ISAP 2020

International Forum for Sustainable Asia and the Pacific

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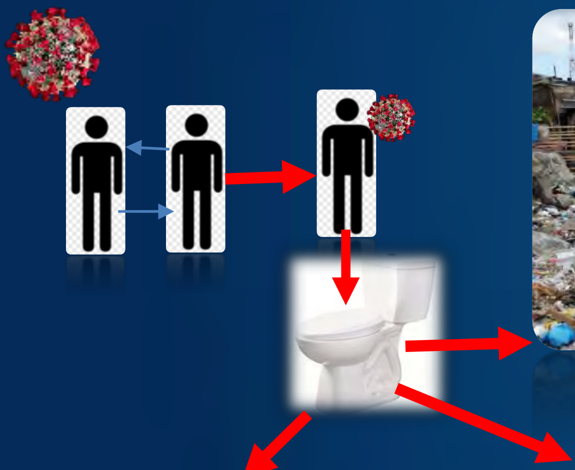
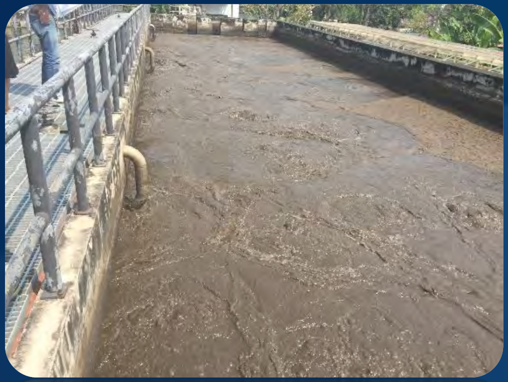
Institute for Global Environmental Strategies

Beyond COVID-19

Addressing Associated Risks of COVID-19 Infections Across Water and Wastewater Services in Asia





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12nd November 2020

BACKGROUND

ASIA

> 30%

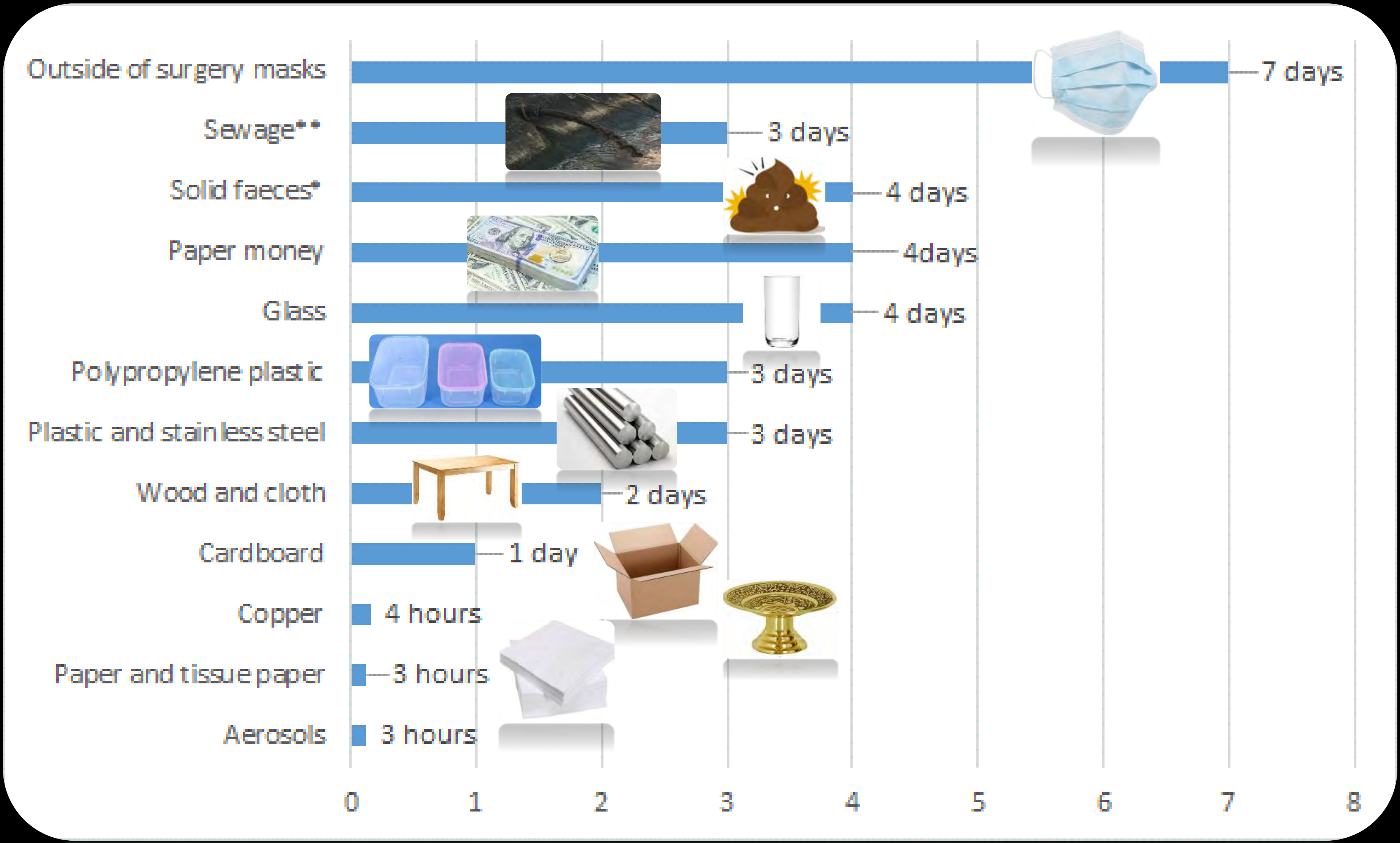
> 22%

Asia Confirmed*
15, 728,876

Asia Deaths*
280,199

Ongoing global pandemic of novel coronavirus (or COVID-19 pandemic) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is causing significant public health impacts at global scale, with more than 50 million infected cases have been reported and more than 1.26 million deaths have been confirmed throughout over 200 countries according to the latest information from Johns Hopkins University, as of 10th November 2020

Life span of COVID-19 on different surfaces



Detection of SARS-CoV-2 in Human Faeces

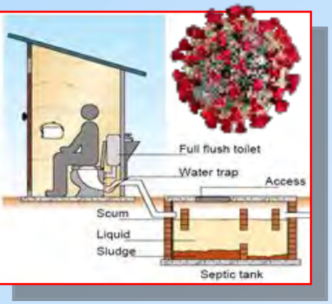
- SARS-CoV-2 was found in the stool of COVID-19 patients for a long duration (up to five weeks)

- SARS-CoV-2 RNA was also detected in the faeces of infected people who had mild or even no symptoms

- Regarding the concentration of SARS-CoV-2 RNA, up to 10^8 copies/g-faeces were reported; but normally in the range of 10^3-10^8 copies/g-faeces, depending on the infection's course

- The virus concentration had its highest peak during the first week of symptoms and gradually decreased during the duration of the clinical course

Detection of SARS-CoV-2 in human faecal, domestic and hospital wastewater



Detection of SARS-CoV-2 in raw and treated wastewater

- SARS-CoV-2 are shed in human faeces and urine, which subsequently reach the sewerage systems.

