A toolbox for identifying future biosecurity threats under climate change

R Exchange 2023 Epi-interactive

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Content

01. Background

Will cover background information on ecological niches and the history of the Climate Matching tool.

02. Functionality

Will cover the key features and how to effectively use the tool.

03. Case study

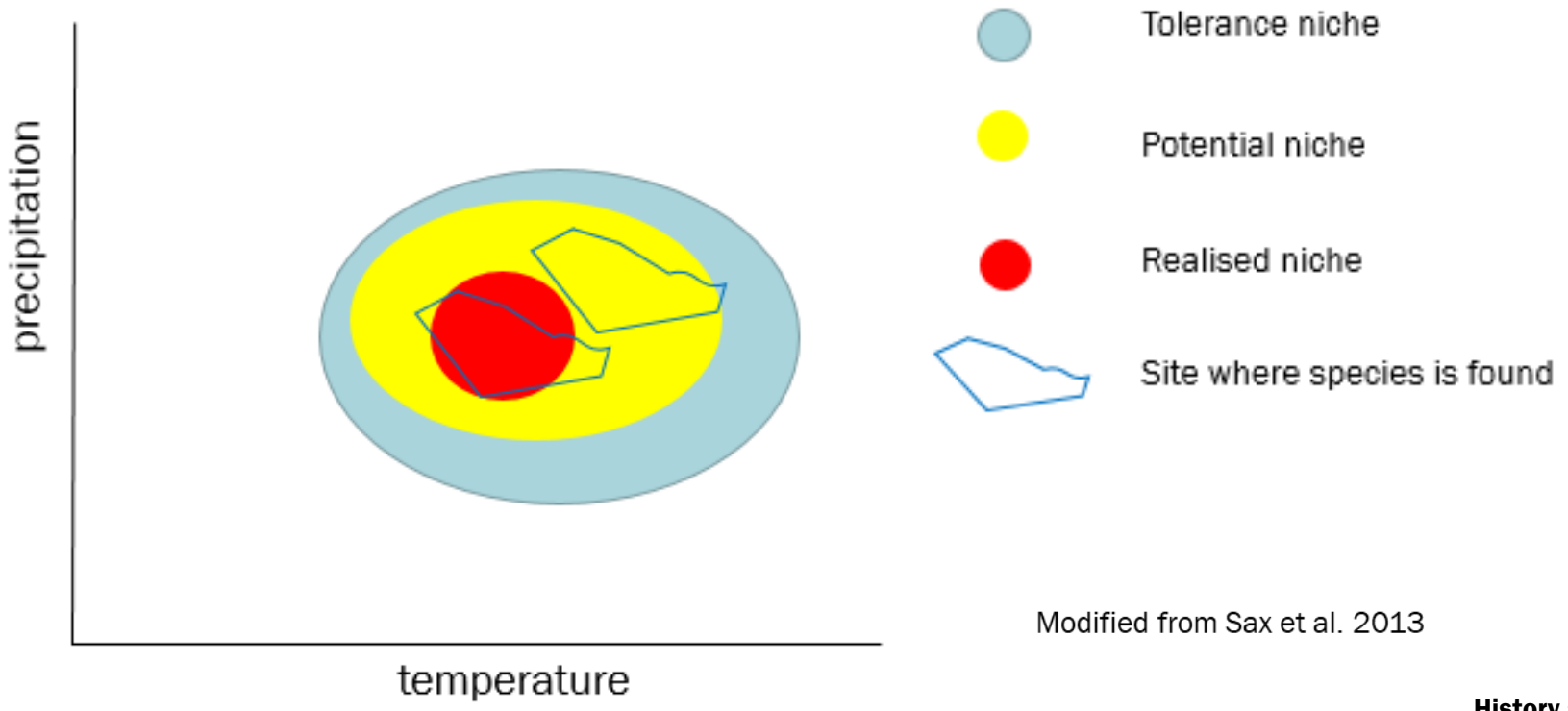
Will show how to use the tool with Oriental Fruit Fly as a case study.

