



CLIMATE SERVICES FOR HEALTH:
*A TRANSDISCIPLINARY APPROACH TO DENGUE
FORECASTING WITH DECISION-MAKERS*



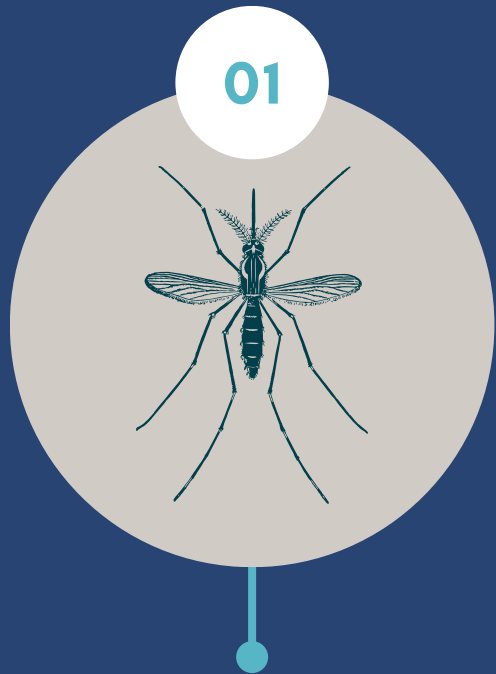
Aedes aegypti:

- Vector for dengue, Zika, chikungunya, & yellow fever
- Lay its eggs in clean, stagnant water
- Breeding sites include water containers, flower pots, tires etc.
- Daytime biter, with peak periods between morning & dusk

CLIMATE AND VBDS

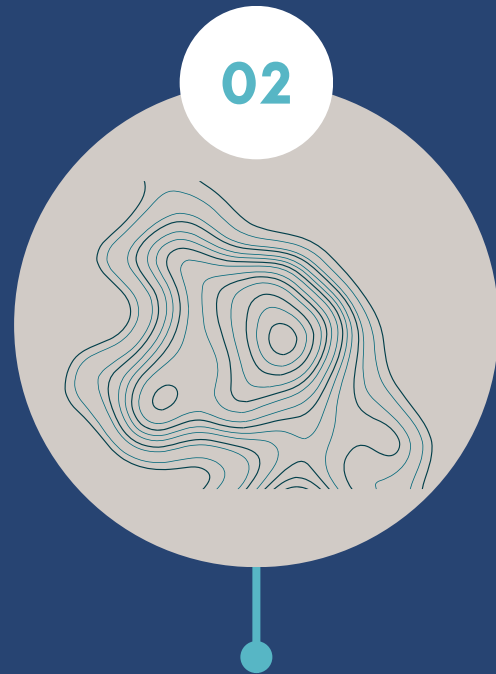
Climate change and natural variability impact disease risk in the following ways:

