Implementing Wastewater and Environmental Surveillance in an Archipelagic Rural Setting in the Philippines

Asia-PGI Webinar Series I 26 March 2025

Lea Necitas G. Apostol, RMT, MPH, PhD
Chief Science Research Specialist
Department of Virology
National Reference Laboratory for Polio and Other Enteroviruses
Inter-country Reference Laboratory (ICRL) for ES in the WHO-Western Pacific Region
WHO-accredited National Polio Laboratory: Virus Isolation, ITD, ES

Department of Health
Research Institute for Tropical Medicine

Outline

- Establishment of WES Network in the Philippines
- Stakeholders' engagement
- Challenges of building a sustainable WES in an archipelagic rural setting

The Philippines

- Archipelago (>7100 islands)
  - 3 divisions:
    - Luzon
      - 8 regions
    - Visayas
      - 3 regions
    - Mindanao
      - 6 regions

- Population: 106 M

- 182 languages/dialects

- Different cultures, landscapes

Always a challenge to establish surveillance systems in archipelagic rural areas…

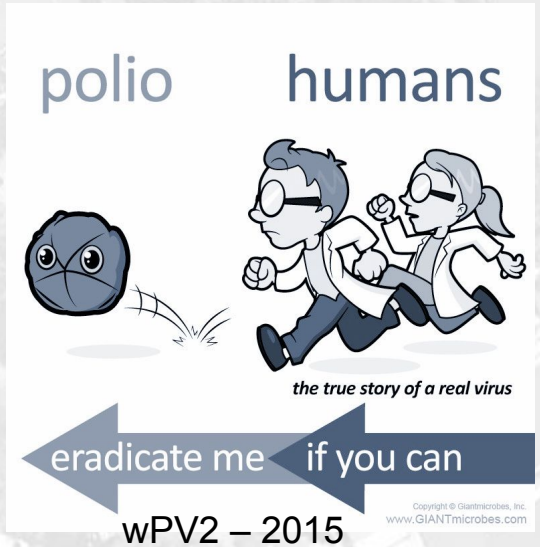
- Geographical inaccessibility (“silent areas”)
- Logistics for remote areas for laboratory investigation
- 180+ languages/dialects (trainings/orientation to be conducted in local languages)
- Prone to natural disasters
- Various stakeholders
- Social dynamics
  - Political
  - Community
- Resource-limited

Establishment of WES
– *The Global Polio Eradication Program*

The *Polio Eradication & Endgame Strategic Plan 2013–2018* has four primary objectives:

- **OBJECTIVE 1:**
  Poliovirus detection and interruption

- AFP Surveillance
- *Environmental Surveillance*



wPV2 – 2015
wPV3 – 2019
wPV1 - ?

Rationale of establishing ES (Polio) – *Risk Assessment Indicators*

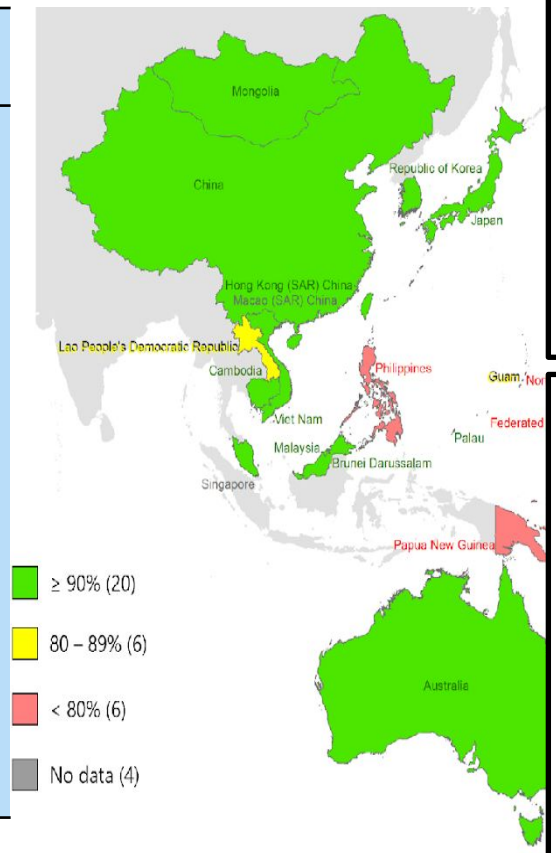
SUSCEPTIBILITY	SURVEILLANCE	PROGRAM/POPULATION
•OPV Coverage	•1/100K Non-polio AFP rate	•Probability of importation (borders, travel links, ports)
•IPV Coverage	•80% with adequate stool	•Polio importation and preparedness plan
•SIAs/Catch-up Activities	•Geographical gaps in surveillance	•Health system status
•AFP Cases with 0 dose	•Environmental surveillance	•Sanitation/hygiene