Understanding biosecurity risks

- Pathways
  - how the risks can come to NZ
- Species biology
  - Species survival
  - Species reproduction
  - Species establishment

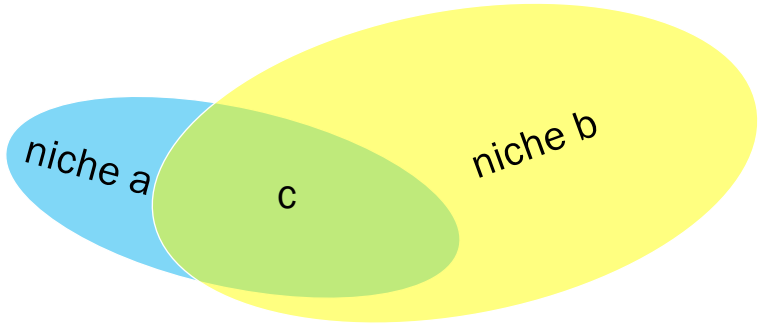
Ecological niche

- Species occurrence is a representation of the ecological niche



Modified from Sax et al. 2013

Calculations of overlap (similarity)



CMI (Composite Match Index) is one way to represent this overlap

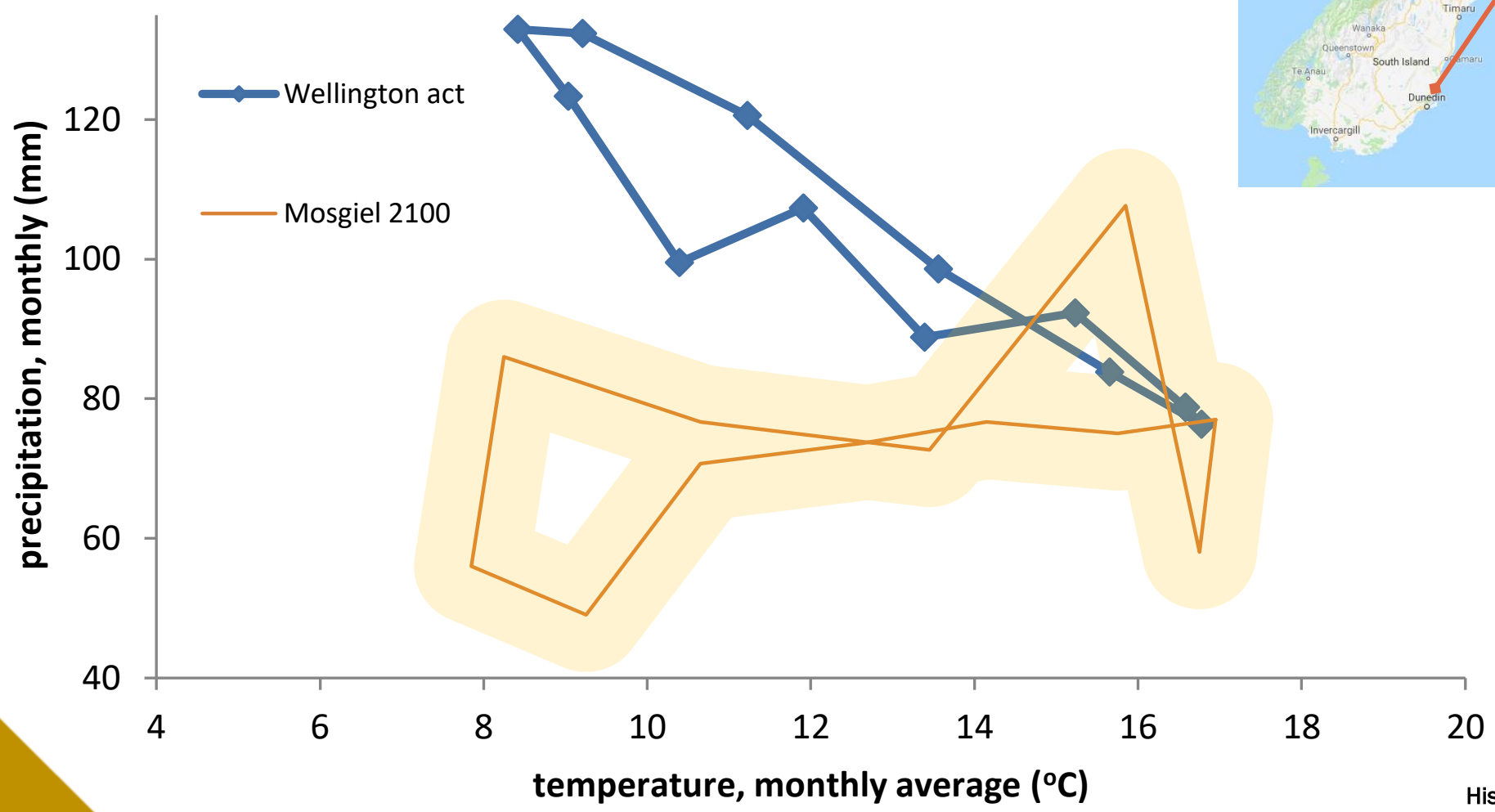
Why?