- During the peak of the epidemic (between 5 March and 23 April) in the Parisian area in France, raw wastewater from three wastewater treatment plants (WWTPs) were examined for the presence of SARS-CoV-2 RNA. All the samples (23/23, 100%) were found positive for SARS-CoV-2 (Wurtzer et al., 2020)

- In similar studies conducted in the United States of America, France, Australia and Spain, the detection rates of SARS-CoV-2 RNA in raw wastewater ranged from 22% to 83%. The range of SARS-CoV-2 RNA concentration in raw wastewater widely varied from $1.2 \times 10^2 – 3.0 \times 10^6$ copies/L.

- When comparing between faeces and wastewater, the concentration of SARS-CoV-2 in wastewater was 3-5 orders of magnitude less than that in faeces.

- The survival of SARS-CoV-2 in wastewater might vary depending on environmental factors (e.g. pH and temperature, light exposure, organic matters and presence of antagonist microorganisms).

With strong evidences from scientific communities

Countries	No. patient	Detection rates[a]		SARS-CoV-2 concentration	Detection methods[c]	Reference
		No.	%			
China	95	31/65	47.7	na	rRT-PCR	Lin et al. (2020)
China	42	6/28	21.4	na	rRT-PCR	Chen et al. (2020b)
China	74	41/74	55	na	rRT-PCR	Wu et al. (2020b)
China	205	44/153	29	<2.6 × 10^4 copies/mL (Ct value >30)	rRT-PCR	Wang et al. (2020c)
China	73	39/73	53.4	na	rRT-PCR	Wu et al. (2020a)
China	178	8/15	53.3	Ct value: 19.5–33.6	RT-qPCR	Zhang et al. (2020b)
China	82	9/17	53	5.5 × 10^2 –1.2 × 10^5 copies/mL	RT-qPCR	Pan et al. (2020)
China	57	11/28	39	Ct value: 24–39	rRT-PCR	Chen et al. (2020a)
Korea	46	2/46	4	Ct value: 27.4–31.6	rRT-PCR	Park et al. (2020)
Singapore	18	4/8	50	Ct value: 20–<40	rRT-PCR	Young et al. (2020)
France	5	2/5	50	6.3 × 10^5–1.3 × 10^8 copies/g-faeces	rRT-PCR	Lescure et al. (2020)
Germany	9	8/9	89	10^3–10^8 copies/g-faeces	rRT-PCR	Wölfel et al. (2020)

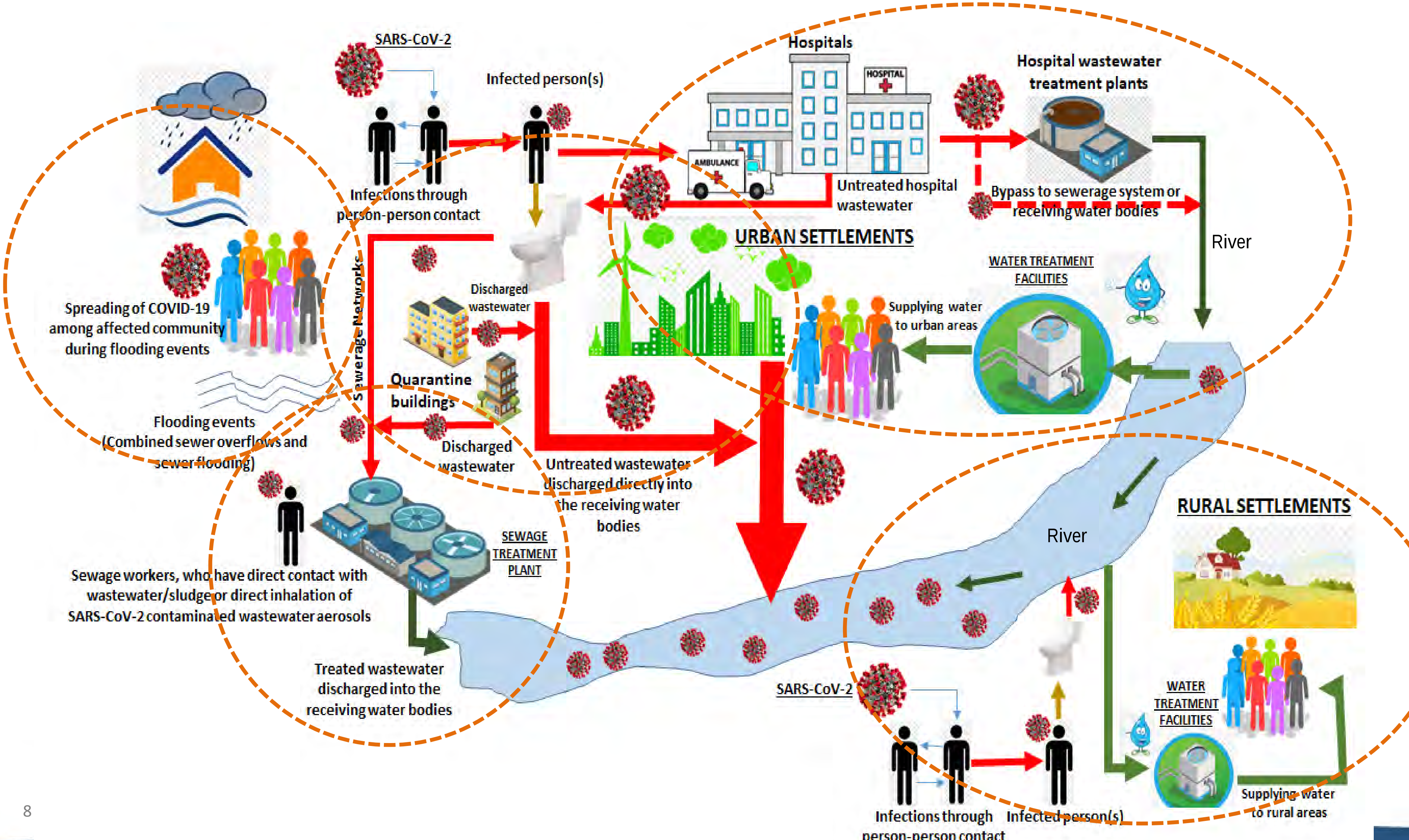
[a] Detection rate was calculated based on the number of patients examined.
[b] the concentration of SARS-CoV-2 was expressed as copies/mL, copies/g-faeces or Ct value.
[c] Presence of SARS-CoV-2 was determined by real-time reverse transcription-polymerase chain reaction (rRT-PCR) or quantitative reverse transcription-polymerase chain reaction (RT-qPCR).
na: not available.

