

TNC's SLR and Storm Surge Mapping Methods

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Sea level rise mapping

Many types of elevation data sets have been used in previous studies to quantify the potential inundation from SLR (see Gesch and others 2009). Poulter and Halpin (2008) detail the various approaches used to model SLR, ranging from the “bathtub fill” approach to inundating lands that are hydrologically connected to the ocean. The bathtub fill approach simply fills low-lying elevation points. Often this method can create erroneous inundated areas that are not connected to the ocean as all areas equal to or below the given SLR interval become inundated, therefore creating “islands” of inundation. The hydrologically connected approach forces coastal inundation to occur only where low-lying elevation is hydrologically connected to the ocean. It is worth noting that Gesch 2009 stated as follows, “[the] development of large-scale spatially explicit maps presents a new set of challenges. At scales useful for local decisionmaking, the hydrological connectivity of the ocean to vulnerable lands must be mapped and considered.” Though we are in full agreement with this assertion, the time required to adequately condition the DEM to allow for accurate hydrological connectivity was beyond the scope of this project. In light of the importance of hydrologic connectivity, many newer data sets are being developed to force proper water flow. We used the bathtub fill approach to identify the most vulnerable lands for our various sea-level rise scenarios.

Topography data sets such as those used in this study are usually collected for land-based applications and are therefore rarely referenced to tidal datums. Because we mapped SLR, transforming the DEMs’ datum from NAVD88 to mean high water (MHW) was necessary. Several tools and techniques have been developed to assist with datum transformations, with the most popular being NOAA’s VDATUM, which was also used in this study (<http://vdatum.noaa.gov/>).

To spatially illustrate the uncertainty associated with mapping a 1-meter SLR, we mapped three inundation zones—high, medium, and low—while incorporating the vertical root mean square error (RMSE) of the elevation data in an effort to give users a transparent picture of the variability associated with these elevation data sets (Figure 9). RMSE is a measure of precision that calculates the differences between values predicted by a model and the values actually occurring in the data set being modeled. The RMSE is the same accuracy metric used for the assessment of the entire conterminous U.S. NED (Gesch 2007) and is described in Maune, Maitra, and McKay (2007). Gesch (2009) recommends that two inundation zones be mapped as determined by the linear error at the 95% confidence interval in order to spatially illustrate uncertainty. The linear error (L.E.) is the metric used by the National Standard for Spatial Data Accuracy (see Federal Geographic Data Committee 1998 for more information: www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy/part3/chapter3). These zones are as follows: High = 1-meter SLR + 1.96 x RMSE, and Low = 1-meter SLR - 1.96 x RMSE, respectively, for

the 1-meter SLR scenario. Although their approach is certainly more cautious, we decided to calculate a third interval using the actual mapped value (e.g., medium = elevation \leq 1 meter), in addition to using the high and low extents noted above. This was done to provide a “middle ground” SLR estimate. It should also be noted that error can be introduced during the datum conversion process going from NAVD88 to MHW, and where possible this should be considered here. We modified Gesch’s approach and used the following rules to determine the SLR inundation zones:

- High (1-meter) = elevation \leq 1 meter + (1 x RMSE)
- Medium (1-meter) = elevation \leq 1 meter
- Low (1-meter) = elevation \leq 1 meter - (1 x RMSE)

Storm surge mapping

The National Hurricane Center’s Sea, Lake and Overland Surges from Hurricanes (SLOSH) model was used to map storm surge for our study area, which “estimate[s] storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes by taking into account pressure, size, forward speed, track, and winds.”

One type of SLOSH model output was mapped – Maximum Envelopes of Water (MEOWs). MEOWs represent the worst-case scenario or highest surge from a specific type of storm with defined parameters, such as a Category 2 storm moving north northeast at 40 mph making landfall at high tide. MEOWs portray what could happen when a specific storm makes landfall and are used to plan for specific types of storms. MEOW Category 2 and 3 Hurricanes were chosen for the Future Scenario Mapper and were aligned with CCSR projections to produce water levels comparable to a 40 year return period storm and a 70 year return period storm, respectively

Maximum Envelopes of Water (MEOWs) were exported as shapefiles out of the SLOSH Display Program, converted to rasters and mapped onto the digital elevation models. We utilized the following two MEOW projections for displaying specific storm scenarios and combining them with SLR.

- Category 2 MEOW, moving 40 mph North Northeast with landfall at high tide
- Category 3 MEOW, moving 60 mph North with landfall at mean tide

Combining storm surge with sea level rise

To calculate the effects of potential sea level rise on storm surge for Category 2 and 3 storms, we added each sea level rise scenario to the abovementioned storm surge maps. For example, if we were to calculate the effect of 1 meter of sea level rise on a present day Category 2 storm, simply add 1 meter of depth to the Category 2 storm surge map. If a Category 2 surge resulted in a 2 meter surge at Battery gauge and a 3 meter surge at Montauk gauge, with an added 1 meter of sea level, the final sea level rise plus storm surge map would show 3 meters of surge at Battery and 4 meters of surge at Montauk.

References

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