Likelihood of establishment is an important component of risk analysis for potential pests and diseases.

A key element of this analysis is investigating how much the climates of potential establishment areas overlap with climates in the organism's present range

Species tracking change?

In 2100, to find a temperature seasonal climate similar to Wellington today a species would have to move some 650 km in a straight line to Dunedin or Mosgiel (not considering barriers to migration)



Funding and development of the tool

Funding

- MPI Operational research fund

Project team

Ministry for Primary Industries
Manatū Ahu Matua

- Hossein Narouei-Khandan
- Stephan Halloy
- Ursula Torres
- Davide Santoro
- Kaavya Benjamin
- Michal Kuchar

agresearch
āta mātai, mātai whetū

- Craig Phillips and his team

EPI-interactive

- Uli Muellner and his team

Description of the tool

Data

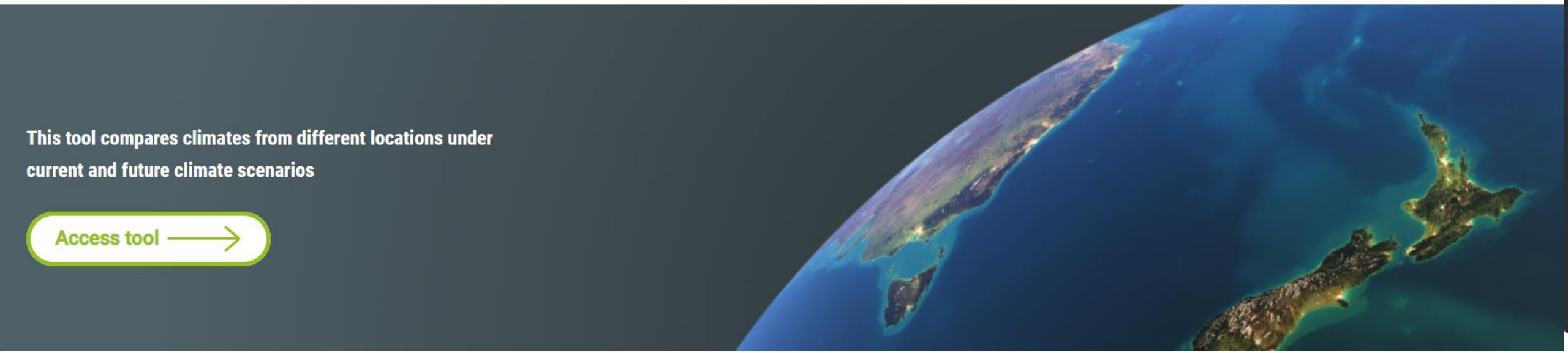
- Historical climate data 1970-2000 ("1985")
- Future climate scenarios
  - 2021-2040 ("2030")
  - 2041-2060 ("2050")
  - 2061-2080 ("2070")

  under Shared Socioeconomic Pathways (SSP) 126 ("low emissions"), 245 ("medium emissions") and 585 ("high emissions").

Niche overlap

- Composite match index
  - maximum temperature
  - minimum temperature
  - Precipitation

Climate Matching Tool



NZ - World similarities

This section allows the user to explore climate similarities between New Zealand and the rest of the world or occurrences

Choose locations - Map

This map allows the user to compare weather stations' climates

Choose locations - Table

This table allows the user to compare multiple weather stations' climates

About

Information on the tool

Oriental Fruit Fly (OFF) (*Bactrocera dorsalis*)

Source: Wikimedia Commons

Climate Matching Tool

How suitable is the present and future climate of New Zealand for the establishment of OFF?

Oriental Fruit Fly:
NZ climate match can be done with new app.

Climate Matching Tool

NZ - World similarities | Choose locations - Map | Choose locations - Table | About

Map

Select climate

World 1985, NZ 1985

Map view

Climate matching index (CMI)

Altitude

Show crop areas

None

Upload occurrences

The table needs to have longitude and latitude of occurrences. Download example for format

Select csv file

Browse GBIFfilter_bactrocera_dors...

