25es journées annuelles de santé publique

Review of the Concept and Notions of the Usefulness and Feasibility of SARS-CoV-2 Wastewater Surveillance

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Presentation outline

- Notion and concept
- Analytical methods
- Interest
- Conditions for success
- Limits

Concept of virus surveillance in wastewater

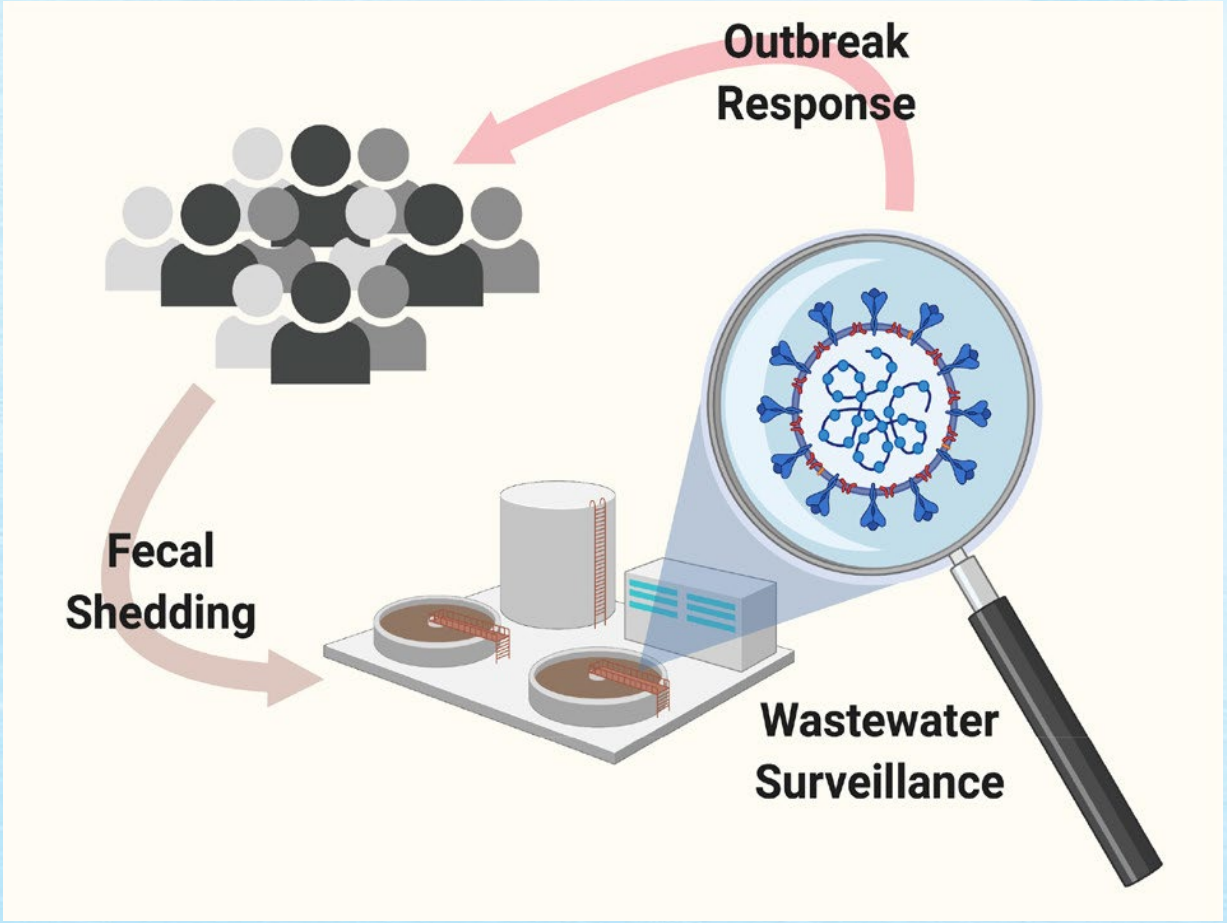
- Notion of "**early surveillance or monitoring** " :
  - Process for identifying and characterizing health threats to the population
  - Detect as early as possible
  - Alert public health authorities so they can take action

