



Coastal Geomorphology: Monitoring Mangrove Soil Surface Elevation Tables in Biscayne National Park

2020

Importance

Mangrove wetlands provide flood control, storm protection, shore stabilization, water filtration (capturing soil runoff), carbon sequestration, and habitat for fish and wildlife communities. The economic value of the services derived from mangroves has been estimated as high as \$200,000–\$900,000 per hectare (Wells et al. 2006).

Soil elevation, hydrology, and mangrove forest health exist in a feedback loop. The soil elevation in mangrove forests affects tidal inundation period and frequency, overall hydroperiod, sedimentation, erosion, and the shrink and swell of soil materials, all of which affect mangrove seedling species recruitment, community composition, and survival (Whelan et al. 2005; Whelan et al. 2009). If the rate of relative sea level rise (2.32–2.65 millimeters per year [0.09–0.10 inches] in Key West, Florida; tidesandcurrents.noaa.gov) is greater than the rate at which mangrove soil elevation increases, as the trees die off and there is no mangrove recruitment to replace them. These areas will eventually convert to shallow open water marine habitats and the mangrove forest will move inland (upslope).

Understanding the rate of change in mangrove soil elevation is critical to predicting the long-term ability of mangrove forests to regenerate.

Objectives and Approach

The objective is to monitor rates of soil accretion and erosion to determine if soil processes are keeping pace with the rate of relative sea level rise. The approach uses Soil Surface Elevation Tables (SETs) and marker horizons. A SET instrument is designed to temporarily attach to a permanent benchmark and fiberglass pins are lowered to measure the distance to the sediment surface (Figure 1). The marker horizons are a layer of feldspar placed on the soil surface allowing measurement of deposition at the site using soil cores (Figure 2). There are two soil elevation monitoring stations (BISC1 and BISC2) located in Biscayne National Park (BISC).

Our approach has been documented using a [protocol implementation plan](#) with seven standard operating procedures and four appendices specific to this network (Whelan et al. 2016).



Figure 1. Kevin Whelan, SFCN ecologist, is measuring soil surface elevation using the Soil Elevation Table (SET). The SET is attached to a permanent benchmark. The height of the pins transcribes the elevation of the soil and standardizes it to a fixed reference point (the metal arm). Repeated measurements over time monitor the rate of soil elevation change.



Figure 2. Measuring accretion, which is the material deposited above the white line. The white line is feldspar, a mark layer placed at the site on a previous sampling event. Here we can see turtle grass (*Thalassia testudinum*) that is becoming incorporated into the soil.



Results

Both sites were monitored in fall of 2019, however due to COVID19 no monitoring was conducted in spring or fall of 2020. During the fall 2019 sample event, it appears that the soil surfaces at both sites were gaining in elevation. Over the period of monitoring, the accretion levels seem to be steadily increasing. Total soil surface elevation increased for a period of time (until 2016), then more recently the surface elevation decreased. This suggests that while the overall soil elevation is gaining accretion at the soil surface, below ground processes (e.g., subsidence, compaction) may be causing overall elevation loss. Both sites are subject to periodic seagrass inputs that cause spikes in accretion that then appear to incorporate into the soil profile over time. One such spike occurred during the most recent sampling in August 2019 right after two tropical storm events (Figure 3).



Figure 3. Lasting damage from Hurricane Irma at BISC1 includes downed trees and piles of debris.

In 2017, the South Florida SET sites were affected by Hurricane Irma. Since the hurricane, sites exhibited signs of windstorm damage (Figure 3). Immediate effects of the storms on the elevation data appeared to be minimal (Figure 4). Storm deposition from Hurricane Irma occurred further inland than the monitoring sites locations. However, the long-term impacts of mangrove die-off are not yet known and will require continued long-term elevation monitoring.

References:

Wells, S., C. Ravilous, and E. Corcoran. 2006. In the Front Line: Shoreline Protection and Other Ecosystem Services from Mangroves and Coral Reefs. United Nations Environment Programme World Conservation Monitoring Centre, Cambridge, UK.

