

# Institutionalising wastewater surveillance systems to minimise the impact of COVID-19: cases of Indonesia, Japan and Viet Nam

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## ABSTRACT

This mini review describes the current status and challenges regarding institutionalisation of wastewater surveillance systems against COVID-19. Monitoring SARS-CoV-2 in wastewater has been proposed to be a potential tool to understand the actual prevalence of COVID-19 in the community, and it could be an effective approach to monitor the trend during the COVID-19 pandemic. However, challenges to institutionalise wastewater surveillance systems are still abundant and unfolding at a rapid rate given that the international understanding regarding the scientific knowledge and socio-political impacts of COVID-19 are in the developing stages. To better understand the existing challenges and bottlenecks, a comparative study between Japan, Viet Nam, and Indonesia was carried out in the present study. Through gaining a better understanding of common issues as well as issues specific to each country, we hope to contribute to building a robust multistakeholder system to monitor SARS-CoV-2 in wastewater as an effective disease surveillance system for COVID-19.

**Key words** | COVID-19, Indonesia, institutionalisation, Japan, Viet Nam, wastewater surveillance system

## HIGHLIGHTS

- Governance of wastewater surveillance systems for COVID-19 in Indonesia, Japan and Viet Nam is discussed.
- Challenges and opportunities to institutionalise wastewater surveillance of COVID-19 are proposed.
- Although wastewater monitoring is contextualised to each locality, all countries will benefit from an international or regional network to exchange information and experiences.

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## STATE OF COVID-19 IN INDONESIA, JAPAN AND VIET NAM

On 31 December 2019, China reported an outbreak of pneumonia of unknown aetiology occurring in Wuhan (WHO 2020a). This disease caused by a novel coronavirus was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) on 11 February 2020 (WHO 2020b). On 2 March 2020, the coronavirus causing the outbreak was officially designated severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the *Coronaviridae Study Group of the International Committee on Taxonomy of Viruses* (2020). COVID-19 was declared a global pandemic on 11 March 2020 (WHO 2020c). As of 26 July 2020, there have been 15,785,641 confirmed cases including 640,016 deaths globally (WHO 2020d).

Table 1 shows cases of COVID-19 in Indonesia, Japan and Viet Nam as of 26 July 2020. In each country, testing for COVID-19 has been performed in less than 1% of the total population. Considering that some individuals are tested multiple times, it is expected that the actual number of people tested is lower than the number of cases tested. For example in Japan, the number of people tested (606,403) is 61% of the total number of cases tested (999,883), and comprises 0.5% of the total population.

### WASTEWATER SURVEILLANCE OF COVID-19

An estimated 18–31% of SARS-CoV-2-infected individuals within a population are likely to be asymptomatic (Mizumoto *et al.* 2020, Nishiura *et al.* 2020), but nevertheless

still carry and contribute to the spread of the virus. This makes it difficult to ascertain the actual degree of viral circulation in a community based on clinical testing of symptomatic patients. Meanwhile, as asymptomatic patients can also excrete SARS-CoV-2 in faeces (Tang *et al.* 2020), wastewater surveillance could potentially provide a method of evaluating the spread of infection in a community, even where resources for clinical diagnosis and reporting are limited or unavailable. Moreover, wastewater monitoring can help to understand variations in strains of the virus through nucleotide sequencing and phylogenetic analysis, allowing for comparisons between geographic locations and helping to track the evolution of the viral genome over time (Nemudryi *et al.* 2020). Wastewater surveillance can thus be useful as an indication of whether the introduction or reintroduction of SARS-CoV-2 or other novel viruses has occurred in a community, or to evaluate the effectiveness of public health interventions (Kitajima *et al.* 2020).

### WASTEWATER MANAGEMENT IN INDONESIA, JAPAN AND VIET NAM

Service coverage rates (shown here as percentage of population) of centralised wastewater treatment systems and decentralised or on-site wastewater systems are shown in Table 2. These were the three categories of wastewater we considered for monitoring the spread of COVID-19.