Countries	Type of sample	Detection results		LOD (copies/L)	Detection methods	References
		No. (%)	Concentration (copies/L) or (Ct value)			
Japan	-Raw wastewater -Secondary-treated wastewater -River water	-0/5 (0%) -1/5 (29%) -0/3 (0%)	- nd -2.4 × 10^3 - nd	-<6.6×10^4 -<1.4×10^2 -<3.7×10^2	RT-qPCR	Haramoto et al. (2020)
USA	-Raw wastewater -Secondary-treated wastewater -Final treated wastewater	-2/7 (28.6%) -0/4 (0%) -0/4 (0%)	-3.1×10^3 - nd - nd	-1.0×10^3 -1.0×10^3 -1.0×10^3	RT-qPCR	Sherchan et al. (2020)
France	-Raw wastewater -Final treated wastewater	-23/23 (100%) -6/8 (75%)	-2×10^4–5×10^6,a -<10^4–10^5,a	-10^3 -10^3	RT-qPCR	Wurtzer et al. (2020a)
The Netherlands	-Raw wastewater	18/30 (60%)	-1.2×10^4–1.9×10^6	- na	RT-qPCR	Medema et al. (2020)
Italy	-Raw wastewater - Final treated wastewater - River water	-4/8 (50%) -0/8 (0%) -4/6(67%)	- na - nd - na	- na	rRT-PCR	Rimoldi et al. (2020)
Australia	- Raw wastewater	-2/9, (22 %)	-1.2-1.9× 10^2	- na	RT-qsPCR	Ahmed et al. (2020)
Spain	-Raw wastewater -Secondary-treated wastewater -Tertiary-treated wastewater	-35/42 (83%) -2/18 (11%) -0/12 (0%)	-1.2-3.2×10^5 -2.5×10^5 - nd	-2.8–8.1×10^4 -2.8–8.1×10^4 -2.8–8.1×10^4	RT-qPCR	Randazzo et al. (2020)
India	-Raw wastewater - Final treated wastewater	-2/2(50%) -0/2(0%)	- Ct: 32.6–35.5	- na	rRT-PCR	Kumar et al. (2020)
Pakistan	-Raw wastewater	-21/78 (27%)	- na	- na	rRT-PCR	Sharif et al. (2020)
Israel	-Raw wastewater	-10/26 (38%)	- Ct: 32.7–38.5	- na	RT-qPCR	Bar Or et al. (2020)

[a] the concentrations were estimated from the graph.
LOD: limit of detection; na: not available; nd: not detected

Possible routes of SARS-CoV-2 infections and contamination across water and wastewater services in Asia

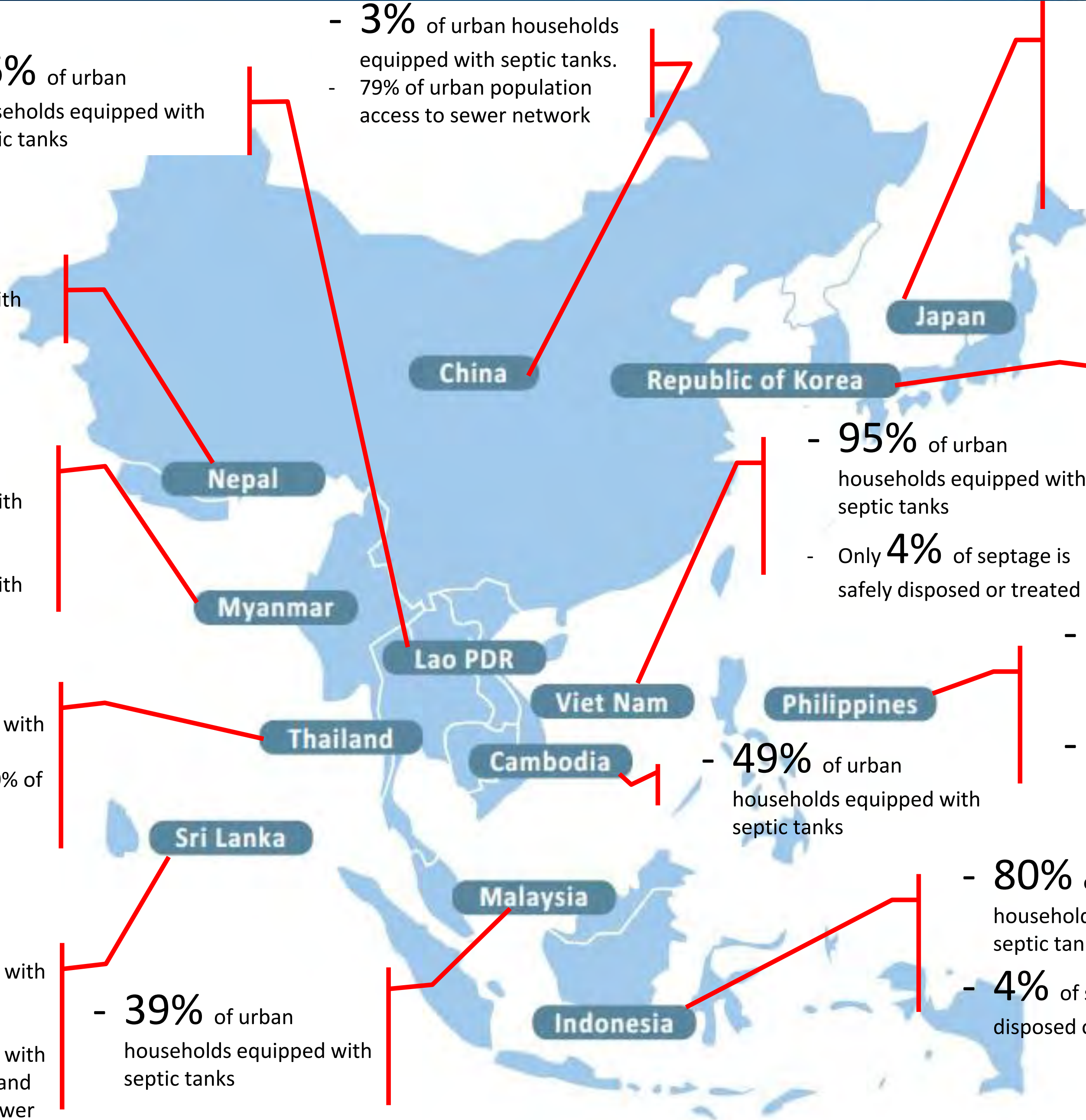
More than 43 million infected cases have been reported and more than 1.1. million deaths have been confirmed throughout the world