- Concept of **surveillance** :
  - Continuous process of assessing the health status of a population
  - On a long time cycle (annual)
  - To inform the population about health and its determinants
  - To inform the decision making of public health authorities

https://publications.msss.gouv.qc.ca/msss/fichiers/2014/14-268-01W.pdf

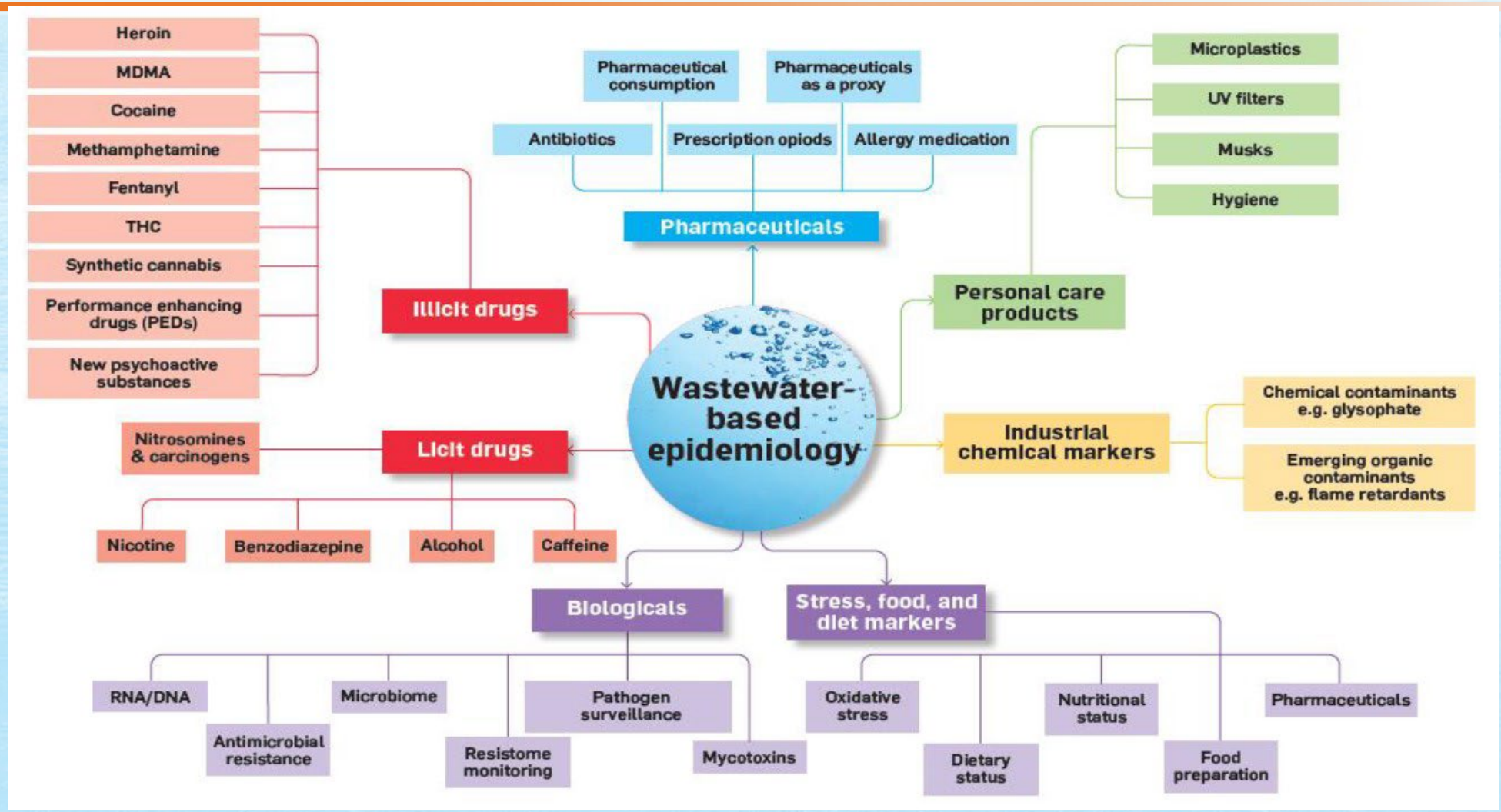
Concept of **virus surveillance in wastewater**

