong and overcome the crisis.

Do unpleasant tasks (eg: burying dead animals) together rather than alone.

Encourage and allow people to talk and share their feelings about what has happened if they want to.

Do little things that everyone enjoys, eg: Listening to the radio or music while cleaning up the house will help make an unpleasant

task easier.

Understand how the stressful event has made you and your family feel and be patient with each other.

It may take some time to get a house back into its original condition. These are ways that can help you and family.

When going back to your home go with family or friends who can help and support you.

Some family members or children may not want to go back, may want to avoid the place or may develop strong fear reactions.

Before entering the house, get advice from a skilled person about the supply of electricity, water, gas, etc. Get their advice on necessary repairs and do not enter the house if you cannot get any advice.

Make sure that there is no more threat of occurrence of floods in the near future.

Have the kitchen cleared and functioning as soon as possible so you can cook and serve food to your family and yourself.

Get the assistance of skilled persons to repair leaks.

Clear up, drain and start drying out the house when flood water has recedes.

Take out everything that is wet and that can be moved out.

On dry days keep all doors and windows open

Repair latrines and disinfect the water supply sources of the household.

Check for trapped water and mud in wall cavities.

How to Lessen Future Flooding and its Impacts

Have a meeting with the village community and leaders to review the proceedings during and after flooding.

Encourage community members to participate in the cleanup of the environment and common areas.

Plant bamboo or appropriate trees around the houses and in the common areas to prevent erosion.

Stop cutting trees. Instead plant trees. They provide a strong natural protection against floods.

Do not throw rubbish in rivers or canals.

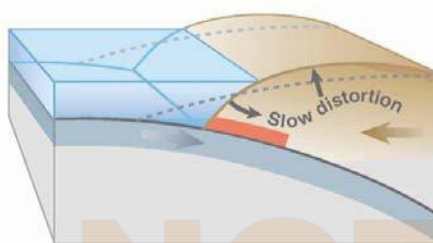
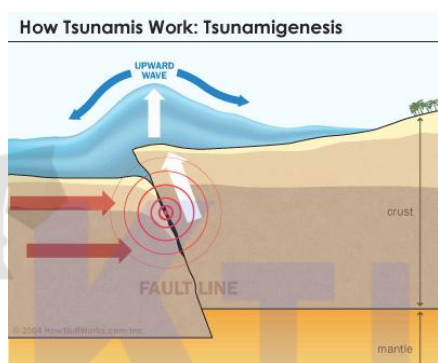
Do not throw things like cigarette butts, wrappers especially those made of plastic or non-biodegradable objects, etc, anywhere which may clog or block the drainage system thereby impeding the flow of water.

Support community activities intended to lessen effects of floods.

TSUNAMI

A tsunami is a series of waves most commonly caused by violent movement of the sea floor. In some ways, it resembles the ripples radiating outward from the spot where stone has been thrown into the water, but a tsunami can occur on an enormous scale. Tsunamis are generated by any large, impulsive displacement of the sea bed level. The movement at the sea floor leading to tsunami can be produced by earthquakes, landslides and volcanic eruptions.

Earthquake Tsunamis: Most tsunamis, including almost all of those traveling across entire ocean basins with destructive force, are caused by submarine faulting associated with large earthquakes. These are produced when a block of the ocean floor is thrust upward, or suddenly drops, or when an inclined area of the seafloor is thrust upward or suddenly thrust sideways. In any event, a huge mass of water is displaced, producing tsunami.



Such fault movements are accompanied by earthquakes, which are sometimes referred to as “tsunamigenic earthquakes”. Most tsunamigenic earthquakes take place at the great ocean trenches, where the tectonic plates that make up the earth’s surface collide and are forced under each other. When the plates move gradually or in small thrust, only small earthquakes are produced; however, periodically in certain areas, the plates catch. The overall motion of the plates does not stop; only the motion beneath the trench becomes hung up. Such areas where the plates are hung up are known as “seismic gaps” for their lack of earthquakes. The forces in these gaps continue to build until finally they overcome the strength of the rocks holding back the plate motion. The built-up tension (or comprehension) is released in one large earthquake, instead of many smaller quakes, and these often generate large deadly tsunamis. If the sea floor movement is horizontal, a tsunami is not generated. Earthquakes of magnitude larger than M 6.5 are critical for tsunami generation.