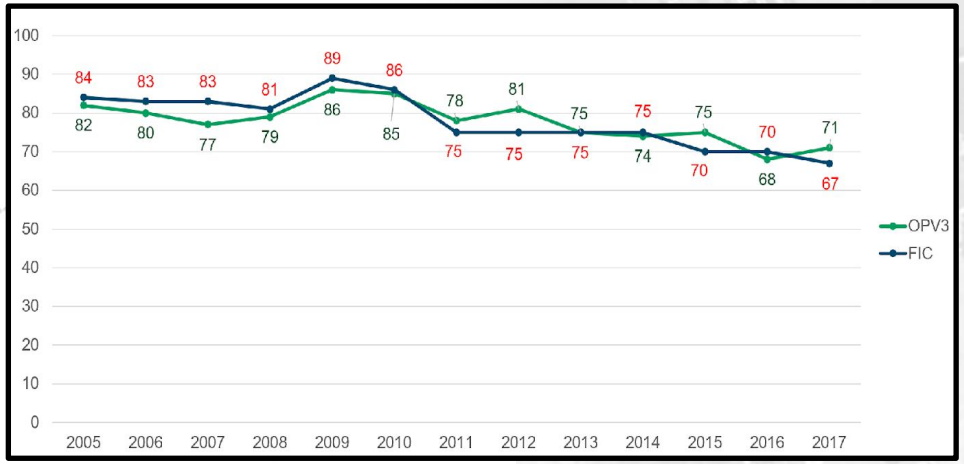
Risk Assessment Indicators

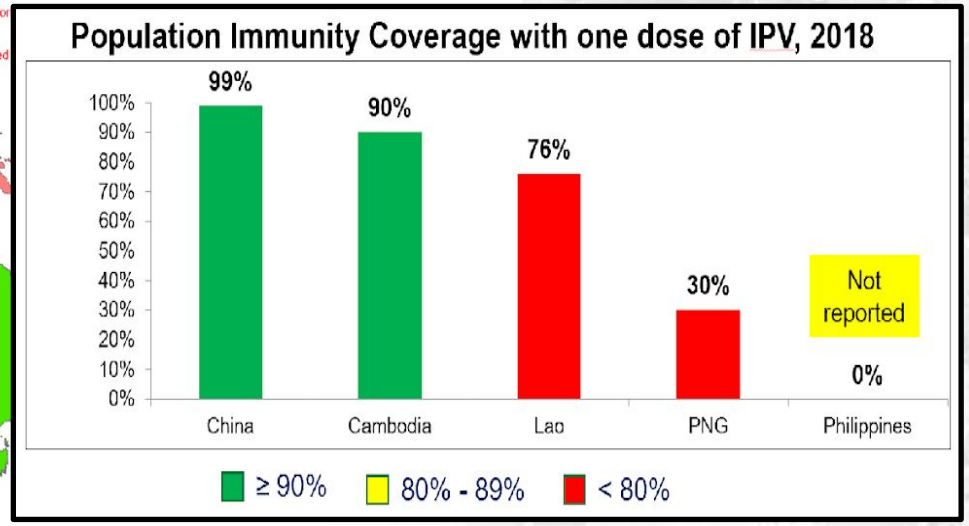
SUSCEPTIBILITY

- OPV Coverage
- IPV Coverage
- SIAs/Catch-up Activities
- AFP Cases with 0 dose

Reported OPV3 coverage





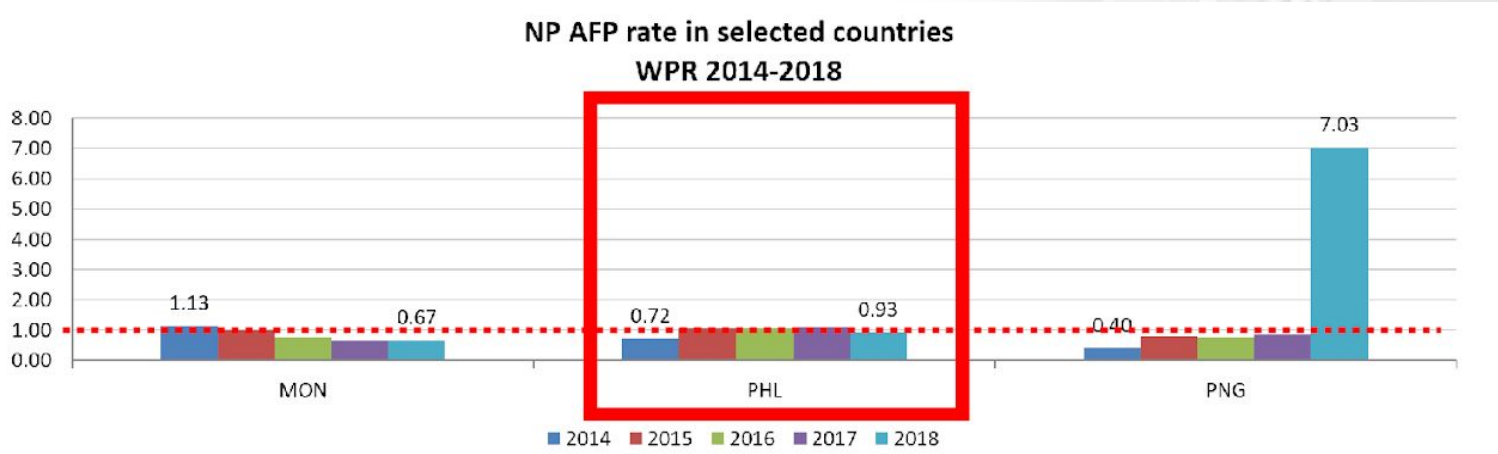


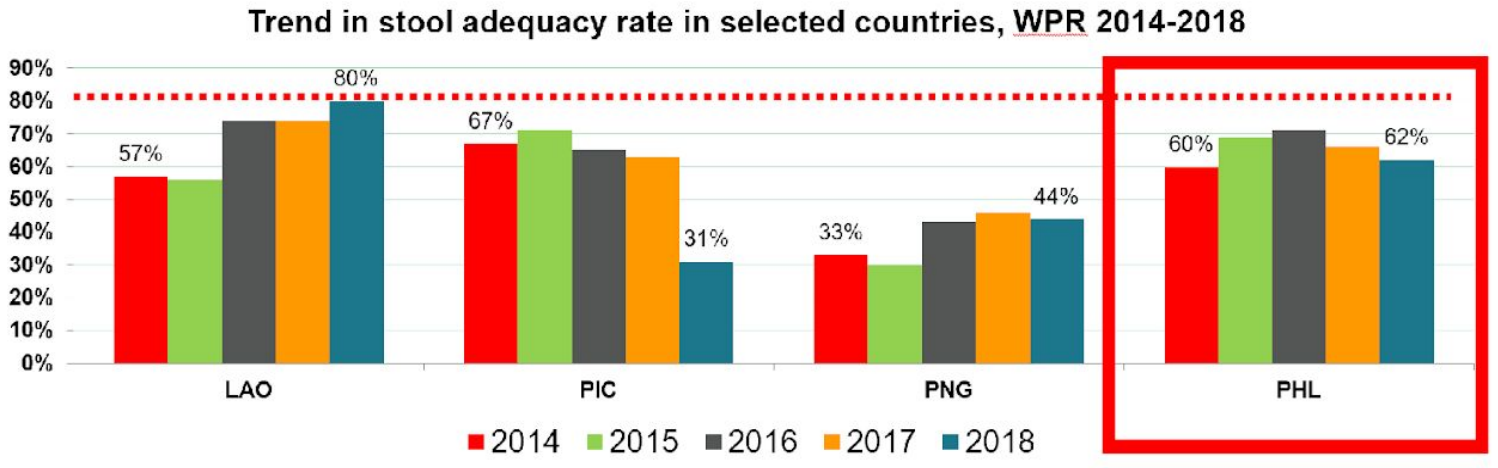
Department of Health
Research Institute for Tropical Medicine

Risk Assessment Indicators

SURVEILLANCE

- Non-polio AFP rate (1/100K)
- 80% with adequate stool
- Geographical gaps in surveillance
- Environmental surveillance





Risk Assessment Indicators

PROGRAM/ POPULATION

- Probability of importation (borders, travel links, ports)
- Polio importation and preparedness plan
- Health system status
- Sanitation/hygiene

% Households with Complete Basic Sanitation Facilities

	2015	2016	2017	2018
Philippines	68	68	68	69
NCR	100	88	96	94
CAR	52	52	55	58
I	85	88	88	89
II	74	64	71	75
III	77	84	83	77
IVA	81	83	80	81
IVB	74	67	69	69
V	44	44	50	51
VI	54	62	66	69
VII	42	48	38	45
VIII	59	60	58	68
IX	38	41	50	36
X	61	61	66	66
XI	65	70	71	69
XII	63	66	60	65
ARMM	16	33	16	19
CARAGA	56	55	49	56

Number of Barangays Declared Zero Open Defecation, 2018

Philippines	*3,484 (8% of total number of Barangays)*
NCR	*No Data*
CAR	*No Data*
I	*No Data*
II	185
III	186
IV-A	442
IV-B	*No Data*
V	*No Data*
VI	446
VII	327
VIII	1,032
IX	*No Data*
X	405
XI	40
XII	302
CARAGA	119
BARMM	*No Data*

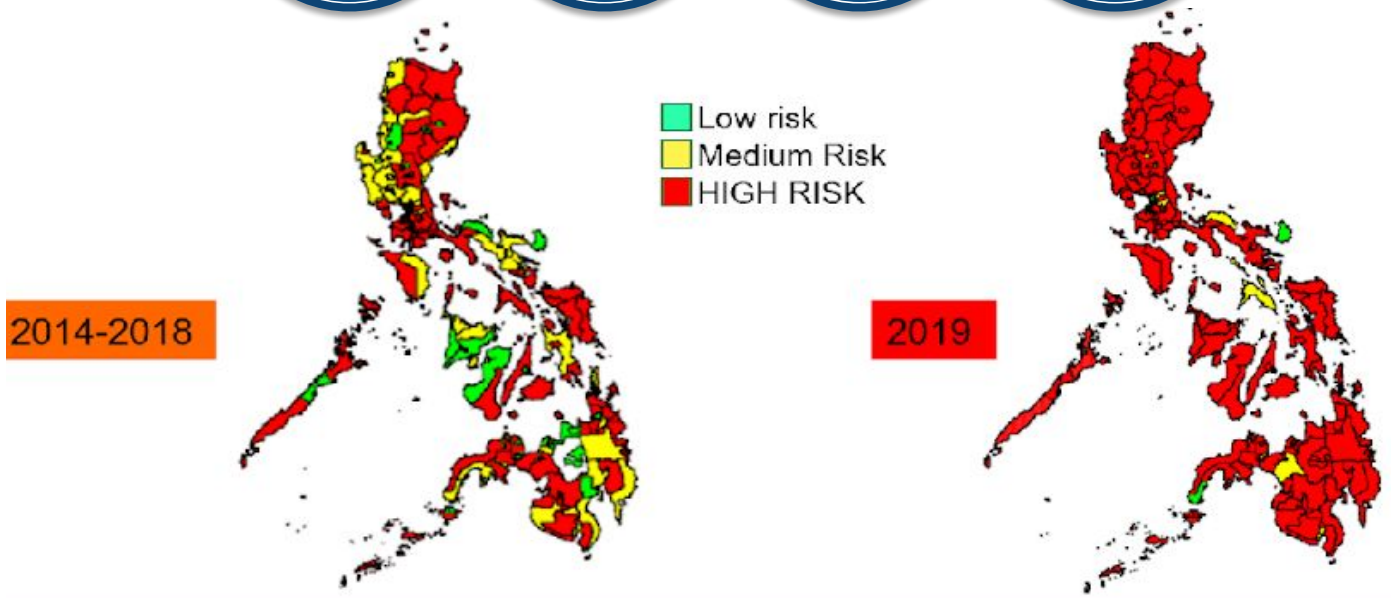
A supplemental surveillance is needed

1993 Last polio case (Cebu)

2001 Outbreak of cVDPV1

2015 Isolation of aVDPV2

2017 ????? ?????



SUSCEPTIBILITY	SURVEILLANCE	PROGRAM/POPULATION
• OPV Coverage • IPV Coverage • SIAs/Catch-up Activities • AFP Cases with 3 doses, with 0 dose	• Non-polio AFP rate • % with adequate stool • Geographical gaps in surveillance • Environmental surveillance	• Probability of importation (borders, travel links, ports of entry) • Health system status • Sanitation/hygiene • Polio importation and preparedness plan

Environmental Surveillance (ES)

In AFP (Human) Surveillance….

