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What is a Tidal Wave?

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WHAT IS A TIDAL WAVE?

# WHAT IS A TIDAL WAVE?

1. What is a tidal wave?

A tidal wave is a rapid rise in the level of the sea which is caused by a cyclone. A tidal wave is not actually a wave; it is a large mass of water which rises above the normal level of the sea and is pushed along by the cyclone, moving in the same direction as the cyclone system. This movement creates a front or leading edge which may be many miles (kms.) across and as high as 65 feet (20 m.) The high water behind the leading edge may extend backward from the front for many miles (kms.) Tidal waves are more properly called storm surges.

2. What causes a tidal wave?

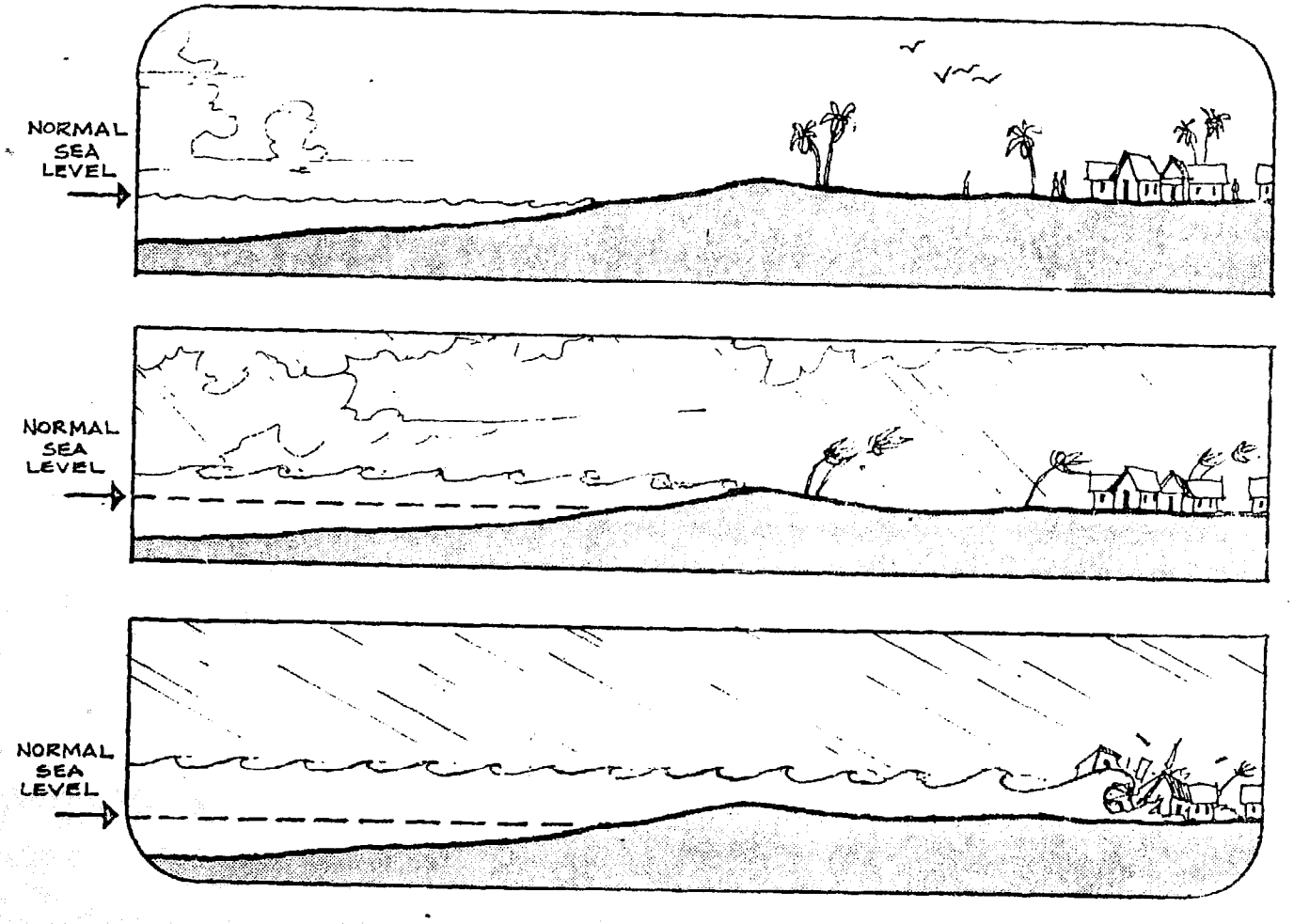
A tidal wave is created by a number of factors associated with a cyclone. First, the air pressure in the center of a cyclone is very low. This release of pressure on the surface of the sea allows the sea to expand and rise upward in a hump. Second, as the fast winds of a cyclone move over the water, they pile the water up as the cyclone moves toward the coast. Large waves are pushed against the shore but cannot retreat from the coastline rapidly because the winds slow their return into the sea. This problem is made more severe if the sea bed is shallow. By the time the center (or eye) of the cyclone arrives, the large mass of water raised above the normal level of the sea by the low pressure at the eye rides over the water which has been piled up by cyclonic winds and moves inland across the shore in one rapid surge.

