

## CASE STUDY: COASTAL INUNDATION MODELING

**Application:** Predicting Sea Level Rise in a Tidal Embayment: Elkhorn Slough, Monterey, California

**Data Provider:** Elkhorn Slough Estuarine Research Reserve; California State University, Monterey Bay; Intergovernmental Panel on Climate Change (IPCC)

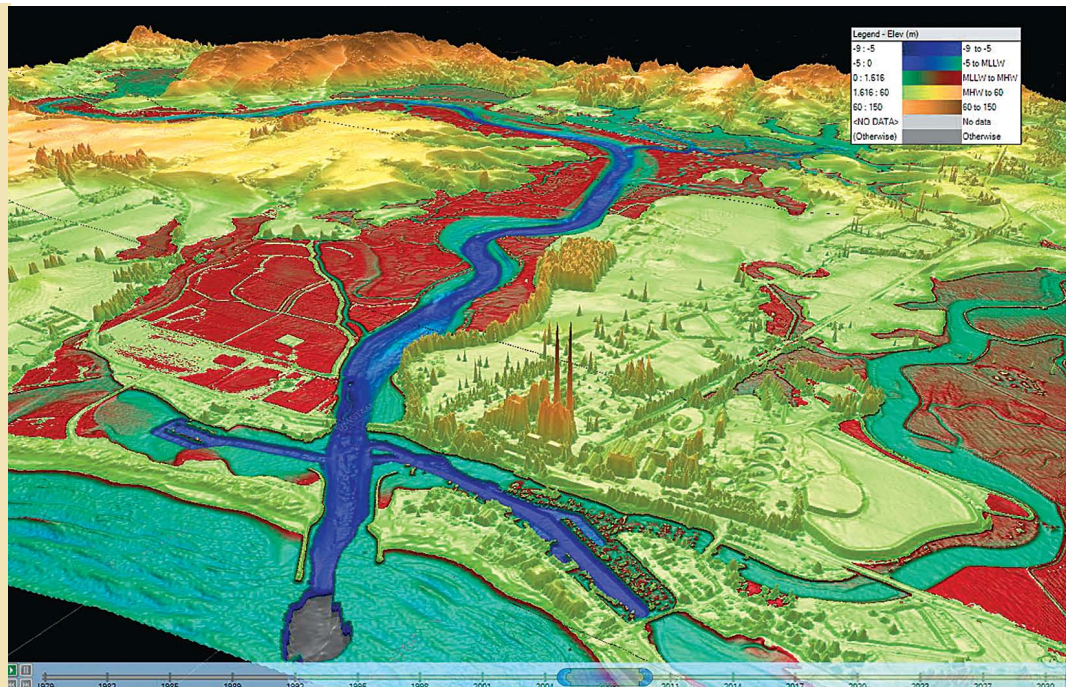
- Key Results:**
- Efficient integration and processing of large data sets
  - Implementation of complex environmental models within a single 4D environment

### Project Description

Elkhorn Slough is a shallow-water embayment that is part of a 585-km<sup>2</sup> watershed at the easternmost extent of the Monterey Bay in California. In 1947, the shoreline dunes along its western marsh were breached for the expansion of the Moss Landing Harbor. This action provided open access to coastal waters but also initiated a tidal scour process that has widened the main channel and eroded the banks of the slough. Since construction

of the harbor, researchers and engineers have measured and observed dramatic increases in the tidal prism and tidal current velocities which have resulted in extensive erosion in Elkhorn Slough both vertically in the subtidal channel and laterally into the channel banks and mudflats. The salt marshes bordering Elkhorn Slough have also seen increased inundation and coverage by tidal waters during this time.

