MAKING PATHOGENS VISIBLE

to guide investment in what matters

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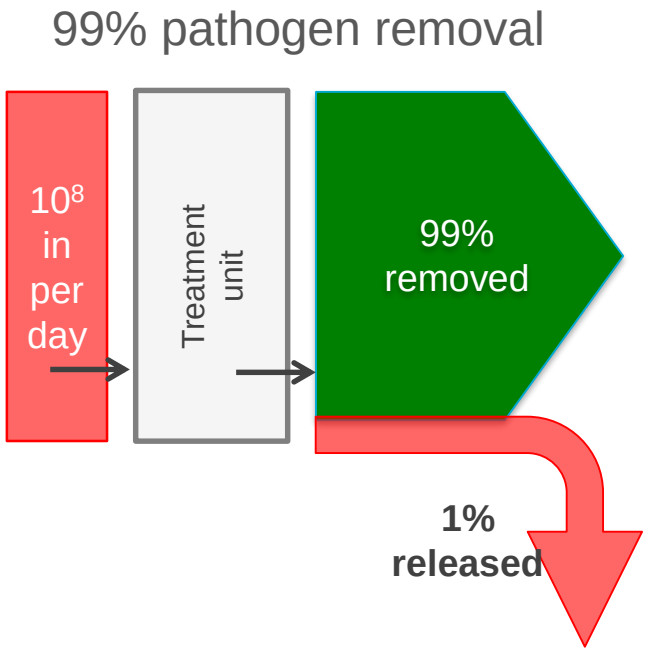
KEY MESSAGES

- There are big gaps in our knowledge and practice around pathogens and pathogen removal by sanitation treatment systems
- ‘Safely managed sanitation’ requires attention to all waste streams from onsite/local scale systems – ‘faecal sludge’ and liquid effluents
- We risk investing in treatment options that increase unsafe return
- We need practical tools to pragmatically assess local hazard levels because actually measuring pathogens is still out of reach
- The Pathogen Hazard Diagram is offered as a starting point

PATHOGEN REMOVAL REPRESENTED BY PERCENTAGES LEADS TO MISUNDERSTANDING



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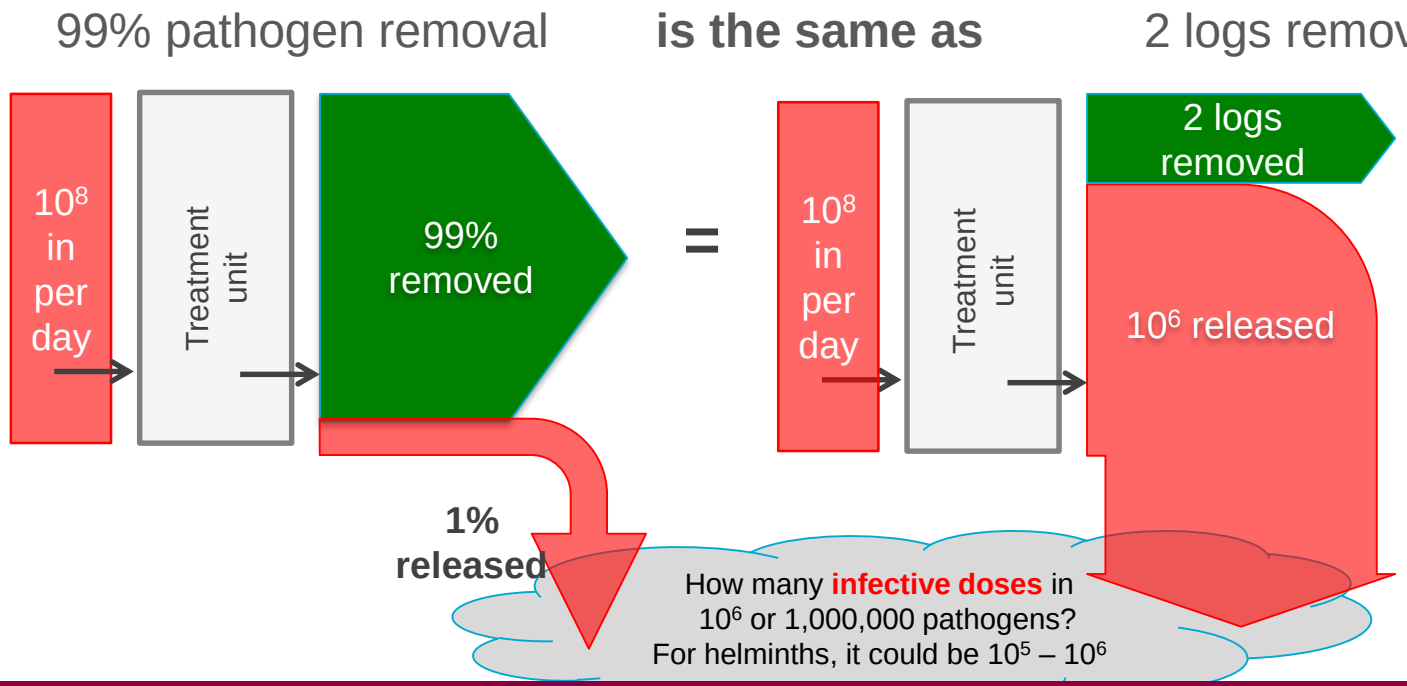