Tsunamis produced by landslides: Probably the second most common cause of tsunami is landslide. A tsunami may be generated by a landslide starting out above the sea level and then plunging into the sea, or by a landslide entirely occurring underwater. Landslides occur when slopes or deposits of sediment

become too steep and the material falls under the pull of gravity. Once unstable conditions are present, slope failure can be caused by storms, earthquakes, rain, or merely continued deposit of material on the slope. Certain environments are particularly susceptible to the production of landslide-generated earthquakes. River deltas and steep underwater slopes above sub-marine canyons, for instance, are likely sites for landslide-generated earthquakes.

Tsunami produced by Volcanoes: The violent geologic activity associated with volcanic eruptions can also generate devastating tsunamis. Although volcanic tsunamis are much less frequent, they are often highly destructive. These may be due to submarine explosions, pyroclastic flows and collapse of volcanic caldera.

(1) Submarine volcanic explosions occur when cool seawater encounters hot volcanic magma. It often reacts violently, producing steam explosions. Underwater eruptions at depths of less than 1500 feet are capable of disturbing the water all the way to the surface and producing tsunamis.

(2) Pyroclastic flows are incandescent, ground-hugging clouds, driven by gravity and fluidized by hot gases. These flows can move rapidly off an island and into the ocean, their impact displacing sea water and producing a tsunami.

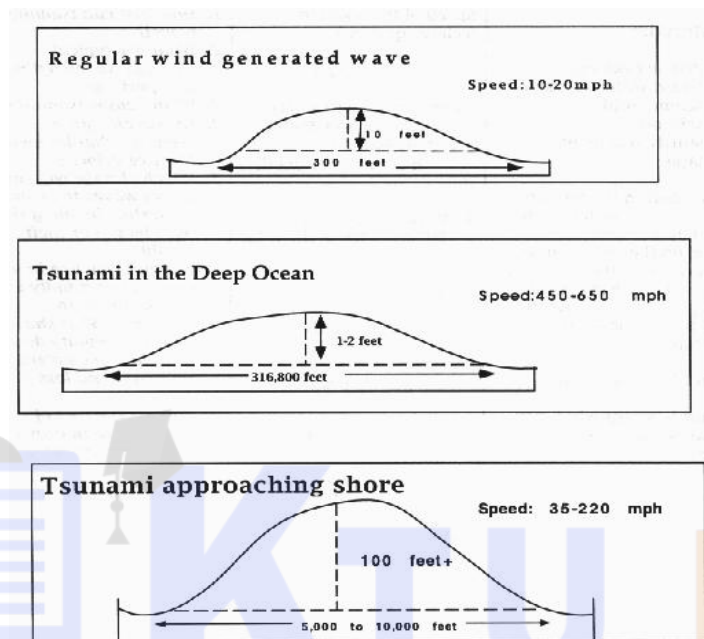
(3) The collapse of a volcanic caldera can generate tsunami. This may happen when the magma beneath a volcano is withdrawn back deeper into the earth, and the sudden subsidence of the volcanic edifice displaces water and produces tsunami waves. The large masses of rock that accumulate on the sides of the volcanoes may suddenly slide down slope into the sea, causing tsunamis. Such landslides may be triggered by earthquakes or simple gravitational collapse. A catastrophic volcanic eruption and its ensuing tsunami waves may actually be behind the legend of the lost island civilization of Atlantis. The largest volcanic tsunami in historical times and the most famous historically documented volcanic eruption took place in the East Indies-the eruption of Krakatau in 1883.

Tsunami waves

A tsunami has a much smaller amplitude (wave height) offshore, and a very long wavelength (often hundreds of kilometres long), which is why they generally pass unnoticed at sea, forming only a passing "hump" in the ocean. Tsunamis have been historically referred to tidal waves because as they approach land, they take on the characteristics of a violent onrushing tide rather than the sort of cresting waves that are formed by wind action upon the ocean (with which people are more familiar).

