The SaniPath Rapid Assessment Tool:
Assessing Public Health Risks from Unsafe Fecal Sludge Management in Poor Urban Neighborhoods

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Background: Global Sanitation

In 2008, for the first time in history, the number of people living in cities outnumbered the population in rural areas.

By 2050, the United Nations projects that 65% of global population will live in cities.

Rapid growth outpaced the ability of government to provide basic services.
Shit Flow Diagrams show many reservoirs of untreated fecal contamination in the environment.

Where does the shit end up?

What are the associated public health risks?

Given complex exposure routes with different levels of contamination and type of exposure contact, it has been difficult to determine what kind of interventions might have the biggest impact on reduction in exposure.
Local governments and development partners lack evidence-based tools to assess relative public health risks from fecal contamination.

What exposure pathways to fecal contamination pose the greatest health risk?

What are the public health implications of poor fecal sludge management for neighborhoods?

How should policy makers prioritize sanitation investments to have the biggest impact on reducing public health risk?
The SaniPath Rapid Assessment Tool is designed to assess public health risks related to poor sanitation and to help prioritize sanitation investments based on the exposures that have the greatest public health impact.
Rapid Assessment Tool

- **Based on in-depth risk assessment** in Accra, Ghana
- **Systematic, customizable method** to collect relevant data on exposure to fecal contamination in low-income, urban neighborhoods
- Designed for use by community, government, and development partners to help guide **decision-making** and **advocacy** surrounding urban sanitation
- **Synthesize data** using open-source software package
- Tool has been used in Accra, Ghana; Vellore, India; Maputo, Mozambique
Pathways of Exposure to Fecal Contamination in the Urban Environment

- Floodwater
- Public latrines
- Soil in public areas
- Surface water
- Public drinking and bathing water
- Wastewater irrigated produce
- Open drains
Data Collection Methods

• Behavioral Exposure Data
  – Collect survey data on reported frequency of behavior of adults and children that leads to exposure to fecal contamination

• Environmental Microbiology Data
  – Collect environmental samples from relevant exposure pathways
  – Analyze for *E. coli*

• Data are combined to assess the relative risk of exposure.
SaniPath Rapid Assessment Tool Outputs

**Frequency of Fruits/Vegetables Contact in Shaibu (children)**

- Every day: 48.39%
- 4-6 days a week: 22.93%
- 1-3 days a week: 19.51%
- Never: 6.34%
- I do not know: 2.97%

**Produce Samples from Shaibu**

Number of samples vs. E. coli concentration/serving
Behavioral and environmental data are combined to estimate exposure to fecal contamination via specific pathways.

**Behavior Frequency**

- Frequency of Municipal Drinking Water Contact in Shaibu (adults)

- Behavior Frequency:
  - Daily: 70.96%
  - 4-6 days a week: 13.59%
  - 1-3 days a week: 9.98%
  - Never: 2.99%
  - I do not know: 0.46%

**Environmental Contamination**

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

- Drinking Water (Adult)
  - Percent Exposed = 89%
  - Log10 Dose 3.1

- The mean dose and proportion of the population exposed are summarized from simulated distributions and displayed in risk profiles (left).

- Tool uses Bayesian analysis to estimate the distribution of environmental contamination and frequency of exposure.
Risk profiles show % of population exposed per month (in red) and the average dose of fecal contamination ingested per month (darker red = higher dose).
Open Drains | Drinking Water | Raw Produce | Public Latrine Surfaces
---|---|---|---
**Adults**
Shiabu Adult drain
- Percent Exposed: 33%
- Log10 Dose: 2.88

Shiabu Adult drinking water
- Percent Exposed: 71%
- Log10 Dose: 2.41

Shiabu Adult produce
- Percent Exposed: 89%
- Log10 Dose: 5.94

Shiabu Adult swabs
- Percent Exposed: 80%
- Log10 Dose: 5.13

**Children**
Shiabu Child drain
- Percent Exposed: 17%
- Log10 Dose: 3.9

Shiabu Child drinking water
- Percent Exposed: 57%
- Log10 Dose: 2.15

Shiabu Child produce
- Percent Exposed: 55%
- Log10 Dose: 5.42

Shiabu Child swabs
- Percent Exposed: 48%
- Log10 Dose: 4.56
Summary of SaniPath Rapid Assessment Tool Goals:

• **Guide** users through the collection of relevant data to estimate the relative public health risk

• **Provide** users with easy-to-use software interface for data collection that can be customized to fit the country context

• **Synthesize** these data to guide community, government, and service providers in their decision-making process

• **Limitations:**
  – Designed for use a neighborhood not city level
  – Does not measure health outcomes
Next Steps

• Adapt tool to optimize user interface and output
• Identify candidate cities for tool deployment where major sanitation interventions are being considered
• Develop Stakeholders Advisory Board
Appeal to SuSanA members for input

• Suggestions about where we can deploy the SaniPath Rapid Assessment Tool?
  – partners working at city level interested in deploying tool to inform sanitation interventions
  – partners who can use this type of data to inform their work
  – institutions that would be good candidates to learn to use the tool

• Suggestions for candidates for the advisory committee?
  – What are the greatest challenges facing sanitation decision makers?
  – What scale are decision makers most interested in (city vs. neighborhood level)?
  – How can we best -- engage potential users? -- convey risk results visually? -- Facilitate the translation of the tool recommendations into actionable interventions?
Acknowledgements

Bill & Melinda Gates Foundation
  Erica Coppel, Radu Ban, Alyse Schrecongost

Center for Global Safe Water, Sanitation and Hygiene at Emory University
  Christine Moe, Clair Null, Peter Teunis, Monique Hennink, Kelly Baker, Amy Kirby, Habib Yakubu, Kate Robb, Heather Reese, Katherine Roguski, Suraja Raj, Megan Light, Steven Russell, Deema Elchoufi, Yuke Wang, Jimi Michiel, David Berendes, Eddy Perez, Pengbo Liu, Stephanie Gretsch, Dorothy Peprah, Matthew Freeman, Julie Clennon

Water Research Institute- Joseph Ampofo

Noguchi Memorial Institute for Medical Research – George Armah

TREND- Nii Wellington
Thank You

For more information and to download the tool visit SaniPath.com

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Dose Calculations
Calculating Dose

The intake value is defined as the volume ingested per exposure event. When relevant, the duration of event is also taken into account.

