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NOAA Inundation Dashboard

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Audra Luscher & Paul Fanelli
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Hampton Roads Sea Level Rise/Flooding Adaptation Forum
July 29, 2016

http://tidesandcurrents.noaa.gov/inundationdb/newyork.html
http://tidesandcurrents.noaa.gov/inundationdb/lowerchesapeake.html
http://tidesandcurrents.noaa.gov/inundationdb/northcarolina.html
Coastal Dashboard Strategic Driver

**OUTCOME**

Cl2 Coastal communities will use a decision support system for local to regional predictions of total water level and its impacts in three to five geographies.

**STRATEGY** [Lead: CO-OPS, NGS]

**Cl2.1** Improve the ease with which coastal communities use information about total water level and its impacts to make decisions.

<table>
<thead>
<tr>
<th>ACTIONS</th>
<th>TIMELINE</th>
<th>NOS PROGRAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cl2.1.1 Inundation benchmarks.</strong> Establish “Coastal Inundation Benchmarks” in 3-5 communities and associated tool kit to apply the protocols in additional communities: Train community leaders and members on using the tool kit as a means of translating storm surge forecasts to water level impacts on their community.</td>
<td>FY14-17</td>
<td>Lead: CO-OPS</td>
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<td></td>
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<td>Support: NGS, IOOS, OCM</td>
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<tr>
<td><strong>Cl2.1.2 Total water levels.</strong> Improve predictions of total water level: Provide and consider regional topography and bathymetry data, geodetic data, and regional scale models and expertise in order to improve predictions of total water level and its impacts. Leverage ongoing team efforts on Storm Surge Roadmap and VDatum improvements.</td>
<td>FY14-17</td>
<td>Lead: NGS, OCS</td>
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<td></td>
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<td>Support: IOOS, CO-OPS, OCM</td>
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<tr>
<td><strong>Cl2.1.3. Products for inundation.</strong> Develop new products and improve existing ones to more effectively communicate the impacts of inundation: new products will address unique regional inundation issues. Visualization of total water impacts will be improved in Quicklook by integrating National Weather Service (NWS) storm surge guidance or products. Collaborations with NWS on graphics, terminology and media partnerships will result in more effectively conveying above ground level flooding.</td>
<td>FY14-16</td>
<td>Lead: CO-OPS</td>
</tr>
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<td>Support: OCS, IOOS, OCM</td>
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</tbody>
</table>
# East Coast Water Level Gaps

<table>
<thead>
<tr>
<th>Usage Categories</th>
<th>East Coast Water Level Gaps</th>
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</thead>
<tbody>
<tr>
<td>Storm Surge</td>
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<tr>
<td>Climate</td>
<td>47</td>
</tr>
<tr>
<td>Navigation</td>
<td>26</td>
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<td>Ecosystem Management</td>
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<tr>
<td>Mapping</td>
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</tr>
<tr>
<td>Tsunami</td>
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</tr>
</tbody>
</table>
Trends in Water Level Products: Operational flood forecasting products

Storm Surge Warning System: www.stevens.edu/SSWS

Examples of local products.

Sandy er på kanten af en 100-årssormflood
Orkanen Sandy, der er på vej ind over den amerikanske øyeblik, bliver forventet langt kraftigere end tidligere år.

NOAA’s CENTER for OPERATIONAL OCEANOGRAPHIC PRODUCTS and SERVICES
Trends in Water Level Products: Climate Education Products and Crowd Sourcing

MyCoast

Quick & powerful coastal-incident reporting

As of May 11th, 2016, MyCoast has:
- 3634 Reports & 5943 Photos
- Including 300 new reports in the past 6 months

MyCoast allows anybody to quickly submit photos of coastal events, such as storm damage or nuisance flooding, especially when caused by King Tides. Our servers autonomously geolocate each photo and assign metadata to it, including meteorological and tidal conditions. A small selection of that information is then displayed on the public site, where visitors can view the reports on a map, photo-gallery, or list. (Here’s an example of a storm damage report.) More data is available to participating state partners.

You’re going to love the (FREE!) MyCoast App

King Tides Project

Communities around the world are joining the King Tides Project. We are an international network bringing awareness to climate change and the impact of sea level rise.

