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To Save the Planet, Plant a Tree: Tracking the Tree Canopy of the City of Temple Terrace using Aerial Lidar Datasets

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One of the most effective ways communities can mitigate the impacts of climate change is to create and manage a healthy tree canopy. Trees help the climate by absorbing CO_2 emissions, increase human comfort by providing shade, and make our public spaces more attractive. Local governments need tools to help them track changes in their tree canopies over time. Fortunately, technologies like Lidar can help them in this effort.

Temple Terrace is a Tampa Bay area city known for its tree cover. In fact, the **Tree City USA** program administered by the Arbor Day Foundation, which recognizes cities and towns across America for committing to a viable tree management program, recognized Temple Terrace with Tree City USA status in 2008. The city was shown to meet four core standards of sound urban forestry management: maintaining a tree board or department, having a community tree ordinance, spending at least $2 per capita on urban forestry, and celebrating Arbor Day. These policies promote healthier communities, provide wildlife habitats, and decrease the urban heat island effect.

Temple Terrace is known for its variety of oaks, which include laurel oaks, water oaks, and the giant, long living live oaks. One measure of success for urban tree health and sustainability is the coverage area of the tree canopy. Traditional measures of tree canopy utilized infrared aerial photos. However, this 2D method of analysis has its limitations. For example, most vegetation will have a similar spectral signature in the infrared range. Vegetation of all sizes could be counted as canopy, including crops and grassy areas.

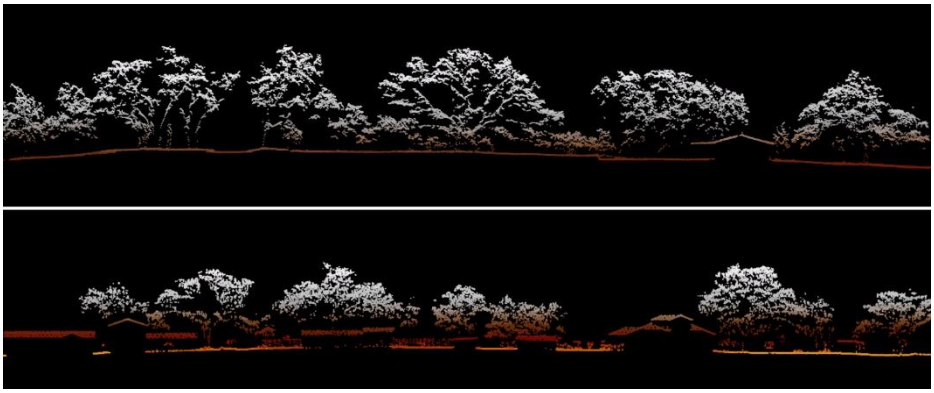

Figure 1: Two Lidar point cloud profile views of the 2017 Hillsborough County dataset.

An alternative method of measuring tree canopies is using Lidar point clouds to map and model features of interest. Lidar (Light Detection and Ranging) is a laser scan mapping technology collected by airplane scanners, mobile scanners (automobile, drones, etc.), and stationary scanners (tripod mounted). Aerial Lidar datasets have been collected all throughout the State of Florida for the past 2 decades. Some regions have been scanned multiple times and therefore we can analyze change over time.

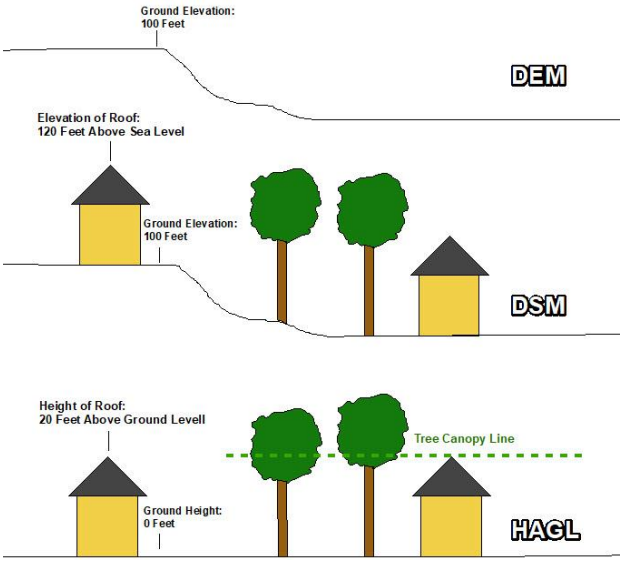

Figure 2: Concept of a Height Above Ground Level (HAGL) model.

