Pathogen flows:

applying public health principles to urban sanitation

#pathogenflow #WWWeek

UTS Institute for Sustainable Futures

UNC WATER INSTITUTE

World Health Organization

SNV

UNIVERSITY OF LEEDS

WSUP Water & Sanitation for the Urban Poor

EMORY UNIVERSITY Center for Global Safe Water, Sanitation, and Hygiene

CAST

Cynthia Mitchell
Juliet Willetts

Institute for Sustainable Futures

Kate Medlicott
Sophie Boisson

World Health Organization

Peter Hawkins

Independent

Antoinette Kome

SNV

Pete Kolsky
Musa Manga

UNC WATER INSTITUTE

Christine Moe

EMORY UNIVERSITY
Center for Global Safe Water, Sanitation,

Barbara Evans

UNIVERSITY OF LEEDS

Guy Norman

WSUP
Water & Sanitation for the Urban Poor

Isabel Blackett

Independent

#pathogenflow

#WWWeek

ACT 1

What's the situation?
What are we doing about it

Pete Kolsky

Kate Medlicott

Christine Moe

Barbara Evans

Cynthia Mitchell

#pathogenflow

#WWWeek

Pete Kolsky

UNC
WATER INSTITUTE

#pathogenflow

#WWWeek

Pathogen flow…why it matters

"Pathogens" ≡ "disease-causing organisms"

Sanitation-related diseases

- 800 ***thousand*** diarrhoeal deaths/year…> 2 000 per day!
- Hundreds of ***millions*** of intestinal worm infections

How can we really improve public health without understanding:

- ***the relative size and importance of pathogen flows*** **(both solid and liquid)?**
- ***The impact of sanitation technology on pathogen flow?***

Amazingly, we are only beginning to address these questions.

A Sanitation Nightmare

30% are sewered, but flows without effective treatment into water source

30% use improved pit latrines, but sludge emptied, recycled or dumped informally, without regulation

30% use septic tanks,

- Sludge is emptied, recycled or dumped informally without regulation
- Tank overflow goes directly into open neighbourhood drains

10% of the population practice open defecation…an obvious hazard

Q: Which of these represents the most significant public health hazard?

A1: We don't know, and even worse….

A2: Little rational guidance to offer the local govt about setting priorities!!

If we knew more about pathogen flows, and the effects of technologies on them, we could set better priorities!

UNC work on these questions

Past

- Lit review on unsafe return of human excreta to environment
- 4 national level desk studies (one example in today's activities), based on JMP data and local expertise

Current

- Model Development
- Local field studies in India beginning shortly to measure pathogens and onsite tech performance in pathogen removal
- Long-run goal is simpler tools for urban sanitation planning

