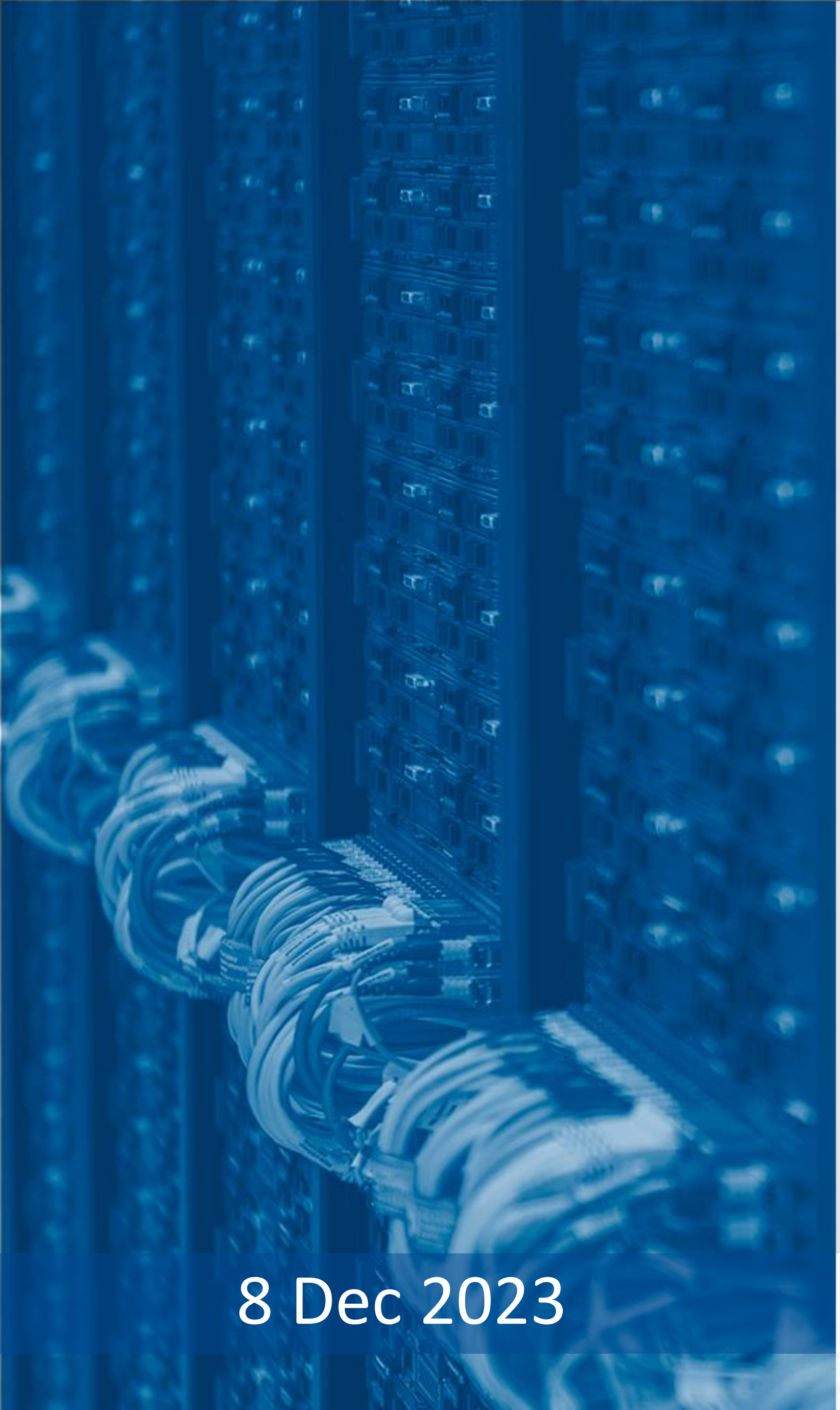

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IDExtremes

Uma ferramenta para modelagem preditiva de surtos de doenças infecciosas a partir de eventos climáticos extremos

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Postdoctoral Researcher

Global Health Resilience Group | Earth Sciences Department

Congresso E-Vigilância 2023, Rio de Janeiro, Brasil

Outline

1. Climate-sensitive infectious diseases
2. The IDExtremes project
3. The IDExtremes tool
4. Co-design process and user engagement

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Climate-Sensitive Infectious Diseases (CSIDs)

Diseases that are influenced by, and often exacerbated or modified by, climate factors. Climate-sensitive diseases are typically diseases sensitive to changes in temperature, precipitation, humidity, and other environmental variables associated with climate patterns, such as:

1. **Vector-borne Diseases** (e.g., Dengue, Malaria)

2. **Waterborne Diseases** (e.g., Cholera, Amoebiasis)

3. **Foodborne Diseases** (e.g., Salmonellosis, *E.coli*)

4. **Respiratory Diseases** (e.g., Influenza, COVID-19)

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nature climate change
ANALYSIS
https://doi.org/10.1038/s41558-022-01426-1
Check for updates

Over half of known human pathogenic diseases can be aggravated by climate change

Camilo Mora[1], Tristan McKenzie[2,3], Isabella M. Gaw[4], Jacqueline M. Dean[1], Hannah von Hammerstein[1], Tabatha A. Knudson[1], Renee O. Setter[1], Charlotte Z. Smith[5], Kira M. Webster[1], Jonathan A. Patz[6] and Erik C. Franklin[1,7]

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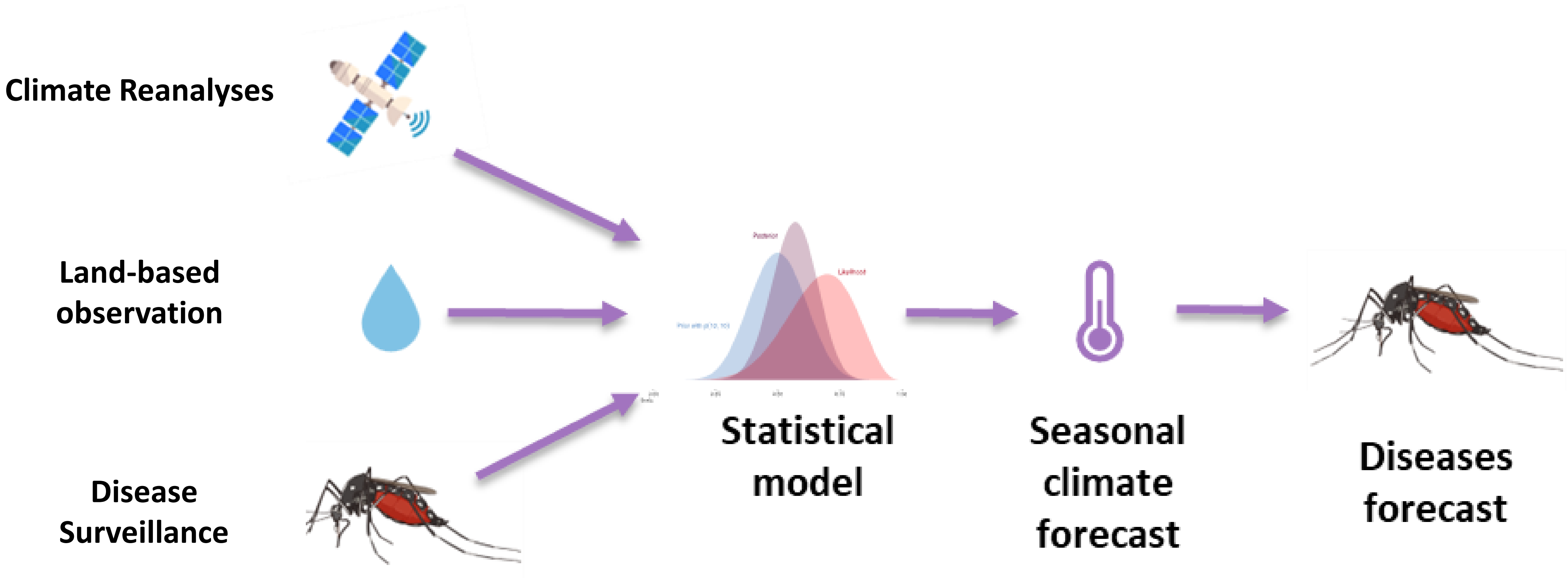
CSIDs and extreme climatic events

