



BIODIVERSITY  
BUILDING  
BLOCKS FOR  
POLICY

# Occurrence Cubes & Biological Invasions

Examples using Python and R  
**b3alien** & **invasimapr**

**Maarten Trekels & Sandra MacFadyen**



Funded by  
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**Meise  
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National Institute for  
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UNIVERSITEIT

# From Biodiversity Observations to Insights

## Hands-on Training

FEBRUARY TO MARCH

### FROM BIODIVERSITY OBSERVATIONS TO INSIGHTS: HANDS-ON TRAINING

Registration open

Start date: 20 February, 15:00 CET

Six live sessions, held on consecutive Fridays at 15:00 CET.



### Programme

#### 20 February, 15:00 CET - Species occurrence cubes

Andrew Rodrigues (GBIF) and Lina Estupinan Suarez (Martin Luther University Halle-Wittenberg)

#### 27 February, 15:00 CET - Occurrence cubes and biological invasions

Maarten Trekels (Meise Botanic Garden) and Sandra MacFadyen (Stellenbosch University)

#### 6 March, 15:00 CET - Indicators for national invasion reporting

Tsungai Alfred Zengeya (South African National Biodiversity Institute)

#### 13 March, 15:00 CET - Mapping biodiversity turnover with dissmapr

Sandra MacFadyen (Stellenbosch University).

#### 20 March, 15:00 CET - Making use of colorblind friendly maps

Duccio Rocchini (University of Bologna).

#### 27 March, 15:00 CET - b3verse: an R package suite to process cubes and calculate indicators

Shawn Dove (Justus Liebig University), Ward Langerlaert (Research Institute for Nature and Forest) and Jasmijn Hillaert (Research Institute for Nature and Forest).

# Introductions

## Occurrence cubes and biological invasions

### Who are we



**Dr Sandra MacFadyen** is a research fellow at the Mathematical Biosciences Lab, Stellenbosch University, South Africa. She completed a joint PhD in Botany at Stellenbosch University and Landscape Ecology at Vrije Universiteit Amsterdam, holds an MSc in Geographic Information Science, and postgraduate qualifications in Nature Conservation. Based in the Kruger National Park for over 27 years, her research focuses on macroscale ecosystem dynamics, applying spatiotemporal statistics, mathematical ecology, and complexity theory to advance biodiversity monitoring and conservation in large protected areas.



**Mr Maarten Trekels** is a biodiversity data scientist and project coordinator at Meise Botanic Garden, Belgium. Trained in physics and working in aerospace and medical tech, he moved into biodiversity informatics by developing standards for Biodiversity Information Standards (TDWG) in EU-funded projects supporting the DiSSCo research infrastructure. He coordinates DiSSCo implementation in Flanders, contributes to FAIR interoperability via the Research Data Alliance, leads a work package in Biodiversity Building Blocks for Policy, and pursues a Stellenbosch BioMath PhD in community ecology.

Maarten will present the possibilities of the b3alien Python package. The package provides a technical solution to track Target 6 of the KM-GBF. It mainly focuses on the headline indicator: rate of invasive alien species establishment, but can provide input to some of the complementary indicators. Sandra will give you a brief overview of the Invasibility Cube, which integrates trait, environment (and site), and community (species) data to quantify invasion fitness and generate spatial indicators of site invasibility and species and/or trait invasiveness.

# Occurrence cubes and Biological invasions

Examples using the `b3alien` python package and `invasimapr` R package

## Course Outline

- **Part 1: Data cubes and `b3alien` to monitor invasions** (Maarten)
  - A general overview of the **b-cubed Project**
  - **Essential Biodiversity Variables** (EBVs) explained
  - A brief introduction to **CBD targets** on **invasive alien species**
  - **Hands-on** with `b3alien`
- **Part 2: Species Invasiveness and Site Invasibility** with `invasimapr` (Sandra)
  - Biological invasions are a major threat to biodiversity.
  - Traditional Species Distribution Models and their limitations
  - The Fourth-Corner Problem >> Linking traits with environment
  - `invasimapr` computes **invasion fitness** = **abiotic suitability** - **niche crowding** - **site saturation**



