Determining coarse woody debris and dead biomass in mangrove forests of the Florida Everglades after Hurricane Irma using airborne lidar imagery

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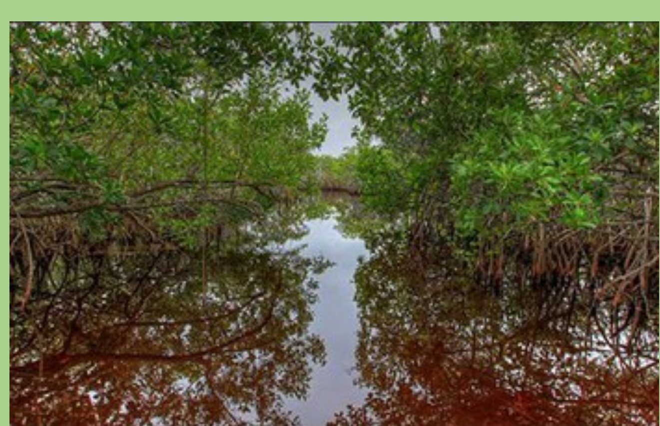
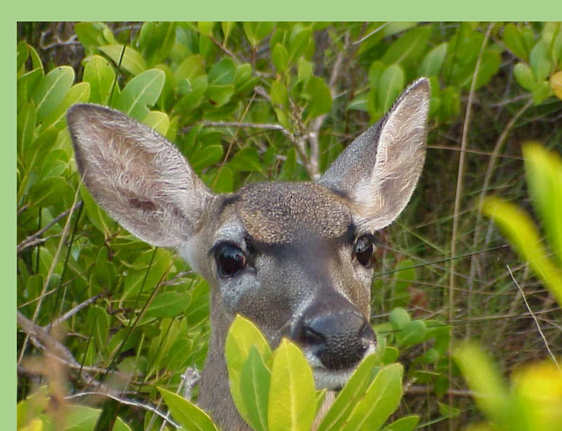
Introduction

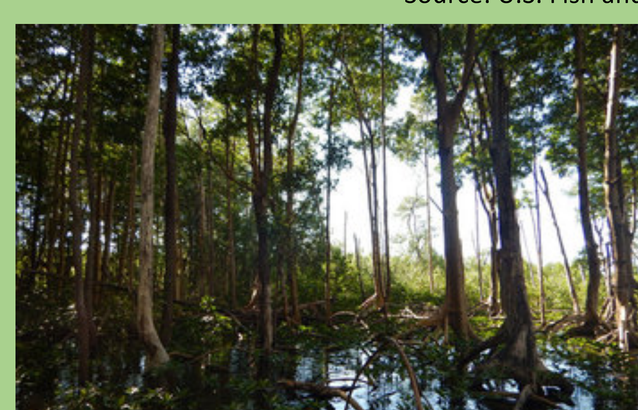
Mangrove forests provide important biological and socioeconomic ecosystem services. Some of the benefits of mangroves include helping provide critical habitats for animals and commercial fish stocks, helping store carbon, and providing wood and wood products for local communities. Another important benefit of mangrove forests is their role in protecting coastlines from large storms such as hurricanes. Although mangroves help protects coastal communities from large and powerful storm events, mangroves themselves can be highly damaged as result of storm impacts. This includes defoliations, broken branches, and snapped and fallen tree and also standing dead trees. Hurricane Irma hit the south Florida in September 2017 as a category 3 hurricane causing damage to mangrove forest located in the area. Figure 1. displays some photos of examples of mangroves found in the Everglades National Park



Source: National Park Service



Source: U.S. Fish and Wildlife Service by Paul Frank



Source: National Park Service

Figure 1. Examples of mangroves in found in the Everglades National Park

Study Area

Our study area will encompass the mangrove forest areas located within the Everglades National Park. The mangroves forest located in the Everglades are the largest mangrove forests in North America, which is periodically impacted by hurricanes. It is estimated to cover an area of about 224,579 hectares and includes three mangrove types: Red mangroves (*Rhizaphora mangle*), Black mangroves (*Avicennia germinans*) and White mangroves (*Laguncularia racemosa*). A map of the extent of mangrove within the Everglades National Park and aerial photography image of damage from Hurricane Irma can be seen in Figure 2.

