

8th International Workshop on Decentralized Wastewater Treatment in Asia

"From the Perspective of Japan's Experience in Decentralized Wastewater  
Management: Water-borne Diseases and Disasters"

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# Mechanism of Water-borne Diseases and Countermeasures

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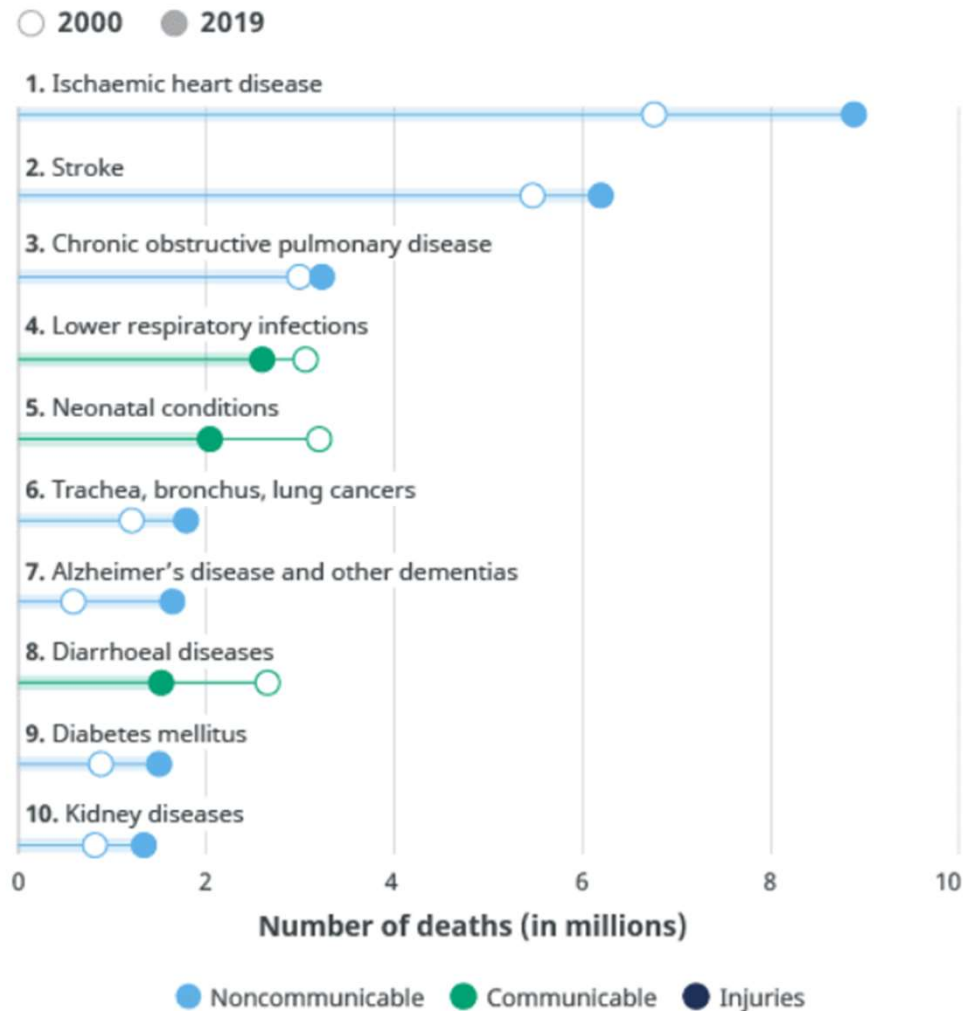
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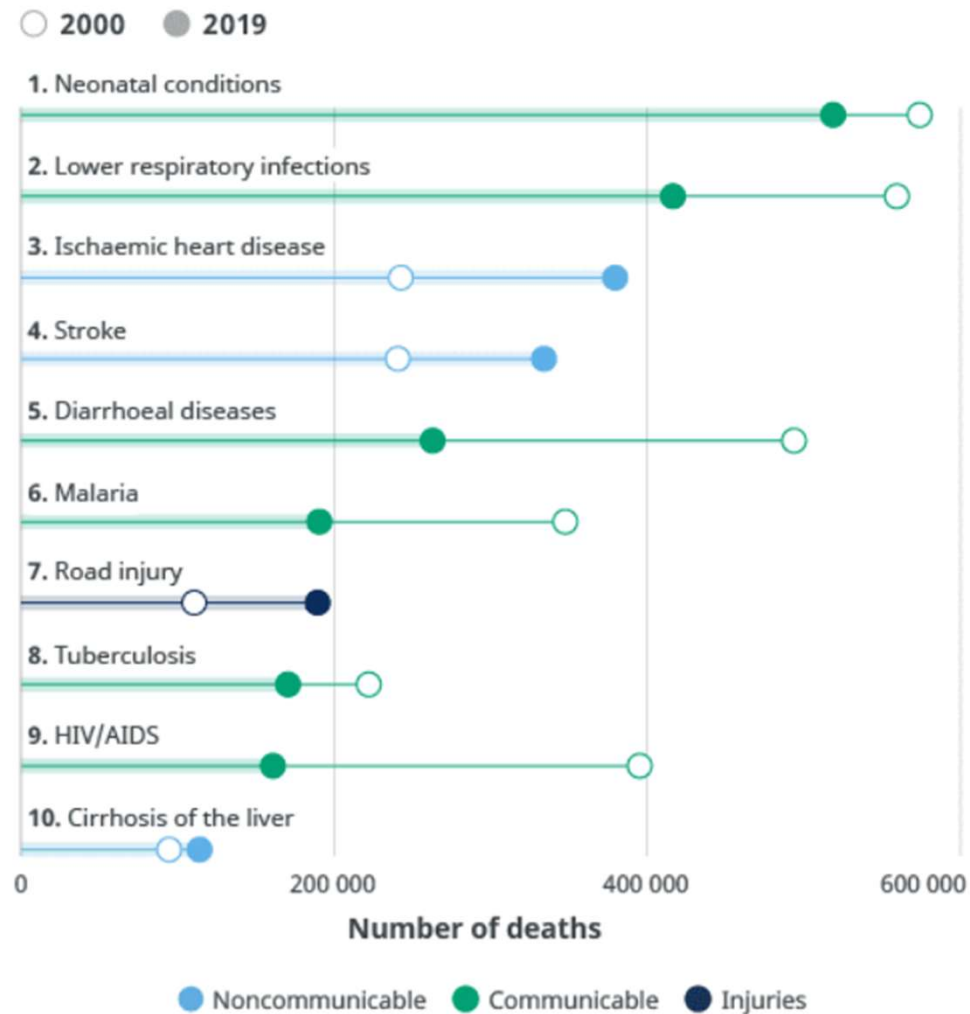
WHO Collaborating Centre for Community  
Water Supply and Sanitation (JPN-51)

