National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Keeping pathogens under control

Bataafs Genootschap

September 19, 2024

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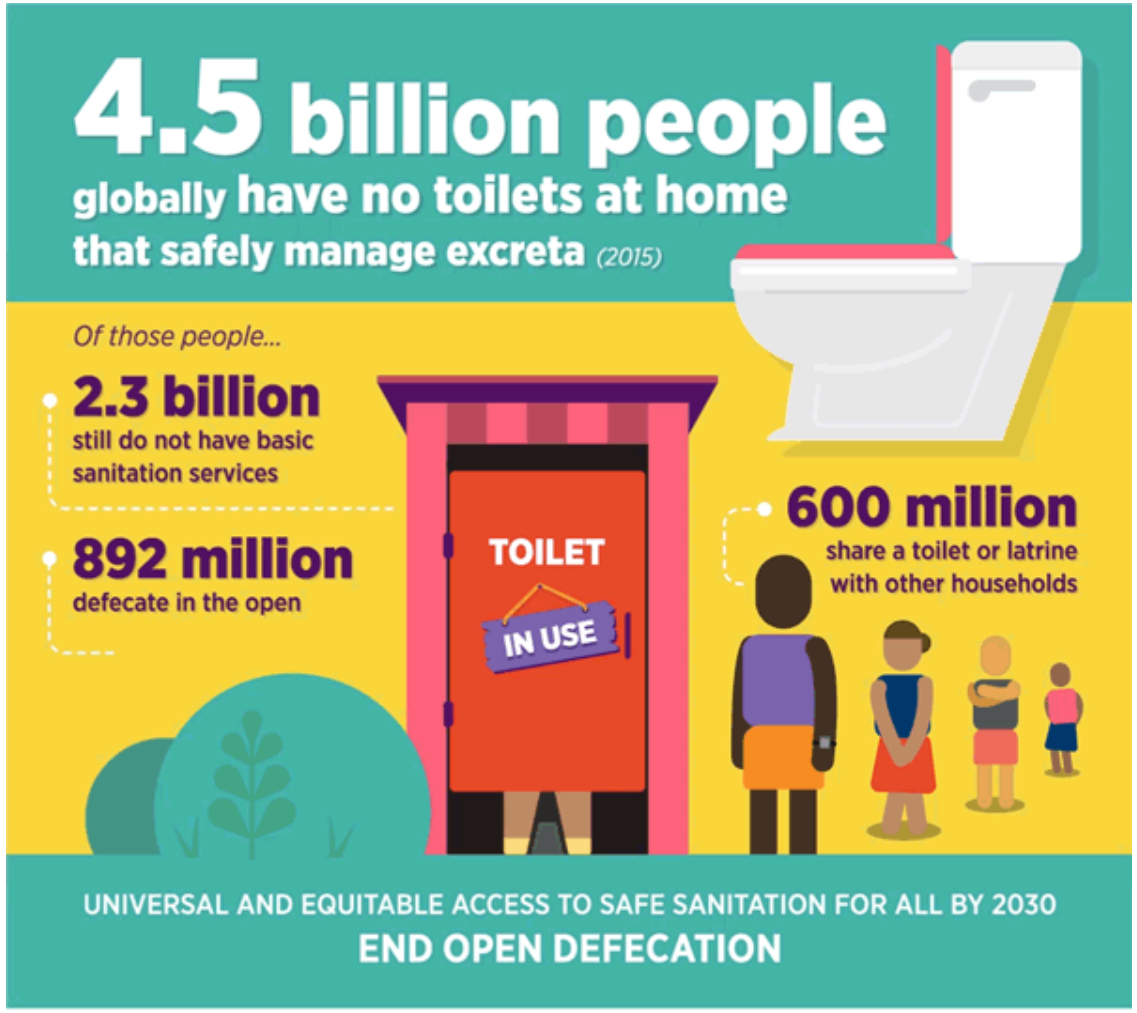
RIVM/ Utrecht University

WHO CC for Risk Assessment of Pathogens in Food and Water

Utrecht University

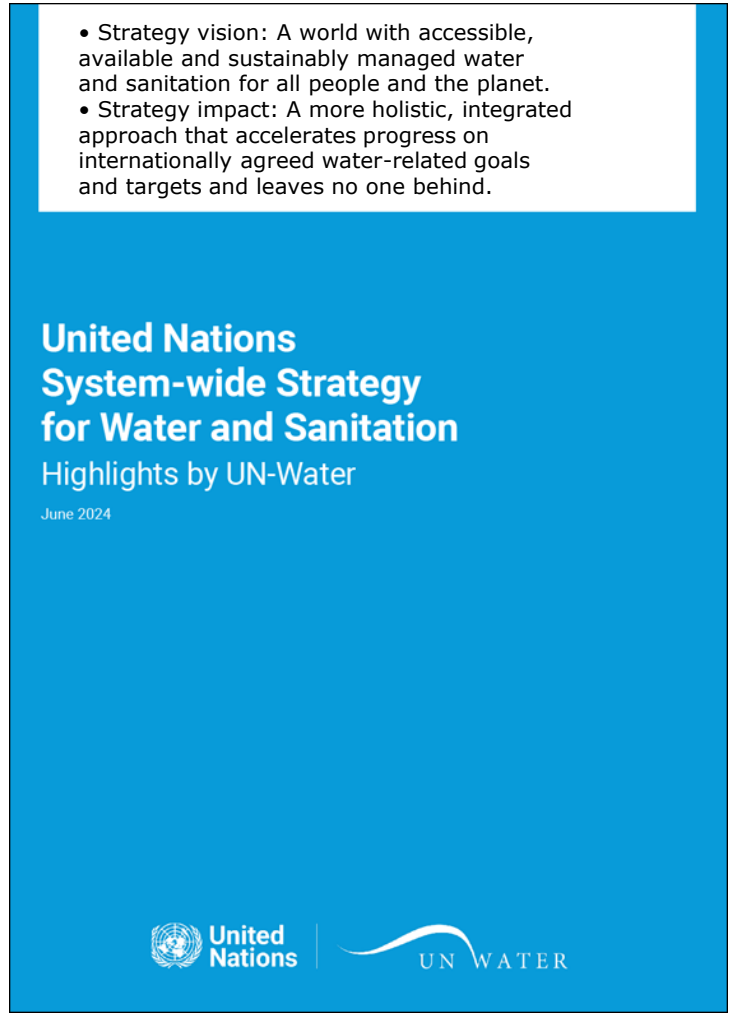
WHO Collaborating Centre for Risk Assessment of Pathogens in Food and Water