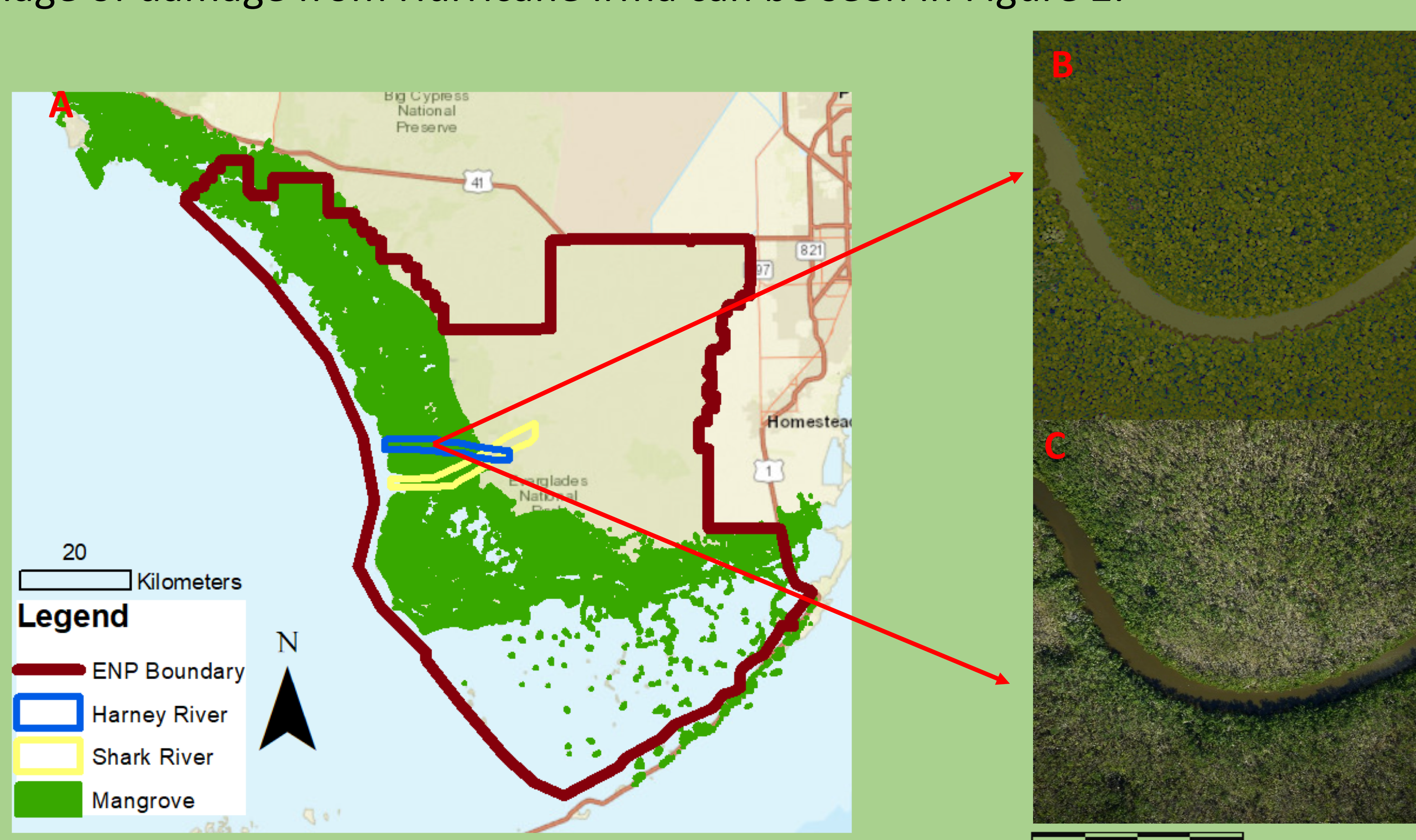


Figure 2. (A) Extend of Mangroves within the Everglades and a aerial photography showing before (B) and after (C) imagery of mangrove located in the Harney River affected by Hurricane Irma taken from the G-LiHT data portal

