# Laying a foundation for sustainable infectious disease surveillance in low resource settings

**IGHS Seminar**
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Director, Rapid Response

# Infectious causes of disease

*...just the tip of the iceberg.*

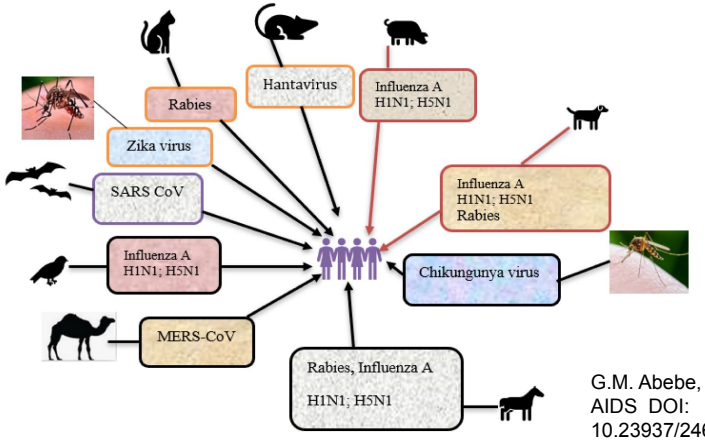

Endemic:
*hepatitis; chicken pox*

Re-emerging:
*tuberculosis, flu, pertussis*

Emerging:
*SARS, ebola, Zika*

Challenges:

- Limitations in diagnostics
- Break-through of vaccine preventable diseases
- Antimicrobial resistance



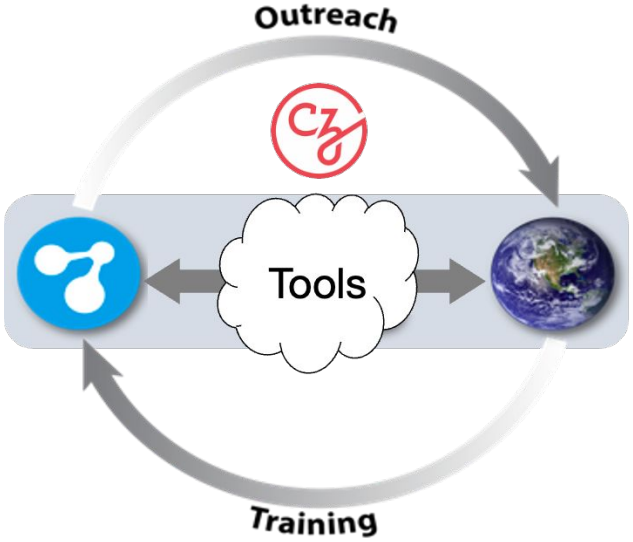

G.M. Abebe, Internat J Vir & AIDS DOI: 10.23937/2469-567X/1510067

# CZ Biohub Rapid Response Mission

- Rapid pathogen detection and identification.

- Establish platforms for pathogen discovery.

- Provide strategies for One Health.

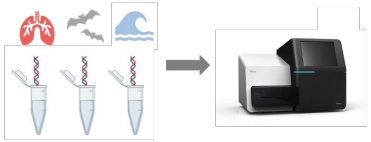



***... support the science and technology that will make it possible to cure, prevent or manage all diseases by the end of the 21st century."***

# Strategy: Enable access to and use of mNGS technology

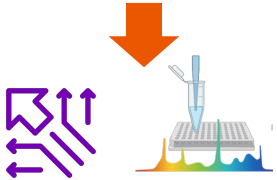
## Why?

Metagenomics empowers surveillance and unbiased pathogen detection.



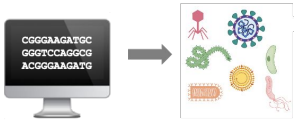
Comprehensive analysis of all genetic material in a sample

## How?



Deploy wet lab training

## Remaining challenges



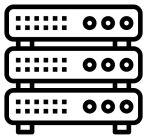

Large, complex datasets.

Computationally expensive.

Difficult to implement bioinformatics.