Some CSIDs might show a particular sensitivity to extreme climatic events, including heavy rainfall, floods, tropical cyclones, heatwaves and drought.

Disease	Heavy Rainfall	Tropical Cyclones	Drought	Flooding	Heatwaves	Multiple Events
Cholera	**Low evidence** (N=1) Outbreak [53]	**High agreement, high evidence** (N=7) Outbreak [51, 54–59]	**High agreement, low evidence** (N=2) Outbreak [46,52]	**Medium agreement, medium evidence** (N=4) Outbreak [41,60] [50] noted the floods did not seed the outbreak; outbreaks began during only one out of every 14 floods [46]	**Low evidence** (N=1) Outbreak [30]	**High agreement, medium evidence** (N=3) Including drought followed by heavy rains [49] and two systematic reviews investigating water-related disasters[48, 61]
Dengue	**High agreement, medium evidence** (N=3) Increased outbreak risk[31,42,43]	**Low agreement, high evidence** (N=5) Outbreak[96,73, 103] No outbreak[90,100]	**High agreement, medium evidence** (N=4) Increased outbreak risk[42,43,64,99]	**Medium agreement, low evidence** (N=2) Unclear impacts of flooding on outbreaks Mixed findings, including decreases and increases[95] Decreased risk (possibly due to vector control activities)[78]	**Medium agreement, medium evidence** (N=3) Outbreak: [31,97] No outbreak[29]	**Low evidence** (N = 1) [98]investigate heavy rainfall, but defined 'flood' periods caveating that this did not necessarily correspond with actual flood waters

Alcayna et al. Climate-sensitive disease outbreaks in the aftermath of extreme climatic events: A scoping review. 2022. *OneEarth*.

Climate-Informed Early Warning Systems



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Climate-Informed Early Warning Systems

JOURNAL OF THE ROYAL SOCIETY INTERFACE

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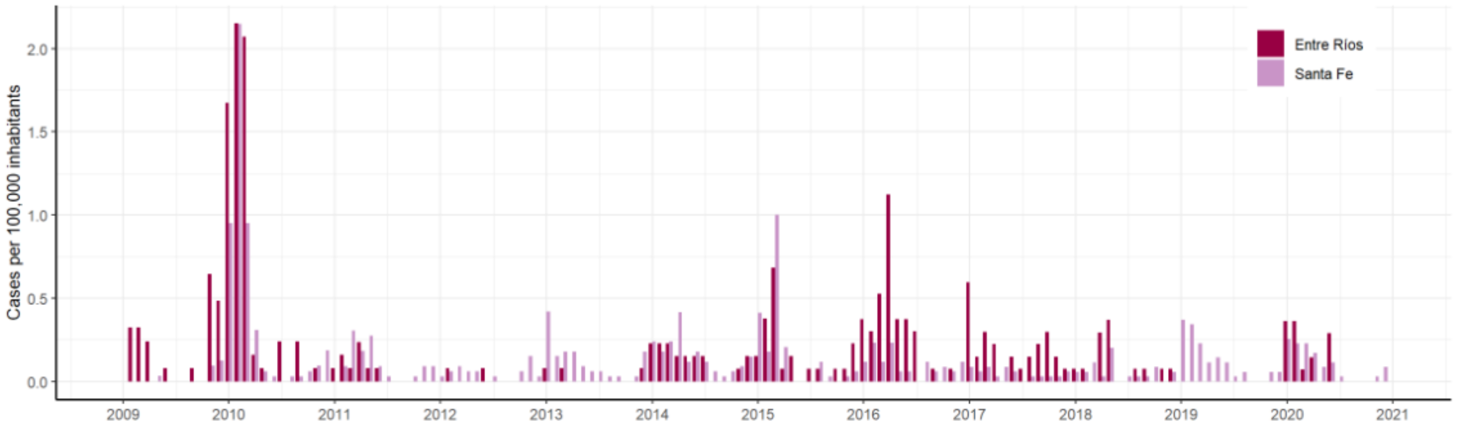
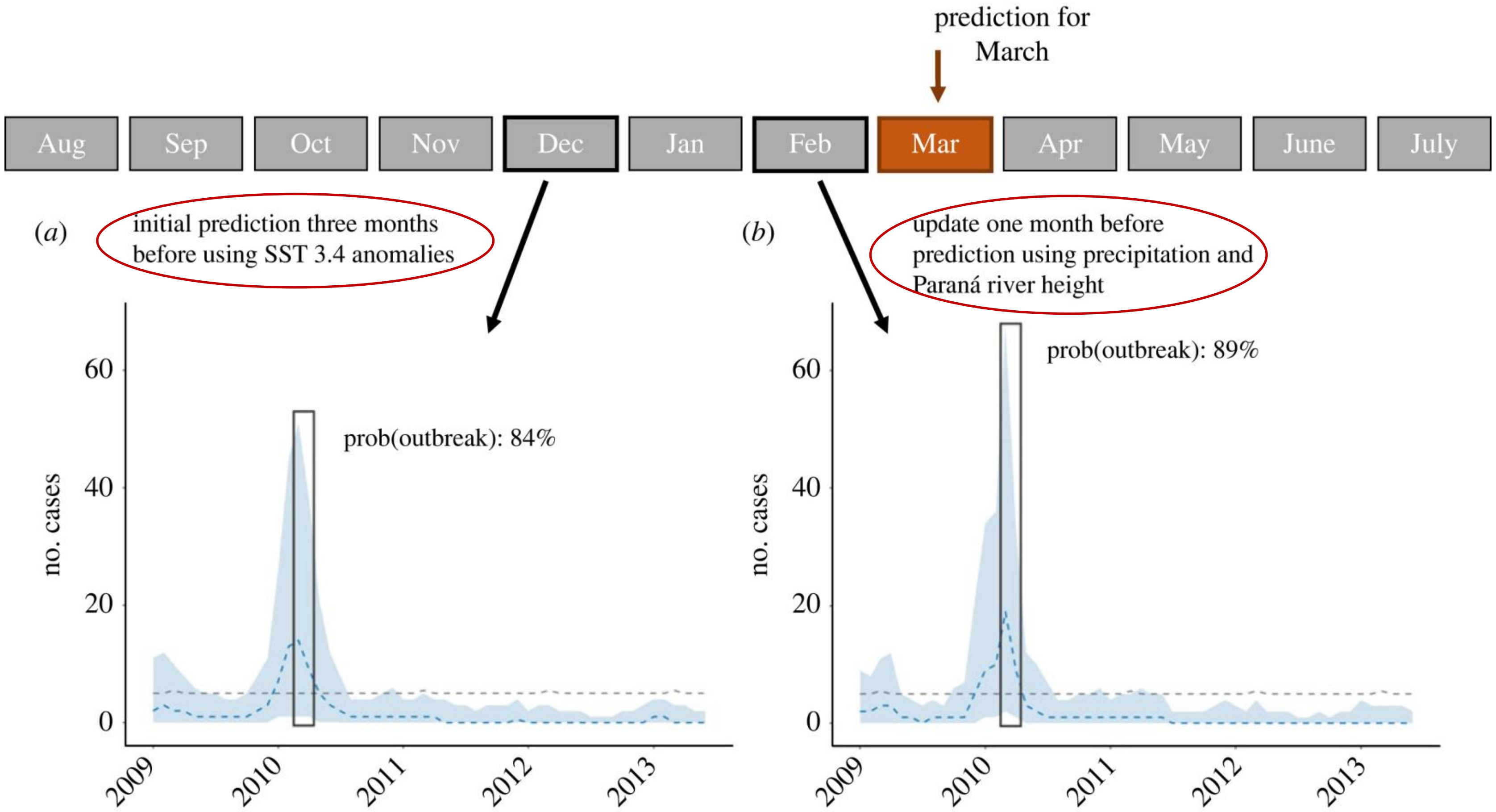
Towards a leptospirosis early warning system in northeastern Argentina

