Agenda Item XI

Sierra Nevada Watershed Improvement Program (WIP) Update

Attachment B

USDA
United States Department of Agriculture
Forest Service
PACIFIC SOUTHWEST REGION

Direct Greenhouse Gas Emissions From Megafires Are Only One Piece of the Forest Carbon Emission Story

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Background And Purpose

GHG emissions caused by wildfire do not necessarily end when the fire is put out, especially when megafires burn at uncharacteristically high severity and kill the trees that comprise the canopy. This brief summarizes what we know about the relative importance of direct fire emissions, post-fire mortality-driven emissions, and drought-related emissions for the last three years on federal lands.

GHG Emissions Direct From Fire Combustion:

In 2013, the Rim fire, fueled by accumulated, dry biomass, burned over 250,000 acres and emitted 10-15 MMTCO2e (million metric tons of CO2 equivalents), ushering in a 3-year period of unprecedented fire activity in California, corresponding with unprecedented drought. Here is what we know about greenhouse gas (GHG) emissions from U.S. Forest Service (USFS) and National Park Service (NPS) forests in CA during that timeframe:

- Methods for estimating wildfire emissions are an area of active research, but our best estimates of total emissions in 2013-2015 for GHGs from CA wildfires on federal lands alone have consistently amounted to around 20-25 Million Metric Tons of Carbon Dioxide Equivalent (MMTCO2e) each year.
- Each year, one or two large megafires generated somewhere around half the total wildfire emissions from federal lands in CA, and 4 large fires accounted for around half of the total emissions over that 3 year period (Figure 1)

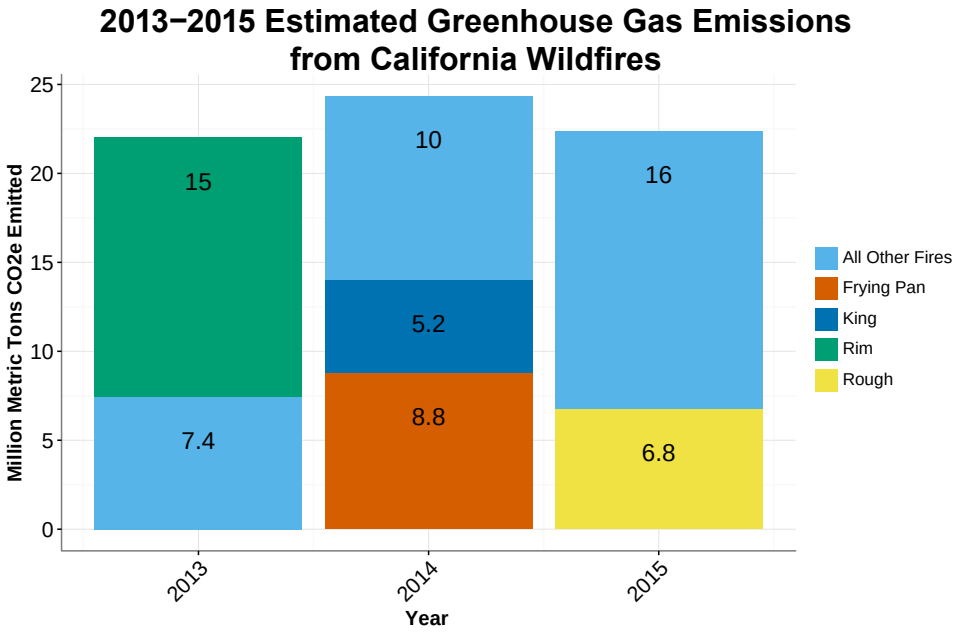

Figure 1. Active wildfire greenhouse gas emissions[1] from National Park Service and National Forest lands in CA, 2013-2015. Emissions from the 2015 Valley and Butte fire (CA State lands) were not available at the time of analysis.

1 Wildfire emissions estimated using FOFEM 6.1, with a geospatial preprocessor developed for the California Air Resources Board.

Post-Fire and Mortality-Induced GHG Emissions

Models based on satellite data show that in many places the amount of carbon soaked up by green, photosynthesizing (healthy) plants exceeds the amount of carbon released as CO2 by plant and microbial respiration (net absorption of GHGs, as new biomass, to the landscape from the atmosphere), at least in years with normal precipitation. This balance between respiration and photosynthesis is called Net Ecosystem Productivity, or NEP. In drought years and in places where forests are unhealthy and tree death (mortality) is high, this balance can change to a negative value, meaning that the landscape is losing carbon to the atmosphere in the form of CO2 and other GHGs (net GHG emissions).

