The geomorphic-social resiliency of Fire Island, NY: A millennial perspective

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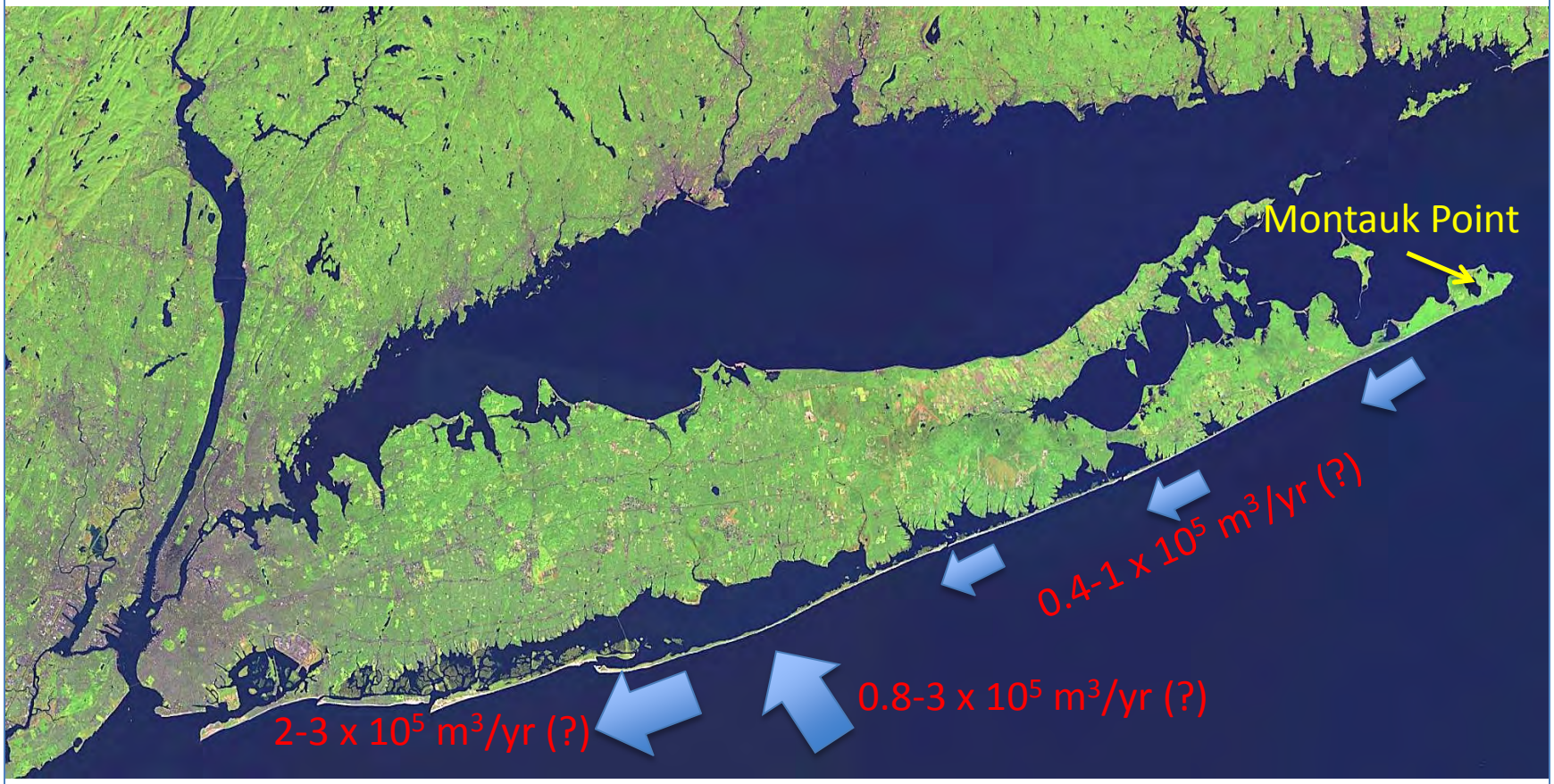
Long Island's Barrier-Island System

Estimated Sand Inputs (Hapke et al., 2010)



Long-term resiliency: What is it?

Geomorphic resiliency

1. Operates over the long term (millennia).
2. Requires change: landward migration as sea-level rises.
3. Barrier-island migration necessitates:

- Overwash processes;
- Flood-tidal delta development;
- Back-barrier salt marshes.