Upload complete

Download example file

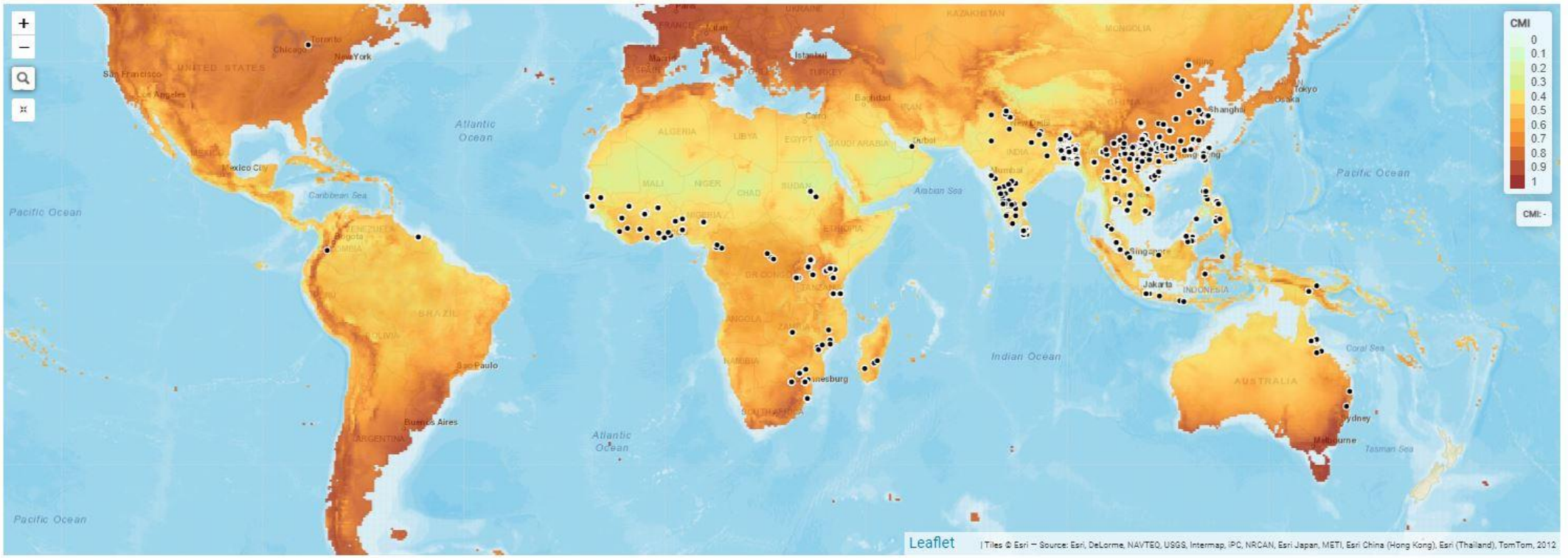
Maps | CMI Cells | Occurrences

NZ - World similarities

This map shows the climate similarities between New Zealand and the world.

OFF current distribution – map by Climate Matching Index (CMI)

Climate similarities between New Zealand and the world



Oriental Fruit Fly:
NZ climate match can be done with new app.

Climate Matching Tool

NZ - World similarities | Choose locations - Map | Choose locations - Table | About

Select weather station and climate

Region: Oceania
Country: New Zealand
Station: Tauranga Aero (NZL)
Climate: 1985

Select comparison climate

Climate: 1985

Map View

- Default map
- Köppen-Geiger climate
- Altitude

Show crop areas

None

Upload occurrences

The table needs to have longitude and latitude of occurrences. Download example for format

Select csv file

Browse... GBIFfilter_bactrocera_do...

