Sedimentation in our Bay

...More than Mud!

**How It Works**

Rivers and streams pick up rocks and dirt, carrying these sediments as they flow toward San Francisco Bay. When the river meets the Bay, it slows, depositing sediment.

In San Francisco Bay, these particles of rocks and dirt are continually deposited and resuspended into the water by tidal currents and wind-driven waves.

Water brought to shore slows when it reaches the marsh. This slowing causes suspended particles to fall from the water.

Larger sediment particles settle out first, near the edges of the marsh and creek channels. This deposition offsets some erosion at the edge of the marsh and creates creek levees.

As the waters flow over the marsh, they continue to slow. Smaller particles settle out onto the marsh plants and soil surface. At high tide, the water is neither rising nor falling, allowing all but the smallest particles to settle out.

As the ebb tide drains the marsh, some sediments are re-eroded and transported back into the Bay where they continue the cycle of deposition and erosion.

**Did You Know?**

A group of microscopic algae called diatoms play a key role in marsh and mudflat accretion. They live in the top 2 millimeters of sediment – that’s the thickness of just 20 sheets of paper. These organisms produce mucus as part of their propulsion system, and this mucus traps fine sediments, preventing the sediments from being carried back into the water.

accretion - The net build-up of sediment over time: total sedimentation minus total erosion.

**Scientist Spotlight**

**Oliver Fringer, Ph.D.**

Department of Civil and Environmental Engineering, Stanford University

Professor Fringer’s fluid dynamics lab uses computer models to study sediment transport and coastal ocean circulation. A key to modeling is incorporating accurate underwater topography and knowing the initial distribution of sediments throughout San Francisco Bay. Surprisingly, this is the most difficult part because the sediment constantly moves. “You think you know it, and then the tide comes in and out a few times!” says Fringer. His research examines the effects of restoring tidal action to former salt ponds on the rest of San Francisco Bay.
**WHY SEDIMENTATION MATTERS**

- High tides, storms, and seasonal floods can cause erosion and flooding at the water’s edge. If salt marshes are present, they can absorb the effects of these natural occurrences and protect the **uplands**. Sedimentation naturally renews this protective barrier.

- As sea level rises, the balance of sedimentation and erosion can build up the salt marsh, maintaining its height, as long as there are sufficient sediment sources.

- The photosynthetic organisms floating in the Bay require light. Tidal currents and wind-driven waves erode sediment from the mudflats and shallow waters of the Bay, reducing the amount of light that penetrates Bay water.

- Pollutants such as heavy metals and **PCBs** become attached to sediment particles, or are themselves particles that settle out of the water. As sediments are cycled in the Bay by sedimentation and erosion, the Bay ecosystem is continually exposed to pollutants that may have been deposited long ago. To understand and remediate pollutants in the Bay, patterns of sedimentation and erosion must be taken into account.

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**SEDIMENTATION RESEARCH**

If you were designing a salt marsh restoration project or a new development along the Bay shoreline, how could you estimate changes in the salt marshes so that your project would last for decades? Researchers use computer simulation models to predict and analyze changes in marsh elevation over time and under varying environmental conditions.

1. Scientists research the current scientific understanding of factors contributing to salt marsh accretion and erosion. They critically examine previous studies, looking for uncertain assumptions or missing processes.

2. Researchers use the physics known to govern each of these processes to develop a mathematical description of the system, called an analytical model.

3. To obtain estimates for input parameters for the model, researchers look in the scientific literature, take field measurements, and utilize data gathered by government agencies.

4. Researchers use a computer to do the thousands of calculations necessary to apply the analytical model and input parameters at many points in time and space.

5. To check for accuracy, researchers compare the simulation results to field or laboratory data.

6. By running simulations many times with different input parameter values, researchers use the model to test the effects of varying environmental conditions, such as lower and higher wind speeds, wave heights, and water speeds.

7. Researchers use this new, more in-depth understanding to inform others and help plan future management decisions. For example, if the model predicts a loss of salt marsh in one location, then a researcher might recommend building a bulkhead to prevent erosion.

Such models help researchers identify which parameters affect the result of interest, such as marsh height. Models are also used to estimate what may happen in the future, process information from very long or very short time scales, and look back in history.

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**Did You Know?**

Suspended sediment gives San Francisco Bay its brown color most noticeable on windy afternoons.

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**UPLANDS**

Areas above the reach of the tides and river waters. These are the lands our schools, houses, and workplaces sit on.

**PCBs** – Polychlorinated biphenyls are persistent organic pollutants that were once used in transformers, capacitors and coolants. These chemicals are highly toxic and were banned in 1976. Unfortunately, they degrade slowly and are still found in high concentrations in some areas.

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*created by Allison Stafford, Stanford University School of Earth Sciences, 2009*