

High-Resolution Grid Modeling of Coastal Flood Inundation at Newport Harbor, CA

Timu Gallien
University of California, Irvine
Civil and Environmental Engineering
October 28, 2009



Outline

- Study Site
- Motivation
- Data
- Model
- Results
- Conclusions



Study Site – Newport Beach, CA



Motivation

- Newport Beach is a highly developed, economically important coastal lowland in Southern California
- Currently 70,000 people in Orange County vulnerable to 100 year flood (Herberger, 2009)
- California Climate Change Center expects 1-1.4 m of sea level rise in next 100 years (Cayan 2009, Herberger 2009)
- More rigorous modeling at regional scale needed to guide coastal adaptation (Herberger, 2009)



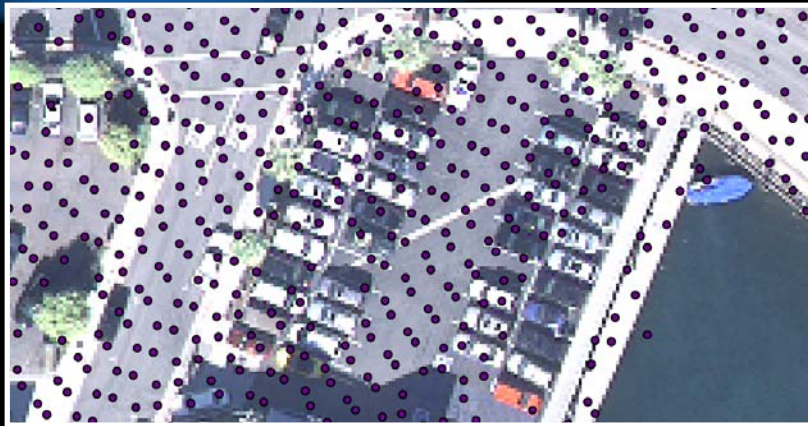
Data

- LiDAR of Newport Harbor Area
 - Merrick Survey, 2006
 - Vertical Accuracy 0.182 m RMSE
- Orthoimagery of Newport Harbor Area
 - Merrick Survey, 2006
 - 7.62 cm imagery coarsened to 30 cm
- December 12, 2008 Tide, 2.266 m (MLLW)
 - Field survey
- January 10, 2005 Tide, 2.418 m (MLLW)
 - Photographic reconstruction
 - City of Newport Beach input



Data

LiDAR Data



City Services Photo & Accounts



UCI Field Survey



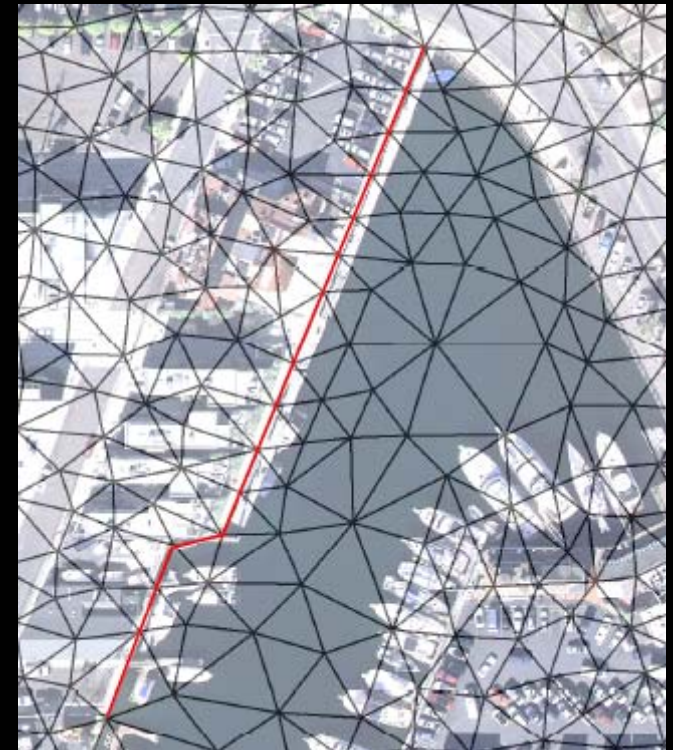
Modeling

- BreZo
 - Godunov based finite volume code
 - 2D shallow-water equations
- Input
 - LiDAR (ground elevation data)
 - Flow resistance parameter
 - $n = 0.02 \text{ m}^{-1/3}$