Since they are not actually related to tides the term is considered misleading and its usage is discouraged by oceanographers. These waves are different from other wind-generated ocean waves, which rarely extend below a depth of 500 feet even in large storms. Tsunami waves, on the contrary, involvement of water all the way to the sea floor, and as a result their speed is controlled by the depth of

the sea. Tsunami waves may travel as fast as 500 miles per hour or more in deep waters of an ocean basin. Yet these fast waves may be only a foot or two high in deep water. These waves have greater wavelengths having long 100 miles between crests. With a height of 2 to 3 feet spread over 100 miles, the slope of even the most powerful tsunamis would be impossible to see from a ship or airplane. A tsunami may consist of 10 or more waves forming a 'tsunami wave train'. The individual waves follow one behind the other anywhere from 5 to 90 minutes apart.



As the waves near shore, they travel progressively more slowly, but the energy lost from decreasing velocity is transformed into increased wavelength. A tsunami wave that was 2 feet high at sea may become a 30-foot giant at the shoreline. Tsunami velocity is dependent on the depth of water through which it travels (velocity equals the square root of water depth h times the gravitational acceleration g , that is $(V=\sqrt{gh})$).

The tsunami will travel approximately at a velocity of 700 kmph in 4000 m depth of sea water. In 10 m, of water depth the velocity drops to about 35 kmph. Even on shore tsunami speed is 35 to 40 km/h, hence much faster than a person can run. It is commonly believed that the water recedes before the first wave of a tsunami crashes ashore. In fact, the first sign of a tsunami is just as likely to be a rise in the water level. Whether the water rises or falls depends on what part of the tsunami wave train first reaches the coast. A wave crest will cause a rise in the water level and a wave trough causes a water recession.

Seiche:

Seiche (pronounced as 'saysh') is another wave phenomenon that may be produced when a tsunami strikes. The water in any basin will tend to back and forth in a certain period of time determined by the physical size and shape of the basin. This sloshing is known as the seiche. The greater the length of the body, the longer the period of oscillation. The depth of the body also controls the period of oscillations, with greater water depths producing shorter periods. A tsunami wave may set off seiche and if the following tsunami wave arrives with the next natural oscillation of the seiche, water may even reach greater heights than it

would have from the tsunami waves alone. Much of the great height of tsunami waves in bays may be explained by this constructive combination of a seiche wave and a tsunami wave arriving simultaneously.

Reefs:

The presence of a well developed fringing or barrier of coral reef off a shoreline also appears to have a strong effect on tsunami waves. A reef may serve to absorb a significant amount of the wave energy, reducing the height and intensity of the wave impact on the shoreline itself.

Bore

The popular image of a tsunami wave approaching shore is that of a nearly vertical wall of water, similar to the front of a breaking wave in the surf. Actually, most tsunamis probably don't form such wave fronts; the water surface instead is very close to the horizontal, and the surface itself moves up and down. However, under certain circumstances an arriving tsunami wave can develop an abrupt steep front that will move inland at high speeds. This phenomenon is known as a bore. In general, the way a bore is created is related to the velocity of the shallow water waves. As waves move into progressively shallower water, the wave in front will be traveling more slowly than the wave behind it. This phenomenon causes the waves to begin "catching up" with each other, decreasing their distance apart i.e. shrinking the wavelength. If the wavelength decreases, but the height does not, then waves must become steeper. Furthermore, because the crest of each wave is in deeper water than the adjacent trough, the crest begins to overtake the trough in front and the wave gets steeper yet. Ultimately the crest may begin to break into the trough and a bore formed. A tsunami can cause a bore to move up a river that does not normally have one. Bores are particularly common late in the tsunami sequence, when return flow from one wave slows the next incoming wave. Though some tsunami waves do, in deed, form bores, and the impact of a moving wall of water is certainly impressive, more often the waves arrive like a very rapidly rising tide that just keeps coming and coming. The normal wind waves and swells may actually ride on top of the tsunami, causing yet more turbulence and bringing the water level to even greater heights.