3. Do all cyclones have tidal waves?

Every cyclone has a tidal wave. Many are small, but a few are very large. Many different factors determine how big a tidal wave is, how far it moves inland, and how much damage it does.

4. What does a tidal wave look like?

The drawing below shows what a typical tidal wave looks like in cross-section. While the leading edge of a tidal wave appears to someone standing in its path as a wave, it must be remembered that it is in fact a rapid rise in sea level, and everything in its path will be submerged for a long period of time after the leading edge has passed.



5. In what direction do tidal waves move?

A tidal wave moves in the same direction that the cyclone is moving, not in the direction of the wind. A tidal wave is normally pushed along in front of a cyclone.

6. How fast does a tidal wave move?

A tidal wave moves at the same speed as the cyclone itself. If the cyclone is moving forward at a speed of 12 miles per hour (20 kph), the tidal wave moves at a speed of 12 mph (20 kph). If the cyclone is moving at 60 mph (100 kph), the tidal wave moves at 60 mph (100 kph). The tidal wave which struck Andhra Pradesh was moving at approximately 20 mph (32 kph) and this is the estimated speed of the tidal wave.

7. How high is a tidal wave?

There are four factors which determine the height of a tidal wave:

A. The air pressure at the center of the storm;

B. The speed of the cyclone;

C. The speed of the winds in the cyclone;

D. The height of a normal tide.

Of these factors, the last one is one of the most important to consider. For example, the low pressure at the center of the storm may raise the level of the sea 20 feet (6 m). The winds which pile up the water usually add another five feet (1.5 m). The speed of the cyclone usually adds another 5-10 feet (1.5 - 3 m). If the tidal wave arrives at the coastline at the low tide period, then the height of the wave will be reduced by an amount equal to the difference between normal sea level and the low tide. In other words, if low tide is ten feet (3 m) below sea level, then the height of the tidal wave will be reduced by ten feet (3 m).

However, if a tidal wave arrives at high tide, then the height of the tidal wave will be increased by the height of the tide above normal sea level. Thus, if the normal high tide is ten feet (3 m) above sea level, that ten feet (3 m) will be added to the height of the tidal wave. The tidal wave which struck Andhra Pradesh arrived almost at the time of the highest tides.

8. What is the highest tidal wave that could occur in Andhra Pradesh?

Theoretically, the highest tidal wave which could occur in Andhra Pradesh would be approximately 45-50 feet (13-16 m). Add to this the height of the accumulated wind and wave action, and assume that the surge arrives during the high tide period. A tidal surge of over 65 feet (20 m) could cross the shoreline. Tidal waves of this height have been recorded in other areas of the Bay of Bengal. The tidal wave which struck Bangladesh in November 1970 was estimated to have been 65 feet (20 m) high when it crossed the shoreline.

