Impacts of Hurricane Irene on the Chesapeake Bay watershed

Hurricane Irene - Leaving Maryland, August 28, 2011
Image courtesy of MODIS Rapid Response Project at NASA/GSFS (2km resolution, True color)
Blue circle identifies Wallops Station, near Chincoteague, VA

Summary

The passage of Hurricane Irene off the Atlantic coast of Maryland on August 27-28, 2011 had significant impacts not only along the coastal area of the State, but also along Chesapeake Bay and its tributary streams as far west as Frederick County.

All US Geological Survey stream gages in the Maryland Bay watershed showed peak flows from the heavy rains, which were more dramatic at gage sites on the Eastern Shore. These flows carry a high level of polluted runoff toward the Bay which can fuel late season algal blooms in rivers and in the Bay and reduce water clarity which can impact the growth of aquatic grasses and fishing activities.

The strong, mostly northerly winds in the Maryland portion of the Bay created turbulent currents that all but eliminated the summer-long "dead zone" of low oxygen conditions in the deep waters of the Bay.

Maryland Department of Natural Resources will continue to monitor water quality conditions and aquatic resources in State waters, including Chesapeake Bay.

Background

On August 27-28, 2011, Hurricane Irene moved along the Mid-Atlantic coast just west of the Delmarva shoreline. While the storm track east of Chesapeake Bay kept the highest winds and storm surge off the coast, damage on the Eastern Shore and in counties west of the Bay was reported from high winds and locally heavy rains (Figure 1)

