

Delta Sea Level Rise Inundation and Overtopping Layers – Eastern Solano and Contra Costa Counties

Summary

These inundation and overtopping layers provide a regional-scale illustration of potential permanent inundation and temporary flooding due to coastal and riverine processes in the Delta in response to sea level rise (SLR) and are intended to improve sea level rise awareness and preparedness in eastern Solano and Contra Costa Counties. The layers were prepared in support of the San Francisco Bay Conservation and Development Commission's (BCDC) Adapting to Rising Tides (ART) Project and extend previously developed San Francisco Bay SLR inundation layers eastward into the Delta. Funding to perform this work was provided by the Delta Stewardship Council. The work was managed by BCDC with consultants AECOM and Anchor QEA.

Description

Topographic Data

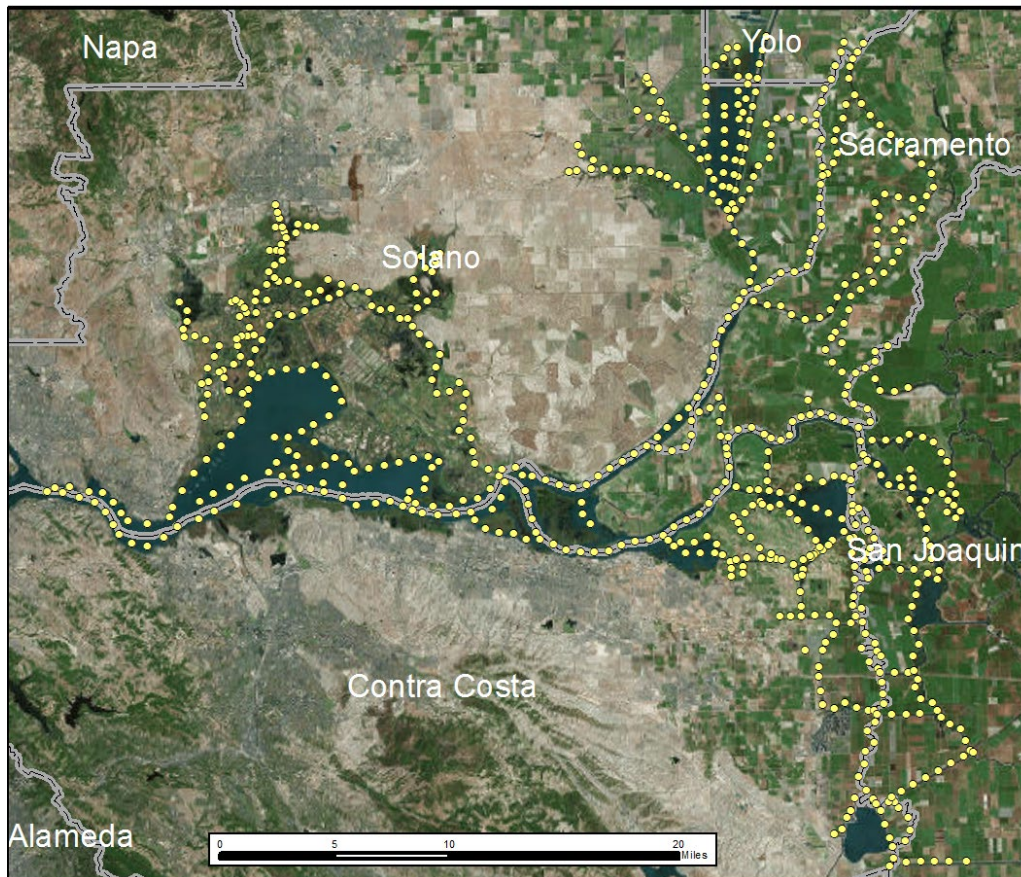
The topographic data used for this analysis relied on a 2017 seamless digital elevation model (DEM) developed by the California Department of Water Resources (DWR). The terrain dataset relies on multiple sources of topographic data, including 2007-2008 Delta lidar, 2002 U.S. Geological Survey lidar, 2008 Solano County lidar, and 2005 Suisun Marsh/Yolo Bypass lidar. The DWR seamless DEM is a 1-meter resolution bare-earth lidar dataset.