9. How far inland does a tidal wave move?

A tidal wave will move inland until it reaches a point where the ground is as high above sea level as the top of the tidal surge. In other words, if a tidal wave is 20 feet (6 m) high, it will continue to move inland until it reaches a point where the land is 20 feet (6 m) above sea level. Before the tidal wave reaches this point, however, the leading edge will have crashed and the deadly impact of the leading edge will be lessened from that point of crash. The wave crashes when it reaches an area where the water depth becomes too shallow for the wave-like motion of the leading edge to continue. When the wave crashes, the water which continues inland will be extremely violent, moving up and down at the surface creating smaller, rapid-moving waves which criss-cross each other, and carrying much underwater turbulence with it. The momentum of the water may carry the surge slightly beyond the contour level of the land which is equal to the original height of the wave. Thus a number of areas beyond that point can be inundated with water, but the water moving in these areas will not have the force or energy of the original tidal surge.

10. How long will a tidal wave remain in the area?

Once a tidal wave has stopped moving forward, the water will begin to retreat to the sea. However, on the surface of the water, new waves may be created by the action of the high winds associated with a cyclone. All the water will not leave until the eye of the cyclone has passed and the winds begin to subside as the cyclone moves inland. The actual tidal wave itself may inundate an area for as long as 45 minutes. It should be remembered that the torrential rains which accompany a cyclone themselves contribute to the severe flooding problems which occur after the actual tidal wave has receded into the sea.

11. What is the farthest distance that a tidal wave has been known to move inland?

Tidal waves have been known to go as far inland as 65 miles (105 kms).

12. What is the effect of tidal waves on houses?

A tidal wave can damage or destroy a house in many different ways. First, the speed of the tidal wave places great stress and force on the walls, just by the great momentum of the water. Second, the currents and turbulence associated with a tidal wave destroy a structure by eroding the foundation. Third, the debris carried by a tidal wave (such as uprooted trees, fences, parts of broken houses) will act as battering rams which cause further damage and destruction to the structures. Fourth, other damage may be caused by the sand and gravel carried by the fast-moving currents at the bottom of a tidal wave, having the effect of "sand papering" the foundations of buildings. Fifth, damage can be caused by water lifting parts of a structure up to float on top of the wave. This is know as the "flotation effect" and it can happen

even to buildings made of brick and cement. It is caused by the rapid rise of the water outside a building, which creates such pressure differences that the building attempts to float. Once the walls have left the foundation and water enters the structure, the building will collapse.

13. How can a person protect himself from a tidal wave?

There is no means of erecting a safe shelter to protect a person from a tidal wave. The only way to protect your life is to evacuate the area as soon as the threat of a tidal wave is known. Every cyclone has a tidal wave; and as pointed out in question #7, the height of a tidal wave depends on many factors. However, there are certain areas that will always be hit by tidal waves. These are areas along the river deltas and regions which have particularly large, low-lying areas along the coast with adjacent sea beds which are very shallow. If you live near one of these areas, the only real protection you have is to leave the area and move to high ground. There are no shelters which can be built to be absolutely safe in a tidal wave. Even if a shelter could withstand the force of the turbulent water, it could still be damaged or destroyed by debris propelled by the tidal surge. Even if the building survived, the people inside might well be drowned.

14. How can the risk of damage or destruction to property be decreased?

The only type of structure which has any chance of surviving a tidal wave is one built on stilts. Even so, these structures must have a floor which is above the height of a tidal wave; they must have a minimum of area exposed to the tidal wave and water forces; and they must be braced and anchored properly. This type of structure, however, is very impractical for the area of Andhra Pradesh and is very expensive to build. Furthermore, the survivability of this type of structure is dependent on its being above the height of the tidal surge; as the wave may be as high as 65 feet (20 m), the chance that these structures will survive is still only minimal.