WARNINGS AND PREVENTION

A tsunami cannot be prevented or precisely predicted, but there are some warning signs of an impending tsunami, and there are many systems being developed and in use to reduce the damage from tsunami. However, since earthquakes are often a cause of tsunami, an earthquake felt near a body of water may be considered an indication that a tsunami will shortly follow. In instances where the leading edge of the tsunami wave is its trough, the sea will recede from the coast half of the wave's period before the wave's arrival. If the

slope is shallow, this recession can exceed many hundreds of meters. People unaware of the danger may remain at the shore due to curiosity, or for collecting fish from the exposed seabed. This can serve as an advance warning of the approaching crest of the tsunami, although the warning arrives only a very short time before the crest, which typically arrives seconds to minutes later. In the 2004 tsunami that occurred in the Indian Ocean the sea receding was not reported on the African coast or any other western coasts it hit, when the tsunami approached from the east.

Regions with a high risk of tsunami may use tsunami warning systems to detect tsunami and warn the general population before the wave reaches land. In some communities on the west coast of the United States, which is prone to Pacific Ocean tsunami, warning signs advise people where to run in the event of an incoming tsunami. Computer models can roughly predict tsunami arrival and impact based on information about the event that triggered it and the shape of the seafloor (bathymetry) and coastal land (topography).

One of the early warnings comes from nearby animals. Many animals sense danger and flee to higher ground before the water arrives. The Lisbon quake is the first documented case of such a phenomenon in Europe. The phenomenon was also noted in Sri Lanka in the 2004 Indian Ocean earthquake. Some scientists speculate that animals may have ability to sense subsonic Rayleigh waves from an earthquake minutes or hours before a tsunami strikes shore. More likely, though, is that the certain large animals (e.g., elephants) heard the sounds of the tsunami as it approached the coast. The elephants' reactions were to go in the direction opposite of the noise, and thus go inland. Humans, on the other hand, head down to the shore to investigate.

While it is not possible to prevent a tsunami, in some particularly tsunami-prone countries some measures have been taken to reduce the damage caused on shore. Japan has implemented an extensive programme of building tsunami walls of up to 4.5 m (13.5 ft) high in front of populated coastal areas. Other localities have built floodgates and channels to redirect the water from incoming tsunami. However, their effectiveness has been questioned, as tsunamis are often higher than the barriers. For instance, the tsunami which struck the island of Hokkaidō on July 12, 1993 created waves as much as 30 m (100 ft) tall - as high as a 10-story building. The port town of Aomae was completely surrounded by a tsunami wall, but the waves washed right over the wall and destroyed all the wood-framed structures in the area. The wall may have succeeded in slowing down and moderating the height of the tsunami, but it did not prevent major destruction and loss of life.

Tsunami Fact sheet

1. Tsunamis striking coastal locations are mostly caused by earthquakes.

These earthquakes might occur far away or near where you live.

2. Tsunamis can occur at any time, day or night.
3. Some tsunamis can be very large with their height as great as 30 feet or more (100 feet in extreme cases), and they can move inland several hundred feet.
4. All low-lying coastal areas can be struck by tsunamis.
5. A tsunami consists of a series of waves. Often the first wave may not be the largest. The danger from a tsunami can last for several hours after the arrival of the first wave.
6. Tsunamis can travel up rivers and streams that lead to the ocean.
7. Tsunamis can move faster than a person can run.
8. Sometimes a tsunami causes the water near the shore to recede, exposing the ocean floor.
9. The force of some tsunamis is enormous. Large rocks weighing several tons along with boats and other debris can be moved inland hundreds of feet by tsunami wave activity. Homes and other buildings are destroyed. All this material and water move with great force and can kill or injure people.

Prepare in advance for a possible tsunami.

1. Be aware of tsunami facts. This knowledge could save your life! Share this knowledge with your relatives and friends. It could save their lives!
2. Discuss the dangers of a tsunami with your family members and why you need to prepare for a disaster.
3. Develop an emergency plan. Practice and maintain your plan on a regular basis.
4. Be prepared to be on your own, without outside assistance, for at least three days. Prepare a three-day emergency supply kit.
5. Choose an emergency family meeting place. This should be an accessible, open area that family members can reach by walking.
6. Contact local authorities for the approved evacuation route for your area.
7. Assemble and make copies of important documents such as wills, insurance papers, medical records, etc. Keep original documents in a fireproof / waterproof container.
8. Arrange an out-of-area contact person and keep this and other emergency phone numbers near the phone.
9. Replace food and water in your emergency supply kit every six months.
10. Pack food, water, and toys for your pets. They are family too!
11. Stay in contact with the state, district and local administration for tsunami preparedness and mitigation measures being undertaken.

