



## Coastal Geomorphology: Monitoring Mangrove Soil Surface Elevation Tables in Virgin Islands 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 (2.06 millimeters per year [0.081 inches] in St. Thomas; [tidesandcurrents.noaa.gov](https://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 (upper photo) attach to a permanent benchmark and fiberglass 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 two soil elevation monitoring stations (SETs) located in Virgin Islands National Park (VIIS)

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

Due to COVID19, no monitoring was conducted in spring or fall of 2020. The overall soil surface elevation at VIIS Mary's Creek appears to be increasing since its establishment in June 2014. Both the accretion and overall site elevation appear to reflect the same pattern suggesting that elevation at this site is driven by surface accretion (Figure 3). VIIS Water Creek's overall elevation also appears to be increasing since its establishment in June 2014. VIIS Water Creek is located at the base of a slope, and it appears that material is deposited from upslope periodically and is then incorporated into the soil profile. The break in accretion reflects a gap in sampling when the original accretion plots had no recovery, and new plots were established (Figure 3).

In 2017 both Saint John VIIS SET sites were hit by Hurricane Irma and Hurricane Maria (Figures 4 and 5). Since the hurricanes, the sites were visited and signs of severe wind storm damage were observed, with up to 90% tree mortality. Direct effects of the storms on the soil elevation data appeared to be minimal. However, the long term impacts of mangrove die-off are unknown and will require continued long-term elevation monitoring.



**Figure 4.** Hurricane damage at Saint John VIIS SET site. Severe wind damage caused debris deposits, mangrove die-off, and missing or damaged platform boards.

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.

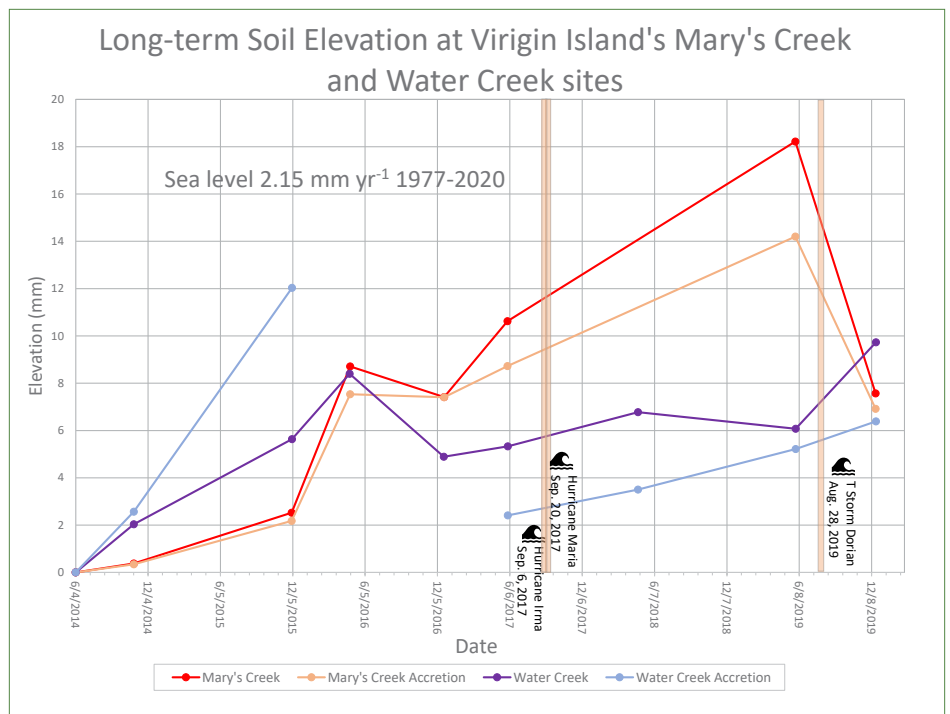


**Figure 3.** The graph depicts the absolute change in mangrove soil surface elevation at VIIS Mary's Creek and Water Creek. Vertical bars indicate storm events. The sea-level estimate is from the Charlotte Amalie NOAA tide gauge station on Saint Thomas (<https://tidesandcurrents.noaa.gov/>).



**Figure 5.** Hurricane damage at Saint John VIIS SET site. Severe wind damage caused debris deposits, mangrove die-off, and missing or damaged platform boards. This site had a capsized 30 foot boat in it.