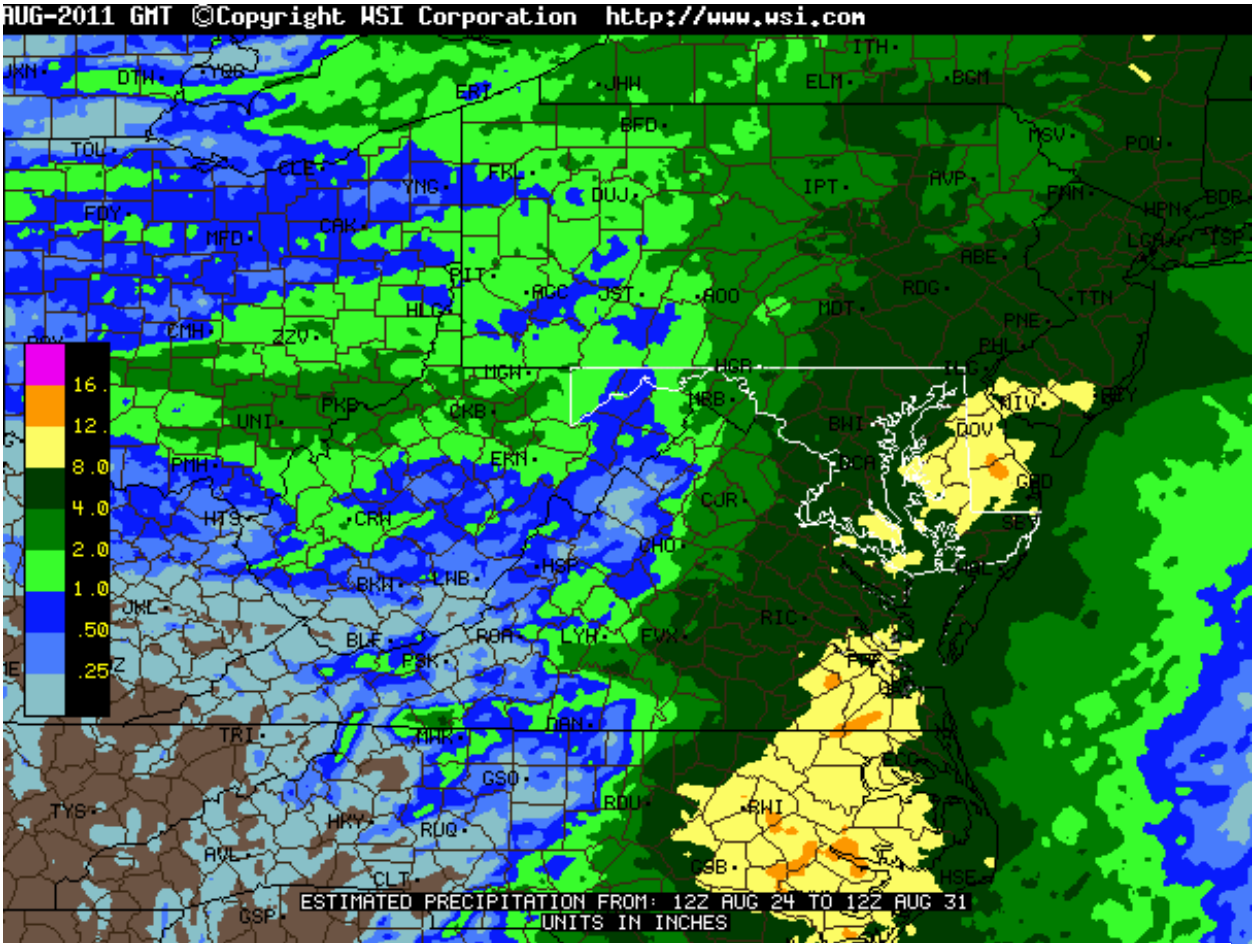

Figure 1*. One week rainfall estimate from radar from http://www.intellicast.com*

Stream impacts

Runoff from these rains eventually drained to nearby streams, dramatically increasing the volume/water level. US Geological Survey (USGS) has real-time surface water gages on many streams in the Chesapeake Bay watershed - all of which recorded stream flows as rapidly rising, then slower falling water levels (see: *http://md.water.usgs.gov/waterdata/*). Unlike the large spring floods in 2011, the Susquehanna River levels did rise, but did not reach flood levels and is in the normal/non-flood stage. In this watershed, rainfall was less of an issue than in nearby Delaware River and coastal New Jersey watersheds where flooding conditions were reported. The USGS stream gage on the Choptank River near Greensboro recorded the highest stream flows there in more than 60 years.

These storm flows carry high loads of nutrient and sediment pollutants from the land into nearby streams, to larger rivers and, eventually, to Chesapeake Bay. Additional nutrients at this time of the year can fuel the growth of late season algal blooms in rivers and in the Bay. Until these materials settle, loads of suspended sediments can reduce water clarity which can shade aquatic grasses and reduce their growth, and affect fishing success in rivers and in the Bay. The following satellite image shows areas affected by suspended sediment as light tan areas in some upper Bay tributaries (Figure 2).

***Figure 2**. Image of Upper Chesapeake Bay (post-Hurricane Irene; August 30, 2011) showing high suspended sediment plumes in some tributary rivers*
http://mddnr.chesapeakebay.net/eyesonthebay/satellite.cfm

Chesapeake Bay impacts

The US National Oceanic and Atmospheric Administration's National Data Buoy Center collects weather data from instrumented buoys and land stations and makes these data available online. Initial wind data from the weather station at Thomas Point Light (TPLM2) near the western shore of Chesapeake Bay (*http://www.ndbc.noaa.gov/station_realtime.php?station=TPLM2*) documents winds in the upper Bay as Irene was passing along the MD-DE coastline. For the 48-hour period centered on the passing storm, winds at Thomas Point Light were nearly all from the Northeast to Northwest quadrant with the strongest winds blowing from the north and down the axis of the Bay (Figure 3).