A **logarithmic** scale is necessary for representing pathogens because their numbers are very large.

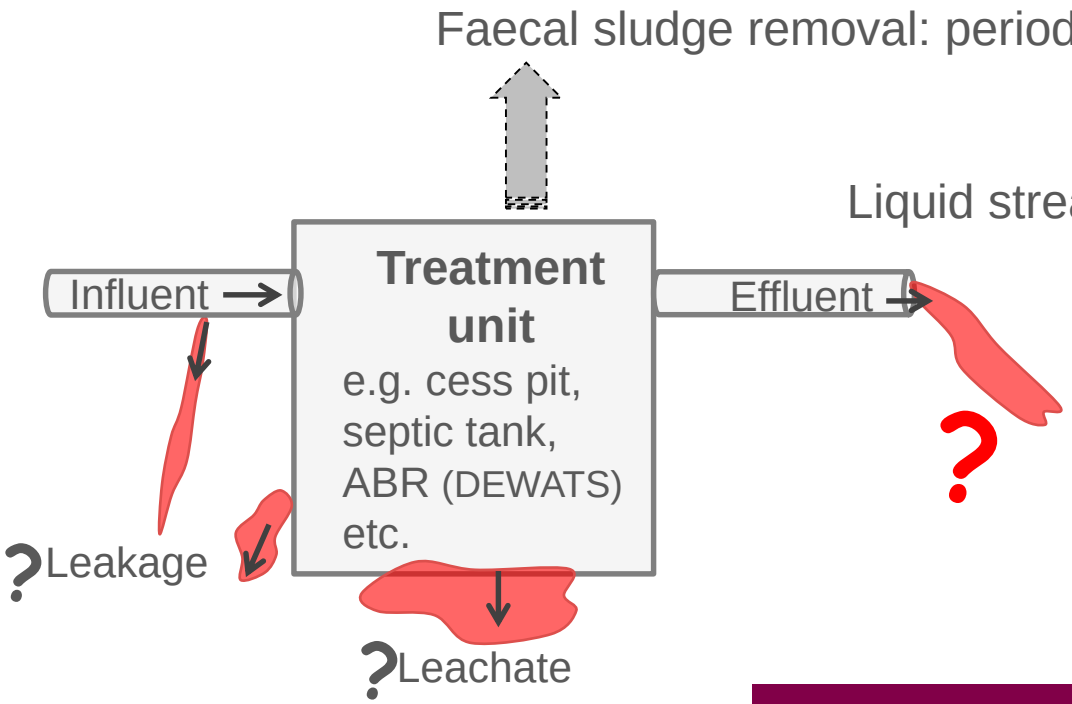
OUR KNOWLEDGE OF PATHOGEN REMOVAL IS LIMITED AND/OR OUT OF DATE

	Bacteria	Viruses	Protozoa	minth eggs
1. Removal or Containment Mechanisms i.e. Mechanisms where pathogen movement is restricted				
Filtration/Sorption (e.g. soil around a leach pit)	Yes e.g. strain through biomat [1]	Yes	Yes e.g. 8 log re	Yes dual media on [3]
Sedimentation (e.g. within septic tanks or anaerobic digestors)	No	No		[3]
2. Inactivation Mechanisms i.e. Mechanisms where pathogen viability is reduced				
Physical				
Dry environment / desiccation / evaporation	Yes			?
Biological				