**Table 1** | Reported cases of COVID-19 in Indonesia, Japan and Viet Nam (date of COVID-19 information in brackets)

Parameters	Indonesia (26 July 2020)	Japan (26 July 2020)	Viet Nam (30 July 2020)
Total population <sup>a</sup>	273,523,621	126,476,458	97,401,417
First case reported <sup>b</sup>	2 March 2020	15 January 2020	24 January 2020
Cases of COVID-19 testing	796,950 (cases tested) <sup>c</sup>	1,001,178 (cases tested) 606,403 (persons tested) (0.5% of population) <sup>d</sup>	449,564 (cases tested) <sup>e</sup>
Confirmed cases of COVID-19	97,286 (12.0% of cases tested) <sup>b</sup>	30,426 <sup>d</sup> (4.1% of cases tested)	450 (0.1% of cases tested) <sup>e</sup>
Deaths by COVID-19	4,714 (4.8% of COVID-19 cases) <sup>b</sup>	995 <sup>d</sup> (3.4% of COVID-19 cases)	0 (0% of COVID-19 cases) <sup>e</sup>

<sup>a</sup>Source: UN DESA (2020).

<sup>b</sup>Source: WHO (2020d).

<sup>c</sup>Source: Our World in Data (2020).

<sup>d</sup>Source: MHLW Japan (2020).

<sup>e</sup>Source: MoH Viet Nam (2020).

**Table 2** | State of wastewater treatment in each country (year of data in brackets)

Country	Service coverage rate of centralised wastewater treatment systems	Service coverage rate of decentralised/on-site systems	No wastewater treatment	References
Indonesia	0.5% (2017)	76.4% (2017)	23.1% <sup>a</sup>	Perkasa (2018)
Japan	75.8% (2018)	24.1% (2018)	0.1% (2018)	MoE Japan (2020)
Viet Nam	12.5% (2019)	50% (2012)	37.5% <sup>a</sup>	World Bank (2019)

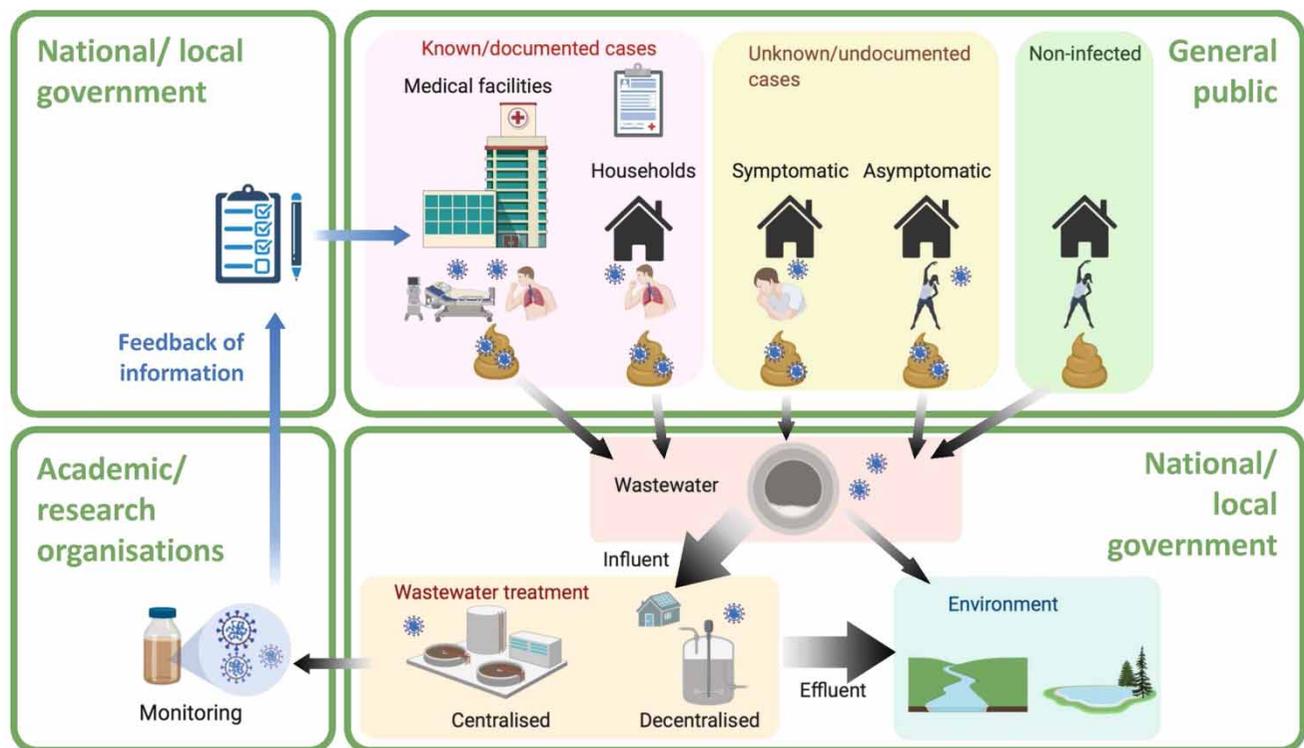
<sup>a</sup>Calculated by subtracting centralised and decentralised service coverage rates from 100%.

