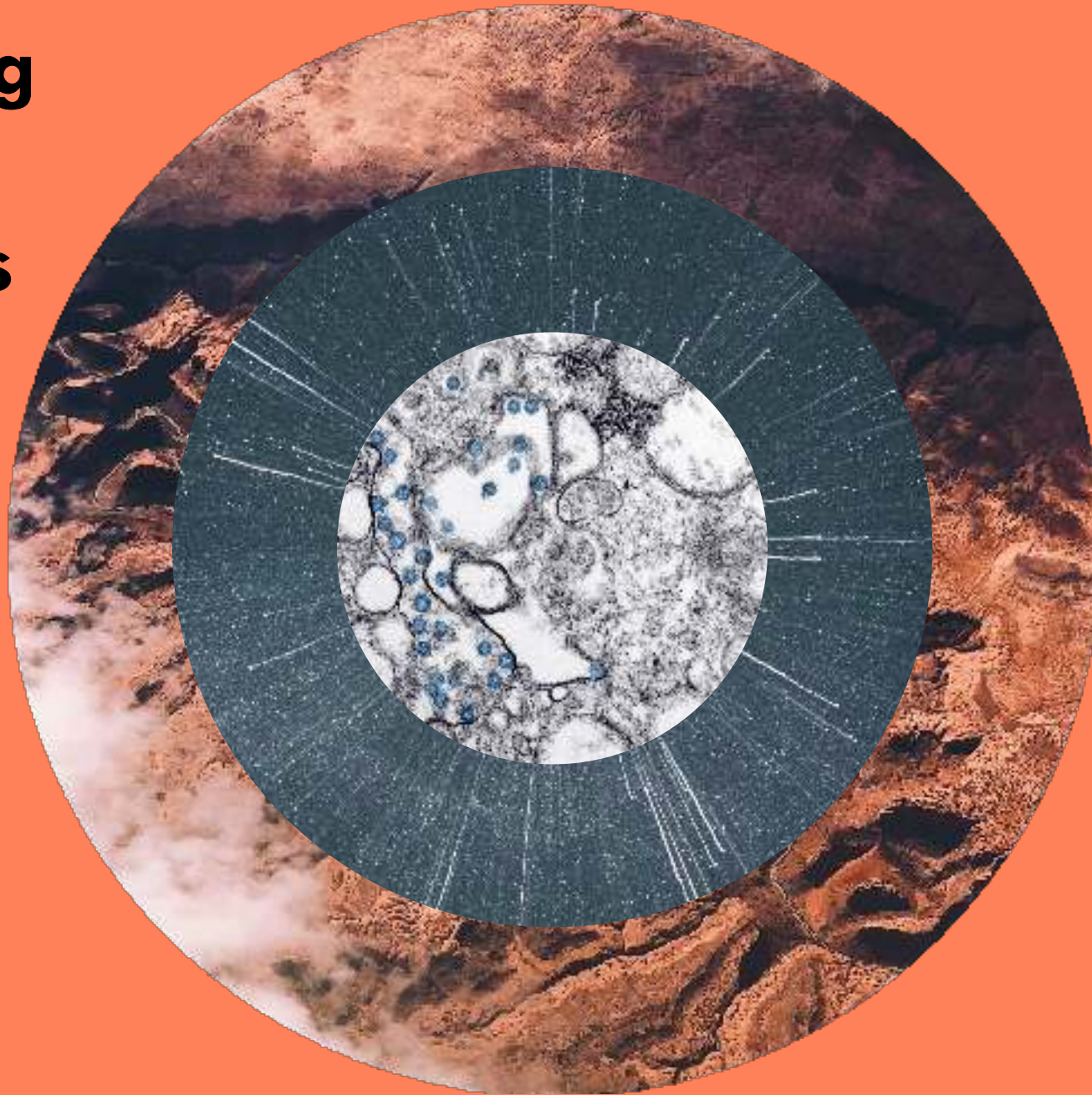


Early Warning for Pandemic Preparedness



**Briefing for the
United Nations
General Assembly
February 7, 2023**

Pandemic Preparedness Speakers



Presenters

- **James Golden, PhD** – Chief Data Officer, The Rockefeller Foundation (USA)
- **Niamh B. O'Hara, PhD** – Research Assistant Professor SUNY Downstate Health Sciences University, CEO and Cofounder Biotia (USA)
- **Rafael Maciel-de-Freitas, PhD** – Researcher in Public Health Instituto Oswaldo Cruz, Fiocruz and Institute for Tropical Medicine (Brazil, Germany)

Respondents

- **Soojin Jang, PhD** – Founder and Head of the Antibacterial Resistance Laboratory at Institut Pasteur (South Korea)
- **Dr. Maria Almiron** – Unit Chief of Health Emergency Information and Risk Assessment, WHO Regional Office for the Americas