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## Part 1: b3alien

A python package to report on KM-GBF  
Target 6.1

Maarten Trekels



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Stellenbosch  
UNIVERSITY  
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UNIVERSITEIT

04 June 2025  
Online  
NITheCS mini-school

The background of the slide is a close-up photograph of a large number of bees, likely honeybees, on a green, textured surface. The bees are in various positions, some in sharp focus and others blurred, creating a sense of a busy, natural environment. The overall color palette is dominated by greens and yellows.

# **b3alien**

A python package to report on KM-GBF  
Target 6.1

Maarten Trekels

# About



## Challenges

The global biodiversity crisis requires **rapid, reliable and repeatable biodiversity monitoring data** which decision makers can use to evaluate policy.



## Opportunities

Such information – from local to global level and within relevant timescales – calls for an **improved integration of data on biodiversity** from different sources.



## Aim

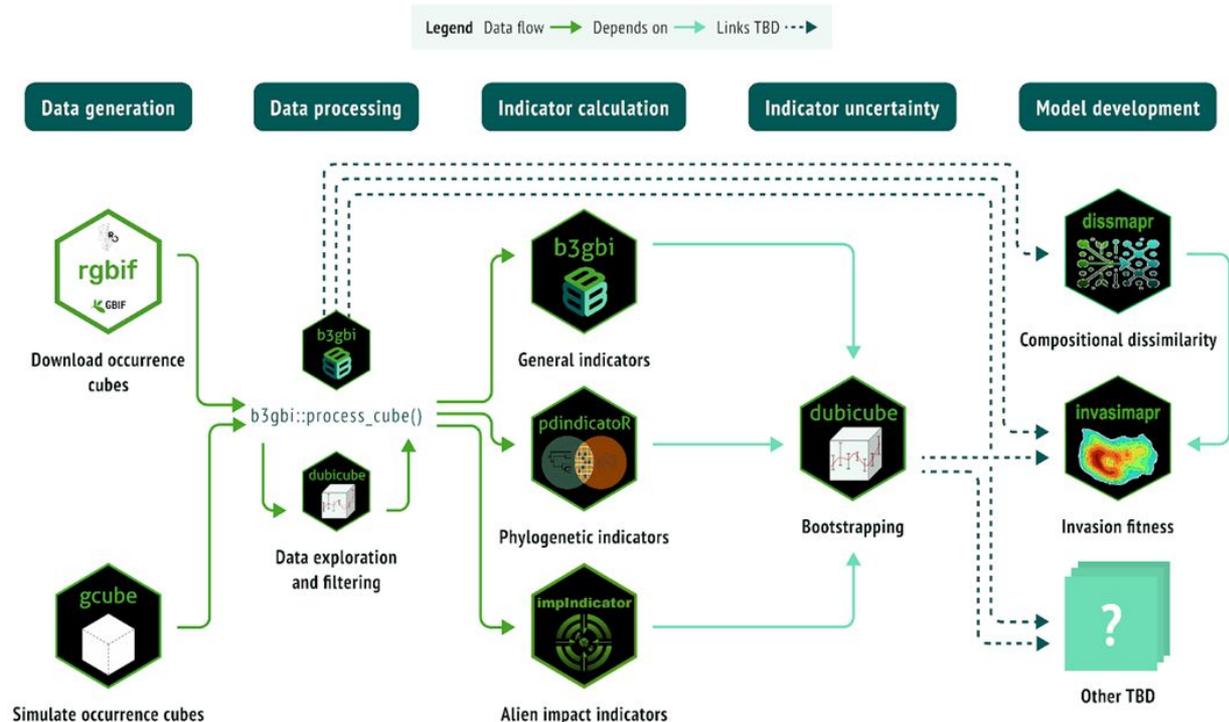
B-Cubed is **standardising access to biodiversity data**, empowering policymakers to address the impacts of biodiversity change.

