

South Florida/Caribbean Network Inventory and Monitoring

National Park Service
U.S. Department of the Interior



Coastal Geomorphology: Monitoring Mangrove Soil Surface Elevation in South Florida/Caribbean Network Parks

Importance: Monitoring Mangrove Soil Surface Elevation In Relation to Sea Level

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 level 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. 2009; Whelan et al. 2005). If the rate of relative sea-level rise (2.18–2.48 millimeters per year in Key West, Florida; tidesandcurrents.noaa.gov) is greater than the rate at which mangrove soil elevation increases, then the areas currently occupied by mangrove forests will eventually convert to shallow open water marine habitats as the trees die off and there is no mangrove recruitment to replace them, 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.



Figure 1. Kevin Whelan (Ecologist, National Park Service) measures soil surface elevation using the Soil Elevation Table (SET). The SET is a sampling device that 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.

Objectives and Approach: Using Soil Elevation Tables (SETs) and Marker Horizons

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 (Figure 1) attach to a permanent fixed location and long pins are lowered to measure the distance to the sediment surface. The marker horizons are a layer of feldspar placed on the soil surface allowing measurement of deposition at the site using soil cores. There are soil elevation monitoring stations (SETs) located in Biscayne National Park, Virgin Islands National Park and Salt River Bay National Historical Park and Ecological Preserve.

Our approach has been documented using a protocol implementation plan of an established protocol with seven standard operating procedures and four appendices specific to this network. This document has finished the review process and was published as NPS/SFCN/NRR–2016/1249.



Figure 2. In 2017, SFCN finished surveying the SET benchmarks. Surveying will be done once a year at all of the sites using the Standard Operating Procedure created by National Park Service Academy intern Ana Rojas.



South Florida/Caribbean Network
18001 Old Cutler Rd. Suite 419
Palmetto Bay, FL 33157

http://science.nature.nps.gov/im/units/sfcn/monitor/geomorphology/coastal_geomorphology.cfm

Results

All SET sites were monitored twice in Fiscal Year 2017. Soil processes are long term events and it takes approximately five years of soil elevation data before interpretation of the rate of soil surface elevation can begin. Most of these sites have too few sampling events to interpret the data; however, we have included a graphic (Figure 3) of soil elevation data for Biscayne National Park for site BISC1 established in February 2011.

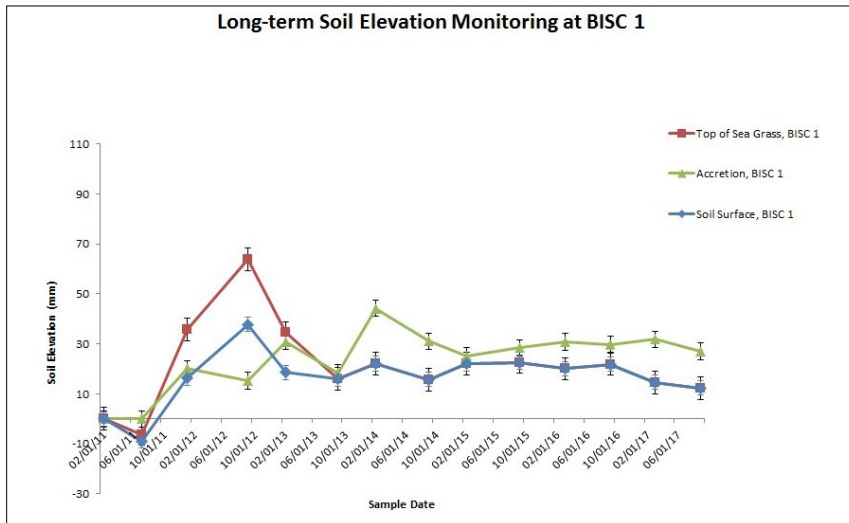


Figure 3. The graph depicts the absolute change in mangrove soil surface elevation, and accretion at one site in Biscayne National Park since the establishment of the SET in 2011. Top of sea grass was included as a measurement at some visits due to an overwhelming amount of deposited sea grass.

NPS Academy Intern, Ana Rojas, correlated shallow soil wells established at the BISC sites which measure water depth to a hydrological stage gauge managed by the South Florida Water Management District (Figure 4). A standard operating procedure was developed which determines the relationship between the two measurements. The South Florida/Caribbean Network can now predict the duration of flooding and maximum water depths at the BISC site based on the data at the stage gauge.

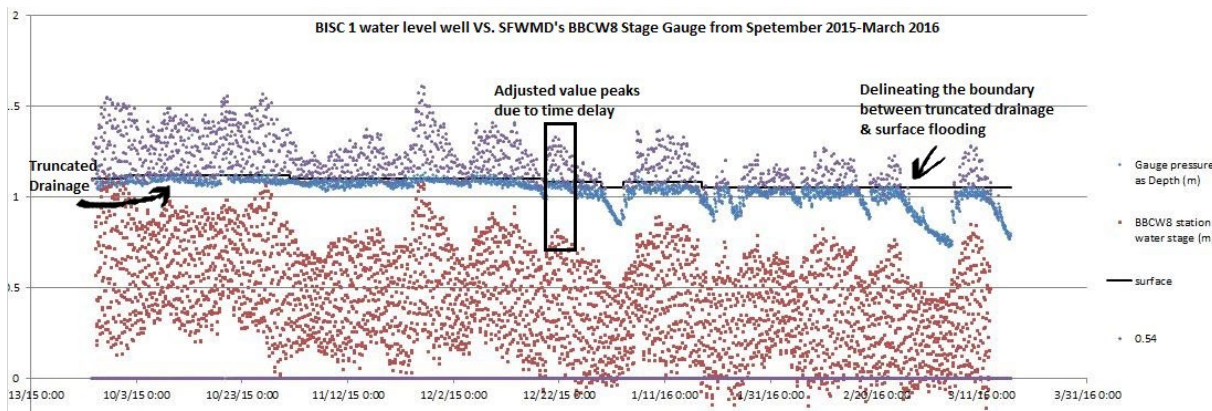


Figure 4. Graph of time series correlation between BISC 1 shallow water well and the BBCW8 stage gauge.

Literature Cited

- Wells, S., Ravilous, C., Corcoran, E., 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.



South Florida/Caribbean Network
18001 Old Cutler Rd. Suite 419
Palmetto Bay, FL 33157

http://science.nature.nps.gov/im/units/sfcn/monitor/geology/coastal_geomorphology.cfm