Before and During Tsunami

1. If a large undersea earthquake occurs near the coast, a local tsunami may follow. The first waves may reach shore in as little as 15 minutes. This may not be enough time for an official warning to be issued.
2. If you are near the shore and see the water level rise or drop significantly, this is another sign a tsunami may be on the way. Move immediately to high ground.
3. Turn on your radio to learn if there is a tsunami warning if an earthquake occurs and you are in a coastal area.
4. Move inland to higher ground immediately and stay there.
5. Stay away from the beach. Never go down to the beach to watch a tsunami come in. If you can see the wave you are too close to escape it.
6. CAUTION - If there is noticeable recession in water away from the shoreline this is nature's tsunami warning and it should be heeded. You should move away immediately.
7. If you are in school and you hear there is a tsunami warning, you should follow the advice of teachers and other school personnel.
8. If you are at home and hear a tsunami warning, you should make sure you entire family is aware of the warning. Your family should evacuate your house if you live in a tsunami evacuation zone.
9. If you are at the beach or near the ocean and you feel the earth shake, move immediately to higher ground, Do not wait for a tsunami warning to be announced
10. Tsunamis generated in distant locations will generally give people enough time to move to higher ground.
11. Homes and small buildings located in low-lying coastal areas are not designed to withstand tsunami impacts. Do not stay in these structures should there be a tsunami warning.
12. Offshore reefs and shallow areas may help break the force of tsunami waves, but large and dangerous wave can still be a threat to coastal residents in these areas.

After a Tsunami

Stay away from flooded and damaged areas until officials say it is safe to return.

Stay away from debris in the water; it may pose a safety hazard to boats and people.

Save yourself - not your possessions

CYCLONES

A cyclone is a huge strong wind system which blows around the centre of intense low pressure area. Cyclones are the local name of the Indian Ocean and the South Pacific Ocean, but in the Northwest Pacific Ocean they are known as typhoons, and in the Northeast Pacific Ocean and North Atlantic, they are known as hurricanes. Since the cyclones form in the tropical region, they are also known as tropical storms, tropical revolving storms or tropical cyclones. In the northern hemisphere, cyclone winds blow anticlockwise and they reverse in the southern hemisphere.

How do cyclones occur?

Cyclones develop over warm seas near the equator. Air heated by the sun rises very swiftly, which creates areas of very low pressure. As the warm air rises, it becomes loaded with moisture which condenses into massive thunder clouds. Surrounding air rushes in to fill the void that is left. But because of the constant turning of the earth on its axis, the air is bent inwards and then spiral upwards. The swirling winds rotate faster and faster, forming a huge circle which can be up to 500-1000 km across. At the centre of the storm is a calm, cloudless area called the eye - where there is no rain, and the winds are fairly light

Categories of Cyclones

Cyclones are categorized according to wind speeds and the damage they cause. Category 1 Cyclone: Wind speeds between 90 and 125 kilometres per hour, some noticeable damage to houses and trees.

Category 2: Wind speeds between 125 and 164 kilometres per hour, damage to houses and significant damage to crops and trees.

Category 3: Wind speeds between 165-224 kilometres per hour, structural damage to houses, extensive damage to crops and uprooted trees, upturned vehicles and destruction of buildings.

Category 4: Wind speeds between 225 and 279 kilometres per hour, power failure and much damage to cities and villages.

Category 5: Wind speeds over 280 kilometres per hour, widespread damage.

Hazards associated with cyclones

There are three hazards associated with a cyclone, which cause destruction.