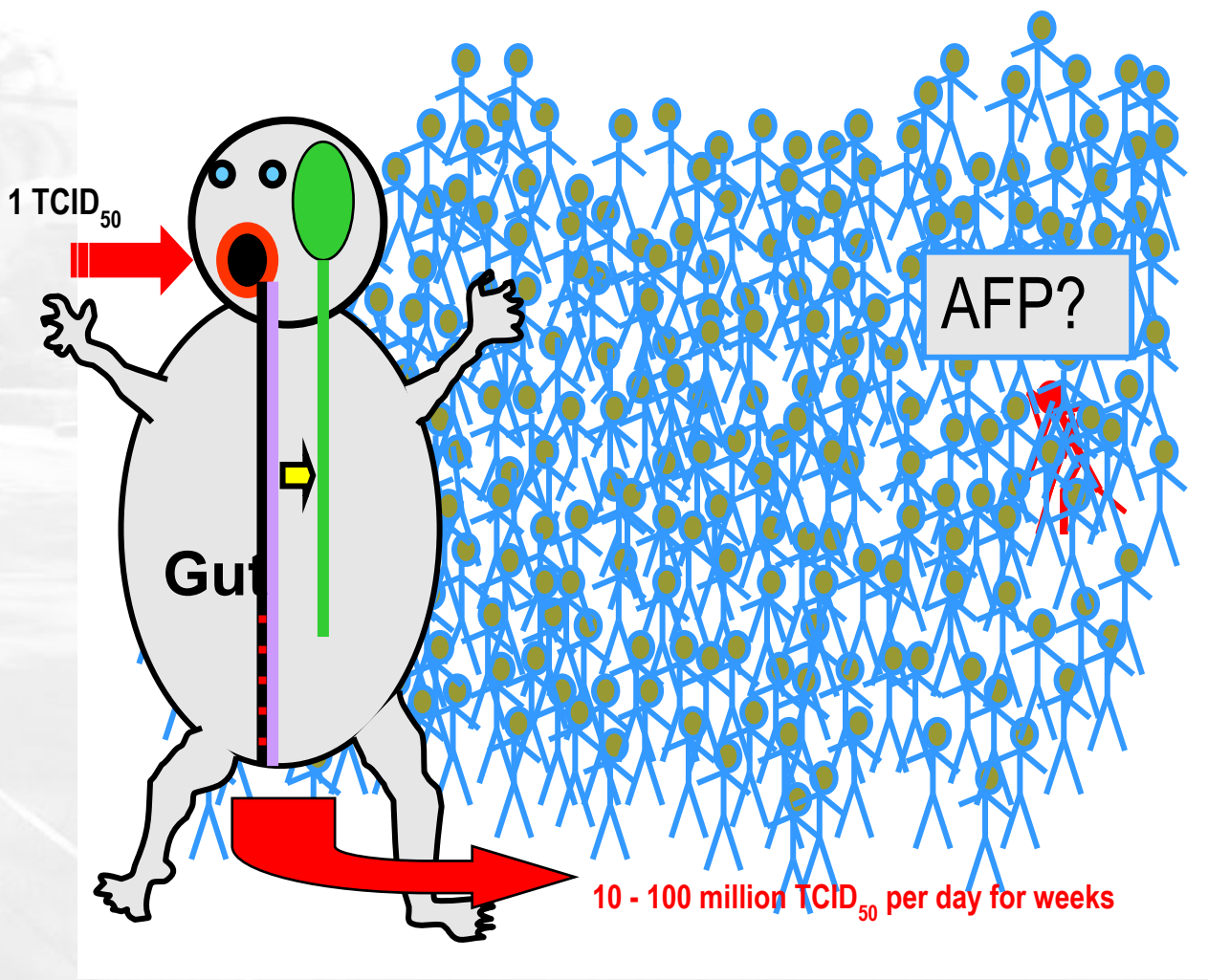
AFP surveillance = GOLD standard for surveillance in the GPEI

The rationale for ES

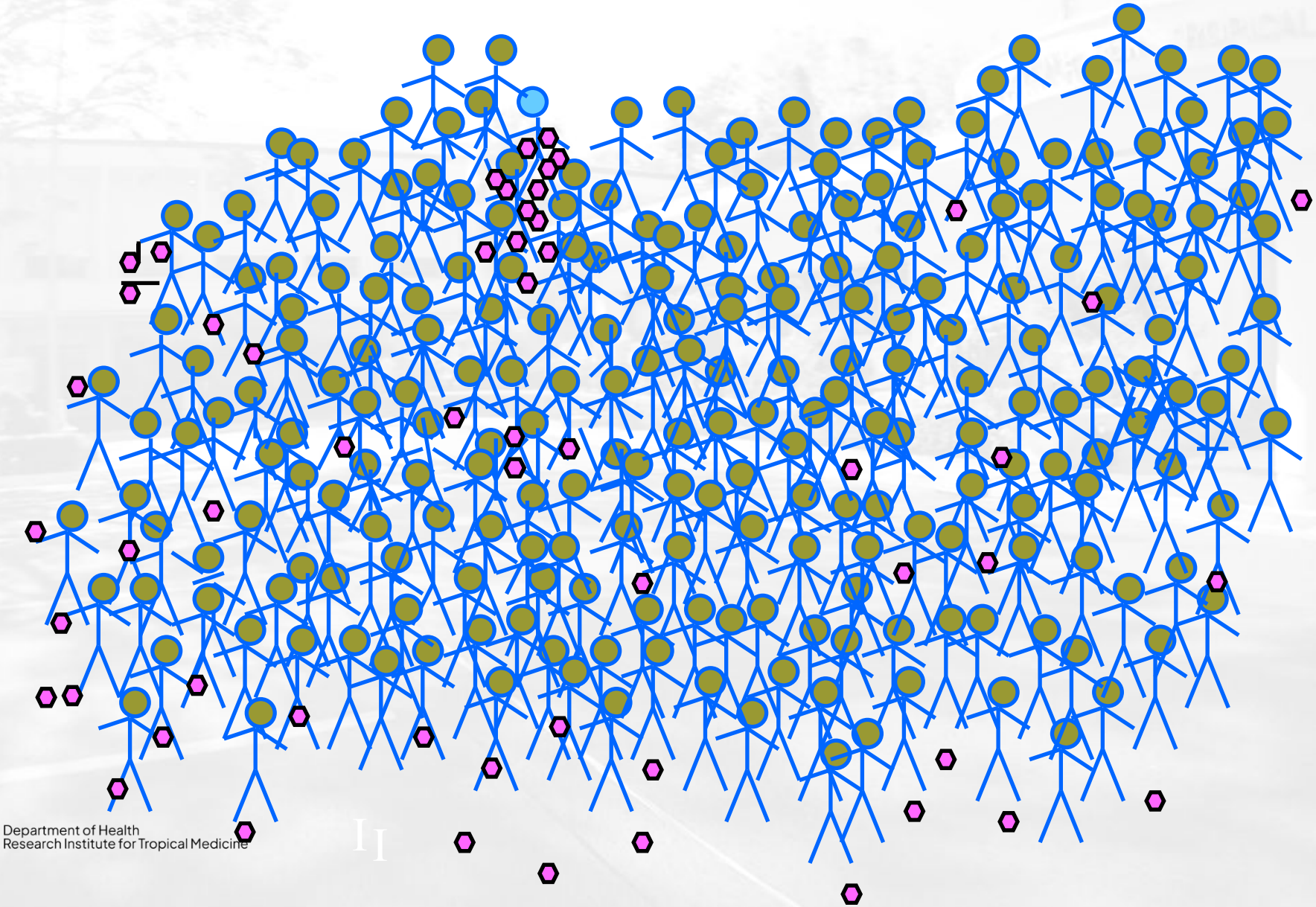
→ “characteristic poliovirus excretion pattern”

⟶ Large numbers of excreted poliovirus particles **remain infectious in the environment** for varying lengths of time depending on the immediate conditions

⟶ **Available laboratory methods** for concentration and identification



In ES.....



Strategies for implementating WES

Prerequisite:

- Trained staff
- Dedicated laboratory for WES
- Available equipment and supplies
- Standard protocols for testing
- Institutionalized funding

- **Phase-based implementation**
  - **Site Expansion:** Pilot testing from two regions before expansion
  - **Laboratory Expansion:** Establishment of one WES Laboratory to 3 WES Laboratory Hubs
  - **Pathogen Test Expansion:** From Polio to other viral and bacterial pathogens
- **Multi-sectoral approach**
  - Identification of key stakeholders
  - Consultative meetings with national and local stakeholders
  - Memorandum of Agreement with the local partners
  - Community engagement

Milestones



MOA Signing: Manila Water Company, Inc. | Baguio Sewage Treatment Plant | Maynilad Water Services, Inc.






