

Project Title: STORMTOOLS Coastal Environmental Risk Index (CERI) Risk and Damage Assessment *app*

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Abstract

The vision for *STORMTOOLS* is to provide web access to a suite of coastal planning tools (numerical models, etc.) that allows widespread accessibility and applicability at high spatial resolution for user selected coastal areas of interest. The first tool developed under this framework was a flood inundation prediction, with and without sea level rise, for varying storm return periods. The methodology is based on using the water level vs return periods at a primary NOAA water level gauging station and then spatially scaling these values using predictions from the US Army Corps of Engineers (USACE) numerical hydrodynamic/wave model predictions, performed as part of the North Atlantic Coastal Comprehensive Study (NACCS).

The mapping methodology follows the NOAA sea level rise protocol and is applicable to any coastal region. Unlike many existing sea level rise and coastal inundation viewers, the maps are provided for return periods (e.g. 25, 50, and 100 yr) and explicitly include the effects of sea level rise (SLR) (1 to 10 ft). The focus on generating maps for return periods (e.g 100 yr) was employed in recognition that these maps have regulatory status in coastal states and are routinely used in planning and building codes. Simulations were also performed for historical hurricane events and nuisance flooding events. To help reach the widest possible audience and keep access and use as simple as possible the maps are web accessible via ArcGIS. The *STORMTOOLS* maps have been available for several years and numerous outreach programs and activities (training sessions, presentations at local libraries, featured newspaper articles, etc.) have been undertaken to introduce the maps to municipal and state planners and the public. The RI Coastal Resources Management Council (CRMC) formally adopted *STORMTOOLS* as part of their coastal program in December 2018 and recommends its use to aid in designing coastal projects and assessing vulnerability of existing public and private assets.

One of the other challenges facing municipal and state planning and management agencies is the development of an objective, quantitative assessment of the risk, to both structures and infrastructure, that coastal communities face from storm surge, in the presence of changing climatic conditions, particularly sea level rise. To address the need a Coastal Environmental Risk Index (CERI) has been constructed using *STORMTOOLS* surge and wave maps and shoreline change maps as building blocks and integrating recent advances in assessing damage from storm events by the USACE NACCS. The goal of CERI is to develop and apply the index

to assess the risk that structures and infrastructure face from storm surges, including flooding and the associated wave environment, in the presence of SLR, and the associated shoreline erosion/accretion. To allow quantification of the risk, CERI uses percent damage for structures and infrastructure associated with storm flooding. It estimates damages from inundation, waves, and erosion and then all damages combined, for each structure in the study area. As an option, CERI provides maps of risk for the entire study area and hence a spatial representation to help assess the risk in the immediate vicinity of the site of interest. As an alternative to STORMTOOL flooding maps, FEMA's Flood Insurance Rate Maps (FIRMs) can also be used to specify the surge and wave conditions necessary as input to CERI, but these maps unfortunately do not include the effects of SLR.

CERI flood damage assessments have been completed for eight coastal communities in RI, with funding from HUD and NOAA OCM PSM (FY2017) program. CERI has been extended to include storm wind damages as well and linked to the ASCE 7-16 Minimum Design Standards referenced in the building codes for RI communities. An additional HUD funded project has recently been completed to provide STORMTOOLs Design Elevation (SDE) maps, including the effects of SLR, for all RI coastal communities. These maps provide the equivalent of Base Flood Elevation (BFE) for all coastal areas in the state and explicitly include the effects of SLR. This provides one of the fundamental building blocks for application of CERI to all RI coastal communities. SDE maps (and CERI) were designed to support the risk-based assessment methodology that CRMC is currently implementing for the design and permitting of coastal structures and infrastructure as part of the Shoreline Change (Beach) Special Area Management Plan (SAMP).