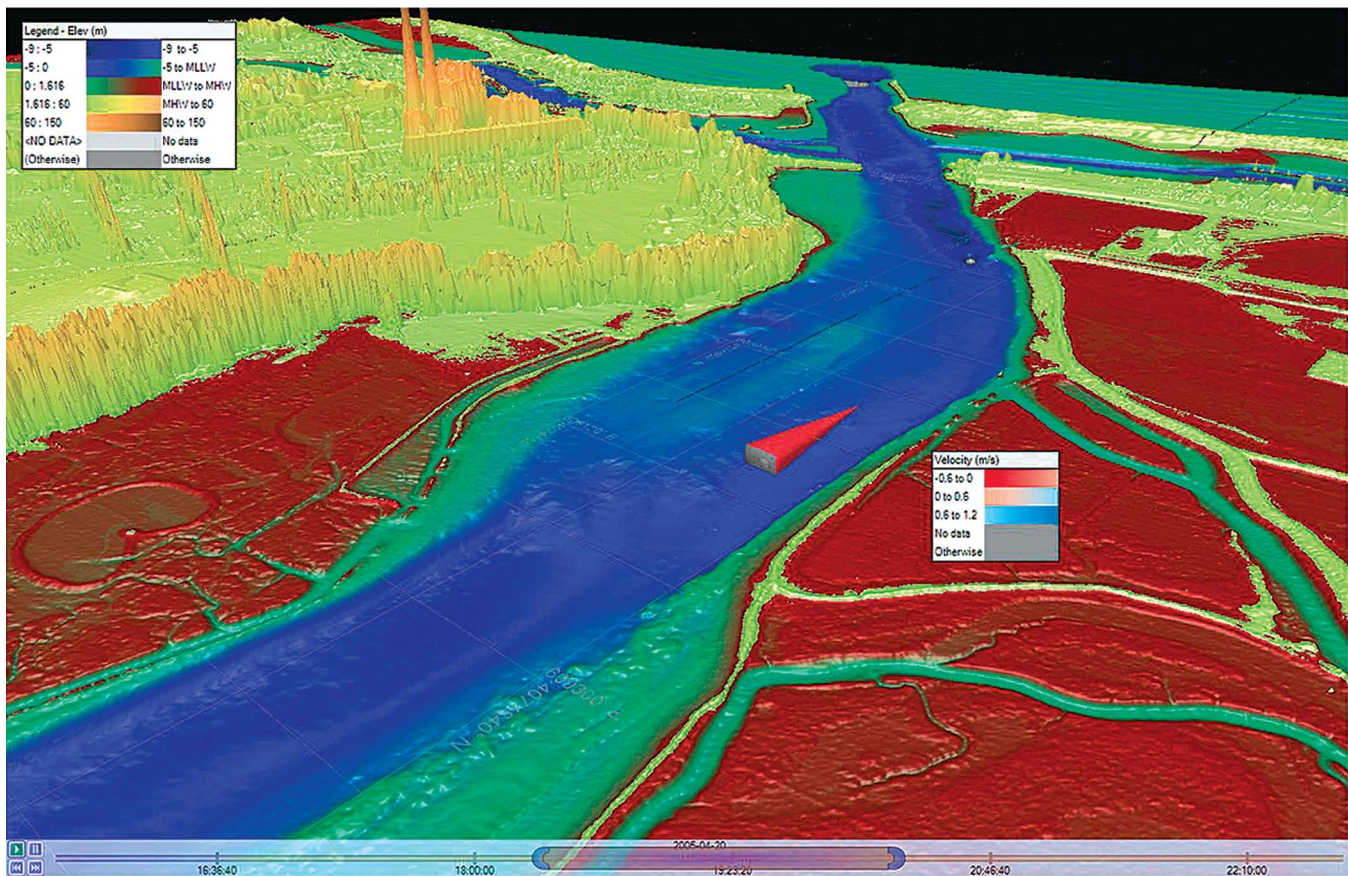
*Eonfusion was used to generate and visualize the topography around Elkhorn Slough, Monterey, California. Data provided by CSU Monterey Bay's Seafloor Mapping Lab.*



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There are many processes that have resulted in a larger volume of water occupying Elkhorn Slough. Tidal currents directly entering the slough via the Moss Landing Harbor mouth are the most clearly understood. With every incoming tide, water enters the slough through an opening whose width is locked by the armoring protecting the Highway 1 Bridge at

this watershed's westernmost extent. During outgoing tides, a large volume of water that entered during the rising tide needs to exit the slough. Due to an increased hydraulic head, high water velocities increase amount of erosion leading to the loss of critical salt marsh habitat and threatening nearby roads, railroads and structures.



Tidal current velocities (color coded by range with direction indicated by glyph) have resulted in extensive erosion in Elkhorn Slough.

### The Challenge

While the tidal erosion problem is well-documented, the potential impacts of rising sea level are not as well understood and the models that have been created to predict these effects have never been synthesized with sampled data to create a holistic view on the Elkhorn Slough system. The challenge in developing such a synthesized model lies in the fact that researchers and engineers have traditionally used a variety of different software solutions to collect and integrate data, and model and analyze systems. A single application

capable of performing all of these tasks has never been available.