# Leading causes of death globally



- At a global level, 7 of the 10 leading causes of deaths in 2019 were noncommunicable diseases.
- The world's biggest killer is ischaemic heart disease, responsible for 16% of the world's total deaths.
- One of the largest declines in the number of deaths is from diarrhoeal diseases, with global deaths falling from 2.6 M in 2000 to 1.5 M in 2019.

# Leading causes of death in low-income countries



- Despite the global decline, six of the top 10 causes of death in low-income countries are communicable diseases.
- Malaria, tuberculosis and HIV/AIDS all remain in the top 10. However, all three are falling significantly.
- Diarrhoeal diseases are more significant as a cause of death in low-income countries: they rank in the top 5 causes of death.

# 10 leading risk factors causing death by income group, 2004

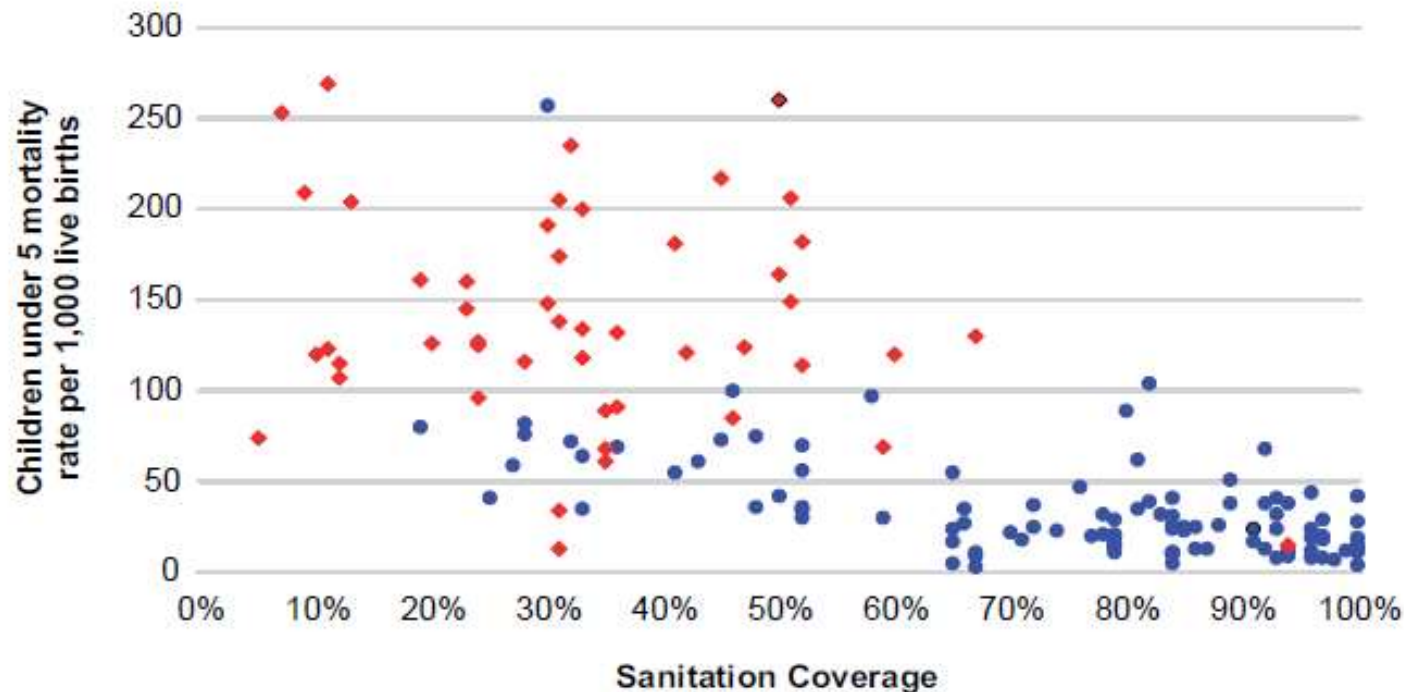
Risk factor	Deaths (millions)	Percentage of total	Risk factor	Deaths (millions)	Percentage of total
<b>World</b>			<b>Low-income countries<sup>a</sup></b>		
1 High blood pressure	7.5	12.8	1 Childhood underweight	2.0	7.8
2 Tobacco use	5.1	8.7	2 High blood pressure	2.0	7.5
3 High blood glucose	3.4	5.8	3 Unsafe sex	1.7	6.6
4 Physical inactivity	3.2	5.5	4 Unsafe water, sanitation, hygiene	1.6	6.1
5 Overweight and obesity	2.8	4.8	5 High blood glucose	1.3	4.9
6 High cholesterol	2.6	4.5	6 Indoor smoke from solid fuels	1.3	4.8
7 Unsafe sex	2.4	4.0	7 Tobacco use	1.0	3.9
8 Alcohol use	2.3	3.8	8 Physical inactivity	1.0	3.8
9 Childhood underweight	2.2	3.8	9 Suboptimal breastfeeding	1.0	3.7
10 Indoor smoke from solid fuels	2.0	3.3	10 High cholesterol	0.9	3.4
<b>Middle-income countries<sup>a</sup></b>			<b>High-income countries<sup>a</sup></b>		
1 High blood pressure	4.2	17.2	1 Tobacco use	1.5	17.9
2 Tobacco use	2.6	10.8	2 High blood pressure	1.4	16.8
3 Overweight and obesity	1.6	6.7	3 Overweight and obesity	0.7	8.4
4 Physical inactivity	1.6	6.6	4 Physical inactivity	0.6	7.7
5 Alcohol use	1.6	6.4	5 High blood glucose	0.6	7.0
6 High blood glucose	1.5	6.3	6 High cholesterol	0.5	5.8
7 High cholesterol	1.3	5.2	7 Low fruit and vegetable intake	0.2	2.5
8 Low fruit and vegetable intake	0.9	3.9	8 Urban outdoor air pollution	0.2	2.5
9 Indoor smoke from solid fuels	0.7	2.8	9 Alcohol use	0.1	1.6
10 Urban outdoor air pollution	0.7	2.8	10 Occupational risks	0.1	1.1

