

San Diego Bay Terrain Model

Progress Report (August 1, 2010- November 1, 2010)

**Richard M. Gersberg, Ph.D, Principal Investigator
San Diego State University Research Foundation**

Purpose of the grant:

The main goal of this project is to define the potential impacts of sea level rise due to global climate change on the habitats of San Diego Bay's wetlands and eelgrass beds.

Objectives

Key concerns include sea level rise, coastal wetland alteration, possible eelgrass habitat loss, and San Diego's adaptation to sea level rise. The IPCC (Intergovernmental Panel on Climate Change) estimates that the global average sea level will rise between 0.6 and 2 feet (0.18 to 0.59 meters) in the next century and that by 2100, sea level rise could convert as much as 33 percent of the world's coastal wetlands to open water. However, more recent estimates by Vermeer and Rahmstorf (2009, published in the Proceedings of the National Academy of Sciences) who based their analysis on measurements of sea level and temperature taken over the past 130 years, identified a strong link between the rate of sea level rise and global temperature and project a sea level rise of 0.75 to 1.9 meters by 2100.

Specific objectives of the San Diego Bay Terrain Model project include:

1. Couple a high-resolution LiDAR digital elevation model of San Diego Bay's watersheds (recently developed from City of San Diego LiDAR data), with the high resolution bathymetry to be developed by Dr. Neal Driscoll at SIO, to generate a relatively seamless digital map of San Diego Bay's terrain.
2. Using the seamless high resolution terrain model of San Diego Bay generated above, delineate the specific effect of sea level rise on eelgrass and wetland and benthic habitats of San Diego Bay.
3. Using the SLAMM (Sea Level Affects Marshes) Model, delineate the effect of sea level rise on San Diego Bay's National Wildlife Refuge including the Sweetwater Marsh Unit and the South Bay Unit. This modeling will allow prediction of wetland inundation (and associated habitat change) under the range of plausible sea level rise scenarios.

Description of Work Completed

To date, we have been making steady progress towards the goals detailed above. On September 22, 2010 a meeting was held between the PIs on this project- Dr. Neal Driscoll, myself, and Dr. Todd Anderson of SDSU. At that time, we were told that the new bathymetry would not be available until boat time is available sometime in January, 2011, so that in lieu of waiting for this new bathymetry, our GIS team has chosen to move ahead to tie the existing San Diego Bay bathymetry with the existing high resolution LiDAR data.

At about the same time, Michelle White of the San Diego Unified Port District organized a Conference call with Drs. Driscoll and I to discuss how our work could help on the new Climate Mitigation and Adaptation Plan for Port tidelands, that is now underway. Michelle sees our work as an important part of the Port's assessment of baseline conditions and determination of vulnerabilities in and around San Diego Bay. In support of this effort on October 1, 2010 I had

my GIS staff prepare several sea level rise maps of high resolution examples of future inundation scenarios for two specific areas along San Diego Bay - the Convention center and Shelter Island, where sea level rise could affect coastal infrastructure. These were provided to Michelle White at the Port for planning purposes.

A major part of our terrain and sea level rise modeling efforts for San Diego Bay will be focused on the San Diego National Wildlife Refuge, which consists of the Sweetwater Marsh and the South San Diego Bay Units (Figure below). This Refuge is situated at the south end of San Diego Bay, and is surrounded by urban development within the Cities of National City, Chula Vista, San Diego, Imperial Beach and Coronado. The Refuge encompasses approximately 2,620 acres of land and water in and around San Diego Bay. The 316 acre Sweetwater Marsh supports tidally influenced salt marsh habitat, disturbed upland habitat and the D street Fill, an old dredge disposal site that provides nesting habitat for terns and western snowy plovers (USFWS, 2006). However the most significant habitat on this Refuge Unit is coastal salt marsh. This habitat supports an array of invertebrates and juvenile fish, and provides habitat (nesting, foraging and refuge) for the Federally-endangered light-footed clapper rail, and the state endangered Belding's savannah sparrow. The clapper rail depends almost entirely on salt marsh habitat for feeding and nesting. Belding's savannah sparrow is found throughout the salt marsh area of this Refuge unit, and forage within salt marsh and intertidal mudflat habitat. The intertidal mudflat and coastal marsh habitats of the Sweetwater Marsh Unit are also important wintering areas for many species of shorebirds, such as long-billed curlews, whimbrels, and red knots. And the D Street Fill provides nesting habitat for several species of ground nesting birds including California least terns, horned larks and killdeer (USFWS, 2006).