- Figure 2 shows evidence that the post-fire mortality from the 2013 Rim fire and the 2014 King and Frying Pan fires has caused hotspots of negative NEP values in subsequent years, indicating substantial post-fire losses of GHGs to the atmosphere due to these fires.
- Figure 2 also shows widespread, but less intense losses, likely due to drought and insect mortality.
- Neither the precise size of these annual emissions, nor how much is due to drought versus fire mortality in these post-fire hotspots is yet precisely known, but recent research suggests that the magnitude of these post-fire emissions in subsequent years could rival or even exceed the direct emissions of the initial wildfire event (Matchett, J.M. et al. 2015, Battles, J. et al. 2015).
- Over decades, this progressive loss due to drought and wildfire-caused mortality could tip the scales so that some forests may release more carbon (as GHGs) than they absorb (Gonzalez et al., 2015).
- Other recent research has found that low and moderate severity fires (e.g., prescribed fire) reduce mortality due to fire and drought (van Mantgem, P., et al. 2016; Hurteau, M. D., et al. 2015; Hood, S. M., et al. 2015), which may help minimize the subsequent GHG emissions.

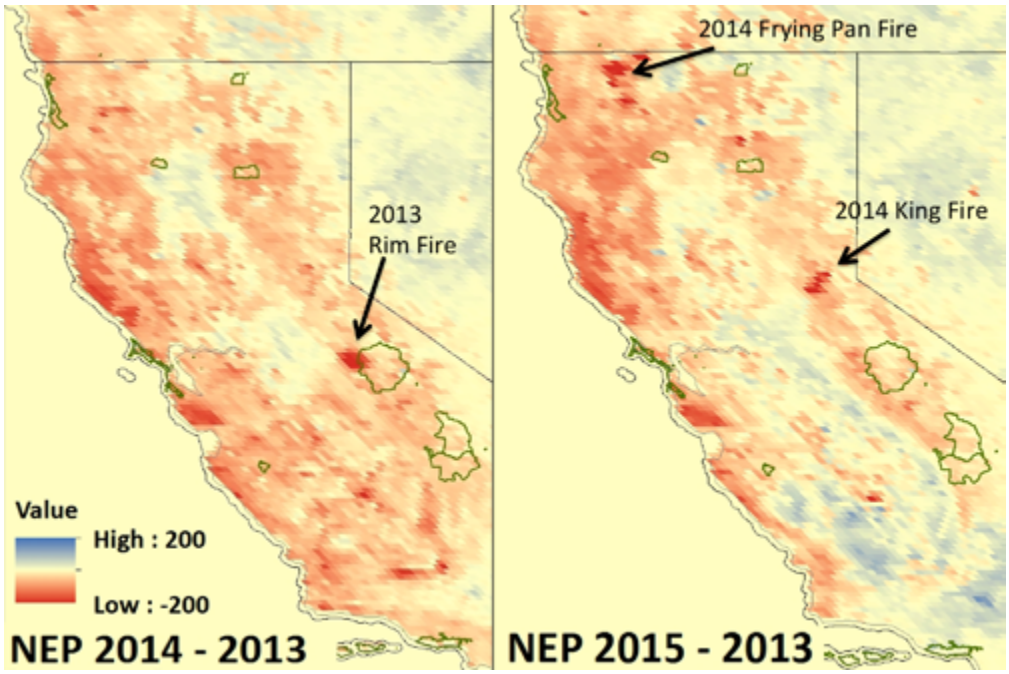

Figure 2. Satellite-derived Net Ecosystem Productivity (NEP)[1], showing intense areas of progressive net carbon gain (blue) or loss (red, grams of carbon per square meter) from burned areas after 2013 and 2014 fires. Specifically, the above figures depict the differences between 2013 NEP and 2014 NEP (left panel) and the difference between 2013 and 2015 NEP (right panel). Larger areas of progressive net loss compared to this 2013 baseline year, likely due to drought and insect mortality, are also apparent throughout the CA forests (green outlines are National Park borders for orientation).

1 Net Ecosystem Productivity (NEP) is the amount of carbon gained on a landscape from plant growth minus the amount lost from plant and microbial respiration: a negative value indicates carbon lost to the atmosphere as GHGs. Estimates are based on: Potter, C., S. Klooster, A. Huete, and V. Genovese, 2007, Terrestrial carbon sinks for the United States predicted from MODIS satellite data and ecosystem modeling, Earth Interactions, 11: 1-2