About the Project

King Tides Project International is an initiative delivered by a network of organisations on coastlines around the world. We are citizen scientists, capturing data and images showing what the future sea levels will be and what is at risk.

The King Tides Project helps people all over the world understand how sea level rise will impact their lives.

What are King Tides?

While the term “king tide” isn’t a scientific term, it is used to describe an especially high tide event occurring twice a year, when there is alignment of the gravitational pull between the sun and moon, other King tide occur during extreme storm events. Floods or storms, sea levels can rise to higher levels and have the potential to cause great damage to property and the coastline.
Invitation to Engage

- Establish a short term working group to provide Cross-NOAA feedback on the product before we go out to external constituents.
  - Short-term timeframe for commitment
  - Agile development focused on product enhancements to:
    - Functionality/Usability
    - Content
    - Communication/Messaging (building on the storm surge social science we have already invested in)
Product Description

- Inundation Dashboard provides real-time flood alerts and historical inundation information
- Initially available in three regions with additional regions to follow:
  - New York City/Long Island Sound;
  - Lower Chesapeake Bay (Hampton Roads); and
  - Coastal North Carolina
- Limited inundation information at other NOS tide stations
- CO-OPS will have the capability to disseminate custom, event-specific dashboards as needed
Release Schedule

- Initial Beta (experimental) version released – April 2016
- Website being gradually rolled out to gather feedback.
  - NWS WFO’s (Upton, NY, Wakefield, VA, Moorehead City, NC)
  - Storm Surge Roadmap Team
  - NERACOOS
  - National Conversation on Integrated Water Information
- Updated versions of the Beta website will be released on a regular basis with additional requirements implemented and based on stakeholder feedback (Agile development approach)
- Operational product will be available in FY17
Real-time Alerts

- Station alert based on exceedance of minor NWS flood threshold
  - Latest observed data
  - Peak observed water level today
  - Forecast water level for the next 48 hours (model forecast or tide predictions)
- Highlights that flooding may be occurring or is possible
- Accurate model data critical to account for non-tidal effects!
Geospatial Map

- Regional maps display NOS, USGS stations
  - Possibly adding additional partner gauges in the future
- Stations with inundation alerts (NOS only) show blinking station markers and are listed at the top
- Map displays available Inundation Landmarks and Impact Graphics
- Ability to generate URL with custom region
Additional Map Layers

- In addition to real-time data, map will incorporate:
  - Sea Level Rise Inundation Layer
  - Satellite Imagery
  - Tropical Cyclone Information
Station Pop-up

- Clicking on an NOS station displays a pop-up with the latest observed and forecast water level, referenced to Mean Higher High Water (MHHW).
  - Present water level
  - Next high tide
  - Peak water level today and tomorrow
  - (Minor) flood threshold
- Can adjust units/time/datums
- Links to Inundation History and Station Home Page
Relating Measured Water Level to On-the-ground Effects

Inundation Landmarks

- By photographing and surveying (leveling) to local landmarks, such as a well-known statue, you can tie a given water level height at a nearby water level station to expected inundation at the landmark.
- Useful for the most significant events where photography during an event is unsafe.
Relating Measured Water Level to On-the-ground Effects

Impact Graphics

- Photographs during actual flooding events allow users to relate past flooding events at specific locations to measured water levels at a nearby tide gauge at the corresponding time.

- No leveling needed!
Inundation History

Water Level Plot

- View observed and forecast water level (where available) along with tide predictions.
- NWS minor, moderate and major flood thresholds.
- Adjust units, time zone and datums (tidal, geodetic)
- View past verified water level data with respect to flood thresholds
Inundation History

Sea Level Trend

- For long-term (> 30 year) water level stations, a sea level trend is calculated using monthly mean water levels.
- Plot is taken from http://tidesandcurrents.noaa.gov/sltrends/sltrends.html
- As sea levels rise, the number of nuisance flooding events is expected to increase

The mean sea level trend is 4.59 millimeters/year with a 95% confidence interval of +/- 0.23 mm/yr based on monthly mean sea level data from 1927 to 2015 which is equivalent to a change of 1.51 feet in 100 years.