Upload complete

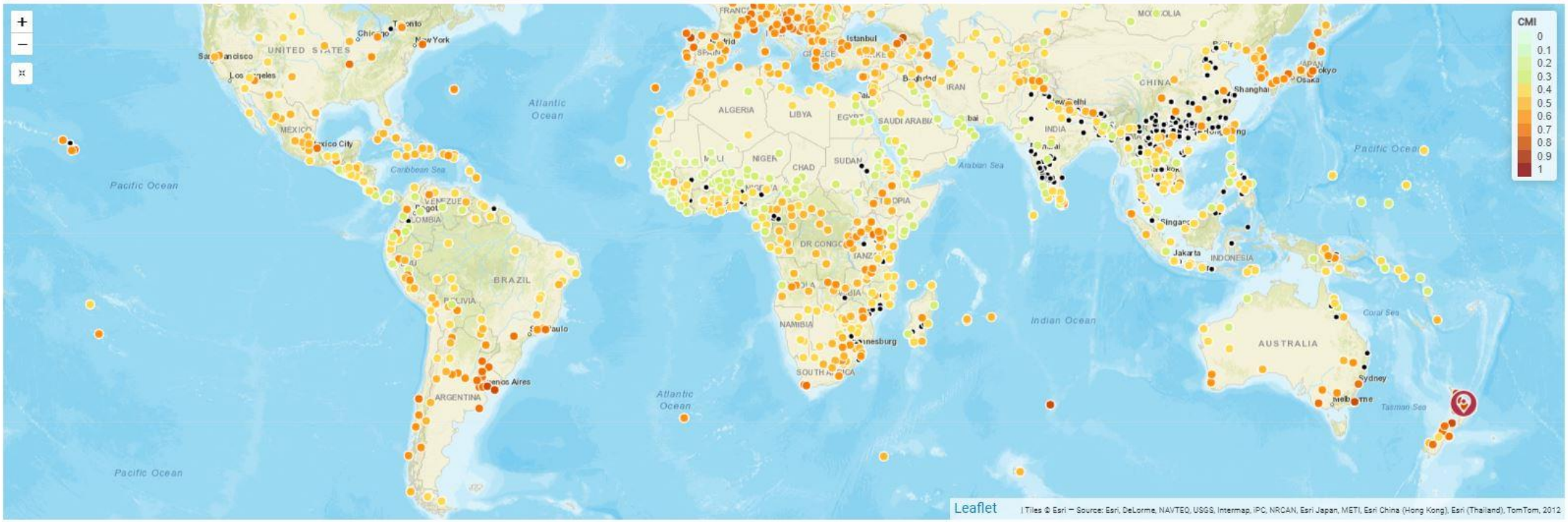
Download example file

Choose locations - Map

This map allows user to compare a weather station's climate against the rest of weather stations.

OFF current distribution – map by locations – CMI Tauranga

Weather stations' climate similarities (CMI)



NZ - World similarities | Choose locations - Map | Choose locations - Table | About

Select weather station and climate

Region: Asia

Country: Cambodia

Station: Battambang (KHM)

Climate: 2030 - Medium emis...

- 1985
- 2030 - Medium emissions
- 2050 - Low emissions
- 2050 - Medium emissions
- 2050 - High emissions
- 2070 - Low emissions
- 2070 - Medium emissions

Select com

Climate:

Map View

- Default map
- Köppen-Geiger climate

Show crop areas

None

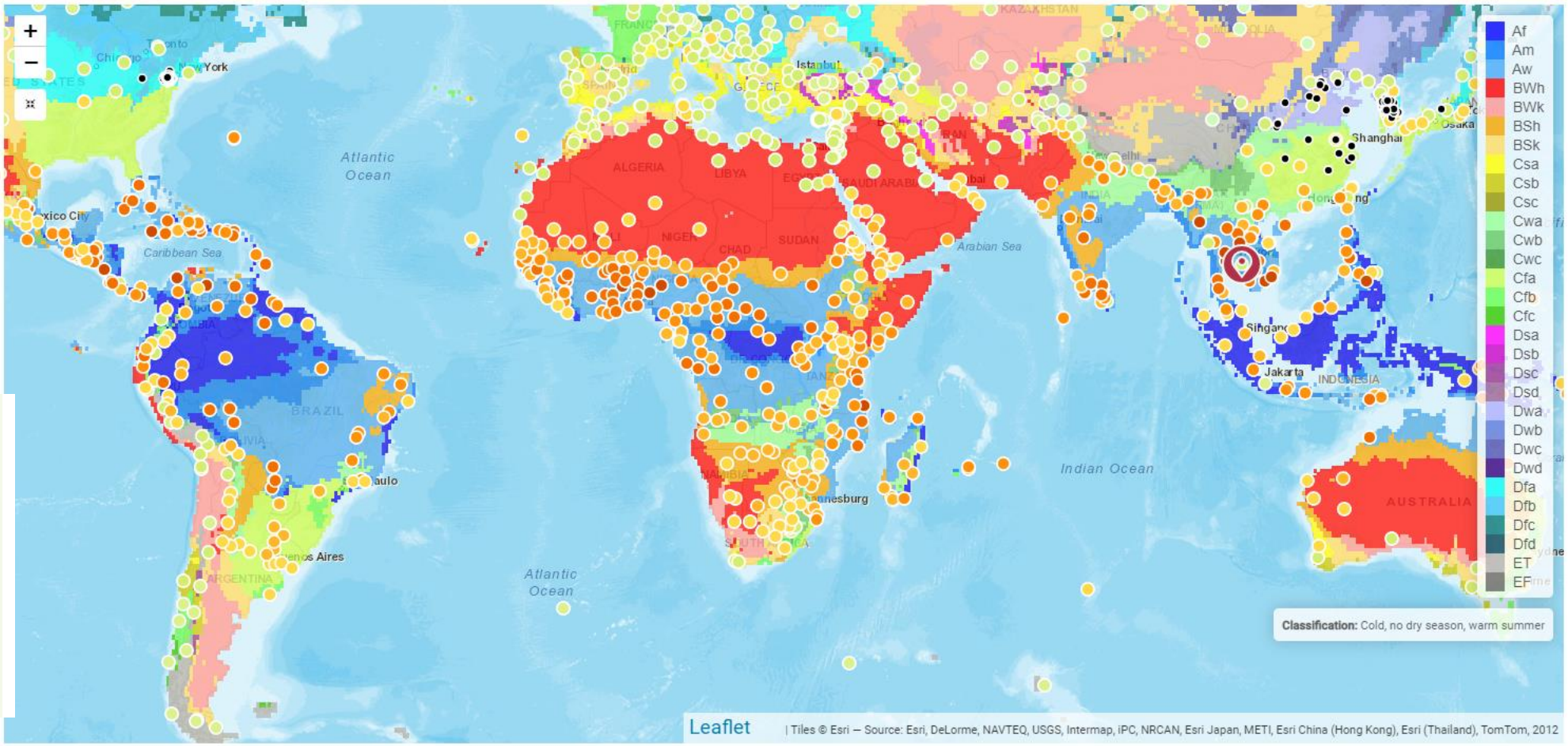
- None
- Viticulture
- Kiwifruit
- Brassicas
- Citrus
- Native
- Kauri