Overview of Domestic Wastewater Management in Asia

Population with limited and unimproved sanitation services and open defecation in 2000 and 2017 (millions)

(Source: WHO and UNICEF, 2019)



- 36% of urban households equipped with septic tanks

- 3% of urban households equipped with septic tanks.
- 79% of urban population access to sewer network

- 18% of households equipped with onsite systems (eg. Johkasou)
- 78% of households connect to sewer network (Nationwide)

- 57% of urban households equipped with septic tanks

- 3% of households equipped with latrines
- 97% of households connect to sewer network (Nationwide)

- 25% of urban households equipped with septic tanks
- The remaining urban households equipped with other simple latrines

- 95% of urban households equipped with septic tanks
- Only 4% of septage is safely disposed or treated

- 87% of urban households equipped with septic tanks
- It is estimated that 70% of collected septage is disposed of in environment

- 83% of urban households equipped with septic tanks
- 10% of septage is safely disposed or treated (mainly in Metro Manila)

- 49% of urban households equipped with septic tanks

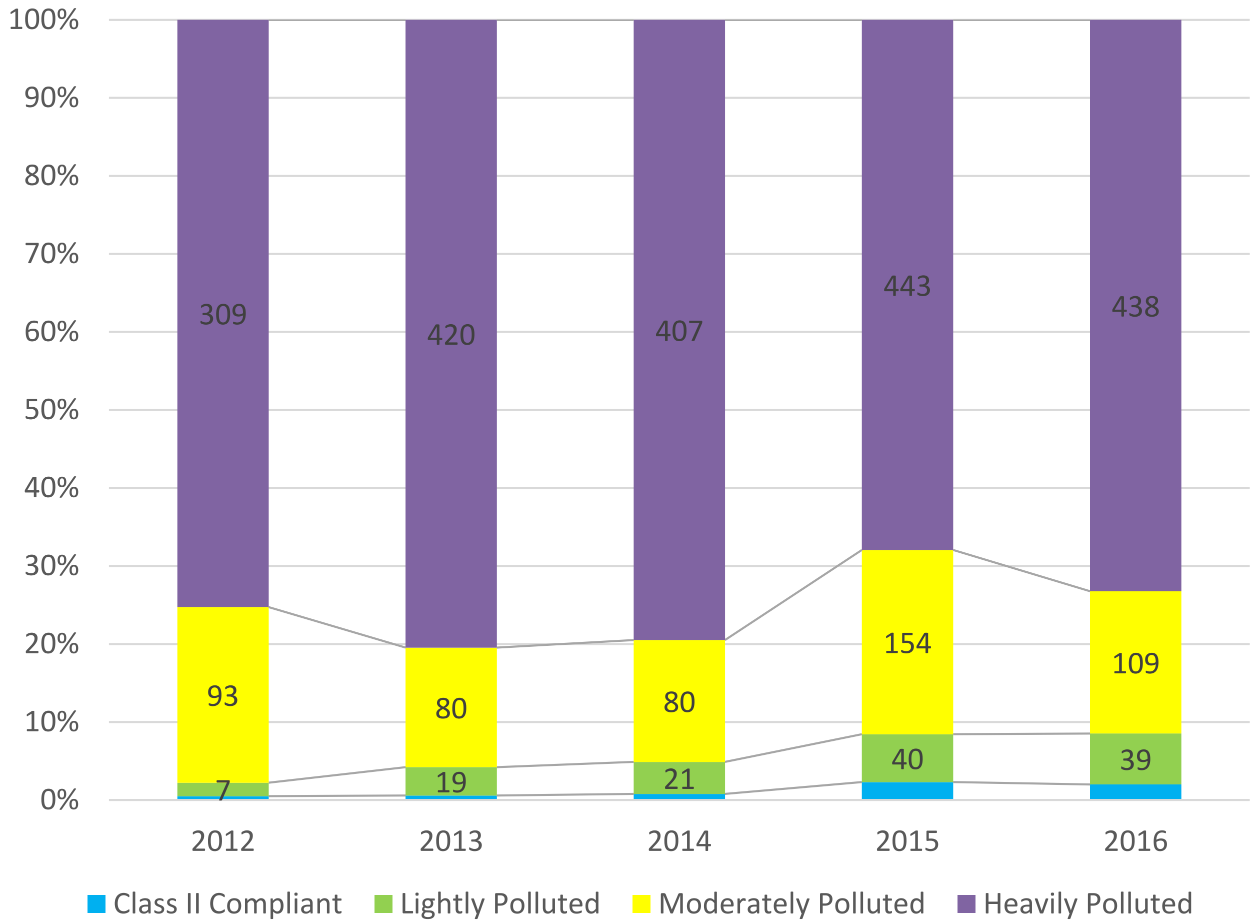
- 4% of urban households equipped with septic tanks
- The remaining urban households equipped with other simple latrines and only 13% access to sewer network in urban areas

- 39% of urban households equipped with septic tanks

- 80% of urban households equipped with septic tanks
- 4% of septage is safely disposed or treated

(Source: WHO and UNICEF, 2019; and database from WEPA website)

Example of water quality deterioration in rivers across Indonesia due to the discharges of untreated wastewater (2012- 2016)