AECOM reviewed the topographic dataset prior to use in the inundation mapping and made modifications to the DEM to better represent existing conditions. Modifications reflect comments provided by stakeholders during review of the preliminary inundation layers and correct issues identified by the AECOM team based on review of the dataset. Potential issues were identified by examining locations where levee overtopping was projected to occur at low to moderate water levels (such as daily high tide plus 1 foot of SLR) – especially for areas without a history of frequent flooding. A shapefile is included with the topographic DEM that identifies the modifications that were made. Example modifications include “opening” or “closing” specific water control structures (for areas that are either open or closed to tidal action, based on stakeholder comments), adding in constructed levees (e.g., Delta Coves development in Bethel Island) or planned levees (e.g., Dutch Slough) that were not represented in the DEM, or correcting issues with the DEM where it was clear that the DEM was not an accurate representation of conditions on the ground. Constructed or planned levee alignments and elevations were estimated from design or as-built drawings obtained from stakeholders by BCDC. Identified DEM issues primarily pertain to levee segments with sharp discontinuities in the crest elevation where the levee crest was much lower than adjacent areas and a clear artifact was present in the DEM. Aerial photographs were reviewed at these locations to verify that the levee did indeed extend across the apparent gaps and that a true gap or depression in the levee did not exist. At these locations,

a representative crest elevation from adjacent segments of levee was extended across the gap. In ambiguous cases where it was unclear if the DEM was in error or not, the DEM was left as-is.

Water Level and Sea Level Rise Scenarios

The SLR inundation and flooding maps were produced using two base water levels: the mean higher high water (MHHW) tidal datum and the 100-year (1-percent annual chance) peak water level. Both base water levels were estimated from analysis of hydrodynamic model output from a 35-year hindcast using the UnTRIM model (performed by Anchor QEA). The model is driven by tides at the Golden Gate of San Francisco Bay and the tidal boundary condition was adjusted to 2009-equivalent mean sea level using a historical sea level rise trend of 1.387 mm/year to match previous hydrodynamic modeling assumptions by DHI used for the FEMA San Francisco Bay flood studies and prior ART mapping. Additional model inputs include historical inflows, wind, evaporation, and precipitation. Historical operation of salinity control gates, Delta Cross Channel, water export facilities, temporary agricultural barriers, and Delta Island Consumptive Use were assumed. The model output points are shown in the figure below.



Existing conditions tidal datums were estimated using a subset of the hindcast data corresponding to the 1983-2001 National Tidal Datum Epoch (NTDE). Existing conditions 100-year peak water levels were estimated from an extreme value analysis of annual maxima water levels extracted from the 35-year hindcast at each model output point.

Future conditions water levels were simulated for SLR amounts of 12, 36, and 83 inches of SLR. A key distinction in this analysis compared to prior ART mapping in San Francisco Bay is that the SLR amounts were not simply added to the existing conditions local water level estimates at each point throughout the study area, but rather SLR was added to the tidal boundary condition driving the hydrodynamic model and the simulations were re-run to capture the complex hydrodynamic response of Delta water levels to SLR. Due to model runtime limitations, future conditions simulations were performed for a shorter time period of April 1994 to April 1, 1997 (3 years) and direct comparisons were made between the typical daily water levels and peak waters for the three year overlapping period of the historical hindcast and future conditions simulations. Calculated differences were then applied to the existing conditions long-term estimates of MHHW and 100-year peak water level from the full 35-year hindcast. Future conditions MHHW and 100-year water levels were estimated as follows:

- **MHHW:** MHHW was calculated for existing and future conditions using only the 1994-1997 time period. At each model output point, the difference between MHHW estimated for each future conditions SLR run (12, 36, and 83 inches) and the existing conditions run was calculated. The MHHW difference for each SLR amount was then added to the long-term MHHW estimated for the full NTDE period.
- **100-year peak water level:** The peak water level that occurred during the 1994-1997 time period was identified at each model output point for the future conditions simulation. The difference between the existing and future peak water level was calculated and added to the estimated existing conditions 100-year peak water level to estimate future conditions 100-year peak water levels for each SLR simulation.

Future conditions MHHW and 100-year peak water levels for 24 inches of SLR were interpolated from the 12 and 36-inch results.