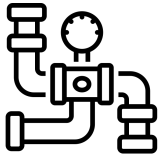
# Strategy - Technology that lowers barriers to analysis

**PROBLEM:**



Access & cost of **compute**

Most custom pipelines & tools are run off the **command line**



Pipelines require **MANY steps**, each with unique tools and inputs/outputs

CZ ID

CZ GEN EPI

*Make complex analysis pipelines globally accessible to empower data-driven decision making about disease prevention and detection around the world.*

# Creating solutions

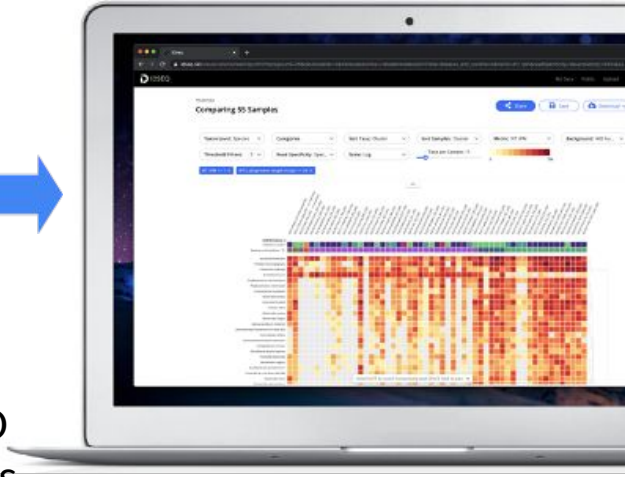
CZ ID

CGGGAAGATGC
GGGTCCAGG
ACGGGAAG

Data upload & filtering

Mapping of reads & contig assembly

Blast
Taxonomic ID
Phylogenetics



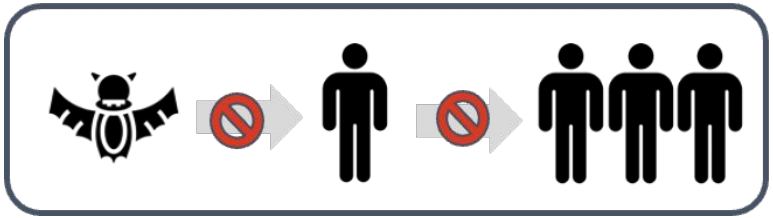
- No code
- Open source
- Cloud-based

- Real time data generation,
- Informed decision making,
- Actionable impact

# Agile methods and tools applied to a multitude of use cases

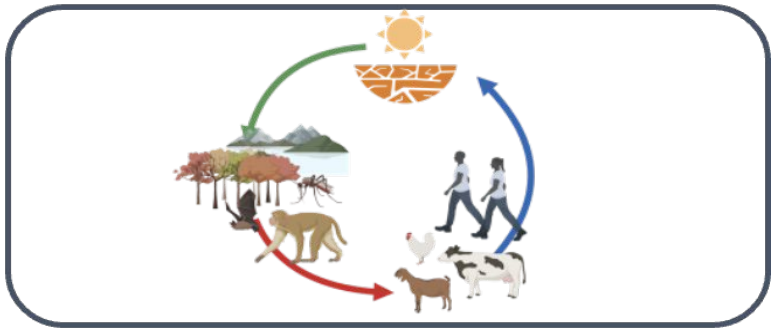
## Pathogen Detection & Identification

- Local pathogen landscape
- Unknown infections
- Novel, emerging, or engineered pathogens