<sup>a</sup> Countries grouped by gross national income per capita – low income (US\$ 825 or less), high income (US\$ 10 066 or more).

WHO: Global Health Risks - Mortality and burden of disease attributable to selected major risks, 2009

[https://www.who.int/healthinfo/global\\_burden\\_disease/global\\_health\\_risks/en/](https://www.who.int/healthinfo/global_burden_disease/global_health_risks/en/)

# Under 5 mortality compared to sanitation coverage, 2008

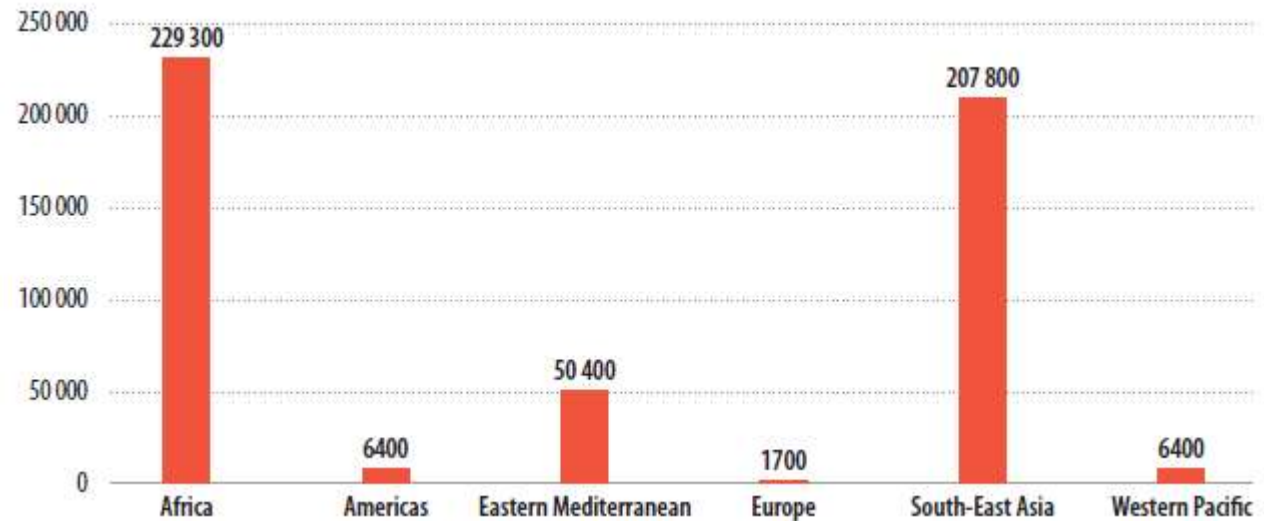


**Figure 1: Under 5 mortality compared to sanitation coverage for individual developing countries. Each point represents a separate country. Red diamonds are countries in sub-Saharan Africa**

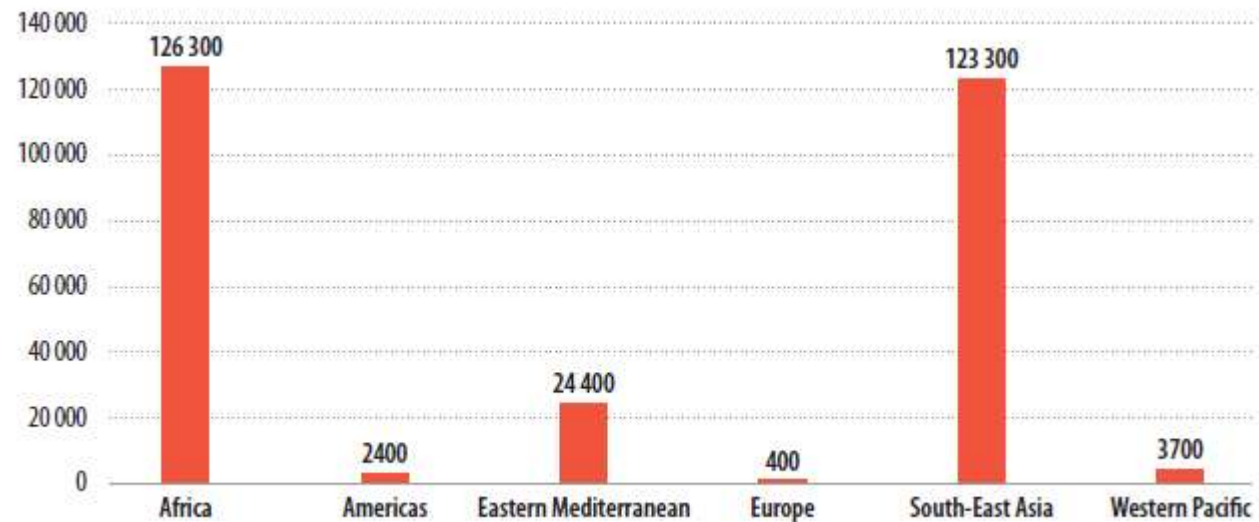
(Adapted from Rosemarin et al., 2008; data from WHO/UNICEF, 2008a and WHO, 2008)