01



**INCREASED VECTOR
ABUNDANCE**

02



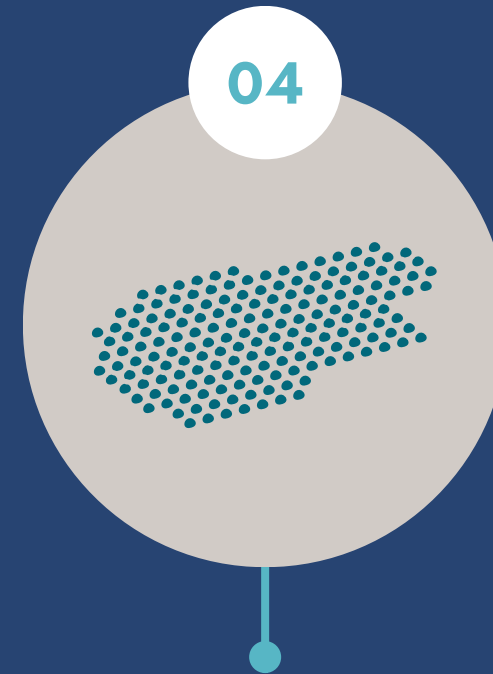
**EXPANDED
GEOGRAPHIC RANGE**

03



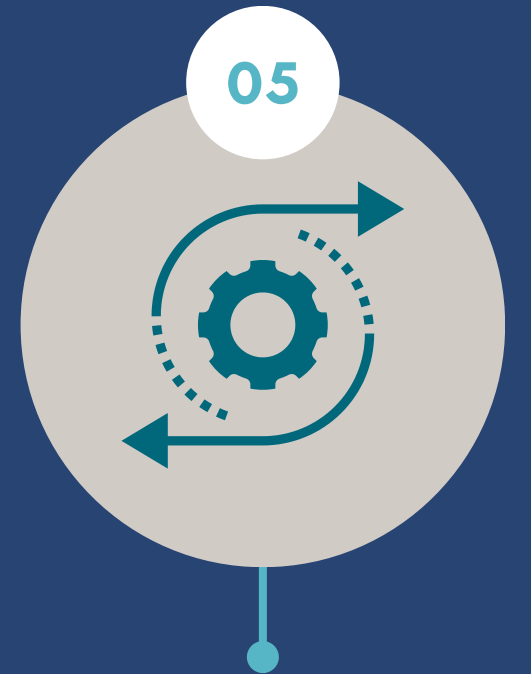
**INCREASED HABITAT
DISTRIBUTION**

04



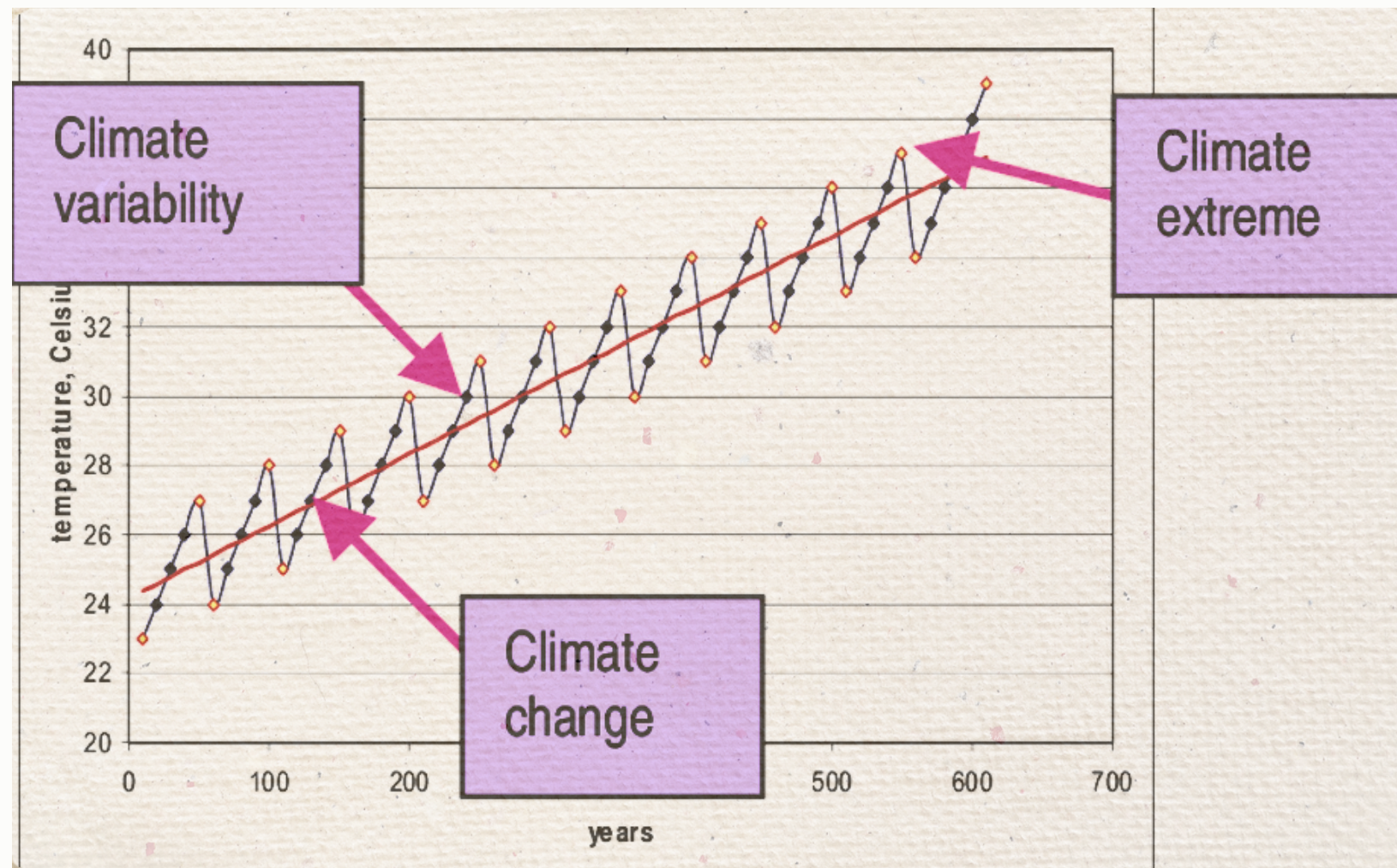
INCREASED VIRILITY

05



BEHAVIOR CHANGES

CONSIDERING BOTH CLIMATE CHANGE AND NATURAL CLIMATE VARIABILITY CAN BE CRUCIAL FOR UNDERSTANDING DENGUE TRANSMISSION.



- Essential for models to consider both long-term climate change trends and short-term natural climate variability.
- Only considering one might lead to incomplete or inaccurate predictions.
- It is important to allocate resources for both immediate threats and long-term challenges.



Landscape mapping of software tools for climate- sensitive infectious disease modelling

Inter-American Institute for Global
Change Research: IAI



Too many climate tools remain academic exercises.

Why?

Lack of true co-production methodology, aka not listening to the demand identified by decision makers to create useful and usable services.

- In 2021 we conducted a landscape analysis with Wellcome Trust on available climate tools for infectious diseases
- We found that over the last ten years, of the **9,500 papers** identified in the literature, only **37 tools** were available to decision makers.

The current landscape of software tools for the climate-sensitive infectious disease modelling community



Sadie J Ryan*, Catherine A Lippi*, Talia Caplan, Avriel Diaz, Willy Dunbar, Shruti Grover, Simon Johnson, Rebecca Knowles, Rachel Lowe, Bilal A Mateen, Madeleine C Thomson, Anna M Stewart-Ibarra

Climate-sensitive infectious disease modelling is crucial for public health planning and is underpinned by a complex network of software tools. We identified only 37 tools that incorporated both climate inputs and epidemiological information to produce an output of disease risk in one package, were transparently described and validated, were named (for future searching and versioning), and were accessible (ie, the code was published during the past 10 years or was available on a repository, web platform, or other user interface). We noted disproportionate representation of developers based at North American and European institutions. Most tools (n=30 [81%]) focused on vector-borne diseases, and more than half (n=16 [53%]) of these tools focused on malaria. Few tools (n=4 [11%]) focused on food-borne, respiratory, or water-borne diseases. The under-representation of tools for estimating outbreaks of directly transmitted diseases represents a major knowledge gap. Just over half (n=20 [54%]) of the tools assessed were described as operationalised, with many freely available online.

