Using high-resolution beach surveys to assess geomorphologic change within the Salinas Subcell (Monterey Bay, CA) before and after the 2015/2016 El Niño

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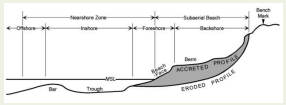
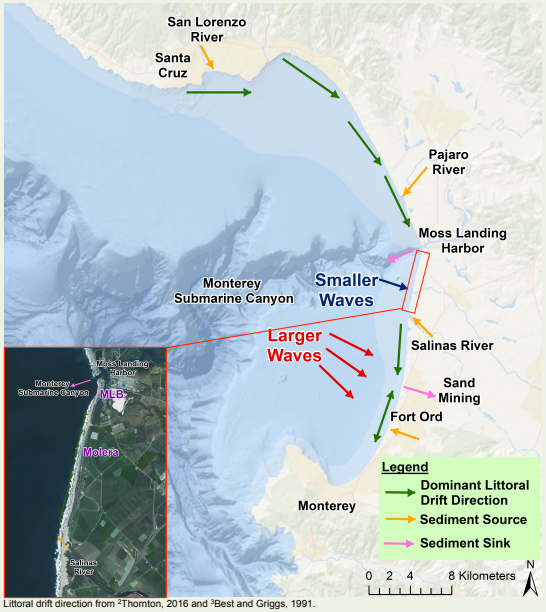
Introduction: Littoral cells characterize California's coast along with many other tectonically active coastal regions worldwide. Long-term (120 years) studies of California beaches and adjacent dunes/seacliffs show that Monterey Bay, particularly around Fort Ord Beach, has experienced the highest erosion rates in the state (-0.6 m/y). This study focuses on two strategically chosen beaches of the Salinas Subcell (part of the Southern Monterey Bay Littoral Cell), between the mouth of the Salinas River and the Moss Landing Harbor. Moss Landing Beach (MLB) is located at the northern end of the cell, with a nearly nonexistent continental shelf due to the presence of the Monterey Bay Submarine Canyon which intercepts littoral transport. Molera Beach, located about 3 km south, represents a more typical beach. Swells in Monterey Bay are generally from the NW during winter conditions, though swells from the W/SW are not unusual, particularly during El Niño winters. As a result, littoral transport is predominantly to the south, with exceptions at specific locations or during select storms.

Previous studies demonstrate long-term trends of beach change and sediment budgets, citing the episodic nature of coastal change. However, high-frequency measurements over short time periods (days to a month) are extremely rare. This study assesses short-term volume change at Moss Landing Beach (MLB) and Molera Beach during and after the 2015/2016 El Niño, combining high-resolution (<10cm) surveying techniques such as terrestrial laser scanning (TLS) and unmanned aerial vehicle (UAV) areophotogrammetry.

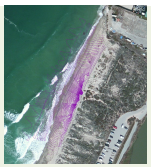


(Left) Idealized profile of an accreted beach typical during summer conditions and an eroded beach typical during winter conditions.

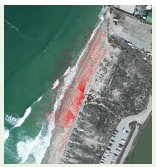
(Above) Figure from [1]Dingler and Reiss, 2002



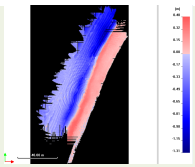
Littoral drift direction from [2]Thornton, 2016 and [3]Best and Griggs, 1991.



