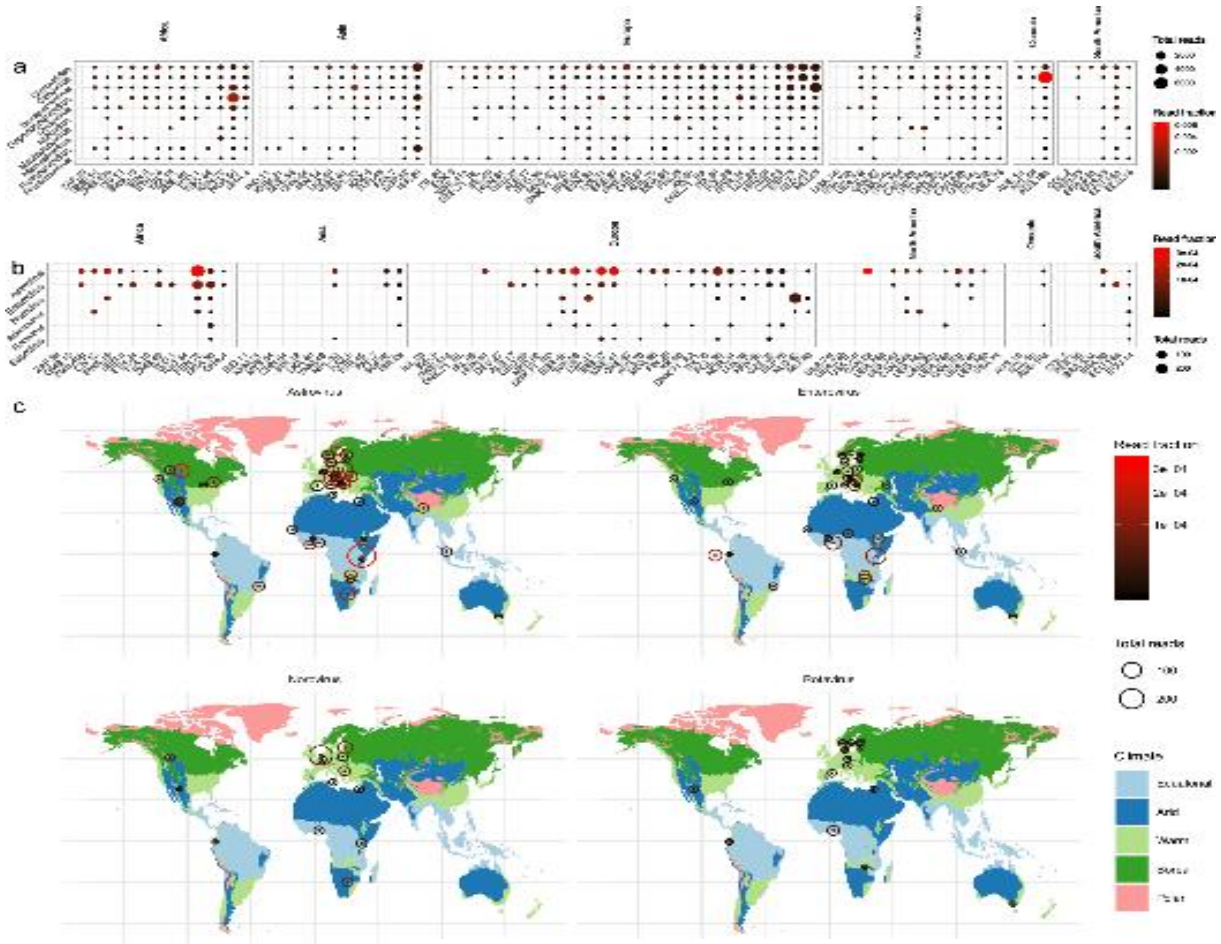
PANDEMIC & DISASTER Preparedness Center (PDPC)

Metagenomic “catch-all’’ techniques

PANDEMIC & DISASTER Preparedness Center (PDPC)

Global (vertebrate) virome via wastewater

- Rationale: urban amplification of rare zoonotic spillovers
- 62 countries
- Easy to see the virus ‘haystack’, need to go ‘deep’
- Challenge: from sequence to interpretation of risk