# Deaths from inadequate drinking-water and sanitation in low- and middle-income countries by region, 2012

## Drinking-water



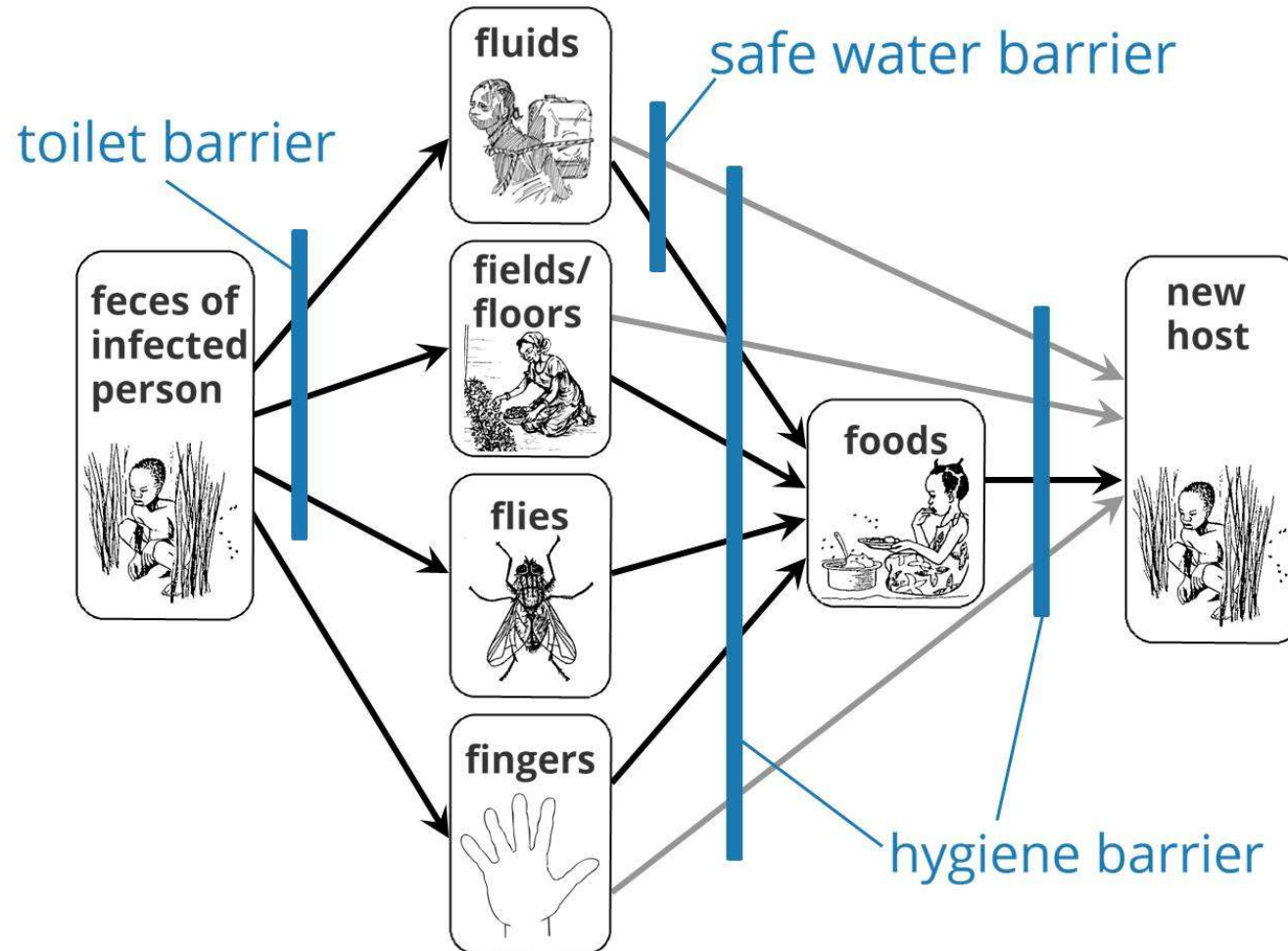
## Sanitation



See Annex Table 7 for grouping of countries by WHO Region.

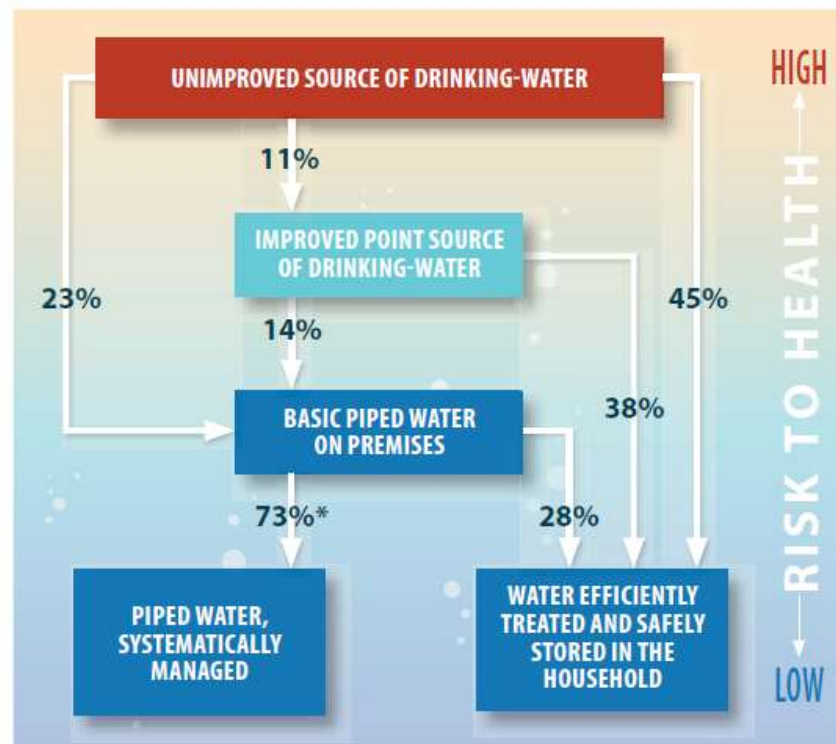
WHO: Preventing diarrhoea through better water, sanitation and hygiene, 2014  
[https://www.who.int/water\\_sanitation\\_health/publications/preventing-diarrhoea/en/](https://www.who.int/water_sanitation_health/publications/preventing-diarrhoea/en/)

# Transmission of pathogens via fecal – oral routes and barriers



# Drinking-water supply/Sanitation transitions and associated reductions in diarrhoeal disease risk

## Drinking-water



\*These estimates are based on limited evidence and should therefore be considered as preliminary and have not been used in the estimation of disease burden.