Sanitation is lagging behind



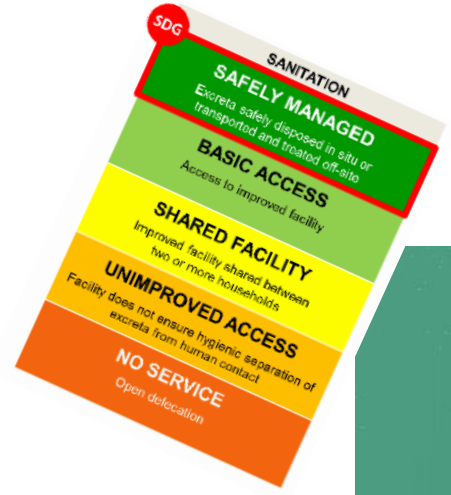
World Health Organization unicef

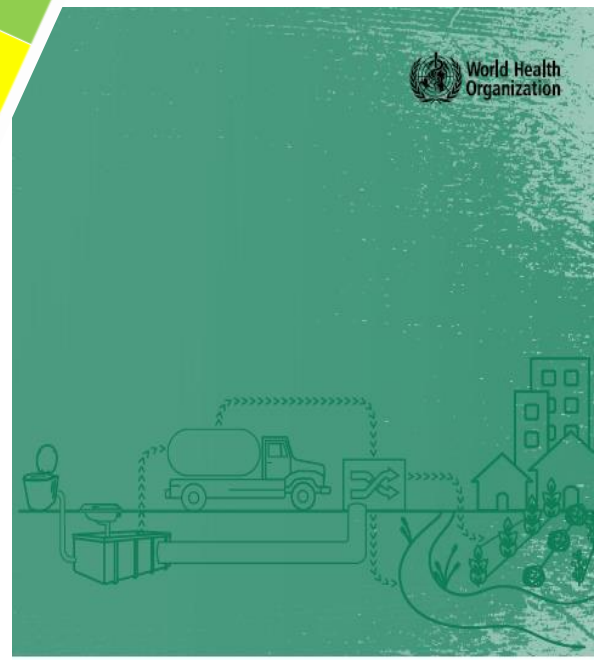
- Strategy vision: A world with accessible, available and sustainably managed water and sanitation for all people and the planet.
- Strategy impact: A more holistic, integrated approach that accelerates progress on internationally agreed water-related goals and targets and leaves no one behind.



Sanitation and Health

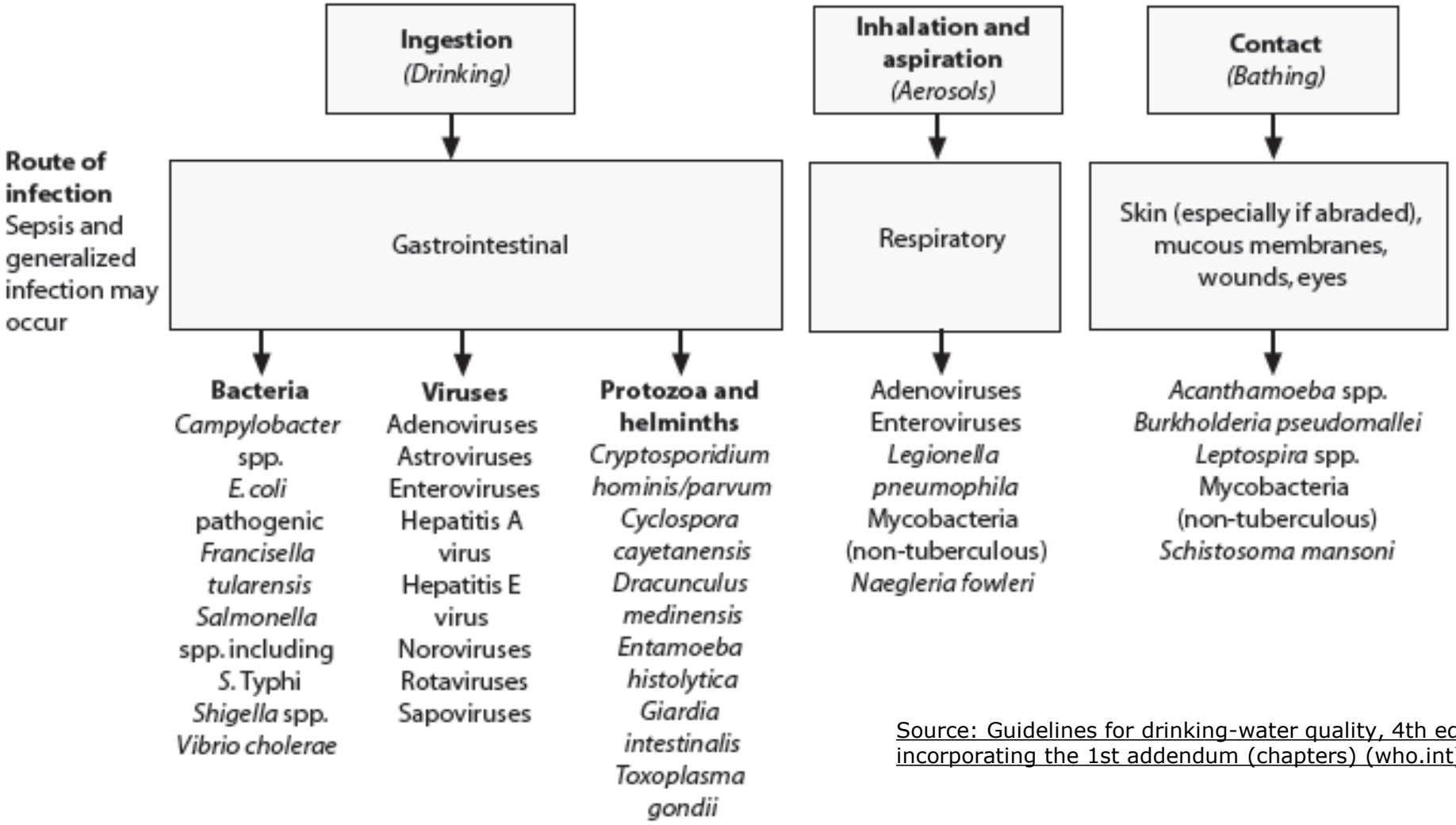
- Evidence of health impact of sanitation
- Addressing Ministries of Health who's role in sanitation has declined over the last 50 years
- There is a lack of public health guidance on how to maximize health gains from sanitation systems
- Shift from basic sanitation to full, safely managed sanitation chain





Source: Guidelines on sanitation and health (who.int)

Pathways and Pathogens



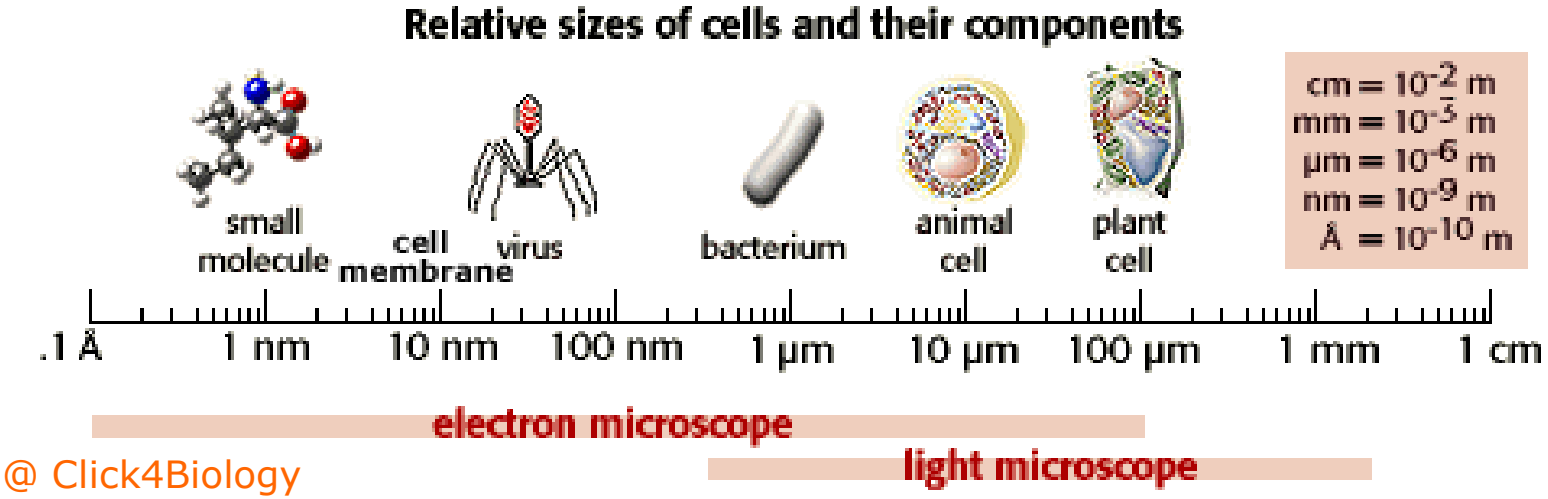
Source: Guidelines for drinking-water quality, 4th ed., incorporating the 1st addendum (chapters) (who.int)