Martín Lotto Batista†, Eleanor M. Rees†, Andrea Gómez, Soledad López, Stefanie Castell, Adam J. Kucharski, Stéphane Ghozzi, Gabriela V. Müller and Rachel Lowe

Published: 17 May 2023 https://doi.org/10.1098/rsif.2023.0069



Climate-Informed Early Warning Systems



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WORK IN PROGRESS

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Aim

To create user-friendly tools to quantify
the combined impact of hydrometeorological extremes
on disease risk and predict the probability of outbreaks using
observed and forecast hydrometeorological indicators.

Case Studies

With support from

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Centro Nacional de Supercomputación

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Tool Overview

The IDExtremes tool will be based on an **R package** developed by the project.

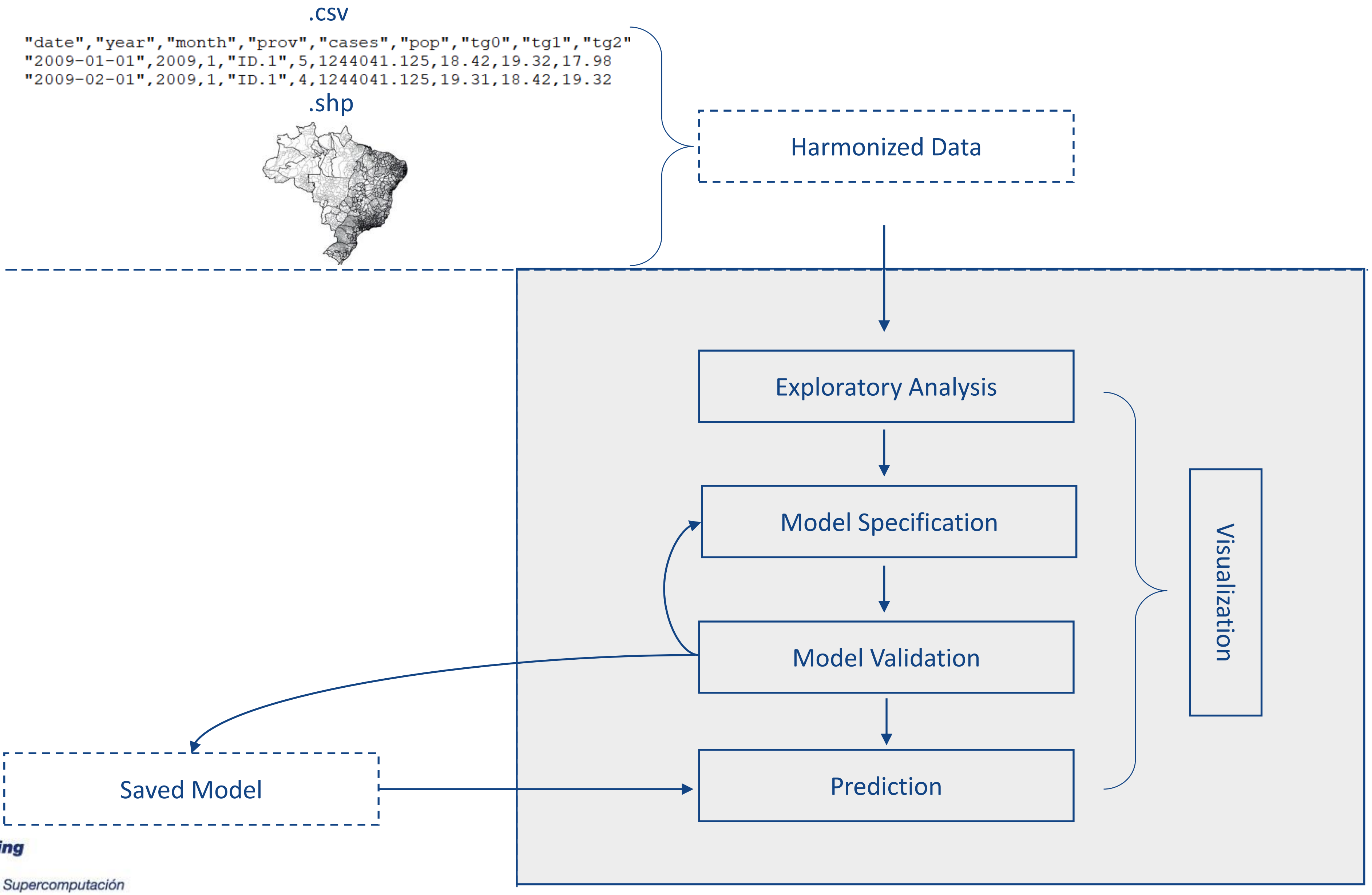
The R package should allow the users to produce probabilistic forecasts of climate sensitive infectious diseases including hydrometeorological indicators.

At the moment 4 steps are identified:

1. Exploratory analysis
2. Model specification
3. Model validation
4. Model prediction

All four steps should be accompanied by appropriate visualisation functions.