Short-term resiliency: What is it?

Engineering resiliency

1. Operates over the short term (years/decades).
2. Dominant mode is control, meaning stasis.
3. Barrier-island control necessitates:

- Restoration with or without armoring;
- Commitment to nourish beaches every 5-10 years;
- A solution that is economically impossible over centuries and millennia.

How should we manage Fire Island?

Should management decisions be based on a simplistic either/or (engineering or geomorphic) resiliency?

What about complex management decisions located between the two polar extremes?

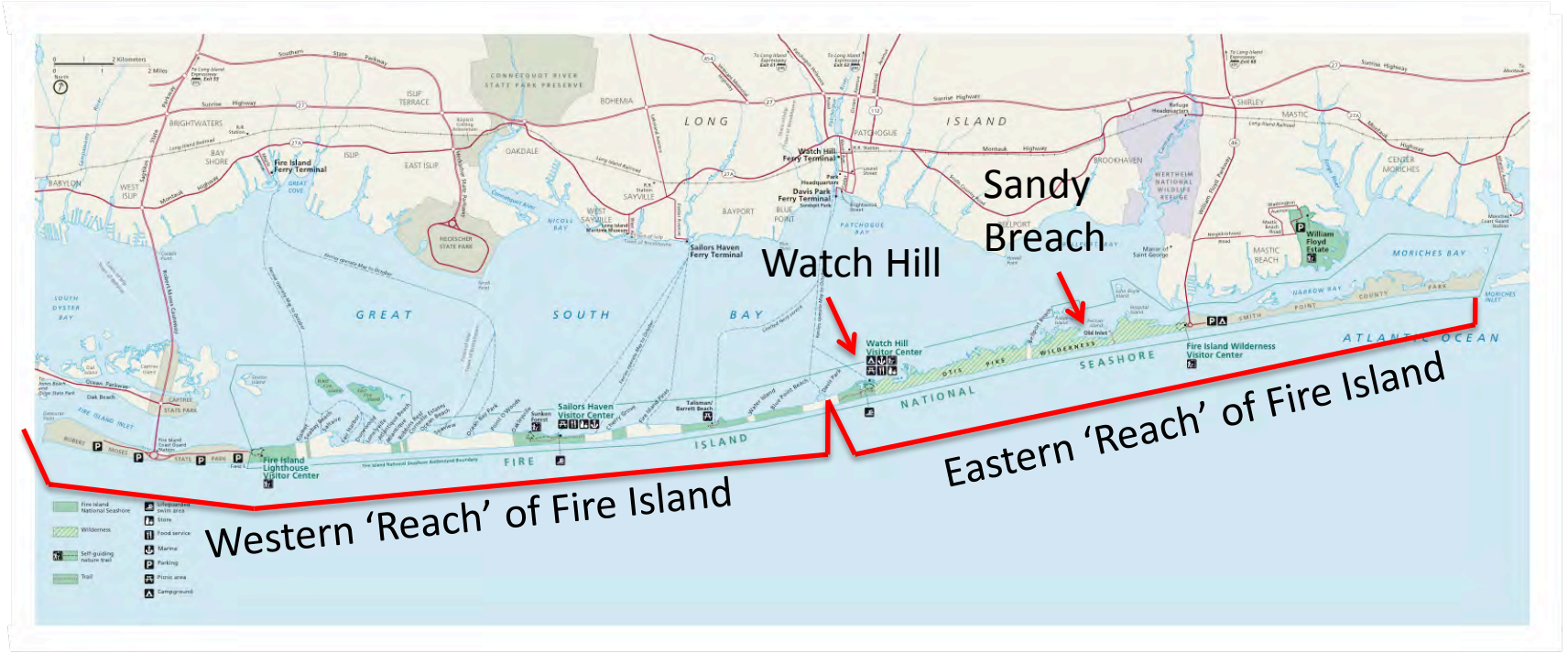
Can we separate small spatial/temporal scales with their fast variables from large spatial/temporal scales with their slow variables?

What are the possible outcomes of sea-level rise on barrier islands?

Both field data (stratigraphy) and modeling experiments indicate that barrier islands subjected to a substantial rise of sea level will either:

- Disintegrate,
- Drown in place, or
- Migrate landward.