Mar 2015
Training of staff at NICD, South Africa

Sep-Dec 2015
Request and delivery of start-up equipment and supplies

2016
Consultative Workshops and Ocular Visits

Mar 2017
MOA signing with partner agencies

Mar 2017
Training of collectors / lab staff

- 2-phase concentration
- CAFÉ Method

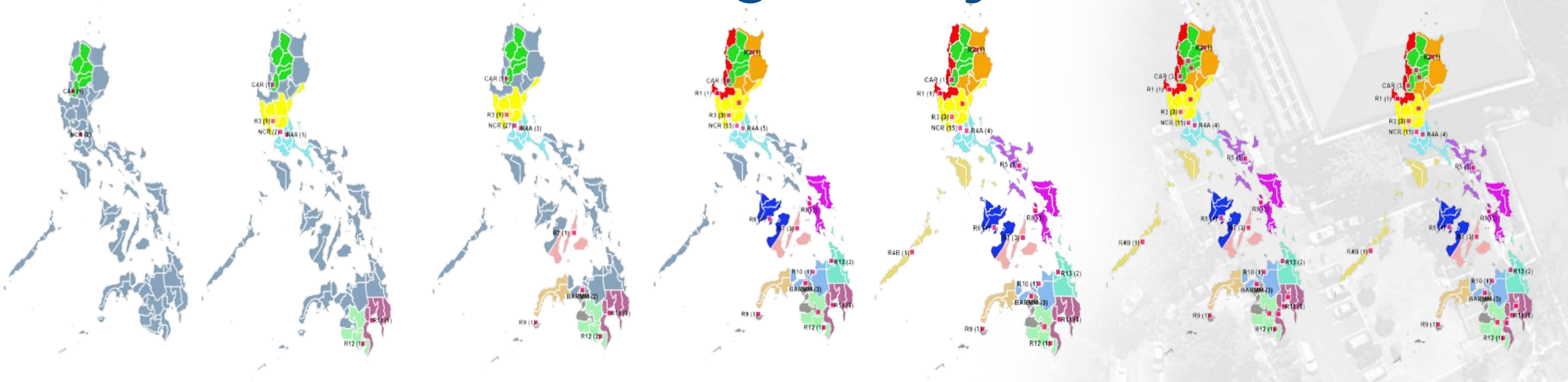
Apr 2017
Start lab operations

2018~~
Annual Multistakeholders Meeting

PLAN | CONSULT | ENGAGE | EMPOWER | NURTURE

Department of Health
Research Institute for Tropical Medicine

ES Network through the years…



2017

2 REGIONS

3 cities/provinces

3 sites

2018

6 REGIONS

7 cities/provinces

7 sites

2019

9 REGIONS

17 cities/provinces

41 sites

Polio outbreak

2020

15 REGIONS

25 cities/provinces

42 sites

COVID-19 pandemic

2021

17 REGIONS

29 cities/provinces

43 sites

Closure of polio outbreak

2022

17 REGIONS

35 cities/provinces

52 sites

2023-2024

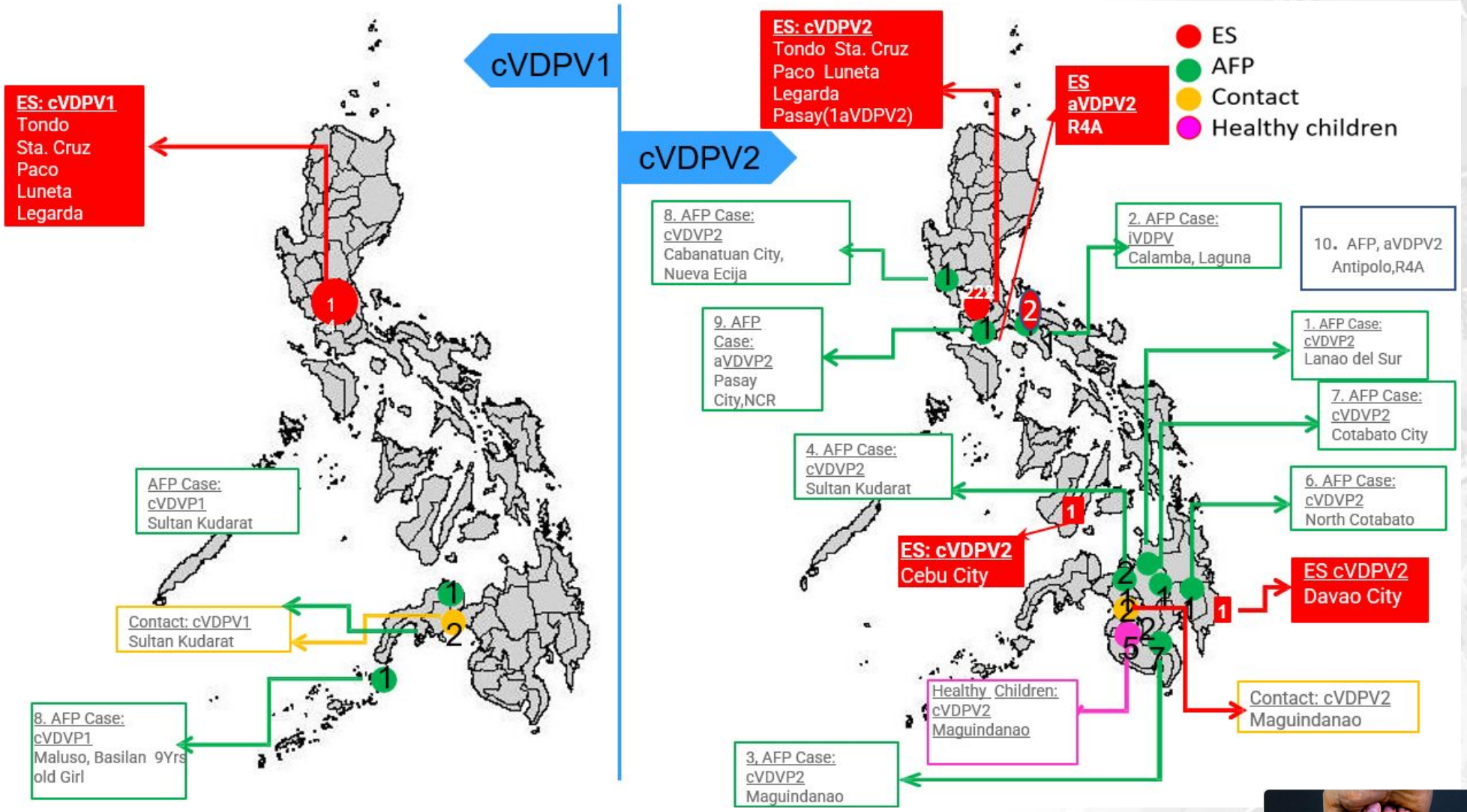
17 REGIONS

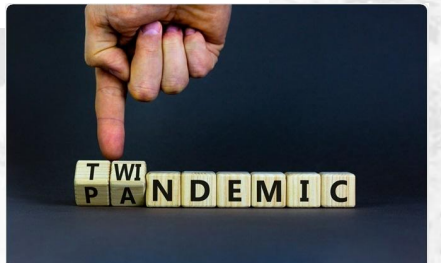
35 cities/provinces

51 sites → 56

Department of Health
Research Institute for Tropical Medicine

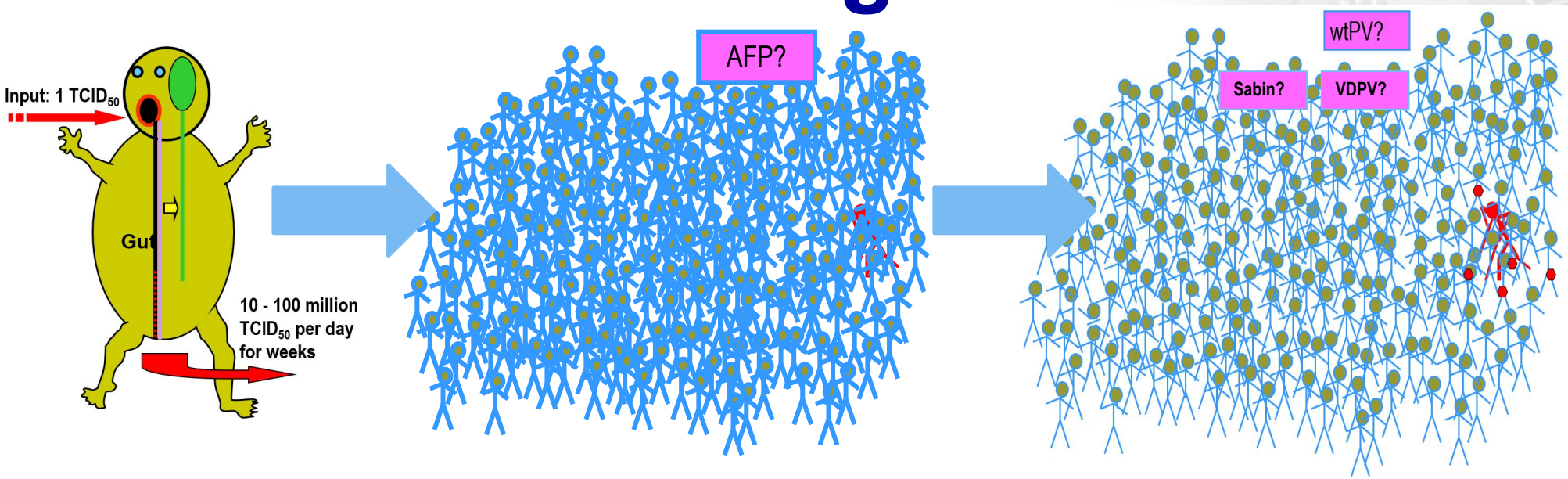
A tale of two outbreaks amidst COVID-19 pandemic…..