Pathogen characteristics

- Size
- Numbers
- Morphology

- Charge
- Infectivity
- Pathogenicity

Size matters



@ Click4Biology

Pathogens are climate dependent

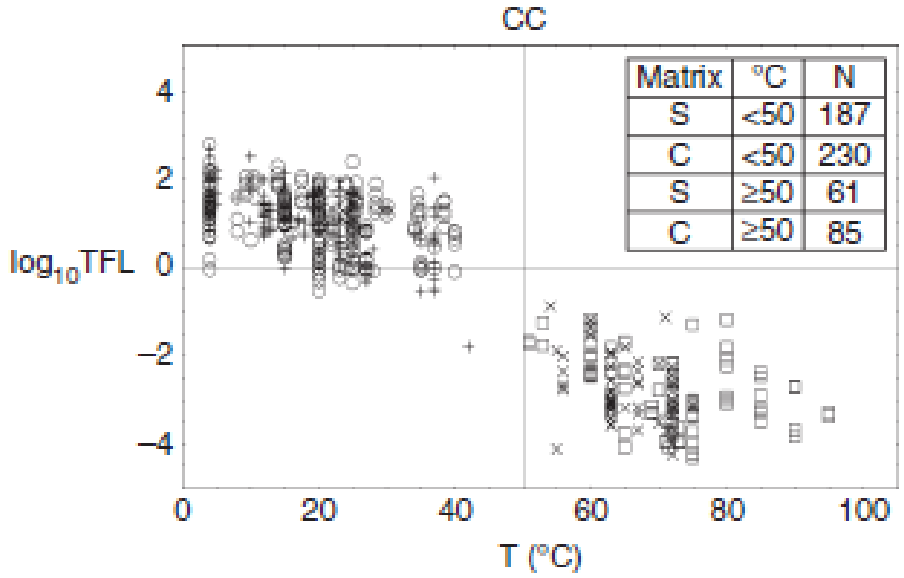


Figure 1 Values of $\log_{10}$ time to first log (n = 563) as a function of temperature, categorized according to detection by cell culture (CC), in simple (S) or complex (C) matrices and temperatures <50°C or ≥50°C. The values shown in this figure were obtained from studies marked by the * after the year of publication in the References.

Direct

Temperature

Relative Humidity

-Rainfall

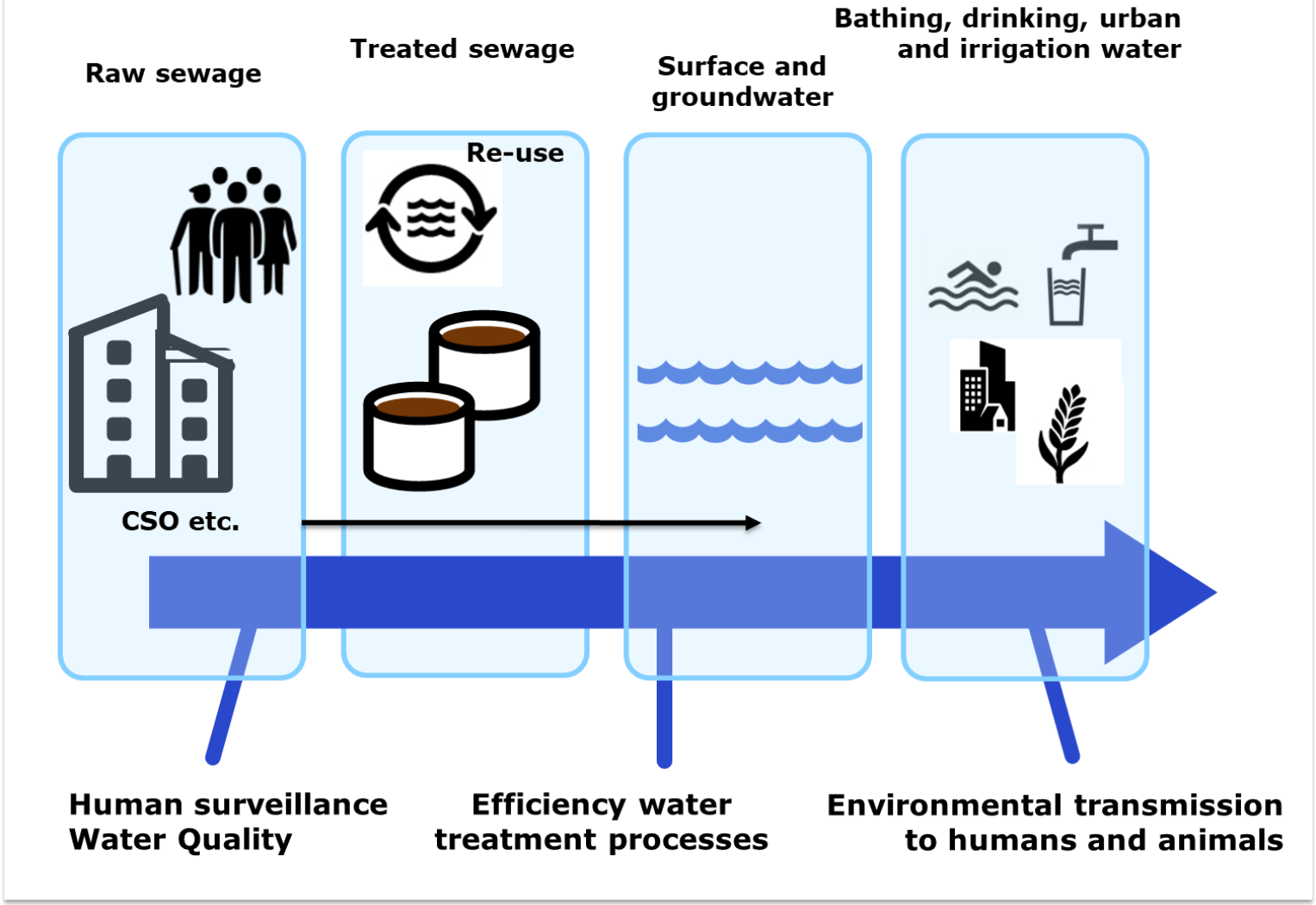
-Drought

Indirect

Nitrogen and other cycles

- Disturbance

Wastewater: Solely a Source of Infectious Diseases or also of Value for Public Health