In presenting results of STORMTOOLs flooding maps and CERI to regulators, permit applicants, state and town planners, builders, insurance and real estate agents, bankers, and the public, the issue of how best to provide access to the information was a repeated theme. While web access was found to be very useful, the overwhelming response was to take the next step and develop a mobile *app* to meet this need. The goal of this effort is therefore to develop an *app* that will provide access to flood and wind risk and associated damages for a user selected structure. Using the device's gps location and information about the structure the *app* will return key attributes of the site and structure (e.g. grade elevation, inundation depth and wave height for selected SLR, location relative to erosion setback, freeboard allowance, building height restrictions, etc.), the ASCE 7-16 hazard assessment for the site (e.g. winds), and the results of CERI for the structure selected for flooding damage, as well as, the risk levels (low to extremely high) in the immediate vicinity of the site.

As an example of its operation for flooding damage, the user (e.g. regulatory or permit applicant) visits (or enters the address of) the structure of interest, selects the structure type (house with/without basement, elevated or not) and how high the first finished floor elevation is above grade. (see screen shots of the proposed app below). The *app* then provides an assessment of the risk (depth of flooding and waves, BFE) and the associated damage (percent loss) for 100 yr plus the user selected SLR value. By modifying the inputs, the user can also assess how changes to the structure (such as elevating it, flood proofing basement windows, etc) will impact the risk/damage. The *app* will initially be developed and tested for selected RI towns that are located along the exposed southern RI coast and inside the more protected Narragansett Bay, for which

CERI is fully operational and then extended to the entire state. Outreach to the coastal regulators (CRMC, DEM, town building officials), and service providers will be performed to assess the utility of the **app** and seek suggestions for its design and improvements. A series of workshops will serve to educate the potential users about coastal hazards, provide hands-on training of the mobile application, and ensure that coastal risk information is correctly interpreted and applied. A project advisory team, consisting of all key constituencies (membership noted above), has been established to help guide the development of the **app**, serve as beta testers, and review outreach and assessment efforts and results. The **app** will be introduced to the larger community in the northeast via Northeast Regional Ocean Council (NROC) and Northeast Regional Association for Coastal Ocean Observing Systems (NERACOOS).

Project Timeline:

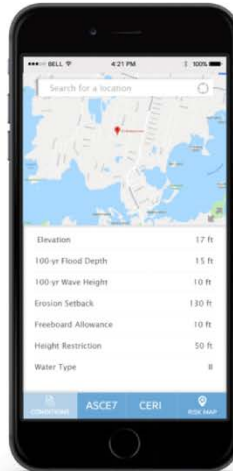
Project initiation November 2018, Project Completion: December 2019. Key times: initial development and testing of **app** for selected and to all towns in RI (May -July 2019); BeachSAMP workshop to introduce **app** to the public (November 2019) and Technical Training Session target to regulators, permit applicants, planners, engineers, insurance and real estate agents, and bankers (November 2019); **App** commercially available (January 2020).

Technical kickoff meeting: January 3, 2019
Setup Advisory Board and Kickoff Meeting: February 13, 2019
Setup Project Web page, Beach SAMP: February 1, 2019
Develop initial app: January 1 to July 15, 2019
Meet with Advisory Board to demonstrate app: July 25, 2019
Receive feedback from Advisory Board: early August 2019
Revise app: late July 2019 to October 2019
Meet with Advisory Board to demonstrate revised app: October 2019
Beach SAMP Workshop (1 hr) – November 2019
Technical Briefing Training Session (3 hr) - November 2019
Prepare papers/presentations of app – November 2019 to March 2020
Final Invoice from URI to CRMC: January 31, 2020

CERI Risk and Damage Mobile Application



Location and Structure



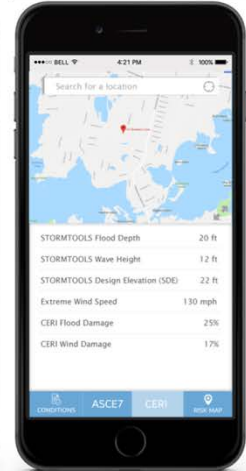
Site Characterization



Extremal Wind Speeds



Flood Risk Maps



Flood Damage