Volumes and event durations were determined based on a combination of EPA values, literature review, and SaniPath Phase 1 data.

<table>
<thead>
<tr>
<th>Exposure Pathway</th>
<th>Age Group</th>
<th>mL/Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking Water</td>
<td>Adults</td>
<td>1043</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>414</td>
</tr>
<tr>
<td>Drain Water</td>
<td>Adults</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>1.0</td>
</tr>
</tbody>
</table>

\[
\text{mL ingested / event} \times \text{average } \text{E. coli} / \text{mL} = \text{dose (CFU E. coli ingested / event)}
\]
Age Group

- Given differences in body size and behaviors, separate intake values are calculated for children and adults.

We assume that children and adults come into contact with drains differently. For example, a child may intentionally enter a drain and may stay in the drain longer. An adult may incidentally be exposed to drain water while working near a drain.
Defining the Event

• **Drain Water**
  - Event = entering a drain for any reason (accidental, incidental or intentional)

• **Drinking Water**
  - Event = one day of drinking water from a municipal source
Exposure Time Unit and Duration of Event

• Exposure Time Unit
  – Some exposures are calculated per day, while others are calculated per event.
    • Drain exposure is calculated in terms of number of drain contact events per month.
    • Municipal drinking water exposure is calculated in terms of the number of days per month that municipal water is consumed (regardless of the number of times in one day water is consumed).

• Duration of Event
  – For some exposures pathways, like contact with surface water, the duration of event is used in addition to the intake time unit.
# Intake Volume and mL ingested/event

- **Intake Volume** = volume (in mL) that is assumed to be ingested per event
  - Volumes were determined based on a combination of EPA values, literature review and SaniPath Phase 1 data

<table>
<thead>
<tr>
<th>Exposure Pathway</th>
<th>Age Group</th>
<th>Intake Volume (mL)</th>
<th>Exposure Time Unit</th>
<th>Duration of Event</th>
<th>mL/Event</th>
<th>Rationale</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking Water</td>
<td>Adults</td>
<td>1,043</td>
<td>day</td>
<td>n/a</td>
<td>1043</td>
<td>US EPA value for drinking water consumption per day by adults. Similar averages found in literature review of studies in developing countries.</td>
<td>When participants site how many days per week they drink municipal water, we assume that all of their water consumption on that day is from the municipal source.</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>414</td>
<td>day</td>
<td>n/a</td>
<td>414</td>
<td>Same as above but for children</td>
<td>Same as above</td>
</tr>
<tr>
<td>Drain Water</td>
<td>Adults</td>
<td>0.06</td>
<td>event</td>
<td>n/a</td>
<td>0.06</td>
<td>Intake volume taken from the US EPA value for an adult wading in water: 3.7ml/hour.</td>
<td>-Any event is likely to lead to high exposure. -There is little or no information about the duration of time adults spend in drains. Therefore, one minute is used to signify 1 drain entry event.</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>1</td>
<td>event</td>
<td>n/a</td>
<td>1.0</td>
<td>Inflation of adult US EPA wading value</td>
<td>Same as above with the additional assumption that kids spend more time in drains and have greater contact with drain water.</td>
</tr>
</tbody>
</table>
### Calculation of Dose

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- The mL/event is multiplied by the average concentration of *E. coli* per 1mL from the environmental samples from the relevant pathway.
- The dose is the number of colony forming units (CFU) of *E. coli* ingested per event.

\[
\text{mL ingested / event} \times \text{average } E. \text{coli} / \text{mL} = \text{dose (CFU } E. \text{coli ingested / event)}
\]
Next Steps
Next Steps: Improvements to Rapid Tool

• Transition to mobile data collection
• Improved statistical methods to estimate risk
• Improved assessment of risks from soil
• Improved spatial analyses
• Microbial source tracking module using phage-based methods
Next Steps: Validation Studies

• Linking SaniPath exposure assessment to health outcomes in Vellore, India
  – Compare fecal exposure assessment to MAL-ED study data on pediatric enteric infection incidence
    • All enteric infections
    • Norovirus and EAEC infections

• Linking SaniPath to fecal sludge management
  • Deployment in two extreme FSM cities
  • Do we see differences in exposure to fecal contamination?
Next Steps: Scaling up and Sustaining

• Develop training hubs with certified sub-contractors in India and Ghana
  – Scale up SaniPath deployments in more cities where sanitation investments are being considered
  – Provide technical support and share information via remote teleconference/video conference
  – Compile and compare city results in central database
Risk = f(Contamination, Exposure)

Higher contamination
Higher Exposure Frequency

High
- Drain water
- Drain sediment
- Flood water
- Flood sediment
- Ocean water
- Beach sand

Middle
- Nursery surfaces
- Nursery particulate
- Household surfaces
- Household particulate
- Public Latrine surfaces

Low
- Produce
- Ready-to-eat food
- Drinking water (all sources)

Household
- Surfaces
- Drinking water
- Particulate

Nursery
- Surfaces
- Drinking water
- Particulate

Public latrine
- Surfaces

Beach
- Sand
- Water

Flood zone
- Sediment
- Water

Open drains
- Sediment
- Water