Tool Overview



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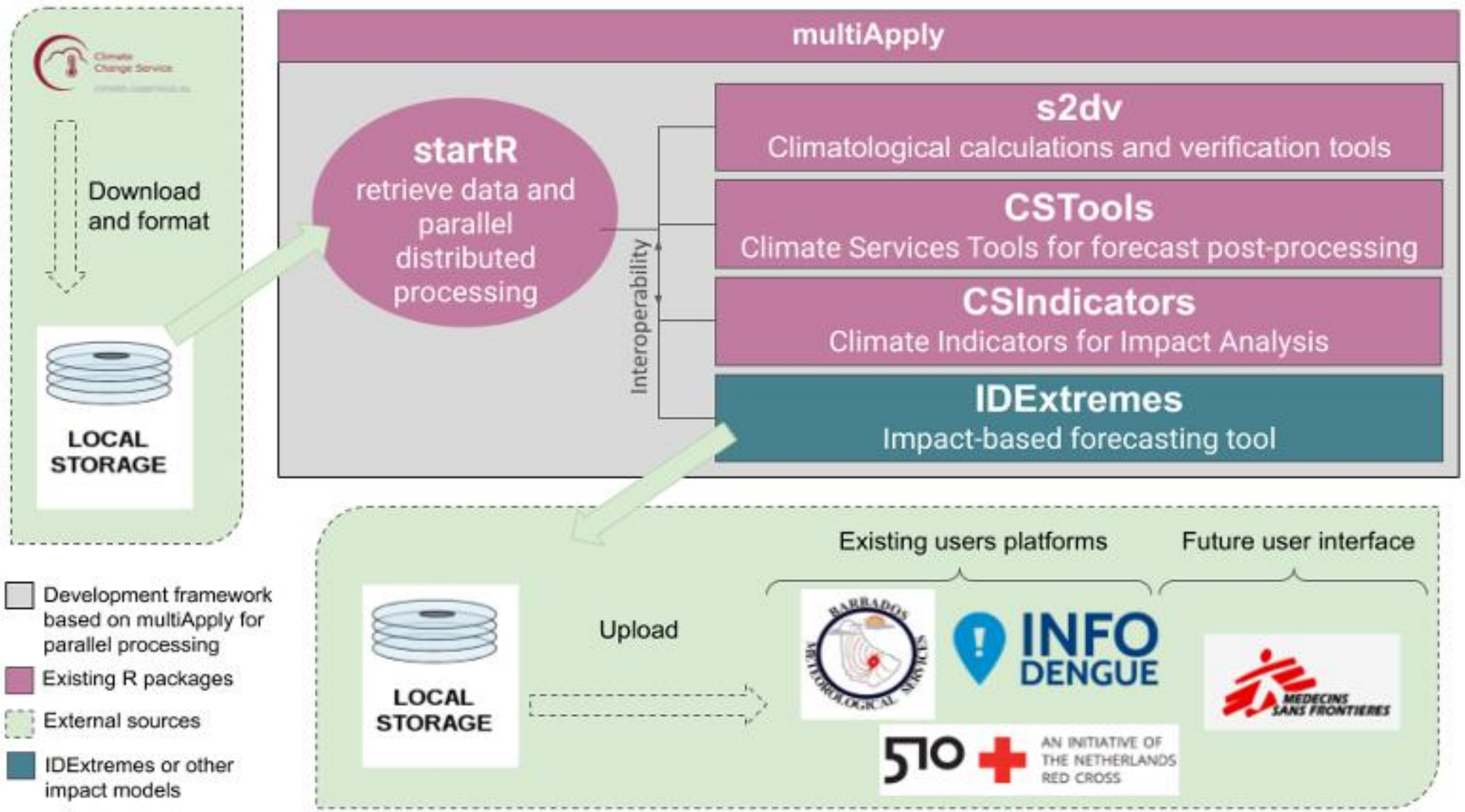
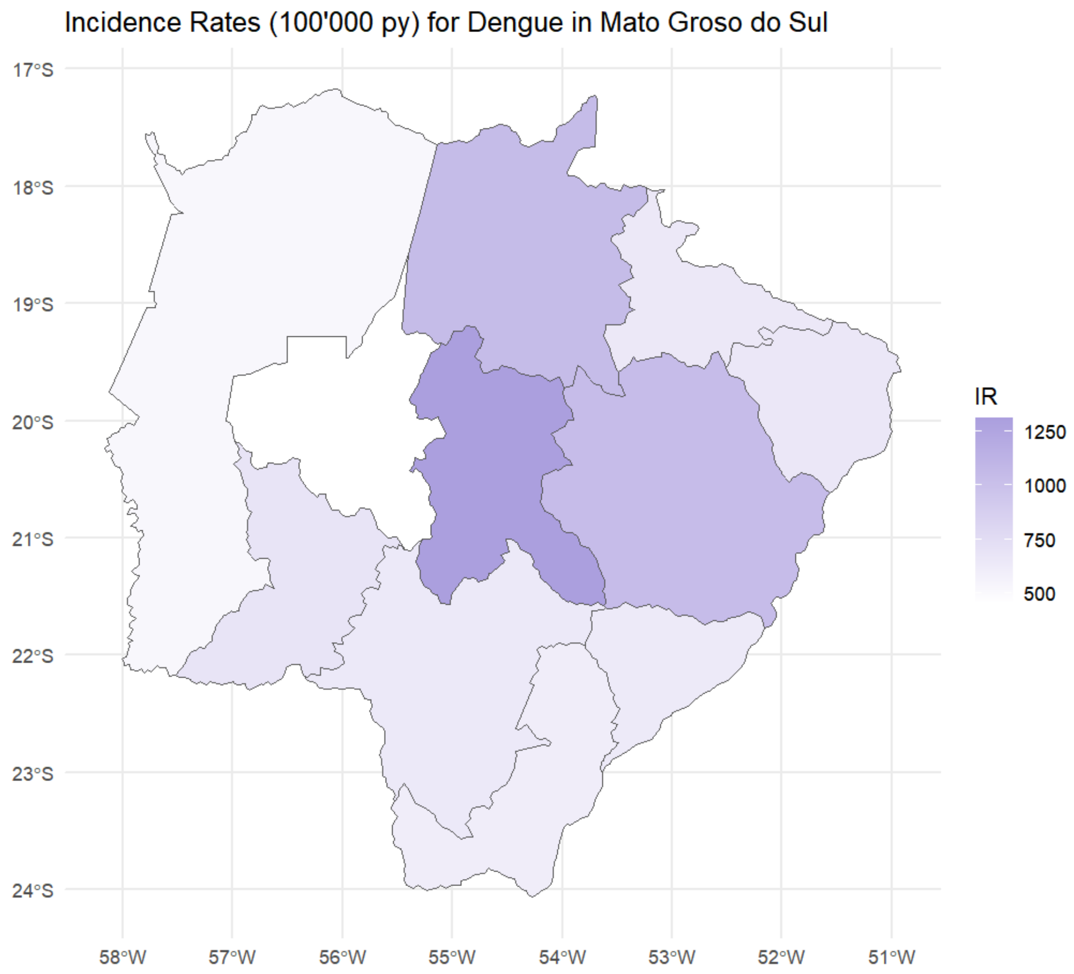
Tool Overview