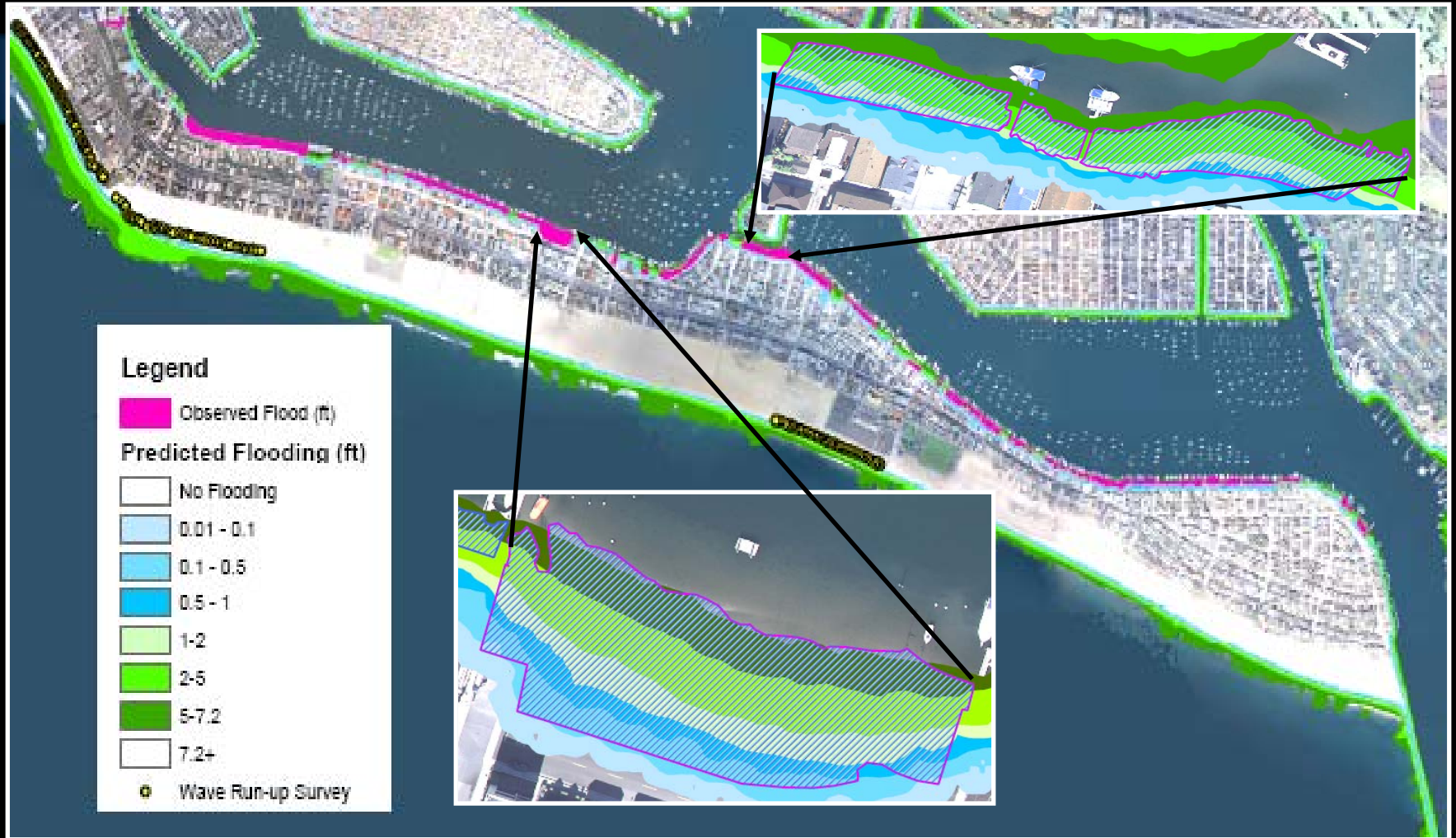


Mesh

- Generated using Triangle (Shewchuk, 1996)
- Spatially variable mesh
- Vertices aligned with sea walls, assigned appropriate elevations
- Resolution
 - Lowland ~ 10 m
 - Bay open water ~ 25 m
 - Offshore ~ 300 m