For houses that are located on the coast, there is no way of making sure that they will survive a tidal wave. However, for those located several miles (kms) inland, there are a number of steps that can be taken to reduce the risk of damage:

A. Clear away any possible sources of debris which could be lifted by a tidal wave and thrown into the side of a house. When a tidal wave is expected, move all loose objects (such as tools, loose wood, bamboo, carts, etc.) into the building or put them behind the building so that they will not be lifted up and thrown into the side.

B. When constructing a house, raise the floor level as high as possible. Earth can be taken from nearby paddies and drainage canals to use in raising the plinth area of a structure. The higher a building can be built, the better.

C. Add as much bracing as possible in the walls for support, especially at the corners.

D. Follow all the rules for building better, wind resistant structures, paying special attention to the foundation, and making sure that all the poles put in the ground are deep and properly treated.

E. Plant suitable shrubs and trees to protect the house by serving as a barrier against debris propelled by the tidal wave.

F. Most importantly, be sure to evacuate the area as soon as there is any chance of a tidal wave occurring. Remember, it will be too late when you see the water coming, as the combined wind and wave forces will knock you over before you can get to high ground and shelter.

15. Are trees and forests good protection from tidal waves?

Trees and forests are good protection from tidal waves as long as the trees which are planted have deep root systems. However, the trees which are normally planted along the coast and which can grow in these areas do not usually have deep root systems and are therefore likely to be ripped loose by the tidal wave and thrown into buildings further inland. Trees and shrubs are good protection only if they are planted several miles inland from the coast.

16. Are seawalls and bunds good protection against tidal waves?

A seawall serves two purposes. The first is to protect the area behind the seawall from flooding. One seawall along the edge of the coast will serve as protection only against very small tidal surges (those which are 3-5 feet/1-1 1/2 m. in height) or larger tidal waves which occur during a low tide. They will not provide much protection against larger tidal waves which occur during a high tide.

The second purpose of a seawall is to break up the force and energy of a tidal wave. The effectiveness of a seawall for this purpose again depends on the height of the wave and on the volume of water which is being propelled in the total surge. Often a seawall can force the leading waves of a surge to crash as they cross the seawall; thus much of the turbulence associated with the tidal wave can be partially reduced. Overall, however, one seawall will offer only minimal protection.

A series of seawalls or bunds which are constructed in parallel lines several miles apart can be effective in reducing the total amount of area which is inundated. If designed properly, they can serve to slow down and eventually stop a tidal wave, thus reducing the distance to which a tidal wave moves inland. A good, elevated road system can be designed in such a way that it serves as a protection from tidal waves. It should be remembered, however, that all seawalls and bunds will be substantially damaged. And in

areas where they are built right on the coast, they may be washed away entirely. This does not mean that they are not effective, because most of the damage to a seawall occurs not with the initial impact of the wave but rather from the debris which is carried along on the bottom and scrapes away at the wall after the leading edge of the tidal wave has passed. Damage is also caused by the tremendous amount of debris which is carried along when the tidal wave rushes back to the sea after the cyclone has passed.

17. Why did the tidal wave in Andhra Pradesh appear to be on fire?

There are two possible explanations for this phenomenon. The first is that there is a tremendous amount of phosphorus carried out to sea by the Krishna River. These small particles of phosphorus lie not only in the mud along the river banks but are also carried out and deposited along the sea bed. When the tidal wave rushed inland, a large amount of the surface of the sea bed was picked up in the turbulence and carried in the front part or leading edge of the wave. This phosphorus may have been illuminated by static electricity generated by the wave as it moved inland. This would give the leading edge of the wave the appearance of being on fire.

The second explanation is that, as a tidal wave moves, it pushes a large amount of air in front of it. This air is very moist, due to the rain and the water spray immediately in front of the wave. When this meets with the low pressure air, a charge of static electricity can be generated and often causes a phenomenon known as "St. Elmo's Fire". This is simply a glow caused by the static electricity as it is blown against the wave and the spray created by the wave.

