Public Health Impact of Prescribed Fire (PHIRE) Study – Baseline and Projected Prescribed Fire Smoke Exposures in California

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Background

• Wildfire (WF) intensity and the frequency of severe WFs are increasing in the U.S. west, including California

• Prescribed (Rx) fires will also increase to combat this threat
  – CAL FIRE is scaling up to a target of 500,000 acres per year for fuels treatment by 2025

What are the air quality and health impacts of Rx smoke, in the context of WF smoke?

  – WF: high-intensity, unmanaged smoke, broad spatial scale
  – Rx: low-intensity, managed smoke, local spatial scale

Agreement for Shared Stewardship of California’s Forest and Rangelands
Research Components

• Exposure Modeling – Sonoma Technology
• Health Analysis – CA Dept of Public Health and U.S. EPA
• Community Engagement – CA Dept of Public Health
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Baseline Scenario – Fire Inventory Data Sources

**WF Data**

- Satellite
  - MODIS 2003-2018
- Agency
  - 2003-2017 (USFS FPA FOD)
  - 2018 (GeoMAC, ICS-209, FIRESTAT, CAL FIRE)

**Rx Fire Data**

- Satellite
  - MODIS 2003-2018
- Agency
  - 2003-2018 (CAL FIRE, USFS FACTS, CARB PFIRS)

All records were spatiotemporally joined and matched to remove duplicates and reconcile differences in data records from different sources.

\(^a\)Short, 2021
Fire Inventory 2003-2018

Total Acres Burned by Fire Type

Million Acres

Total Acres Burned by Data Source

Million Acres

dataset
- matched
- unmatched agency
- unmatched satellite
Baseline Scenario – Smoke Modeling for 2008-2017

• BlueSky Smoke Modeling Framework
  – FCCS (fuel loading) > Consume (fuel consumption) > Prichard-O’Neill Emissions (smoke emissions) > FEPS Plumerise (plumerise)

• HYSPLIT Smoke Dispersion
  – 0-500 m height average
  – North American Mesoscale 12-km (NAM12) meteorology

• Dispersion results downscaled to 1-km grid space using bilinear interpolation

• Daily intersection with HMS smoke plume data

aLarkin et al., 2020; bPrichard et al., 2020
Cumulative Modeled PM$_{2.5}$ Exposure from WF and Rx Smoke (2008-2017)
Cumulative PM$_{2.5}$ from Smoke Exposure

- WF PM$_{2.5}$ exceeds Rx PM$_{2.5}$ at all ZIP codes
- Cumulative Rx PM$_{2.5}$ is at most 32% of cumulative WF smoke at the ZIP code level
Modeled PM$_{2.5}$ Validation

- Best correlations with IMPROVE measured total carbon (TC), although these were only moderate correlations.
- Low-to-moderate correlations with AQS PM$_{2.5}$ and IMPROVE calculated TC.
- In general, there were stronger correlations for modeled WF smoke than for modeled Rx smoke.
Target Prescribed Fire Scenario

• Rx fire inventory used for classifications (size by vegetation type)
• Randomly distributed within CAL FIRE Priority Landscape (risk to communities\(^a\)) Class 4 and 5 (~4 million acres)
• Randomly assigned to eight annual cycles, 500,000 acres per cycle
• Randomly allocated to burn days in each annual cycle
  – CARB Burn Day (go, no-go) for each California Air Basin
• 2014 meteorology data used for smoke modeling of each cycle to keep meteorology constant
  – Median number of burn days for 2008-2017 records
  – Wind, soil moisture, and precipitation within 2 standard deviations compared to baseline period (2008-2017) averages

\(^a\)https://arcg.is/DvCOe
Target Scenario – Projected Prescribed Fire Area

- Fire locations were randomly selected in piecewise manner to avoid overlap.
- Each annual cycle has ~500,000 acres burned.
Target Scenario - PM$_{2.5}$ Exposure from Projected Rx Activities

- Projected smoke impacts seen in the Northern Coast Range, SF Bay Area, Sacramento Valley, San Joaquin Valley, and Sierra Nevada
- Smoke impact level is three times of the baseline Rx smoke impact on average
Summary and Continued Work

- A 2003-2018 wildfire and prescribed fire inventory was developed based on satellite observations and multiple agency records
- Target prescribed fire inventories for eight annual cycles were generated
- Daily emissions and dispersion modeling was done for the baseline and target Rx fire inventories
- Smoke PM$_{2.5}$ exposure was extracted for each California ZIP code
  - Moderate agreement was found with IMPROVE and AQS sites
- This work is ongoing:
  - Intercomparison between baseline and target scenarios
  - Health effects, attributable health burden, and mortality analysis
  - Community engagements, including surveys and listening sessions
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