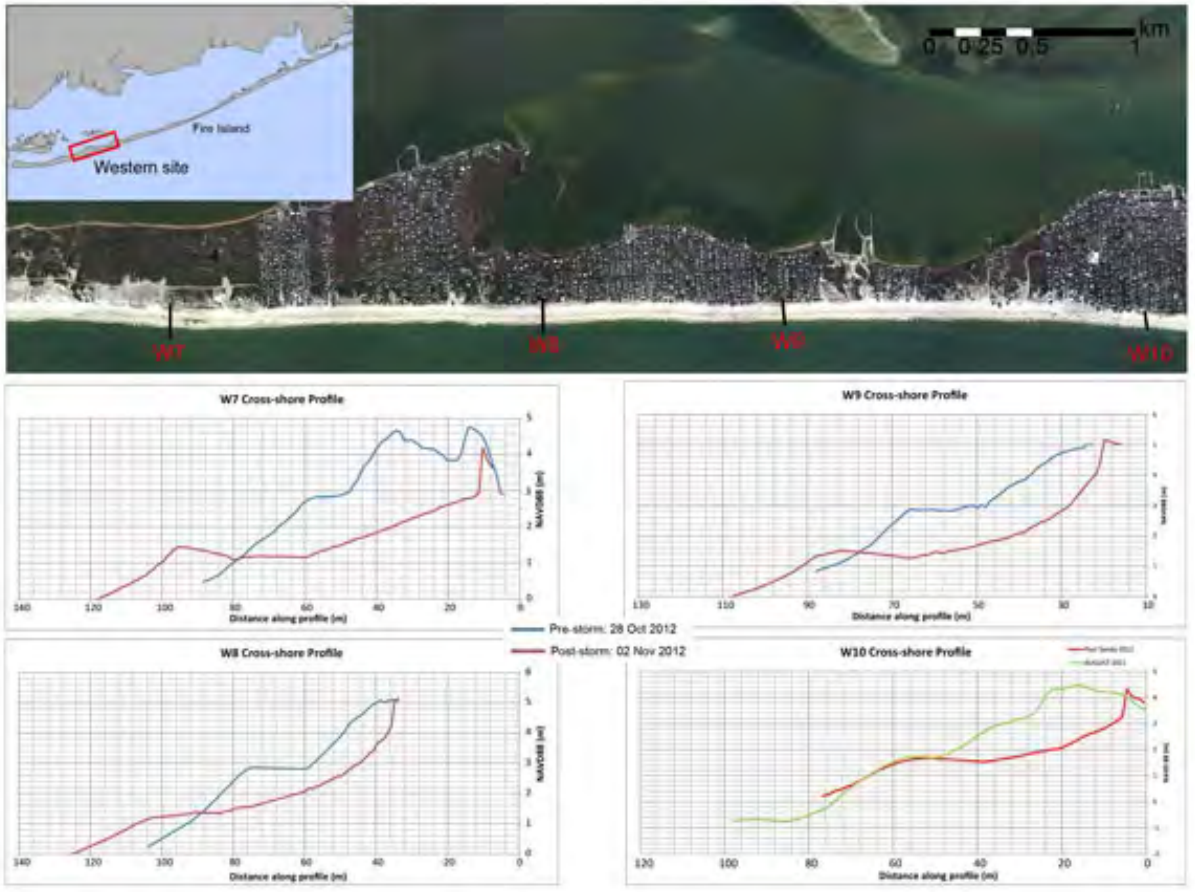
Only the latter outcome is naturally resilient!


Sandy
Breach
Watch Hill
Western ‘Reach’ of Fire Island
Eastern ‘Reach’ of Fire Island
GREAT
SOUTH
BAY
LONG
ISLAND
FIRE
ISLAND
ATLANTIC OCEAN
Watch Hill Visitor Center
Fire Island Wilderness Visitor Center
Sailors Haven Visitor Center
Fire Island Lighthouse Visitor Center
Fire Island Ferry Terminal
Watch Hill Ferry Terminal
Sailors Haven Ferry Terminal
Davis Park Ferry Terminal
William Floyd Estate
OTIS PIKE WILDERNESS
SEASHORE
NATIONAL

Western reach of Fire Island

- Densely populated.
- Highly developed with infrastructure.
- Receives updrift and cross-shore sand input.
- Hurricane damage of dunes and beaches relatively modest.
- No significant history of breaching and overwash processes.