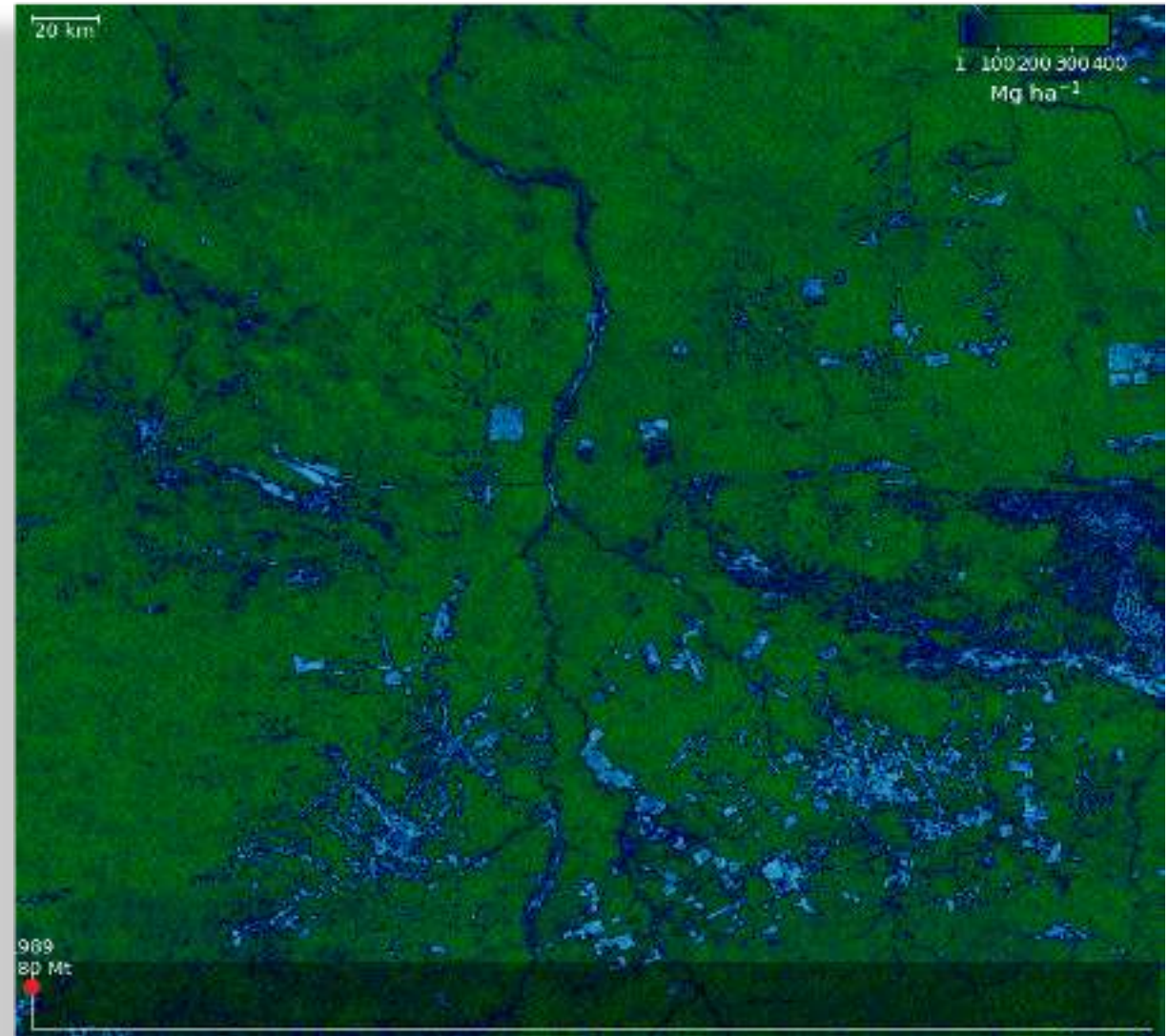
The Need for an Early Warning System

- The COVID-19 pandemic revealed global health, social systems, and economies are linked and surprisingly fragile in increasingly interconnected world
- We are witnessing the dismantling of essential infectious disease monitoring programs
- COVID-19 demonstrated the value of community-based data sharing and resultant scientific insights



Climate and Land Use Changes Drive Risk

- More than half of all infectious diseases could be made worse by climate change
- This is especially evident for vector borne-infections, such as infections spread by mosquitoes as their habitats and breeding grounds expand
- Additionally, we are experiencing rising rates of drug resistance in many of the pathogens causing these infections
- Despite these complexities, the factors leading to pandemics are largely predictable





Advances in Technology

Fortunately, dramatic improvements in computational technology, access to growing numbers of digital data resources, and an increasing pool of global talent, have catalyzed significant breakthroughs in quantitative research over the last 30 years