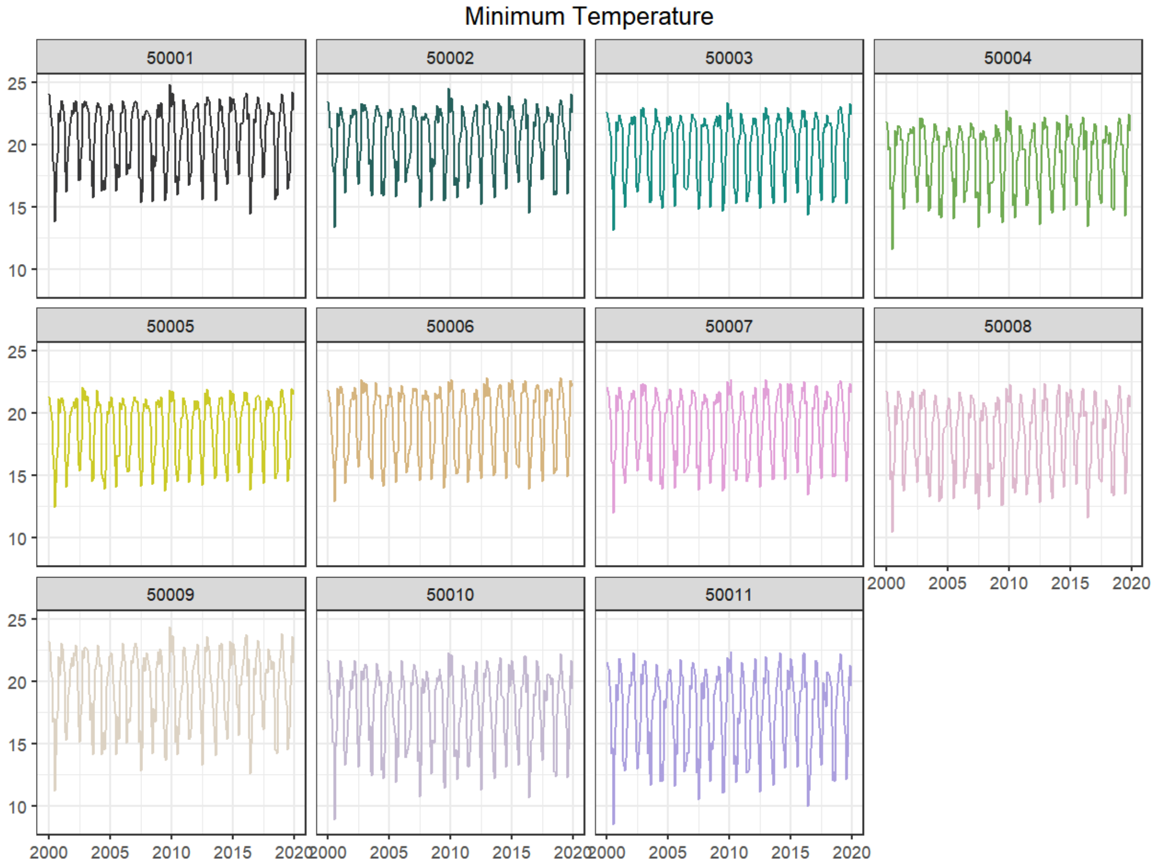


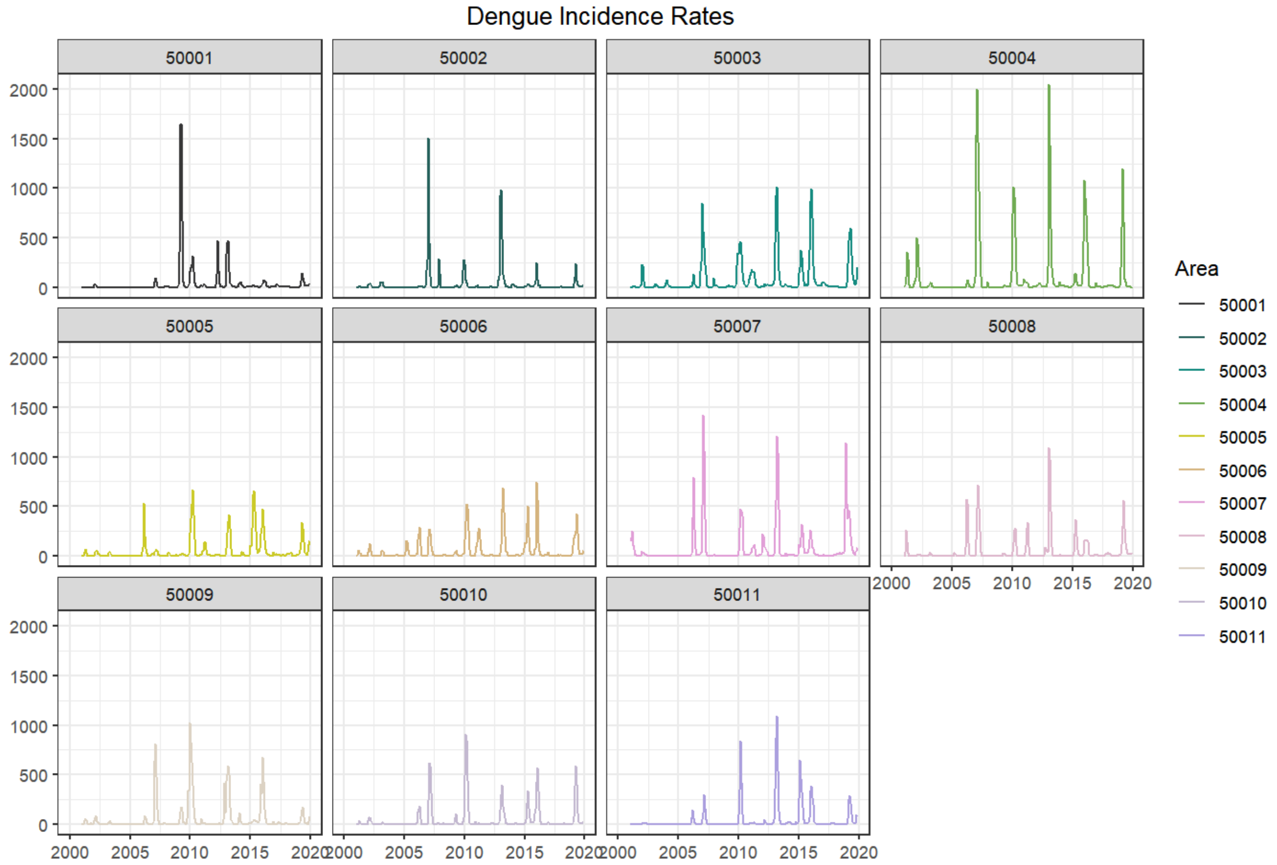
Harmonized Data

```
"date","year","month","prov","cases","pop","tg0","tg1","tg2"
"2009-01-01",2009,1,"ID.1",5,1244041.125,18.42,19.32,17.98
"2009-02-01",2009,1,"ID.1",4,1244041.125,19.31,18.42,19.32
```