UNC WATER INSTITUTE

Research team

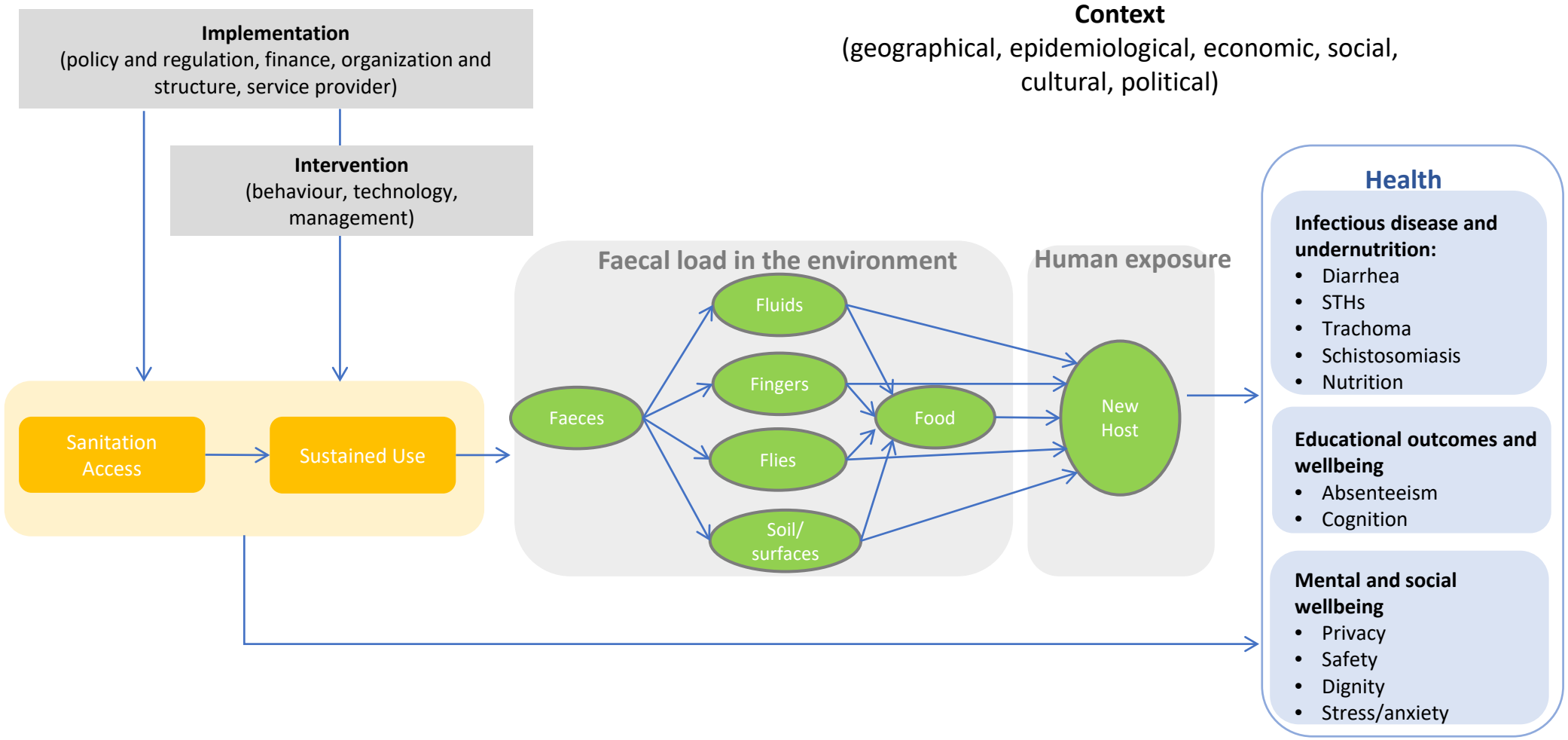
UNC	**Collaborators & Partners**
Prof. Pete Kolsky, PI	Prof Barbara Evans, Univ of Leeds
Prof. Jamie Bartram, PI	Andrew Peal
Prof. Jill Stewart, microbiology lead	Peter Hawkins
Dr. Musa Manga, technical lead	Isabel Blackett
David Holcomb	Lukman Salifu, Ghana
Lisa Fleming	
Katie Brown	Indian Institute for Human Settlements
Ashley Williams	
Alycia Overbo	
University of Alabama	**Funding (& other!) support**
Prof Mark Elliott	Bill & Melinda Gates Foundation
Phillip Grammar	

Kate Medlicott

#pathogenflow

#WWWeek

Epidemiological evidence – needed for public health policy making but alone cannot answer all questions



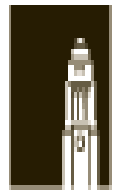
World Health Organization

Christine Moe

#pathogenflow

#WWWeek

Barbara Evans



UNIVERSITY OF LEEDS

#pathogenflow

#WWWeek

Cynthia Mitchell

#pathogenflow

#WWWeek

Institute for Sustainable Futures

WSUP Water & Sanitation for the Urban Poor

Towards better informed decision-making:

Linking hazard, exposure and health risk for alternative sanitation options

Freya Mills, Juliet Willetts, Katie Ross, Kumi Abeysuriya, Cynthia Mitchell
Institute for Sustainable Futures, UTS