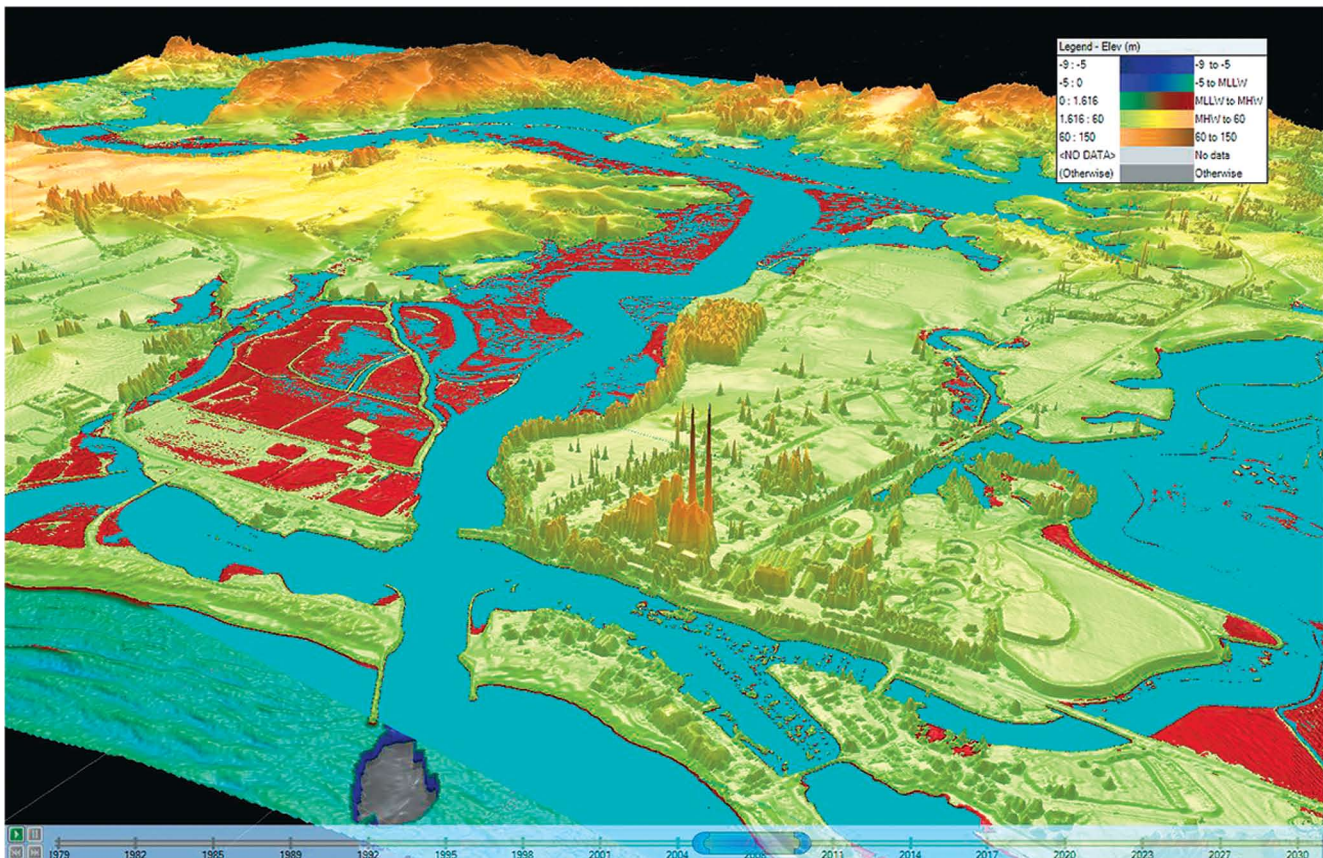
Eonfusion provides users studying the Elkhorn Slough system to integrate both modeled and sampled data to assess current and future problems and visualize the entire system. It also allows them to communicate their impact findings to managers who are responsible for this ecosystem as well as neighboring suburban communities.

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### The Result

Starting with a detailed digital elevation model (DEM) composed of fused high resolution LiDAR and multibeam bathymetry data provided by CSU Monterey Bay's Seafloor Mapping Lab, Eonfusion was used to process the render the data into a 3-dimensional surface. Utilizing the software's flexible color-banding tools, the data was broken up into 5 bands. To accentuate the region most affected by the erosion, the salt marsh, a red color-band was assigned to the region between mean lower-low water (MLLW) and mean higher-high water (MHHW). Sea level rise data (referenced to MLLW)

was converted into a time series of surfaces which represents three possible IPCC sea level rise scenarios and integrated with the model. This basic model enabled a rapid analysis and visualization of the sea level rise scenarios and allowed users to easily visualize storm surge events of any magnitude. In the end, users were able to show a dramatic increase in the hydraulic head and a significant loss of the salt marsh region within 25 years and complete loss in approximately 50 years simply due to sea level rise.



Coastal Inundation at mean higher-high water (MHHW) 2008.