1.Exploratory Analysis





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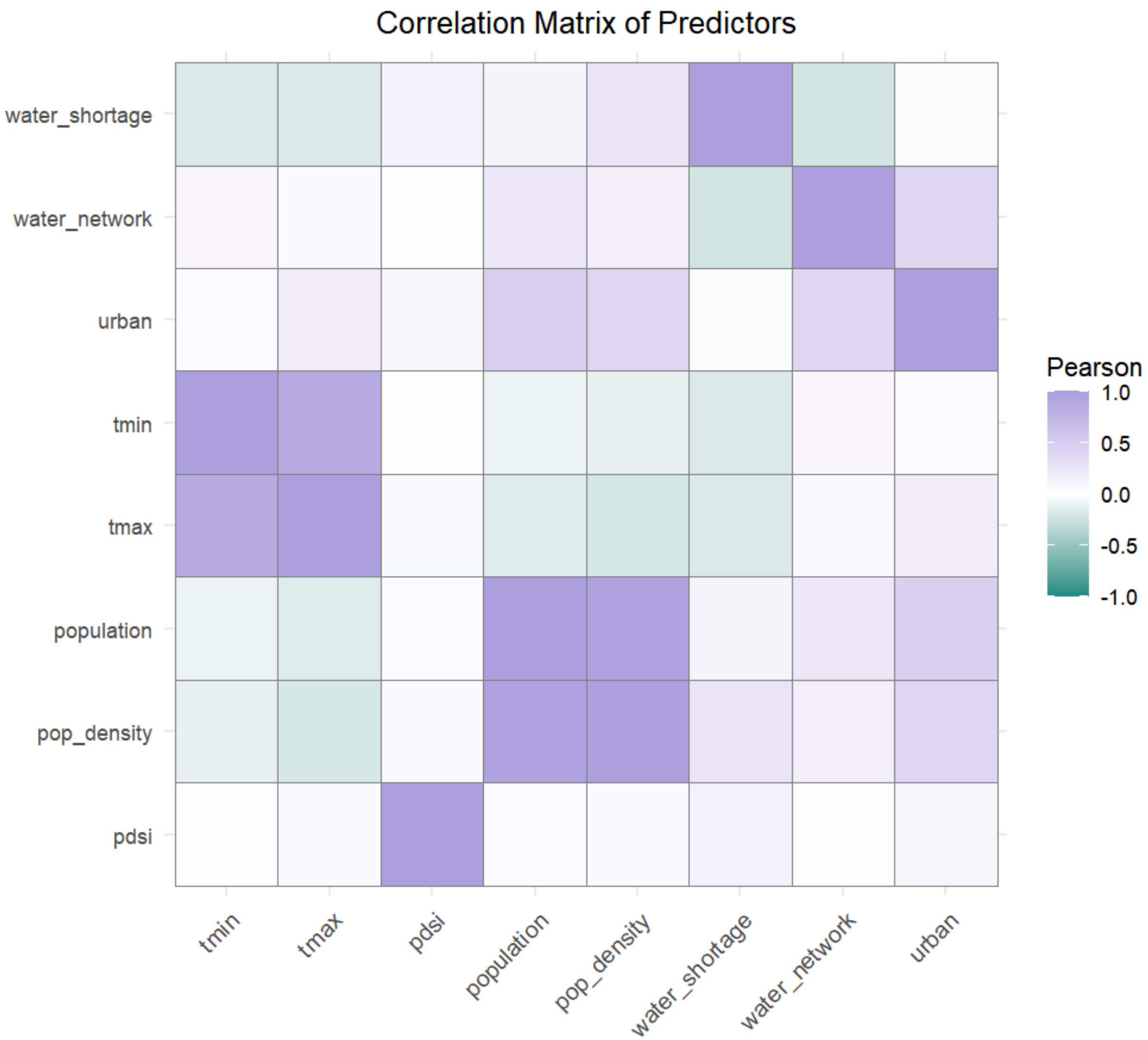
1.Exploratory Analysis



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2.Model Specification

Bayesian Spatio-temporal models

$$Y_{it} \sim Poisson\ (\mu_{it})$$

$$ln(\mu_{it}) \sim 1 + \ln(E_{it}) + X_{it}^{T}\beta$$

Where **for each area *i* and/or time unit *t*:**

- $\boldsymbol{\mu_{it}}$ is the expectation of the observed cases,
- $\boldsymbol{E_{it}}$ are the expected number of cases,
- $\boldsymbol{X_{it}^{T}}$ is a set of spatio-temporal hydrometeorological parameters of interest (lagged)

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Bayesian Spatio-temporal models

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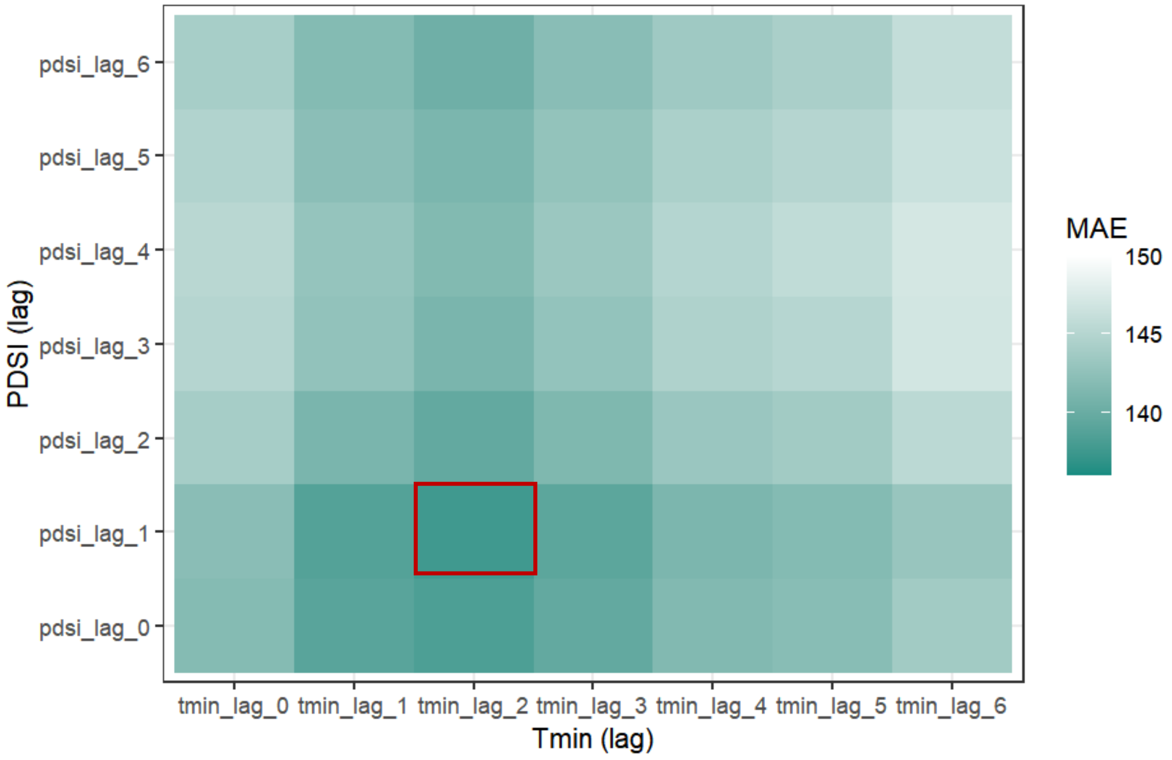
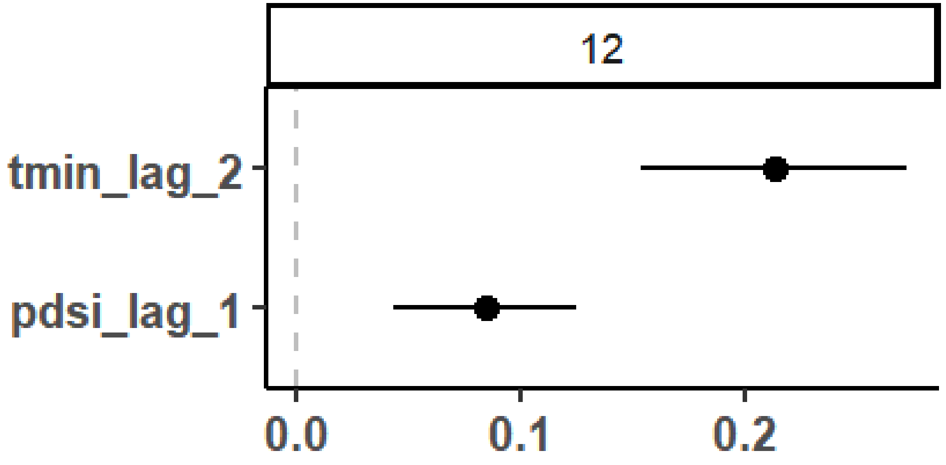
- $\boldsymbol{X_{it}^{T}}$ is a set of spatio-temporal hydrometeorological parameters of interest (lagged)
- $\varphi_{\boldsymbol{i}}$ is the set of spatial random effects
- $\delta_{\boldsymbol{t}}$ is the set of temporal random effect
- $\xi_{\boldsymbol{it}}$ is a set of random effects for space-time interaction