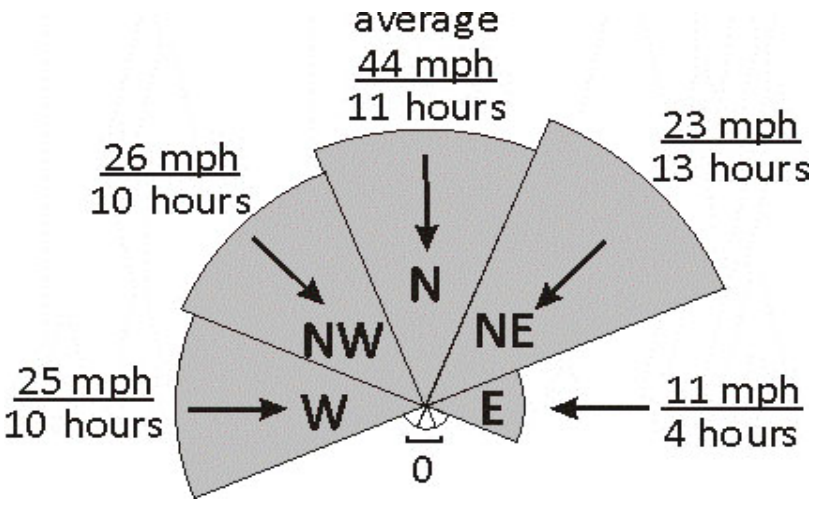

***Figure 3**. Wind rose showing wind direction (45-degree increments), duration (length of wedge and average wind velocity recorded on August 27-28, 2011 at Thomas Point Light in the Chesapeake Bay (near Annapolis). (DRAFT data for analysis from NOAA National Buoy Data Center.)*

In some Bay tributaries, these strong down-Bay winds disrupted the normal tidal cycle and, in some tributaries lowered water levels to expose shallow bottom areas (Figure 4) or raised water levels above normal levels.

Figure 4*. Eroded Severn River beach exposed by extreme low water (2-3 feet below expected level), August 28, 2011. Photo by Sherm Garrison*

Bay monitoring results

As part of the long-term Chesapeake Bay water quality monitoring effort, MD Department of Natural Resources had scheduled two 3-day surveys of the Chesapeake Bay in August. DNR biologists began their most recent survey in the upper Bay near the Susquehanna River (CB1.1) on Monday following the storm passage (August 29). This survey was completed on August 31 with a sample taken mid-Bay at the MD-VA state line (CB5.3).

Initial field findings from this survey show:

- turbid conditions in the upper Bay as a result of runoff to the Bay from some flooded streams (see Figure 2), and
- the extensive summer-long “dead zone” in the deep portions of the Bay has nearly vanished because of this storm.

The “dead zone” is a popular term that describes an area in the deep, cooler waters of the Bay where oxygen conditions are so low (less than 2 milligrams of oxygen per liter of water - mg/L - or parts per million) that few animals, if any, can survive. Since early June, the “dead zone” has extended along the deep Bay areas from near Baltimore into the Virginia portions of the Bay and into some deep Bay tributaries like Eastern Bay, the Patuxent and Potomac Rivers.

During the passage of Hurricane Irene, the long period of high wind velocities aligned with the long reach of open Bay waters (Figure 3) and created turbulent mixing currents in the Bay. This allowed well-oxygenated surface waters to mix with low-oxygen waters in the deeper portions of the Bay and its tributaries. Water quality data from several NOAA Chesapeake Bay Interpretive Buoy System sites (especially the Potomac and Gooses buoys) (*http://buoybay.noaa.gov/locations.html*), show a dip in surface dissolved oxygen levels and water temperatures and increased turbidity in open waters - all of which likely indicate turbulent mixing of surface and deep Bay waters.

Compared to pre-Irene results (blue line), oxygen levels along the bottom of the Bay from the Susquehanna River to the MD-VA Stet line in August 2011 are higher after Hurricane Irene (red line) (Figure 5). Except in one very deep site (more than 100 feet) located just south of the Patuxent River, dissolved oxygen levels near the bottom of the Bay all are above 2 mg/L - essentially ending the extensive "dead zone" for the summer. All post-Irene sites now show that the Bay is well mixed. The one Bay site with low-oxygen levels may have been too deep to be affected by this storm.