Susan Petterson Water and Health

Guy Norman Water and Sanitation for the Urban Poor

there are good reasons why we are in a bit of a mess

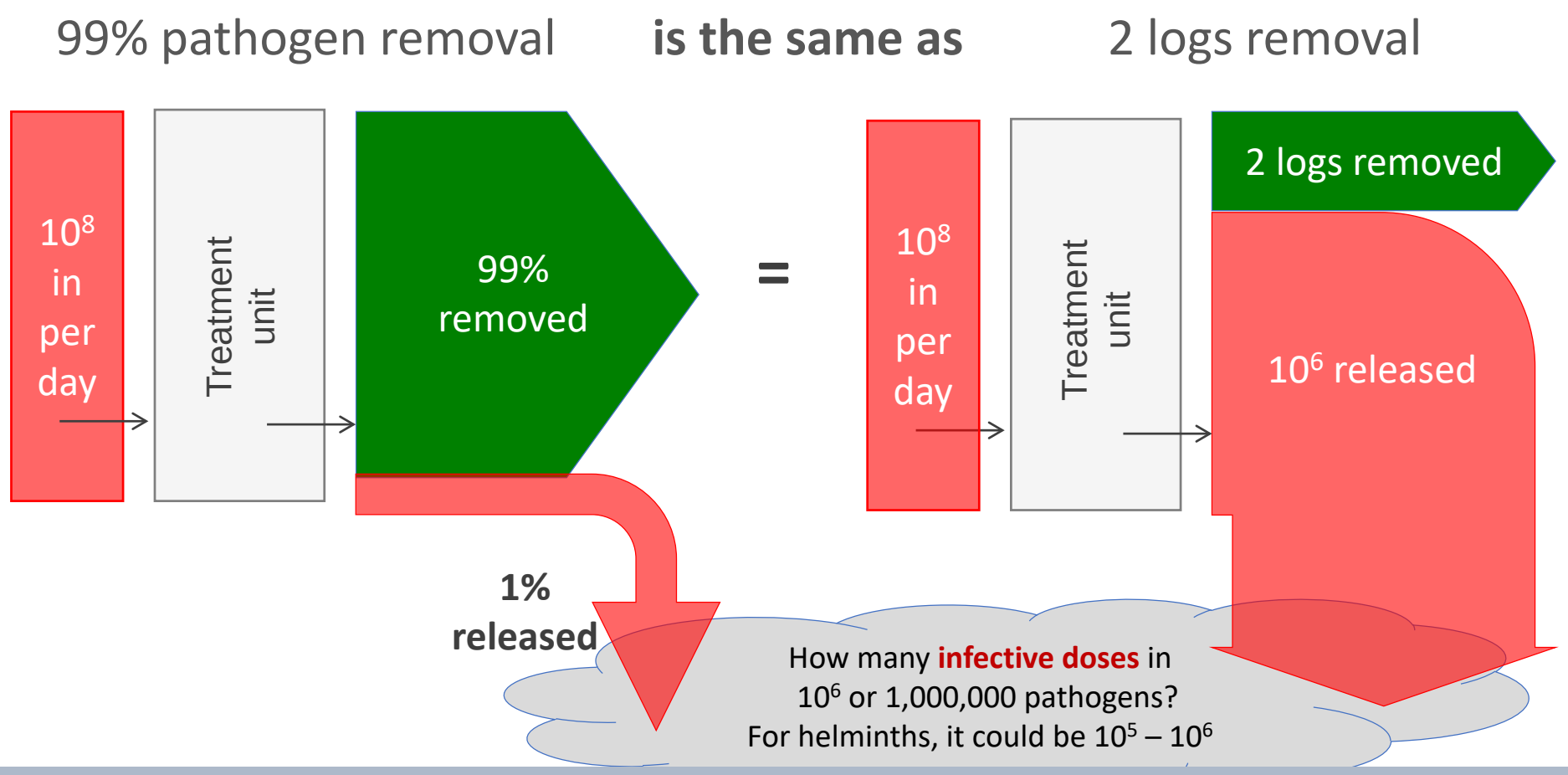
Pathogens are unimaginably diverse, and

Pathogens are difficult/expensive to identify/monitor, and

Pathogens are not part of our design equations…

…We are a little bit blind when it comes to pathogens

pathogen removal represented by percentages leads to misunderstanding



A **logarithmic** scale helps us remember that **what matters** is the **hazard that remains** in the effluent, not how much is removed.

