Why Air Quality Matters to Everyone

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Center of Excellence in Environmental Toxicology
Ambient Air Pollution

EPA Criteria Air Pollution

O3 (ozone)
PM (particulate matter)
SO2 (sulphur dioxide)
NOx (nitrogen oxides)
CO (carbon monoxide)
Lead
Dose-Response Relationship

“The dose makes the poison”
Photochemical Smog (Summer Smog)

Ozone- in stratosphere occurs naturally, protects us from UV radiation

\[ \text{NOx} + \text{VOCs} + \text{sunlight} = \text{O}_3 \]

**Nitrogen oxides** (NOx): fuel combustion (motor vehicles, coal power plants)

**Volatile Organic Compounds** (VOCs): Paints, Pesticides, Gasoline vapors and naturally occurring
Ozone Health Effects

- Respiratory symptoms - wheezing, coughing, chest discomfort, bronchoconstriction, decreased lung function
- Mucous membrane irritation - throat, sinus, eye
- Long-term exposure may cause asthma
- Children particularly vulnerable - high respiratory rate
Geography: Its Effect on Air Pollution

- Urban areas surrounded by mountains or in a bowl type geographical depression are most at risk

- Examples: London, Los Angeles, Mexico City, Bogota, Santiago
Winter Smog: Inversion

- Cold air at high altitude
- Warm polluted air trapped
- Cold air at ground level
Acute Air Pollution Episodes and Attributed Mortality

- Meuse Valley of Belgium 1930- 60 deaths during thermal inversion

- Denora, PA 1948- 20 deaths during thermal inversion (steel mills, coke ovens, zinc production, sulfuric acid manufacturing)

- Great Smog of London 1952- 4000 deaths in 2 weeks
Sulfur Dioxide ($SO_2$)

- Created in combustion of fuels containing sulfur (coal, oil)
- Created when gasoline is extracted from oil; and metals extracted from ore
- $SO_2$ reacts in air to form sulfuric acid
- $SO_2$ combines with particulates (PM) to form acidic complexes
Sulfur Dioxide (SO$_2$) Health Effects

- Reduced lung function, bronchoconstriction
- Asthma exacerbation: high levels/ brief periods
- Cardiovascular- myocardial infarction
- Exacerbation of respiratory disease
- Eye, nasal, sinus irritation
- Adverse pregnancy outcomes
- Mortality
Nitrogen Oxides (NOx)

- Created by fuel combustion in motor vehicles (especially), coal power plants etc
- Generates ozone with VOCs and sunlight
- In atmosphere forms reactive nitrogen compounds, nitric acid, nitrates, and acid aerosols
Nitrogen Oxides (NOx) Health Effects

- Irritation eyes, nose and throat
- Short term decreases in lung function
- Bronchoconstriction
- Possible increase in respiratory infections in children
Health Effects of Ozone, SO2 and NOX are Similar and Additive
Particulate Matter (PM)

Mixture of solid particles & liquid droplets

PM 10: airborne particles $\leq 10$ um

PM 2.5: fine airborne particles that are $\leq 2.5$ um

Ultrafine particles are $\leq 0.1$ um

Main sources: gasoline/diesel engines, power plants, incinerators, wood burning, natural -pollens, fires etc.
Particulate matter size distribution

- **PM$_{10}$**: Thoracic particles
- **PM$_{10-2.5}$**: Coarse fraction
- **PM$_{2.5}$**: Fine particles
- **UFP (PM$_{0.1}$)**: Ultrafine particles

Size range:
- 0.01 μm
- 0.05 μm
- 0.1 μm
- 0.5 μm
- 1 μm
- 5 μm
- 10 μm
- 50 μm
- 100 μm

Limit of vision

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Absorption from Inhalation

**Particles**

Size
- Large
- Small

**Deposition site**

- Upper Tract
- Lower Tract

*Figure 2 Particle deposition in respiratory system*
Particulate phase
- Mostly elemental carbon (soot)
  - 20% to 40% adsorbed organic compounds
- Sulfates, nitrates, metals, other trace elements
- The most toxicologically relevant adsorbed compounds (less than 1% of PM by mass):
  - PAHs
  - Nitro-PAHs
  - Oxidized PAH
- 92% of mass is in particles smaller than 1 micron
Health Effects of Fine and Ultrafine Particles

