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Preliminary Data Release for the Humboldt Bay Sea Level Rise Vulnerability Assessment: Humboldt Bay Sea Level Rise Inundation Mapping

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Introduction and Background

This file describes the inundation maps developed as part of the Humboldt Bay Sea Level Rise Vulnerability Assessment (HBSLRVA) project. The inundation maps show areas surrounding Humboldt Bay vulnerable to existing and future sea levels that are currently protected from inundation due to the natural shoreline, levees or berms, and railroad or road grades. The inundation maps are provided as kmz files which can be opened in Google Earth, and shapefiles which can be imported into GIS software such as ArcGIS.

The inundation files may be updated in the future, so users should check to make sure they are using the most updated version of the inundation maps. All inundation maps will have the date of production in the filename so that it is clear when an update occurs. It will be left to the user to insure that the most recent version of the inundation maps is being used.

Five sea level rise (SLR) scenarios were assessed in this work (Table 1 and Figure 1); existing conditions for Year 2012, and half-meter increments of 50 cm (19.7 in), 100 cm (39.4 in), 150 cm (59.1 in) and 200 cm (78.7 in) SLR above Year 2000. Inundation maps were produced for each SLR scenario for mean higher high water (MHHW), mean monthly maximum water (MMMW), mean annual maximum water (MAMW), and the 10-year and 100-year recurrence interval extreme water levels. Also included as a kmz file and shapefile is the developed mean high water (MHW) shoreline for Humboldt Bay which shows areas of the bay that are currently inundated below MHW.

The inundation maps and MHW shoreline kmz files and shapefiles are provided in a file structure with individual folders named for each SLR scenario or shoreline, and contained within a separate folder for kmz files or shapefiles. For example, the folder named YEAR2000+0.5MSLR_140326 within the folder named Generalized_KMZ_Files contains the separate inundation map kmz files for the Year 2000 + 0.5 m SLR scenario generated on 26 March 2014. Each individual inundation map filename contains the SLR scenario, corresponding inundation water level, and the date of production. For example, file YEAR2000+0.5MSLR_10YR_140326.kmz is the 10-year recurrence interval extreme water level inundation for the Year 2000 + 0.5 m SLR scenario, and was generated on 26 March 2014.

Funding for this work was provided by the California State Coastal Conservancy through the Coastal Ecosystems Institute of Northern California. The Humboldt Bay SLR inundation maps should currently be cited as:

> Northern Hydrology & Engineering (2014). Preliminary data release for the Humboldt Bay sea level rise vulnerability assessment: Humboldt Bay sea level rise inundation mapping. Prepared for the California State Coastal Conservancy and the Coastal Ecosystems Institute of Northern California. Prepared by Northern Hydrology & Engineering, McKinleyville, CA, dated 10 April 2014.

Table 1. Humboldt Bay SLR scenarios and assumptions (regional eustatic SLR (ReSLR) rate of 2.28 mm/yr from Burgette et al. (2009))

Conditions and SLR Scenarios	Effective Date	Step SLR (m)	Step SLR (ft)	100-yr Model Simulation
Detrended 100-yr hourly Crescent City tide series referenced to middle of 1983-2001 NTDE	1992-07-02, 00:00			No
Year 2000 (base sea-level condition), step SLR based on 2.28 mm/yr ReSLR over 8 years	2000-07-02, 00:00	0.018	0.0602	No
Year 2012 (existing condition), step SLR based on 2.28 mm/yr ReSLR over 12 years above Year 2000	2012-07-02, 00:00	0.027	0.090	Yes
Year 2000 + 0.5 m	Not defined	0.500	1.640	Yes
Year 2000 + 1.0 m	Not defined	1.000	3.281	Yes
Year 2000 + 1.5 m	Not defined	1.500	4.921	Yes
Year 2000 + 2.0 m	Not defined	2.000	6.562	Yes