Browse... lycorma_delicatula.csv

Choose locations - Map

This map allows user to compare a weather station's climate against the rest of weather stations.

Weather stations' climate similarities (CMI)



Oriental Fruit Fly

GBIF DATA

CMI Cells – Climate NOW

CMIs >= 0.7: 20.4%

Climate Matching Tool

NZ - World similarities | Choose locations - Map | Choose locations - Table | About

Map

Select climate

World 1985, NZ 1985

Map view

- (•) Climate matching index (CMI)
- ( ) Köppen-Geiger climate
- ( ) Altitude

Show crop areas

None

Upload occurrences

The table needs to have longitude and latitude of occurrences. Download example for format

Select csv file

Browse GBIFfilter_bactrocera_dors...

Upload complete

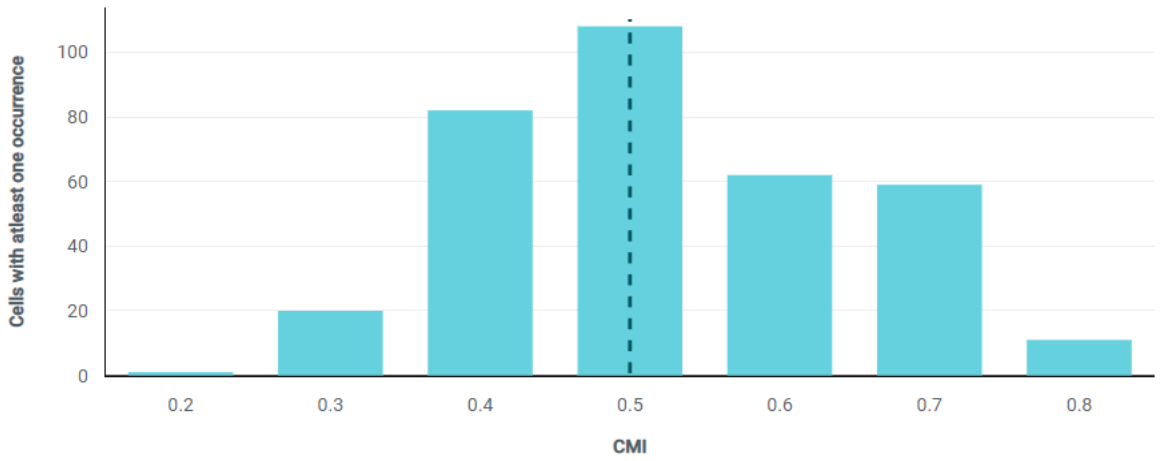
Download example file

Maps | CMI Cells | Occurrences

This feature can be used when uploading occurrences. This graph represents the frequency of climate matching index cells overlapping with unique occurrences. (i.e. if multiple occurrences coincided with a CMI cell, they were counted only once). This graph can be used when the user wants to eliminate the effects of spatial correlation/sampling bias on occurrences.