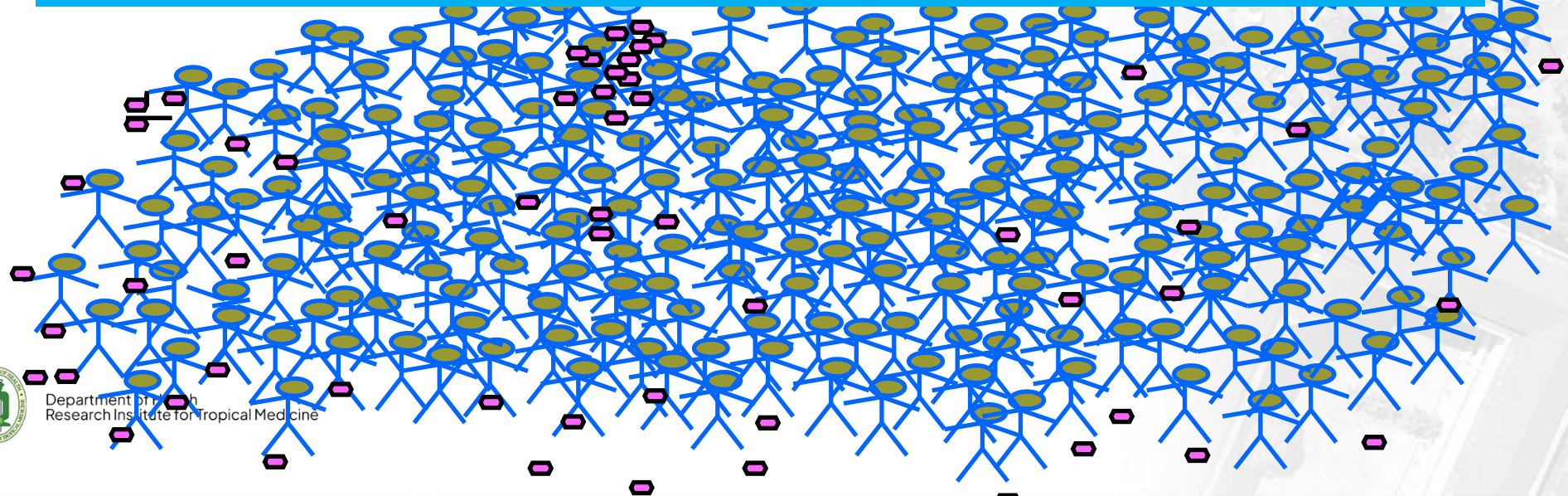


Department of Health
Research Institute for Tropical Medicine

Did we achieve our goals for ES?

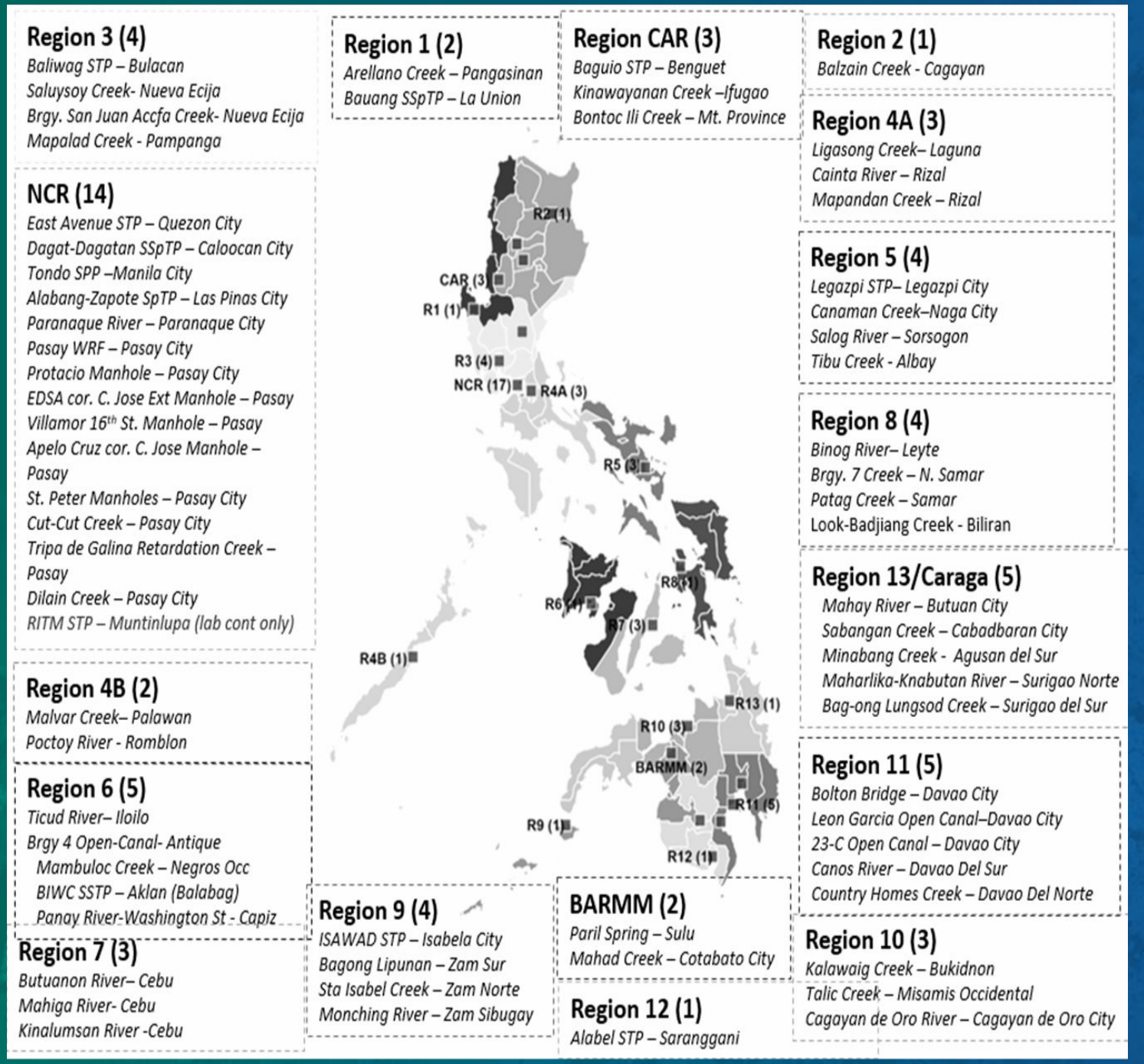


YES, WE FOUND THE VIRUS!



ES Network

- **WHO Inter-country Reference Laboratory for ES in the Western Pacific Region**
  - Lao PDR
  - Cambodia
  - Papua New Guinea
- **66 sites in 53 provinces/cities**
- **Activities:**
  - Expansion of sites to 88 provinces/cities to cover the "silent" areas in the AFP surveillance
  - Establishment of 2 ES Concentration Laboratory Hubs (for Visayas and Mindanao)
  - Detection of SARS-CoV-2/Respiratory viruses, AMR and other pathogens
  - Utilized for One Health and Planetary Health research initiatives