Composting	e.g		Yes e.g. complete elimination after 3 months	Some
UV exposure			Limited	No [3]
Persistence in environment (i.e.		20 days	10 days	Months - years
Ambient Temper		Yes e.g. 5 log removal over 20 days at 23°C [4]	No	No [3]
Chemical				
pH out o lime)	Yes	Some	Limited	No [3]
Urea treatm 100 g dry fae	monia per Yes	Yes	?	Yes e.g. 9 log reduction after 28 days at 24 °C [5]

The Global Pathogen Project will help enormously!

Feachem et al 1983 unless noted. (1) Stevik et al. 2004 (2) Mawdsley et al. 1996 (3) Jiminez-Cisneros and Maya-Rendon 2007 (4) Blanc and Nasser 1996 in Toze 1997 (5) Vinneras et al 2009

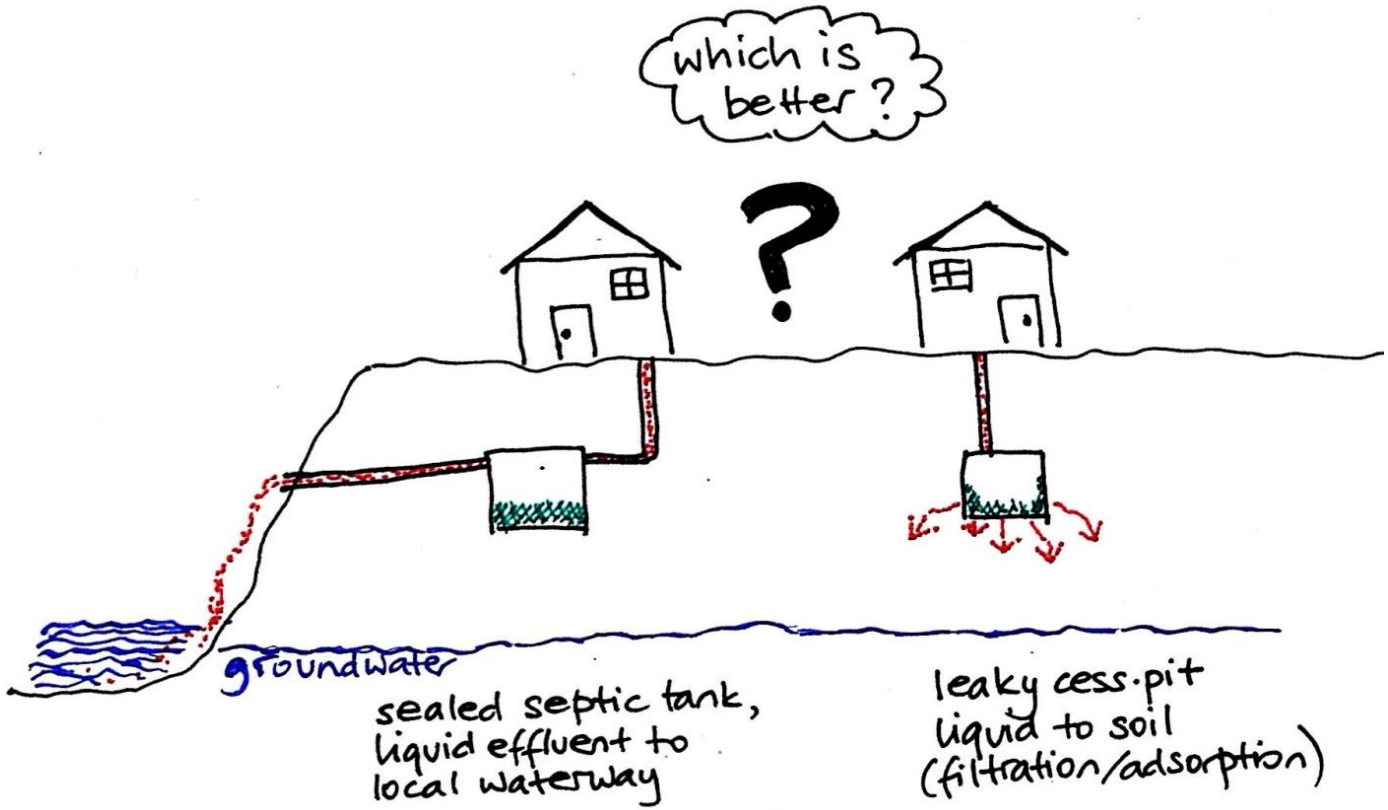
LIQUID STREAMS MAY BE A SERIOUS HEALTH HAZARD