## Sanitation

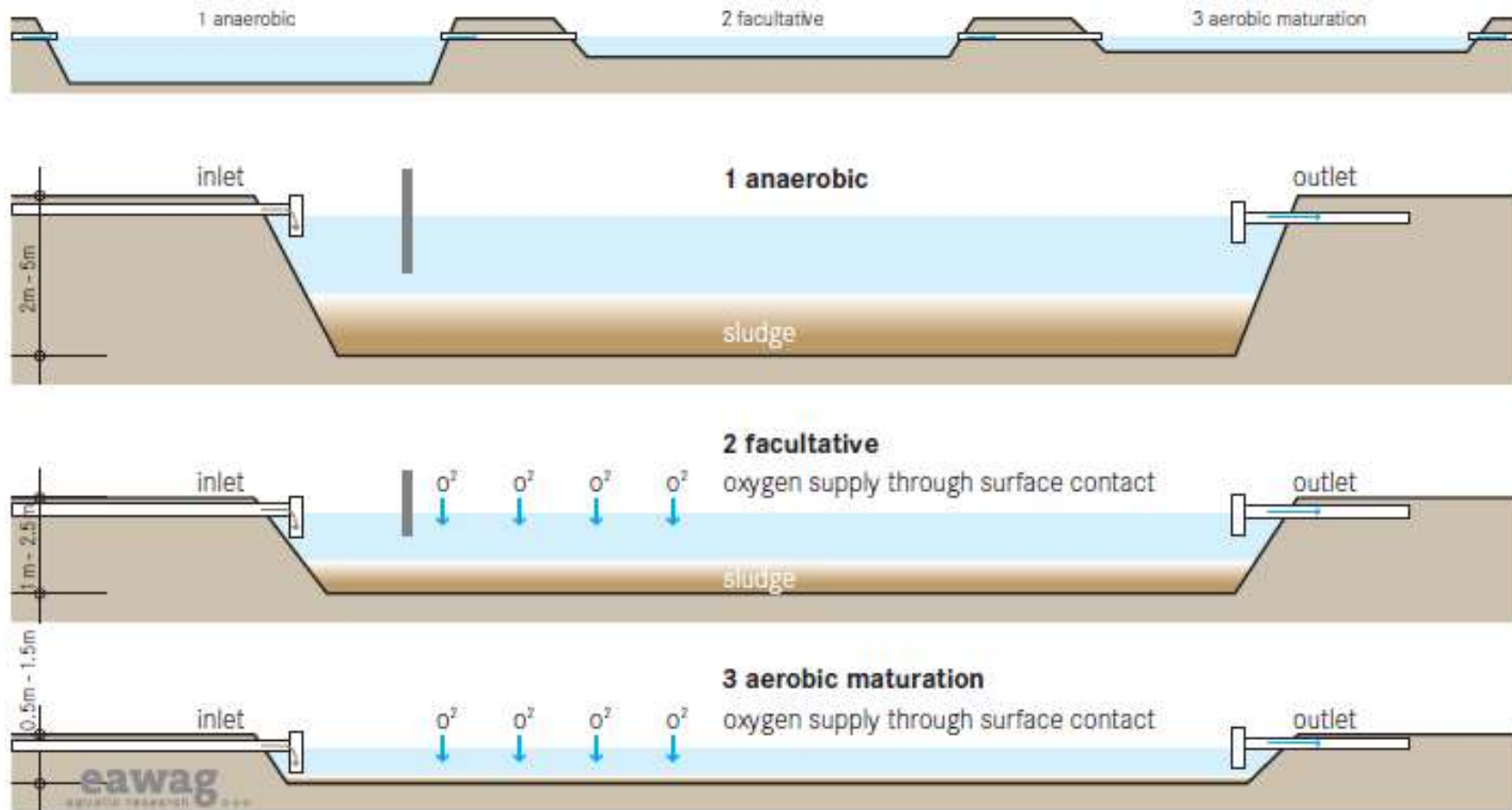


\*These estimates are based on limited evidence and should therefore be considered as preliminary, and have not been used in the current burden of disease estimate.



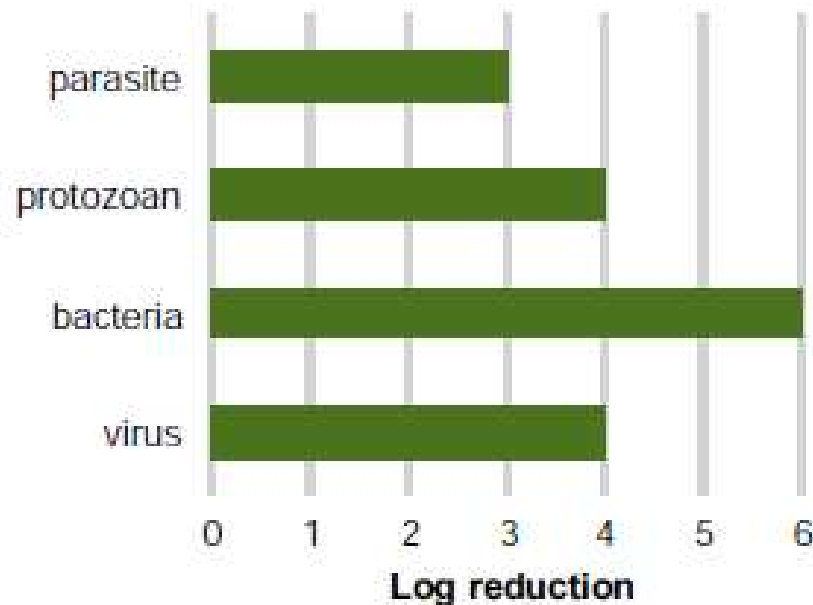
# Removal and/or inactivation of pathogens using centralized treatment technologies

