# San Diego Bay Terrain Model

## Progress Report (November 1, 2012 through January 31, 2013)

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

## 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 '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 made good progress towards all the goals detailed above.

Since, the summer of 2012, we had requested a no-cost extension of this project in order to update and finish the seamless digital elevation model of San Diego Bay. This has been carried out in the last quarter. The purpose of this model is to provide coastal managers and scientists with a tool to better evaluate sea level rise and coastal flooding impacts. This is an important tool in order to best evaluate the multiple impacts of sea level rise on both natural habitats and city and port infrastructure under a variety of sea level rise scenarios.
scenarios.

In San Diego Bay, eelgrass beds are considered to be a valuable shallow-water habitat, providing numerous ecological services including: shelter, nutrient cycling, or breeding habitat for many species of invertebrates, fishes, and some waterfowl. Eelgrass beds also stabilize sediments and provide organic material to nearshore environments. These plants grow in relatively few locations within the Bay and require special conditions to flourish.

Sea-level rise will have a variety of effects on eelgrass habitat. Increased water depth will restrict the amount of light reaching seagrasses, and depending on the bathymetry of the Bay and topography of the surrounding landscape, change the geographic distribution of the eelgrass habitat. Based upon our current understanding of eelgrass distribution, it does indeed seem likely that sea level rise will move the maximum depth of eelgrass growth and abundance closer to the current shoreline. The aim of the current effort is to use the seamless San Diego Bay Digital Elevation Model to better quantify this impact of sea level rise.

The main goal of this project is to define the potential impacts of global climate change on the habitats of San Diego Bay, and specifically, to delineate the specific effects of sea-level rise on submerged eelgrass and coastal wetland habitats, and in turn, how these changes will impact the plants, birds, and fish they support. In order to do this, and to predict such changes, an accurate, and high-resolution terrain model is needed for San Diego Bay. This Quarter we completed the coupling of a new high-resolution LiDAR digital elevation model of San Diego Bay (recently made available by NOAA through Digital Coast), with the high resolution bathymetry developed by Dr. Neal Driscoll at SIO, to generate a relatively seamless digital map of San Diego Bay's terrain.

The new elevation data recently updated into our terrain model were provided by NOAA's Digital Coast Program which represents a new and effective resource for coastal communities and stakeholders. Through this updated data information is provided to explore the implications of sea level rise, conduct risk and vulnerability assessments, develop community green infrastructure plans, and much more in the way of coastal management.

**San Diego Bay Digital Terrain Model Mosaic**

A seamless bathymetric/topographic digital elevation model (DEM) was developed in this project for San Diego Bay. In order to do this, we first needed to replace the high resolution terrain model that we had generated from a 2006 LiDAR flight for the City of San Diego by a new LiDAR DEM generated in 2009-2011 by NOAA (Digital Coast, Coastal LiDAR Project). This hydro-flattened surface was then merged seamlessly with the bathymetry
The latest high resolution bathymetry data was obtained by Dr. Driscoll. The 7 ASCII files for the Scripps bathymetry have been merged into a single grid with a 1-meter resolution. This grid was projected from the WGS84 coordinate space into the UTM NAD83 coordinate space. We first converted the bathymetry data into ArcGIS format, smoothed the data to remove sinks and peaks and QA/QC'd the data, and then merged/mosaicked the bathymetry tiles. We next processed the data for gaps in the bathymetry (shallow areas and the South Bay). The surface was recorded with RTK which is a satellite technique used to enhance the precision of position data derived from satellite-based positioning systems, being usable in conjunction with GPS to provide real-time corrections, providing up to centimeter-level accuracy. Then the GEOID09 model was to create a surface relative to NAVD88. This is the format of the surface in Figure 1 showing the bathymetry merged with the NOAA Digital Coast LiDAR (2011) data to produce the seamless terrain model.