## Disease Epidemiology

- Outbreak investigations
- Emergence of antimicrobial resistance markers



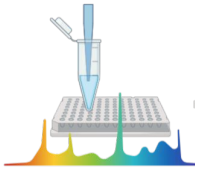
## Planetary Health & Zoonosis

- Vector surveillance
- Livestock & wildlife
- Water & crop monitoring

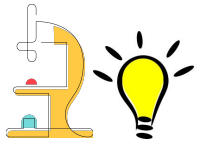
# Comprehensive training

*Group engagement and needs assessment towards capacity*

*Technology transfer and practical use*

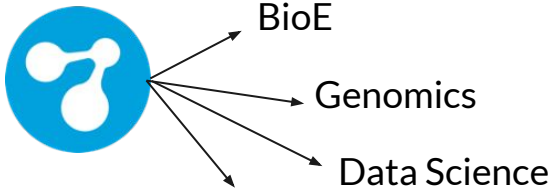


*Hands-on wet lab training for scientific proficiency*

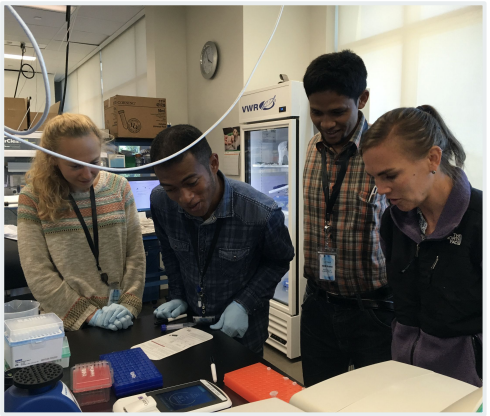


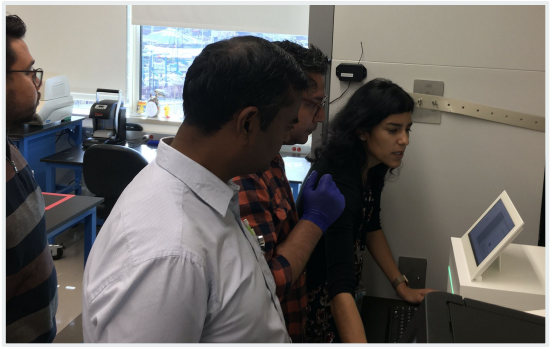
*Applied Research and Protocol Development*

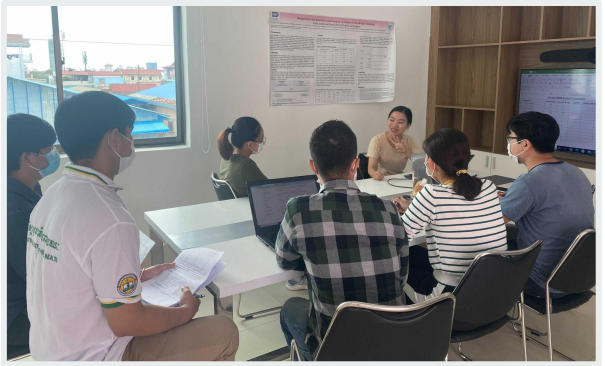
*On-call mentorship*




CZB Group leaders and Investigators







# Capacity building at the local community level

## Basic Research

## Clinical Research

## Public Health Practice

Low-middle income countries & underserved areas

- Universities
- Research foundations & clinics
- Public health laboratories
- Global health organizations (Pasteur,NIH,CDC, etc)

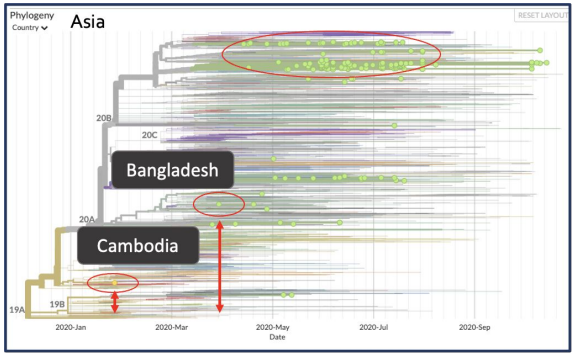
# Collaborating sites

# Field application: Rapid outbreak response

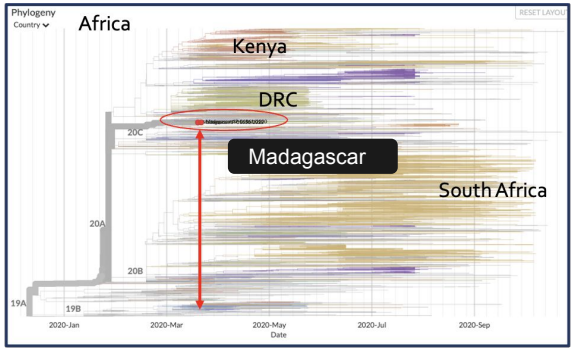
Pivot from mNGS to enrichment protocols for SARS-CoV-2

- **First in-country sequences** for SARS-CoV-2

Saha, et al 2020
Manning et al, 2020
Randremanana et al 2021




https://nextstrain.org/ncov/asia




https://nextstrain.org/ncov/africa

Unmet need

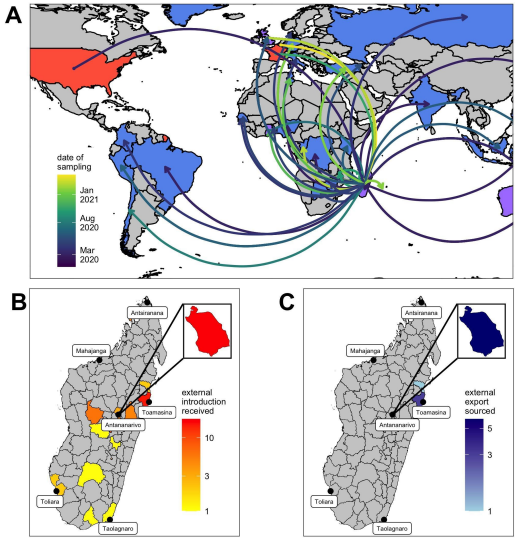
Rapid deployment of a new pipeline for SARS-CoV-2 in **CZ ID** for **low and middle income country (LMIC) groups**:

- Enabled outbreak investigations & Publication of SARS-CoV-2 genomes

# Field application: genomic epidemiology & pathogen discovery

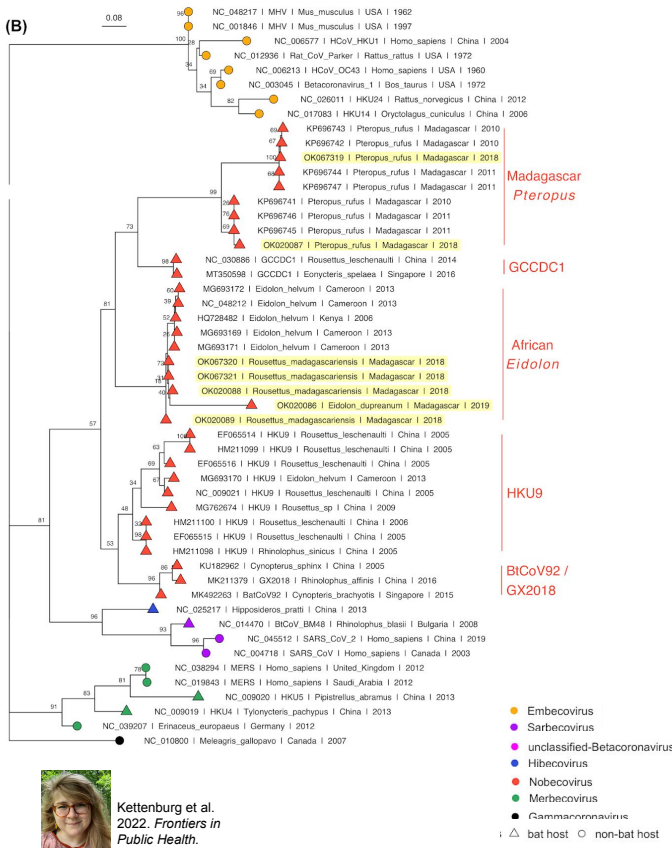
PI: Cara Brook
Madagascar

*"Understanding the genomic landscape of coronavirus circulation in Madagascar"*



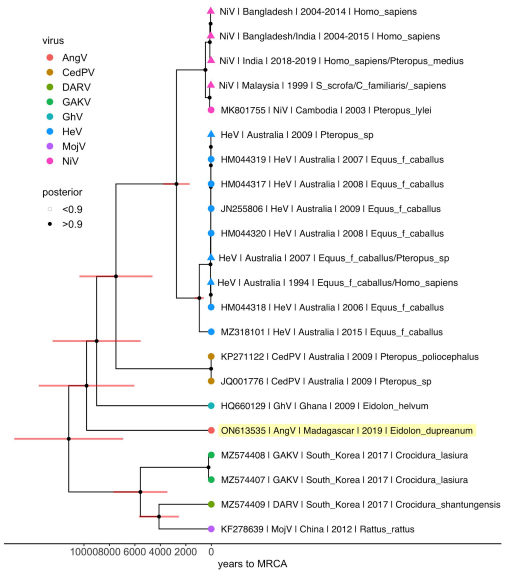

Ranaivoson et al.
*In final prep.*

## Novel bat CoVs (Nobecoviruses)




Kettenburg et al. 2022. *Frontiers in Public Health.*

## Novel bat henipavirus

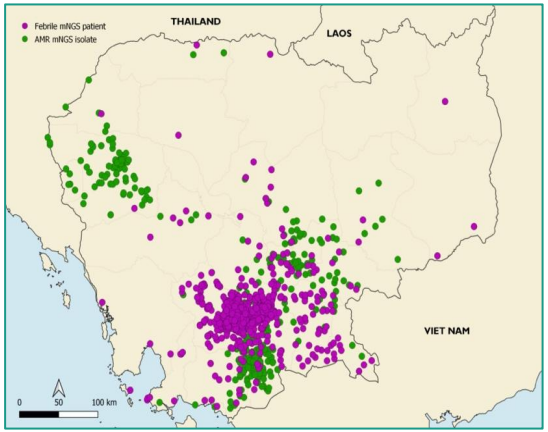



Madera et al. 2022. *Journal of Virology.*

# Field application: Understanding pathogen landscape

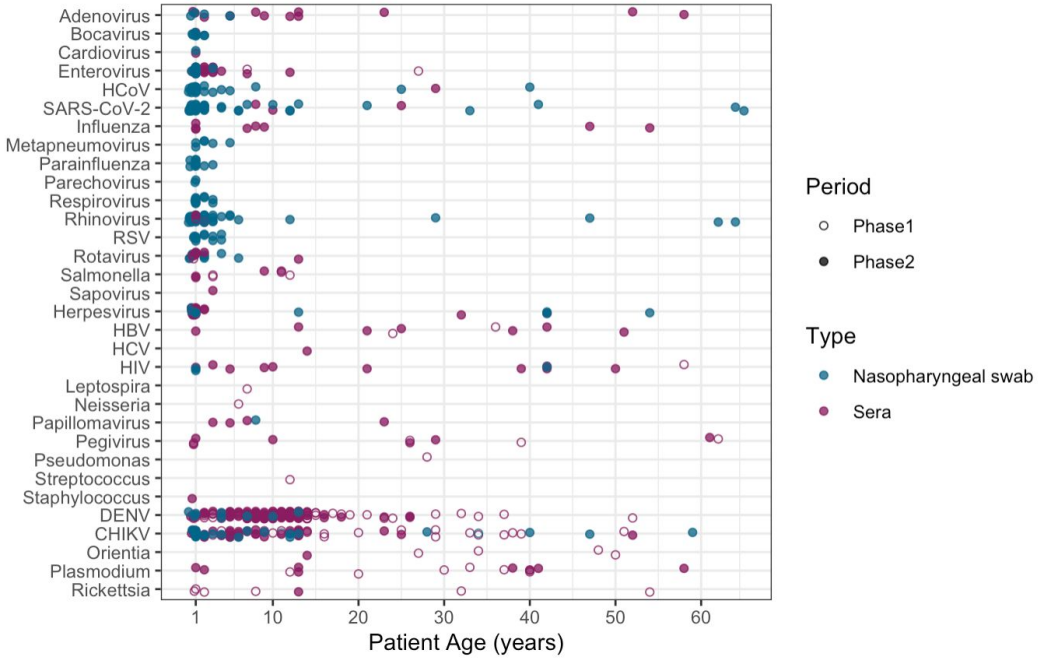
PI: Jessica Manning
NIAID ICER CAMBODIA

*Pathogen Metagenomics in the Mekong: A Multi-faceted Approach to Improve Public Health*