Barplot of CMI cells

Selected map is all NZ. The occurrences coincided with 343 CMI cells. The proportion of the 343 cells with CMIs >= 0.7 is 20.4%.

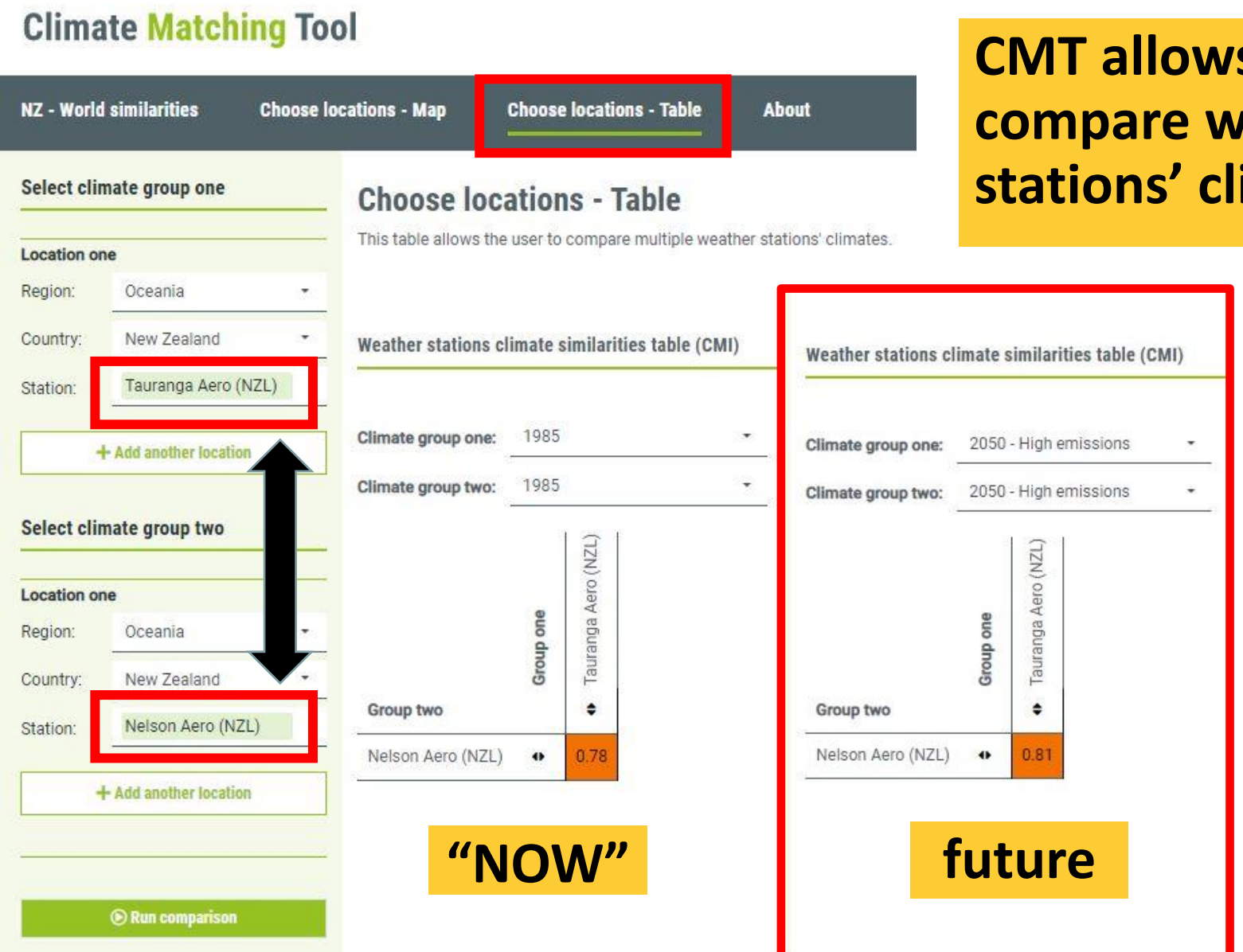


Oriental Fruit Fly:
Likelihood of establishment in NZ will increase for increasing overall climate suitability, especially with high emissions.