Mitchell, Abeysuriya, Ross, 2016. Making pathogen hazards visible:. Waterlines 35(2) doi10.3362/1756-3488.2016.014

Institute for Sustainable Futures

The situation is hopeless.
We must take the next step ☺

Pablo Casals

we can (and must) take steps to map where flows go

Institute for Sustainable Futures

HOUSEHOLD
Ie. 1 household

LOCAL AREA
Ie. 10 households

NEIGHBOURHOOD
Ie. 50 households

CITY/DOWNSTREAM
Ie. 500 households

Toilet to sewer/drain

Closed Sewer

Wastewater Treatment Plant

Toilet to septic tank

Open Drain

Children playing

Local Drain

Large Drain/River

Not treated

Receiving waterway

Leaking

Washing, bathing, recreation

Not emptied

Drinking, washing

Leaking

Flooding

Emptied Sludge

(Stored)

Drinking, washing

Hands, fomite

Dump in river

Untreated sludge reuse

Agriculture Reuse

Taken away

Dump in drain

Manual emptying

Dump on site

Sludge Treatment Plant

Hands, fomite, flies

Open defecation

Local environment

Runoff to drain

Untreated sludge to field

Empty fields

Local waterways

Could add rows for pit latrines, decentralised or other sanitation systems or and other exposures

WSUP
Water & Sanitation for the Urban Poor

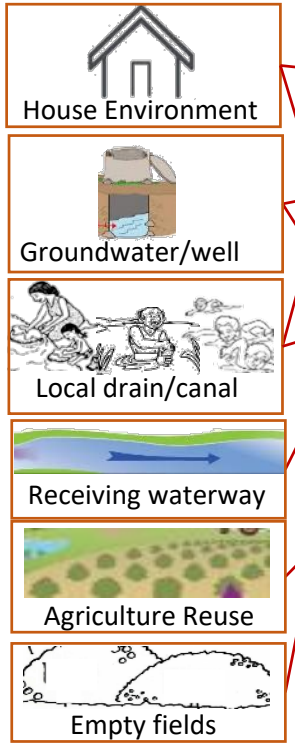
Leveraging off SFDs, how can we **estimate the faecal waste discharged** to various **exposure points**?

Can we link the **estimated pathogen concentrations with exposure data using QMRA** to estimate the **health risks**?

Which **improvements in the sanitation chain** best **reduce pathogens or pathways** which contribute **greatest health risks**?

A. Estimate pathogen concentration at each exposure point

Analyse the pathogen loads, flows, system log reductions and resultant concentration at each exposure point (for each of four pathogen types)



B. Identify transmission pathways and exposure dose

- **Hands & fomite: faecal consumption** - faeces in household environment or poor hygiene
- **Water consumption – direct**
- **Water consumption – indirect** secondary water supply, swimming, bathing, flooding, playing in drains
- **Food: faecal consumption** - contaminated produce through water or soil)
- **Soil and water to skin and vector flies and mosquitos** – faeces in environment and waterways

C. Estimate health risk using QMRA approach

- Dose response relationship for each pathogen
- Frequency of exposure and % population exposed
- Probability of illness
- DALY for each pathogen, pathway and overall

Could be added for hookworm, Schistosomiasis or Trachoma

D. Apply to different scenarios to support decisions

Inform which improvement options could be suitable/tested

Apply model to test alternative sanitation improvement options

Compare change in DALY for different exposure pathways and overall

Relative health risk at each exposure point compared with base case

Option	Household Environment	Groundwater Well	Local Drain	Community Drain	Downstream River	Fresh Produce	Downstream Environment
1		↑			↓	↓	
2	↓	↓	↑	↑	↓	↓	
3			↑				
4	↑	↑				↑	↓
5	↑	↑		↓	↑	↑	↓
6					↑	↑	↑

Source → Pathway → Receptor

UTS Institute for Sustainable Futures

WSUP Water & Sanitation for the Urban Poor

ACT 2 Your turn! Scenarios by scale

Peter Hawkins (independent) **City** scale (5 million)

Musa Manga  **National** scale

Kate Medlicott  **Agricultural** reuse

#pathogenflow

#WWWeek

ACT 3 What's does it all mean? What next?

Reporting Back:

Juliet Willetts

Guy Norman

Barbara Evans

Reflections:

Antoinette Kome

Isabel Blackett (Independent)

#pathogenflow

#WWWeek

Pathogen flows:

applying public health principles to urban sanitation

#pathogenflow #WWWeek

UTS Institute for Sustainable Futures

UNC WATER INSTITUTE

World Health Organization

SNV

UNIVERSITY OF LEEDS

WSUP Water & Sanitation for the Urban Poor

EMORY UNIVERSITY Center for Global Safe Water, Sanitation, and Hygiene