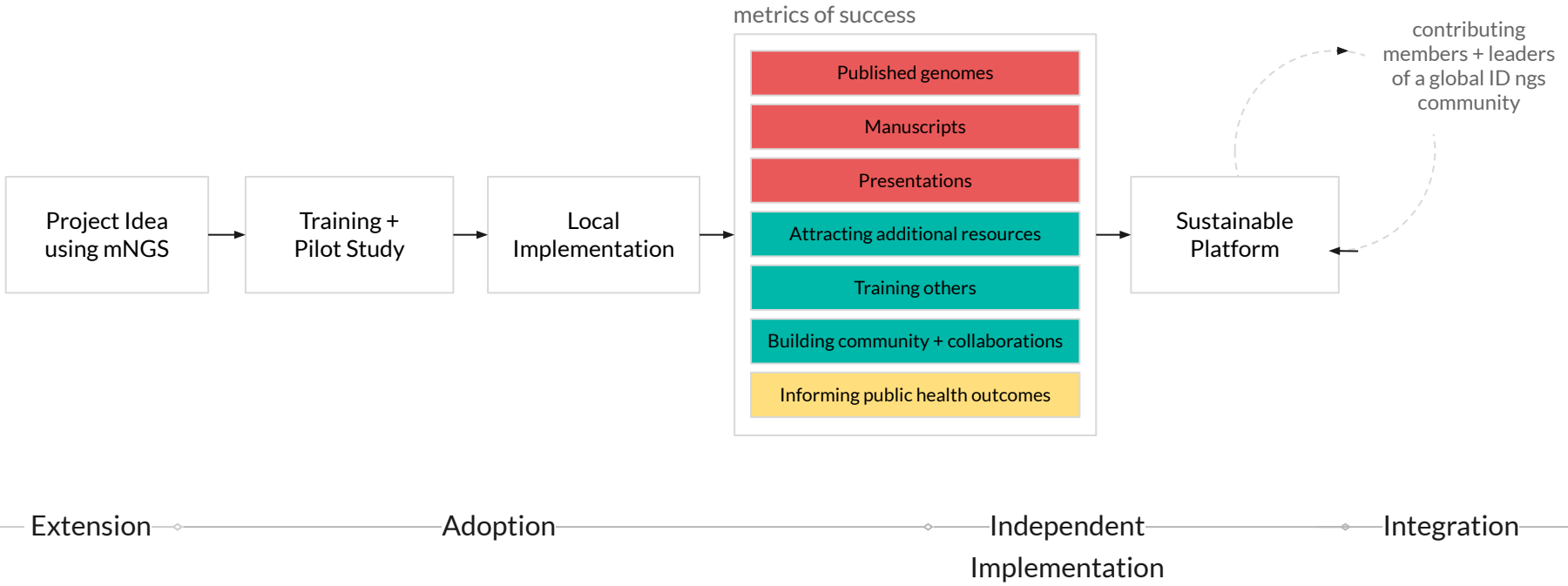



*~2500 patients enrolled, plus 600 clinical isolates*

Building a pathogen landscape of Cambodia to inform public health decisions around drug, vaccine, and vector control priorities

