

## Paradise Lost: Chesapeake Bay and Sea Level Change

Let's examine the influence of sea level change on the region surrounding the Chesapeake Bay. How has sea level changed in the last hundred years? To address this question we will examine historical tide gauge data from the Chesapeake Bay and other global locations using an interactive Excel spreadsheet or Excelet. Go to <http://academic.pgcc.edu/~ssinex/excelets/inundator.xls>. This spreadsheet contains multiple tabs to navigate as shown below.



Click on the "tide gauge data" tab to view tide gauge data plotted as sea level height in millimeters as a function of time in years for a number of gauge location around the bay. The slope of the best-fit line yields the rate of relative sea level change in mm/yr. If you need a refresher on the slope of a line, see the "slope review" tab. Actual locations are shown on the map on the "intro" tab.

Tide Gauge Location	Period of Data Collection*	Average Sea Level Change

\*place your cursor on the first and then last data points to get years

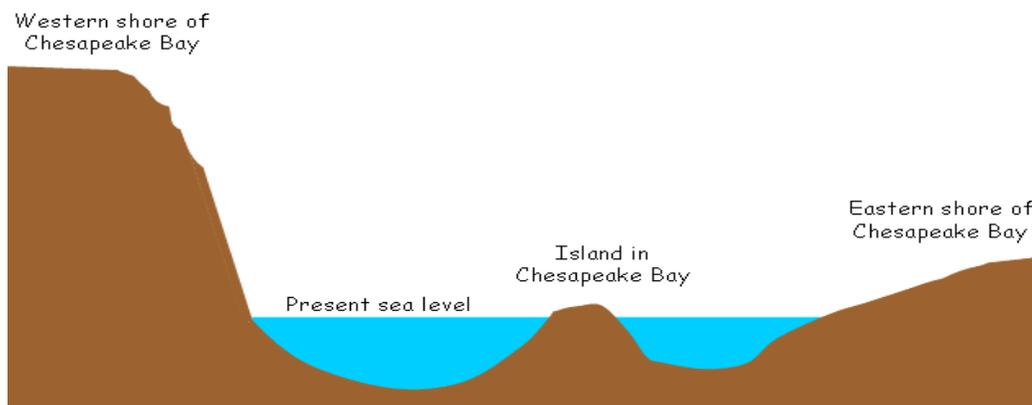
How has relative sea level changed over time in the Bay region?

The average global rate of sea level change is 1.7 mm/yr. Is the global average showing an increase or decrease in sea level worldwide? Explain.

How does this average value compare to the Chesapeake Bay data?

The average rate of change in the Chesapeake Bay region is about twice the average rise worldwide. Now let's consider the consequences of sea level rise and why the Bay area rise is larger.

Go to "the inundator" tab which will allow us to explore the rise or fall of sea level with respect to surrounding land and island. Here is a cross-section of the Chesapeake Bay in the area off Calvert County.

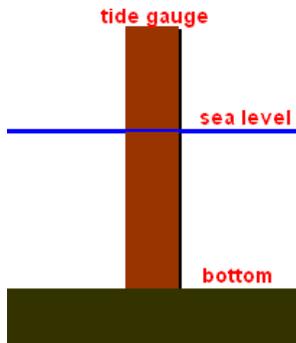


If sea level changes, how does the amount of land lost or gained change for the steeper western shore compared to the gentle slope of the eastern shore? What about the island?

As the steepness of the land decreases, how does the distance inundated respond?

Where is land loss in the Chesapeake Bay region? (See comment box for map)

Let's investigate a number of factors that could influence the measurement using a tide gauge. Mean sea level height is measured. We will consider three factors that might influence sea level.



1. The amount of seawater in the world oceans can vary due to climate changes.
2. The elevation of the coastal land can change due to tectonic processes, especially from glaciation and/or local groundwater/oil withdrawal.
3. Increase sedimentation in coastal waters.

Investigate these three factors on the "tide gauges" tab.

Factor	Factor change	How does relative sea level respond?
Sea level change		
Land elevation change		
Sedimentation		

Now let's look at four tide gauge locations from around the world. Go to the "worldwide look" tab.

Tide Gauge Location	Period of Data Collection*	Average Sea Level Change

\*place your cursor on the first and then last data points to get years

Did you get the results you expected to get? Why?

Now what are the climatic or geologic causes of the factors discussed for the tide gauges. Climatic changes in temperature can influence the volume of glacial ice (ice cover on land, such as Greenland and Antarctica) and hence, the volume of sea level; and the thermal expansion of sea water. These two factors are about equal for a temperature change. This is called eustatic sea level change.

The geologic factor involves tectonic processes, such as action at plate boundaries or glacial rebound (land rising due to removal of past glaciers especially the last ice age), and/or major removal of groundwater from aquifers or oil from rock causing land subsidence. Another cause can be compaction of relative young sediments in deltaic areas especially if modern sediment supply is decreased.

For the Chesapeake Bay region in the Atlantic Coastal Plain, groundwater withdrawal has contributed to double the relative sea level rise above the average worldwide increase. Many low-lying islands in the Bay have also disappeared.

Lewes is located at the mouth of the Delaware Bay (See map on "intro" tab). Go to the "analyze data" tab to find the data for Lewes, Delaware.

1. Plot the scatter graph of the data.
2. Determine the rate of sea level change by performing a linear regression (trendline) on the data.
3. Plot the regression line, regression equation, and  $r^2$  on the graph. What is the rate of sea level change for Lewes, Delaware?
4. How does the rate of change compare to the worldwide average and Chesapeake Bay values?

Go to the "US gauges" tab to see the changes along the US coast. Explain the cause of the changes for the following two areas:

Alaska

Louisiana