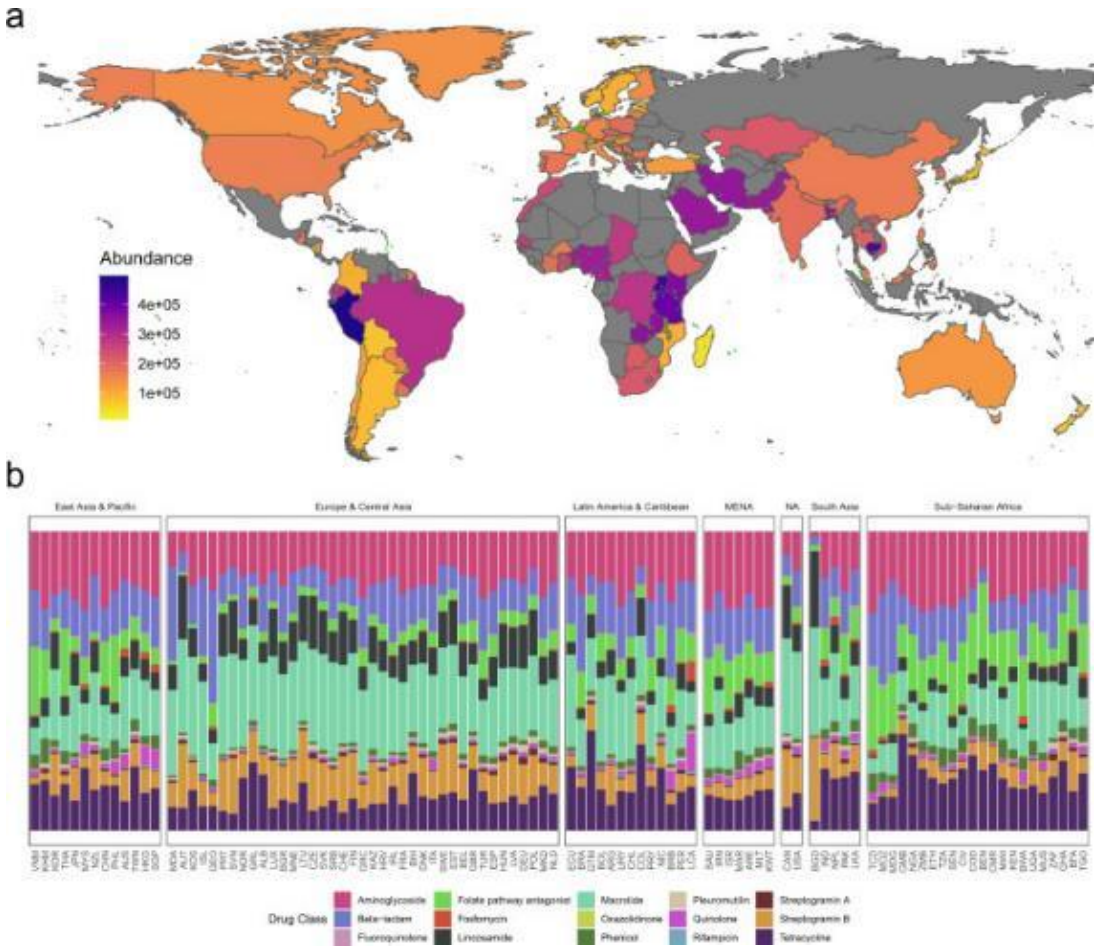
Nieuwenhuijse et al, Sci Rep. 2020; 10(1):13748

Metagenomic “catch-all’’ techniques

PANDEMIC & DISASTER Preparedness Center (PDPC)

Global resistome via wastewater

- Rationale: comparative surveillance, effect of interventions, priorities
- Multiyear, 107 countries
- Resistome is stable over time
- Regional differences
- ARG are mobile

