Assessing Public Health Risks from Unsafe Fecal Sludge Management in Poor Urban Neighborhoods: What does SaniPath tell us about exposure to fecal contamination in 12 neighborhoods in 3 cities?

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Shit Flows Analyses show that Fecal Sludge is NOT Contained – Reservoirs in Urban Environment

What are the public health risks from this fecal sludge in the environment?

What information does local government need in order to address this?

Peal et al. Journal of Water Sanitation and Hygiene for Development. 2014
Pathways of Exposure to Fecal Contamination

Floodwater

Public latrines

Open drains

Surface water

Drinking water

Bathing water

Wastewater-irrigated produce

Soil
Multiple exposure pathways with different risks
Which pathways pose the greatest risk?

- **Household**
  - Surfaces
  - Soil
  - Stored drinking water

- **Food**
  - Ready-to-eat food contaminated by food handler
  - Wastewater-irrigated produce

- **Surface Waters**
  - Bathing
  - Laundry
  - Swimming

- **Flood zones**
  - Soil
  - Water

- **Open drains**
  - Sediment
  - Water

- **Public latrines**
  - Surfaces

- **Municipal Water**
  - Drinking
  - Bathing

- **Soil**
Estimating Exposure to Fecal Contamination

Behavior Frequency

Frequency of produce ingestion in Shiabu (Children)

- Every day: 40.29%
- 4-6 days a week: 23.95%
- 1-3 days a week: 19.51%
- Never: 6.34%
- I do not know: 2.37%

Environmental Contamination

Produce samples from Shiabu

- Percent Exposed = 55%
- Log10 Dose 5.42

Tool uses Bayesian analysis to estimate the distribution of environmental contamination and frequency of exposure.

Other parameters: intake volumes, duration of exposure, etc.

The mean dose and proportion of the population exposed are summarized from simulated distributions and displayed in risk profiles.
SaniPath tool deployments: 2012-2016
Primary data collection completed for 12 different neighborhoods

- Accra, Ghana – 4 neighborhoods
- Vellore, India – 2 neighborhoods
- Maputo, Mozambique – 2 neighborhoods
- Accra, Ghana – 5 neighborhoods
- Siem Reap, Cambodia – in progress
- Dhaka, Bangladesh – in progress
- Dakar, Senegal – in progress
Research Questions

• How do fecal exposure pathways vary in a single neighborhood?
• How consistent are the results of a SaniPath exposure assessment?
• How do fecal exposure pathways vary across neighborhoods in the same city?
• How do fecal exposure pathways vary across neighborhoods in different cities?
How do fecal exposure pathways vary in a single neighborhood?
Chorkor neighborhood, Accra, Ghana, 2016
Research Questions

• How consistent are the results of a SaniPath exposure assessment?
  • How do the exposure estimates vary between two different teams of data collectors in the same neighborhood at the same time?
  • How do the exposure estimates vary between two different teams of data collectors in the same neighborhood in two different years?
Examining consistency of SaniPath results

1. Is risk ranking of pathways similar?
2. Are risk estimates similar (percent of exposed population and $\log_{10}$ dose)?
3. If different, where are the differences and why?
Two teams collect SaniPath data simultaneously in Chorkor neighborhood, Accra, Ghana.

Team 1:
- **Drain**: Percent Exposed = 72 %, Log10 Dose= 7.07
- **Produce**: Percent Exposed = 92 %, Log10 Dose= 7
- **Piped Water**: Percent Exposed = 67 %, Log10 Dose= 5.17
- **Public Latrine Surface**: Percent Exposed = 89 %, Log10 Dose= 1.88

Team 2:
- **Drain**: Percent Exposed = 72 %, Log10 Dose= 6.32
- **Produce**: Percent Exposed = 97 %, Log10 Dose= 6.77
- **Piped Water**: Percent Exposed = 78 %, Log10 Dose= 5.16
- **Public Latrine Surface**: Percent Exposed = 83 %, Log10 Dose= 1.87
Comparing 2012 and 2016 results from Shiabu in Accra, Ghana

