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!
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/°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.