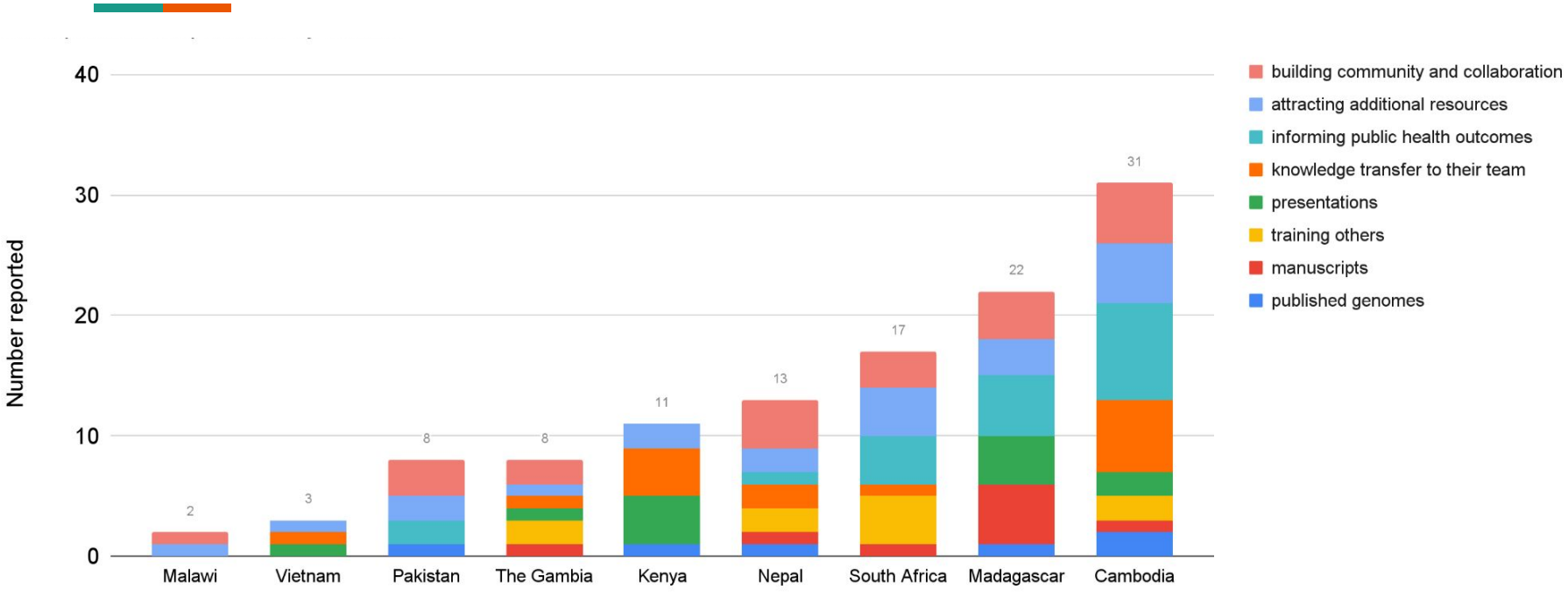


# Will this be sustainable?




Katrina Kalantar

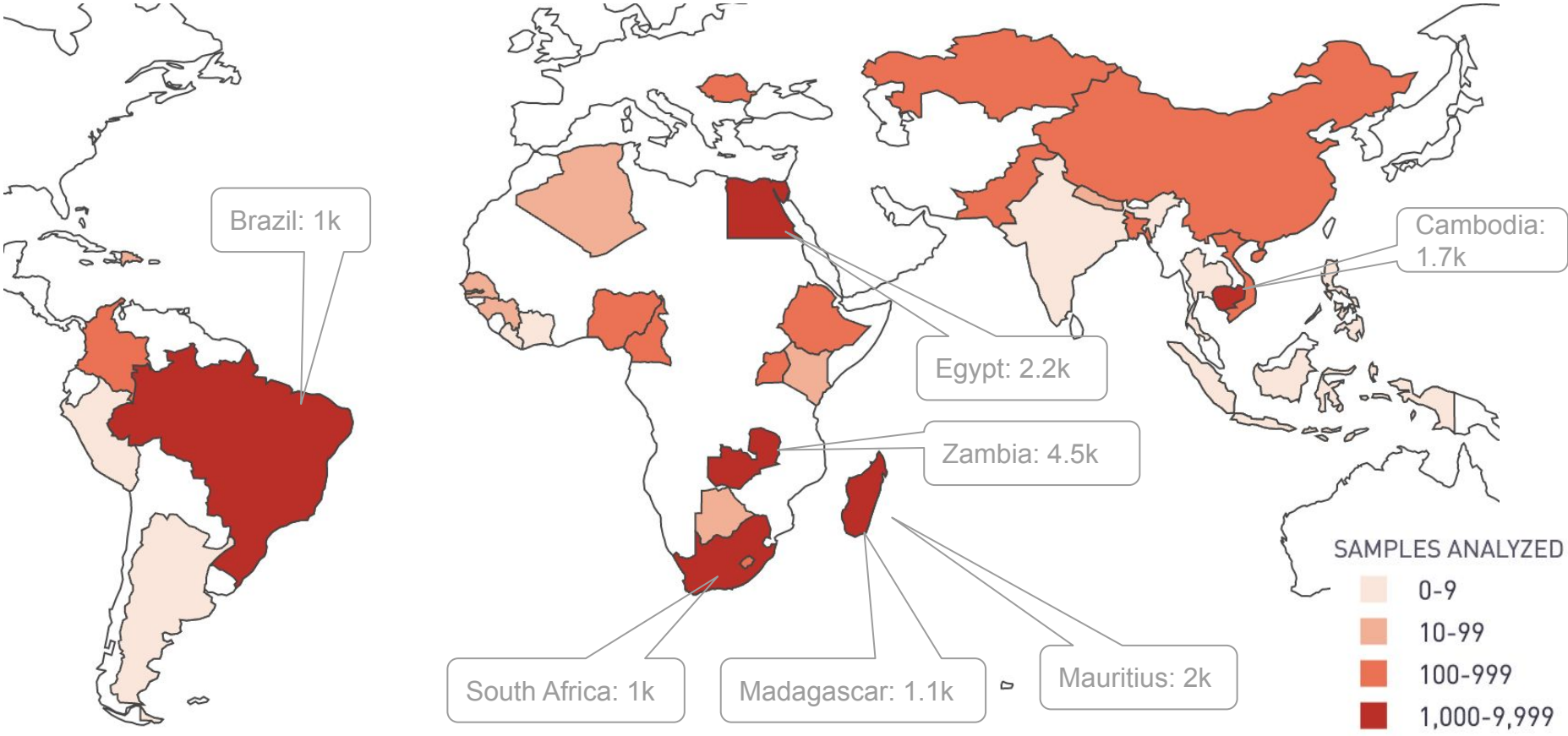
# Metrics of success




Amy Krystosik

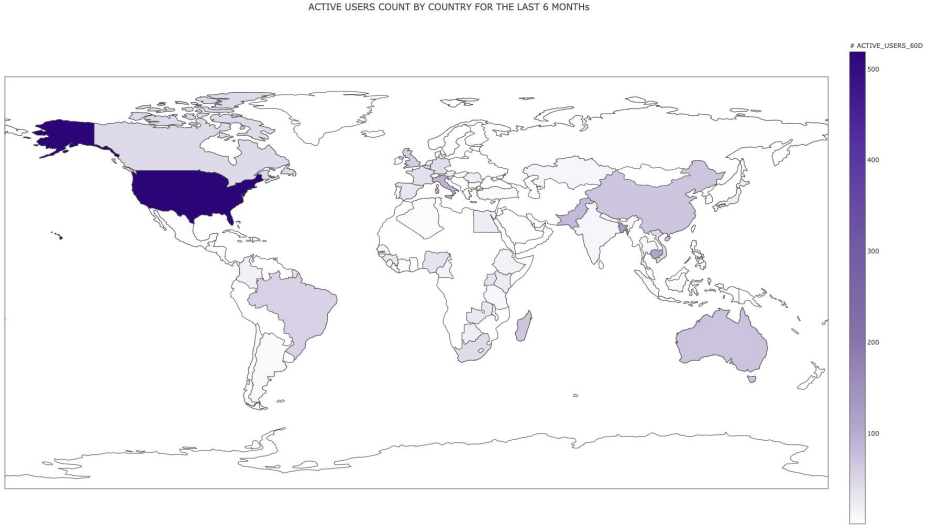
# Samples uploaded: LMIC users, March - August 2022

125 users from 36 LMIC countries uploaded 19k samples



# CZ ID Users

(2018 - Aug 2022)




**1181** Independent users

**73** countries

+63 Additional Countries

