ForWarn Forest Change Detection System Provides a Weekly Snapshot of US Forest Conditions to Aid Forest Managers

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The National Early Warning System (EWS) is a coordinated effort to bring cutting-edge monitoring and assessment technologies and forest professionals together (Hargrove and others 2009). Today, technological advances allow us to systematically detect and track forest disturbances from space in near-real time, and a network of professionals is required to accurately interpret observations and communicate conditions to those who can take action, as appropriate. The core technology, *ForWarn*, is a satellite-based change recognition and tracking system developed by the Forest Service, USDA's Threat Assessment Centers, and NASA Stennis Space Center, with substantive involvement by the U.S. Geological Survey, Department of Energy's Oak Ridge National Laboratory, and the University of North Carolina, Asheville's National Environmental Modeling and Analysis Center.

ForWarn provides a strategic national overview of potential forest change which directs attention to places where forest behavior seems unusual or abnormal. These insights can help focus ground and aircraft observation efforts (such as those conducted by the Forest Service's National Insect and Disease Detection Survey program or post-disturbance response efforts). Operating since January 2010, *ForWarn* generates national disturbance maps covering the conterminous United States every eight days, even throughout the winter (Figure 1). It detects all types of forest disturbances, including insects, disease, wildfires, frost and ice damage, tornadoes, hurricanes, blow-downs, harvest, urbanization, and landslides. It also detects drought, flood, and other extreme climate effects and tracks early and delayed vegetation development during spring and fall.

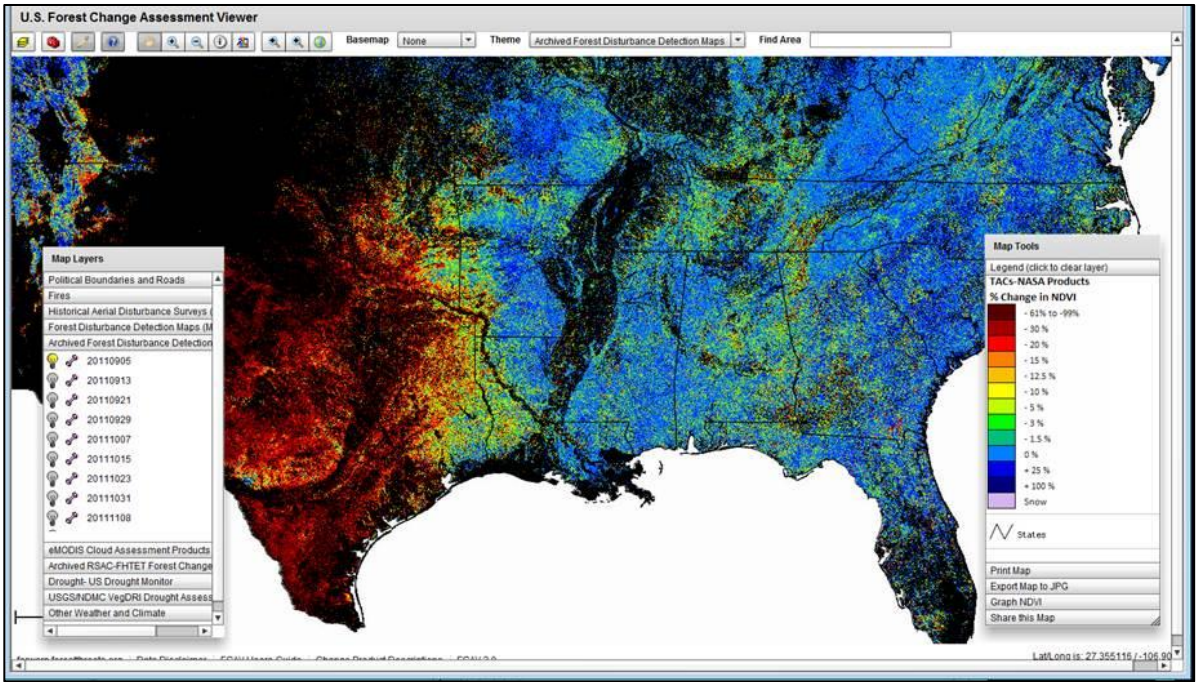

Figure 1. An example screen-capture of the *ForWarn* Forest Change Assessment Viewer. Short-, mid- or long-term NDVI departure images are available every 8 days and accessible to all via any internet browser *(http://forwarn.forestthreats.org)*.

ForWarn uses the Normalized Difference Vegetation Index (NDVI) to measure vegetation vigor, or relative "greenness." NDVI measures the degree to which solar radiation is differentially absorbed across red and infrared wavelengths due to the chlorophyll in plants. Reflectance data are obtained from the MODIS sensors aboard NASA's Terra and Aqua satellites. Using the ForWarn System these satellites provide a daily record of the condition of vegetation, when the view is not obstructed by smoke or clouds. The data are available at a nominal spatial resolution of 250 m, which translates to a map cell size of about 13 acres, or 5.4 ha (the equivalent to about 9 football fields each). While seemingly coarse compared to the dozens to hundreds of individual trees that normally exist within a single hectare of forest, finer resolution data do not exist at high temporal frequency, and even with moderate resolution, this database grows by billions of data points each year.

ForWarn works by comparing current conditions with the "normal greenness" that would be expected for healthy, undisturbed vegetation growing at a location during a given time of year. Locations that are currently less green than expected are marked as potentially disturbed (as indicated by shades of red, orange, and yellow. Unfortunately, clouds can act to decrease the current observed greenness, mimicking the actions of forest disturbance agents. ForWarn overcomes this problem by relying on a moving 24-

day window of daily satellite observations that nearly always provides a cloudless view. The moving window advances forward in eight day time steps. ForWarn also includes maps and time series graphs of raw NDVI values since 2000. Assessing forest change requires a historical baseline or multiple historical baselines of varying durations to determine how "normal," healthy vegetation should appear. *ForWarn* utilizes three baselines—(1) the prior year, (2) the maximum value of the last three years, and (3) the entire period of record. The maximum greenness value is kept from each of the 46 different 8-day time periods per year.

Forest change maps generated using ForWarn are available to anyone via the Forest Change Assessment Viewer, a web-based mapping application that is accessible at http://forwarn.forestthreats.org/fcav/. New, near-real time maps are available at this website, as well as an archive of forest change products since 2000. For additional information, or questions, contact Bill Christie at wchristie@fs.fed.us.

Excerpted from "Highlights of satellite-based forest change recognition and tracking Using the ForWarn System" (http://www.srs.fs.usda.gov/pubs/44239)

Reference

Hargrove, W.W.; Spruce, J.P.; Gasser, G.E.; Hoffman, F.M. 2009. Toward a national early warning system for forest disturbances using remotely sensed canopy phenology. Photogrammetric Engineering & Remote Sensing. 75: 1150-1156. *(http://www.treesearch.fs.fed.us/pubs/33669)*