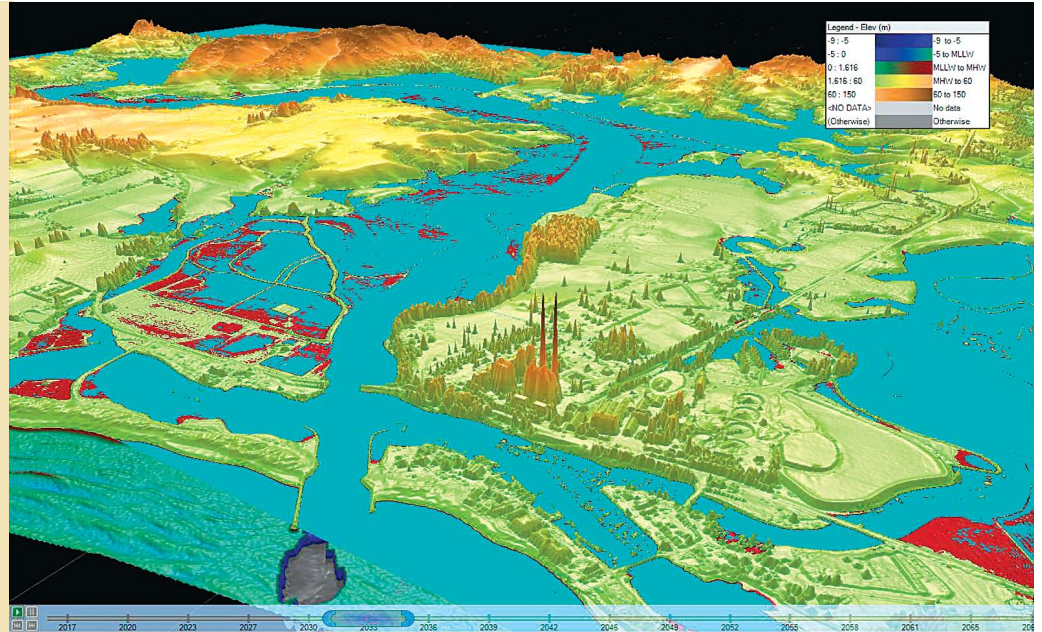
### Future Studies

In cooperation with the Elkhorn Slough Estuarine Research Reserve and California State University, Monterey Bay, Myriax will further enhance the quantification of knowledge by incorporating local geological data into a Bruun model which has already been implemented in Eonfusion.

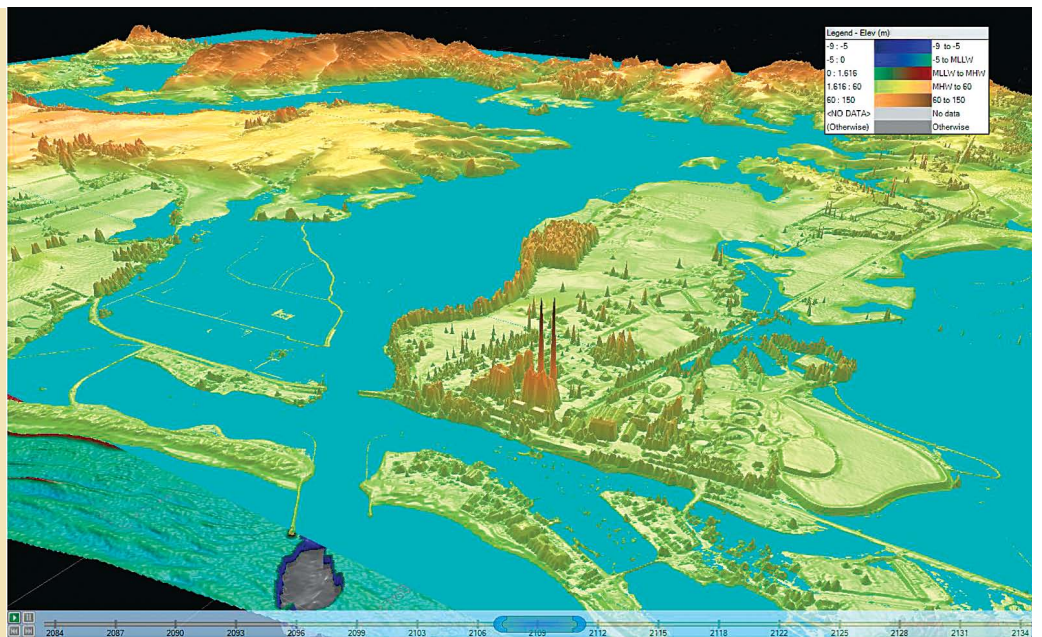
Utilizing this knowledge, a 3D model of the terrain and its vulnerability to erosion will be fused with the original model providing a visualization of the predicted rise in seal level combined with shoreline retreat in 10-year increments for the next 100 years.

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*Predicted coastal inundation in Elkhorn Slough at MHHW in the year 2033.*



*Predicted coastal inundation in Elkhorn Slough at MHHW in the year 2109.*



**Additional Information**

For additional information on Eonfusion or to review other case studies, please visit the Eonfusion website at [eonfusion.myriax.com](http://eonfusion.myriax.com) or email us at [info@eonfusion.myriax.com](mailto:info@eonfusion.myriax.com)