Cumulative Impacts:
Linking regional, local, and household air pollution

Image Source: BAEHC

Silent Spring Institute
Communities for a Better Environment
Brown University
University of California at Berkeley
Pollution Sources in the San Francisco Bay Region

Your health is affected by ....

Regional Air Pollution

Image Source: Bay Area Environmental Health Collaborative
Your health is also affected by ... Neighborhood Air Pollution
and ....

Indoor air pollution inside the home
What are the **cumulative impacts** of multiple pollutions sources?
The Household Exposure Study
What did we do?

Tested for chemicals in and around the home

Outdoor Air

Indoor Air

House Dust
We tested for pollutants that come from local, outdoor sources.
We tested for pollutants that come from household products.
Where did we do our testing?

40 Richmond Homes

10 Bolinas Homes
What did we find?

- 153 chemicals tested
- More chemicals in Richmond than Bolinas
- 80 chemicals in Richmond outdoor air
- 104 chemicals in Richmond indoor air
Particulate Matter (PM2.5)

Sources: traffic, industries, smoking, cooking

Health effects: heart and respiratory problems

Image source: U.S. EPA, Office of Research and Development

Image source: Minnesota Pollution Control Agency
We found unhealthy levels of PM2.5 in nearly half of Richmond homes.
Outdoor Air Pollution
Pollution sources have distinct chemical profiles

Traffic

PAHs  Elemental Carbon

Petroleum Refinery

Vanadium  Nickel

Crude Oil Combustion Sources

Shipping
Identifying Pollution Sources in Richmond **Outdoor** Air

<table>
<thead>
<tr>
<th><strong>Pollutants</strong></th>
<th>“Crude Oil Combustion”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanadium</td>
<td>1.00</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.97</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.18</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.07</td>
</tr>
<tr>
<td>Lead</td>
<td>-0.02</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>0.32</td>
</tr>
<tr>
<td>Fluorene</td>
<td>0.26</td>
</tr>
<tr>
<td>Organic carbon</td>
<td>-0.09</td>
</tr>
<tr>
<td>Elemental carbon</td>
<td>0.01</td>
</tr>
<tr>
<td>Nitrates</td>
<td>0.11</td>
</tr>
<tr>
<td>Sulfates</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Use statistical method called factor analysis to see which pollutants group together.

Pollutants with high numbers (0.4-1.0) in each column likely come from a common pollution source.

Tight clustering of vanadium and nickel in Richmond air samples suggest presence of crude oil combustion.
## Major Emission Sources in Richmond **Outdoor** Air

<table>
<thead>
<tr>
<th></th>
<th>“Crude Oil Combustion”</th>
<th>“Local Industry”</th>
<th>“Traffic”</th>
<th>“Regional Pollution”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanadium</td>
<td>1.00</td>
<td>-0.03</td>
<td>-0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.97</td>
<td>0.03</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.18</td>
<td>0.59</td>
<td>-0.03</td>
<td>-0.02</td>
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<tr>
<td>Manganese</td>
<td>0.07</td>
<td>0.78</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>Lead</td>
<td>-0.02</td>
<td>0.56</td>
<td>0.45</td>
<td>-0.14</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>0.32</td>
<td>0.23</td>
<td>0.53</td>
<td>-0.05</td>
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<tr>
<td>Fluorene</td>
<td>0.26</td>
<td>0.09</td>
<td>0.68</td>
<td>-0.02</td>
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<tr>
<td>Organic carbon</td>
<td>-0.09</td>
<td>0.01</td>
<td>0.65</td>
<td>0.02</td>
</tr>
<tr>
<td>Elemental carbon</td>
<td>0.01</td>
<td>0.15</td>
<td>0.45</td>
<td>0.23</td>
</tr>
<tr>
<td>Nitrates</td>
<td>0.11</td>
<td>0.31</td>
<td>-0.09</td>
<td>0.75</td>
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<tr>
<td>Sulfates</td>
<td>0.04</td>
<td>-0.24</td>
<td>0.06</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Colored cells indicate compounds that group together
Indoor vs. Outdoor Vanadium