In order to measure the tree canopies using the Lidar point cloud, we must first create a Digital Elevation Model (DEM) and a Digital Surface Model (DSM) to compute a Digital Height Above Ground Level Model (HAGL). A DEM is a pixel-based GIS layer that includes an above sea level elevation value of the ground for each pixel in the area of interest. A DSM is a pixel-based GIS layer that includes an above sea level elevation value of all the earths features and a HAGL model is created by subtracting the DEM from the DSM. This map subtraction cancels out the changes in the ground elevation and leaves you with the height of all features on the earth's surface. See Figure 2 on the left.

Once a HAGL model has been generated, a reclassification of height values is computed based on a chosen minimum tree canopy height. In the Temple Terrace example, a minimum 12-foot height was used. All the HAGL values were reclassified into two groups, below 12 feet and 12 feet and above. There is some post processing and quality checks that remove buildings and other built features, such as streetlights, power poles, communication towers, etc. The remaining values that are above 12 feet are mapped as tree canopy.

As I mentioned earlier, many areas of Florida have multiple years of Aerial Lidar data. About 85% of the area in Temple Terrace was collected in 2007 and the entire city was collected in 2017. For the areas with overlapping Lidar datasets, there was an overall increase of 70 acres of canopy from 2007 to 2017. Even though there has been an increase in the area of canopy, there is a clear trend of where the decreases and increases are taking place. Again, Temple Terrace is home to a variety of oaks, and one of those varieties is Laurel Oak. The Laurel Oak has a typical life span of 50-70 years. 2,635 of the 8,932 (30%) properties in Temple Terrace were developed before 1970. Many of the Laurel Oaks were planted on these properties then and have been dying off recently. Figure 3 on the right shows an area in Temple Terrace along Druid Hills Rd. and Cliff Dr. You can see many trees have died off (in yellow shading). Development in the business park area of Temple Terrace (along Fletcher Ave.) has also resulted in a loss of many trees.

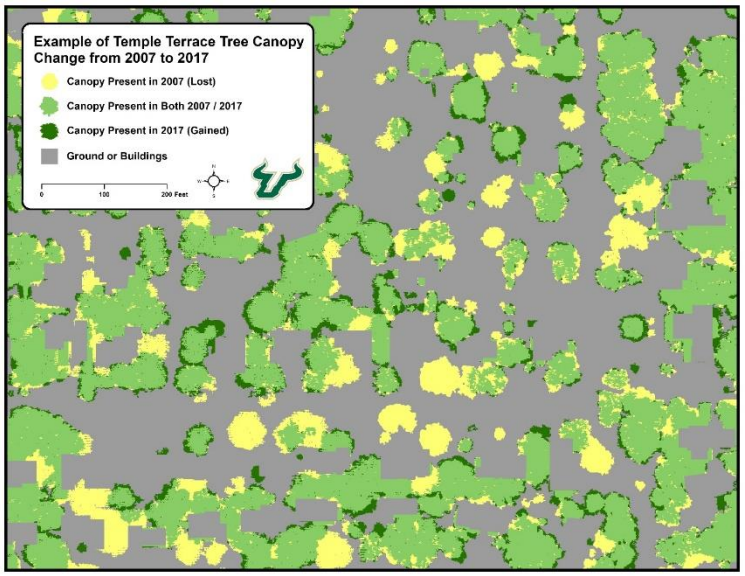

Figure 3: Map of lost, gained, and sustained tree canopy in Temple Terrace, FL.

Fallen live oak on Whiteway Dr. from February 7th storm.

Another factor of canopy loss in Temple Terrace has been natural death by storms. The city frequently loses healthy trees to wind events and lightning strikes. Just recently, 4 large oak trees were knocked down from strong winds during a frontal storm on Whiteway Dr., between Gillette Ave. and Riverhills Dr. The image on the left shows the damage caused by 60mph winds that knocked down a live oak tree.

For 2017, 1,940 acres of the 4,800 acres of the City of Temple Terrace had a tree canopy present, which is just over 40%. The increase of 70 acres over 10 years is mostly due to existing tree growth and replanting. You can see in Figure 3 above that the dark green areas of gained canopy are located around the edges of canopy that was present in 2007 and 2017. This shows the rate and extent of the tree canopy growth over the years. There are also isolated gained canopy areas that show replanted or new trees that will continue to grow and contribute to the future canopy. This is great evidence that the Temple Terrace tree program is a factor in the health and sustainability of the city's natural environment.