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SHORELINES – August 2007

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The 2007 Hurricane Season (part II)

Last month, we briefly discussed the 2007 Hurricane Season and introduced some baseline terminology associated with tropical storms and hurricanes (cyclones). We also established that the Atlantic ocean basin is in a heightened period of tropical cyclone activity and mentioned the often highly publicized hurricane predictions the appear each spring – namely from researchers at Colorado State University, N.C. State University, and the National Oceanic & Atmospheric Administration.

When the track of a tropical cyclone does appear to lead into the southeast Atlantic, we usually pay special attention to five variables that ultimately dictate the scale of inundation (flooding), erosion, and property damage along ocean and estuarine shorelines in the County. Ideally, it would be great to develop a "threat index" by statistically weighing these variables and developing a numerical hierarchy, but in the interim before such an index is developed, our "in-house" pre- and post-storm analyses are usually segregated into the following.

(1) Intensity – No surprises here. You can't turn on the television during hurricane season without hearing some reference to the Saffir-Simpson scale, which includes a 1 to 5 rating based upon wind speeds utilizing the U.S. 1-minute average. A category 1 hurricane has winds ranging from 74 to 95 miles per hour (mph), category 2 ranges from 96 to 100 mph, category 3 ranges from 111 to 130 mph, category 4 ranges from 131 to 155 mph, and a category 5 hurricane has sustained winds exceeding 155 mph. Interestingly only three category 5 hurricanes have ever made landfall – the Labor Day hurricane of 1935, *Camille* (1969), and *Andrew* (1992).

Some of the more memorable hurricanes did reach a category 5 status before dissipating slightly to a category 2, 3, or 4 hurricane and striking land, including; *Isabel* (category 2 in 2003), the category 3 hurricanes of *Ivan* (2004) and *Katrina* (2005), and *Wilma* (category 4 in 2005). Regardless of the other variables mentioned below, being in the crosshairs of a category 1 hurricane is better than a category 4 hurricane in terms of flood and wind damage.

"Archetype" intensity hurricanes – *Wilma* in 2005 is the strongest Atlantic tropical cyclone on record, while *Katrina*, also in 2005, is the most costly.

(2) Duration – An often over-looked variable, but very important. A slow-moving cyclone, besides surficially exposing islands, estuarine shorelines, and adjacent waters to the elements for an extended amount of time, also allows long period swells to impact the area. The wave period is the time that elapses for one wavelength to pass a point. Shorter period swells usually indicate more disorganized conditions located closer to the coast. Long period swells indicative of tropical cyclones travel with more energy below the ocean surface and are less steep so they can easily pass through opposing winds and seas with very little decay. As the swell breaks at the coast, the wave length shortens and the height increases, yet its period remains the same (i.e., the speed of forward motion remains constant). This equates to the high water run-up we often see on the beach even though sometimes the

waves appear to be relatively small and the cyclone can be hundreds of miles away from land.

A slow moving cyclone also allows several of high tides to pass, which can accentuate flooding impacts. This can be akin to nor-easters as less intense storms impact the coast for a very long duration (several days).

Archetype – *Ophelia* in Carteret County (2005). The cyclone erratically spun in the southeast Atlantic for over a week causing winds to pile water into Bogue Sound and seawater to run-up on the beach for several days prior to the cyclone crossing the County at high tide. There was unprecedented sound-side flooding along Bogue Sound (as verified by some of the island's ol' timers) and the beaches lost a considerable volume of sand.

(3) Angle of approach (East v. West) – Perhaps the most important variable. The northeast quadrant is the "wheel house" of a cyclone where the storm surge (see below for an explanation) and highest winds reside. If an area of the County is situated west of the eye, then the damages are less. Conversely, if we are located on the east side of the eye, then we take the brunt of the storm. Wind directions also play an important role in this "angle of approach" variable. Quite possibly, it is better to be positioned west of the center of a category 3 or 4 landfall hurricane than east of a minimal category 1 hurricane.

Archetype - We have firsthand experience with being on the "right" and "wrong" side of hurricanes in Carteret County and it is difficult not to mention hurricane *Isabel* in 2003 – landfall was close to Drum Inlet and caused extraordinary, record flooding in the Down East corridor of the County. On the other hand, the west side of the County near Bogue Banks and ~35 miles west of the hurricane eye sustained minimal damage. Conversely, Bogue Banks was roughly 75 miles east of *Floyd* (1999) and the island incurred significant damage.

(4) Predicted Storm Surge – This can be a big one. Storm surge is caused by; (a) the lift of water as the cyclonic low pressure acts like a straw, mounding the water upwards, and (b) the push of water like a plow by the cyclone. The shape of the continental shelf also plays a factor; flat shelf = bad, steeper shelf = better. The Gulf of Mexico has a flat shelf that allows the surge to penetrate deep inland, e.g., *Ivan* and *Katrina*. In general, a category 1 hurricane can produce a storm surge of 3 to 5 foot above normal, while a category 4 hurricane can produce a surge ranging from 13 to 18 foot above normal, and a 20 foot above normal storm surge can be developed by a category 5 hurricane.

Archetype – *Isabel* (2003) and *Donna* (1960) had an estimated 6 to 8 foot storm surge for N.C., while *Camille's* maximum surge in 1969 topped 24 foot in Mississippi.

(5) Lunar Tide – The tidal range along Bogue Banks is roughly a 3.5 foot total swing and obviously a lower tide is a better time to bear the brunt of any storm. Spring, neap, and other tidal changes also can play a factor in the ultimate flooding potential of a particular hurricane.

A term that is quite often used to describe the additive effects of tides is the ***storm tide***, which is the cumulative height of the storm surge and the tide. Thus for example, a ten foot storm surge plus a two foot tide at time of landfall may produce a 12 foot storm tide that impacts the coast.

Archetype – *Ophelia* again in 2005. After causing water to pile into the sounds for days, the hurricane decided to cross the County at high tide, exacerbating its impact.

Next month…what we do after a hurricane hits.