No major indoor sources of vanadium

Pollutants from outdoor sources are migrating indoors

Points close to the 1:1 solid, black line mean that indoor & outdoor levels are very similar
How does Richmond outdoor air quality compare to other cities in California?
<table>
<thead>
<tr>
<th>City</th>
<th>PM2.5</th>
<th>Sulfates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolinas</td>
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<td></td>
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<tr>
<td>Bakersfield</td>
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<tr>
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<td>Riverside</td>
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<tr>
<td>Sacramento</td>
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<tr>
<td>San Jose</td>
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</tbody>
</table>

Many CA cities have higher levels than Richmond of PM2.5 and sulfates.

Rankings based on median concentration using data from study homes and 14 Cal-EPA monitors.
Richmond levels of vanadium and nickel are among the highest in the state.

<table>
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<tr>
<th>City</th>
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<th>Nickel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond</td>
<td>Highest</td>
<td></td>
</tr>
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<td>Bolinas</td>
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<td>Bakersfield</td>
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Rankings based on median concentration using data from study homes and 14 Cal-EPA monitors.
Indoor Air Pollution
Phthalates
found in 100% of Richmond homes

Sources:
- Fragrances
- Nail polish/Cosmetics
- Vinyl (PVC) products
- Plastic toys

Health Effects:
- Mimic bodies’ hormones
- Alter male reproductive development
- Linked to asthma and allergies
PAHs
found in 100% of Richmond homes

Outdoor Sources

Industry

Traffic

Indoor Sources

Cigarette & incense smoke

Grilling food

Health Effects: Cancer; reproductive harm
Pesticides: A *changing landscape*

**Banned Pesticides**
- DDT (banned in 1972) found in **90%** of Richmond homes

**Limited Use**
- Chlorpyrifos found in **half** of Richmond homes

**Current Use**
- Permethrins found in **nearly every** Richmond home

**Health Effects:** Harm to brain development; cancer
**Phenols**

*Nonylphenol found in 100% of Richmond homes*

**Sources:**
- Detergents
- Paints
- Plastics
- Pesticides

**Health Effects:**
- Mimic bodies’ hormones
- Cause reproductive harm in animal studies
**PBDE flame retardants found in 100% of Richmond homes**

**Sources:** furniture, electronics, carpet padding, and baby products

**Health Effects:** Disrupt thyroid and can affect the developing brain
Median PBDE house dust concentrations across North America and Europe

California PBDE dust levels ~200 times higher than levels from European countries
In our bodies: PBDE blood levels in California nearly two fold higher than rest of the U.S.

Analysis conducted with NHANES national survey data from the Centers for Disease Control (n=1771)
“Poster Child” for Chemicals Policy

- Penta-BDE banned in CA
- Persistent in homes
- Substitutes problematic
- More flammability standards being considered

We need a different approach
Californians have higher levels of flame-retardant PBDEs in their blood.

Researchers find that residents not only have more of the chemicals in their blood than people elsewhere, but that levels in California homes can be 10 times higher.
Environmental Justice Lessons

• More pollutants and higher concentrations in Richmond.
• Outdoor pollutants penetrate indoors
• Indoor concentrations are often higher than outdoor
• Heavy oil combustion leaves a distinctive footprint in homes. Richmond is more affected than others in CA.
Indoor Pollutants Lessons

• Many chemicals in every home
  – Few differences between Richmond and Bolinas

• Banned and current use pesticides in nearly every home

• High levels of PBDE flame retardants
  – Likely due to CA strict fire safety standard.
Linking Household Exposure Study to Paths for Individual and Collective Action

Pollutant Sources

Local Source Pollutants
E.g. Refinery operations

Consumer Products
little/no capacity to avoid
E.g. brominated flame retardants

Consumer Products
individual capacity to avoid
E.g. indoor pesticides

Collective Action

Local Organizing
*Permitting
*Land use decisions

State Policy Advocacy/Organizing
*SB 706 – banning halogenated flame retardants
*Lifting CA flammability retardant standard

Individual Action
*Use of IPM for pests in homes
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Questions?

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www.berkeley.edu