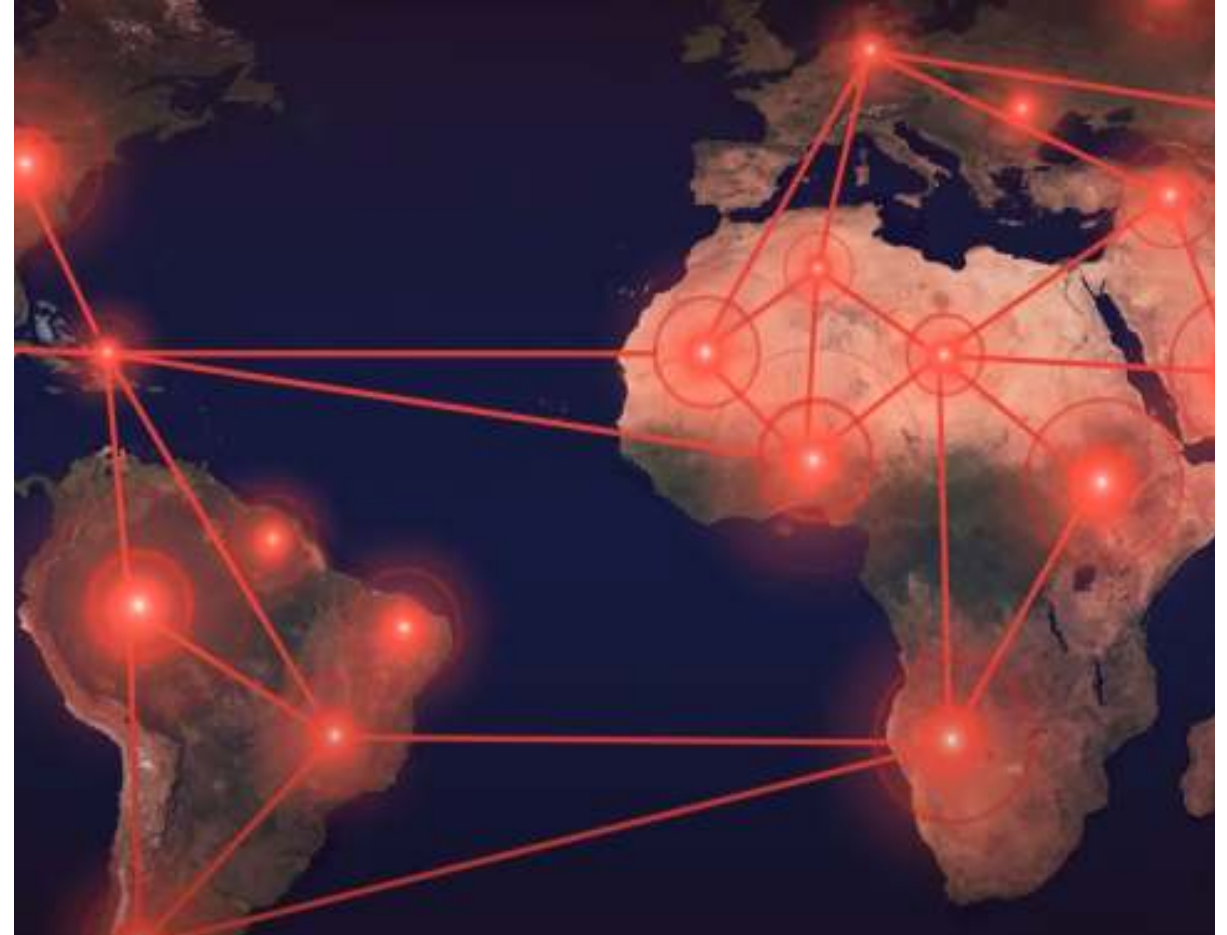
Data Philanthropy and Data Logistics

- This platform needs to be framed around *global data philanthropy* and a *modern logistics of data*
- This system will ingest many kinds of data from many sources - climate, land and water use, mobility and travel, social determinants, epidemiological, and microbial genomics data
- We must respect national data sovereignty and personal privacy, while creating the foundation for predictive modeling, simulation and optimization



Key Take-Aways

- There is an urgent need for ongoing pathogen surveillance and global early warning
- Any platform will need to include data from outside of traditional public health epidemiology, specifically data about land and water use changes affected by climate
- This will require us to adopt a philosophy of *global data philanthropy* and a new logistics of data for locally sourced information



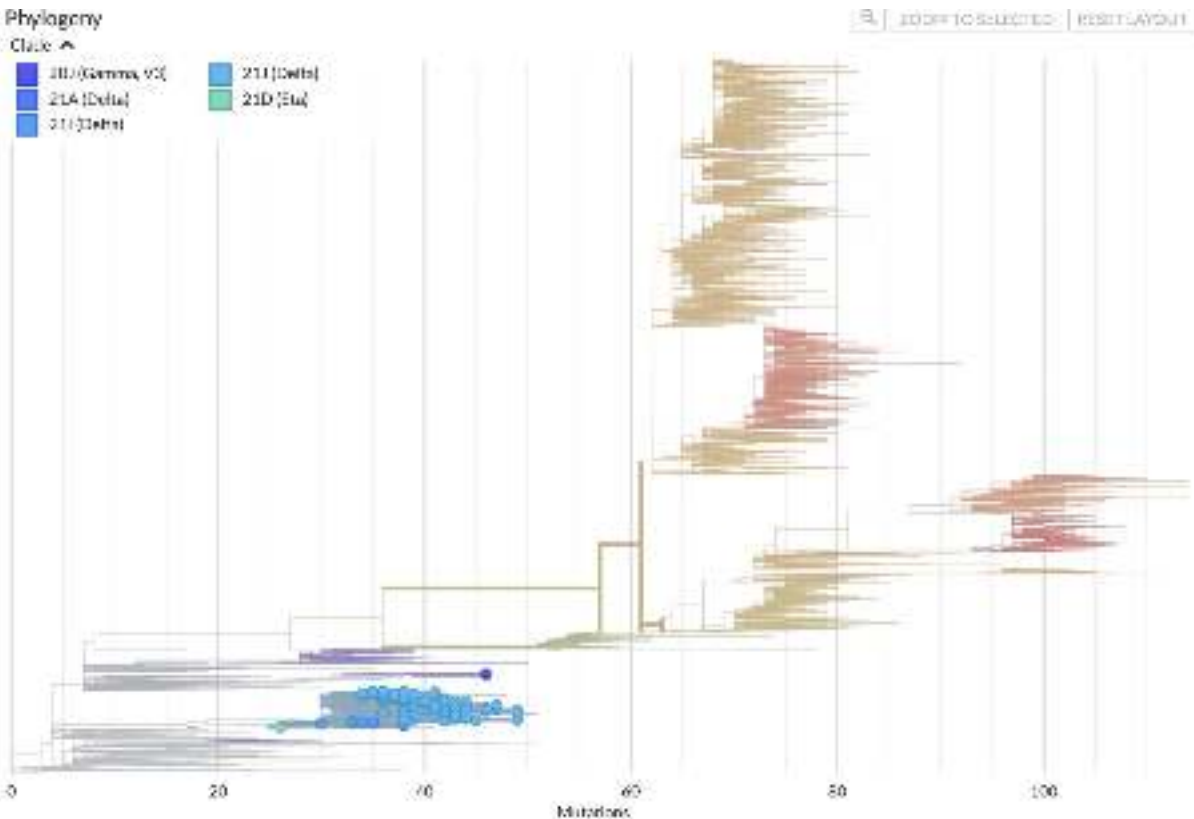
The role of genomics and the need for other key data streams