Climate Matching Tool

The proportion with CMIs >= 0.7	% CMI Cells (n 343-353)
World 1985, NZ 1985	20.4
World 1985, NZ 2030 Medium emissions	24.5
World 1985, NZ 2050 Low emissions	27
World 1985, NZ 2050 Medium emissions	26.5
World 1985, NZ 2050 High emissions	26.2
World 1985, NZ 2070 Low emissions	24.9
World 1985, NZ 2070 Medium emissions	29.6
World 1985, NZ 2070 High emissions	35.1

Oriental Fruit Fly:
Likelihood of establishment in NZ will increase and the South Island will have a suitable climate

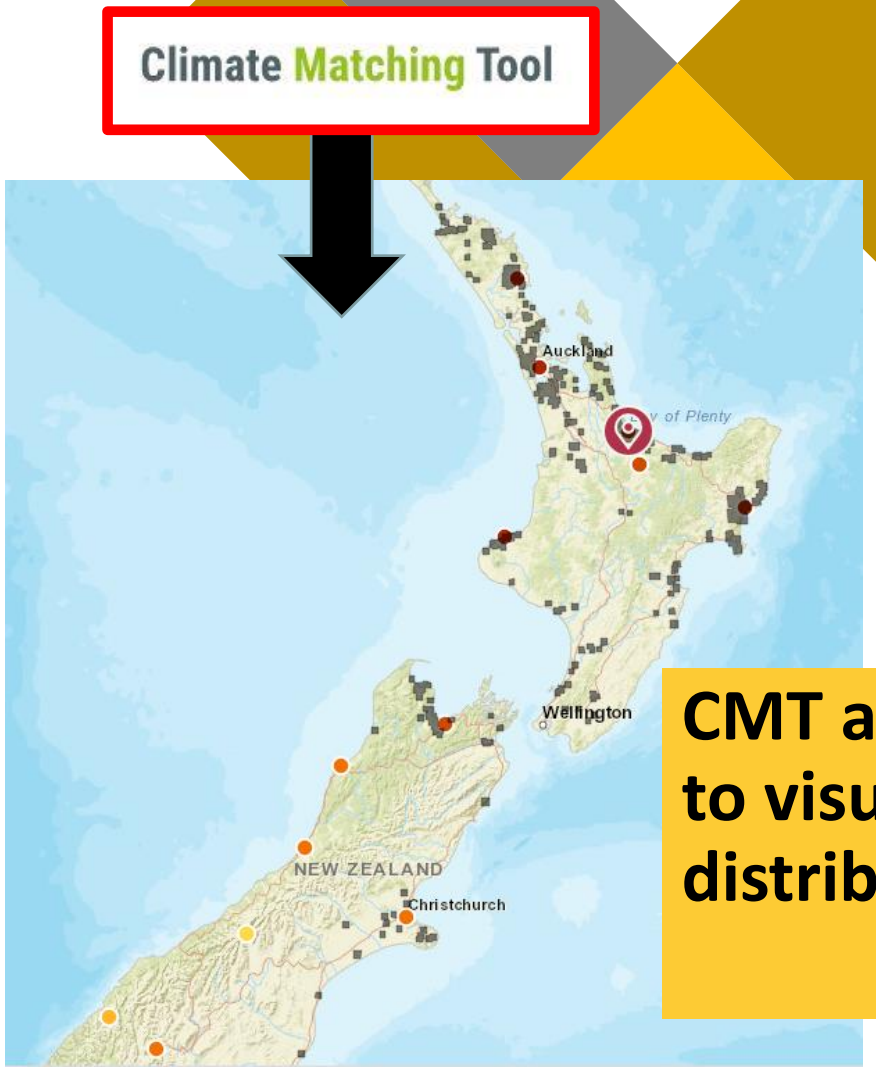


CMT allows us to compare weather stations' climates

"NOW"

future

Oriental Fruit Fly:
Could establish in NZ areas where highest value crops are



CMT allows us to visualise crop distribution

Thank you

AgResearch: Craig Phillips and his team

Epi Interactive: Uli Muellner and his team

MPI Operational Research team: Evan Brenton-Rule, Nirosha Priyadarshani, Clare McDonald

Risk team: Helen Harman, Jo Berry, Huimin Lin, Sarah Sapsford Callum McLean, Hayley Tuck, Andreas Makiola

Biosecurity intelligence team: Andrew Rae

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