## (1) Waste Stabilization Ponds



# Removal and/or inactivation of pathogens using centralized treatment technologies

## (1) Waste Stabilization Ponds



**Figure 10: Maximum reduction of pathogens in an optimally functional waste stabilisation pond\***

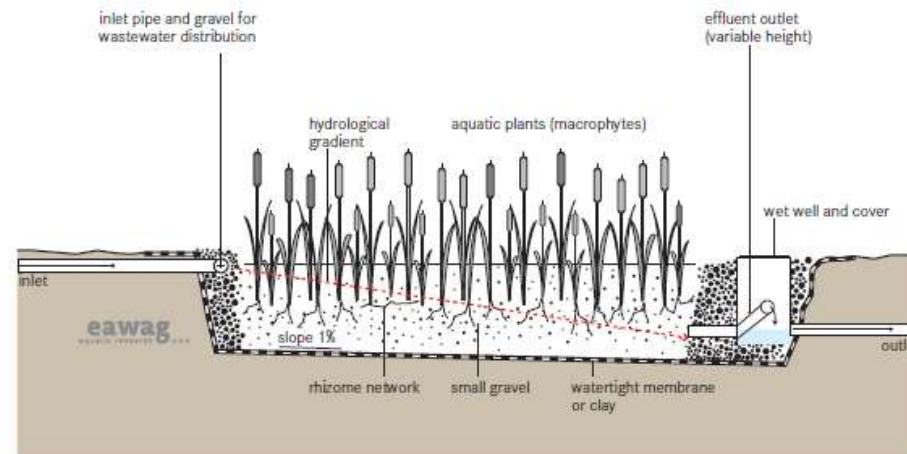
(Based on WHO, 2006)

[\* May be significantly lower. Depends on type of climate zone, retention time and number of ponds.]

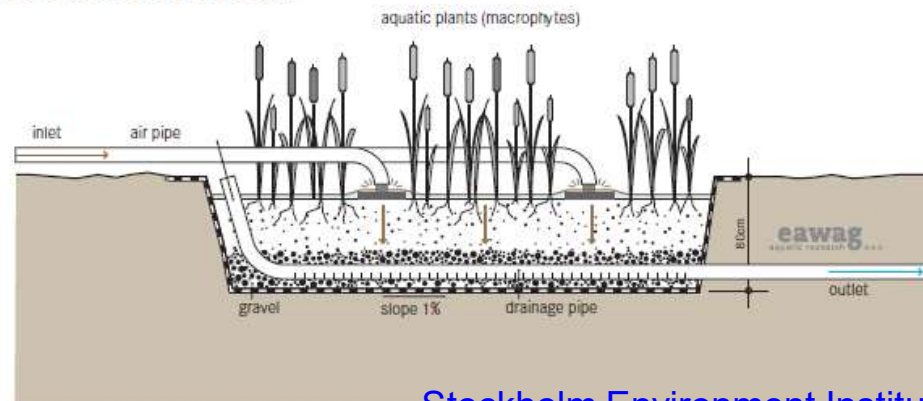
# Removal and/or inactivation of pathogens using centralized treatment technologies