2. Model Specification (Outputs)

Allow the user to specify and evaluate performance of the fitted models



Check Model Performance



Evaluate Size and Timing of Associations

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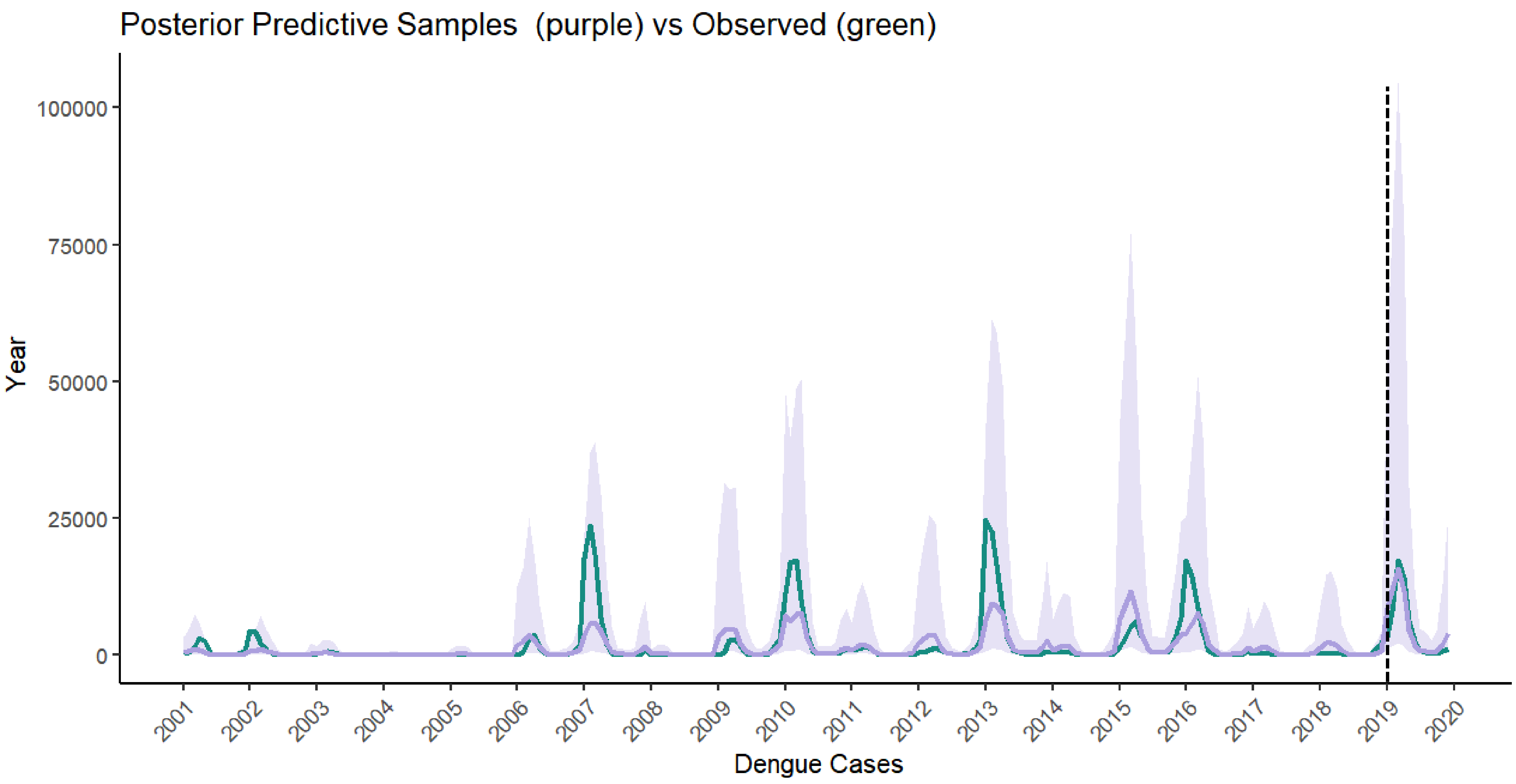
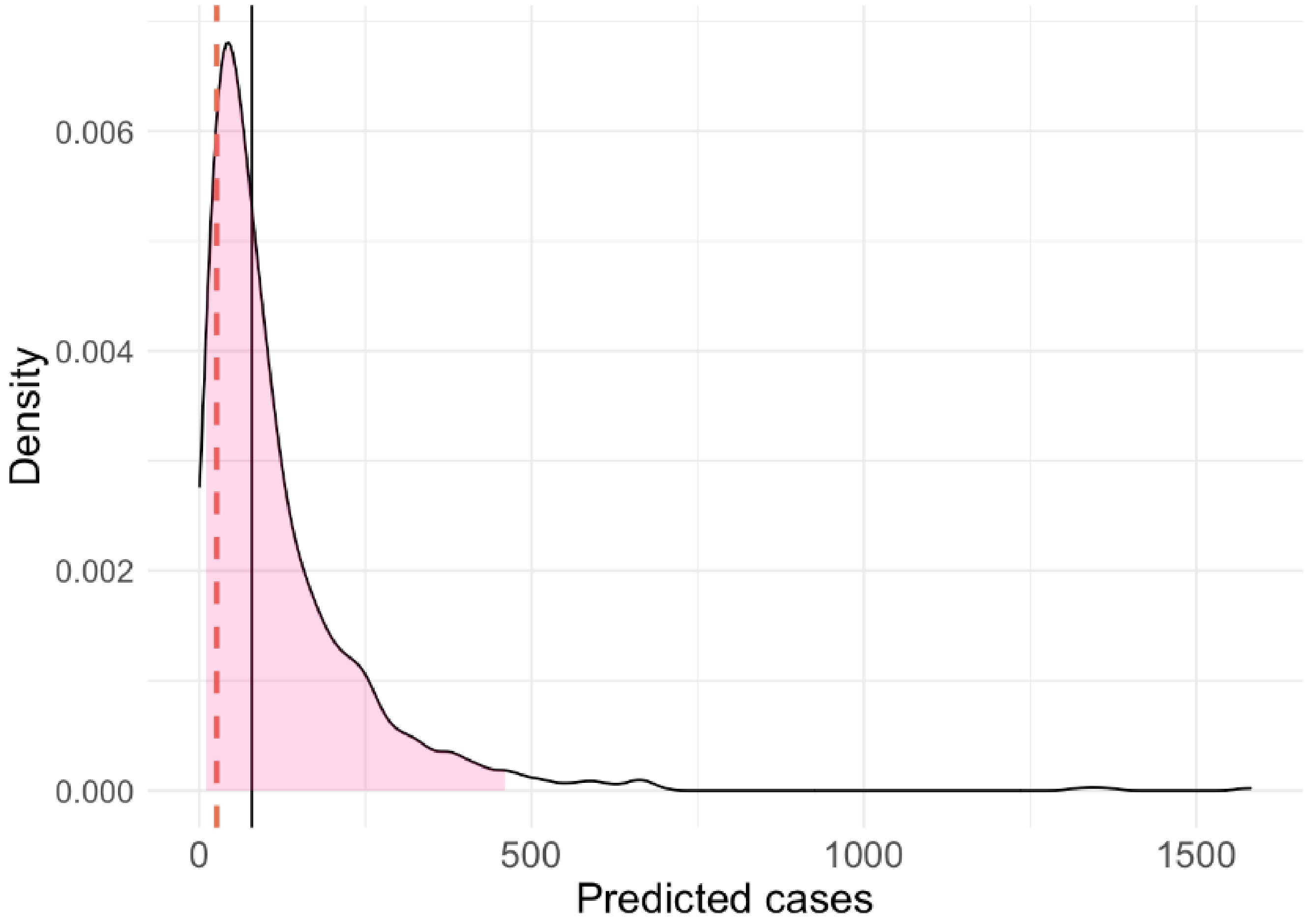
3.Model Validation