- Increased mortality from cardiac/respiratory problems in populations exposed to fine particulates such as in diesel exhaust (Bruske-Holfeld et al, 2005)

- Changes in cardiovascular physiology (arterial diameter and cardiac rhythm)

- Coal miners accumulate ultrafine dust in the liver and the spleen. Accumulation higher in miners exhibiting pulmonary problems (Donaldson, 2005)
Epidemiologic Studies

• Harvard Six Cities (Dockery et al 1993)
  – PM$_{2.5}$ associated with mortality (1.26 (95%CI: 1.08-1.47))
  – Elevated risks for lung cancer and cardiopulmonary disease
  – Lower risks for other air pollutants, sulfates similar

• ACS (Pope et al 2002, 2004)
  – Each 10-µg/m$^3$ elevation in PM$_{2.5}$ associated with
    4% increased risk of all-cause mortality
    6% increased risk of cardiopulmonary mortality
    8% increased risk of lung cancer mortality
Asthma in Children

- Between 1980 and 1995 the prevalence of asthmatic children in the USA increased from 2.3 million to 5.5 million
- Sharpest prevalence increases – urban minority children under 5 years of age
- Atopy (familial allergy to common allergens) with IgE antibody production is the most reliable predictor of asthma development
- Air pollutants potentiate the tendency toward allergy
National Ambient Air Quality Standards (NAAQS)

- December 14, 2012 EPA revised PM 2.5 standard from 15ug/m3 to 12 ug/m3

- Expected to save thousands of ER visits for exacerbation of cardiac and pulmonary conditions
Indoor Air Contaminants

- Biologic Agents
- Combustion Products
- Particulates
- Pesticides
- Radon
- VOCs
Health Effects Attributed to Poor IAQ

- Irritation of mucous membranes
- Headache
- Lethargy
- Sinus congestion
- Allergy
- Asthma
Mold and the Illness it Can Cause

- Anyone can become sensitized (allergic to mold proteins) if the exposure is great or long lasting.

- Atopic individuals are more likely to become sensitized to mold.

- Hypersensitivity pneumonitis occurs with large inhalation exposure only.

- Exacerbation of allergy leading to asthma can occur with ongoing exposure.

Mold grows in large amounts only when there is water intrusion and humidity remains >50%.
Summary: Why Air Quality Matters

- Significant health effects of poor outdoor and indoor air quality
- Vulnerable populations are particularly at risk: children, elderly, those with underlying heart and lung conditions
- Improving air quality saves lives and improves health
REGIONAL AIR QUALITY, IS THAT WHAT WE REALLY WANT TO KNOW?

A tale of South Philadelphia

Carol Ann Gross-Davis, PhD, MS
EPA Region 3
May 16, 2014
WHAT ARE THE QUESTIONS WE ARE TRYING TO ANSWER AND WHAT DATA DO WE HAVE?

- The National Ambient Air Quality Standards (NAAQS) are a regulatory tool used by federal and state agencies alike, AKA the Clean Air Act.

- This approach attempts to measure “REGIONAL” air quality, which is basically the overall or background pollution level in a geographic area over time.

- Not designed to estimate individual or “community” exposures to chemicals measured in ambient air for select pollutant.
Should We Think About Scale... And How

- Temporality and duration are key factors, as well as attempting to address the error around each estimate.

- Peak pollution levels can be the most biologically relevant if the health effect is triggered by short-term exposures compared to steady (average) state.

- Peak concentration of associated with episodic, local emission events resulting in heterogeneous concentrations (Brown et al., 2014).
SO WHAT’S THE BIG DEAL

- Data is lost when we are only working with averages, means, or categories of exposure levels etc…

- These peaks, are of the most interest to the community living close to sources with potential for spikes

END RESULT: These regulatory tools require averaging of samples
BUT aren’t we comfortable we averages, omitting outliers, smoothing the curves…..
WHAT IF YOU WANTED TO KNOW WHAT THE CONCENTRATION IS IN THIS AREA... WHERE WOULD YOU PUT YOUR MONITOR?