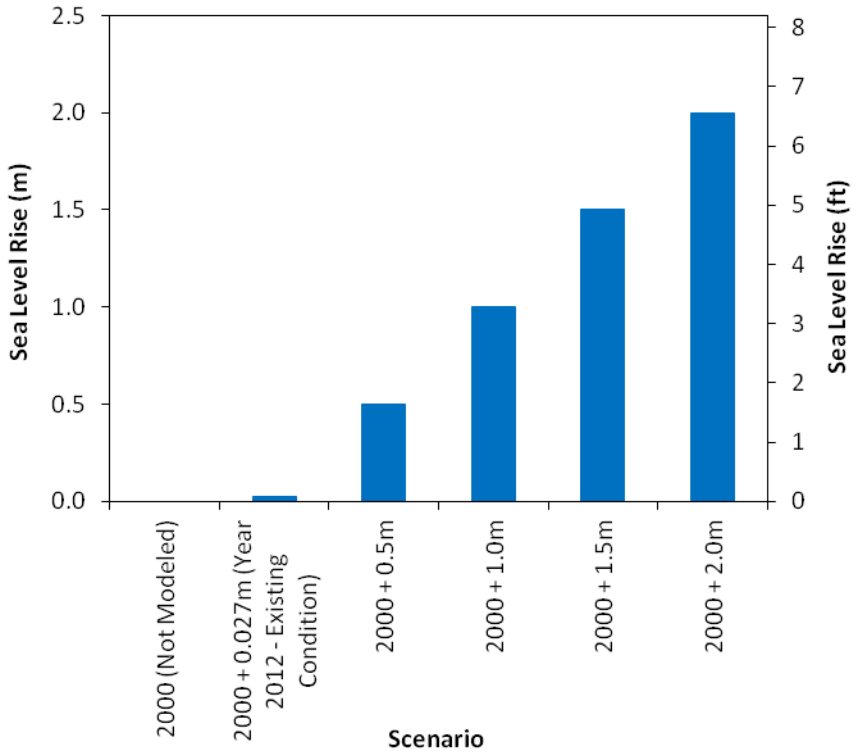

Figure 1. Humboldt Bay SLR scenarios assessed.

Summary of Analysis Approach and Methods for SLR Inundation Maps

The Humboldt Bay SLR inundation mapping files are being provided prior to the distribution of the supporting final report. Consequently, a brief description follows of the hydrodynamic modeling and inundation mapping that was conducted for the Humboldt Bay SLR Vulnerability Assessment work. The Humboldt Bay SLR inundation modeling and mapping is built upon the approach used by Knowles (2010) for similar work in San Francisco Bay.

Project Digital Elevation Model

As part of the HBSLRVA work PWA (2014) developed a seamless topographic/bathymetric digital elevation model (DEM) of Humboldt Bay and the surrounding upland areas (project DEM). The project DEM (Figure 2) was developed in ArcGIS, and includes the 2009-2011 California Coastal Conservancy Coastal Project Lidar hydro flattened bare earth 1-meter DEM, and various subtidal bathymetric data sets of Humboldt Bay conducted by the U.S. Army Corps of Engineers (COE), National Oceanic and Atmospheric Administration (NOAA), NOAA National Ocean Service (NOS), and the Seafloor Mapping Lab (SFML) at California State University Monterey Bay. The project DEM was generated at a 1-m grid resolution, and the projection is UTM Zone 10, WGS84, and the vertical datum is NAVD88.

Figure 2. Hillshade of the Humboldt Bay SLR Vulnerability Assessment project DEM.

Hydrodynamic Model, Boundary Conditions and Analysis

A hydrodynamic model was used to predict water levels within the existing shoreline of the Humboldt Bay. The hydrodynamic model was based on a previously developed three-dimensional hydrodynamic and transport model of Humboldt Bay (Anderson, 2010) using the public domain EPA supported Environmental Fluids Dynamics Code (EFDC) modeling system. The model used in this SLR assessment was configured as a two-dimensional hydrodynamic model (2D model), with 1,560 horizontal grid cells and one vertical layer (Figure 3). Model grid cell elevations (NAVD88) were based on the project DEM (PWA, 2014). The 2D model was

driven by a 100-year hourly sea-level series for the NOAA Crescent City tide station (1913 to 2012). The effects of internally generated wind waves on predicted water levels in Humboldt Bay for the 100-yr simulations were not directly assessed.