Environmental Surveillance - multipurpose

1. Identification of contaminated water source that caused infectious disease cases/ outbreaks (e.g. norovirus, hepatitis E virus, Trichobilharzia)
2. Water- and foodborne transmission routes e.g. norovirus, Coxiella burnetii, rotavirus, enterovirus, Cryptosporidium and Giardia
3. Retrospective environmental surveillance to origin e.g. norovirus, parechovirus, aichi virus
4. Risk-based monitoring e.g. poliovirus
5. Emerging pathogens e.g. Francisella tularensis, nontuberculous mycobacteria, antibiotic resistant pathogens
6. Environmental surveillance in addition to pathogen and disease surveillance e.g. poliovirus and measles virus, resistant pathogens

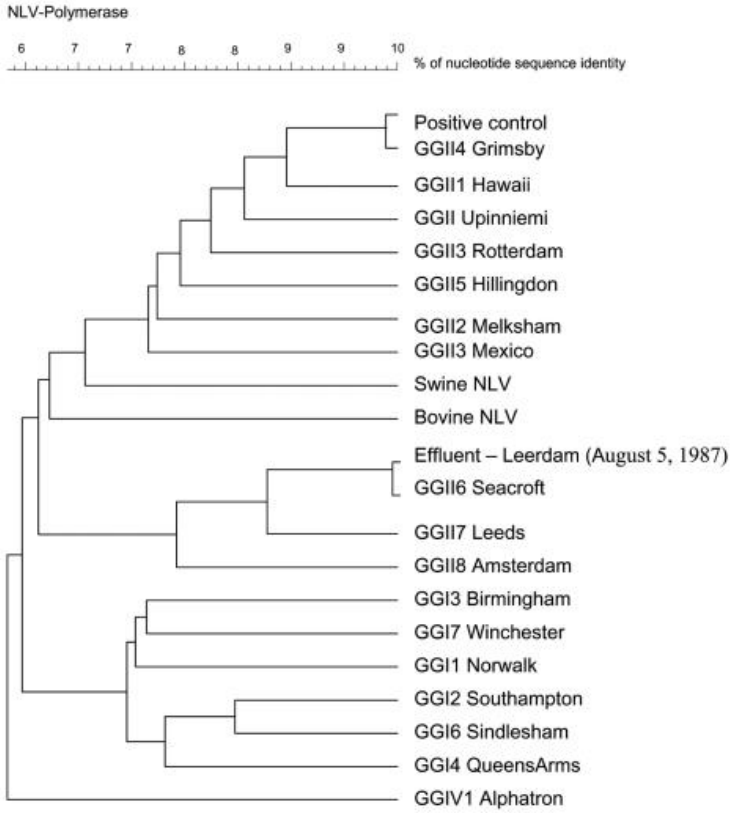
Lodder et al. 1999, 2013a and b; Skraber 2005; Rutjes et al. 2009; Schets et al. 2009, 2018; Benschop et al., 2017; Duizer et al.,2023)

Retrospective environmental surveillance - Norovirus

Norovirus genogroup II Seacroft strain first identified in a stool sample collected in 1990 in the United Kingdom.

Retrospective environmental surveillance confirmed earlier circulation in archival water samples from 1987 in the Netherlands.

Our observation confirms, retrospectively, the potential usefulness of environmental surveillance as a tool for monitoring virus infections in the population.



Skraber et al. Emerg Infect Dis. 2005 Mar; 11(3): 489–491
doi: 10.3201/eid1103.040838

Risk-based monitoring - poliovirus

- On 6 September 2014, 10(13) infectious wild poliovirus type 3 particles were accidentally released into the sewage system by a vaccine production plant in Belgium.
- Virus was discharged directly to a wastewater treatment plant and subsequently into rivers that flowed to the Western Scheldt and the North Sea.
- No environmental surveillance was in place and poliovirus was not detected in post-notification samples from the wastewater, surface waters, mussels from the Netherlands.
- Quantitative microbial risk assessment showed that 1/ the infection risks resulting from swimming in Belgium waters were above 50% for several days and warnings were issued and 2/ that the infection risk for consuming local shellfish warranted a shellfish cooking advice.

Duizer et al. Eurosurveillance 2016

Complementary ES - poliovirus

- On 21 November 2022, a wild poliovirus type 3 (WPV3) was isolated from an environmental surveillance sample of poliovirus essential facilities in the Netherlands.
- All 51 employees with access to this strain were screened for ongoing or recent poliovirus infection.
- One employee shedding WPV3 was identified on 8 December and placed in isolation; monitoring and contact tracing were initiated.
- WPV3 shedding continued for 4 weeks and stopped 5 January 2023.
- Isolation was lifted 11 January and halted further transmission.

Eurosurveillance Europe's journal on infectious disease surveillance, epidemiol

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Rapid communication

Open Access

Wild poliovirus type 3 (WPV3)-shedding event following detection in environmental surveillance of poliovirus essential facilities, the Netherlands, November 2022 to January 2023

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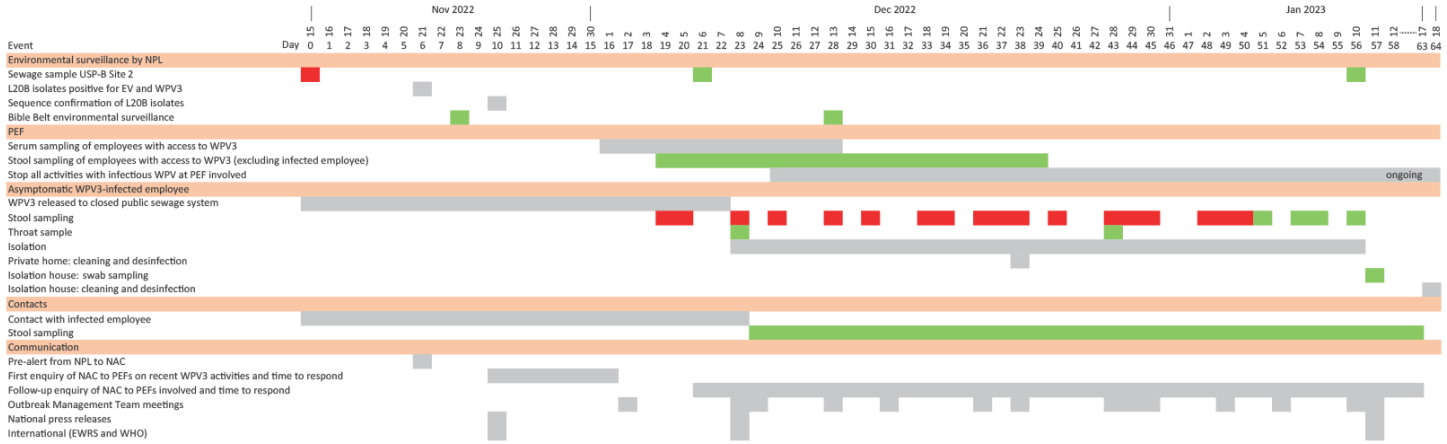