Why Genomics?

- All living things, including pathogens, contain genetic material (DNA, RNA)
- That genetic material in an organism, collectively, is called a genome
- We use genomics, the study of genetic material, to identify and *understand* pathogens



Genomics at Work for SARS-CoV-2



See how a virus is evolving → inform public health response

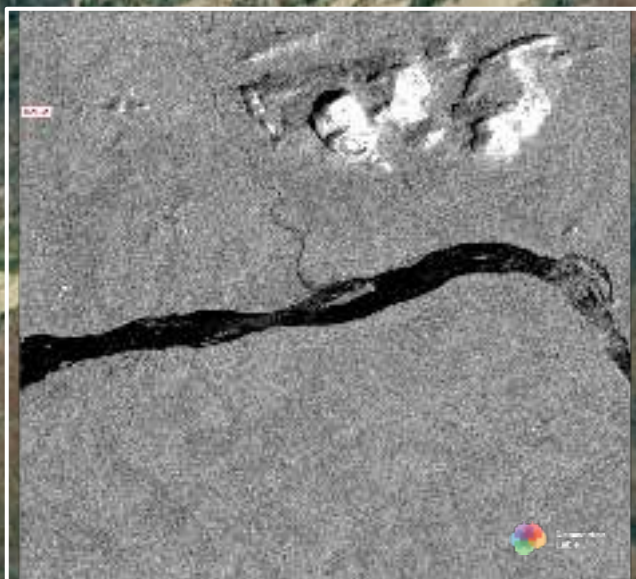
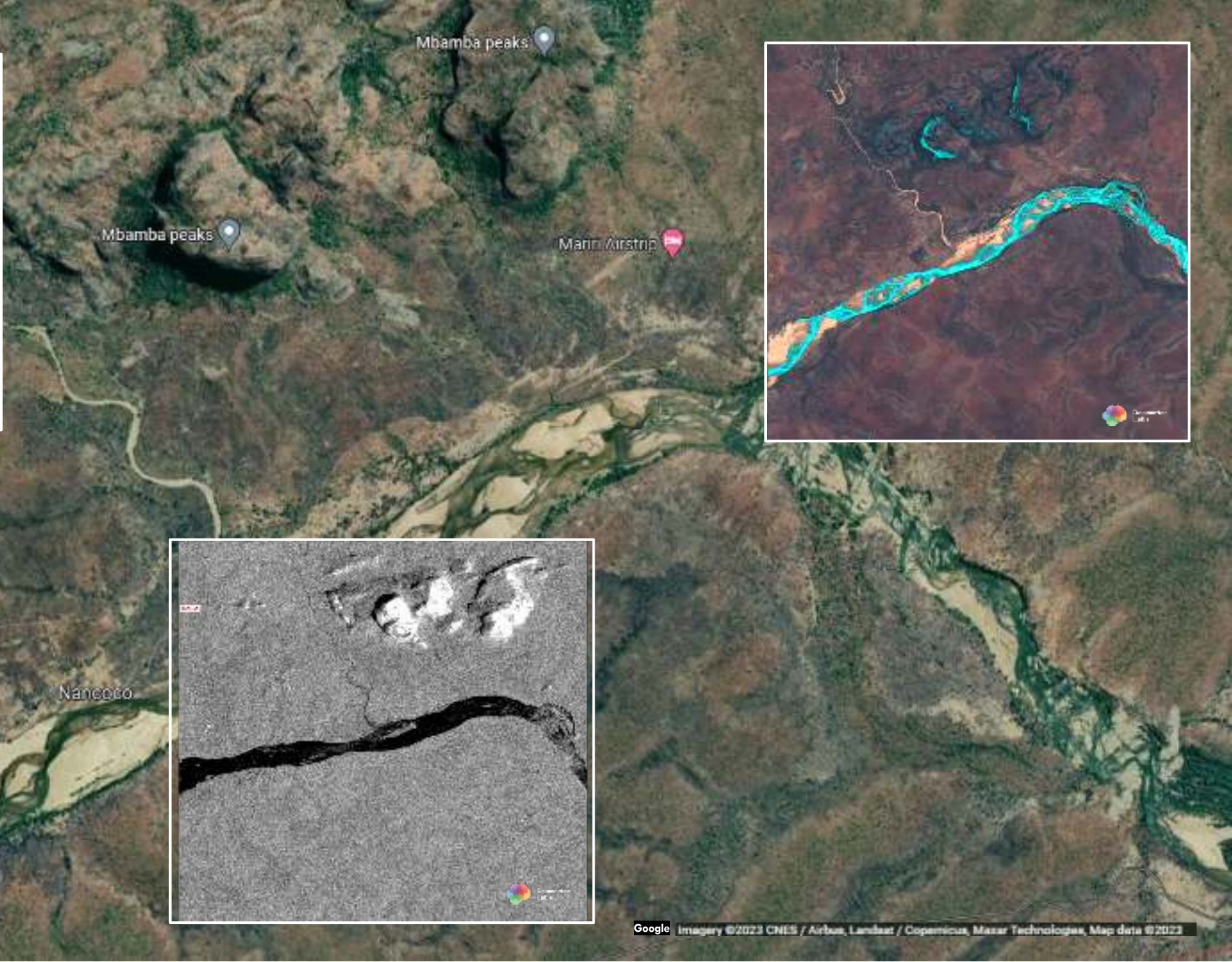
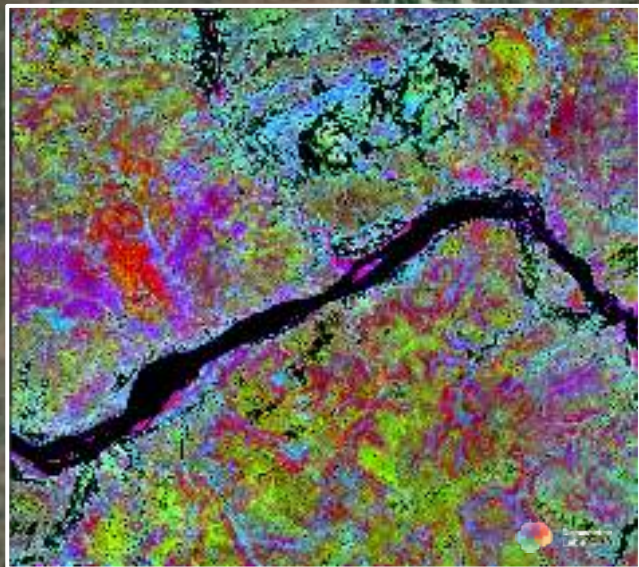
Global Genomics Networks