- Enteric and non-enteric viruses **excreted in stool and urine**
- Use wastewater as **a composite sample of a community or population** served by a wastewater system
- Determine when **a new virus enters a population** before clinical identification
- **Provide timely information** on the prevalence of a viral disease or the utility of an intervention
- **A rapidly expanding field** that goes beyond viruses (resistant genes, pharmaceuticals, drugs…)



Bivins, A., et al. (2020). Wastewater-based epidemiology: global collaborative to maximize contributions in the fight against COVID-19

Applications beyond viruses

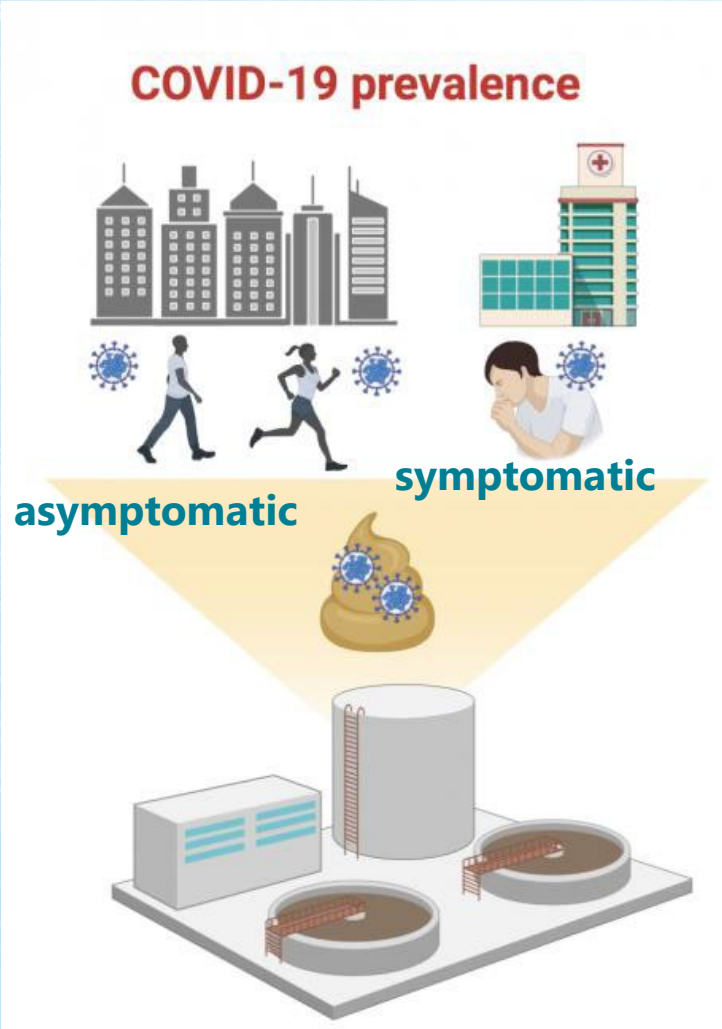


Manning S, Walton M. 2020b. Summary of Findings: Ethical and Responsible Development of Wastewater-based Epidemiology Technologies. Wengton: Institute of Environmental Science and Research Ltd. lli

Why can we track the SARS-CoV-2 virus in wastewater?

