Assessing the Economic Impacts of Climate Change Events to Marine Industries in Long Beach, California

Produced by Aaron McGregor
Lewis Center Award Winner for Innovative Uses of Spatial Analysis and GIS in Policy Analysis

Policy Question
What are the economic impacts of climate change events, specifically rising sea levels and low-probability storm events, to coastal marinas in Long Beach, California?

Results
A respective 1.0 m and 1.4 m sea level rise in 2050 and 2100, will result in measurable impacts to Long Beach's marinas. However, a 2.0 m rise in sea level by 2100 will result in year-round inundation related closures to Shoreline Marina and Rainbow Harbor Marina. A one-year closure to these marinas will result in lost labor income of $0.95 to $1.6 million in 2050 and $1.3 to $2.7 million in lost value added.

A respective 1.0 m, 1.4 and 2.0 m sea level rise accompanied by a single 100-year storm event in 2050 or 2100 will result in a loss of sales totaling approximately $2.6 to $4.4 million in 2050 and $3.4 to $5.2 million in 2100. Total direct and secondary effects amount to a loss of approximately 34 to 57 jobs in 2050 and 45 to 95 jobs in 2100, lost labor income of $0.95 to $2.3 million in 2050 and $1.3 to $2.7 million in 2100, and lost value added of $1.5 to $2.6 million in 2050 and $2.0 to $4.3 million in 2100. The capital cost of structural adaptation measures to increase resiliency of Long Beach's marinas is approximately $164.3 million, with additional annual maintenance costs totaling $2.7 million.

Conclusion and Recommendations
This study illustrates the potential climate change impacts to municipal marinas in Long Beach, CA. In the coming century, a large number of marinas on the California coast will also be presented with similar reductions in economic output due to rising sea levels and extreme storm events. It is imperative that additional analyses be conducted at high-profile marinas along the California coast. Such studies will provide policymakers with the necessary information to make decisions that will bolster California’s boating industry, which currently plays a key role in the state economy. If policymakers plan accordingly for projected climatic changes, boating and supporting industries will continue to play a significant role in the California economy. If adaptation strategies are not incorporated in a timely manner, the recreational boating industry, as well as the California economy, could experience significant impacts.

Climatic Scenarios
This study models a respective sea level rise of 1.0, 1.4 and 2.0 meter (m) in 2050 and 2100. Sea level rise projections were extracted from a series of scientific consensus reports that were most applicable to the California coast.

Respective sea level rise scenarios were modeled into the existing 100-year storm models, adopting the assumption that as sea level rises, the 100-year storm plain will increase.

Sea Level Rise and 100-year Storm Modeling
GIS methods were used to identify areas impacted by a future rise in sea level and a 100-year storm. To delineate Coastal Areas Vulnerable to Sea Level Rise and a 100-year Storm, digital elevation models (DEM) base flood elevation (BFE) models were analyzed. Spatial analyst tools were used to produce inundation plains that conform to the dynamics of flooding.

Depth of Flood Modeling
To calculate the damages to Long Beach’s marinas, existing protective structures, specifically bulkheads and levees were evaluated. GIS layers were created to map existing structures and calculate the cost of raising such structures to address rising sea levels.

Structural Adaptation Modeling
To evaluate potential losses as they relate to the cost of increasing the resiliency of Long Beach’s marine industries, existing protective structures, specifically bulkheads and levees were evaluated. GIS layers were created to map existing structures and calculate the cost of raising such structures to address rising sea levels.

Economic Impact Modeling
To estimate a reduction in economic impacts to Long Beach’s marinas, the mean flood depth Long Beach’s marinas have parameterized and translated into lower, mid-range and upper bound restoration rates that evaluate the time needed to address structural damage, salt water intrusion, natural gas and electric damage, fuel and pump stations damages. To evaluate for availability and inspections and permits. Within GISs attribute fields, restoration timetables were linked to daily economic output values to calculate the total economic losses for the various climatic scenarios.

Mid-Range Cumulative Economic Losses ($ Thousands) for 100-year Storm Following a Rise in Sea Level at Long Beach’s Marinas

Infrastructure Loss Modeling
To calculate the damages to Long Beach Marine Bureau infrastructure, parcel data was overlaid on the inundation plain. Using GISs attribute fields, the depth of flooding at each parcel was linked to supplemental depth damage curves in order to calculate total losses to infrastructure and their contents.

Acknowledgments
The data compiled for this presentation would not have been possible without the assistance of many parties, starting with the funding generously provided by the Department of Boating and Waterways.

I especially want to thank my reviewers: Russ Boudreau, Medllatt & Nichol; Matt Hieberger, Pacific Institute; Ben Pfugh, Scripps Institute of Oceanography; Phil King, San Francisco State; Leo Estrada, UCLA; Randy Crane, UCLA; and Kim Sterrett, Boating and Waterways.