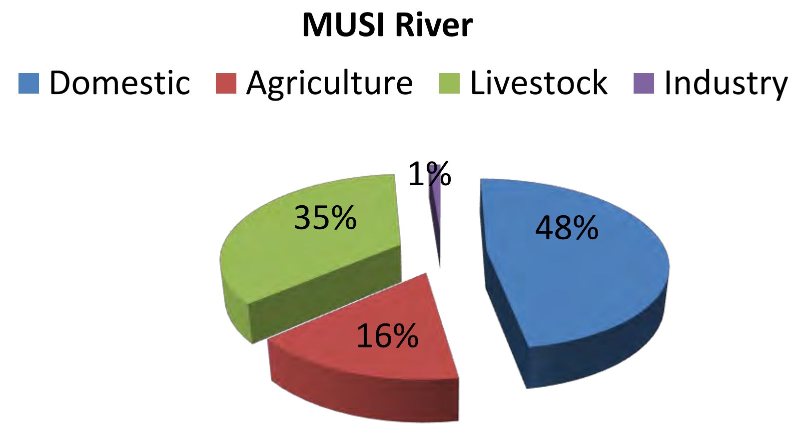


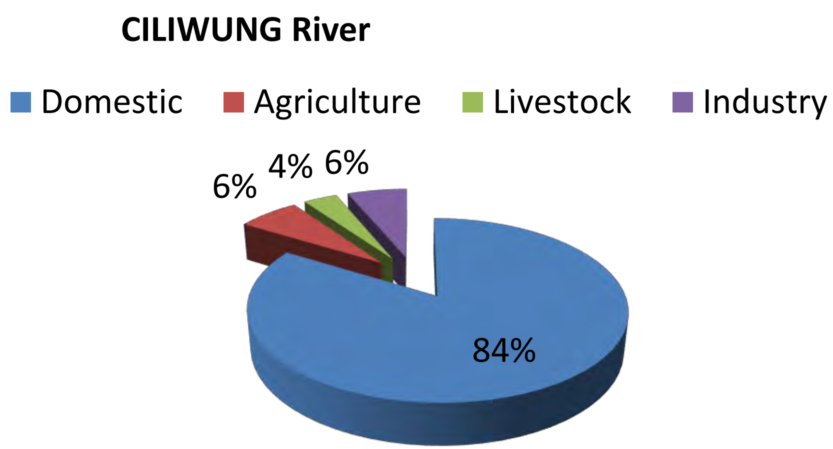
*Numbers Indicate sampling points

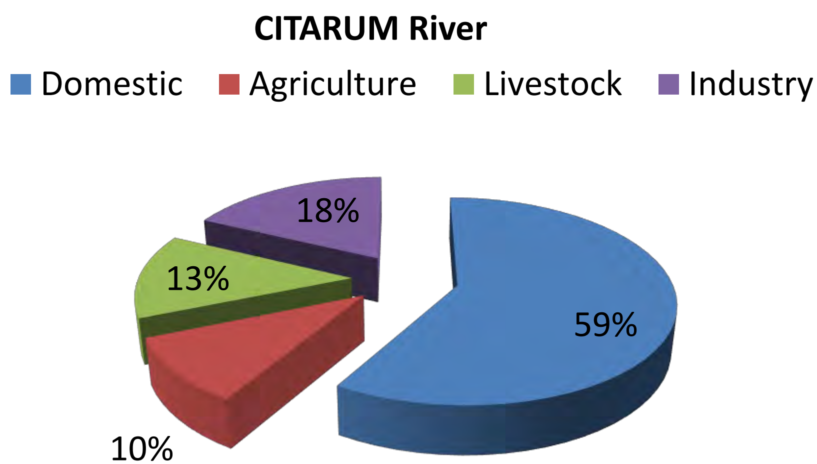
Status of compliance with water quality in Indonesia

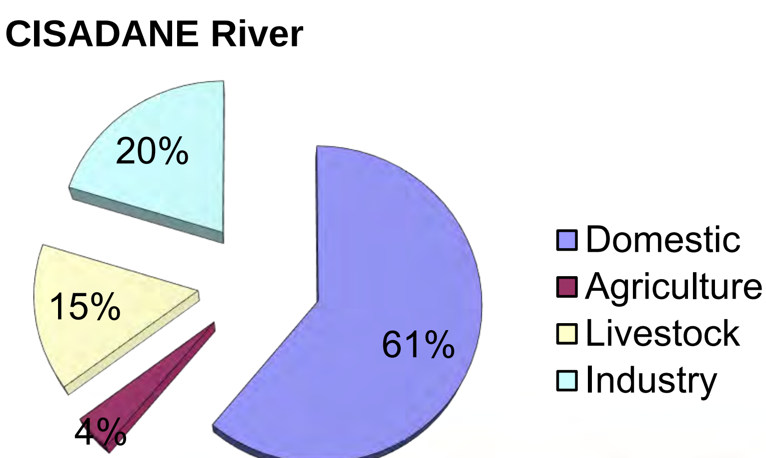
(Source: Created by WEPA based on data from MoE 2017)

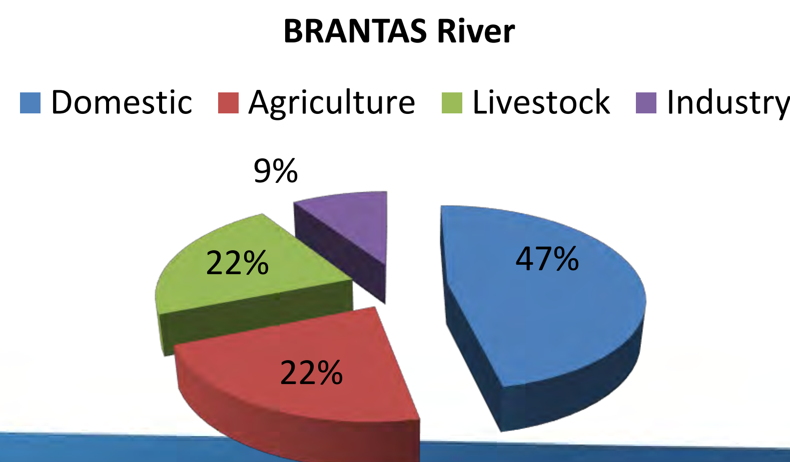
CONTRIBUTION OF POLLUTION SOURCES IN MAJOR RIVER BASINS











(Source: Budi, 2016)

Big gaps between “Science” and “Reality” in addressing septage issues

Science seems to be clear…but Reality & Future is NOT

5m^3 truck load of FS dumping ~ 5,000 pe. practicing open defecation

1g of faeces may contain:

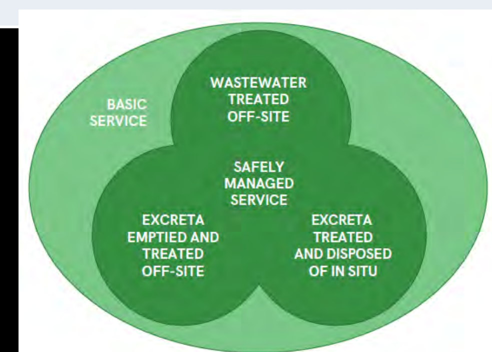
- ✓ 100 Parasite eggs
- ✓ 1000 Protozoa
- ✓ 1,000,000 Bacteria
- ✓ 10,000,000 Virus

