Climate Change, Sea Level Rise, Flooding and Health

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Outline

• Overview of Climate Change and Sea Level Rise
• Overall Health Effects of Sea Level Rise and Flooding
• Respiratory Health Effects of Sea Level Rise and Flooding
• Recommendations and Adaptation Strategies
Why should we care?


Global Injustice

- Climate change effects people around the world
  - things are a bit hotter, or a bit colder and a bit more uncertain,
  - too little or too much water, not enough food,
  - not safety and security
- It is a survival…
Vulnerability

• “Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.”
  IPCC Fourth Assessment Report (AR4), 2007

• Vulnerable groups
  – Sick
  – Old and young
  – Physically or mentally challenged
  – Disadvantaged groups
    • minorities, less educated, non-English speakers
  – Women
    • the single mother household

Climate Change and Health

• Climate change directly impacts health
  – Climate change impacts the weather, air, food supply, water, and economic longevity of humans
  – Temperature increases has been shown to impact the biological and physical systems of humans worldwide
  – Mental health
  – Respiratory Health has shown to be a concern!
    — Increases amount of pollen and allergen
    — Increases mold
    — Increases the concentrations of outdoor ozone and particulate matter
  D’Amato, Cecchi, D’Amato, & Annesi-Maesano, 2014
Climate Change and Sea Level Rise

- Climate change impacts
  - rate of glaciers melting
  - diminishing snow cover
  - frequency and severity of precipitation as well as increase in extreme weather events
  - Facilitates rising sea levels and flooding all around the world

D'Amato, Cecchi, D’Amato, & Annesi-Maesano, 2014

http://en.wikipedia.org/wiki/Climate_change_in_the_Arctic

The Impact of Sea Level Rise

- Estimated 3.3 billion people worldwide at risk of the impacts of sea level rise
- A large percentage of Americans who live in coastal cities will be exposed to additional wet housing conditions due to a rise in sea level
  - New Orleans, Miami, Tampa, Charleston, and Virginia Beach are among the most at risk!

Barnes et al., 2013; Bloetscher, Heimlich, & Romah, 2011; Strauss, Ziemlinski, Weiss, & Overpeck, 2012
Effects of Sea Level Rise on Health

- Injury
- Infrastructure damage
- Food and water contamination and insecurity
- Release of chemicals, sewage, and pollutants
- Vector born diseases
- Impacts on chronic diseases and mental health
- As sea level rises and rainfall patterns change, mold allergies will increase
  - Increase in damp environments which will contribute to the growth of mold
- Population displacement

Barnes et al., 2013

Health Effects of Coastal Storms and Flooding

Lane et al, 2013
Flooding and Health

- 2/3 of the fatalities from Hurricane Katrina were associated with flooding
- In 2010, there were 103 flood-related fatalities in the US according to National Oceanic and Atmospheric Administration
- 1 of 7 most costly insurance loss vents in the US in 2010 (6.3 billion in losses)

Climate Change, the Indoor Environment, and Health, 2011

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Flooding and Health

- Indirect health effects of flooding:
  - Damage to water and sanitation infrastructure
  - Damage to crops and or disruption of food supplies
  - Damage/destuction of property
  - Disruption of livelihood and income
  - Population displacement
  - Damage to health care infrastructure

Few & Matthies, 2013
Flooding and Health

- Direct health effects of flooding:
  - Drowning
  - Injuries
  - Vector and rodent borne diseases
  - Chemical contamination
  - Skin/eye infections
  - Mental health
  - Diarrhoeal diseases
  - Respiratory Diseases

  Few & Matthies, 2013

Flooding and Respiratory Health

- Lower respiratory symptoms were reported more frequently in homes with dampness or mold in children and adults
- Allergen levels higher in flooded homes
- Flooding leads to loss of electrical power which can be substituted by petroleum-fuelled equipment
  - Increases risk of carbon monoxide poisoning
  - Increases risk of exposure to harmful fumes or particulate matter

Flooding in England

- Respondents at focus groups following flooding in England in 2000 were likely to report chest infections, coughs, asthma, flu and colds due to flooding.
- Results from a flood and respiratory health symptoms study in Lewes England in 2004 found that there was an association between self-reported worsening of asthma and flooding in adults.

Fewtrell et al. 2006; Tapsell et al. 2002

Flooding in Pakistan

- Pakistan is ranked 9th in terms of flood-affected countries worldwide.
- In the summer of 2010, the northern province of Khyber-Pakhtunkhwa received more than 312 mm of rain in a 56 hour period.
- Respiratory infections are one of seven major diseases were identified to increase in the aftermath of natural disasters.

Baqir, 2012
Flooding in Vietnam

• The association between annual river flood pulse and pediatric hospital admissions in a Vietnam Mekong Delta city.
• Daily pediatric hospital admissions is significantly associated with annual river flood
  – 1.66 (95%CI, 1.57-1.74) for respiratory infection

Phung, 2014

Flooding in Guyana

<table>
<thead>
<tr>
<th>Flood date</th>
<th>Affected (#people)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>No data</td>
</tr>
<tr>
<td>1996</td>
<td>38,000</td>
</tr>
<tr>
<td>2005</td>
<td>274,000</td>
</tr>
<tr>
<td>2006</td>
<td>35,000</td>
</tr>
<tr>
<td>2008</td>
<td>100,000</td>
</tr>
</tbody>
</table>

http://www.wondermondo.com/Best/SA/GuyanaFallsList.htm
The case of Cove& John, GUYANA

• The town was flooded in December 2008
• To evaluate the prevalence of respiratory symptoms among occupants of water-damaged houses after the 2008 floods in Guyana
• Out of 185 households, a total of 130 households completed the questionnaire (70%).