Data

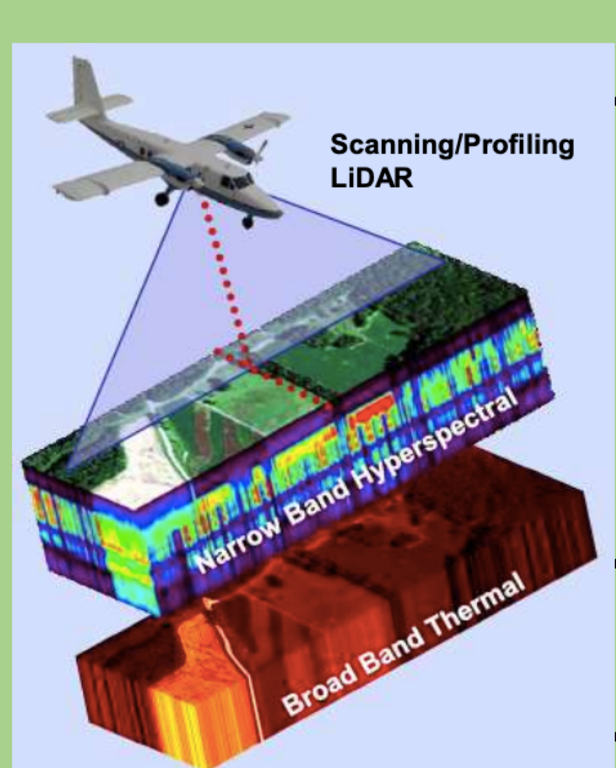


Figure 3. Overview of the G-liHT imager including a look at how the Lidar, hyperspectral and thermal imager all work together. (University of Alaska Fairbanks Hyperspectral Imaging laboratory,2013).

- Lidar data from NASA's Goddard's Lidar, Hyperspectral, and Thermal (G-LiHT) was used. The G-LiHT system includes a Lidar (Light Detection and Ranging) Scanner that provides 3D information on foliage and canopy elements using a pulsed laser, as well as hyperspectral and thermal sensors that further help gather addition data about vegetation cover and land surfaces.
- In early 2017 G-LiHT was flown over the Everglades to determine forest structure and and other biophysical variables
- A few months later the everglades where impacted by Hurricanes Irma. In order to assess the hurricane's damage on the mangrove forests, another campaign was flown over the Everglades. Before and after point clouds and changes in point count can be scene in Figure 4.

Preliminary Results

Using the location of field plots established in a January 2018 rapid forest assessment, lidar data from two G-LiHT flights acquired in March and December 2017 where downloaded and processed. Starting at 0.25 meters, the point cloud for each plot was dived by half meter intervals and the number of pulse returns at each height class was calculated. The relationships between mean course woody debris (CWD), standing dead biomass , and different G-LiHT metrics can be applied to calculate and model CWD volumes and standing dead biomass for entire area of mangrove forests along Shark and Harney Rivers. Currently we were able to model standing dead biomass for the Shark River and Harney River to be an estimated 6.0 Mg/ha and 8.3 Mg/ha, respectively, representing roughly 5-10% of the pre-hurricane above ground biomass in the study areas. Map of a preliminary standing dead biomass model can be scene in Figure 5.