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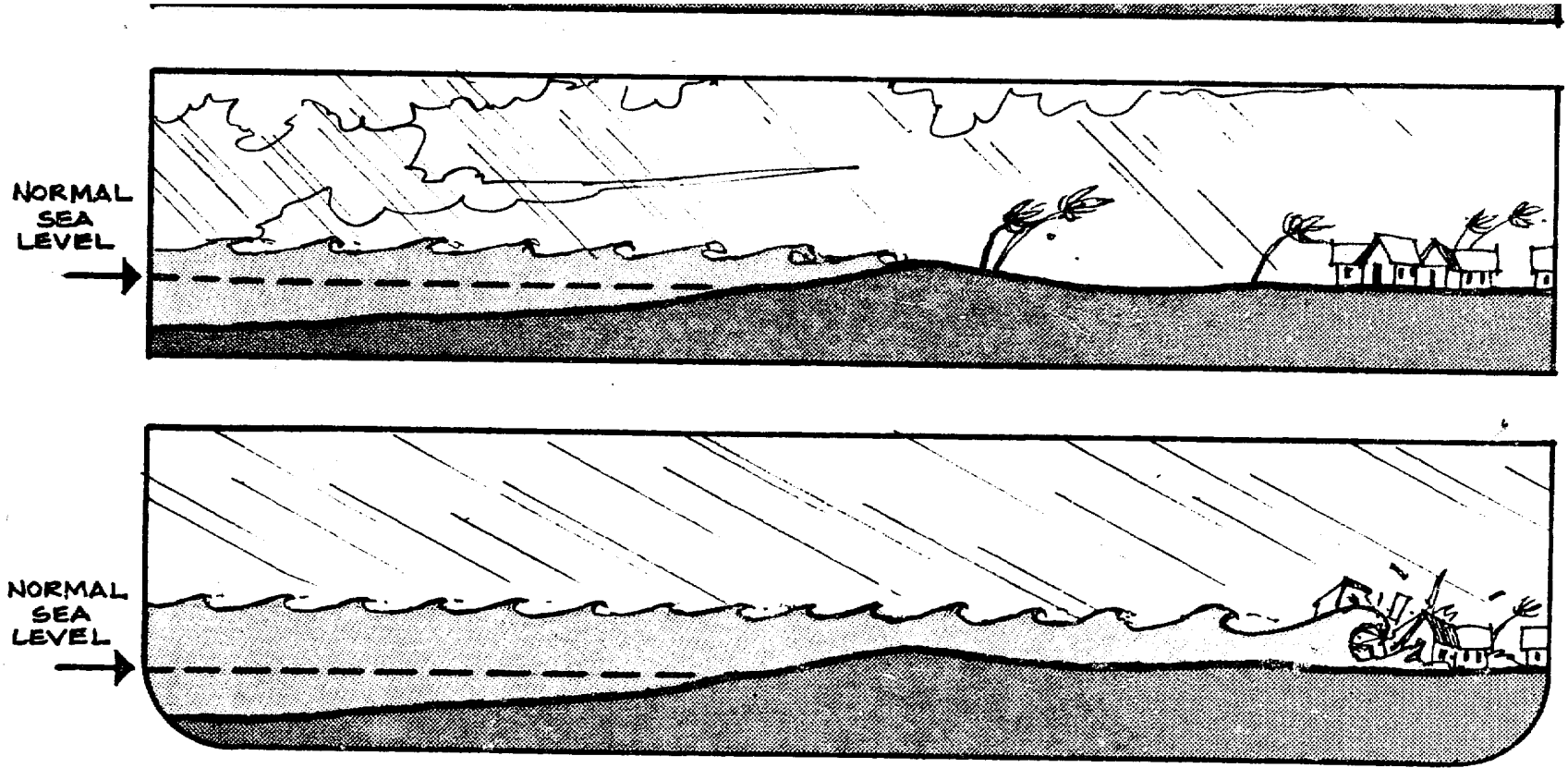
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