Duizer et al. Eurosurveillance 2023

Complementary sewage surveillance - AMR

Lessons learned

1. Resistant bacteria of concern at STP w/o HCI: largest contribution from open population indicating complementarity of information from sewage surveillance to clinical surveillance
2. Sensitive detection of resistant bacteria: originating from few people among thousands
3. Global sewage surveillance useful in data-limited regions: improving sanitation and health potentially limit global AMR burden

Blaak et al. STOTEN 2021; Hendriksen et al. Nat Commun 2019

Proofs of principle SARS-CoV-2 in sewage

SARS-CoV-2 RNA fragments detected in feces (published beginning of February) approx. 50% samples independent of GI and severity

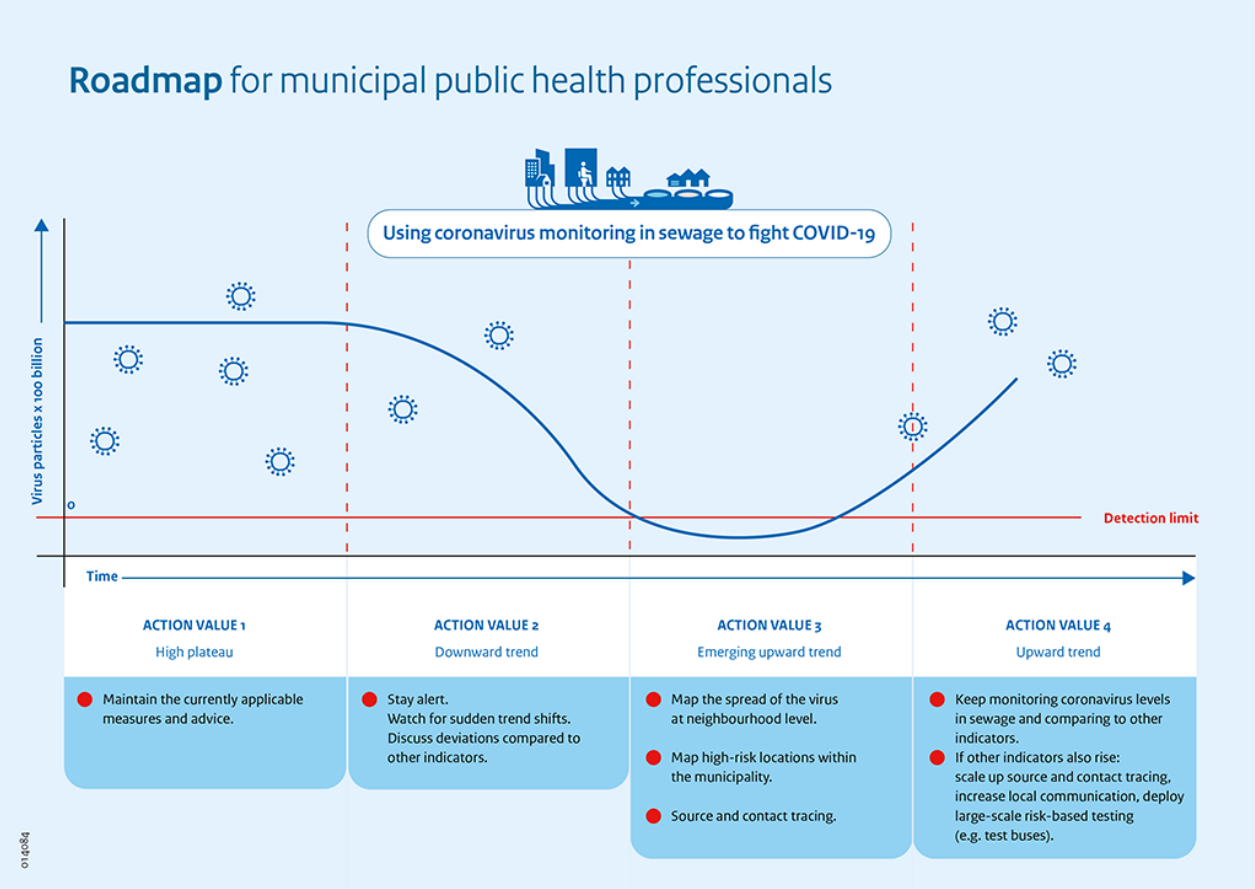
Wastewater sampled at different locations, analysed for SARS-CoV-2

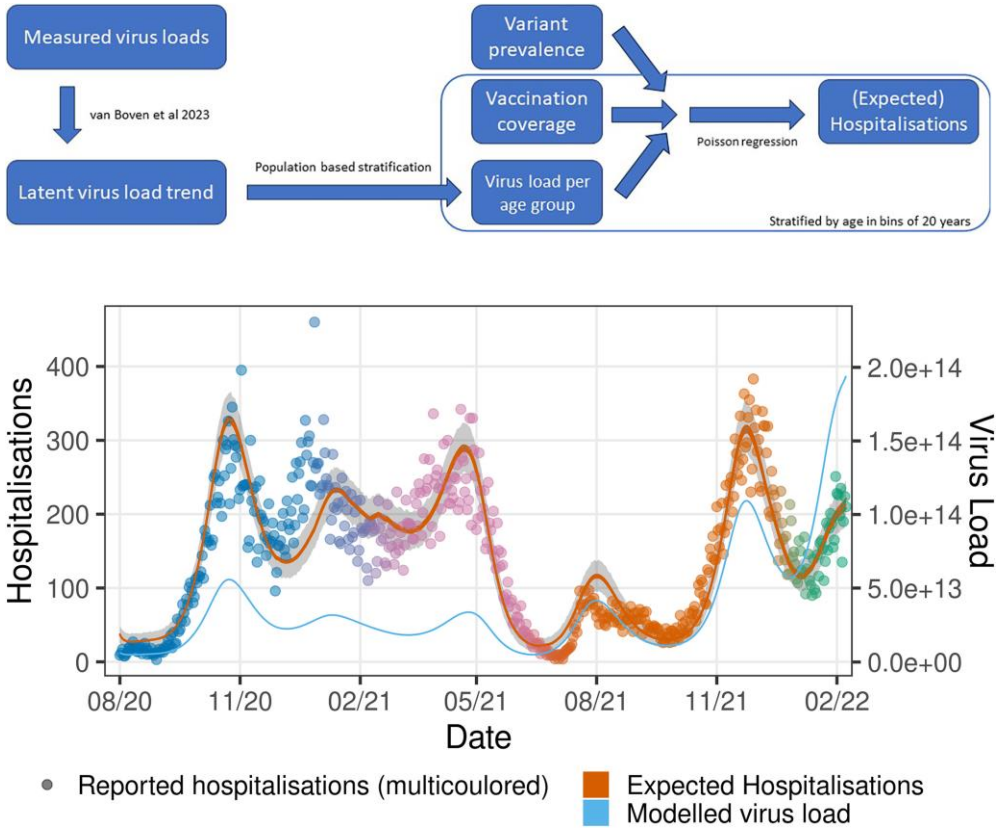
1. In absence of severe cases: in line with the contribution of virus in feces or other excreta from for instance presymptomatic people
2. Near the first notified case: showing wastewater surveillance is a sensitive tool detecting few in 1000s of cases

- Wastewater of importance for COVID-19 surveillance
- But less so as a risk for spread of SARS-CoV-2
- Protection for those working with human waste and wastewater needed

Lodder and de Roda Husman 2020 Lancet Gastroenterology and Hepatology

Trends in viral loads – SARS-CoV-2





Using coronavirus monitoring in sewage to fight COVID-19 | LCI richtlijnen (rivm.nl); Hetebrij et al. STOTEN 2024