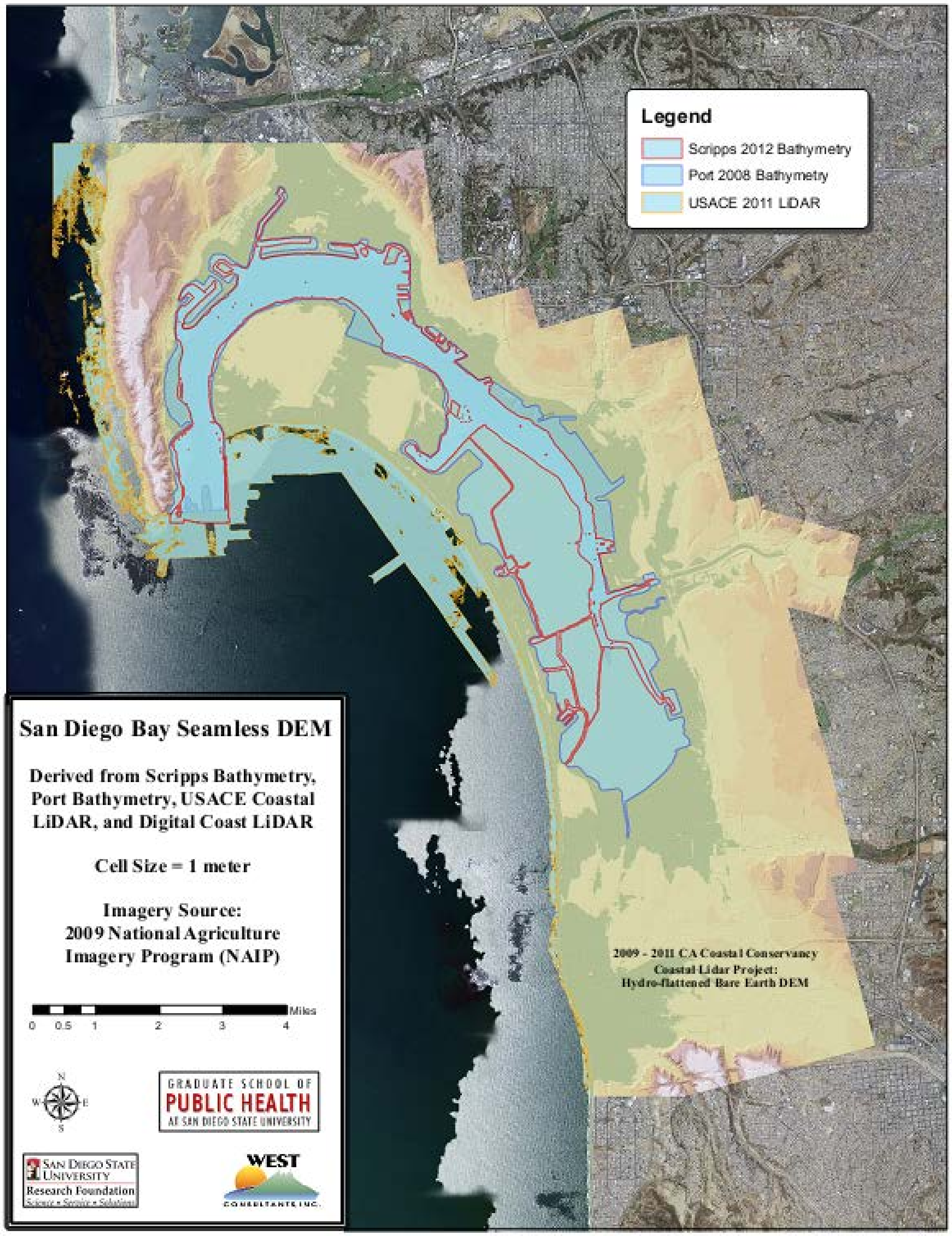


Figure 1. The area within the defined boundary on the PDF is the San Diego Bay seamless DEM derived from Scripps Institute of Oceanography bathymetry (2012), the existing bathymetry (2008) of the Port of San Diego, and the NOAA Digital Coast LiDAR (2011).

**Eelgrass bed characterization and surveys of fishes**

Data on the spatial extent, location, density, and height of eelgrass was collected by Dr. Anderson and his lab in summer, 2012 at nine sites in San Diego Bay. These data were then entered and the analysis is ongoing. Recently these data were error-checked and statistical analysis of the data will now begin. Next, basic characterization of these sites in terms of the density, height, and depth of eelgrass, and the average density and size distributions of fishes will be determined at each of the nine sites. Importantly, the next goal in this study is to combine the geo-referenced seafloor mapping data collected by Dr. Neal Driscoll at SIO that also provides the spatial extent of eelgrass beds, with the LIDAR data collected by Dr. Gersberg and the data collected by Dr. Anderson on eelgrass parameters and fish densities. All these data will then be incorporated into our new digital terrain model so that the effects of sea level rise can be predictively modeled to determine how eelgrass beds will contract or expand in the bay and how this might affect fish assemblages.

## Significance and Next Steps

The development of a San Diego Bay bathymetric/topographic model, has resulted in a prototype digital product that that can be employed for marine GIS and coastal zone management applications. It demonstrates how disparate spatial data can be utilized together if they are first transformed to a common reference coordinate system. Use of a merged seamless elevation model as a base data layer facilitates overlay and incorporation of other spatially referenced coastal and marine datasets. The base DEM can easily be converted to:

- support eelgrass mapping and other GIS applications,
- enhanced for data visualization,
- used for input to 2-D and 3-D environmental models,
- employed in a predictive fashion to model inundation processes
- help adaptation and preparedness planning,
- do pollution modeling and pollutant dispersal modeling, and
- do long-term planning for coastal change associated with sea level rise

Next quarter we will continue data analysis and prepare the final report for the project.