Rain falling on the Hudson tends to be acidic; fortunately, the river has a built-in antacid: carbonaceous rock.

The average rainfall in New York has a pH between 4 and 4.5, 30 times more acidic than unpolluted rainwater. The sources of this acidity, sulfur dioxide and nitrogen oxide air pollution, are products of fossil fuel combustion and are emitted by automobiles, industry, and coal burning power plants. When combined with moisture in the atmosphere, they form sulfuric and nitric acids.

Using the high frequency data set provided by HRECOS, we can sometimes see rises in the river’s acidity after a heavy rain. The daily fluctuations are due to the influence of photosynthesis, respiration, and tidal currents (see HRECOS Stories: "Plant Breath in the Hudson River" and "The Breathing Tide"). Responses to rain events will occur over the course of one to three days. For example, 43 millimeters of rain fell on Schodack Island from July 16 to July 18 this summer resulting in a change in acidity of 0.12 pH units.

Still, the decline we observe in pH is less than expected. Assuming the rainfall had a pH of at
least 4.5, a 43 millimeter rain should have reduced the pH of the estuary by at least 0.98 instead of the 0.12 change actually observed (see insert: "Conservative and Simple Estimate of the Impact of Acid Rain"). The fact that the change was not this dramatic indicates the system is well buffered. This is where the river's built-in antacid comes into play.

The buffering process works like this: the Hudson River Estuary is rich in calcium carbonate due to the erosion of carbonaceous rock such as limestone in the watershed. Calcium carbonate is the primary ingredient in antacid tablets and it works just as well for a large water body like the Hudson River as it does for our stomachs. This results in the partial neutralization of acid rain as it is added to the river.

It may be for this reason that we don't see a rise in acidity after every rain event. The natural antacid protects the system so well that we are unable to observe the impact of most rainfalls. In addition, there may be a regional difference in the buffering capacity of the river, a factor we will be considering for our next HRECOS story.

To observe changes in acidity after storm events, you may click "Current Conditions" in the menu to the left to access the data yourself or you can download the data used for this story: Data for this HRECOS Story.
Conservative and Simple Estimate of the Impact of Acid Rain

The following is a very rough calculation of the impact of acid rain. The assumptions are very simplistic, however, they are also very conservative in that they should result in an underestimation of the true pH change. The fact that the predicted change in pH is much greater than what is actually observed, implies that there is a significant amount of buffering occurring in the river.

To calculate the expected impact of a major rain event, we will make the following assumptions:

- The pH of the rainwater = 4.5
- The depth of the Hudson River is equivalent at the river’s edge as at it’s deepest point.
- The only rainwater influencing pH in the Hudson River is that which falls on it directly.
- The HRECOS sonde at Schodack Island is influenced by river water spanning 150 feet north and south (from now on referred to as Schodack River Section).

Known Variables:
pH = -log(moles H⁺/L)
pH at Schodack Island Station on July 16, before the rain event = 7.8464
pH at Schodack Island Station on July 18, after the rain event = 7.7299
Total rainfall at Schodack Island from July 16 to July 18, 2009 = 0.043m
Surface area of the Schodack River Section = 182,001 m²
Largest depth of the Schodack River Section = 11 m

Calculations:
Total moles of H⁺ in the Schodack River Section before the storm =
(10⁻⁷.8464 moles H⁺/L)(11 m)(182,001 m²)(1000 L/m³) = 28.5176 moles H⁺
Total moles of H⁺ in the rain water that fell on the Schodack River Section =
(10⁻⁴.5 moles H⁺/L)(0.043 m)(182,001 m²)(1000 L/m³) = 247.4812 moles H⁺
Predicted pH of Schodack River Section on July 19 =
-log (28.5165 moles H⁺ + 247.4812 moles H⁺)
((11 m)(182,001 m²)(1000 L/m³)) = 6.8606
Difference between pH at Schodack Island Station before rain event and predicted pH after rain event = 7.8464 - 6.8606 = 0.9858
Difference between pH at Schodack Island Station before rain event and measured pH after rain event = 7.8464 - 7.7300 = 0.1165
The Hudson River is Buffered Against Acid Rain
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