Department of Health
Research Institute for Tropical Medicine

ES Initiatives

One Health Approach

- Avian Influenza
- SARS-CoV
- AMR
- Arboviruses

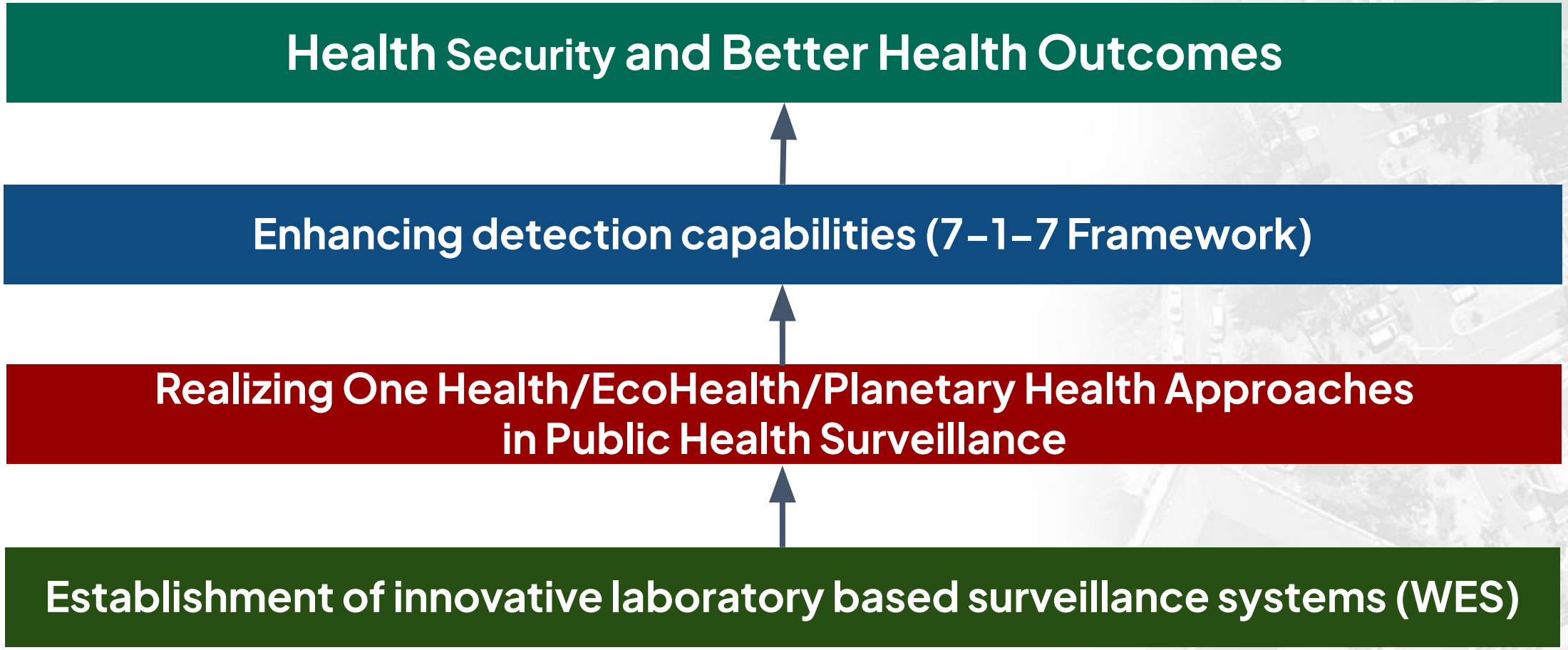
CORE Laboratory Surveillance Systems

Polio/Enteroviruses
VPDs

- AMR

Planetary Health Approach

Framework for WES



Site Selection

- Coordination and consultative meetings
- Ocular visits /assessment of potential sites

Criteria	VPDs/ Respiratory/ Arboviruses	AMR Pathogens (Bacterial/Viral)	Zoonoses (Avian Influ)
Common criteria:	Poor sanitation (ZOD) High prevalence of the disease Catchment pop'n: 30K – 100K Availability of courier in the area Community participation		
Additional considerations:	▪ Evidence of household drainage ▪ Low performance in surveillance ▪ Low immunization coverage ▪ No industrial wastes ▪ Recent circulation of the virus ▪ Availability of courier in the area ▪ PMMoV Positivity	▪ With or without industrial wastes; near pharmaceutical companies ▪ Fish pen/poultry ▪ Presence of slaughterhouses	▪ Fish pen/poultry ▪ Near caves (bat surveillance)
Type of sites (Urban/Rural)	Sewage Treatment Plants Manholes, Inlet/Outlet Downstream Rivers	Sewage Treatment Plants Inlet/Outlet Rivers	Downstream/Midstream/Upstream Rivers

Process Flow

Sampling method:
- Grab vs Composite

Frequency:
- Monthly – Surveillance
- Bimonthly – Outbreak

Temperature Requirement:
- 4-8 C (refrigerated temp)
- Reverse cold chain

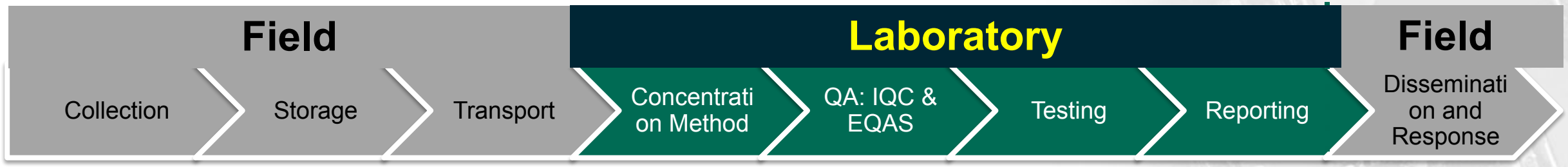
Volume:
- 1 liter

Grab water sampling

Autosampler

Department of Health
Research Institute for Tropical Medicine

Process Flow



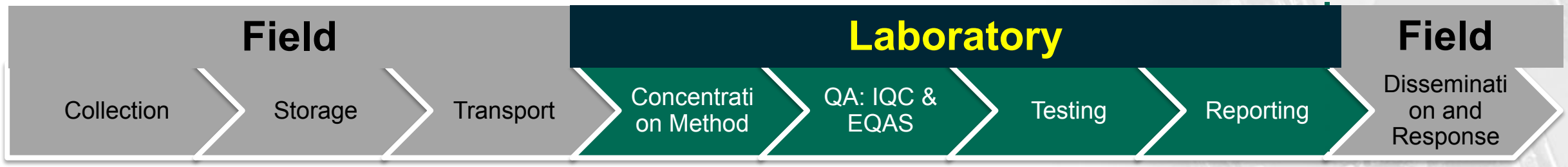
Concentration Method
- Two-phase (Polio)
- CAFÉ Method

https://pmc.ncbi.nlm.nih.gov/articles/PMC9344547/

Quality Controls:
- PMMoV Testing as IQC – in-house
- Crassphage – kit-based
- Concentration Method EQAS by WHO

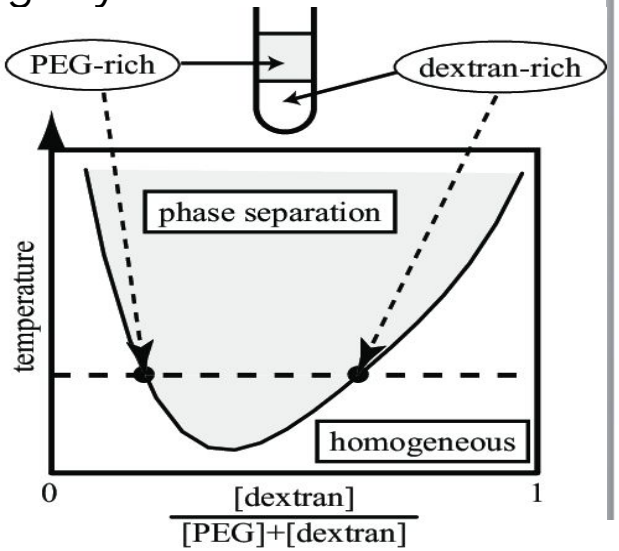
Testing:
- Virus Isolation
- Molecular Tests:
  PCR: Real-time, Conventional, Digital
  Sequencing: Sanger, ONT, Illumina

Process Flow



Concentration Method

- Two-phase (Polio) – long process
- Centrifugation
- PEG + Dextran T40
- Incubation overnight
- Harvest the following day



- The 2-phase separation method is based on delicate physicochemical interactions between two carbohydrate polymers (dextran T40 and polyethyleneglycol (PEG) 6000) in solutions and the virus particles