December 12, 2008 Results

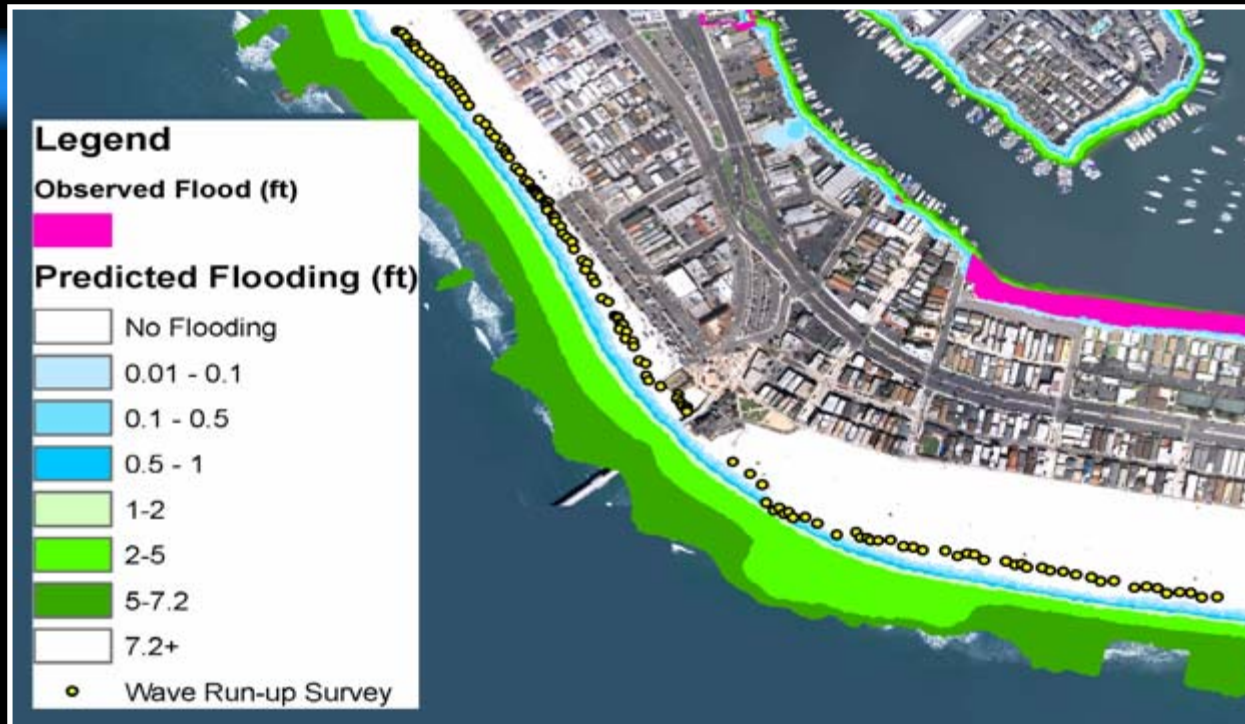


December 12, 2008 Bay Side Results

- Generally good agreement between model and observations
- Raster interpolation needs to remove zeros
- All sea wall boundaries must be imposed in mesh