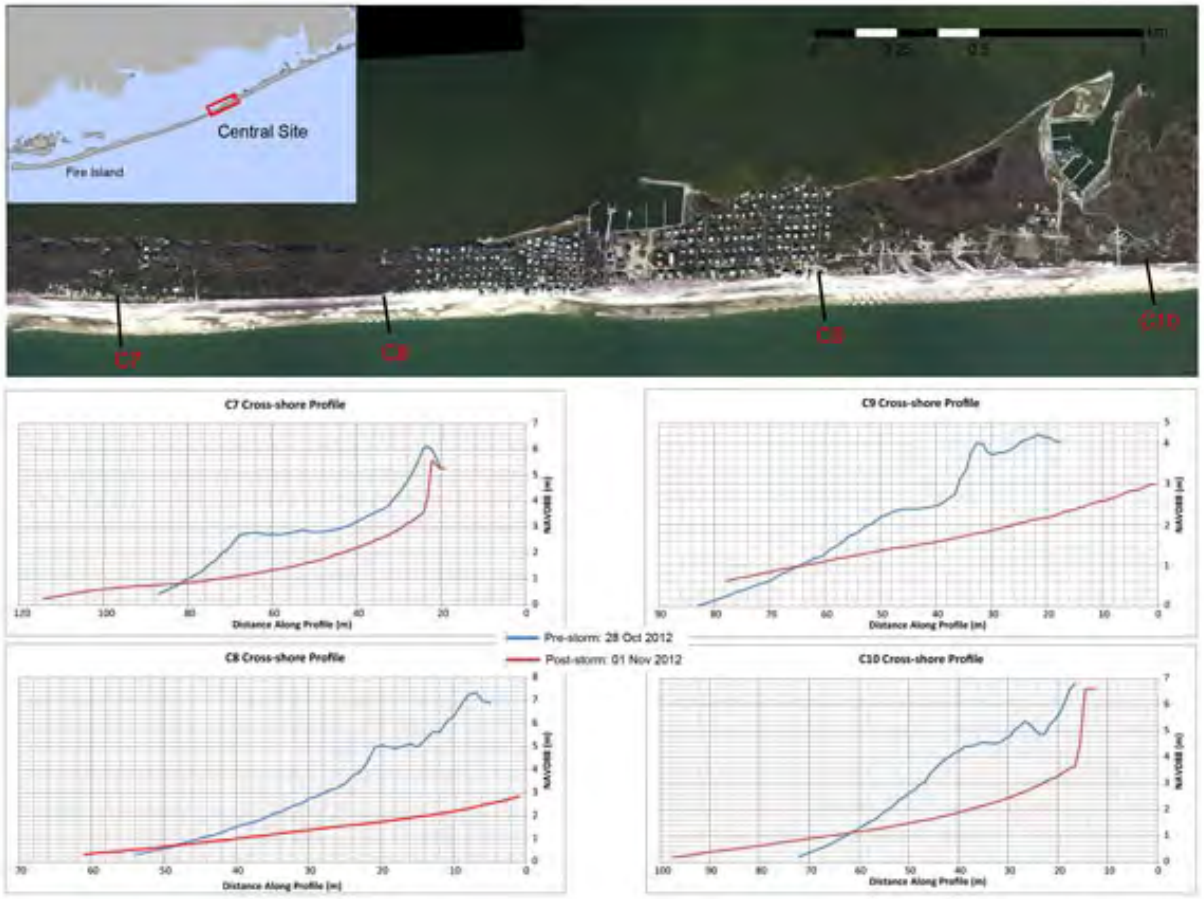
Storm damage by hurricane Sandy along western reach (USGS data)



Eastern reach of Fire Island

- Dominated by parkland and wilderness.
- Modest population in scattered communities.
- Receives mainly updrift sand input.
- Has a long history of storm breaching.
- Highly susceptible to overwash.
- “exhibits more consistent landward migration patterns than the western reach” (Lentz et al., 2013).