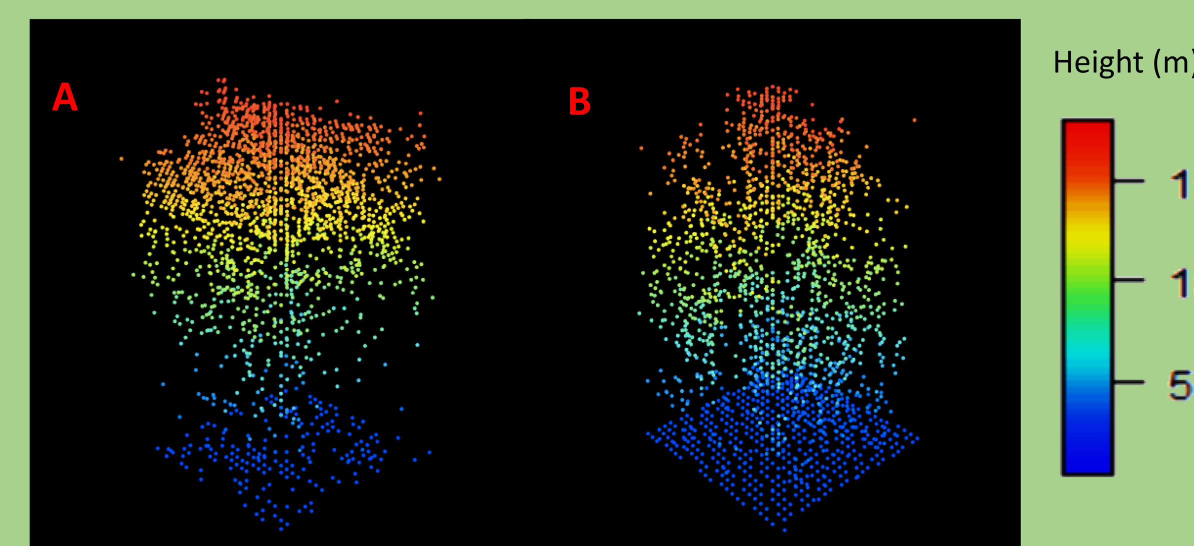


Figure 4. Processed point clouds showing 3D mangrove structure before Irma (a) in which you see a higher point density in upper height of canopy and after Irma (B) where we see point cloud is less dense in upper canopy and more return toward the ground.

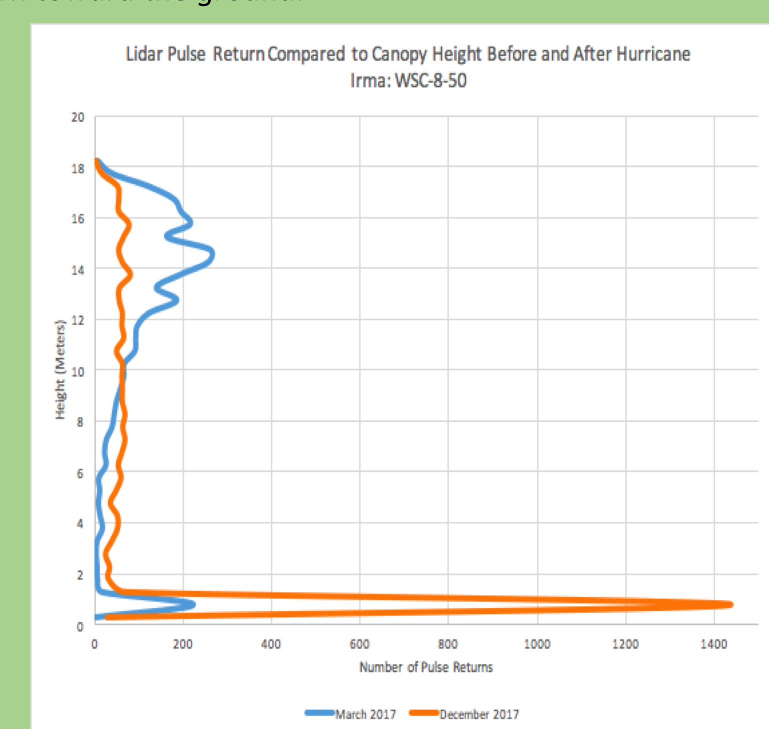


Figure 5. Lidar pulse returns at different heights before Irma and after Irma for site WSC-8-50 located along the Harney River. The blue curve is the pulse return at different height before Irma and the orange curve shows pulse return after Irma