1. **Important excretion of SARS-CoV-2 via different routes including stool**

- About 50% of people, symptomatic or not, shed the virus in their stool
- *Estimated concentrations range from 10^5 to 10^9 RNA units per gram of feces*
- *Duration of shedding in the stool up to 22 days after the disappearance of respiratory symptoms*

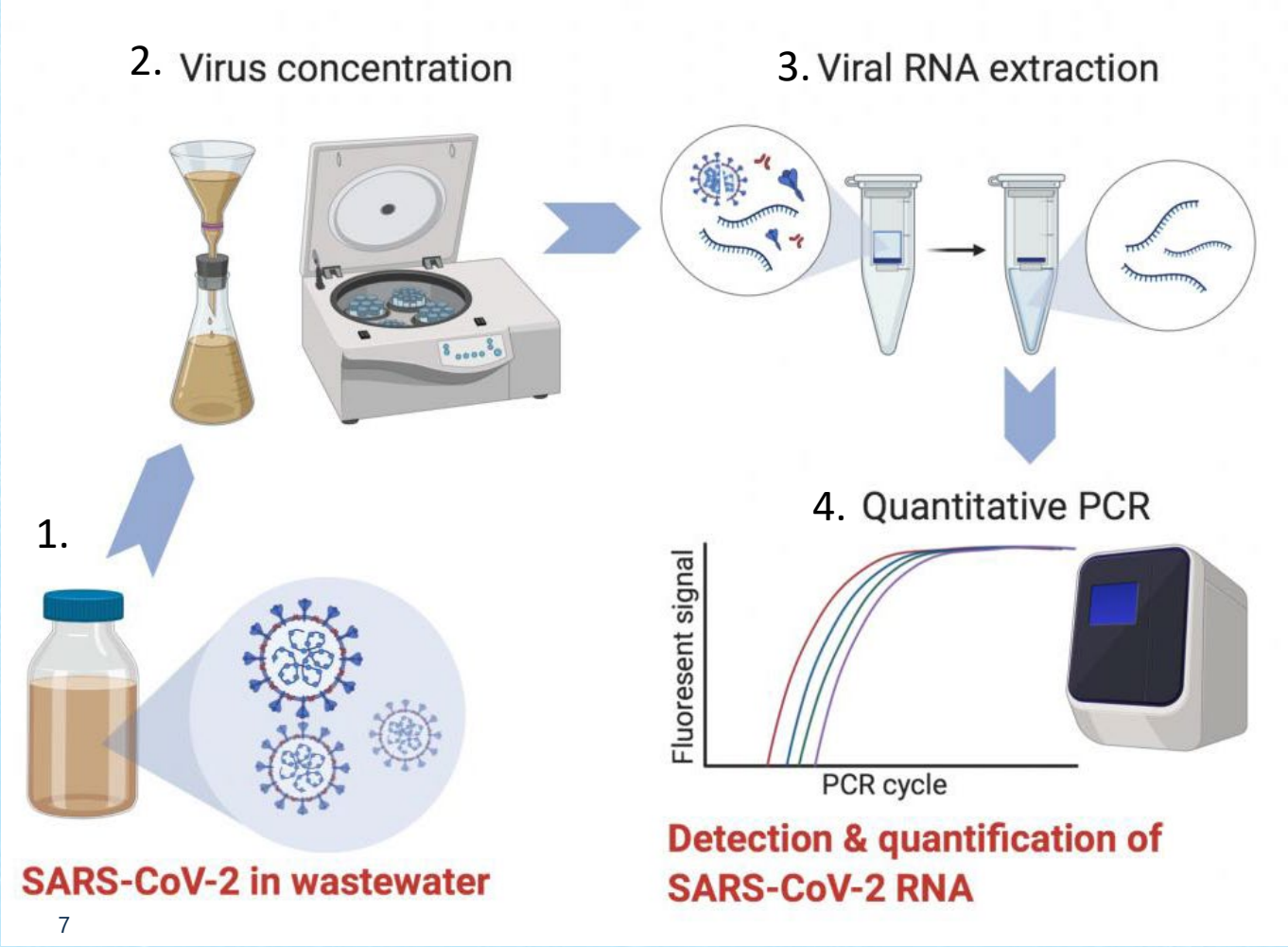


2. **Variability of symptoms within the population**

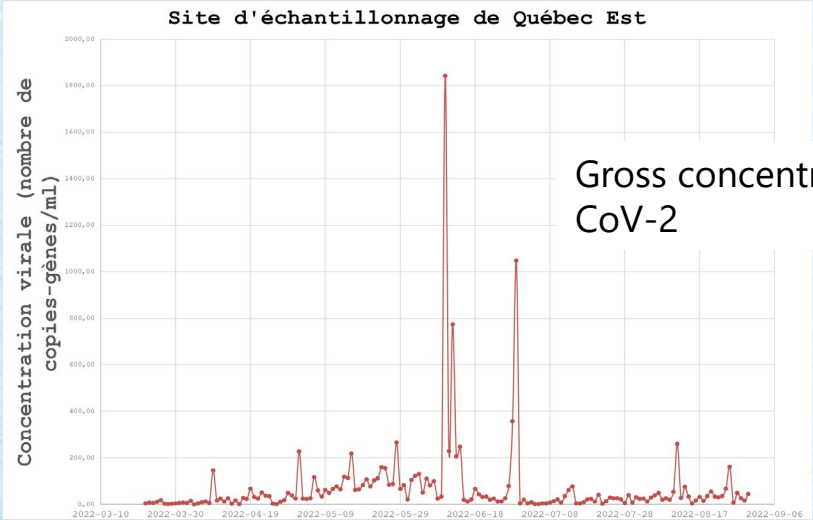
- *Between 20 and 45% of infected people may be asymptomatic*
- *Gastrointestinal symptoms appear at an early stage of infection (before respiratory symptoms)*

3. **Detectable days and weeks in wastewater under certain conditions**

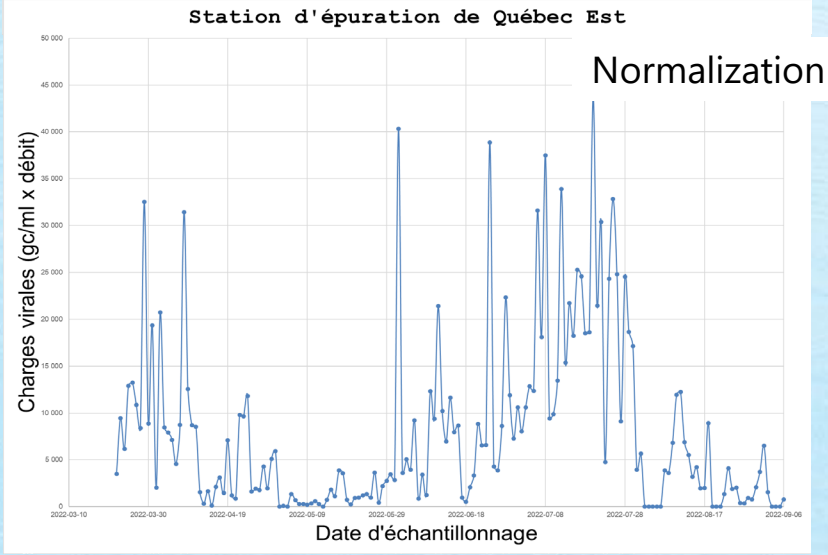
Analytical methods for SARS-CoV-2 in wastewater



Analysis and quantitative interpretation



Gross concentration of SARS-CoV-2



Normalization of raw signal

According to INSPQ 2022

Growing interest in surveillance of SRAS-CoV-2 in wastewater

The context

- Limiting access to individual PCR testing for SARS-CoV-2
- Rapid antigenic tests and self-management of the disease by the population
- Difficulty in accurately assessing the epidemiological situation in the community
- Need for additional information to guide public health decisions
- How can we measure the progression or regression of the virus in the population?

Interest for surveillance of SRAS-CoV-2 in wastewater

- Non-invasive approach
- Can identify the infected population before apparent respiratory symptoms
- Detects asymptomatic cases
- Overview of the infected population
- Is complementary to epidemiological indicators
- Monitors trends in virus circulation in the population
- Low-cost alert system for identifying new outbreaks

Recommendations from international health organizations

- Recommendations, guidelines, or documentation for the implementation of a SARS-CoV-2 wastewater surveillance system
  - World Health Organization (WHO)
  - Centers for Disease Control and Prevention (CDC)
  - European Commission (EU)
  - Public health agencies around the world