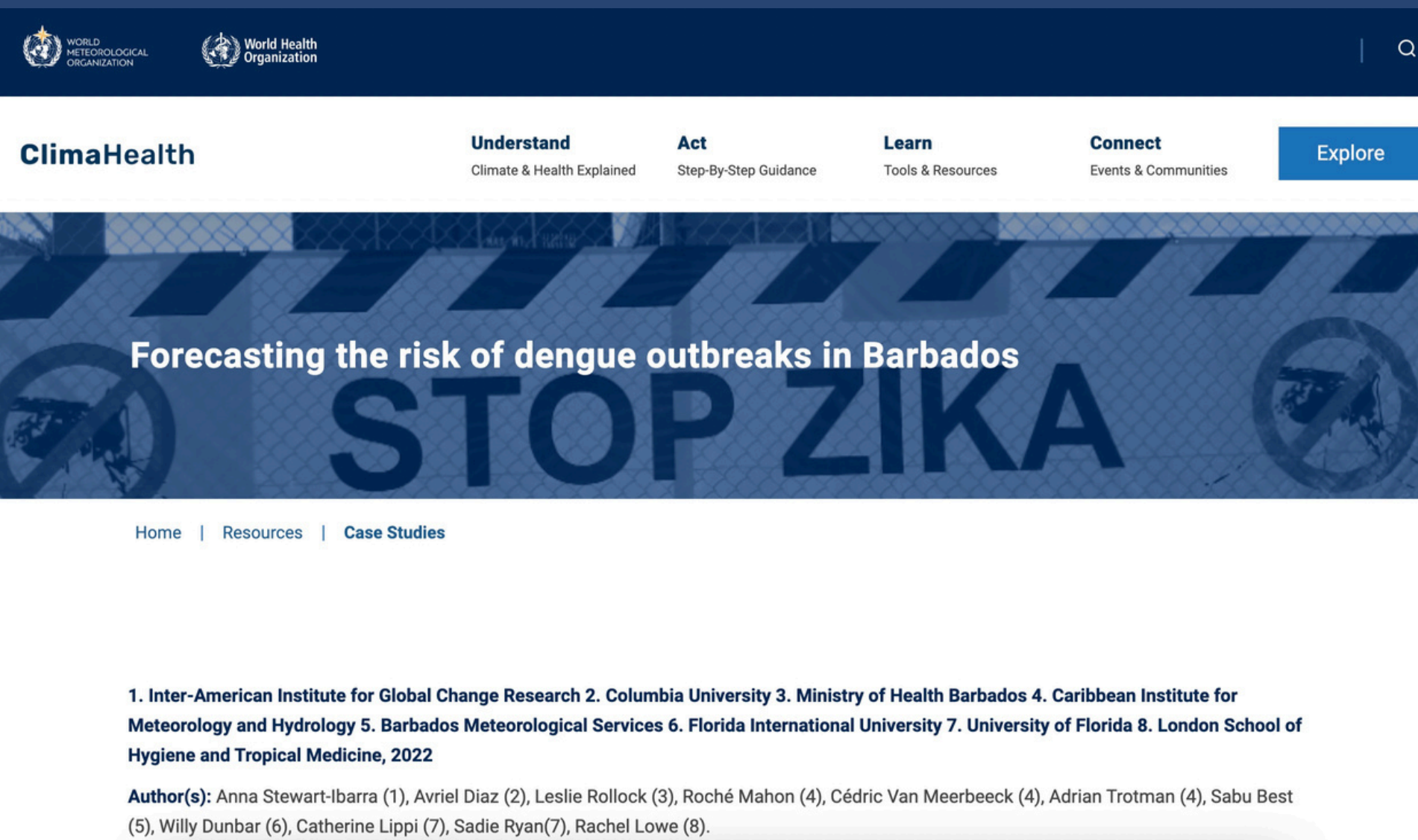
Lancet Planet Health 2023;
7: e527-36

*Contributed equally
Quantitative Disease Ecology
and Conservation Laboratory
Group, Department of
Geography (S J Ryan PhD,
C A Lippi PhD) and Emerging
Pathogens Institute
(S J Ryan, C A Lippi), University
of Florida, Gainesville, FL, USA;
The Wellcome Trust, London,

STATE OF CLIMATE AND HEALTH - BARRIERS TO DECISION MAKERS



CLIMATE AND HEALTH PARTNERS & STAKEHOLDERS IDENTIFIED SEVERAL IMPLEMENTATION CHALLENGES:



The screenshot shows the ClimaHealth website header with logos for the World Meteorological Organization and the World Health Organization. The navigation bar includes links for 'Understand', 'Act', 'Learn', 'Connect', and 'Explore'. The main content area features a banner for 'Forecasting the risk of dengue outbreaks in Barbados' with a 'STOP ZIKA' graphic. Below the banner is a breadcrumb trail: 'Home | Resources | Case Studies'. The footer lists eight partner organizations and the authors of the case study.

ClimaHealth

Understand
Climate & Health Explained

Act
Step-By-Step Guidance

Learn
Tools & Resources

Connect
Events & Communities

Explore

Forecasting the risk of dengue outbreaks in Barbados

Home | Resources | **Case Studies**

1. Inter-American Institute for Global Change Research 2. Columbia University 3. Ministry of Health Barbados 4. Caribbean Institute for Meteorology and Hydrology 5. Barbados Meteorological Services 6. Florida International University 7. University of Florida 8. London School of Hygiene and Tropical Medicine, 2022

Author(s): Anna Stewart-Ibarra (1), Avriel Diaz (2), Leslie Rollock (3), Roché Mahon (4), Cédric Van Meerbeeck (4), Adrian Trotman (4), Sabu Best (5), Willy Dunbar (6), Catherine Lippi (7), Sadie Ryan(7), Rachel Lowe (8).

- Lack of financial resources
- Lack of technical expertise
- Lack of personnel dedicated to climate & health data
- Lack of mandates to address climate-health work
- Lack of formalized partnerships (e.g., MOUs)
- Challenges in translating forecasts into alerts

How can we develop impactful climate services to support decision makers and create more equitable and resilient health systems?