Pathogen Watchtower Program

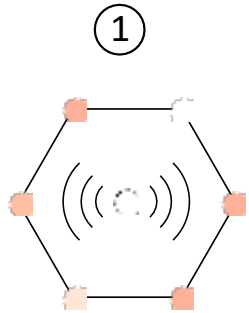


But genomics
doesn't tell the
whole story



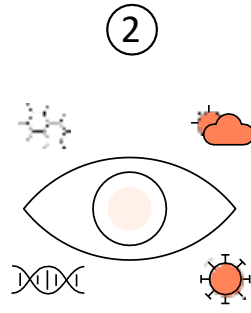
Components of an Early Warning System

Pandemic Early Warning System



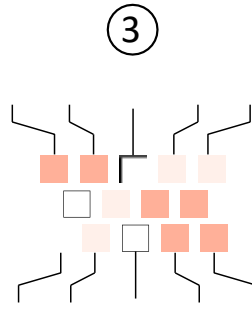
Drivers_

Climate change, other environmental disruptions, biodiversity loss, globalization, and social determinants of health



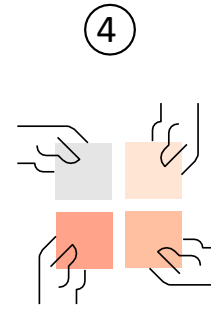
Data streams_

Datastreams should be varied and include Earth observation data, climate, epidemiological, genomic, biodiversity, human mobility, socioeconomic data, media



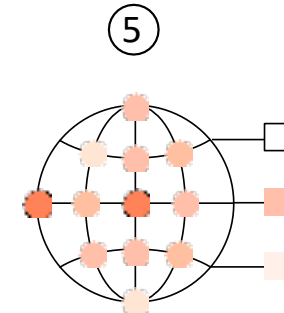
Structure_

Data is harmonized within a "federated system". Insights are connected and data sovereignty is preserved. Important for international collaboration



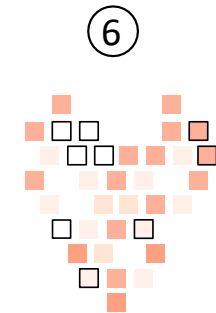
Community_

Data analyzed using community-sourced analysis tools, community-driven, distributed teams develop data science for their specific use cases, open platform



Output_

Risk map and reports for public health agencies, integration to inform responses, coordination of resources, vector control, data for development of diagnostics and vaccines