The South San Diego Bay Unit currently includes about 2,300 acres including portions of open bay (eelgrass habitat), salt ponds, and the Otay River floodplain. The saltponds provide resting and foraging habitat for a wide variety of avian species, while the levees are important nesting habitat for seven species of ground nesting seabirds. Eelgrass beds in the subtidal habitat of the South San Diego Bay Unit provide highly productive microhabitats for a variety of invertebrates and fish. San Diego Bay's population of green sea turtles also relies on eelgrass as an important food source.

Ultimately, a major and significant effort in our work on this San Diego Bay Terrain Model Project is to model how sea level rise in San Diego Bay will alter both the eelgrass habitat as well as the coastal wetlands of San Diego Bay.

Our research this past quarter focused in on the direct modeling of wetland alteration as a result of sea level rise in San Diego Bay for both the Sweetwater Marsh Unit and the South Bay Unit of the National Wildlife Refuge using the SLAMM model. In this model, relative sea level change is computed for each wetland site depending on the climate change scenario chosen. Sea level rise may be offset in the model by sedimentation and accretion. Where direct measurement of marsh accretion rates exist (e.g. the PI of this proposal has directly measured accretion rates for the Tijuana Estuary) these more specific parameters were input into the model in place of default values. For each time period into the future chosen (e.g. 2100) the fractional conversion from one habitat class to another is computed.

SLAMM Version 5.0 was the version of the SLAMM Model used, first developed in 2006. SLAMM 5.0 provided the following refinements:

1. The capability to simulate much larger sites by processing model runs on the computer's hard-drive rather than the computer's RAM;
2. The capability to simulate fixed levels of sea level rise by 2100 as IPCC estimates of sea level rise have proven to be too conservative;
3. The capability to work with high-precision LiDAR data;

4. The inclusion of "Inland Shore," "Brackish Marsh," "Tall Spartina," and "Tidal Swamp" as model categories.

Depending on the time-steps (e.g. 2050 or 2100) chosen, the output of the model will quantitatively delineate the areal loss and/or conversion of the following :

- dry land that may be inundated,
- tidal mudflats that may disappear,
- brackish marsh that may be converted to saltmarsh or tidal flats (and viceversa)
- saltmarsh that may be lost or alternatively, formed as a result of conversion of dry land or brackish/freshwater to saltmarsh.

In addition to our work above on focused modeling for San Diego Bay's coastal wetlands of the National Wildlife Refuge, we also have made progress on the following:

- a. NWR boundaries - registered (georeferenced) and digitized the NWR boundaries for our modeling uses.
- b. Bathymetry - the detailed boundary of bathymetry contours has been digitized
- a bathymetry grid has been generated to tie to the LiDAR DEM
- c. We then have nearly completed combining (mosaic) the SD Bay bathymetry with the DEM, and are proceeding with a QC check and now troubleshooting a 1 cell spatial shift.
- d. We have been in touch with Drew Decker of the USGS and the U.S Army Corps of Engineers to download a new LiDAR dataset that was flown in 2009-10, and will strive to download this new dataset to update our LIDAR DEM for the coastal margin (western fringe of San Diego Bay and ocean side of the Silver Strand).


Anticipated Work for the Next Reporting Period

1. Begin to tie together the high resolution bathymetry to be developed by Dr. Neal Driscoll at SIO, with our existing LiDAR DEM to generate a relatively seamless digital map of San Diego Bay's terrain.
2. Continue the modeling of wetland alteration as a result of sea level rise in San Diego Bay for both the Sweetwater Marsh Unit and the South Bay Unit of the National Wildlife Refuge using the SLAMM model. Develop quantitative tables for loss and gain of each wetland class.
3. Develop statistical frequency distributions of eelgrass abundance versus depth (and do field verification of this with Dr. Todd Anderson) to generate a predictive capability with which to model the effect of sea level rise on eelgrass habitat.



Figure 2
San Diego Bay NWR Comprehensive Conservation Plan
Project Study Area (Area of Potential Effects)

Source: USFWS, Local Agency Partnership 2000 (2 ft imagery)


 0 0.25 0.5 Miles
 Carlsbad Field Office - 2003
 /stem/stacey/ssdbay/fig_sum/figures.apr