demand driven
+
co-produced & co-delivered
+
transdisciplinary approach

DEMAND IS DEFINED BY COUNTRY PRIORITIES

TRANSDISCIPLINARY SCIENCE APPROACH FOR EARLY WARNING



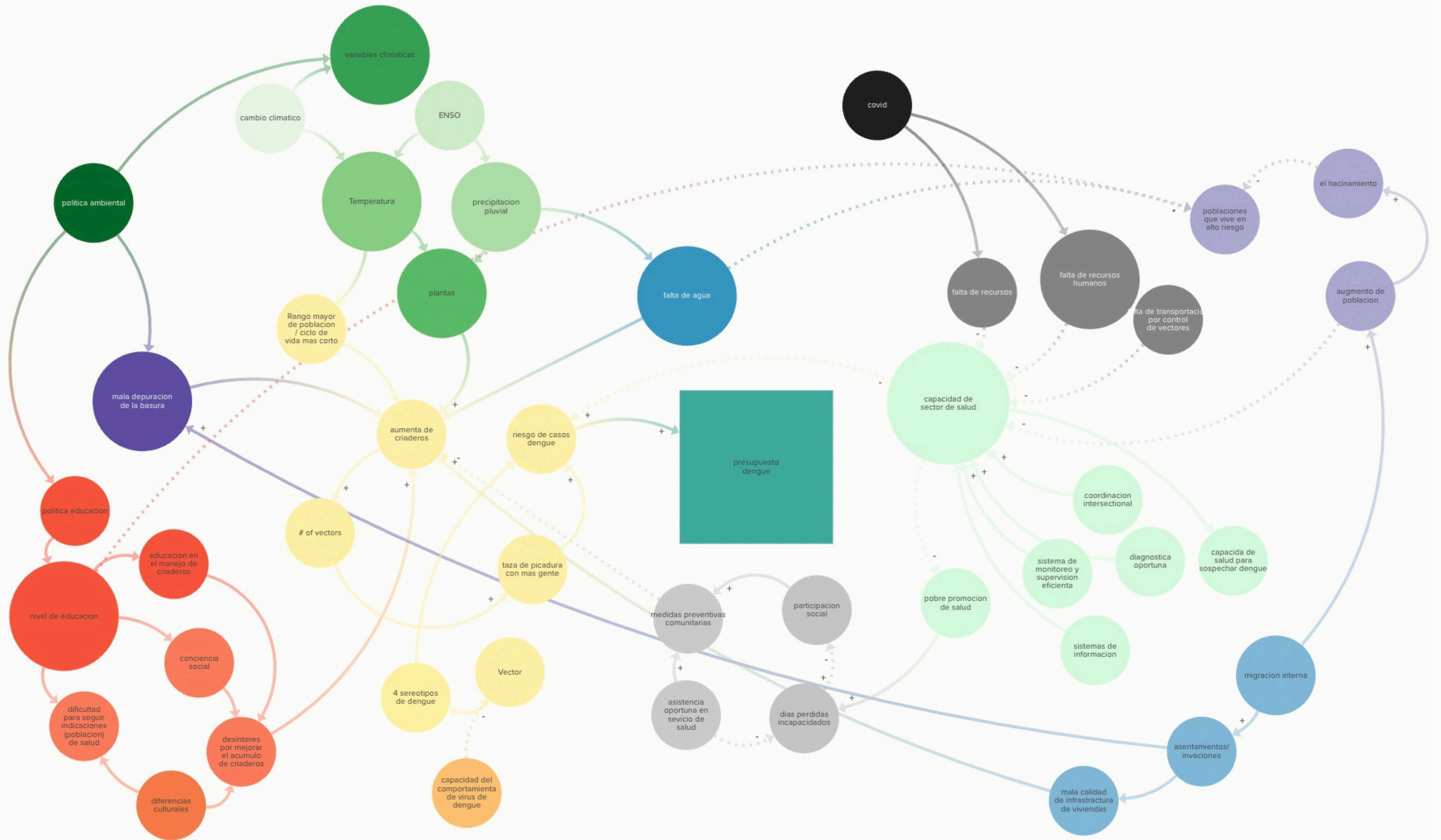
(Diaz et al., 2024)

TRANSDISCIPLINARY
RESEARCH

CONCEPTUAL
MODEL

CANDIDATE
PREDICTORS







> [BMJ Glob Health](#). 2022 Jan;7(1):e007842. doi: 10.1136/bmjgh-2021-007842.

Co-learning during the co-creation of a dengue early warning system for the health sector in Barbados

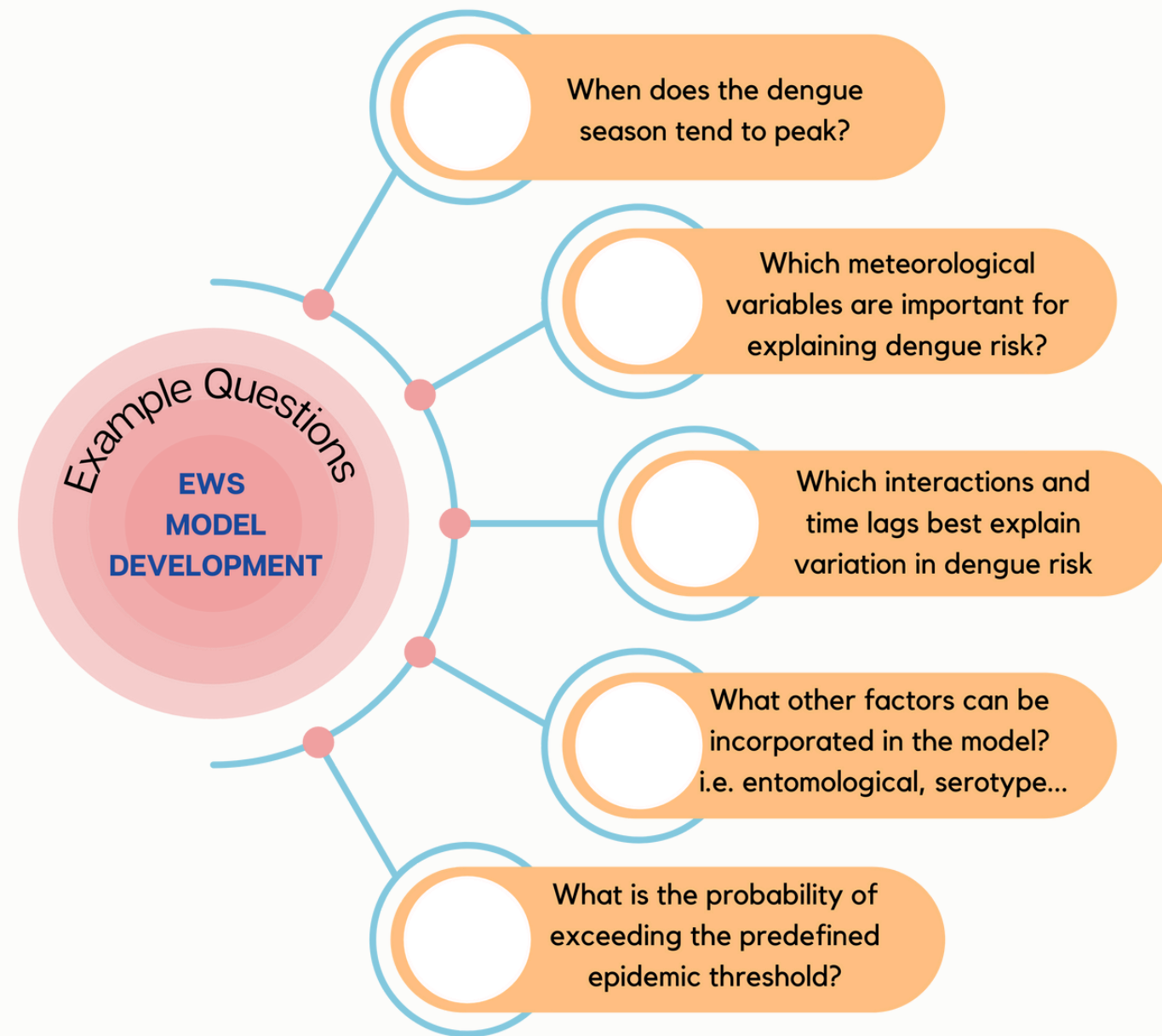
Anna M Stewart-Ibarra ¹, Leslie Rollock ², Sabu Best ³, Tia Brown ³, Avriel R Diaz ⁴,
Willy Dunbar ⁵, Catherine A Lippi ⁶, Roché Mahon ⁷, Sadie J Ryan ⁶, Adrian Trotman ⁷,
Cedric J Van Meerbeeck ⁷, Rachel Lowe ^{8 9 10}