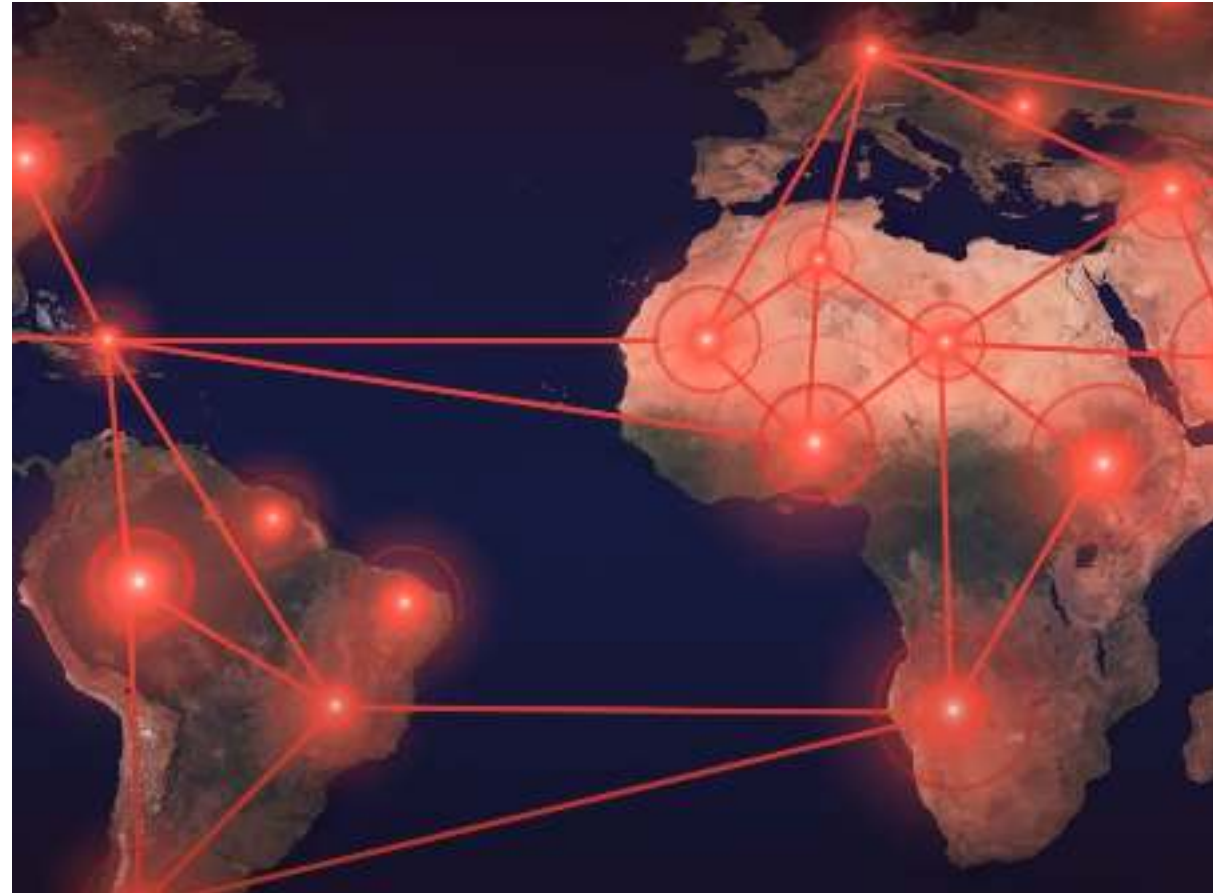


Impact_

Data-driven decisions, improved public health, and patient health outcomes

Key Take-Away

Genomics provides powerful insights into infectious disease dynamics, but an early warning system benefits from incorporating varied data streams including from Earth observation, epidemiology, climate, and social determinants of health



Biosurveillance and mosquitoes in Brazil

Mosquito-Borne Diseases

- >17% of all infectious diseases are vector-borne causing >700K deaths annually¹
- Common vector-borne diseases include malaria, dengue, chikungunya, Zika, yellow fever, and West Nile
- Dengue most prevalent viral infection transmitted by urban *Aedes* mosquitoes
- Climate change and land use changes have been shown to alter and increase vector-borne infectious disease rates²