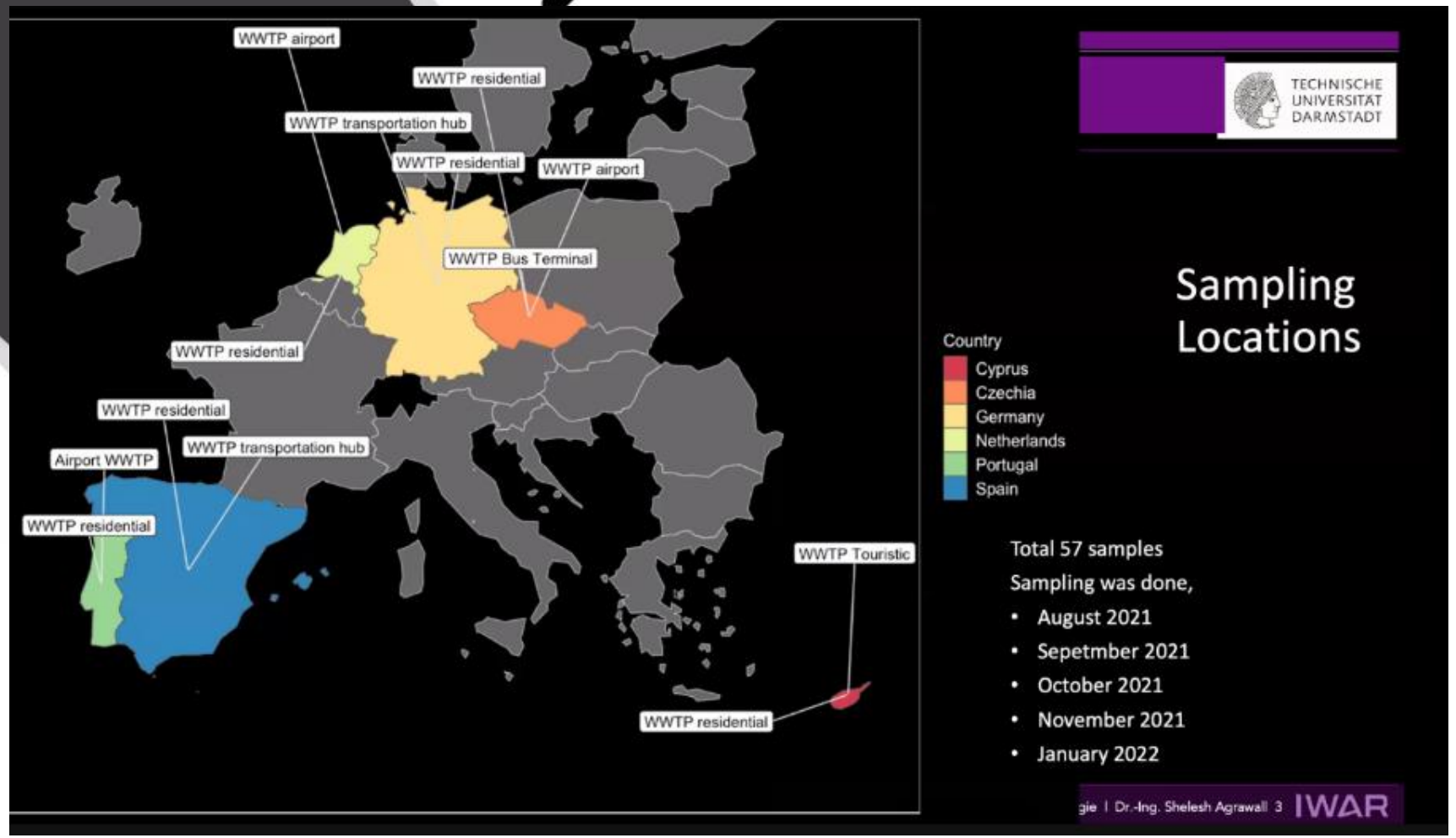


Munk et al, Nat Commun. 2022; 13: 7251

Supersites

Does Wastewater surveillance of Supersites reveal different story compared to the city ?

PANDEMIC & DISASTER Preparedness Center (PDPC)



Omicron via air travel

AMERICAN SOCIETY FOR MICROBIOLOGY | Microbiology Resource Announcements

OMICS DATA SETS

Genome Sequencing of Wastewater Confirms the Arrival of the SARS-CoV-2 Omicron Variant at Frankfurt Airport but Limited Spread in the City of Frankfurt, Germany, in November 2021

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[a]Technical University of Darmstadt, Department of Civil and Environmental Engineering Sciences, Institute IWAR, Chair of Water and Environmental Biotechnology, Darmstadt, Germany

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[c]Life Technologies, Darmstadt, Germany

ABSTRACT Wastewater-based severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) surveillance of Frankfurt Airport by genome sequencing was used to detect SARS-CoV-2 variants entering the region. In November 2021, we found all characteristic mutations of Omicron in wastewater originating from Frankfurt Airport before the first confirmed clinical report from an arriving passenger on 26 November 2021.