Affiliations + expand

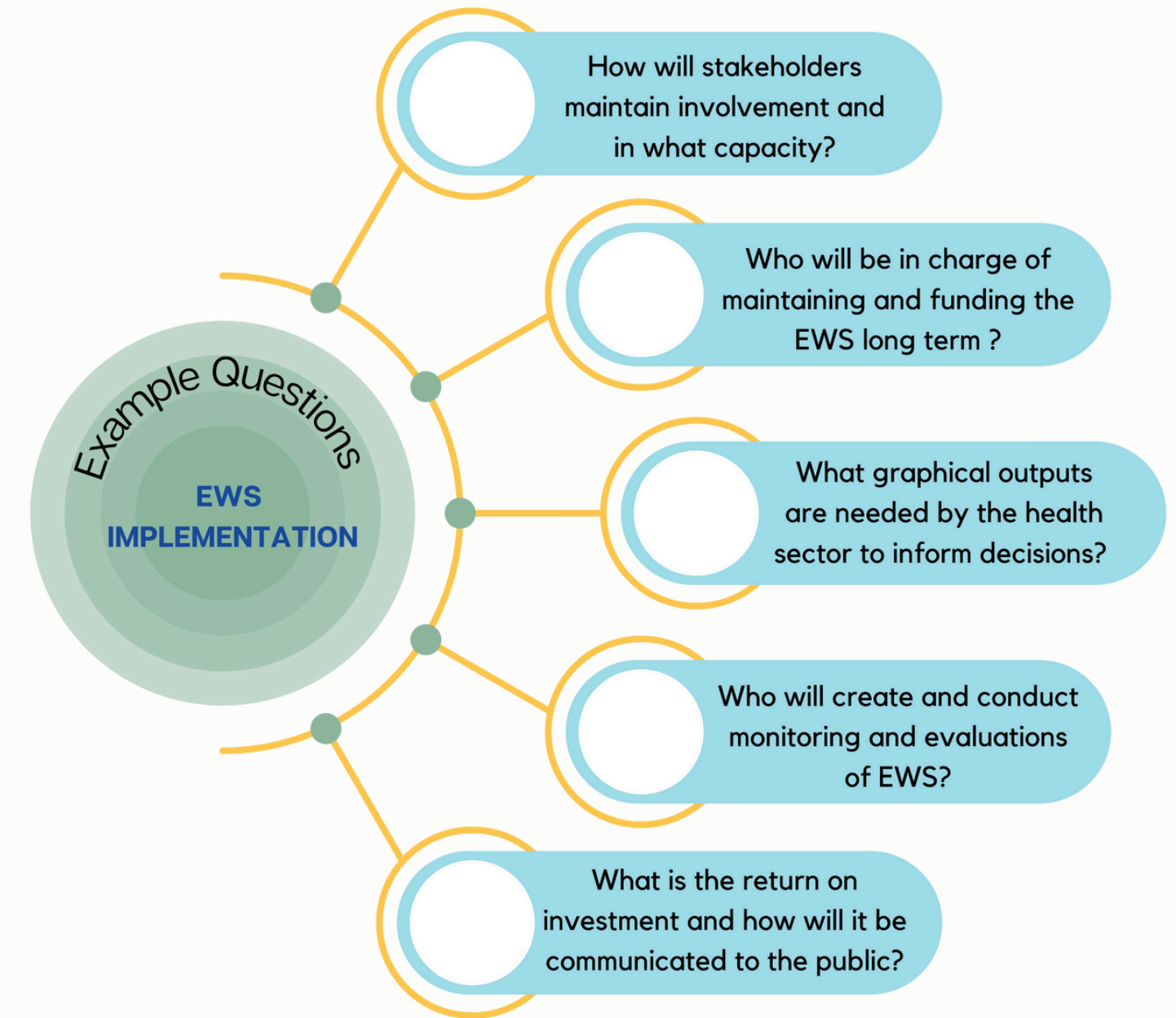
PMID: 34992079 PMCID: [PMC8739055](#) DOI: [10.1136/bmjgh-2021-007842](#)