DEXTRAN **PEG**

Mix together in a solution

Leave to stand undisturbed for hours at cold

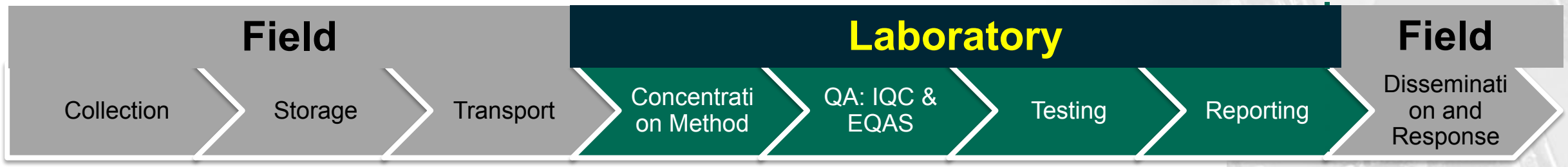
PEG,more hydrophobic UPPER

Dextran, more hydrophilic LOWER

Form two aqueous layers

Department of Healt
Research Institute fo

Process Flow

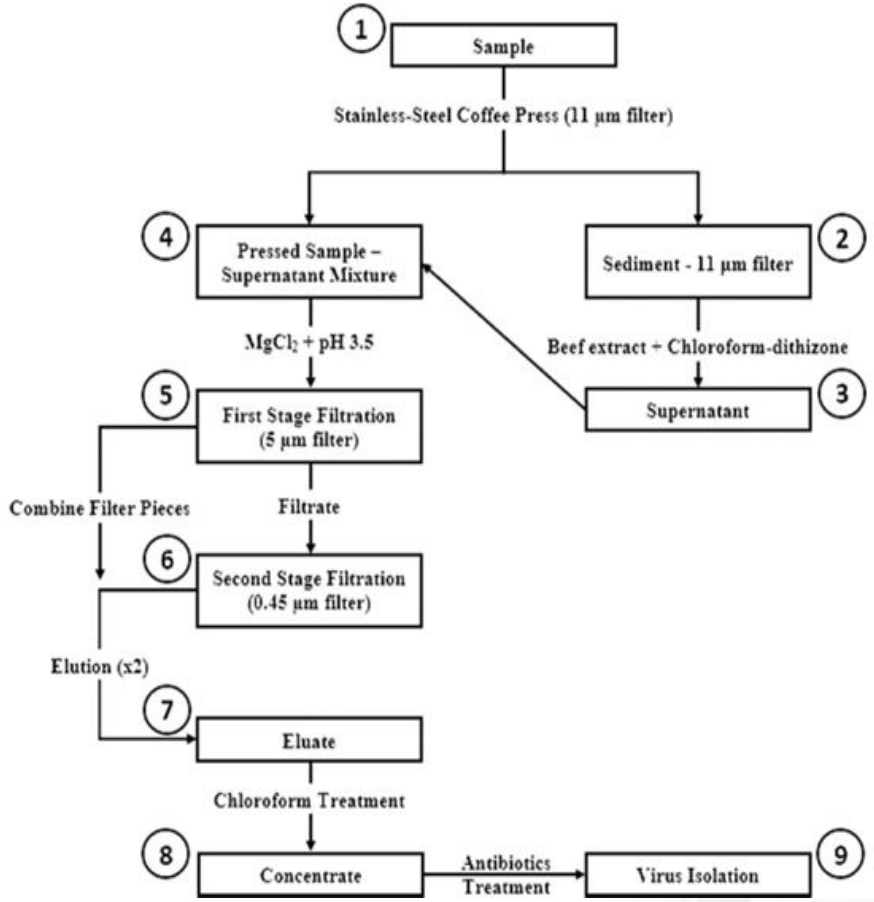


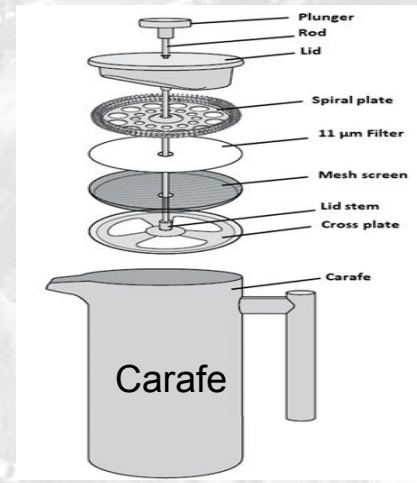
Concentration Method

- Two-phase (Polio)
- **CAFÉ Method**

https://pmc.ncbi.nlm.nih.gov/articles/PMC9344547/

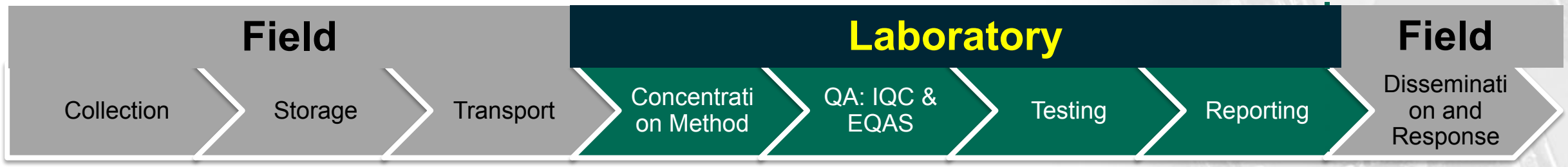
- Based on the principle of charge-based methods, where electrostatic forces are instrumental in virus-filter interactions.





Department of Health
Research Institute for Tropical Medicine

Process Flow



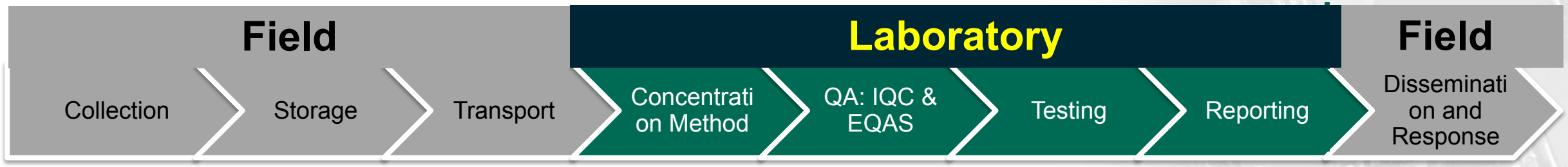
Quality Controls:

- IQC:
  PMMoV Testing – in-house
  Crassphage – kit-based

- EQAS:
  Concentration Method by WHO

- Started in 2022 as an IQC of the ES-COVID study
- Mastermixes optimized based on available reagents
  - 3 protocols developed
- Consistently observed in quantifiable and high concentration in wastewaters* in the Philippines, Lao PDR, Cambodia and PNG
  - **Wastewater: Sewage treatment plants, septage treatment plant, river waters, open canals*
  - Ct values: 24 – 31
- Can be detected in raw sewage and ES concentrates

Process Flow



Culture Viral and Bacterial

- Polio and other Enteroviruses
- AMR pathogens

Molecular Real-time, conventional, digital PCR

- Polio and other enteroviruses and other VPDs
- Respiratory, Gastrointestinal and arboviruses
- AMR

Molecular Sequencing

- Sanger: Polio and other VPDs
- ONT and Illumina: Other pathogens (research)

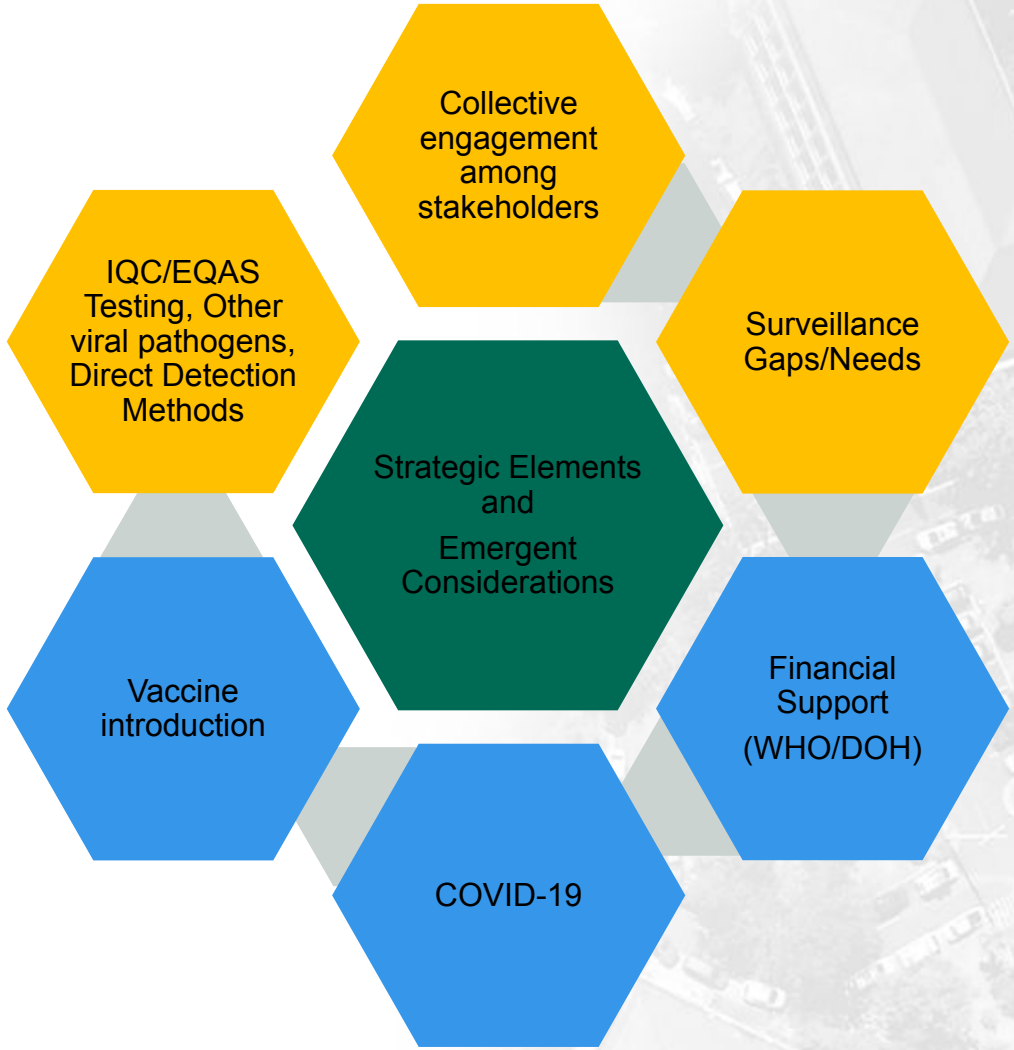
Lessons Learned During the Pandemic

OPERATIONS

- Affected surveillance activities
- Difficulty in updating databases
- Postponed ocular visits for ES expansion in outbreak regions due to travel ban
- Decreased routine laboratory workload
- Disruption of routine collection of environmental samples due to infection among collectors and lockdown
- Disruption of shipment of samples from island regions to lab; from NPL to Global Specialized Lab in Japan
- Upsurge of specimens when shipment resumed (laboratory overload)
- Compromised turn-around time for testing and reporting
- “Delayed” sequencing of isolates due to bottlenecks in shipment internationally