Harmonized guidance for polio, COVID-19 and AMR

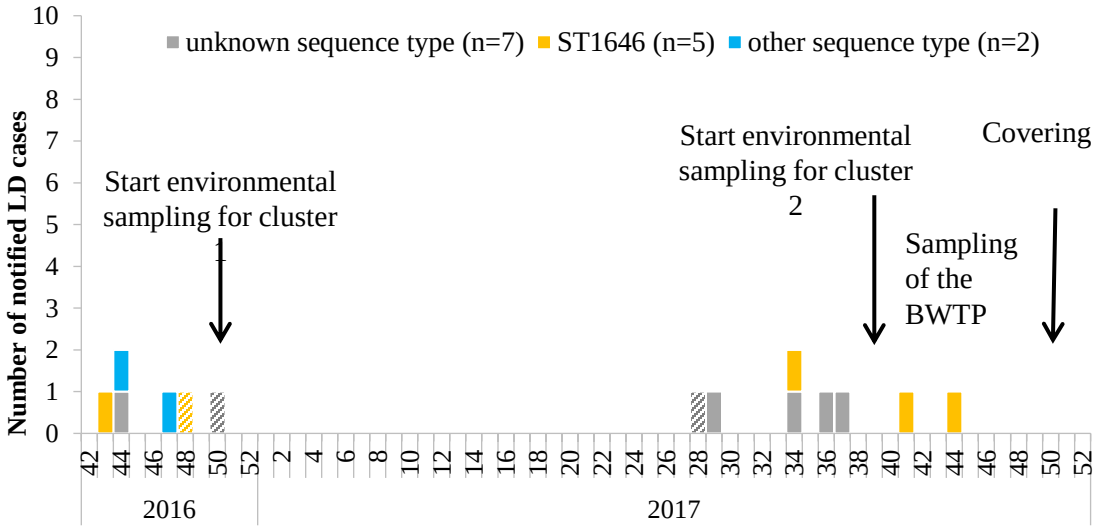
- A multi-pathogen common harmonised approach to wastewater surveillance
- Presents key principles of wastewater surveillance and areas of harmonisation e.g. governance
- Pragmatic actions and tools to support the integration of these principles into protocols and policies
- Case studies
  - Pakistan
  - South Africa
  - Iraq

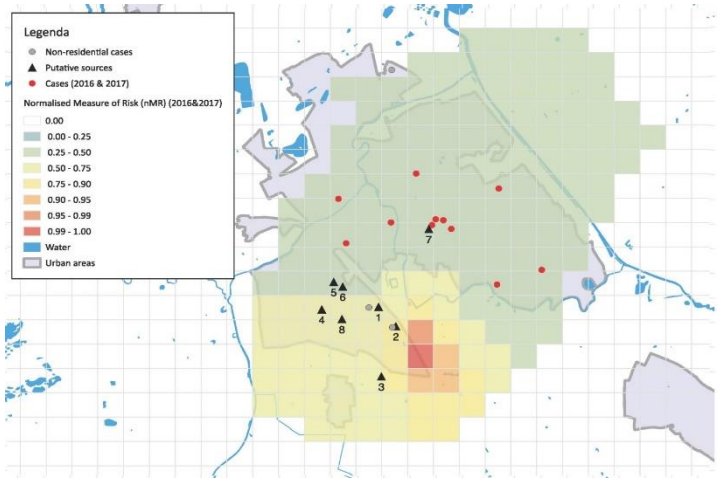
Lock, Sprokholt et al. 2021

whocc.micro@rivm.nl

Biogas production from industrial wastewater

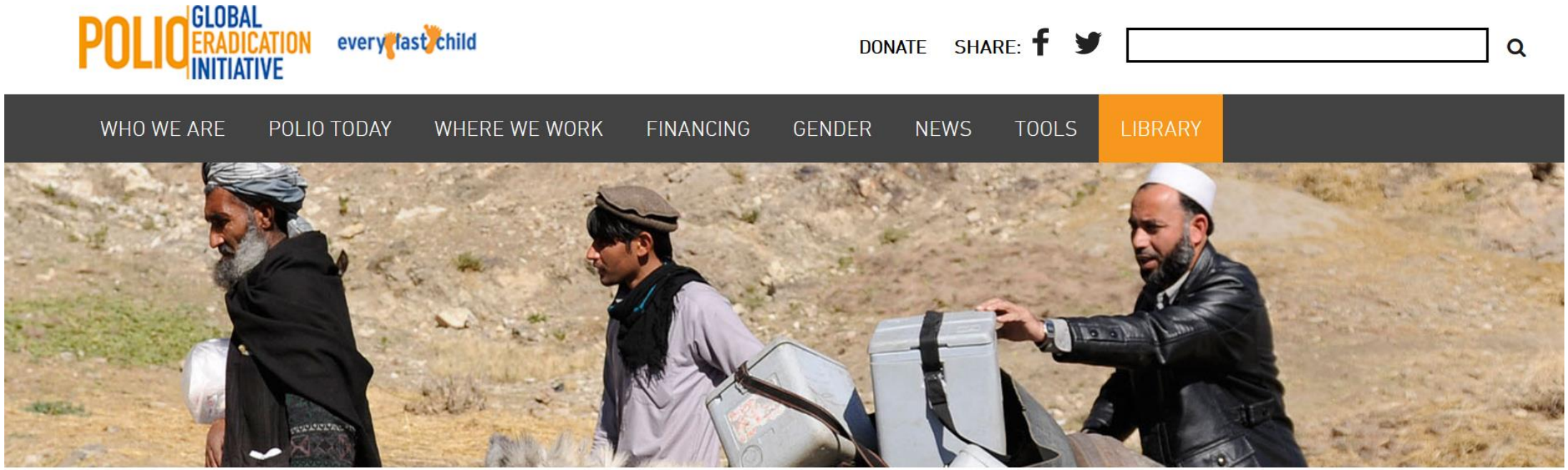
- In 2016 (cluster 1) included 4 residents of Boxtel (■) and two non-residents working in the industrial area of the town (⁄⁄)
  - symptom onset between 28 October and 11 December 2016
- In 2017 (cluster 2) 8 more cases were reported
  - symptom onset between 10 July and 3 November 2017





Loenenbach et al. 2018

What can WE do to further ES?
1/ What is the societal challenge?
2/ Who is responsible?
3/ Which public health action follows from the intended environmental surveillance program?