State of knowledge on the subject (INSPQ)

- To provide a state-of-the-art assessment on the feasibility and usefulness of monitoring SARS-CoV-2 in wastewater Systematized methodology
  - Literature review from November 2019 to February 2021
  - 12 primary studies and 1 literature review
  - Quality assessment of studies
  - 2nd literature review in progress: update of the literature (February 2021 to March 2022)

https://www.inspq.qc.ca/publications/3194-faisabilite-utilite-surveillance-covid-19-monitorage-eaux-usees

Public health uses of SARS-CoV-2 wastewater data

- Monitor and verify **trends** in the virus and its variants
- Provide **early warning signals**
- Serves as a **complementary** and **independent** tool to other health indicators
- Can be used especially when **general population screening is poorly deployed or used**
- **Facilitate**s the deployment of appropriate response measures in a timely manner
- Is a source of information for **people making their own health decisions**

https://www.inspq.qc.ca/publications/3194-faisabilite-utilite-surveillance-covid-19-monitorage-eaux-usees

A few conditions for success

- Should preferably include a high sampling frequency that can adapt to the epidemiological situation in the population
- Prioritize internal quality assurance and quality control (QA/QC) processes in laboratory analysis
- Use a quick, easy normalization process to improve quantitative relationships between wastewater data and epidemiological data
- Have a quick turnaround time and well-controlled logistics to generate usable results in a timely manner
- Continue to collaborate with various international experts in the field to improve data analysis and interpretation
- Promote knowledge translation to public health professionals and physicians for the appropriation and use of data

https://www.inspq.qc.ca/publications/3194-faisabilite-utilite-surveillance-covid-19-monitorage-eaux-usees

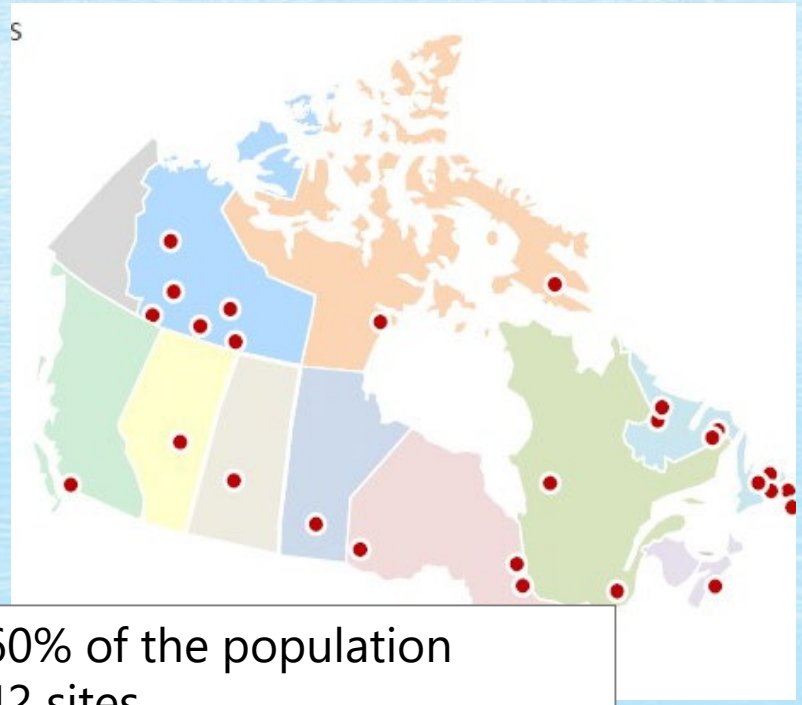
Some limits

- Results influenced by variability in wastewater data
- Some parameters are still unknown
- Currently, there does not seem to be an ideal standardization process
- Early detection requires good sampling, analysis, and data processing, which to this day still represents a significant logistical challenge
- Indicator that could lag behind a decline in the infection rate in the population
- The level of sensitivity of the signal detection varies between laboratories
- Current uncertainties make it impossible to use wastewater data to estimate the number of infected people in the population
- Further optimize intersectional collaborations and develop effective technology platforms that improve data sharing

https://www.inspq.qc.ca/publications/3194-faisabilite-utilite-surveillance-covid-19-monitorage-eaux-usees