Survey 1



Survey 2

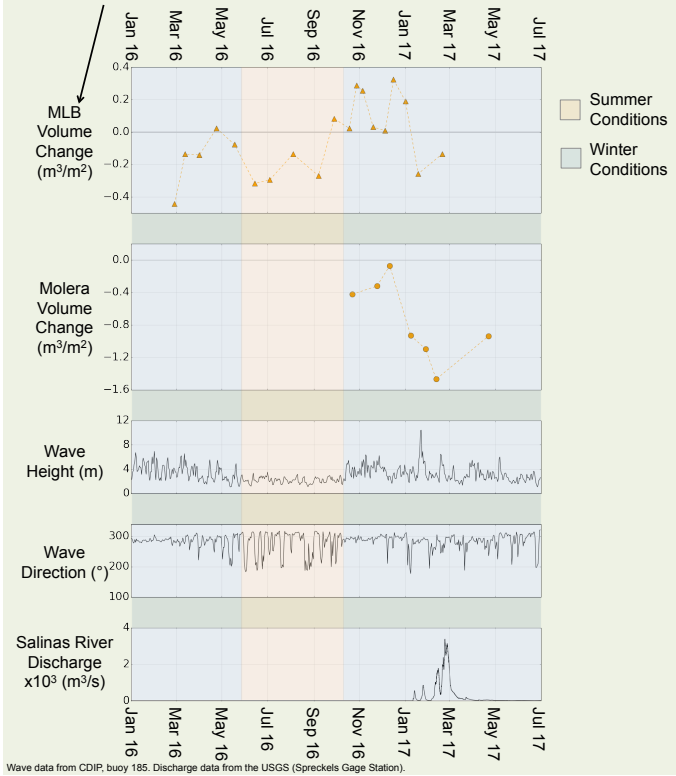


Survey 2 – Survey 1

How to measure volume change when area covered varies from survey to survey?

1. Calculate the volume difference (survey 2 – survey 1) where surveys overlap.
2. Normalize by the planar area

Volume Change (m^3/m^2) = (Survey 2 – Survey 1) / Planar Area



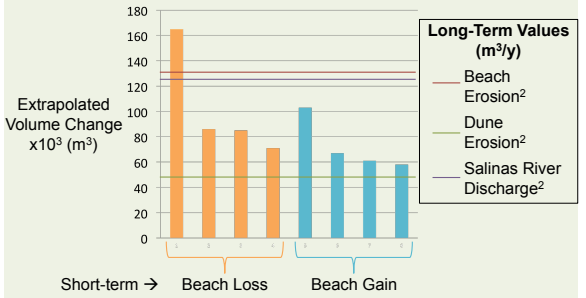
Wave data from CDIP, buoy 185. Discharge data from the USGS (Spreckels Gage Station).

How does short-term beach variability compared to long-term trends and the sediment budget?

Extrapolate volume change to the area of the Salinas Subcell:

1. Assume normalized volume change is representative of the Salinas Subcell.
2. Estimate the length of the subcell and the average beach width.
3. Multiply normalized volume change by the length and width of the subcell.

Extrapolated Volume Change (m^3) = Volume Change (m^3/m^2) x 5,500m x 35 m



Main Findings:

- Short-term beach variability (days to a month) within the Salinas Subcell is on the same order of magnitude as previous estimates of yearly components of the sediment budget for Southern Monterey Bay.
- MLB experiences quick pulses of deposition following select erosional events.
- MLB does not follow the expected accreted beach profile during summer conditions and eroded beach profile during winter conditions.

Future Work

- Rates and direction of littoral drift at various spatial and temporal scales
- Relative contribution of sources and sinks to the sediment budget

References

[1]Dingler, J.R., Reiss, T.E., 2002. Changes to Monterey Bay beaches from the end of the 1982-83 El Niño through the 1997-98 El Niño. Marine Geology, vol. 181, pp. 249-263.

[2]Thornton, E.B., 2016. Temporal and spatial variations in sand budgets with application to southern Monterey Bay, California. Marine Geology, v. 382, pp. 56–67.

[3]Best, T.C., Griggs, G.B., 1991. A sediment budget for the Santa Cruz littoral cell, California. In: Osborne, R.H. (Ed.), From Shoreline to Abyss: Contributions in Marine Geology in Honor of Francis Parker Shepard. Society for Sedimentary Geology Special Publication, vol. 46, pp. 35-50.