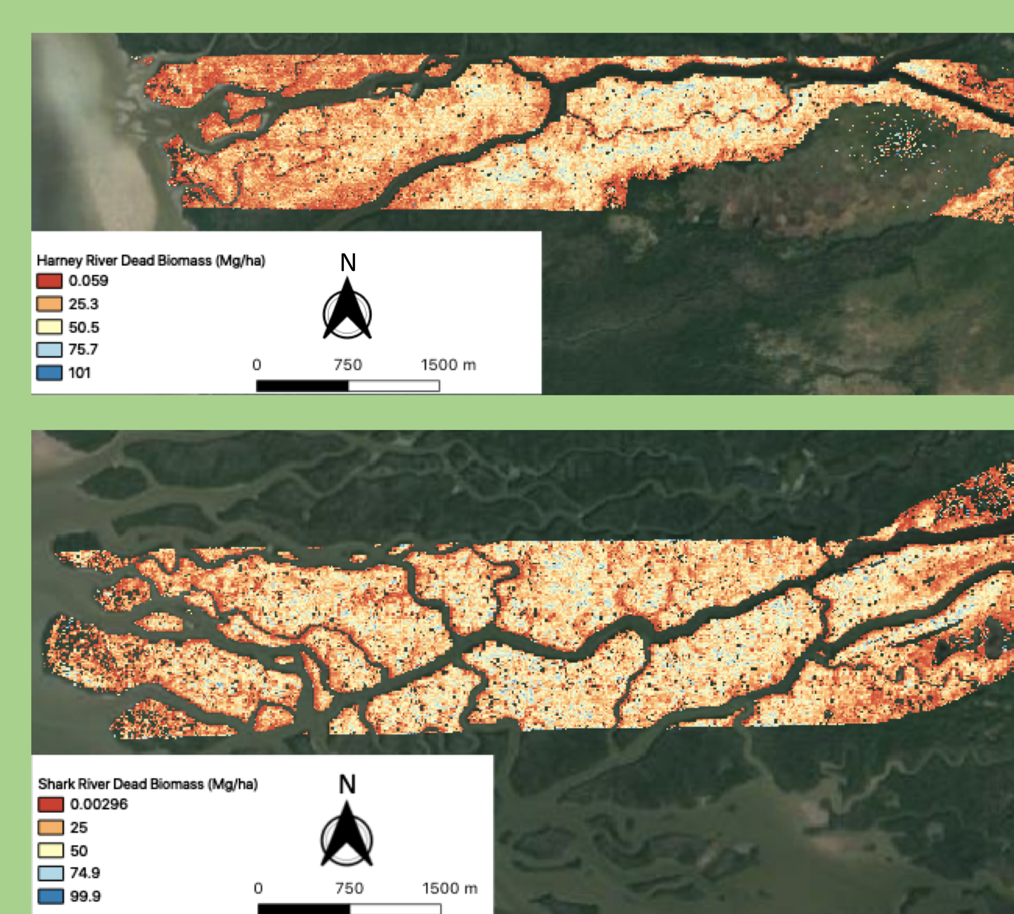


Figure 6. Map of modeled standing dead biomass along the Harney river and the Shark River

Future Work

Continual work will be done in order to further enhance our standing dead biomass and also create a model for CWD. Aside from modeling volumes of CWD and Biomass we are working on using Normalized Difference Vegetation Index (NDVI) in order to model and track the recovery of mangroves forest areas affected by Hurricane Irma. NDVI will be calculated primarily from NASA's Landsat 8 OLI sensor but calibrated using multiple measurement from different multispectral remote sensing sensors. This will allow us to not only understand the damage Irma on just a canopy or surface level, which is what is mostly seen when using just multispectral remote sensing data, but understand the damage on multiple forest structure levels (i.e canopy, woody vegetation, and ground) by using to two distinctly different remote sensing instruments.

Acknowledgments

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References

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