Or how about here?

Here?

Courtesy of Cynthia Stahl, PhD
CONSIDER A SCENARIO WHERE YOU MONITOR BUT DON’T FIND ANYTHING BUT THE POLLUTANT SPATIAL FIELD REALLY LOOKS LIKE THIS....

Who have we helped? Who have we hurt?

Courtesy of Cynthia Stahl, PhD
Public Health (Adapted from Jellata, Gale and Kontgis, 2009 [3]).
South Philadelphia

- Focus on the Philadelphia Energy Solutions (PES) facility, formerly Sunoco refinery and the surrounding Communities
  - Largest source of air pollution in the greater Philadelphia area
  - Communities directly next to the facility (Point Breeze, Greys Ferry)
    - High health risks from NATA
    - Lower income and education
    - Emissions expected to increase
Overview Maps Showing Philadelphia Refinery and the Greys Ferry & Point Breeze Neighborhoods
GREYS FERRY & POINT BREEZE NEIGHBORHOODS

- Point Breeze and Grey's Ferry lie next to an oil refinery along with other industrial sites.

- Residents have been experiencing disproportionate exposure to environmental health hazards for decades.

- Communities in the South Philadelphia West neighborhood have long been concerned about the possible impacts specifically the oil refinery also located in this area.

- 45,000 residents live within 1.6 km from the refinery, 59% were black, 29% white, 8% Asian and 4% Latino. Thirty-two % live below the federal poverty level.
AMS Monitor Locations
WHO IS ON THE TEAM?

Over the last 2 years, Region 3 has collaborated with

• EPA/Office of Research and Development (ORD)
• EPA/Office of Environmental Information (OEI)
  • toxics Release Inventory (TRI)
• City of Philadelphia
  • Department of Health, Air Management Services (AMS)
  • Parks and recreation Services
  • Philadelphia housing Authority
• University of Pennsylvania and Drexel University
R3, ORD, OAR, City of Phil. AMS and Housing Authority cooperation

AMS deployed low-cost UV open-path system (OAQPS community scale grant)
South Philadelphia West, zip codes 19145, 19146, 19147 and 19148

Web based, non-static map allows users to turn on and off any layer of interest, and drill down with clicks to get more information about a particular point of interest.

MAP LEGEND

- Light Blue Squares = 2012 TRI Facilities
- Yellow Circles = Nursing Homes
- Orange Circles = Schools
- Purple Circles = Playgrounds
- Blue Circles = Hospitals
CHALLENGES TO BE ADDRESSED

We need to acknowledge these limitations of the regulatory sampling methodologies.

Monitoring sites are widespread and local impacts are not typically captured “yet”.

Yet, there is a real potential for significant public health threats.

Local air quality impacts have many challenges and they have not been adequately addressed by EPA.

Sensor, mobile monitoring devices and small scale modeling are being developed or already exist.

We must do a better job at describing ambient air exposures and human health risk for communities close to sources?
THANK YOU  QUESTIONS?

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Indoor Air Quality

Pennsylvania Integrated Pest Management Program
Philadelphia School & Community IPM Partnership
215-471-2200 Ext. 109
Email: pscip@psu.edu
Website: www.paipm.org
Air Pollution – Where is it?
But what about ...
Indoor Air Quality

• Most Americans spend 90% of their time indoors
• Indoor concentrations of pollutants are commonly 3 to 5 times higher than outdoor concentrations
• Indoor air quality is affected by cleaning products and processes, HVAC systems, interior finishes, exterior pollutants, personal-care products, pesticides, and pet dander
Air is all Connected

If you breathe it, you are taking it into your body = exposure
Health Problems Related to Housing Conditions

- Asthma
- Allergies
- Brain damage
- Behavior problems
- Learning problems
- Developmental delays
- Lung cancer
- Injuries
- Poisonings
- Death
What Allergens and Irritants Trigger Asthma?