Omicron via air travel

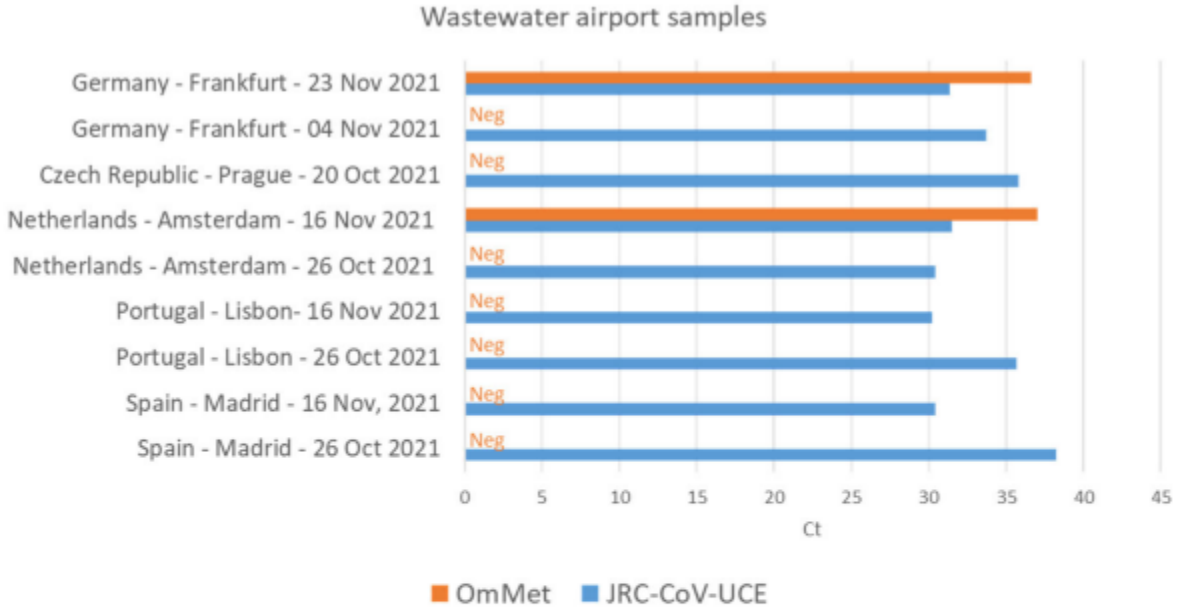
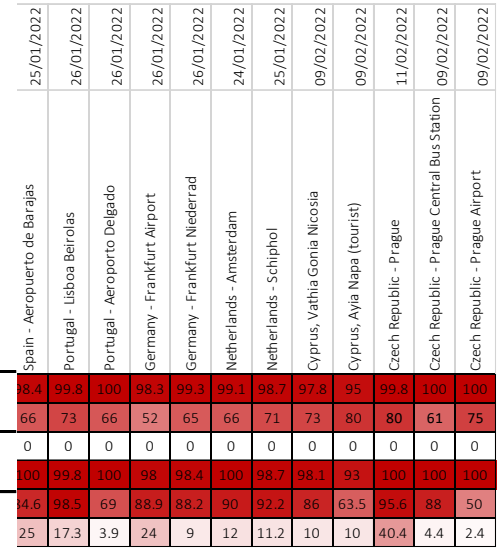


Figure 6. Early detection of Omicron in airport wastewater samples. Samples from the indicated airports were analyzed by RT-PCR with both the JRC-CoV-UCE and the Omicron-specific OmMet [22] assays. SARS-CoV-2 (most likely the Delta variant, which was highly predominant at that time) was identified in all of the samples while Omicron was only detected at lower concentrations (higher Ct numbers) in two samples from airports in Frankfurt and Amsterdam from the middle and end of November 2021. The presence of Omicron was confirmed by genome sequencing [44]. Neg: no detection of Omicron by using the OmMet assay.