Additional study outputs include:

- Existing conditions tidal datums: MLLW, MLW, MSL, MTL, MHW, and MHHW
- Future conditions MHHW tidal datum for 12, 24, 36, and 83 inches of SLR
- Peak water level estimates for existing conditions: 2-yr, 5-yr, 10-yr, 20-yr, 25-yr, 50-yr, 100-yr, and 500-yr
- Future conditions 100-year peak water level for 12, 24, 36, and 83 inches of SLR
- Peak water level and estimated return period for peak simulated during the 1994 to 1997 hindcast time period
- Peak water level and estimated return period for peak simulated during the full 35-year hindcast time period

Sea Level Rise Inundation Mapping

Inundation maps were developed using the NOAA Coastal Services Center methods (Marcy et al. 2011). The initial step in creating the inundation maps was to create the inundated water surface DEM. Daily high tide (MHHW) and 100-year peak water level elevations derived from the UnTRIM model output points were used to define the water surface elevations for the existing and future conditions. The

water surface elevations were then interpolated across Delta islands and extended inland to project the water surface over the inundated topography. A water surface DEM was created for each water level and SLR scenario. Depth of flooding raster files were created by subtracting the land-surface DEM from the water surface DEM. The resultant DEM provides both the inland extent and the depth of inundation in feet. The final step used in creating the depth and extent of flood maps relies on an assessment of hydraulic connectivity. The assessment of hydraulic connectivity removes areas from the inundation zone if they are protected by levees or other topographic features that are not overtopped.

Overtopping Assessment

The overtopping potential layers depict segments of shoreline or levees where the water surface DEM exceeds the topography DEM. Overtopping layers provide insight to help identify low-lying segments of shoreline or levees where water levels overtop and lead to inundation or flooding of inland areas. The overtopping layers show the extent of shoreline or levee overtopping and the depth by which the water surface DEM exceeds the topography DEM along the delineated shoreline. AECOM delineated a continuous shoreline within the study area that traces high ground and levee crests. A levee centerline file provided by the Delta Stewardship Council was used as a guide in the delineation where available. Due to the extensive levee network and shoreline complexities in the study area, the shoreline and levee crest delineation is not perfect and could benefit from further review and refinement in future efforts.

Disclaimer

The inundation maps and the associated analyses provide a regional-scale illustration of inundation and coastal flooding due to specific sea level rise scenarios, and are intended to improve sea level rise awareness and preparedness. The maps are not detailed to the parcel-scale and should not be used for navigation, permitting, regulatory, or other legal uses. Flooding due to sea level rise, coastal, and riverine processes is possible in areas outside of those predicted in these maps, and the maps do not guarantee the safety of an individual or structure. Nor do the maps model flooding from other sources, such as local precipitation or stormwater sources. The contributors and sponsors of this product do not assume liability for any injury, death, property damage, or other effects of flooding. The maps relied on a 1-meter digital elevation model created from LiDAR data collected since 2007 and additional survey data and information (where available). Although reasonable care was taken to capture all relevant topographic features and structures that may impact inundation, it is possible that structures and levees may not be fully represented, especially those that are narrower than the 1-meter horizontal map scale.

The maps are based on model outputs and do not account for all of the complex and dynamic San Francisco Bay-Delta processes or future conditions such as erosion, subsidence, future construction or shoreline/levee protection upgrades, or other changes to the San Francisco Bay-Delta shoreline or the region that may occur in response to sea level rise. These inundation maps should not be used for detailed design or construction and users should consult a licensed engineer for information regarding existing and future flood risk at an individual site. The inundation maps and associated analyses are provided "as is." Neither the San Francisco Bay Conservation and Development Commission, the Delta Stewardship Council, nor their contractors, make any warranty whatsoever, whether expressed or implied, as to the accuracy, thoroughness, value, quality, validity, merchantability, suitability, condition,

or fitness for a particular purpose of the inundation maps and associated analyses, nor as to whether the inundation maps and associated analyses are error-free, up-to-date, complete or based upon accurate or meaningful facts.

Attachments

Figure	Description
1	Estimated MHHW tidal datum estimated for 1983-2001 National Tidal Datum Epoch
2	Estimated 100-year peak water level from annual max analysis of 35-year hindcast
3	Max simulated water level in 35-year hindcast
4	Max simulated water level in 3-year hindcast period (1994-1997)
5	Approximate return period of max water level in 3-year hindcast period (1994-1997)
6	Difference between MHHW estimated for 12" SLR and existing conditions
7	Difference between MHHW estimated for 36" SLR and existing conditions
8	Difference between MHHW estimated for 83" SLR and existing conditions
9	Difference between peak water level for 12" SLR and existing conditions (during 1994-1997) period
10	Difference between peak water level for 36" SLR and existing conditions (during 1994-1997) period
11	Difference between peak water level for 83" SLR and existing conditions (during 1994-1997) period