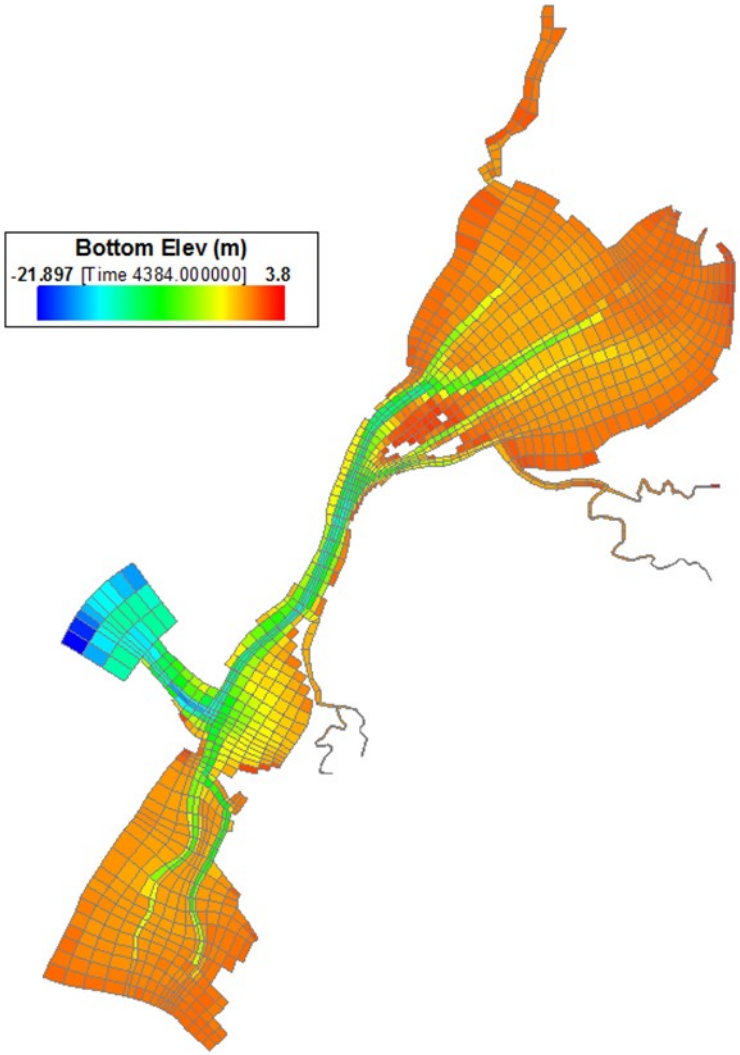

Figure 2. Humboldt Bay hydrodynamic model grid and bottom elevations.

The Crescent City 100-yr hourly sea-level series (still water elevations) consists of 639,011 hourly sea-level observations (1933 to current, not continuous) and 246,373 hourly sea-level predictions. The hourly observations were downloaded from NOAA on Station Datum (STND) and detrended using least-squares liner regression to remove the SLR and vertical land motion (VLM) signal from the data, which also effectively references the data to midnight on 2 July

1992, the middle of the current 1983-2001 National Tidal Datum Epoch (NTDE). The hourly sea-level predictions were based on NOAA astronomical tide predictions for Crescent City on STND, and a non-tide sea-level model that accounts for wind, atmospheric pressure and ENSO variability following the approach of Cayan et al. (2008). The detrended 100-yr hourly sea-level series was converted from STND to NAVD88 using the published NOAA and National Geodetic Survey (NGS) datum conversion for the Crescent City tide station.

Five SLR scenarios were assessed for Humboldt Bay (Table 1 and Figure 1). For each SLR scenario a constant step SLR was added to the Crescent City detrended 100-yr hourly sea-level series referenced to Year 2000. To adjust the 100-yr sea-level series to Year 2000, which was originally referenced to the middle of the 1983-2001 NTDE, a regional eustatic SLR (ReSLR) rate of 2.28 mm/yr (Burgette et al., 2009) was applied for 8 years (0.018 m adjustment). The 2.28 mm/yr ReSLR rate applied over 12 years (0.027 m adjustment) was also used to provide the step SLR for the Year 2012 existing condition simulation.

Each of the five 100-yr SLR scenarios (Table 1) was modeled with the 2D model. Predicted water levels (NAVD88) were output every 15 minutes for the 100-yr simulation the entire model domain. Data post-processing for each SLR scenario consisted of determining MHHW, MMMW, MAMW, and extreme water level frequency values using a generalized extreme value (GEV) analysis for each grid cell in the model domain.

Inundation Mapping

Inundation mapping of areas surrounding Humboldt Bay vulnerable to existing sea-levels (Year 2012) and SLR scenario flooding were developed using ArcGIS. For Year 2012 and each modeled SLR scenario (Table 1) a gridded water level elevation surface was developed from the 2D model data analysis representing MHHW, MMMW, MAMW, 10-year and 100-year recurrence interval levels. For each water level elevation surface, the water elevations along the approximate shoreline boundary was extended horizontally and mapped onto the 1-meter project DEM (PWA, 2014) to create inundation maps of areas vulnerable to sea-level inundation. Each inundation map was then clipped using the MHW shoreline to remove areas inundated below MHW. The clipped inundation maps were cleaned and generalized (5-m generalization) within ArcGIS prior to producing the generalized kmz files and shapefiles. The horizontal projection of the inundation maps is UTM Zone 10, WGS84.

References

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