Marchini et al 2023, Viruses

Sample site	Netherlands - Schiphol	Netherlands - Amsterdam	Germany - Frankfurt Niederrad	Germany - Frankfurt Airport
Sample date	16/11/2021	16/11/2021	23/11/2021	23/11/2021
G339D (%)	2.8	0	0	2.9
N856K (%)	0	0	0	0
N501Y (%)	0	0	0	0
K417N (%)	0	0.9	0	0
Del69-70 (%)	24	0.9	0.5	4
LPPA24S (%)				



Schiphol & Frankfurt: 3 days before first omicron positive clinical sample

PDPC Frontrunner projects

PANDEMIC & DISASTER Preparedness Center (PDPC)

1. Climate change and increased risks of vector-borne virus outbreaks
2. Airborne: Predicting, measuring and quantifying airborne virus transmission
3. Pandemic lessons for flood disaster preparedness
4. Towards social and urban resilience for pandemics and disasters
5. Integrated early warning surveillance methods and tools

Frontrunner INSPECT

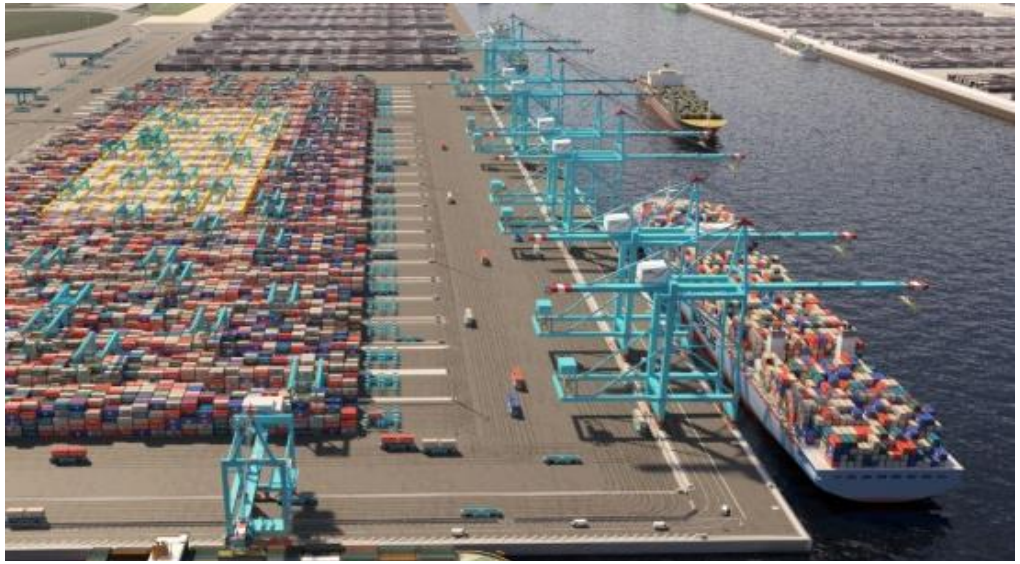
International Network Surveillance for Pandemic EmergenCe via Transport hubs

PANDEMIC & DISASTER Preparedness Center (PDPC)

- Intelligent One Health system for early warning

- identify critical nodes in the complex global transport of people, animals and goods for the import of new disease agents

- target these with an innovative early warning surveillance tools. The tools we envisage are rapidly deployable and combine the power of bioinformatics, innovative sampling and detection methods, network data analytics and social media data mining.



Frontrunner INSPECT

International Network Surveillance for Pandemic EmergenCe via Transport hubs

PANDEMIC & DISASTER Preparedness Center (PDPC)

- WP1. NL as hub in the global network: map and categorize pandemic risk sources and routes
- WP2. Refine and evaluate targeted detection of (zoonotic) viruses and emerging ‘sequences-of-concern’ in environmental surveillance of transport and trade hubs
- WP3. Living lab: intelligent pandemic One Health surveillance in the Port of Rotterdam and Schiphol airport