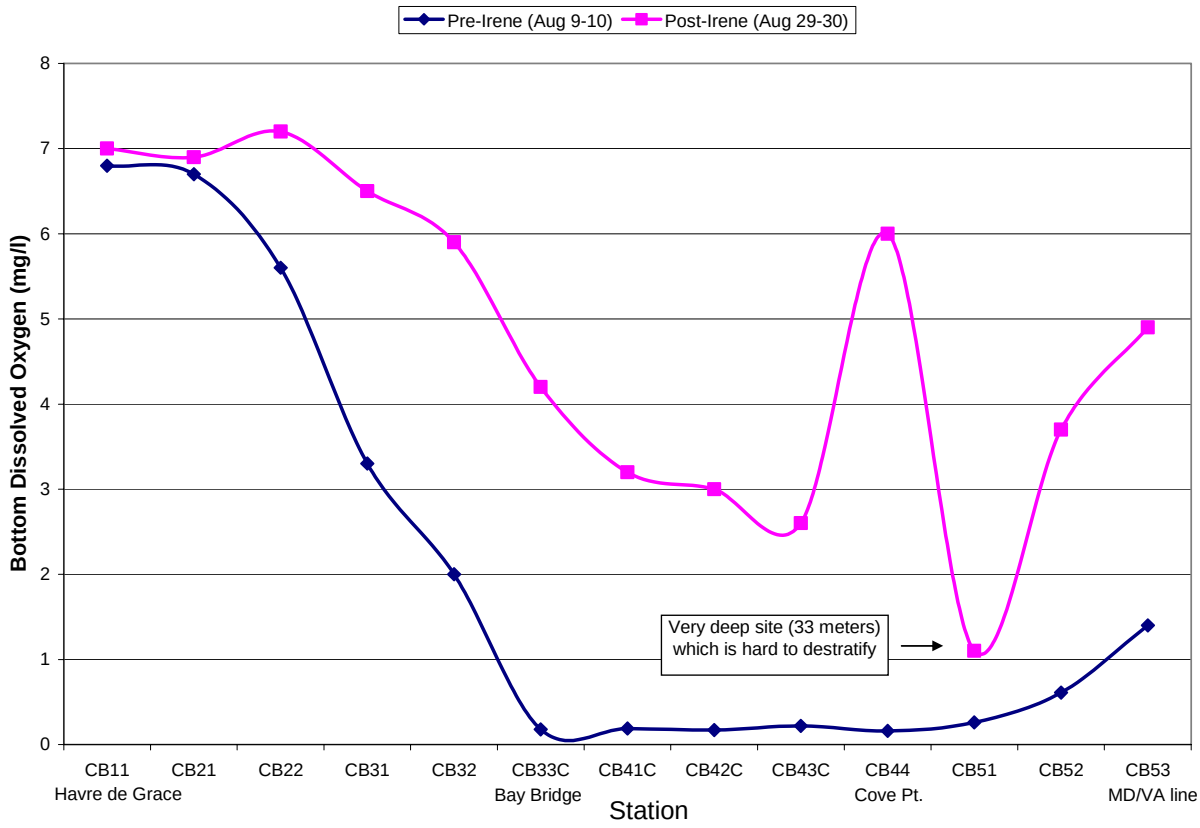

Figure 5*. Bottom dissolved oxygen measurements from the MD Chesapeake Bay mainstem water quality monitoring program (DRAFT)*
Before Irene *(August 8-10) (blue line)* - ***After Irene*** *(August 29-31) (red line)*
Data sites are distributed from the Susquehanna River (CB1.1) to MD/VA state line (CB5.3)

With calm wind conditions after the storm, the deep, low-oxygen areas in the Bay may set up again before cooler temperatures and stronger winds more regularly mix the water column. At this time of the year, it is not expected that the volume and intensity of any low-oxygen "Dead Zone" that may set up in the Bay's deep waters now would be as significant as early summer observations.

Maryland DNR will continue to monitor and evaluate water quality conditions in the State's streams, rivers and in Chesapeake Bay for further issues related to Hurricane Irene.

For more information:

- Real-time Maryland Tidal Water Quality Conditions: *www.eyesonthebay.net*
- Restoring the Chesapeake Bay: Maryland's Actions & Progress: *www.baystat.maryland.gov/*
- What You Can Do to Help the Bay: *www.baystat.maryland.gov/what_you_can_do.html*