**Drain**
- Percent Exposed = 33%
- Log10 Dose: 2.88

**Produce**
- Percent Exposed = 89%
- Log10 Dose: 5.94

**Piped Water**
- Percent Exposed = 71%
- Log10 Dose: 2.41

**Public Latrine Surface**
- Percent Exposed = 80%
- Log10 Dose: 5.13

**Drain**
- Percent Exposed = 70%
- Log10 Dose: 7.56

**Produce**
- Percent Exposed = 92%
- Log10 Dose: 6.69

**Piped Water**
- Percent Exposed = 72%
- Log10 Dose: 3.83

**Public Latrine Surface**
- Percent Exposed = 84%
- Log10 Dose: 4.58
Comparing 2012 and 2016 results from Shiabu in Accra, Ghana: Drains

- *E. coli* concentrations in drain samples were at upper limit of detection in 2012.
- Dilutions of drain samples were adjusted in 2016 and the *E. coli* concentrations in the drain samples were quantified more accurately.
Research Questions

• How do fecal exposure pathways vary in a single neighborhood?
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• How do fecal exposure pathways vary across neighborhoods in the same city?
• How do fecal exposure pathways vary across neighborhoods in different cities?
5 Sanipath deployment neighborhoods, Accra, Ghana, 2016

Two adjacent coastal neighborhoods (Shiabu and Chorkor)

Higher income neighborhood (Ringway)
SaniPath deployment in 5 neighborhoods
Accra, Ghana, 2016

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Percent Exposed</th>
<th>Log10 Dose</th>
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</thead>
<tbody>
<tr>
<td>Adabraka</td>
<td>58%</td>
<td>5</td>
</tr>
<tr>
<td>Chorkor</td>
<td>71%</td>
<td>6.4</td>
</tr>
<tr>
<td>Kokomlemle</td>
<td>50%</td>
<td>5.51</td>
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<tr>
<td>Ringway</td>
<td>52%</td>
<td>4.64</td>
</tr>
<tr>
<td>Shiabu</td>
<td>70%</td>
<td>7.56</td>
</tr>
</tbody>
</table>
SaniPath deployment in 5 neighborhoods
Accra, Ghana, 2016
SaniPath deployment in 5 neighborhoods Accra, Ghana, 2016
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SaniPath Risk Profiles:
3 pathways
3 cities

Greatest variability between 3 cities in magnitude of fecal contamination and exposure was in drain pathway.

Moderate fecal contamination of drinking water, but high proportion of population exposed

Produce is always highly contaminated, but proportion of the exposed population varies by city due to cultural differences in diet
Summary

• Good consistency in SaniPath risk profiles based on data collected by different teams at same time
• Good consistency in SaniPath risk profiles for same neighborhood based on data collected about 4 years apart
• Risk profiles show how exposure to fecal contamination **varies across pathways in a single neighborhood**
• Risk profiles show how exposure to fecal contamination **varies across neighborhoods in a single city and across pathways for 3 different cities**
• Sanitation planners can use information on geographic differences and pathway differences to target investments to areas/pathways of greatest risk
Overview of Tool Architecture

Mobile Data Collection

Data/Form Repository

Analysis and Dashboard

“The Cloud”
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**International Expert Committee; Local Expert Committee; SaniPath Advisory Committee**
Thank You

For more information visit SaniPath.org

@SaniPath

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Comparing Ocean water pathway, 2 neighborhoods, Accra, Ghana 2016

Ocean Water

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Percent Exposed</th>
<th>Log10 Dose</th>
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</thead>
<tbody>
<tr>
<td>Chorkor</td>
<td>62%</td>
<td>3.41</td>
</tr>
<tr>
<td>Shiabu</td>
<td>49%</td>
<td>2.61</td>
</tr>
</tbody>
</table>
Research Questions

• How do fecal exposure pathways vary in a single neighborhood?
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• How do fecal exposure pathways vary across neighborhoods in the same city?
• How do fecal exposure pathways vary across neighborhoods in different cities?
Comparing risk profiles for 5 pathways in 2 neighborhoods in Vellore, India

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Percent Exposed</th>
<th>Log10 Dose</th>
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</thead>
<tbody>
<tr>
<td>Bathing</td>
<td>100%</td>
<td>1.97</td>
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<tr>
<td>Drain</td>
<td>57%</td>
<td>3.78</td>
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<tr>
<td>Piped Water</td>
<td>97%</td>
<td>4.95</td>
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<tr>
<td>Produce</td>
<td>42%</td>
<td>6.08</td>
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<tr>
<td>Public Latrine Surface</td>
<td>59%</td>
<td>3.33</td>
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<tr>
<td></td>
<td>100%</td>
<td>1.71</td>
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