Sanitation Safety Planning

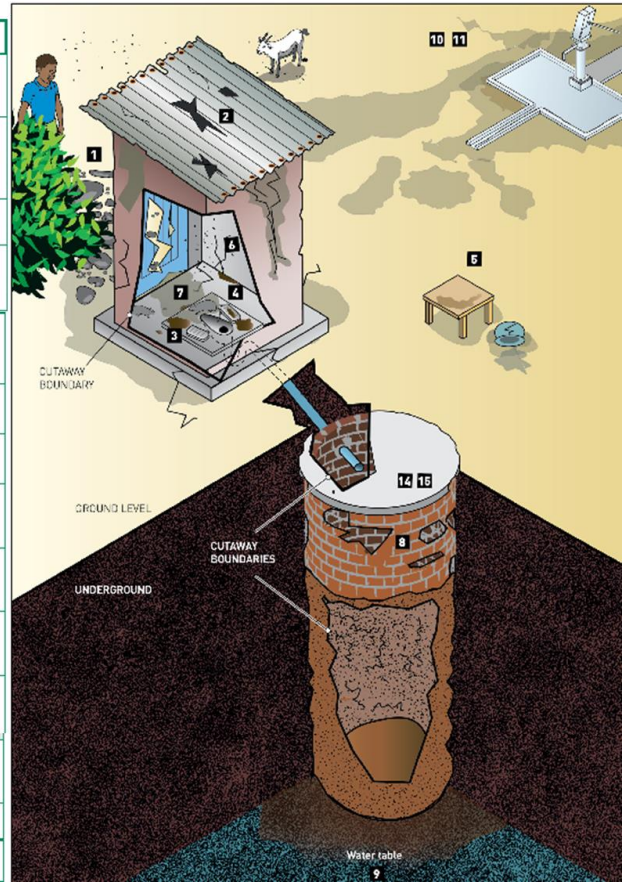
SANITATION SAFETY PLANNING

Step-by-step risk management for safely managed sanitation systems

Source: https://www.who.int/publications/i/item/9789240062887

Sanitary Inspection using Forms

		Sanitary inspection questions	NO	YES (risk)	What action is needed?
TOILET	1	**Is the toilet not accessible for all intended users?** The location (e.g. ensuring a clear and secure access path) and design should make it easy to use by all users including those with special needs or reduced physical mobility (e.g. the elderly, disabled, sick). This may include adding features like an access ramp, handrail etc.	❑	❑	
	2	**Is the toilet superstructure absent, incomplete, damaged and/or does not provide privacy and security to the intended users?** Ingress of rainwater may cause the pit to fill up and overflow, while animals, rodents, insects etc. entering the toilet and/or pit can damage the facility and carry excreta to the community. A door lockable from the inside and a working light will help provide privacy and security to the user.	❑	❑	
	3	**Is the toilet dirty with visible excreta on surfaces?** If the toilet is not kept clean, the users may be exposed to excreta when using the toilet and/or this may discourage toilet use.	❑	❑	
	4	**Is anal cleansing material (e.g. toilet paper, leaves, water) absent or inappropriate for the technology?** If culturally appropriate facilities are not provided, users could be exposed to excreta. If anal cleansing material is not appropriate for the technology used, this may cause blockages or damages to the system.	❑	❑	
TOILET	5	**Are handwashing facilities absent inside or next to the toilet?** Handwashing facilities consist of the presence of water and soap. They may be fixed or mobile and include a sink with tapwater, buckets with taps, tippy-taps, and jugs or basins designated for handwashing. Soap includes bar soap, liquid soap, powder detergent, and soapy water.	❑	❑	
	6	**Can flies and other insects easily enter and leave the pit/container/tank?** Flies can carry disease from the excreta in the pit/container/tank to the local community.	❑	❑	
	7	**Are there excreta overflowing from the squat hole, pan or pedestal; and/or are there ponds of effluent visible on the ground outside the toilet?** If there are, users may be exposed to excreta.	❑	❑	
VIRONMENT	8	**Is the pit poorly maintained such that the cover slab is cracked or damaged, and/or the side walls are not stable?** If the walls are not stable and/or the slab cracked, there may be a risk that the pit will collapse putting users at risk (e.g. falling into pit)	❑	❑	
	9	**Is the bottom of the pit less than 1.5 m* from the water table where groundwater supply is used for drinking?** If so, the pit may contaminate groundwater (e.g. by infiltration). This may pose health risks were groundwater is used for drinking.	❑	❑	
	10	**Is the toilet and pit located within 15 m* of a well or hand pump that is used for drinking?** Toilets close to groundwater supplies may affect water quality (e.g. by infiltration) and pose health risks to those relying on this water source for drinking.	❑	❑	
	11	**Is the pit/septic tank located on higher ground from the drinking water source?** Pollution on higher ground poses a risk, especially in the wet season, as faecal material may flow towards the water source below.	❑	❑	
	14	**Is the container/pit/septic tank not accessible for emptying?** Workers need to be able to access the pit with tools and emptying equipment to safely remove faecal sludge. There should be at least one removable access hatch/cover/lid over a hole large enough for hoses to be inserted for emptying the pit/septic tank.	❑	❑	
	15	**Is the pit/container/septic tank almost full?**	❑	❑	
		Total number of risks identified: ...../13			



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SIF tool for digital sanitary Inspections (WHO)

Publication date 07-10-2016 | 00:00 Modification date 20-11-2018 | 14:49

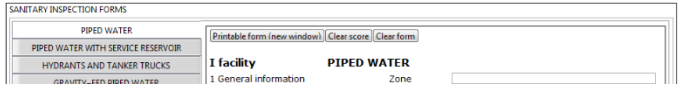
The SIF tool developed by RIVM (based on WHO GDWQ, 2nd ed.) provides a way tot perform sanitary inspections on a tablet or smart phone. Filled-out forms can be saved (as pdf's) and printed for administrative purposes. A sanitary inspection is an on-site inspection of a water supply to identify actual and potential sources of fecal contamination or microbial risks. The physical structure and operation of the system and external environmental factors (such as latrine location) are evaluated. This information can be used to select appropriate remedial action to improve or protect the water supply in a qualitative and cost-effective manner.

This is a draft version based on the sanitary surveys first published in 1976 (WHO monograph series #63 "Surveillance of Drinking Water Quality"), No rights can be derived from the use of this tool.

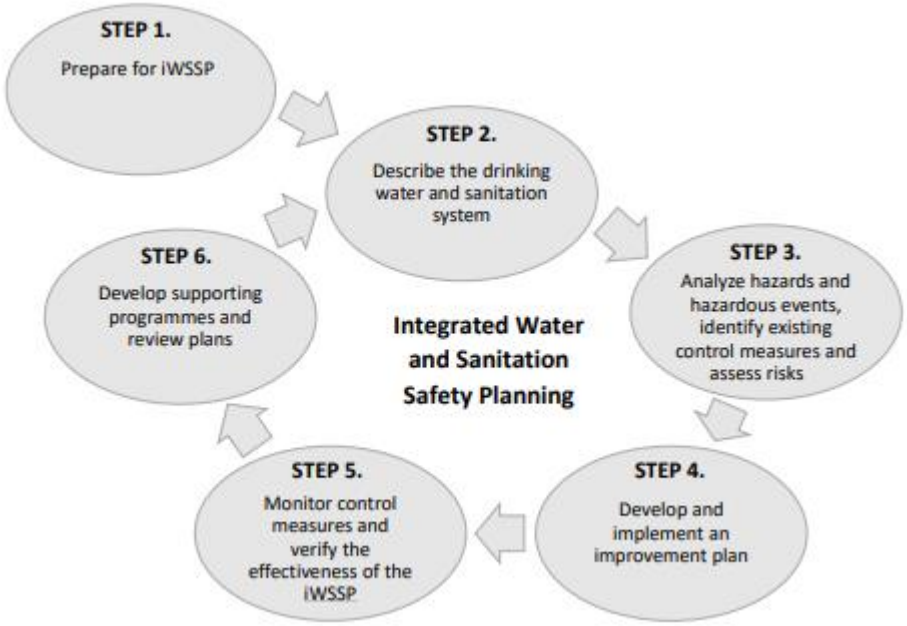
Downloads

Instruction: Save SIF.cdf first on your computer; Then load it as a stand alone tool with the CDF Player for full functionality.