Irritants:
• Secondhand smoke
• Pollutants
• Ozone
• Strong smells or sprays
• Exercise
• Allergies
• Hot or cold air

Allergens:
• Dust mites
• Pets
• Molds
• Cockroaches
• Pollen
• Rats
• Mice
• Birds
7 Principles of a Healthy Home

Keep It:

1. Dry
2. Clean
3. Ventilated
4. Pest-Free
5. Safe
6. Contaminant-Free
7. Maintained
What is a Pest?

Pests may include: mammals, insects, rodents, bacteria, and plants. Pests spread diseases to people, animals and plants, destroy property, and are a nuisance.

Cockroaches    Ants    Deer
Mice           Fleas   Raccoons
Flies          Birds
Spiders        Bed bugs
Head lice      Weeds
Problems Caused by Pests

• People don’t like them in their spaces

• Health Problems
  – Spread Bacterial Diseases
  – Contaminate Food
  – Trigger Asthma
  – LCMV – spread by mice. Causes meningitis and may harm pregnancies

• Damage Property
What is a Pesticide?

“_____ - cide” means “to kill”

Rodenticide  (kills rodents)
Insecticide  (kills insects)
Herbicide    (kills plants)
Algicide     (kills algae)

Plus “Anti-microbials” such as “Triclosan”
Problems Caused by Pesticides:

Acute Exposure:
- Asthma Attacks
- Flu-like Symptoms
- Vomiting
- Dizziness
- Unconsciousness

Long-Term Exposure:
- Asthma
- Cancer
- Neurological damage
- Immune system damage
- Permanent chemical sensitivity
- Endocrine disruption
# Pesticide Signal Words

Read Labels on Cleaning Products & Pesticides

<table>
<thead>
<tr>
<th>Signal Word</th>
<th>Toxicity</th>
<th>Oral Lethal Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER POISON</td>
<td>Deadly</td>
<td>Fatal if swallowed</td>
</tr>
<tr>
<td></td>
<td>(Skull &amp; Crossbones)</td>
<td></td>
</tr>
<tr>
<td>DANGER</td>
<td>Highly toxic</td>
<td>Few drops to 1 tsp.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Moderately toxic</td>
<td>1 tsp. to 1 Tbsp.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Slightly toxic</td>
<td>1 oz. to more than a pint</td>
</tr>
</tbody>
</table>
Illegal and Unmarked Pesticides

Pesticides that look like candy

Insecticide chalk
(a.k.a. Miraculous or Chinese chalk)

“Tres Pasitos”
What is IPM?

Integrated Pest Management (IPM) is an approach to controlling pests in safer, more effective, and longer-lasting ways.

When you use IPM, you

a. understand a pest's identity and habits so non-toxic, preventative measures can be used first

b. use a combination of different tactics for better effectiveness

c. use least-toxic chemicals, if any at all
How do we do Integrated Pest Management?

1. Keep Pests Out
2. Remove Pests’ Food & Water
3. Remove Pests’ Shelter
4. Monitor for Pests
5. Treat Existing Pest Problems

Routine Monthly Spraying is NOT Part of IPM
IPM Pyramid of Tactics

Pyramid of IPM Tactics Inside Buildings
Start with People

- What good are they?
- What’s difficult about people?
- How can you deal with people?
Challenges

• Communication
  – Literacy
  – Language
  – Education
  – Economics

• Cultural and Social Norms
  – If some is good, more is better (WRONG!)

• Human Behavior
What is Risk?

Human perception:
Hazard x Exposure x Vulnerability

Examples:
- Common/familiar = safe
- Under my control = safe
- Associated dread = risky
Resources for more Information

• US Department of Health & Human Services, Household Products Database
  http://householdproducts.nlm.nih.gov/

• The National Center for Healthy Housing
  http://www.nchh.org/

• The Pennsylvania Asthma Partnership
  http://www.paasthma.org/
Thank you!

Michelle Niedermeier
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