Health problems and flooding

• Flooded houses 76.1%
  – Mould inside the home 37.3% (questionnaire)
  – Dampness and mould 32.8% (direct observation)
• A statistically significant association was found between flooded houses and “Fever and Chills” (p<0.05)
• A statistically significant association was also found between the presence of mould and runny nose, bronchitis (p<0.05)
### Risk factors of self-reported health-related perspective among the study participants

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling Downhearted and depressed</td>
<td>1.4 (0.6 - 3.1)</td>
</tr>
<tr>
<td>Poor Health</td>
<td>4.9 (0.6 - 39.4)</td>
</tr>
<tr>
<td>Interest in daily activities</td>
<td>1.3 (0.5 - 2.9)</td>
</tr>
<tr>
<td>Interference with social activities</td>
<td>1.9 (0.7 - 4.6)</td>
</tr>
<tr>
<td>Trouble concentrating</td>
<td>2.4 (0.9 - 6.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Flooding</td>
<td>3.0 (1.2 - 7.5)</td>
</tr>
<tr>
<td>Mold inside home</td>
<td>0.9 (0.4 - 1.9)</td>
</tr>
<tr>
<td>Smell of mold</td>
<td>1.2 (0.5 - 2.5)</td>
</tr>
<tr>
<td></td>
<td>1.1 (0.5 - 2.3)</td>
</tr>
</tbody>
</table>

*Age-, gender-, income, race, and education adjusted

Akpinar et al, 2017

### Flooding in New Orleans, LO

- “Health effect of exposure to water-damaged New Orleans homes six months after Hurricanes Katrina and Rita”
- Respiratory symptoms were positively associated with exposure to water-damaged homes and respirator use had a protective effect.

Cummings, 2008
Flooding in Eastern North Carolina

• “Schools serving populations already at elevated risk of respiratory illness were disproportionately affected by the flooding of Hurricane Floyd.”

Guirdy et al, 2005

Flooding in New Jersey

• Hurricane Sandy damaged or destroyed more than 375,000 housing units.
• Of the long-term health threats posed by Sandy, the most significant is mold growth in homes that were not properly remediated after flooding.

Emerson et al, 2015
Virginia and Asthma

Hampton Roads, Sea Level Rise, Flooding

This map shows the areas that would be under water should a sea-level rise of four meters occur.

Image credit: Weiss and Overpeck, The University of Arizona
Adults with Current Asthma in Hampton Roads

Age-Adjusted Hospitalization Rate due to Adult Asthma (2013-2015)
Hampton Roads and Asthma

Table 3. General physical health by asthma respondents.

<table>
<thead>
<tr>
<th>Physical Health &amp; Frequency</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>Nag.</th>
<th>p Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Not Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 or more days</td>
<td>1.37</td>
<td>0.99–1.95</td>
<td>0.002, 0.004</td>
<td>0.078</td>
</tr>
<tr>
<td>2 or more days</td>
<td>1.50</td>
<td>1.05–2.15</td>
<td>0.003, 0.007</td>
<td>0.026</td>
</tr>
<tr>
<td>3 or more days</td>
<td>1.64</td>
<td>1.21–2.19</td>
<td>0.004, 0.009</td>
<td>0.011</td>
</tr>
<tr>
<td>4 or more days</td>
<td>1.66</td>
<td>1.17–2.48</td>
<td>0.004, 0.009</td>
<td>0.014</td>
</tr>
<tr>
<td>5 or more days</td>
<td>1.78</td>
<td>1.18–2.68</td>
<td>0.005, 0.011</td>
<td>0.006</td>
</tr>
</tbody>
</table>

1 Cox & Snell, 2 Nagelkerke, 3 Significance, 4 Statistically no significant difference between asthma and non-asthma respondents.

CDC Recommendations

- Homes have been wet for more than two days, it should undergo remediation quickly.
- Use of proper safety precautions when inside water damaged homes such as respirators and ensure proper ventilation of the area
- Strengthen climate-sensitive disease surveillance
- Ensure appropriate policy development regarding climate change and health needs

Miller, 2013: McIver, Woodward, Davies, Tibwe, & Iddings, 2014
Adaptation for Sea Level Rise

- Three types of adaptation options for rising sea levels
  - Protect
    - Building levees or other engineering structures
  - Accommodate
    - Raising existing structures or natural protection measures
  - Retreat
- Create a comprehensive action plan

Bloetscher, Heimlich, & Romah, 2011

Community-based Adaptation

Perhaps…

[Image: Climate Change Will Force Us to Abandon Coastal Cities. We Better Start Preparing Right Now.]

http://www.newrepublic.com/article/117799/climate-change-will-force-us-abandon-cities-if-we-dont-prepare-now

Thank you

[Image: "It’s very difficult for somebody living in the United States to grasp the fact that if the sea level rises just a few feet, a whole nation will disappear.
— Bon Graham, Marshall Islands"

http://archive.itvs.org/risingwaters/

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