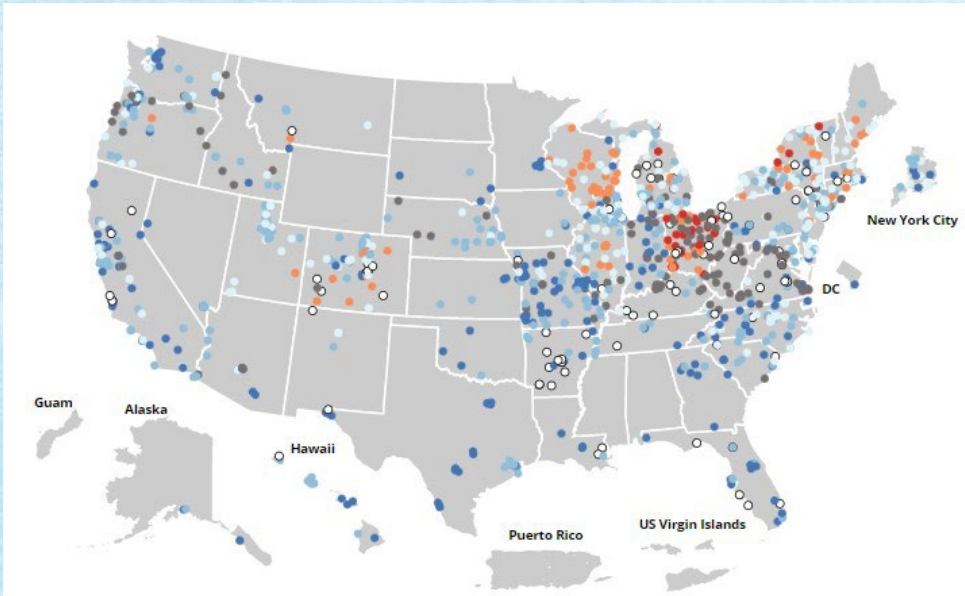
Examples of applications around the world

Canada-wide Wastewater Surveillance Network



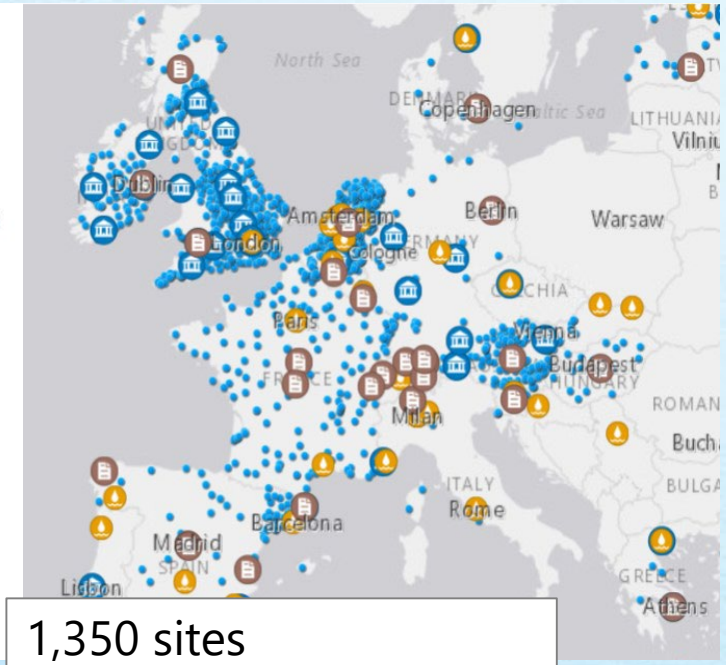
60% of the population
42 sites
9 provinces
Federal/provincial/territorial/ academic

National Wastewater Surveillance System



40% of the population
1,250 sites
46 states
Federal/state/territorial/ academic

European Union Wastewater Monitoring System



1,350 sites
27 countries
governmental/academic

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Thank you and happy training!