Change in local Mean Sea Level (MSL) over time, based on verified monthly mean water level measurements. Water level values are relative to MSL for the present National Tidal Datum Epoch (1953-2001). The measurements have been averaged by month to remove the effect of higher frequency phenomena in order to compute an accurate linear sea level trend. Sea level trends are available only for stations with at least 30 years of water level data. For more information, please visit the Sea Level Trends website.
Inundation History

Yearly Inundation Events

- Analysis of historical verified hourly water level data compared with the NWS minor flood threshold.
- Each day where the observed water level exceeded the flood level is considered a flood day.
- Number of flood days has increased at many locations due to sea level rise.
Inundation History

Top-Ten Historic Water Levels

- Date and height of peak historic water levels, referenced to MHHW
- Lists associated event to provide context to these peak values
  - Allows users to quickly associate peak values with a past storm
Inundation History

Exceedance Probabilities

- Monthly extreme water levels referenced to MHHW
- Lines denoting a 1-year, 2-year, 10-year and 100-year event, adjusted for sea-level rise
- Allows you to view historic peak water levels and how exceedance levels change with sea level rise
  - A 10-year event in 1945 may be a 2-year event today
Unique Features of Inundation Dashboard

- CO-OPS is uniquely positioned to provide inundation information beyond real-time alerts, which sets Inundation Dashboard apart from some existing products that are mostly focused on real-time information.
- The product will provide historical information such as sea-level trends, top historical water levels and the number of past inundation events through the historical data record.
- Inundation Dashboard will allow users to adjust datums and view historical water level data with respect to flood levels.
- Through inundation landmarks and impact graphics, it will provide a way to tie flooding at well-known locations with a water level height at a nearby tide gauge.
Limitations

Model Guidance

- Presently Inundation Dashboard uses forecast data from the NOS New York and Chesapeake Bay Operational Forecast System models (NYOFS & CBOFS) only
- Several stations in this product fall outside of the model domains
  - Only tide predictions are used for future alerts, which rarely if ever exceed the minor flood threshold
- NWS reviews data from several models including ETSS and ESTOFS along with OFS to determine if advisory products should be issued and to arrive at an accurate total water level forecast
- NWS and NOS need to work together to arrive at a unified NOAA water level forecast that can be used in this and other products
  - Water level forecast should be available everywhere so automated alerts take into account both tidal and non-tidal forcing.
Limitations

Flood Thresholds

- Minor, moderate and major flood thresholds for NOS stations were obtained from NWS for many locations
  - These are used in existing products such as AHPS
- Some stations do not have this information
  - Placeholder values used (defined height above Highest Astronomical Tide)
  - Need to work with local NWS offices to establish thresholds at these stations
- At some sites, it is unclear if these values truly represent thresholds resulting in actual on-the-ground effects
  - Historical data indicates 60+ flood days a year for sites in North Carolina. Is this real?
- If historical flooding statistics differ from actual number of flood events, thresholds should be updated.
Limitations

Inundation Landmarks and Impact Graphics

- Presently, Inundation Landmarks are only available near The Battery, NY.
- CO-OPS must work with local partners on standing up additional landmarks throughout all 3 regions.
  - Need local knowledge of well-known locations
  - Partners will need to survey to nearby benchmarks in order to be able to tie water level at landmarks to the nearby tide gauge.
  - Provide detailed photos so CanVis imagery can be developed.
- Only one impact graphic is included thus far (near Bridgeport, CT).
  - Need to work with local stakeholders to take/provide geo-tagged photographs during smaller flood events.
Limitations

Sea Level Trend and Exceedance Probabilities
- Sea level trend and exceedance statistics require a long historical data record over at least 30 years
- This information will be unavailable for stations with a shorter data set

Display of non-NOS Data
- Presently only USGS stations are shown, but other real-time partner stations can be added.
  - Link to USGS website
- Alerts and historical inundation information are limited to NOS water level data since CO-OPS at present only has the capability to generate harmonic constants and datums for in-house data.
Questions?

http://tidesandcurrents.noaa.gov/inundationdb/newyork.html

http://tidesandcurrents.noaa.gov/inundationdb/lowerchesapeake.html

http://tidesandcurrents.noaa.gov/inundationdb/northcarolina.html