San Francisco Bay Sand Budget

Lester McKee, SFEI Presentation to the BCDC Sand Studies Commissioner Working Group 1-3 PM, March 18, 2025

What is a Sediment Budget

- "A statement of the net quantity of sediment deposited or eroded balanced against the sum of sources and external sinks" (Hobbs et al., 1992)
- Mass (or volume) must be conserved "inflow minus outflow must equal the change in storage" (Schoellhamer et al., 2005)
- For a given control volume and period of time:
 - Change in Bed Storage (functionally elevation) = Inflow Outflow
 - \circ $\:$ If inflows are smaller than outflows, bed erosion must occur
- A sediment budget does not account for any sediment outside the control volume. This is deemed permanently stored and not dynamically in transport

Whole-Bay Sediment Conceptual Model



Whole-Bay Conceptual Model



Control Volume: Boundary Conditions and Assumptions

Space - San Francisco Bay

- Mallard Island → Golden Gate Bridge
- Bay is everything below head of tide
- Wetland deposition is assumed to be permanently stored

Accounting period

• 2001-2020

"Active" bed sediment

• Any sediment that is exposed to estuarine currents at any time during the accounting period



Revised USGS bathymetric volume change

- USGS is required to do data releases associated with their reports
- During preparation for release, an error in the Central Bay bathymetric change volume was discovered
- SFEI and BCDC notified September/October 2024
- Below is an excerpt from the revised tables received at that time

	Area of	Sediment	Sand	Sand in	Area of	Sediment	Sand erosion	Sand in	Change in	Change in	Rate of
	sediment	deposition	deposition	depositional	sediment	erosion	volume	erosional	net sediment	net sand	change in
	deposition	volume	volume	areas	erosion	volume	(Mm3)	area	volume in	volume in	net sand
	(km2)	(Mm3)	(Mm3)	(%)	(km2)	(Mm3)		(%)	bed	bed	volume in
									(Mm3)	(Mm3)	bed
											(Mm3/yr.)
Central Bay 2023 DRAFT	114.4	94.24	37.98	40.3	109.2	78.04	36	46.1	16.2	1.98	0.06
Central Bay <mark>revised</mark> FINAL	<mark>123.4</mark>	<mark>100.6</mark>	<mark>40.17</mark>	<mark>39.9</mark>	<mark>100.1</mark>	<mark>72.44</mark>	<mark>33.77</mark>	<mark>46.6</mark>	<mark>28.16</mark>	<mark>6.4</mark>	<mark>0.18</mark>

Revised Sand Sediment Budget - Central Bay



- Net bathymetric mass change was revised by just 50%
- No other elements were revised
- The increase in change from --0.41 to -0.20, caused a large drop in GG flux from 0.25 to 0.034 Mt/y (functionally 0 given uncertainties)

Are the changes "significant" relative to uncertainties?

Boundary	Sand flux (Million metric tonnes per year (Mt/y))							
Central Bay - Pacific Ocean	Lower	Upper	Range	Best				
Old	-0.66	1.1	1.8	0.25				
New	-0.58	0.61	1.2	0.034				

- Old conclusion Given uncertainties net sand flux to the ocean is probably indistinguishably from zero, however, since the sensitivity analysis exaggerates uncertainties there may be a net loss
- New conclusion Given uncertainties net sand flux to the ocean is <u>definitely</u> indistinguishably from zero
- Why the change in range in the sensitivity analysis?
 - NO MISTAKES IN THE PRIMARY BUDGET CALCULATIONS OUT TO 7 DECIMAL PLACES !!
 - But did correct several mistakes in cell formulae in the sensitivity analysis (done in a separate spreadsheet)
 - Carried forward more significant figures

How Does Mining Affect the Budget?

- Sand mining is the largest term in the <u>whole Bay</u> sand budget and in the <u>Suisun and Central Bay budgets</u>. Mining undoubtedly has an influence on the Bay morphodynamics at both these scales.
- If the sand mining were to be "turned off", since <u>sand mining is a large term</u>, there would be <u>large changes to other elements</u> in the budget.
- BUT A BUDGET AT THESE SCALES CANNOT TELL US WHICH OTHER ELEMENTS WOULD CHANGE AND BY HOW MUCH (BUT MASS MUST BE CONSERVED).

Next steps

- Revise the
 - Sediment budget report with the new numbers and a slightly adjusted story
 - Document all changes in a track changes version and a final version
- Revise the
 - Sand budget summary report
 - Document all changes in a track changes version and a final version
- Revise the sand budget data base
 - Final published USGS data release
 - Final published USGS bathymetric change report
 - Final versions of revised SFEI documents