December 12, 2008 Ocean Side Results



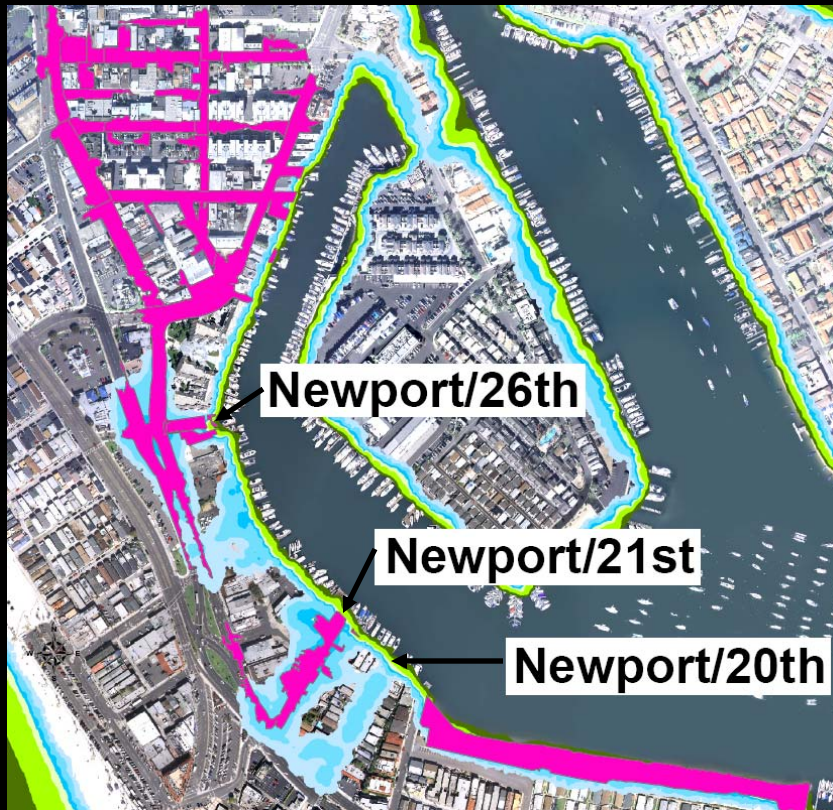
Observation ~ 0.8 m higher than prediction
Local significant wave height ~ 0.62-0.71 m



January 10, 2005 Results



January 10, 2005 Results



- Newport and 26th under prediction
 - Sea wall condition
 - LiDAR
- Newport and 21st correct routing
- Newport and 20th over prediction
 - LiDAR
- Tide height > ponded water elevation



January 10, 2005 Results



No prediction
Storm drain



Over prediction
LiDAR accuracy?
No City Services Report



General Results

- Flood water height < tide height
 - 2.195 m flood water vs. 2.418 m at LA Buoy
- Model over prediction
 - LiDAR data accuracy – flooding threshold
- Model under prediction
 - Infrastructure
 - Damaged or leaking sea walls
 - Homeowner alteration of sea walls
 - Storm drainage



Conclusions

- **Accuracy**
 - *Forcing factors and thresholds must be accurately characterized*
 - *LiDAR terrain data 0.182 RMSE vertical accuracy may be insufficient to characterize threshold of overtopping*
- **Threshold infrastructure**
 - *Sea walls, subsurface drainage must be considered*
- **Elevation of ponded water consistently lower than local high tide level**
 - *Simplistic flood assessments over predict*
- **Waves are important on the open coast**
 - *More effective proxy than tide height may be $\text{tide} + H_s$*



Acknowledgements

This work was supported by a grant from the National Science Foundation (CMMI-0825165) and gracious cooperation from the City of Newport Beach.



References

- Cayan, D., Tyree, M., Dettinger, M., Hidalgo, H., Das, T., Maurer, E., Bromirski, P., Graham, N., Flick, R. (2009). "Climate change scenarios and sea level rise estimates for the California 2008 Climate Change Scenarios Assessment". Sacramento, California Climate Change Center
- Heberger, M. Cooley, H., Herrera, P., Gleick, P.H., Moore, E. (2009). "The impacts of sea-level rise on the California Coast". Sacramento, California Climate Change Center
- Shewchuk, J. R. (1996). "Triangle: Engineering a 2D quality mesh generator and Delaunay triangulator." Applied computational geometry: Towards geometric engineering: 203-222.