Septage management requires an integrated approach, considering the overall sanitation service chain

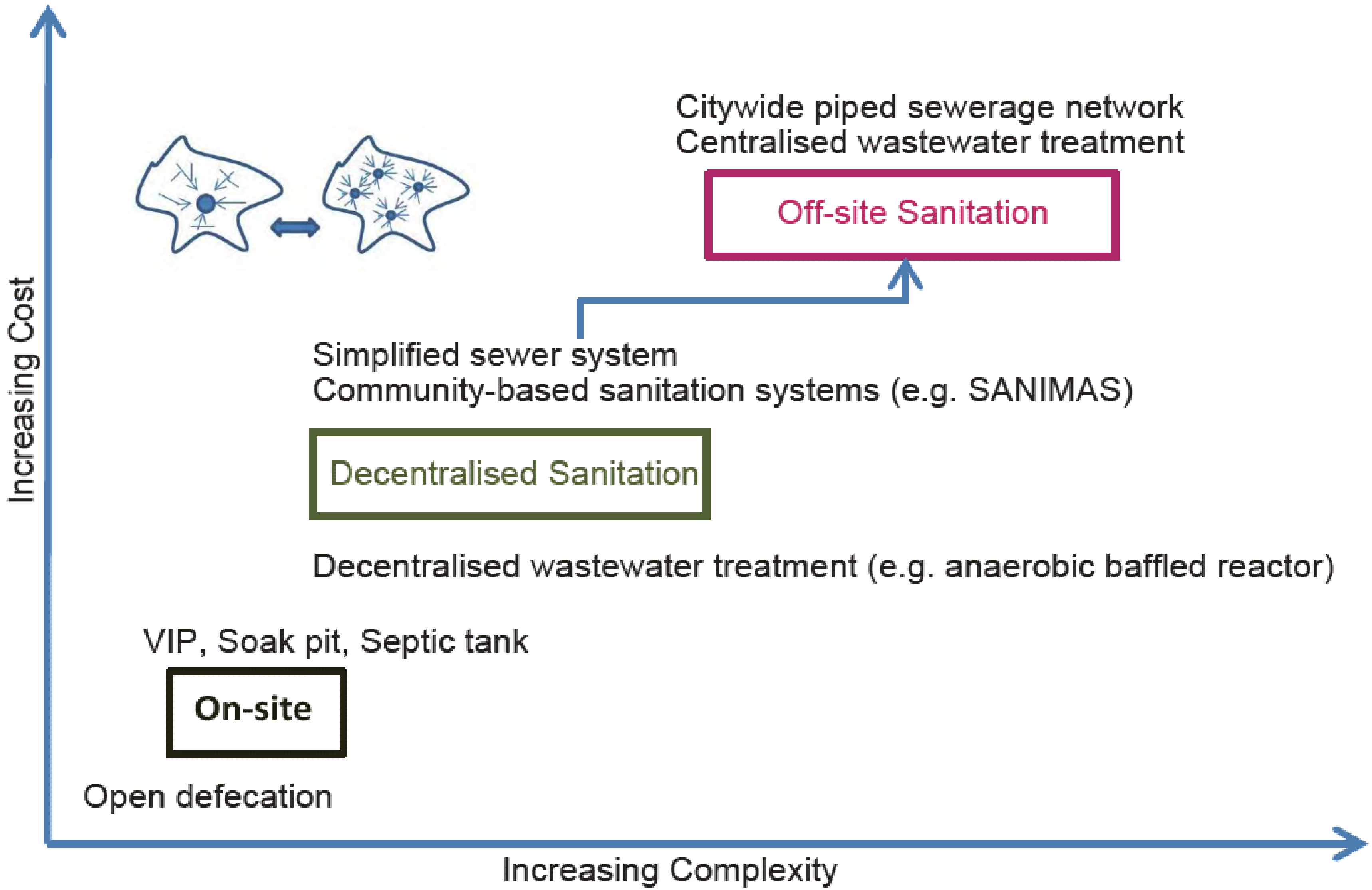
The 2030 Agenda: Leave No One Behind

SDG Global Targets	SDG Global Indicators
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	**6.1.1** Proportion of population using **safely managed drinking water services**
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	**6.2.1** Proportion of population using a**) safely managed sanitation services** and b) a hand-washing facility with soap and water
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	**6.3.1** "**Proportion of domestic** and industrial **wastewater flow safely treated**"
1.4 By 2030, ensure all men and women, in particular the poor and vulnerable, have equal rights to economic resources as well as access to basic services...	**1.4.1** Proportion of population living in households with access to basic services (including access to basic drinking water, basic sanitation and basic handwashing facilities)
4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	4.a.1 Proportion of schools with access to... (e) basic drinking water, (f) single-sex basic sanitation facilities, and (g) basic handwashing facilities
3.8 Achieve universal health coverage (UHC), including financial risk protection, access to quality essential health care services, and access to safe, effective, quality and affordable essential medicines and vaccines for all	[Proportion of health care facilities with basic WASH services]

To meet the new SDG criteria for safely managed sanitation services, households must use an improved type of sanitation facility that is not shared with other households and the excreta produced must either be safely treated in situ, or transported and treated off-site.