- SIF direct link
- Link to free CDF Player to run SIF



Integrated Water and Sanitation Safety Planning



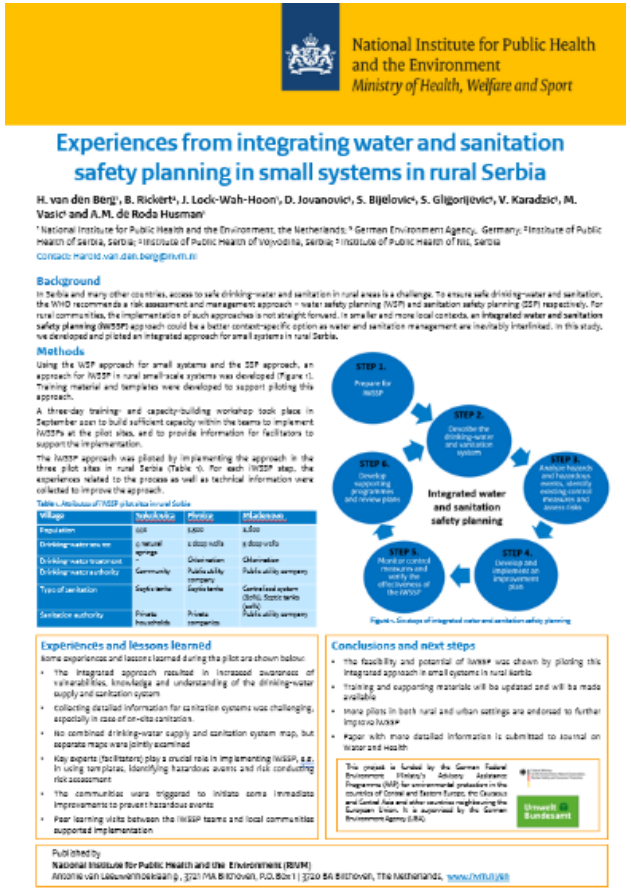
- Identify and manage risks along the entire water supply chain from source to tap and sanitation chain from capture to disposal/end-use.
- Desirable approach for rural areas with limited resources and support.
- Probably also applicable for large supplies.

Van den Berg et al. PhD thesis 2024

iWSSP – pilot project in rural Serbia

Assess and demonstrate the feasibility of integrating water and sanitation safety planning.

- templates and guidance for iWSSP implementation
- training workshops
- iWSSP implemented in 3 small systems



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Experiences from integrating water and sanitation safety planning in small systems in rural Serbia

H. van den Berg[1], B. Rickert[2], J. Lock-Wah-Hoon[3], D. Jovanovic[4], S. Bijelovic[4], S. Gligorijevic[4], V. Karadzic[4], M. Vasic[4] and A.M. de Roda Husman[1]

[1] National Institute for Public Health and the Environment, the Netherlands; [2] German Environment Agency, Germany; [3] Institute of Public Health of Serbia, Serbia; [4] Institute of Public Health of Vojvodina, Serbia; [5] Institute of Public Health of Nis, Serbia

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Background

In Serbia and many other countries, access to safe drinking-water and sanitation in rural areas is a challenge. To ensure safe drinking-water and sanitation, the WHO recommends a risk assessment and management approach – water safety planning (WSP) and sanitation safety planning (SSP) respectively. For rural communities, the implementation of such approaches is not straight forward. In smaller and more local contexts, an **integrated water and sanitation safety planning (iWSSP)** approach could be a better context-specific option as water and sanitation management are inevitably interlinked. In this study, we developed and piloted an integrated approach for small systems in rural Serbia.

Methods

Using the WSP approach for small systems and the SSP approach, an approach for iWSSP in rural small-scale systems was developed (Figure 1). Training material and templates were developed to support piloting this approach.

A three-day training- and capacity-building workshop took place in September 2021 to build sufficient capacity within the teams to implement iWSSPs at the pilot sites, and to provide information for facilitators to support the implementation.

The iWSSP approach was piloted by implementing the approach in the three pilot sites in rural Serbia (Table 1). For each iWSSP step, the experiences related to the process as well as technical information were collected to improve the approach.

Table 1. Attributes of iWSSP pilot sites in rural Serbia

Village	Vukobrankovica	Plandiste	Mladenovac
Population	600	1,600	4,800
Drinking-water source	2 natural springs	2 deep wells	6 deep wells
Drinking-water treatment	–	Chlorination	Chlorination
Drinking-water authority	Community	Public utility company	Public utility company
Type of sanitation	Septic tanks	Septic tanks	Centralized system (50%), Septic tanks (50%)
Sanitation authority	Private households	Private companies	Public utility company

Figure 1. Six steps of integrated water and sanitation safety planning

Experiences and lessons learned

Some experiences and lessons learned during the pilot are shown below:

- The integrated approach resulted in increased awareness of vulnerabilities, knowledge and understanding of the drinking-water supply and sanitation system
- collecting detailed information for sanitation systems was challenging, especially in case of on-site sanitation.
- No combined drinking-water supply and sanitation system map, but separate maps were jointly examined
- Key experts (factotum) play a crucial role in implementing iWSSP, e.g. in using sanitary risk, identifying hazardous events and risk conducting risk assessment
- The communities were triggered to initiate some immediate improvements to prevent hazardous events
- Peer learning visits between the iWSSP teams and local communities supported implementation

Conclusions and next steps

- The feasibility and potential of iWSSP was shown by piloting this integrated approach in small systems in rural Serbia
- Training and supporting materials will be updated and will be made available
- More pilots in both rural and urban settings are endorsed to further improve iWSSP
- Paper with more detailed information is submitted to Journal on Water and Health

This project is funded by the German Federal Environment Ministry's Advisory Assistance Programme (AAP) for environmental protection in the countries of Central and Eastern Europe, the Caucasus and Central Asia and other countries neighbouring the European Union. It is supervised by the German Environment Agency (UBA).

Umwelt Bundesamt

Published by
National Institute for Public Health and the Environment (RIVM)
Antonie van Leeuwenhoeklaan 9, 3721 MA Bilthoven, P.O. Box 1 | 3720 BA Bilthoven, The Netherlands, www.rivm.nl

FOLLOW-UP

More pilots to improve and finalize the iWSSP templates and guidance.

Van den Berg et al. JWH 2023

Acknowledgements

- Environmental surveillance pre-COVID - Willemijn Lodder, Ronald Italiaander, Sylvain Skraber, Saskia Rutjes, Ciska Schets, Harold van den Berg and many others
- Polio - Erwin Duizer, Saskia Rutjes, Jack Schijven
- AMR - Heike Schmitt, Hetty Blaak, Merel Kemper
- COVID-19 – Willemijn Lodder, Erwin Roex, Jerome Lock-Wah-Hoon, Wouter Hetebrij, Erwin Nagelkerke, Ruud van der Beek, Anne-Merel van der Drift and many others
- Multi-pathogen approach – Jerome Lock-Wah-Hoon, Joris Sprokholt, Erwin Duizer, Heike Schmitt
- iWSSP – Bettina Rickert, Harold van den Berg and many others

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