Allow the user to cross-validate the model with out-of-the-sample predictions



4. Model Prediction

Bayesian inference takes into account uncertainty propagation. In this context outbreaks probability can be estimated by computing the number of posterior predictive samples above a threshold level for each time and space unit.



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Translating results into relevant indicators for Public Health

Prototype developed by
Barbados Meteorological Services

Caribbean Public Health Agency
CARPHA

Ministry of Health and Wellness
Barbados

Caribbean Institute for Meteorology and Hydrology
CIMH

Barbados Meteorological Services

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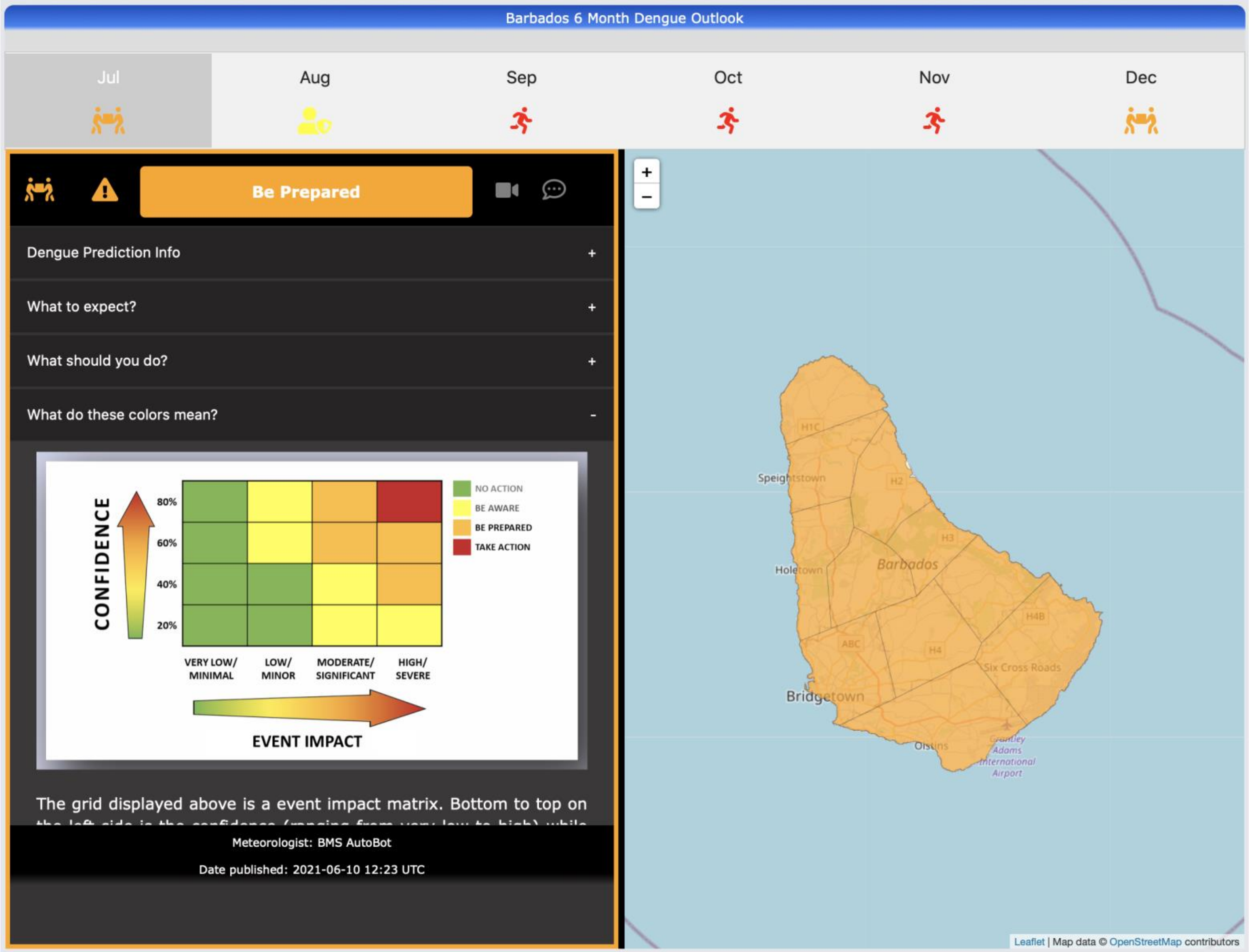

IDExtremes consortium

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Barbados Meteorological Services

Ministry of Health and Wellness Barbados

Inter-American Institute for Global Change Research (IAI)

Ministério da Saúde
FIOCRUZ
Fundação Oswaldo Cruz

Climate Centre

510 An initiative of the Netherlands Red Cross

Medecins Sans Frontieres

Info Dengue

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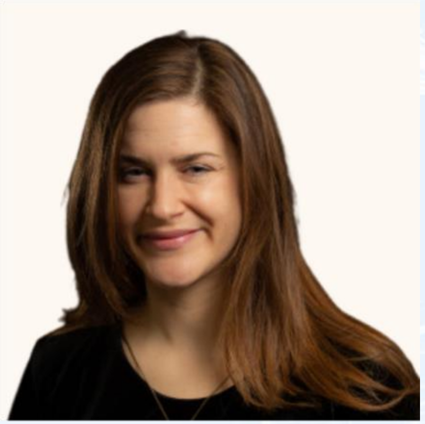
Prof. Rachel Lowe

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Martin L. Batista


Daniela Lurhsen


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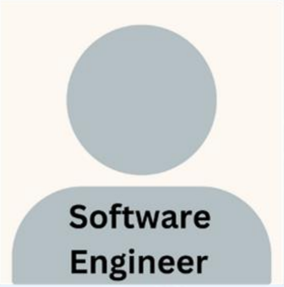
Sophie Belman



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Obrigado

Perguntas?

bruno.carvalho@bsc.es