TOOL

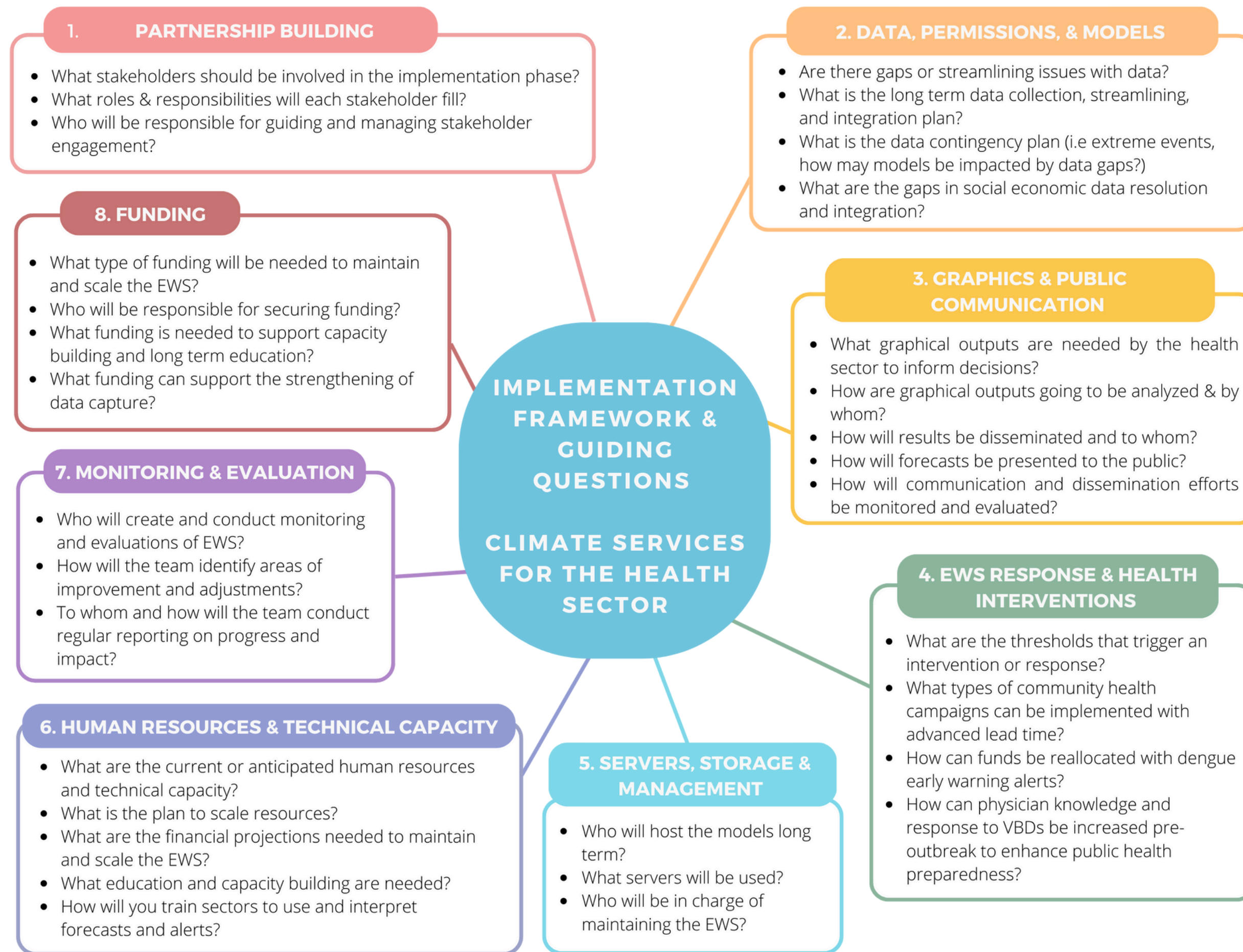
SERVICE & IMPLEMENTATION



(Lowe et al., 2018)



(Diaz et al., 2024)