Erasmus MC

GGD Rotterdam-Rijnmond

WAGENINGEN UNIVERSITY & RESEARCH

ERASMUS UNIVERSITEIT ROTTERDAM

TU Delft

Port of Rotterdam

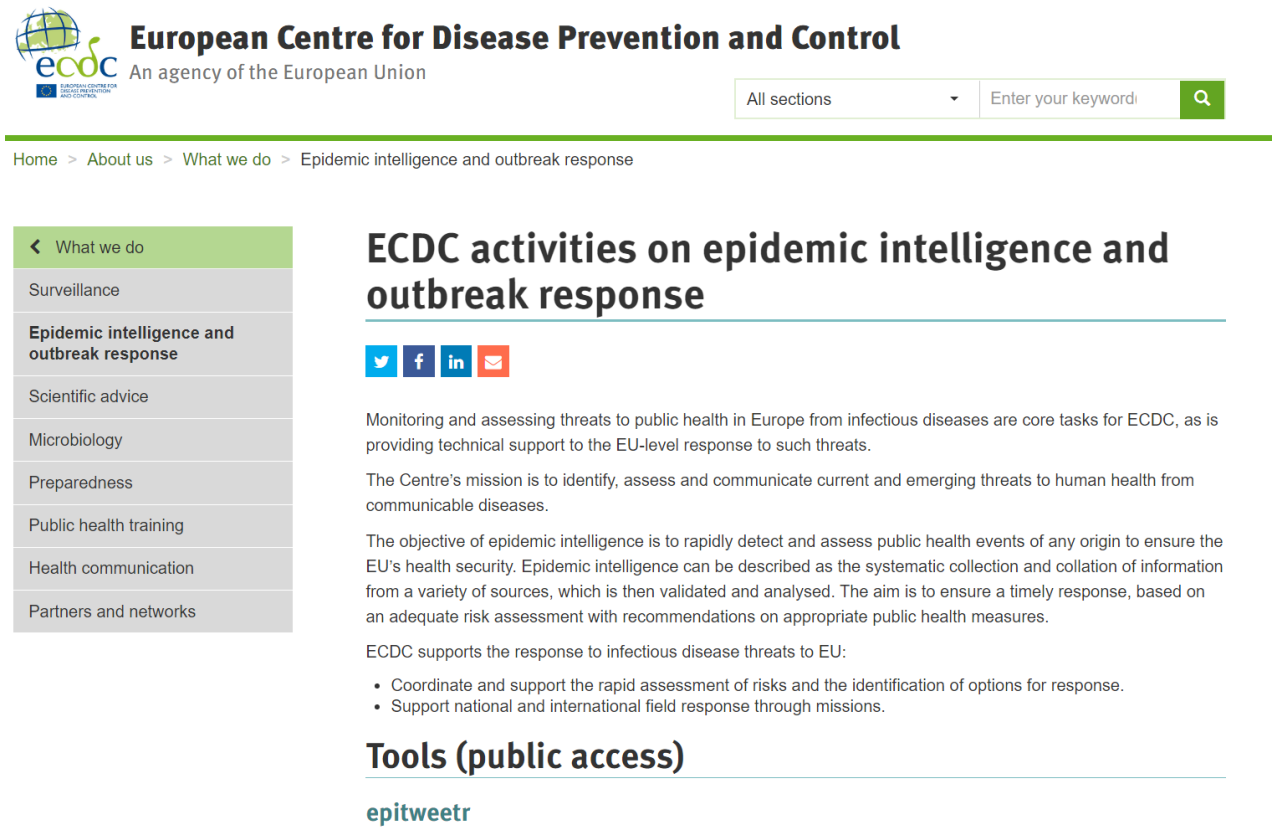
KWR

Early warning for new emerging viruses

PANDEMIC & DISASTER Preparedness Center (PDPC)

Create/combine:

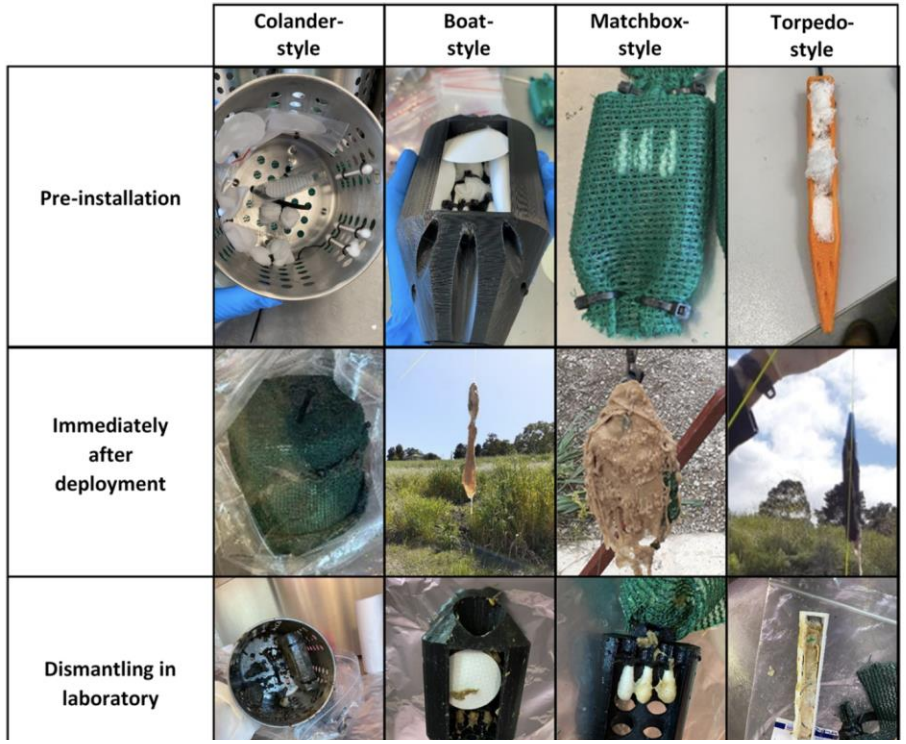
- Epidemic intelligence
- Metagenomic intelligence
- Transport network intelligence
- Environmental surveillance tools



Early warning for new emerging viruses

PANDEMIC & DISASTER Preparedness Center (PDPC)

Develop and validate rapidly deployable sampling and analytical/bioinformatic methods for targeted detection and evaluation of emerging viruses and ‘sequences-of-concern’.



- Targeted techniques:
  - q/dPCR for known viruses (variants)
  - Virus panels
- Semi-targeted techniques:
  - Target enrichment of ‘pandemic virus families’ (i.e. coronaviridae)
  - Target enrichment of human viruses
- Non-targeted

