Tidal Patterns – Tutorial Script

The most regular feature of any coastline anywhere in the world is the daily rise and fall of the tides. What causes these tides? Why do they happen at such regular time intervals? And why do their heights differ from one day to the next and one location on the planet to the next?

Let's start our discussion of tides by reviewing tidal data for a day in San Francisco. In this graph, the x-axis shows time, in this case one day's worth of time; and the y-axis shows height above a zero level. So this image shows how tidal wave height varies over a 24 hour period at a specific beach in San Francisco.

Note that the y-axis uses a zero level that is not the equilibrium level of this wave. What is that zero level, otherwise known as **tidal datum**? As you can see, the tidal waves that occur in one day in San Francisco show two high points (crests or high water or high tide) and two low points (troughs or low water or low tide). As the troughs are different in their level, we refer to one as Higher Low Water and the other as Lower Low Water. The zero line on the Y-axis is Mean Lower Low Water or MLLW, which means the average height of the lower low waters that happened daily over the past year. Why use this for our zero, instead of mean sea level? So that most of our tidal heights are measured as positive numbers, and we get negative heights only when the lower low waters are lower than average. And these are considered special tides during which much of the coastline is exposed, and it's a good time to explore tide pools, dig for clams, or clean the bottom of your boat.

Let's continue to apply wave terminology from the waves tutorial to the particulars of a tidal wave. Remember that the **period** of a wave is the time it takes for one complete wavelength to move past a point. And wavelength is the distance from crest to crest or trough to trough. So the period of one tidal wave is about 12 hours and 25 minutes. Two complete waves (crest, to crest, and back to crest again) occur every 24 hours and 50 minutes. What that means is that if you experience high tide on a beach at 3 pm this afternoon; the next high tide would be at 3:25 am tomorrow morning; then another at 3:50 pm tomorrow afternoon; and so on.

The height of a tidal wave gets its own term: **tidal range**. The tidal range is calculated by taking the vertical distance between the crest and the trough. When crest or trough height varies, calculate tidal range as the maximum vertical distance from the highest crest to the lowest trough.

If you were on the San Francisco coastline on January 20th and experiencing these tides, at 4:30 am, you would be experiencing a low tide, during which water would be neither rising, nor falling. We call this **slackwater**. After low tide, sea level would rise slowly at first, and then faster and faster. Water is flooding the land. We call this moving water a **flood current**. It slows down its advance as 11 am approaches. At 11 am, it has reached another still point or slackwater. And we are now experiencing high tide. After high tide, the water starts to retreat from the coastline, slowly at first, then faster and faster as an **ebb current**. That current slows as 5 pm approaches, when we get yet another slackwater and low tide. After 5 pm, we get another flood current until at about midnight, when high tide arrives again, and so on, repeating two waves every 24 hours and 50 minutes.

We call this type of tidal pattern, in which the land experiences two high tides, two low tides, two flood currents, and two ebb currents in one 24 hr and 50 minute period, a semidiurnal pattern. Because the water level of the high tides are different, as are the water level of two lows, we append the word "mixed" to the pattern. So it's **semidiurnal mixed**.

Tides have been studied and data on tidal water levels have been collected for hundreds of years. In fact, their regularity makes them one of the few environmental phenomena that can be accurately predicted for over a year in advance. Tide books are available with this information at all fishing shops, and tidal data are available freely online. If you are planning to spend time along the coast, fishing, boating, swimming, or picnicking, be sure to figure out first what the tides will be doing in your area on that day. While we can predict tidal water levels, tides do not happen at the same time or the same way everywhere. In fact, they vary quite a lot from one part of the coastline to the other. So you must consult the data for a particular beach.

Here we can see tidal patterns from four different locations across the United States. Let's see what we can learn by studying these data more closely. First, we see that there are represented here three different tidal patterns.

A diurnal tidal pattern means one high tide and one low tide every 24 hours and 50 minutes. This graph shows diurnal tides at a beach in Florida.

A semidiurnal tidal pattern as already discussed means one high tide and one low tide every 12 hours and 25 minutes or two high tides and two low tides every 24 hours and 50 minutes. Water levels of each high are roughly the same. Water levels of each low are roughly the same. Eastport, Maine has a semidiurnal tidal pattern.

A semidiurnal mixed tidal pattern means they behave exactly like semidiurnal tides in their periodicity, but the water levels of the two highs can be quite different, as can the water levels of the two lows. This semidurnal mixed pattern is from San Francisco and similar to what we've already discussed.

The other thing we see by studying tidal patterns from different locations, is that tidal range fluctuates on a 2-week period. Looking just at the tidal chart from Florida, we can see that twice during the month, the tidal range becomes much smaller. We call those **Neap Tides.** After each neap tide passes, tidal range grows again until it reaches a maximum tidal range, which we call **Spring Tides**. After Spring Tides pass, tidal range again diminishes for another week until it reaches another Neap Tide. And it continues this way – every week moving from Neap to Spring then back to Neap then back to Spring. Spring Tides happen every 2 weeks. Neap Tides happen every two weeks. Notice that during Neap tides, we get both the lowest highs and the highest lows. The opposite is true for Spring Tides, which have the highest highs AND the lowest lows. At which time would you expect to get the negative tides that indicate really low water and good tidepooling? The Spring Tides! At which time would you expect water levels to be highest and thus the safest time to move boats through normally shallow water ways? Spring Tides. At which time would you want to plan a beach picnic so you could minimize water level changes around your picnic site? Neap Tides. Finally – there are some ships that must time their entry to San Francisco Bay to make it easier for them to pass below the Golden Gate Bridge without hitting it. They are looking for the lowest water levels. When would that be? Again, Spring Tides.

Finally, when we look again at these tidal charts from various locations within just the United States, we see a lot of variety in, not only tidal pattern, but also tidal range. The smallest tidal range on this page occurs in Florida, which during its Neap Tides receives a tidal range of only about 5 inches. The highest is in Anchorage Alaska, with 36 feet of tidal range during its spring tides. In that area of Alaska, the tides rise and fall 36 feet two times a day. That's a lot of land alternately covered and uncovered on a regular basis! We'll discuss these tides in Alaska and show you some video footage in the video tutorial on Living with the Tides.

Pause now.

For more information and more detail, continue on to the next video in this series.

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Tides Series:
Part 1. Tidal Patterns
Part 2: Causes of Tides
Part 3: Living with the Tides

Tidal Patterns
Geoscience Video Tutorial
Produced by Katryn Wiese
City College of San Francisco

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