## (2) Constructed Wetlands

*Horizontal sub-surface flow constructed wetland*

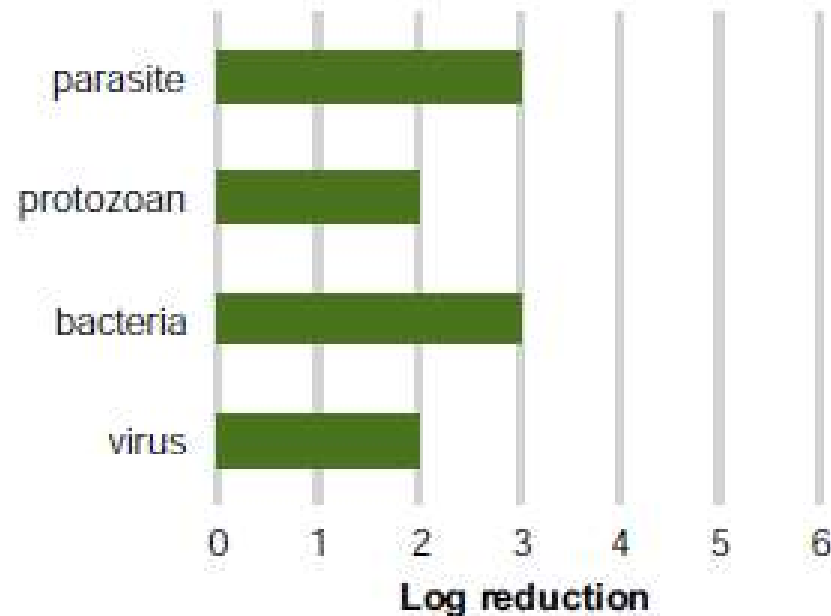


*Vertical flow constructed wetland*



# Removal and/or inactivation of pathogens using centralized treatment technologies

## (2) Constructed Wetlands

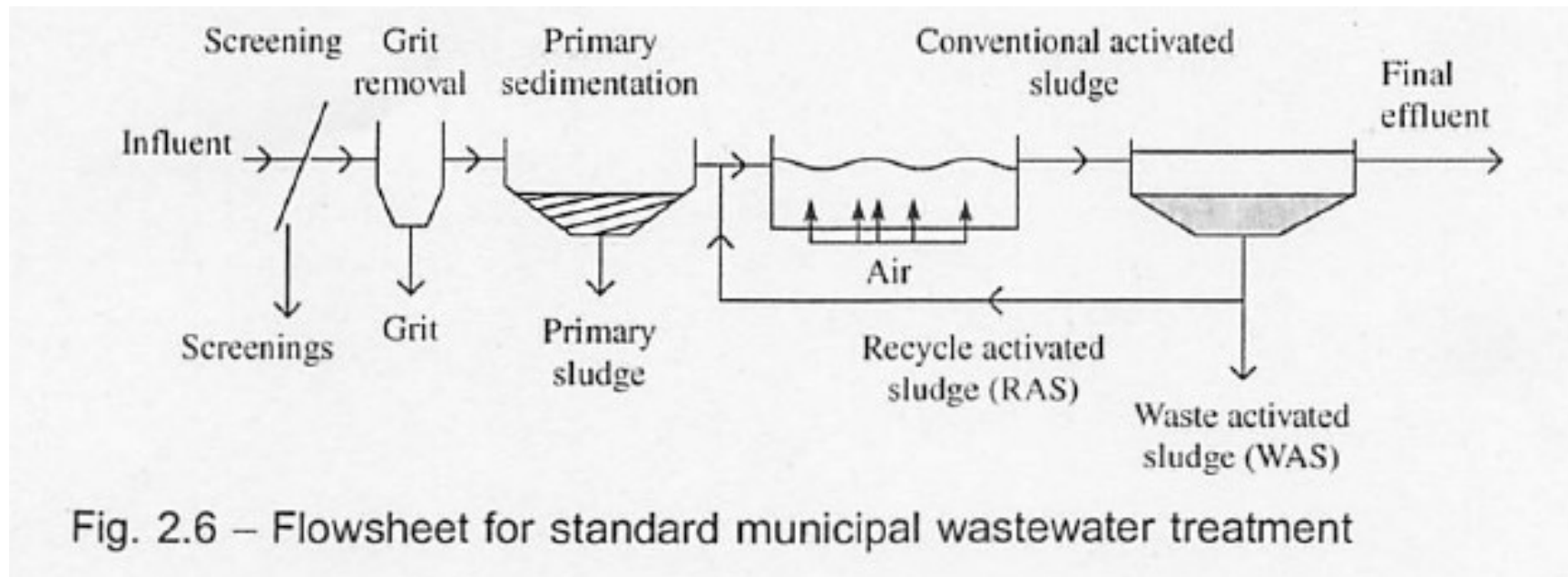


**Figure 11: Maximum reduction of pathogens in an optimally functional constructed wetland\*** (WHO, 2006)

[\*Depends on type of wetland, filter material, retention time and vegetation. ]

# Removal and/or inactivation of pathogens using centralized treatment technologies

## (3) Conventional Wastewater Treatment (incl. Activated Sludge)



# Removal and/or inactivation of pathogens using centralized treatment technologies

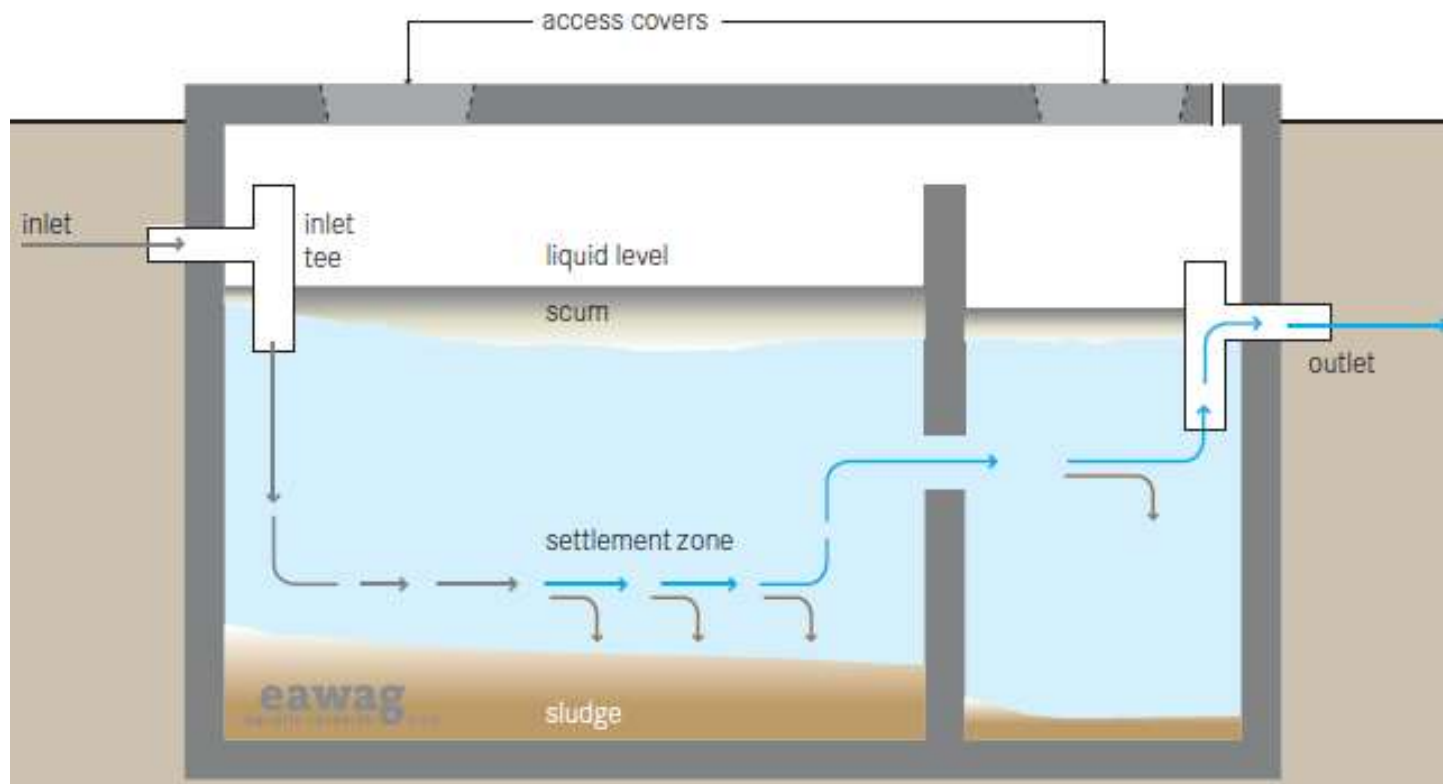
**Table 3: Pathogen removal efficiency of different wastewater treatment processes**