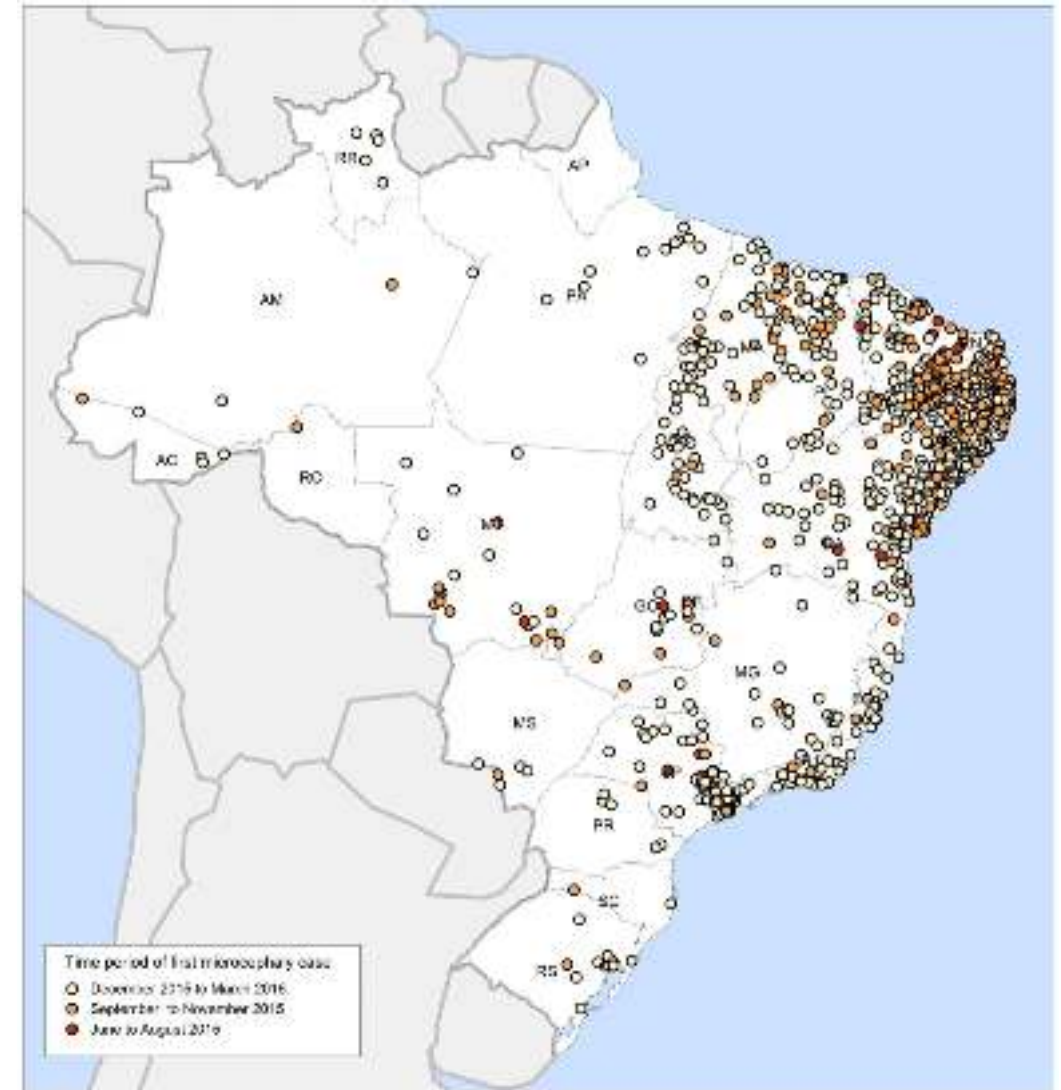


Source: James Gathany, CDC

¹ <https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases>; ² <https://wellcome.org/news/how-climate-change-affects-vector-borne-diseases>

Ex 1: Brazil and Zika

- Potential entry during mass gathering events at the Canoe Race 2013 or FIFA World Cup in 2014
- The Northeastern region accounted for 83% of Zika cases in Brazil (2015-2016). More than 1700 newborns with congenital Zika syndrome
- Transmission by *Aedes aegypti* mosquito, present in high densities in urban settings
- An early warning system would have helped



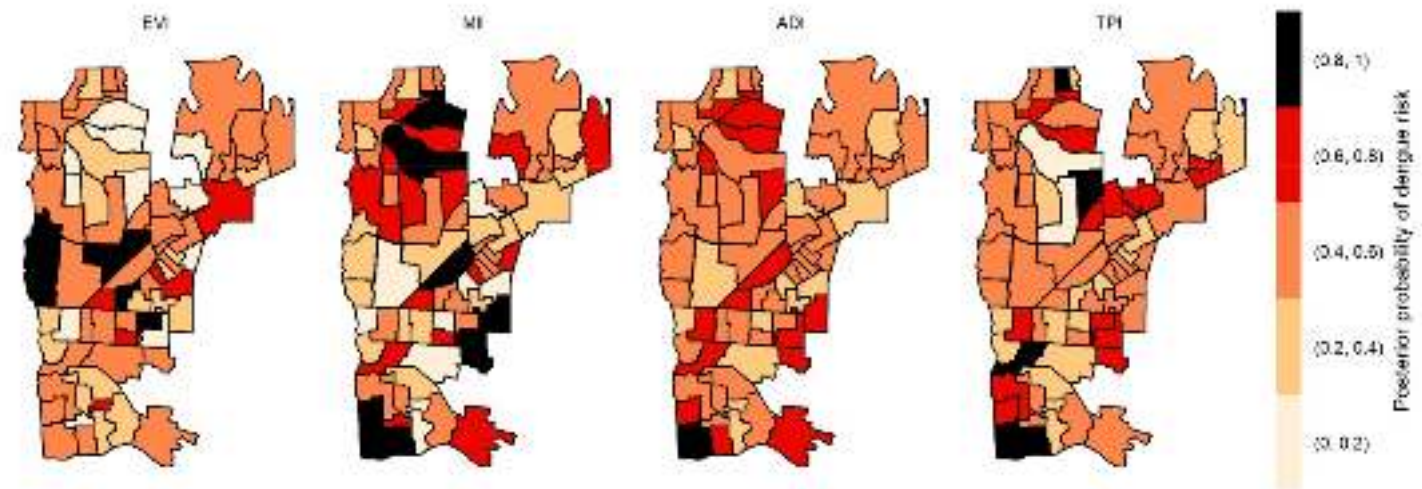
Ex 2: Brazil and Yellow Fever

- Yellow fever virus transmission once restricted to the Amazon region
- Reduction of a 'Safe Zone' in the last years
- Causes are multifold: low vaccination coverage outside the Amazon, high primate diversity, competent mosquito vectors, failure in surveillance (monitoring death of non-human primates)
- > 2000 cases; >700 deaths 2017-2018