Figure 1 shows that raw domestic wastewater comes from three groups in the population: (i) known or documented cases of COVID-19, (ii) unknown or undocumented cases of COVID-19, and (iii) the non-infected. Wastewater flows into either a centralised treatment system or a decentralised system, or is discharged into the environment without any treatment. In the case of centralised wastewater treatment systems, it is possible to collect and monitor influent and effluent samples given the local authorities agree, with information fed back into society via national or local governments (Kitajima *et al.* 2020). Decentralised wastewater systems would be challenging to monitor, as it would be a resource-intensive process to collect samples from each household or facility. A possible solution would be to analyse sludge samples from the sludge treatment

plants where septage or sludge from the decentralised systems are taken.

Untreated wastewater is an even greater challenge to monitor, and would require a whole-of-community approach to find a solution which best addresses the needs and risks of the community.

It is important to note that although decentralised treatment or untreated wastewater constitutes a larger challenge than centralised systems, communities with decentralised treatment or untreated wastewater may also have the most to gain from wastewater surveillance systems. These communities include informal settlements, evacuation shelters, and refugee camps, and in many cases face socio-economic challenges such as availability or affordability of clinical testing, in addition to being

**Figure 1** | Overview of proposed wastewater surveillance systems for COVID-19.

disproportionately affected by the health and economic risks (UNDP 2020).

## STAKEHOLDERS FOR WASTEWATER MONITORING

Various stakeholders need to be involved in the cycle of a monitoring framework, which includes the sampling, analysis, information feedback and any subsequent action or decision-making. Table 3 shows the stakeholders responsible for each process. The Committee of COVID-19 Handling and National Economy Recovery in Indonesia is placed directly under the President, and has the authority to issue binding instructions to ministries. The Cabinet Office (CAO) of Japan is directly managed by the Prime Minister. The National Steering Committee for COVID-19 Prevention and Control in Vietnam was established by the Decision of the Prime Minister on 30 January 2020 and is headed by a Deputy Prime Minister. In Japan and Viet Nam, the jurisdiction of centralised and decentralised wastewater treatment systems falls under different ministries. The actual implementation and operation of wastewater treatment systems as well as COVID-19 countermeasures are managed by local governments in all countries. The analysis of samples and development of technological solutions including monitoring equipment are mainly carried out by academic/research institutions and private sectors.

Therefore, it is critical to involve all agencies when building a national platform for wastewater surveillance systems. Furthermore, special care needs to be taken that the views of the disproportionately affected, including women (UN 2020), LGBTI (lesbian, gay, binary, transexual and intersex) people (OHCHR 2020), youth and children, and persons with disabilities (UNDP 2020), are taken into consideration when institutionalising such systems, for example through a consultative process to ensure that their rights and needs are not neglected, including their right to education.

## CHALLENGES AND OPPORTUNITIES

Based on informal consultations with various stakeholders in each of the case study countries, challenges and opportunities for institutionalising wastewater surveillance systems for COVID-19 are listed in Table 4. This is not an exhaustive list, and does not reflect official views of any of the governments involved.

## RECOMMENDATIONS

Multiple challenges exist before such wastewater surveillance systems can be formally institutionalised, or woven into the governance fabric at national or local government levels.