Treatment process	Removal efficiency (log reduction)			
	Viruses	Bacteria	Protozoan (oo) cysts	Helminth eggs
<b>Primary treatment</b>				
Primary sedimentation	0 - 1	0 - 1	0 - 1	0 - <1
Chemically enhanced primary treatment	1 - 2	1 - 2	1 - 2	1 - 3
Anaerobic upflow sludge blanket reactors	0 - 1	0.5 - 1.5	0 - 1	0.5 - 1
<b>Secondary treatment</b>				
Activated sludge + secondary sedimentation	0-2	1-2	0-1	1-<2
Trickling filters + secondary sedimentation	0-2	1-2	0-1	1-2
Aerated lagoon + settling pond	1 - 2	1 - 2	0 - 2	1 - 3
<b>Tertiary treatment</b>				
Coagulation/flocculation	1 - 3	0 - 1	1-3	2
High rate granular or slow rate sand filtration	1 - 3	0-3	0-3	1-3
Dual media filtration	1-3	0-1	1-3	2-3
Membranes	2.5->6	3.5 ->6	>6	>3
<b>Disinfection</b>				
Chlorination (free chlorine)	1-3	2-6	0-1.5	0-<1
Ozonation	3-6	2-6	1-2	0-2
Ultraviolet radiation	1 - >3	2->4	>3	0

Source: WHO (2006)

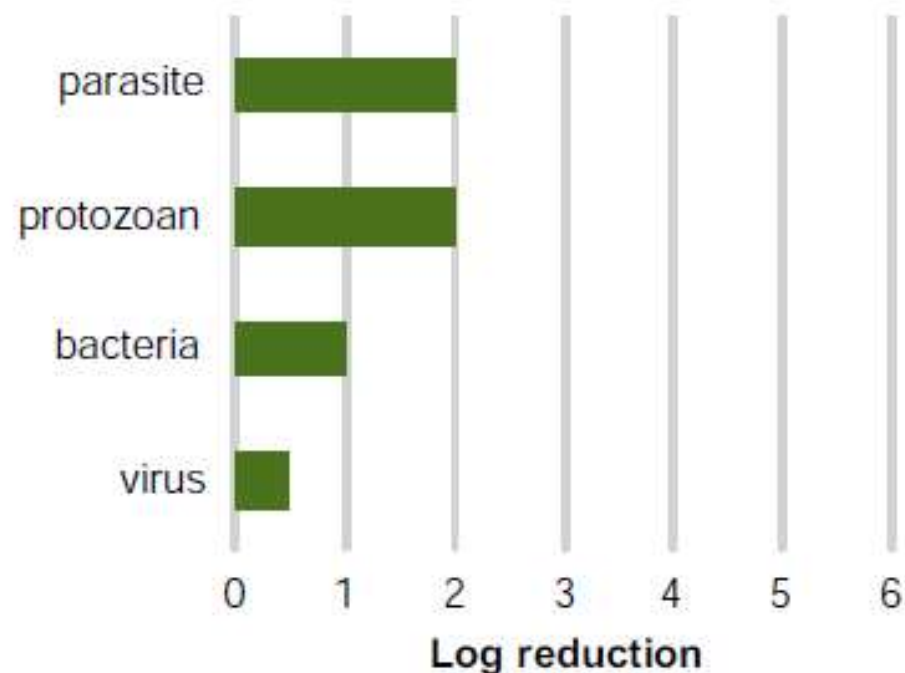
# Removal and/or inactivation of pathogens using **decentralized** treatment technologies

## (1) Conventional and Improved Septic Tanks



# Removal and/or inactivation of pathogens using **decentralized** treatment technologies

## (1) Conventional and Improved Septic Tanks



**Figure 7: Reduction of pathogens in an optimally functional septic tank** (WHO, 2006)



# Removal and/or inactivation of pathogens using **decentralized** treatment technologies

## (2) “Johkasou” system



Septic tank	Johkasou
• anaerobic treatment	• anaerobic / aerobic treatment
• additional treatment is necessary	• effluent can be discharged on-site to public water
• low treatment performance (low BOD removal ratio)	• high treatment performance (90% or more BOD removal ratio). • nitrogen and /or phosphorus removal types are available.

Japanese Ministry of the Environment, 2019.  
Night soil treatment and decentralized wastewater treatment systems in Japan

- Reduction ratios of *E. coli* O157 and *Salmonella enteritidis* depended significantly on the water temperature and BOD.
- **Four log reduction** could be expected to both pathogens under water temp. around 20 and 30° C.
- Higher reduction ratios were observed under lower influent BOD.

M. Kaneko; T. Nambu; M. Tokoro, 2001.  
Behaviour of pathogenic *E. coli* and *Salmonella enteritidis* in small domestic sewage treatment apparatus (“Johkasou”) *Water Science & Technology*, **43** (12), 191–193.

# Summary

- ✓ Lack of safe drinking water and basic sanitation still have been one of the significant risk factors causing death in low-income countries.
- ✓ Multiple WASH barriers/interventions are effective for blocking fecal pathogen transmission and reducing diarrhoeal disease risk.
- ✓ Pathogen removal/inactivation capability by decentralized wastewater treatment technologies could be comparable to centralized ones, depending operational conditions, maintenance, etc.