- **Storm surge:** A storm surge is an abnormal rise of sea level near the coast caused by a severe tropical cyclone; as a result, sea water inundates low lying areas of coastal regions drowning human beings and livestock, eroding agricultural land, beaches and embankments, destroying vegetation and reducing soil fertility.
- **Strong wind:** The most destructive force of a cyclone comes from fierce

winds. These winds are strong enough to easily topple fences, sheds, trees, power poles and communication systems, while hurling helpless people through the air. Many people are killed when the cyclone winds cause buildings and houses to collapse and completely blow away resulting in loss of life and property.

- **Flood:** Heavy and prolonged rains due to cyclones may cause floods and submergence of low lying areas causing loss of life and property. Floods and coastal inundation due to storm surges pollute drinking water sources causing outbreak of epidemics. Long after a cyclone has passed, road and rail transport can still be blocked by floodwaters. Water often becomes contaminated from dead animals or rotten food, and people are threatened with diseases like diarrhoea and other infections.

When a cyclone approaches

- Listen to radio and watch TV for storm advices and warning. A cyclone may change direction, speed or intensity within a few hours, so stay tuned to the radio for updated information.
- Secure all doors and windows and draw curtains.
- Store or secure loose boards, corrugated iron, rubbish tins or anything else that could become dangerous flying objects.
- Tape up large windows to prevent them from shattering.
- Put valuables, medicines and spare warm clothing in plastic bags with the emergency kit and keep handy.

Evacuation before the cyclone

- In area subject to river flooding, or close to the beach at a low level, move to a safe shelter above flood level before the cyclone arrives. Don't wait until the last minute in the hope of saving all your possessions. You could disappear with them.
- Wear strong clothing and shoes to protect against glass cuts.
- When evacuating, make sure everyone knows where you are going.
- If time is limited, take the emergency kit only. If there is time to gather supplies, follow priorities. Suggested priorities are:
 - Emergency kit
 - Extra food and water
 - Important documents and paper
 - Blankets and clothes
 - Plastic sheeting
 - Other valuables
- Switch off electricity and gas and lock the house before you leave.
- While evacuating, be careful of –
 - Washed out bridges
 - Broken power lines

- Floating debris in streams
- Falling trees and branches
- Flowing building debris, particularly glass and corrugated iron
- Flying objects in the strong winds

When the cyclone hits

- Stay indoors and take shelter in the strongest part of your house.
- Stay well away from glass windows and doors, particularly glass louver windows
- Listen to the radio and follow instructions from local authorities.
- If a window or a door opens due to storm wind, open a window make a hole on the opposite.
- Beware of the calm 'eye' of the storm. This can last for an hour or so. If the wind drops suddenly, stay inside unless you have to make emergency repairs. Strong wind will blow suddenly from opposite direction.
- If it needs to go outside, take shelters again as soon as you hear the sound of wind rising. It will probably rise very quickly, be very strong and come from a new direction.
- If the house starts to break up, protect everyone with mattresses or blankets; hold on to strong fixtures or shelter under beds or strong tables.

After the cyclone passes

- Don't go outside until officially advised it is safe to do so. Check for gas leakages and don't use electrical appliances if wet.
- Continue to listen to your local radio for official warnings and advice.
- If you did evacuate your home, don't return until advised it is safe to do so.
- On return, use a recommended route and don't rush.
- Beware of fallen power lines, damaged bridges, buildings and trees, and don't enter floodwaters.
- If the house has become uninhabitable due to cyclone damage, contact your Community-based Organization on Disaster Risk Reduction or to local authority to identify for further assistance

Cyclone Warning System in India

The Indian Meteorological Department is responsible for forecasting the occurrence of cyclones, for estimating and categorizing them, and for issuing warnings when necessary. Cyclones in the Bay of Bengal and in the Arabian Sea are predicted by the Area Cyclone Warning Centres (ACWC) and the Cyclone

Warning Centres (CWC) departments of the IMD respectively. The National Cyclone Warning Centre (NCWC) in New Delhi acts as a coordinator between the two. In 2014, the IMD launched an SMS based cyclone warning system that shall enable the masses to stay alert and prepared in the event of an approaching cyclone. From time to time the Indian Army and the Indian Air Force have also been roped in to rescue Indians from the devastation caused by tropical cyclones. Apart from this the National Disaster Response Force (NDRF) is responsible for relief operations.