Genomics platform for mNGS, WGS, AMR and CG for ONT and Illumina

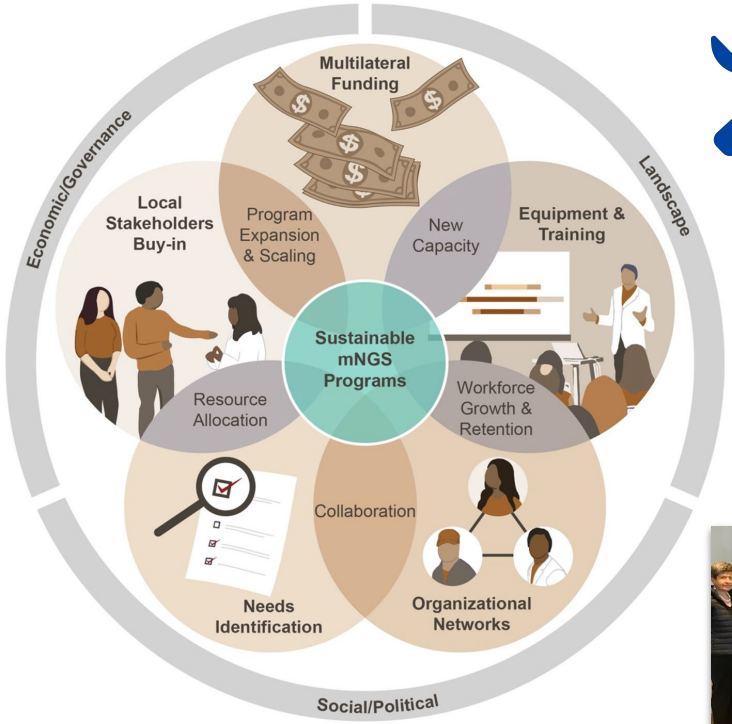
↗3 more analyses pipelines, 1 more sequencing platform

Groups are using CZ ID as a training tool

**121** Citations

# Working towards sustainable disease surveillance in LMICs.

- WHO Hub
- Africa CDC
- Regional Pathogen Genomics Initiatives
- Veterinary Medicine




- Identify pathogens
- Understand how the pathogen landscape is changing
- Inform diagnostic workflow
- Enable better public health resource management & prioritization

Chan Zuckerberg Initiative

CHAN ZUCKERBERG BIOHUB

## Infectious Disease Technology Team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Ryan Lim


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Bill & Melinda Gates Foundation
Farhad Imam

CHRF, Bangladesh
ICER, Cambodia
IPC, Madagascar
All of our GCE partners

Cori, Joe, Steve and Sandy