1) Simulation of Forecast-Based Interventions to Reduce the Health and Economic Burden During a Wildfire Episode

and

2) Estimating Smoke Burden and Novel Tools to Manage Impacts in Population

Prepared by: Ana G. Rappold
April, 2015
Case Study: Impacts of smoke exposure on human health in rural communities of North Carolina

- 2008 Pocosin Lakes Wildlife Refuge Wildfire
- 2011 Pains Bay Wildfire

Photo Credit: USFWS
**Daily Counts of Asthma ED Visits**

2008 Pocosin Lakes National Wildlife Refuge Peat Fire

![Graph showing daily counts of asthma ED visits with peak exposure from 11 June to 21 June.]

- **First day of flaming**: 1 June
- **3 days of high exposure**: 11 June to 21 June

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*Exposed Counties / Satellite AOD*

*Rappold AG et al. Environ. Health Perspectives 2011*
Percent change in cumulative RR by discharge diagnosis category for exposed and referent counties.
### Economic Value of Health Burden

#### Environmental Benefit Mapping and Analysis Program (BenMAP)

#### 2008 Pocosin Lakes National Wildlife Refuge Peat Fire

<table>
<thead>
<tr>
<th>Endpoint</th>
<th>Health Outcomes</th>
<th>Age Group (years)</th>
<th>Excess Incidence (95% CI)</th>
<th>Value in 2010 $</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Premature Mortality</strong></td>
<td>Mortality</td>
<td>0-99</td>
<td>4.4 (0, 12)</td>
<td>$42 M (0, 190)</td>
</tr>
<tr>
<td><strong>Chronic Illness</strong></td>
<td>Nonfatal heart attacks</td>
<td>&gt;18</td>
<td>31 (7.9, 56)</td>
<td>$3.9 M (.58, 9.8)</td>
</tr>
<tr>
<td><strong>Hospital Admissions</strong></td>
<td>Cardiovascular Hospital Admissions*</td>
<td>18-64</td>
<td>4.3 (2.3, 6.4)</td>
<td>$180K (91, 260)</td>
</tr>
<tr>
<td></td>
<td>Respiratory Hospital Admissions**</td>
<td>18-64</td>
<td>4.7 (-3.0, 9.8)</td>
<td>$150K (-96, 310)</td>
</tr>
<tr>
<td></td>
<td>Asthma ED visits</td>
<td>All ages</td>
<td>16 (-4.4, 33)</td>
<td>$6.7K (-1.9, 15)</td>
</tr>
</tbody>
</table>

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<tr>
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<tr>
<td>Acute Bronchitis</td>
<td>8-12</td>
<td>41 (-9.8, 91)</td>
<td>$20K (-4.2, 56)</td>
</tr>
<tr>
<td>Lower Respiratory Symptoms</td>
<td>7-14</td>
<td>530 (200, 850)</td>
<td>$11K (3.2, 23)</td>
</tr>
<tr>
<td>Upper Respiratory Symptoms in asthmatics</td>
<td>9-11</td>
<td>760 (140, 1400)</td>
<td>$25K (3.7, 62)</td>
</tr>
<tr>
<td>Asthma Exacerbations, Asthma Attacks</td>
<td>6-18</td>
<td>810 (-94, 1,900)</td>
<td>$47K (-5, 140)</td>
</tr>
<tr>
<td>Minor Restricted Activity Days</td>
<td>18-65</td>
<td>22 (18, 27) x 1000</td>
<td>$1.5M (-.8, 2.3)</td>
</tr>
<tr>
<td>Work Loss Days</td>
<td>18-65</td>
<td>3.7 (3.2, 4.3) x 1000</td>
<td>$0.52M (440, 600)</td>
</tr>
</tbody>
</table>

5 Rappold AG et al. Environ. Sci & Technologies, 2014
Can we reduce health impacts in communities?

We simulated forecast-based interventions in population using forecast predictions of PM$_{2.5}$ from NOAA’s Smoke Forecasting System and asked:

1) Can forecasts of PM$_{2.5}$ predict the observed association between PM$_{2.5}$ and health outcomes?

2) If we reduced exposures according to the forecasts do we observe a corresponding reduction in health effects?
Forecast Based Interventions for Asthma and Congestive Heart Failure ED visits

NOAA’s Smoke Forecasting System predictions of PM$_{2.5}$ in forecast and re-analysis mode:

9 interventions defined by combination of

3 smoke levels: Low (5µg/m$^3$), Intermediate (20µg/m$^3$), High smoke (50µg/m$^3$) and

3 adherence levels: Good (5µg/m$^3$), Moderate (20µg/m$^3$), and Poor (50 µg/m$^3$)
1) Can forecasted concentrations of PM$_{2.5}$ predict the observed association with health outcomes?

Asthma related ED visits

Observed association using **re-analysis** as a measure of presumed true exposure

Association using **forecasted** concentrations of PM

Yes! Forecasted PM$_{2.5}$ levels are predictive of the observed associations

% change per 10 $\mu g/m^3$ of PM$_{2.5}$

<table>
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<th>Without Intervention</th>
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<tbody>
<tr>
<td>Re-analysis</td>
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<tr>
<td>Forecast</td>
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</table>
2) If we reduced exposures according to the forecasts would we observe a corresponding reduction in health effects?

Counties implementing intervention reduce the average exposure to 5µg/m³-GOOD, 25µg/m³-Moderate, 50µg/m³-POOR.
2) If we reduced exposures according to the forecasts would we observe a corresponding reduction in health effects?

Implementing interventions at “High Smoke” only does not improve health outcomes.
How accurately did the forecast based interventions predict the re-analysis based predictions?

<table>
<thead>
<tr>
<th></th>
<th>Low Smoke Level $T_i=5$</th>
<th>Intermediate Smoke Level $T_i=20$</th>
<th>High Smoke Level $T_i=50$</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive Rate</td>
<td>3.7%</td>
<td>3%</td>
<td>1.6%</td>
</tr>
<tr>
<td>(1- specificity)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Positive Predictive</td>
<td>81%</td>
<td>68%</td>
<td>57%</td>
</tr>
<tr>
<td>Value (Precision)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>74%</td>
<td>74%</td>
<td>76%</td>
</tr>
<tr>
<td>(True Positive Rate)</td>
<td></td>
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</table>
The example above was for one fire alone, but Fires are many and Fires impact many. Is there a potential for use of forecasting methods in the Public Health domain?
Estimating fire smoke related health burden and novel tools to manage impacts on urban populations, JFSP 2014

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Martin Cope, The Commonwealth Scientific and Industrial Research Organization, AU
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Ana Rappold, US EPA, Statistician
Estimating fire smoke related health burden and novel tools to manage impacts on urban populations, JFSP 2014

The goal of the project is to

- Characterize smoke exposure in US and AU (composition and concentrations)
- Characterize the overall health and economic impact in population
- Develop tools for predicting health impacts in real time (calibration of smoke predictions and linkage to BenMAP) -- to leverage current information about the health effects from smoke exposures and other sources of air pollution with public health tools (AQI, AirNOW) and provide information to individuals – particularly those at risk- in real time.

HYSPLIT PM2.5 forecast and expected increase in cases of asthma aggravation from BENMAP-CE for June 12, 2008, Evans Road Fire North Carolina.
• The content of the presentation does not necessarily represent the views or policy of the Environmental Protection Agency.

• The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented.
Thank you

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