

Automating REM: Using FVS to Update the TreeMap Inventory Data

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Introduction

We have developed a process for updating the TreeMap tree inventory data product from the USFS to any year of interest, including projecting conditions into the future. Like TreeMap itself, this approach is only appropriate for forested areas. We rely on FVS (the Forest Vegetation Simulator), along with spatial information about past disturbances, to simulate the effects of natural forest succession along with these past disturbances and then summarize the results into a database.

Compile Past Disturbance Data

The information used to update the 2016 TreeMap inventory data can be related to either 1) past disturbances such as forestry operations or fuel treatments, or 2) wildfires. Spatial data on past disturbances is compiled from CONUS-wide public and private data sources into a single GIS vector file (Kearns et al. 2022). Each feature in the vector file represents a past disturbance and has these two primary attributes: the date of the disturbance and the name of the disturbance (e.g., "tree encroachment control"). Features may overlap; for instance, a feature may represent a preliminary fuel treatment at a given area in one year and another feature may represent a follow-up fuel treatment at the same area in a later year. These past disturbances are summarized by type, severity, and year for TreeMap updating purposes.

Non-wildfire disturbances. We rely on the three primary LANDFIRE disturbance types: "fire", which in this case is only prescribed fire; "mechanical add", which typically involves rearranging fuels (e.g., mowing or chipping); and "mechanical remove", a mechanical treatment where biomass (merchantable or non-merchantable biomass) are removed from the site (e.g., a group harvest). There are three levels of severity- low, medium, and high- defined by the effect of the disturbance on landcover. Harvest and fuel treatment data is integrated based on Kearns et al. (2022; see Appendix B for an overview of datasets).

Wildfire. Spatial information about past wildfires is similarly compiled but is saved as a raster rather than vector data. Fire perimeters come from MTBS (2013-2020)¹ or NIFC (2011, 2022) and fire severity was calculated using a Google Earth Engine tool (Kearns et al. 2022). Every cell of the raster is assigned a code from which the time since disturbance (either one year or two-five years) and severity (unburned, low, medium, or high) can be extracted.

Currently, we include past disturbances covering the period 01 January 2017 - 31 October 2022 and wildfires covering 01 January 2017 - 30 June 2022. We consider anything before 01 January 2017 to be already represented by the latest TreeMap data. We typically compile new data on past disturbances and wildfires annually.

¹ MTBS only reports on wildfires one year and older. This is driven by the fact that MTBS wildfire severity mapping relies on a one-year plus survival of trees which can only be recorded after the fact.

Set up FVS

Once the GIS past disturbance and wildfire data have been formatted, we run a custom Python script that "flattens" the past disturbances and then extracts all unique combinations of TreeMap ID, past disturbances, and wildfires. Flattening the overlapping vector features allows us to simulate repeated disturbance over the same area in different years. To keep the Python processing more manageable only medium- and high-severity past disturbances are included, on the assumption that low-severity disturbances are unlikely to significantly affect the FVS simulation anyway. In the event that there are more than three past disturbances for any given TreeMap ID, only the three most recent past disturbances will be included.

Execute FVS

This list of unique combinations is then used by another Python script to build the FVS input database. Each unique combination is treated as an individually-simulated forest stand in FVS. During the course of the previous processing steps rasters are produced that spatially tie each stand to the landscape. Any given stand can occur in multiple locations across the landscape, so we produce a table that defines the total area represented by each stand. The 2016 TreeMap FIA-based tree inventory information is used as the basis for the FVS simulation. The previously-developed past disturbance and wildfire information is used during this process to assign appropriate FVS addfiles to any disturbed stands. Each unique combination of disturbance severity, type, and year has its own addfile (e.g., moderate-severity mechanical add in 2017) containing the necessary FVS keywords to simulate that disturbance, as does each combination of wildfire severity and time since disturbance (e.g., moderate-severity wildfire one year ago). Finally, we begin an FVS simulation in 2016 and let it run until the year of interest. It simulates forest growth, fuel accretion, fuel decay, etc. along with the included past disturbances and wildfires for each stand and then reports the results in various database tables which may be combined and queried later as needed.

Citations

- Kearns, E.J.; Saah, D.; Levine, C.R.; Lautenberger, C.; Doherty, O.M.; Porter, J.R.; Amodeo, M.; Rudeen, C.; Woodward, K.D.; Johnson, G.W.; Markert, K.; Shu, E.; Freeman, N.; Bauer, M.; Lai, K.; Hsieh, H.; Wilson, B.; McClenny, B.; McMahon, A.; Chishtie, F. The Construction of Probabilistic Wildfire Risk Estimates for Individual Real Estate Parcels for the Contiguous United States. *Fire* 2022, 5, 117. <https://doi.org/10.3390/fire5040117>
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