Whelan, K. R. T., T. J. Smith III, G. H. Anderson, and M. L. Ouellette.

2009. Hurricane Wilma's impact on overall soil elevation and zones within the soil profile in a mangrove forest. *Wetlands*, 29(1):16–23.

Whelan, K. R. T., T. J. Smith III, D. R. Cahoon, J. C. Lynch, and G. H. Anderson. 2005. Groundwater control of mangrove surface elevation: Shrink and swell varies with soil depth. *Estuaries*, 28(6): 833–843.

Whelan, K. R. T. 2016. Protocol implementation plan for monitoring mangrove soil surface elevation tables in South Florida / Caribbean Network parks. Natural Resource Report NPS/SFCN/NRR—2016/1249. National Park Service, Fort Collins, Colorado.

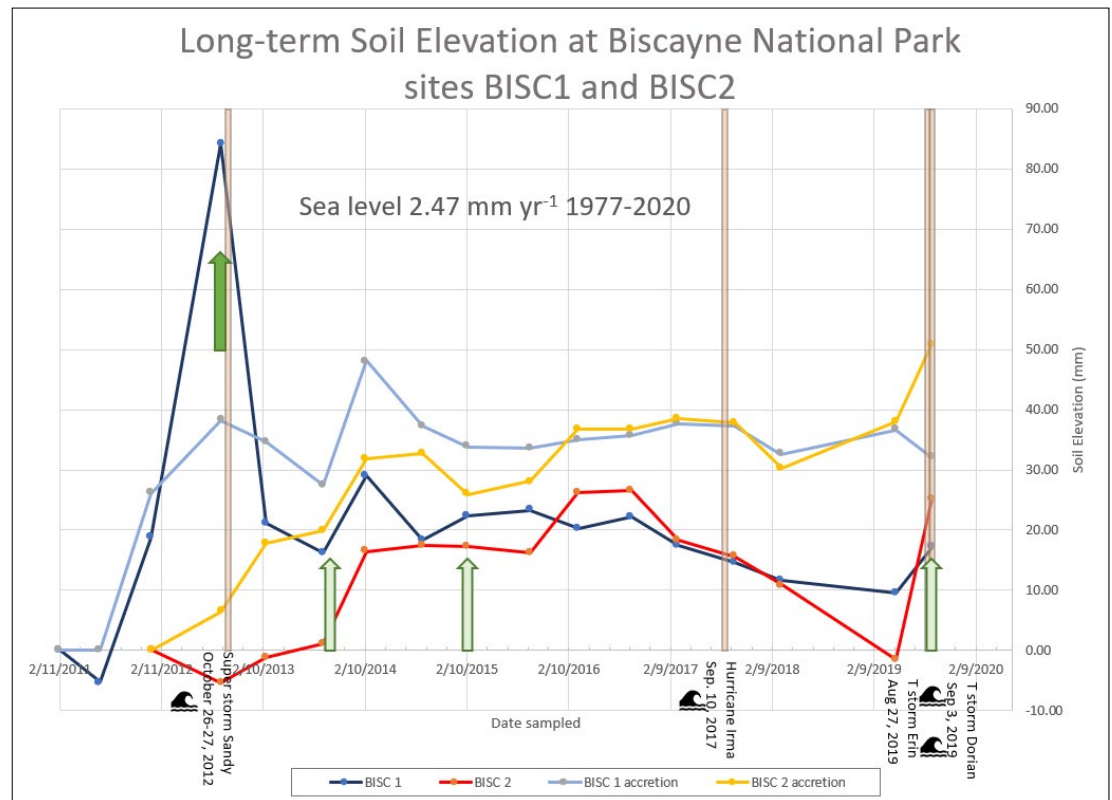


Figure 4. The graph depicts the absolute change in mangrove soil surface elevation and accretion at BISC 1 and BISC 2 since their establishment in 2011 and 2012, respectively. Vertical bars indicate storm events, dark green arrows indicate seagrass washup events at BISC1, and light green arrows indicate seagrass washup events at BISC2.



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<https://www.nps.gov/im/sfcn/coastal-geo.htm>

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