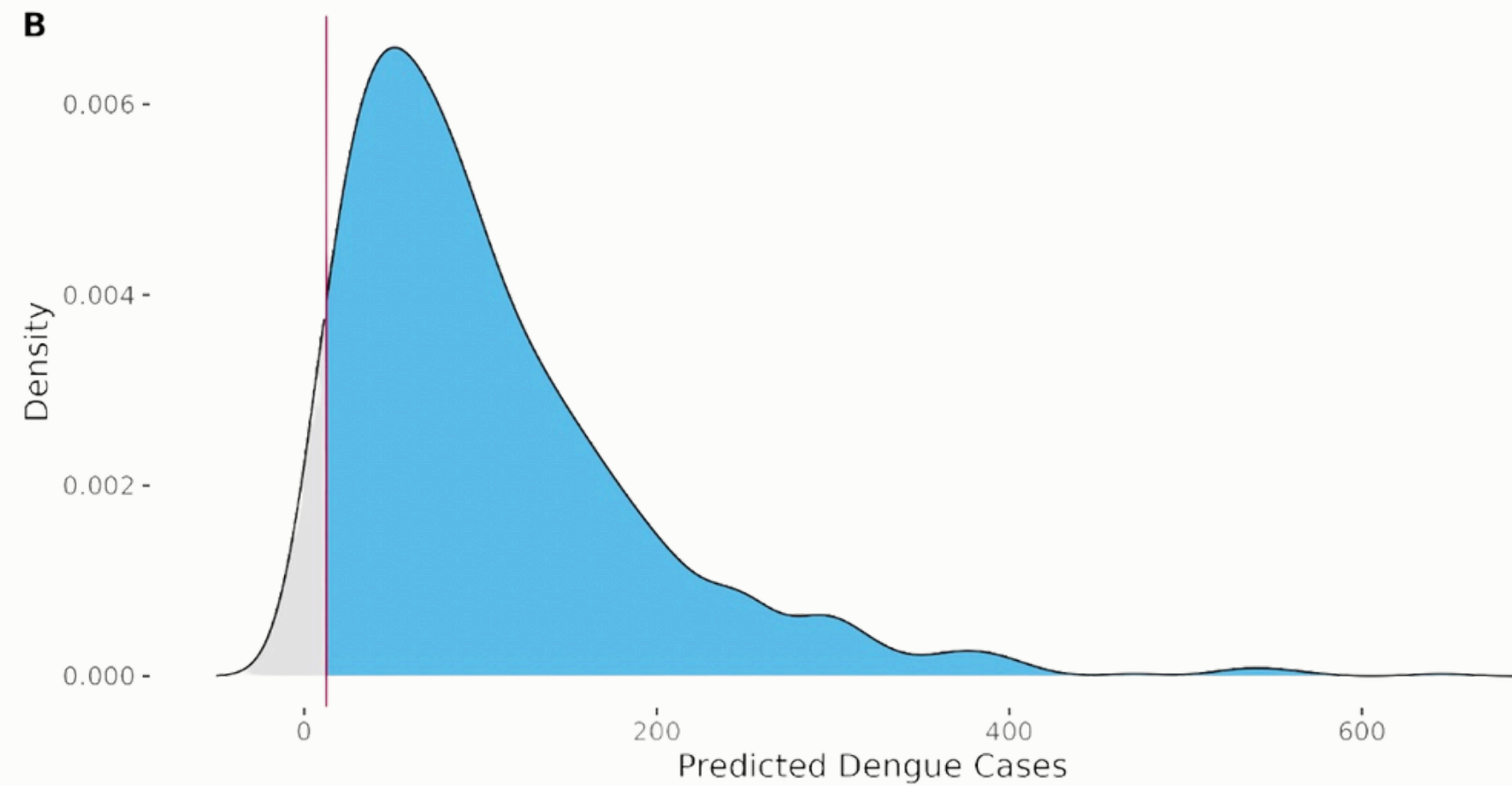
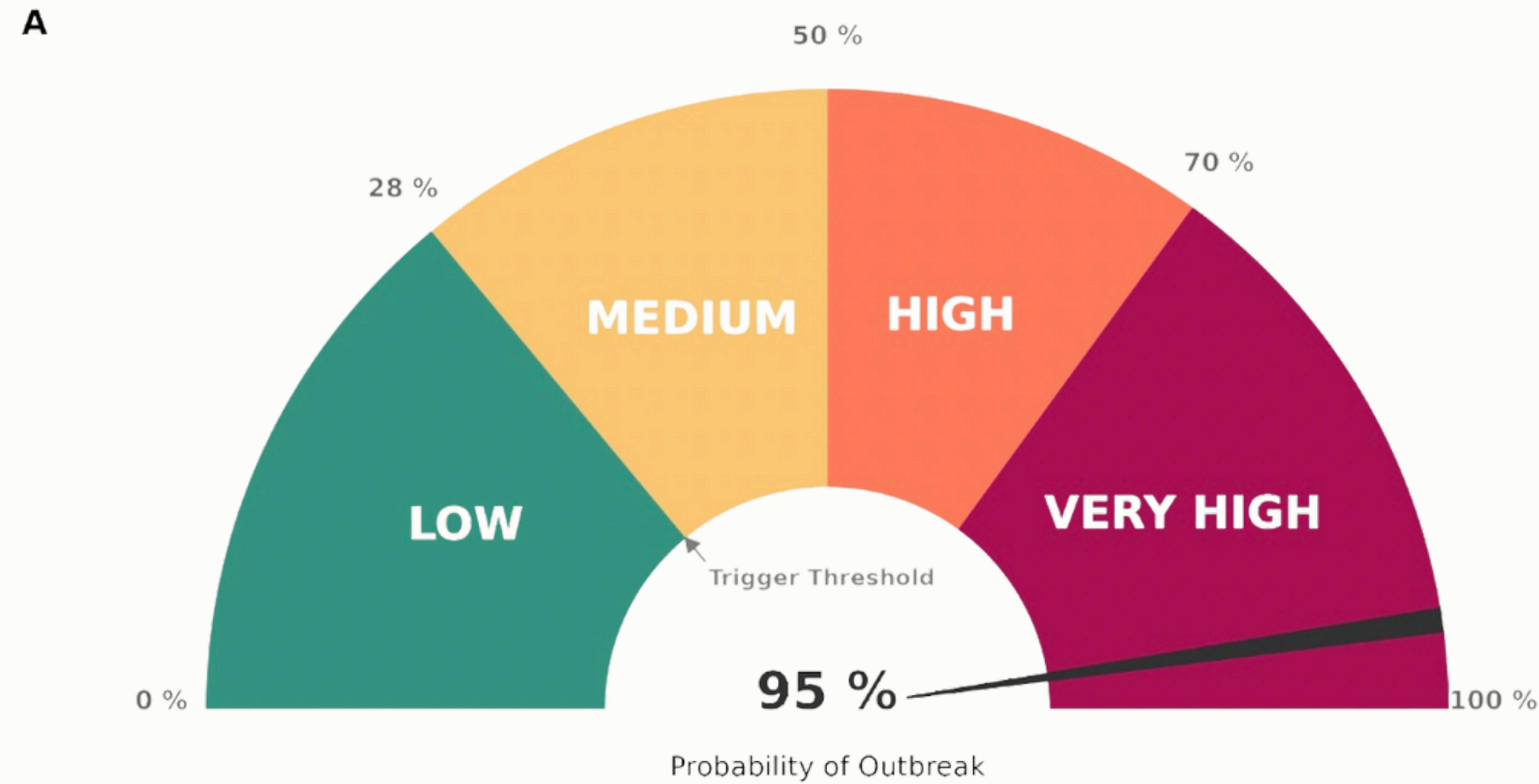
Evaluation of the selected model after performing cross validation from June 1999 to May 2022:

A) **Monthly predicted dengue cases** for selected model (mean = solid orange line, 95% credible interval = orange shading) compared to observed dengue cases (solid black line).