Chang et al, 2021

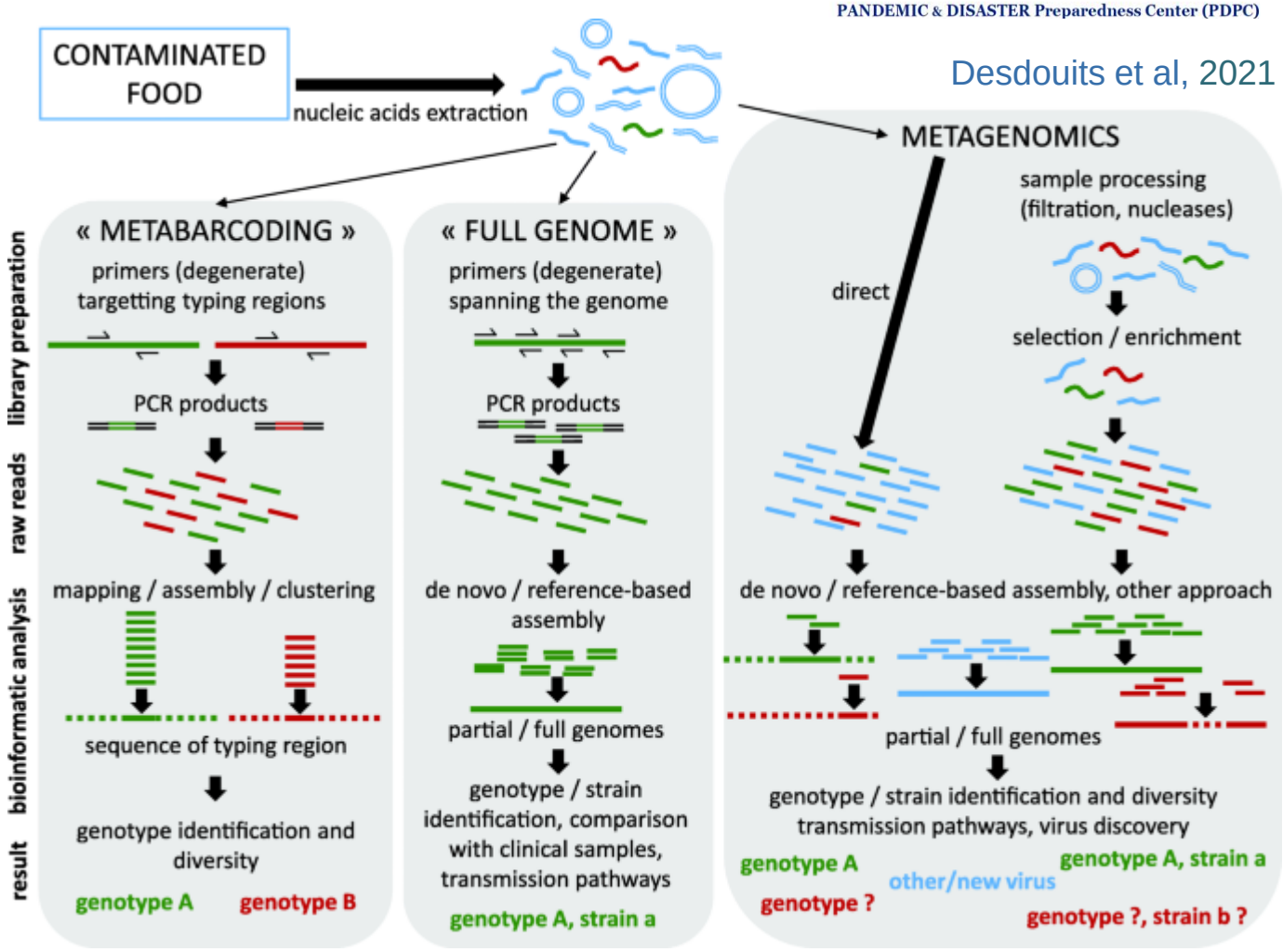
Early warning for new emerging viruses

PANDEMIC & DISASTER Preparedness Center (PDPC)

Metaviromics and bioinformatics

Explore approach developed for food testing

Desdouits et al, 2021



“Sequences of concern”

Which viruses?

- enteric (norovirus/enterovirus)
- respiratory (influenza)

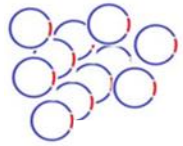
When should viruses be tested

- mutations in binding domains
- mutations in antigenic domains

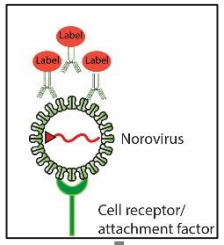
Which phenotypical assays

- attachment to cells
- antibody recognition

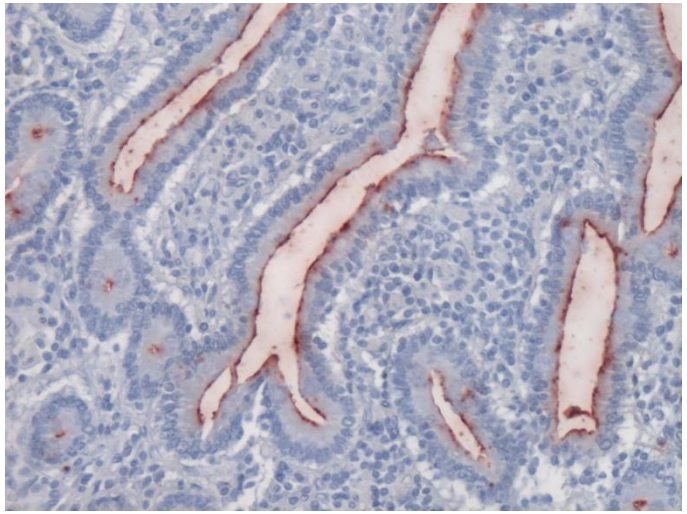
Environmental DNA



Clone libraries



Expression



phenotypic screening

PANDEMIC & DISASTER Preparedness Center (PDPC)

Frontrunner INSPECT

International Network Surveillance for Pandemic EmergenCe via Transport hubs

PANDEMIC & DISASTER Preparedness Center (PDPC)

- **from surveillance to action**: develop criteria (validity, timeliness, strength, ethics) for intelligent surveillance system to underpin public health actions; develop system to turn surveillance signals into alarms, develop response strategies.

- **ethics**: evaluate how ethical considerations such as anonymity, prior and voluntary informed consent and the data protection regulation (eg GDPR) interplay with the data collection and response

Frontrunner INSPECT

International Network Surveillance for Pandemic EmergenCe via Transport hubs

PANDEMIC & DISASTER Preparedness Center (PDPC)

PhD's

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