**Table 3** | Main entities responsible for each field related to wastewater surveillance systems for COVID-19 in each country

Responsibility	Indonesia	Japan	Viet Nam
Overall coordination of COVID-19 countermeasures	The Committee of COVID-19 Handling and National Economy Recovery <sup>a</sup>	Cabinet Office	The National Steering Committee for COVID-19 Prevention and Control
Public health	Ministry of Health	Ministry of Health, Labour and Welfare (MHLW)	Ministry of Health (MoH)
Wastewater treatment (centralised)	Ministry of Public Works and Human Settlement (KeMenPUPR)	Ministry of Land, Infrastructure, Transport and Tourism	Ministry of Construction
Wastewater treatment (decentralised)	KeMenPUPR	Ministry of the Environment (MoE)	Ministry of Natural Resources and Environment (MoNRE)
Environmental water management	Ministry of Environment and Forestry	MoE	MoNRE
Implementation of countermeasures	Local governments	Local governments	Local governments
Analysis of samples, development of technological solutions	Academic/research institutions, public sector	Academic/research institutions, public sector	Academic/research institutions, public sector/private sector

<sup>a</sup>Source: Government of the Republic of Indonesia (2020).

**Table 4** | Governance challenges and opportunities

Governance level	Challenges	Good practices or opportunities identified
National government	<ul style="list-style-type: none"> <li>• Siloed governmental/budget structure restricting cross-cutting collaboration</li> </ul>	<ul style="list-style-type: none"> <li>• Mandate coordination by overarching government entity (e.g., organisations directly under the head of state)</li> </ul>
National and local government	<ul style="list-style-type: none"> <li>• Lack of political will</li> <li>• Difficulty in legislating new procedures due to lengthy legislative processes depending on physical contact/documents</li> <li>• Difficulty in accessing different finance mechanisms for pandemic prevention and response</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness raising towards decision-makers</li> <li>• Information sharing at international/regional levels</li> <li>• Digitise legislative processes while taking into account security concerns</li> <li>• Establish flexible budget which can be used both for response (monitoring during pandemic) and prevention (early warning)</li> </ul>
Local government	<ul style="list-style-type: none"> <li>• Limited human/financial resources</li> <li>• Lack of appropriate tools, knowledge and guidelines</li> <li>• Fear of negative reaction by public/mass media against detection of SARS-CoV-2 in wastewater leading to disinclination towards monitoring/information disclosure</li> </ul>	<ul style="list-style-type: none"> <li>• Cross-organisational collaboration to share the burden between organisations/individuals with too much/too little work as a result of COVID-19</li> <li>• Education/awareness raising of public/mass media</li> <li>• Have robust communication policy/framework in place</li> </ul>
Academic/research institutions, private sector	<ul style="list-style-type: none"> <li>• Limited human/ financial resources</li> <li>• Lack of effective coordination</li> <li>• Administrative challenges</li> <li>• Peer competition leading to non-disclosure of information until publication/patent</li> </ul>	<ul style="list-style-type: none"> <li>• Cross-organisational collaboration to share the burden between organisations/individuals with too much work and those with too little work as a result of COVID-19</li> <li>• Diverse financing mechanisms to support needs</li> <li>• Incentivise sharing of outputs with high social benefit</li> <li>• Creation of an overarching platform at international/regional levels to share information</li> </ul>
Civil society	<ul style="list-style-type: none"> <li>• Limited formal mechanisms for inclusive decision-making</li> <li>• Lack of effective coordination, weak financial base, lack of transparency, and lack of commitment</li> </ul>	<ul style="list-style-type: none"> <li>• Formalise inclusive processes during institutionalisation</li> <li>• Sharing of good practices regarding inclusivity at international/regional levels</li> </ul>

Based on the preceding discussion, the following recommendations are proposed as a way forward in institutionalising wastewater surveillance as a tool to reduce risks from COVID-19 in Indonesia, Japan and Viet Nam.

- Build a multi-country or regional platform to exchange information and experiences, including discussion of post-pandemic collaboration.
- Develop a national platform for multistakeholder coordination and collaboration, especially including disproportionately affected communities and groups as active agents.

- Cultivate an environment of sharing knowledge and information across various stakeholders.

This study will benefit from further research into more countries with diverse backgrounds, as well as case studies at local levels.

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## DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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