B) **Probability of an outbreak each month** (categorical in line with Low, Medium, High and Very High risk levels).

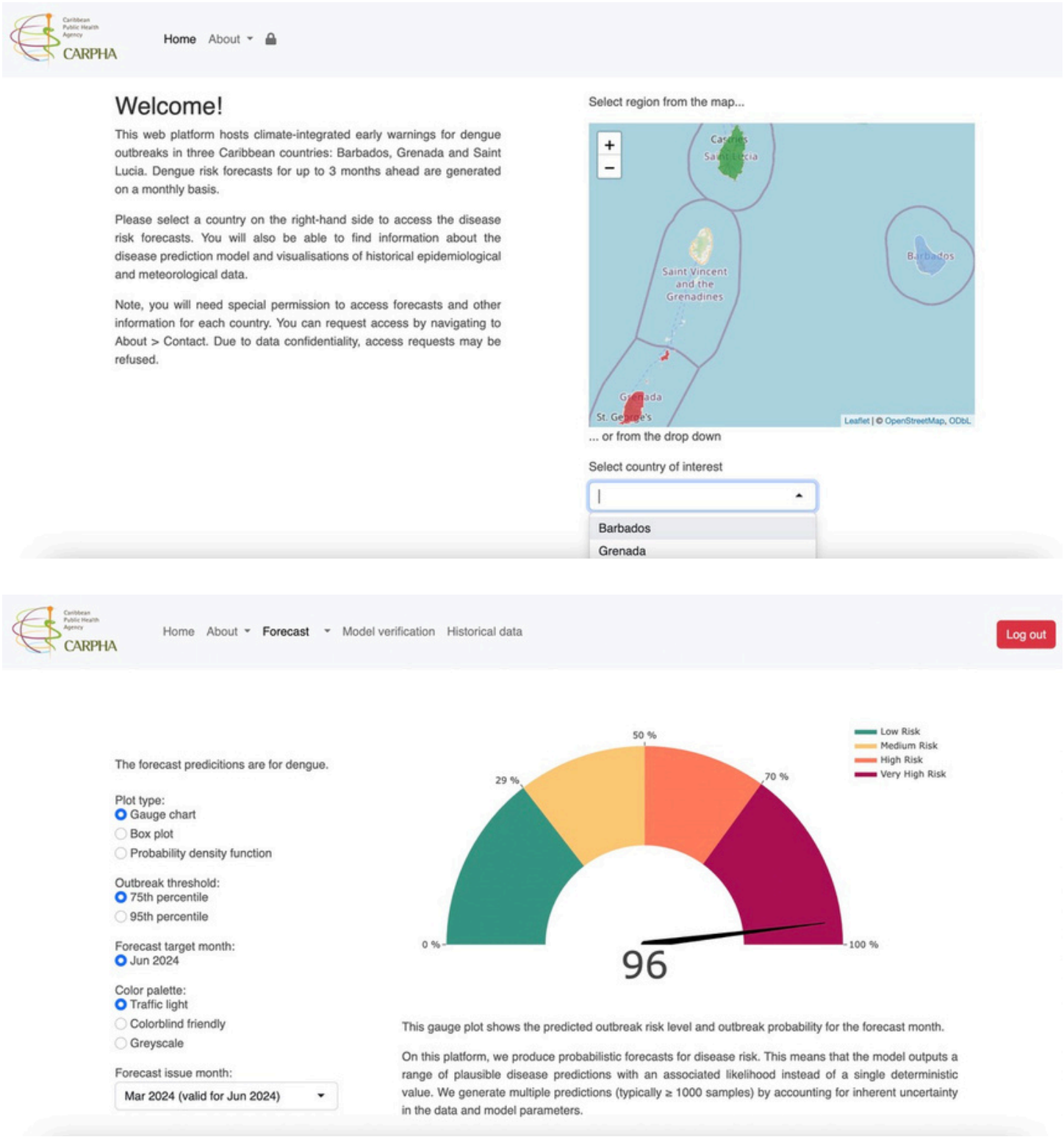
C) Receiver Operating Characteristic (**ROC curve**) for both the selected interaction (orange) and baseline (turquoise) models, which are displayed with 95% credible intervals (shading). The ROC curve can statistically determine the best probability trigger (circle) by **maximising the true positive rate** (specificity) and **minimising the false positive rate** (1-sensitivity). The Area Under the ROC Curve (AUC) measures the prediction accuracy where 1 represents a perfect system such that the true positive rate = 1 and false positive rate = 0.

(Fletcher et.al, 2025)



Dengue risk forecast issued for June 2024 3 months ahead represented by: a) the outbreak probability and associated outbreak risk level with the trigger threshold annotated (arrow and text), and b) the **probability density function** of the model predicted dengue cases with the outbreak threshold annotated (red line).

(Fletcher et.al, 2025)



A statistical Bayesian hierarchical model was specified to estimate the monthly probability of dengue outbreaks.

- Barbados
- St. Lucia
- Grenada

(Fletcher et al, 2025)

Key take aways

Sustainable & Operational Climate Services Need:

- Demand driven processes
- Transdisciplinary teams
- Trust
- Patience
- Deep Listening
- Co-learning, Co- production and Co-Delivery
- Translation between groups~ clear communication
- Boundary spanning scholars committed to working across the climate and health interface

References

1. Laporta, Gabriel Z., et al. "Global distribution of Aedes aegypti and Aedes albopictus in a climate change scenario of regional rivalry." *Insects* 14.1 (2023): 49.
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7. Muñoz, Á. G., et al. "Ae DES: a next-generation monitoring and forecasting system for environmental suitability of Aedes-borne disease transmission." *Scientific Reports* 10.1 (2020): 12640.
8. Armien, Blas, et al. "Clinical characteristics and national economic cost of the 2005 dengue epidemic in Panama." *The American journal of tropical medicine and hygiene* 79.3 (2008): 364-371.

Together we can build climate resilient health systems.

QUESTIONS?

AVRIEL@GCSEGLOBAL.ORG



CARIFORUM



Global Council for Science and the Environment