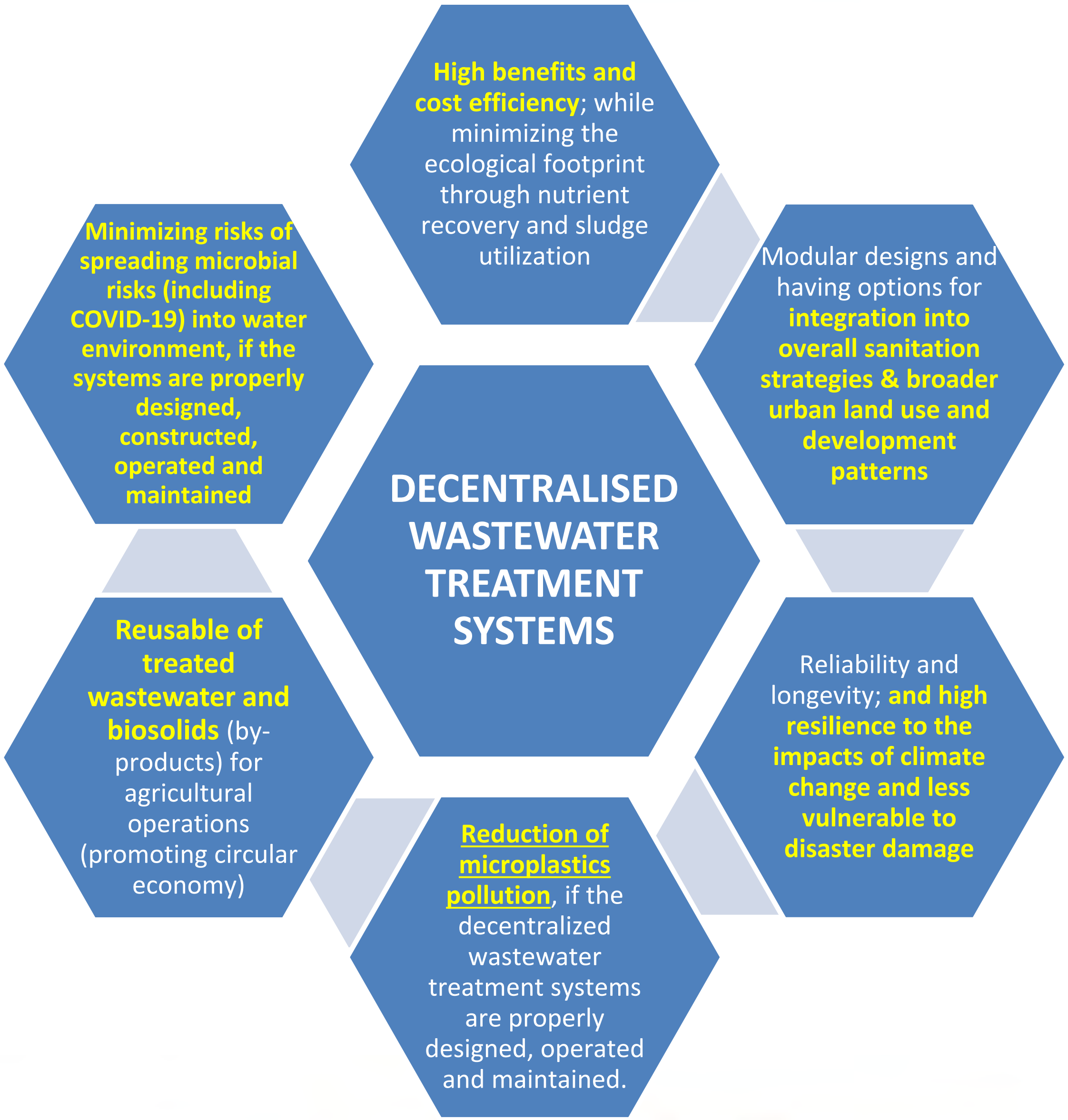
Centralized vs Decentralised Wastewater Treatment & Management Approach



Decentralised sanitation fills the gap between on-site and centralised sanitation options

(Source: BORDA, 2005)

Reasons for Choosing Decentralised Wastewater Treatment Systems



Benefits of Decentralised Wastewater Treatment Systems

Economic

- Low investment & time efficient
- Design works in multiple settings
- Incremental growth
- Sustainable revenue source

Social

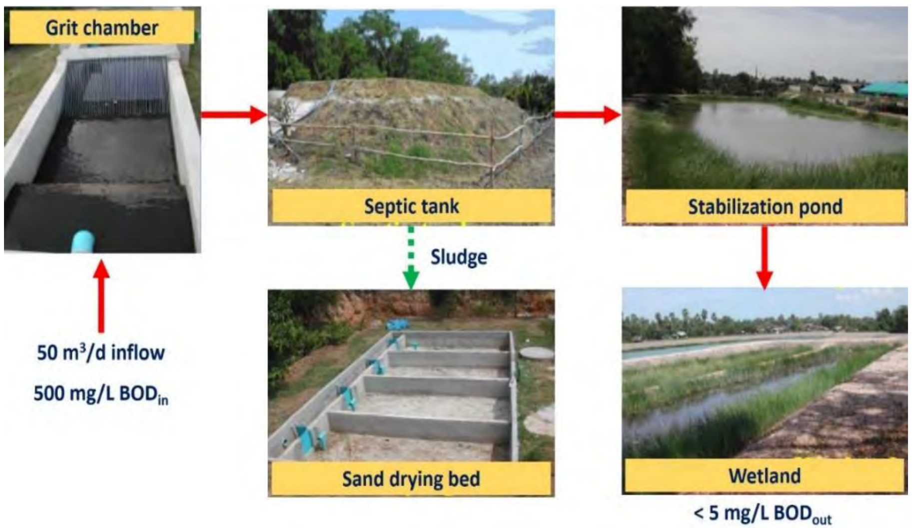
- Improved hygiene
- Opportunity for Public-Private Partnerships
- Opportunities for local to invest.
- Providing a range of low-cost solutions

Environmental

- Water quality improvement
- Reduction of marine plastic debris (microplastics)
- Reduces water needs
- Adaptable to discharge standards
- Water reuse and nutrient recovery opportunities
- High resilience to the impacts of climate change and less vulnerable to disaster damage
- Minimizing risks of spreading COVID-19 pandemic into water environment

Example of decentralised wastewater systems in Thailand

Typical decentralized treatment plants



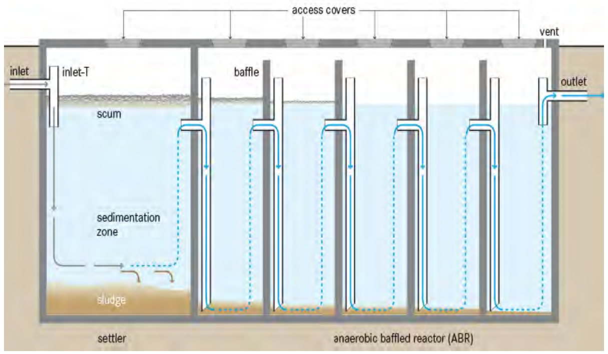
Clustered wastewater treatment system in a community in lakeside Songkhla Province, Thailand *(Nokyoo, 2019)*

An on-site treatment system established in Mae Sa, Chiang Mai Province, Thailand *(Nokyoo, 2019)*

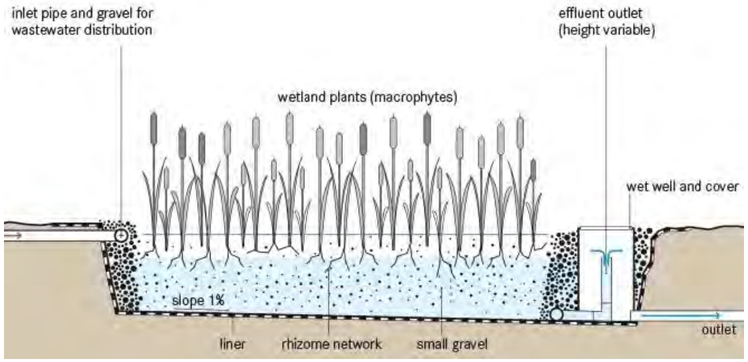
Example of decentralised wastewater systems in Vietnam