Mosquitoes and Early Warning Systems

- Data gathered from mosquito traps between 2017-2022: >85,000 trap inspections
- One city in Brazil: Foz do Iguaçu
- Geospatial modeling: we know when but not where
- Need to think bigger: from city to States, to country, to global
- Data from multiple sources



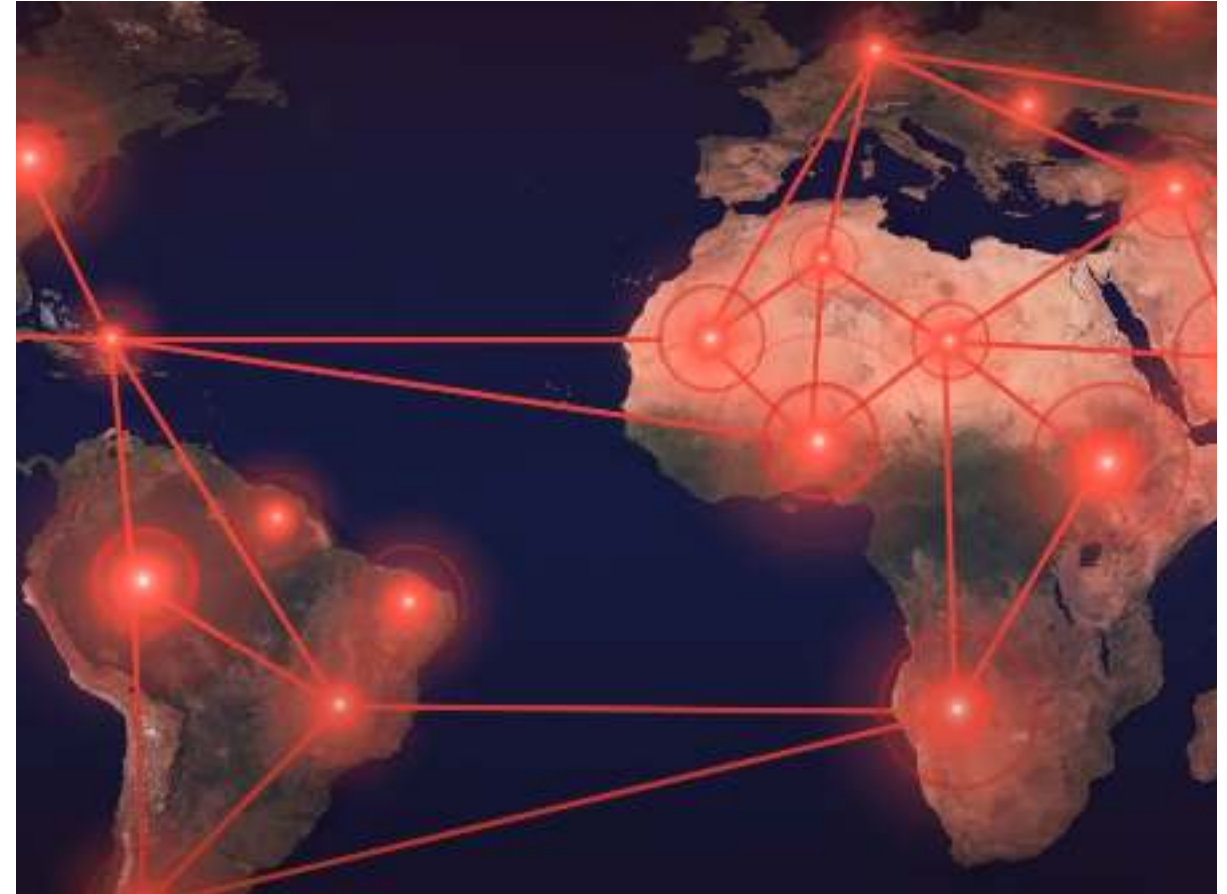
Surveillance for Mosquito-borne Diseases

- Viruses of mosquitoes collected in urban, transition, and native environments of 6 cities of Brazil, representing a range biomes
- Savannah, wetlands, rainforest, deforested areas in agricultural frontier and forest fragments
- Connecting biosurveillance data with climate data
- Nationwide mosquito virus surveillance → global early warning system



Overall Key Take-Aways

- Adopt a philosophy of global data philanthropy and a new logistics of data for locally sourced information
- Genomics provides powerful insights into infectious disease dynamics, but an early warning system benefits from incorporating varied data streams including from Earth observation, epidemiology, climate, and social determinants of health
- Vector-borne diseases have complex transmission cycles. An effective early warning system needs to address complexity and be available for local public health teams to guide further interventions



To Learn More



Paper under peer-review with pre-print
for download using QR code above or at
<https://arxiv.org/abs/2302.00863>



Our group has been building an
early warning system. Please reach
out to collaborate.

<https://www.geoseeq.com/>

Acknowledgements

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