- as an ARCHIPELAGIC COUNTRY
  - Subnational laboratories to process the samples
  - New alternative methodologies
  - Expand ES coverage to fill in some gaps in AFP surveillance (pandemic)
  - Maximizing ES Network for other pathogen testing

OUR collective experience during the concurrent polio outbreak and COVID-19 pandemic had triggered a revision of the routine set-up to address the strategies and emergent challenges

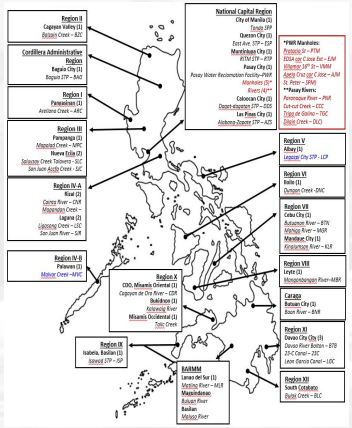


The **PLAN** seeks to drive a shift in **CAPACITY BUILDING** and **CAPABILITY UPGRADE** by addressing the gaps , reflecting the needs of all stakeholders on whom this program depends, and rebalancing the capacity of testing from NRL-level towards regional teams.

PLANS FOR WES

PLAN 1 Build surge capacity to support AFP surveillance strengthening & ES expansion

a. Expansion of ES sites to 88 provinces/cities to cover "silent" areas in AFP surveillance



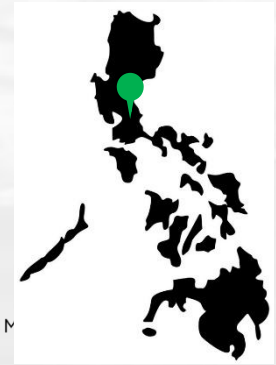
17 regions, 53/88 provinces/cities

2024-2026

61 locations
2022 – 15
2023 – 15
2024 – **15**
2025 – **16**

17 regions, 88 provinces/cities, 88 samples per month

b. Establishment of ES Concentration Labs in Mindanao and Visayas



1 Concentration Lab

2022-2025

Mindanao – 2022-2023

Visayas – 2024-2025

3 Concentration Labs

Department of Health
Research Institute for Tropical M

ES Concentration Labs

Nat'l Polio Lab launches Mindanao environmental surveillance concentration laboratory

Posted on December 21, 2023 by Yvette Kirsten P. Gimena

Environmental Surveillance Network stakeholders from RITM, WHO-WPRO, Davao CHD staff, and DOH Davao.

Department of Health
Research Institute for Tropical Medicine

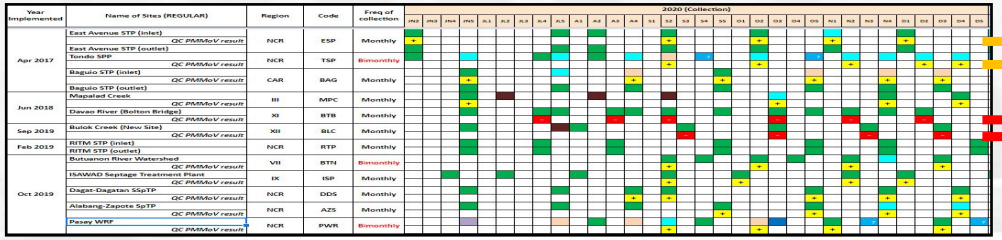
NEXT: ESCL in VISAYAS (Iloilo)

PLANS FOR WES

PLAN 2 Fast track validation & implementation of the new methods

a. Lab readiness for any vaccine introduction in the routine immunization program

b. Implement PMMoV testing as internal quality control for ES site selection



Continue sampling

Investigation

2022

A by-product of ES-COVID study; Implemented in October 2021

c. ***Expansion of testing not just for polio & other enteros but ALL possible viral pathogens***

2024

Started with **SARS-CoV2** study

d. Direct detection methods/multiplex PCRs

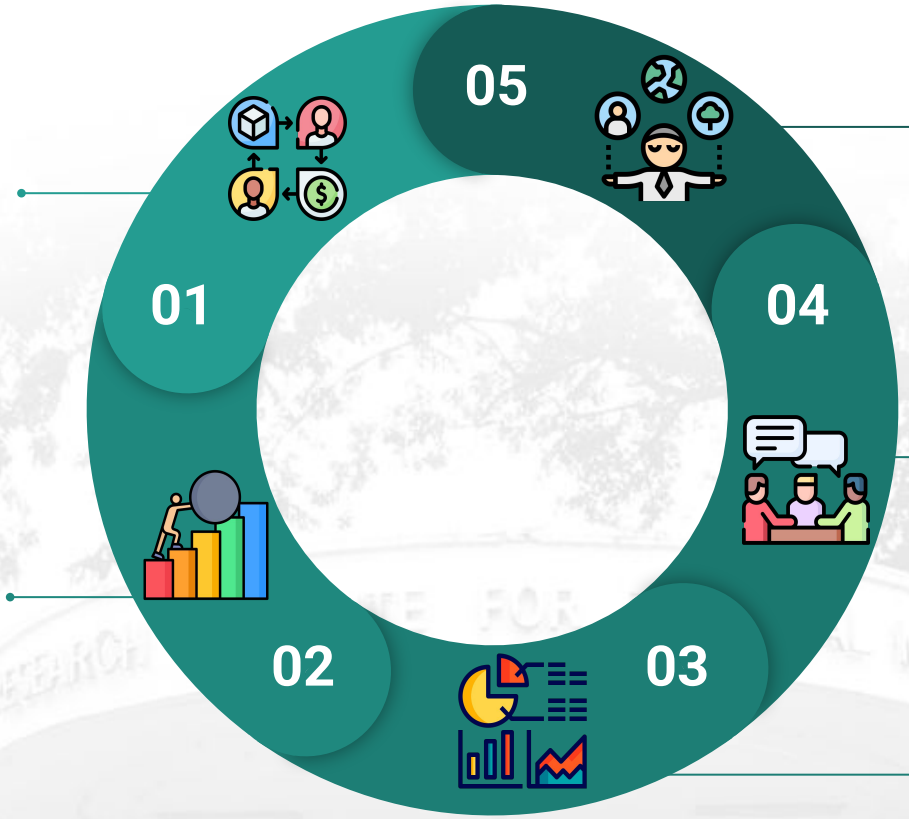
Roles of Stakeholders (Planning to Implementation)

Environmental sector: Department of Environment and Natural Resources
Health sector: Department of Health and 17 Center for Health Development
Local Government Units
Laboratory network

Operationalization
Collection, storage and transport of samples;

Testing – 2–phase concentration technique and CAFÉ Method

Coordination
Communicates with the local government units and private agencies regarding collection of samples



Response
Identification of additional sites based on criteria

Challenges
Address challenges in the field

Surveillance Data Reporting
Dissemination of results to concerned agencies

Challenges in building a sustainable WES

SUSTAINABILITY

- Institutionalize funding for surveillance
- Address human resource limitations by maintaining a pool of trained staff

MULTI-SECTORAL APPROACH

- Engaging key stakeholders from planning to implementation
- Continue to nurture the relationship through the conduct of annual meetings

COMMUNITY OWNERSHIP/COMMITMENT

- Political support
- Leverage the existing roster of front-line workers at the local level
- Establishing trust at the local level

SUMMARY

- Careful planning including risk assessment, must be made and all the prerequisites* must be in place before starting a WES
- Importance of inclusive, culturally-sensitive and participatory approaches in establishing WES
- Successful implementation of ES requires a phase-based and multisectoral approach
- Engaging people and all key stakeholders is critically important in the process of establishing ES
- Establishing ES can be a complementary tool to existing surveillances and an innovative tool for outbreak investigation
- Maximize the WES Network for the detection of other pathoges of public health importance

Acknowledgments

National Polio Laboratory, RITM
TULIP Study Group
ES-COVID Study Group
88 Local Government Units
17 Regional Center for Health Development

Thank you.

Department of Health
Research Institute for Tropical Medicine