

Wildfire Emission Estimates for 2019

Introduction

California Air Resources Board (CARB) staff has developed preliminary estimates of the amount of pollutants emitted to the atmosphere due to wildfires that occurred throughout California in 2019. These estimates are derived using version 6.7 of the First Order Fire Effects Model (FOFEM, released March 2020) developed by the U.S. Forest Service (USFS) together with Geographic Information System (GIS) records of 2019 fire perimeters published by the California Department of Forestry and Fire Protection (CAL FIRE).

Sources and Methods

Emissions were estimated using GIS format data on fire perimeters, containment date, fuel type, fuel densities (tons/acre), and fuel moistures. The geospatial data were used to develop inputs to a wildland fire emission model (FOFEM). Modeled emissions in flaming and smoldering phases (lbs./acre) by fuel type were integrated over vegetation types to calculate total consumption and emissions for fire footprints. Flaming and smoldering emissions were summed for reporting and include every fire reported and mapped for the calendar year.

The magnitudes of emissions are proportional to the amount of biomass fuel consumed, and various pollutants are generated in the flaming and smoldering phases of combustion. Forest and woodland vegetation types contain greater fuel densities (tons/acre) than vegetation types dominated by shrubs, herbaceous plants, or grasses. Large fires often extend across a variety of vegetation types. Fuel densities for vegetation types categorized by the Fuel Characteristic Classification System (FCCS) are defined in FOFEM. In FOFEM 6.7, fuel densities are lower for certain categories of dead fuels in common California forest and woodland vegetation types, than in prior versions of FOFEM. Fuel moistures (gridMET) were obtained from the University of Idaho Climatology Lab.

Results

The statewide total wildfire footprint area for 2019 was 278,556 acres: a modest quantity compared to previous years. Based on an overlay of fire footprints (polygons) on to a fuel type map (FCCS), GIS analysis tabulated 146,341 acres of fire footprint area comprised of shrubland and grassland vegetation types and 120,944 acres of forest and woodland types. Another 11,270 acres of fire footprint area mapped as urban/developed or agricultural land and were excluded from the analysis.

Fuels consumed across all vegetation types totaled nearly 4 million short tons (Table 1). The magnitudes of emissions are similar to estimates for prior years (re-analyzed using FOFEM 6.7) characterized by modest fire activity e.g., 2000, 2001, 2004 and others (CARB 2020).

Pollutant emissions associated with fuel consumption in the smoldering phase include PM₁₀, PM_{2.5}, CO, CH₄ and total non-methane hydrocarbons (TNMHC). Emissions associated with the flaming phase include NO_x, CO₂, and N₂O.

Table 1. Summary of 2019 wildfire area, fuel consumption and emissions.

Wildfire area (acres)	Fuel consumed (short tons)	PM10 (thousand short tons)	PM2.5 (thousand short tons)	CO2 (million metric tons)
278,556	3,545,005	56.2	47.5	4.76

Uncertainty

Uncertainties associated with mapped fuel types, fuel loading (tons/acre by fuel size category), fuel moisture, burned area, modeled fuel consumption in flaming and smoldering phases, and emission factors (mass of pollutant species/unit mass fuel consumed) contribute to large uncertainties in emission estimates. Emission estimates reported here may have an uncertainty of between a factor of 2 to 3. The wildfire emission estimates reported here are developed using sources and methods that are independent from those used for the statewide natural and working lands inventory of ecosystem carbon stocks and stock-change. Large uncertainties associated with the fire emissions estimates and the lack of yearly data in the natural and working lands inventory preclude an accuracy assessment.

Reference Material

Abatzoglou, J. T. (2013) Development of gridded surface meteorological data for ecological applications and modelling. *International Journal of Climatology* (33), 121-131.

CARB (2020) California Wildfire Emission Estimates. <https://ww2.arb.ca.gov/wildfire-emissions>

Fire perimeters: A multi-agency statewide database of fire history. Fire and Resource Assessment Program, California Department of Forestry and Fire Protection. <https://frap.fire.ca.gov/mapping/gis-data/> (Accessed May 21, 2020)

First Order Fire Effects Model (FOFEM) <https://www.fs.usda.gov/ccrc/tools/fofem>

Fuel Characteristic Classification Fuelbeds (FCCS) <https://www.landfire.gov/fccs.php>

gridMET: A dataset of daily high-spatial resolution surface meteorological data covering the contiguous US from 1979 to yesterday. University of Idaho Climatology Lab. <http://www.climatologylab.org/gridmet.html> (Accessed May 21, 2020)

Ottmar, R. D., D. V. Sandberg, C. L. Riccardi, and S. J. Prichard (2007) An overview of the Fuel Characteristic Classification System - Quantifying, classifying, and creating fuelbeds for resource planning, *Can. J. For. Res.-Rev. Can. Rech. For.*, 37(12), 2383-2393, doi:10.1139/x07077.