Storm damage by hurricane Sandy along east-central reach (USGS data)



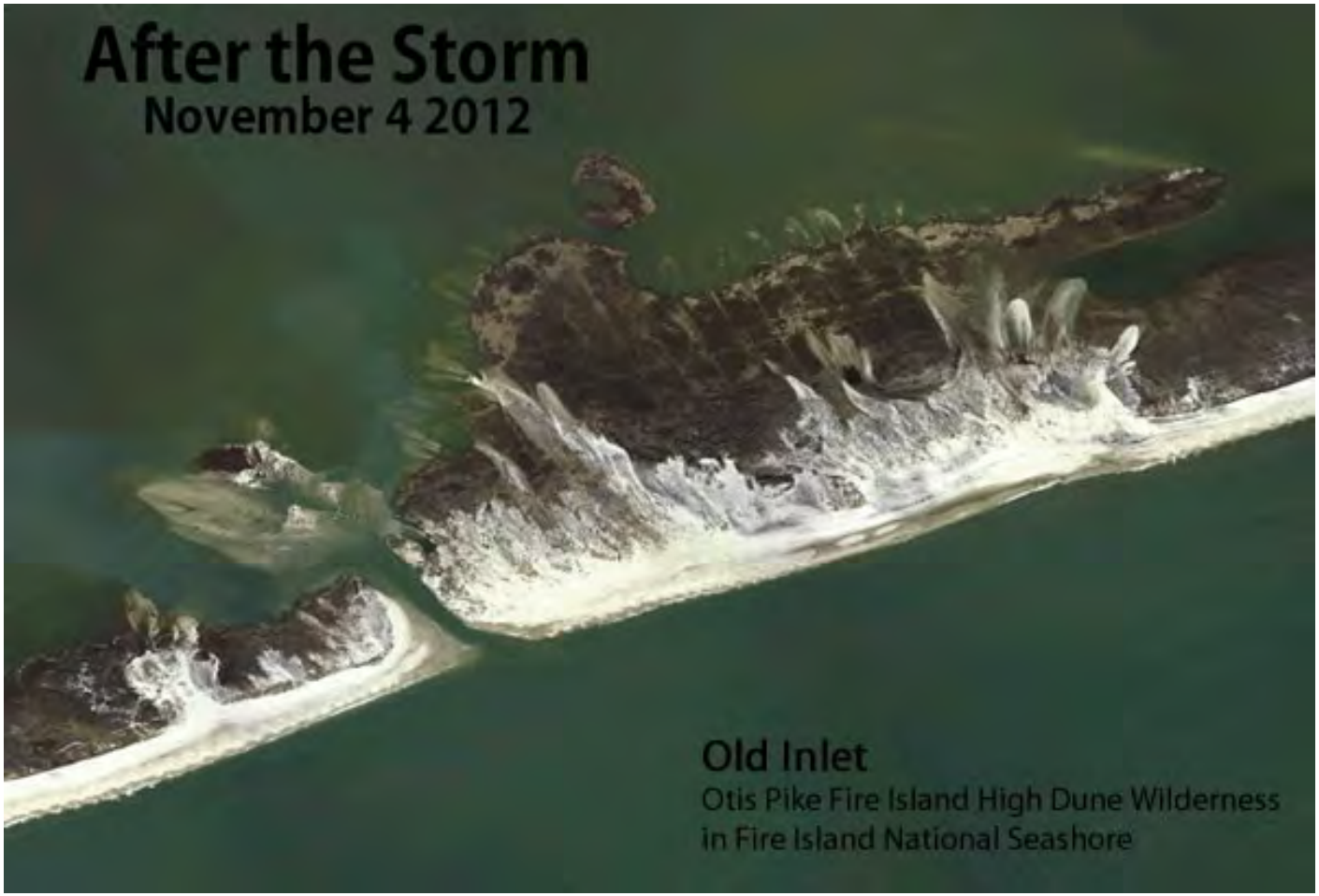
A management strategy for the western reach of Fire Island

- Deal appropriately with “soft” engineering solutions (nourishment, breaching closure, dredging) to protect property and infrastructure.
- Promote the growth of dunes and salt marshes; do not dredge nearshore sand.
- Be certain that the public understands that these engineering solutions are not economically sustainable over centuries.

A management strategy for the eastern reach of Fire Island

- Apply “soft” engineering strategies that resonate with long-term migration, allowing, even promoting the vertical sand build-up of the island’s interior and backshore.
- Use a system’s approach and protect the longshore drift of sand received from updrift barrier islands and mainland beaches.
- Remain flexible about the closure of breaches.
- Humans will have to adapt to island migration.

Storm breach at Old Inlet (USGS)



What will happen to Fire Island after several millennia of sea-level rise?

- A sea-level rise of ~ 2.3 m/^{o}C over the next 2,000 years (Levermann, et al., 2013)
- The western reach likely will have low geomorphic resiliency and be in an advanced stage of disintegration.
- The eastern reach will have migrated bayward by hundreds of meters and be fragmented (?), though geomorphologically resilient.