In Vietnam, a combination of the following is used for decentralized treatment

Anaerobic baffled reactor (ABR)

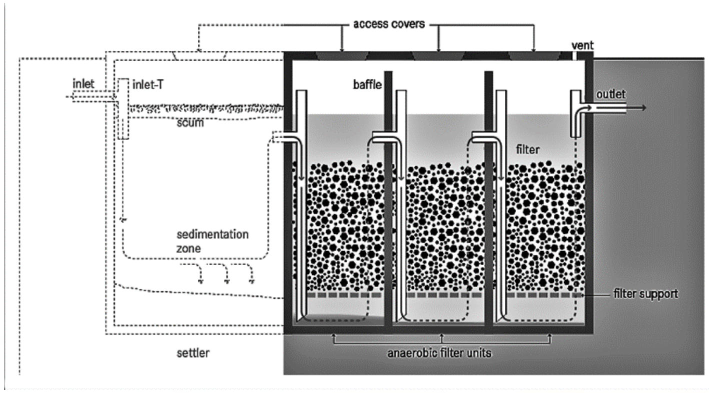


Horizontal gravel filter (HGF)



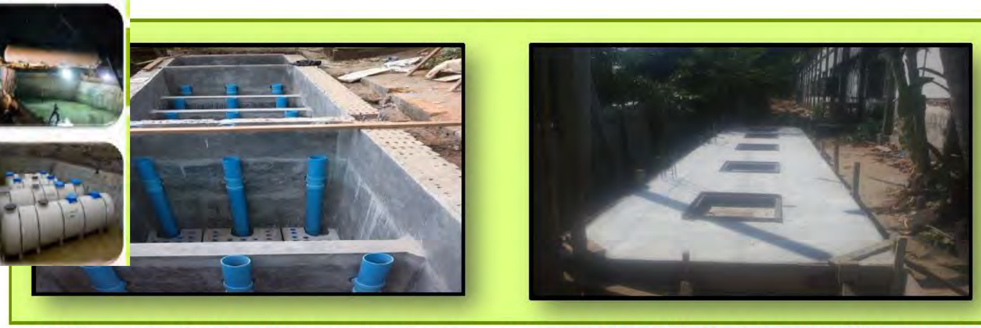
Polishing pond (PP)

Anaerobic filter (AF)



- ABR – AF – HGF : Kieu Ky Commune **Craft villa**ge, Bear Rescue Center **National Park**, Cam Thanh Primary **School**
- ABR – AF – PP : Khac Niem **Noodle Processing Village**, Viem Xa **Village**
- ABR – AF – HGF – PP : Ninh Khanh **Prison**, Thanh Hoa Pediatric **Hospital**, Ha Phong **Slaughterhouse**

Example of decentralised wastewater systems in Myanmar



(BORDA) Decentralization Wastewater Treatment System ($7 m^3$/day) at B.E.H.S (1)Tamwe, Yangon

Location – YCDC Officer Housing-Membrane Bio-Reactor System ($30 m^3$/day, $38 m^3$/day)

(Source: Thein Min, 2018)

Example of decentralised septage treatment systems in Thailand (Nonthaburi)

Sand beds

Effluent storage ponds

Final products (fertilizer to be sold to farmers and gardeners – 5 tons/month in average)

Anaerobic digestion tanks – 31 units

Disinfection techniques must be introduced at decentralized wastewater treatment facilities for effectively minimizing the risks of SARS-CoV-2 infection

- Appropriate disinfection techniques must be applied in the effluent of decentralised wastewater treatment facilities.

- Use of chlorine and chlorine dioxide have been proven to be effective for disinfection of SARS-CoV in wastewater. According to this study, a chlorine concentration of 10 mg/L was able to inactivate 100% of SARS-CoV with a contact time of 10 minutes, resulting in a residual chlorine level of 0.4 mg/L. On the other hand, a chlorine dioxide concentration of 40 mg/L was able to 100% inactivate SARS-CoV in 5 minutes of contact, with a free residual chlorine of 17.59 mg/L.

- Optimal doses should be identified for effectively inactivating SARS-CoV-2 without generating disinfection byproducts.

- For hospital wastewater, there are a number of commonly used disinfectants such as liquid chlorine, sodium hypochlorite, chlorine dioxide, ultraviolet radiation and ozone. The choice of appropriate technology will likely depend on various factors such as investment and operational costs, safety, wastewater volume, disinfectant supply and level of operational control.

Turning Challenges into Opportunities

- Stopping the Spread of COVID-19 Infections in Communities through Regular Virus Surveillance in Wastewater for COVID-19 -

Regular virus surveillance in wastewater for COVID-19

- Regular virus surveillance in wastewater has a long history of use and been considered a proven concept in public health, particularly for investigating the infection of enteric viruses (e.g. poliovirus, norovirus and enterovirus) and their genetic diversity in the human population

- This approach can overcome the limitations of traditional clinical surveillance, which is time-consuming, laborious and expensive. In addition, the clinical test cannot identify asymptomatic patients and so may underestimate the real scale of virus infection.

- Potential to use regular virus surveillance in wastewater as an early warning tool for the occurrence of COVID-19 in communities, monitoring the status of COVID-19 infection in local communities, evaluating the trends and tracking hotspots, revealing true scale of the coronavirus outbreak.

- Early warning of infection would provide valuable time for infected communities to implement actions to control the spread of COVID-19.

Challenges for Scaling up the Regular Virus Surveillance in Wastewater for COVID-19

A number of challenges or gaps have been identified and these challenges must be overcome for effective utilisation of this early-warning tool for stopping the spread of COVID-19 infections, including:

(i) Lack of access to testing facilities or laboratories for detection of SARS-CoV-2 in water/wastewater/sludge samples;

(ii) Lack of knowledge and scientific evidence on how SARS-CoV-2 behaves in wastewater and faecal sludge;

(iii) Unavailability of detailed technical guidance on monitoring in both sewered and non-sewered areas;

(iv) Lack of protocols or standard methodologies for sampling, collection, treatment, and examining the wastewater for the presence of SARS-CoV-2;

(v) Prohibitive costs; and finally

(vi) Inadequate collaboration between water/wastewater utilities and health authorities.

ご清聴ありがとうございました。

Thank you for your attention.

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