Scale of liquid hazard is not known

Liquid discharges may need as much attention as FSM

HOW SHOULD WE CHOOSE IN PRACTICE?



WE NEED A PRACTICAL TOOL TO IMPROVE EFFICACY OF INVESTMENT AT LOCAL LEVEL

We need to help decision-makers

- ✓ notice pathogens
- ✓ synthesise health, engineering + local knowledge
- ✓ avoid investing in technologies that actually increase unsafe return.

Despite the challenges in

- knowledge + data about treatment efficacy
- differences between pathogens
- measuring pathogens locally

The Pathogen Hazard Diagram, using available science plus first principles

Mitchell, C., Abeysuriya, K. and Ross, K., 2016. Making pathogen hazards visible: a new heuristic to improve sanitation investment efficacy. Waterlines vol 35 no 2, April 2016. (OPEN SOURCE)

PATHOGEN HAZARD DIAGRAM ASKS THREE SIMPLE QUESTIONS

A. How many pathogens enter the system?
B. How many pathogens leave the system?
C. How much do the surviving pathogens matter?

PATHOGEN HAZARD DIAGRAM EXAMPLE: SEPTIC TANK

A. How many pathogens are in the influent?

Pathogens from an Infected individual (#/day)

10^{10} bacteria [a,b]

10^{11} virus particles [b,c]

10^{7} protozoa [a]

10^{6} helminth eggs [a]

B. How many pathogens are leaving the system?

Inactivated & contained pathogens

Periodic sludge removal

Pathogens (#/day) after 1-2 Log removal[a]

10^{8} – 10^{9} bacteria

10^{10} virus particles

10^{6} protozoa

10^{5} helminths

Piped treated liquid effluent exiting daily

Boundary of the treatment system

Leakage or leachate
(A sealed septic tank would have no flow here)

[a] Feachem et al., 1983
[b] Leclerc et al., 2002
[c] McCray et al., 2009

C. How much do the surviving pathogens matter?

What is the *hazard level* in the liquid effluent of a septic tank?

	Minimum infective dose	Potential hazard (# of doses)
bacteria [b]	10^2 - 10^8	**Up to 10^7**
viruses [b]	10^0 - 10^1	**Up to 10^{10}**
protozoa [b]	10^0 - 10^2	**Up to 10^6**
helminth eggs [a]	10^0 - 10^1	**Up to 10^5**

[a] Feachem et al., 1983
[b] Leclerc et al., 2002

What are the potential *exposure pathways*?

Source: Esrey et al. 1998. Ecological Sanitation. Swedish International Development Cooperation Agency

Source: http://www.nzdl.org/gsdl/collect/envl/archives/HASH0189/618d3b8b.dir/p081.gif

TAKE HOME MESSAGES

- ✓ There are big gaps in our knowledge and practice around pathogens and pathogen removal by sanitation treatment systems
- ✓ ‘Safely managed sanitation’ requires attention to all waste streams
- ✓ We risk investing in treatment options that increase unsafe return
- ✓ We need practical tools to pragmatically assess local hazard levels because actually measuring pathogens is still out of reach

The thinking behind the PHD has undergone significant development since this work: come and find out more at our event:

Pathogen flows: applying public health principles to urban sanitation

A collaboration by UTS, UNC, Leeds University, SNV, WSUP, WHO, Emory

Thursday 1600-1730 Room NL Music Hall / Musiksalen

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