Mapping hurricane-related forest change in the Yucatán Peninsula with Google Earth Engine

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Background: Extreme weather events exert a number of detrimental effects on plant productivity and their ability to provide complex ecosystem services for both natural and human systems. Since the mid-1800s, the Yucatán Peninsula has experienced more than 130 land-falling hurricanes and tropical storms, including ten Category four and five storms, with four of those ten occurring since 2000 NOAA Historical Hurricane Tracker. In the Yucatán Peninsula, there is a gradient ranging from tropical rainforest in the south to deciduous forests in the north. A major challenge in understanding the regional effects of severe weather events is our limited ability to scale data, and developing methods to accomplish this can provide new insights on how they spatially and temporally affect terrestrial ecosystems. **Methods:** Here we test the capabilities of Google's Earth Engine (GEE) platform, an emerging online platform that provides data and computational power to support global environmental data analysis. We use the complete Landsat archives to examine forest change patterns in the Yucatán Peninsula— Yucatán, Campeche, and Quintana Roo—before and after a level five hurricane, Dean, swept over the region in 2007. All data were USGS surface reflectance products, and additional methods were used to correct for any bad pixels (i.e., clouds, shadows, water, etc.). The Enhanced Vegetation Index, as well as other indices capable of detecting spectral changes in vegetation land uses, were used. A time series was created with all remaining clear observations, and the spectral trend for each index was calculated and subsequently analyzed. This was done for a series of spatial intervals beginning at Dean's epicenter and moving away from the storm in order to observe whether storm intensity was positively correlated with detected forest changes. **Results:** Our results suggest this to be true, and that GEE provides a powerful tool for efficiently conducting regional-scale vegetation change analyses. **Conclusion:** How hurricane severity and frequency will change with a warming climate is uncertain, and the Yucatán provides an excellent model system for exploring the potential impacts of severe climate-driven weather events across a strong forests ecosystem gradient. The power of Google's vast server network can be used to process massive amounts of spatial data and allows researchers to conduct regional analysis with the complete Landsat archives efficiently.

Better resilient than resistant - Regeneration dynamics of hurricane-disturbed mangroves on Guanaja

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Background: Located at the interface of land and sea, mangroves provide important protection against storms for (sub)tropical coastal regions. At the same time these forests often experience severe disturbances once a storm hits. How the natural regeneration of storm impacted mangroves proceed is still a matter of debate: does - due to the extreme site conditions - regeneration follows a true auto-succession with exactly the same set of species driving regeneration that was present prior to the disturbance, or do different trajectories of regeneration exist? Considering the fundamental ecosystem services mangroves provide, a better understanding of their recovery is crucial, in particular as an increase of the hurricane intensity and/or frequency with global warming is predicted by global climate models. **Methods:** Guanaja offers ideal settings for the study of regeneration dynamics of storm impacted mangrove forests. The island was hit in October 1998 by Hurricane Mitch, one of the most intense Atlantic storms of the past century. Immediately after the storm 97% of the mangroves were classified dead by wind throw, breakage of stilt-roots or removal of leaf buds. In 2005 a long-term monitoring on the regeneration dynamics of the mangroves was initiated, employing permanent line-transects at six different mangrove areas all around the island. The transects were GPS-surveyed and flagged in 2005 and revisited in 2009 and 1016 to document changes. Along the transects all plant species, seedling numbers and amount of woody debris are recorded for statistical analyses. **Results:** Due to the pronounced topography of the island already in 2005 rather different successional pathways appeared depending on the severity of previous disturbance. On the more protected leeward side the mangroves were vital again just seven years after the storm impact. On the windward site storm impacts were significantly more severe, with only marginal traces of regeneration and diverging successional trajectories (incl. grassy and herbaceous stages) during the first decade. The sampling in 2016, however, proves even in the most severely impacted sites a swift return to true mangrove forests once established individuals are propagule-bearing. **Conclusion:** While very obviously not being resistant to storm impacts, mangroves show a high degree of resilience and are able to regenerate within relatively short periods of time even after severe disturbances via different successional pathways.