# B-Cubed

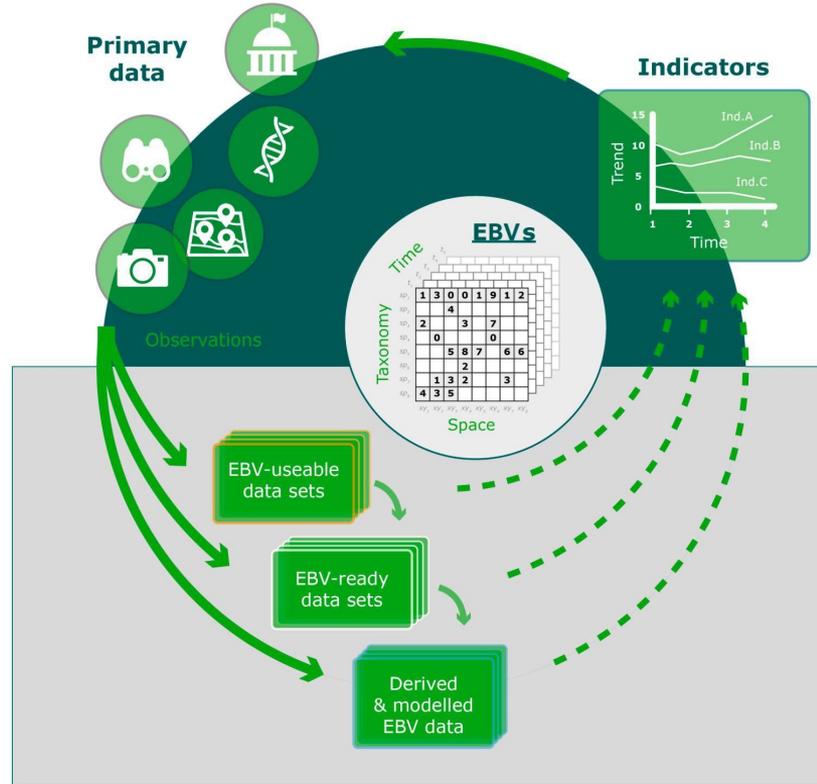
## Biodiversity data cubes for monitoring

### Not just diversity of species

B-Cubed uses biodiversity data cubes to generate **indicators** that translate complex data into clear measures of biodiversity status and trends → **b3verse** - an open-source software ecosystem containing a suite of interoperable R packages.



# Essential Biodiversity Variables (EBVs)



# Practical implementation



### Download cube

This download format allows you to aggregate occurrences by their taxonomic, temporal and/or spatial properties. For example, a data cube can be configured to aggregate occurrences by family, month and grid cell of the European Environment Agency reference grid (three dimensions) and count the number of occurrences (a measure) per combination. The result is a CSV file.

Once configured, a SQL query will be created to generate the data cube. For more advanced use, it is possible to further customize the requested download by editing the SQL query.

[Read more](#)

#### DIMENSIONS

A dimension represents an aspect along which data can be aggregated. Selecting a higher resolution (e.g., species over family, date over year, 100 m over 10 km) will result in more categories and therefore more records.

##### Taxonomic dimension

This dimension aggregates occurrences by their taxonomic rank.

Species

##### Temporal dimension

This dimension aggregates occurrences by time.

Year and month

##### Spatial dimension

This dimension aggregates occurrences in a spatial grid.

Extended quarter degree grid (QDGC)

##### Spatial resolution

The size of each grid cell.

Level 3, 1/4° cells, 14 km at Equator

##### Randomize points within uncertainty circle

For occurrence records with a coordinate uncertainty that covers more than one grid cell, should a random cell be chosen? If not, the cell containing the centroid of the record is used.

Yes  No

Coordinate precision in meters: 1000

658 Type status

16,373

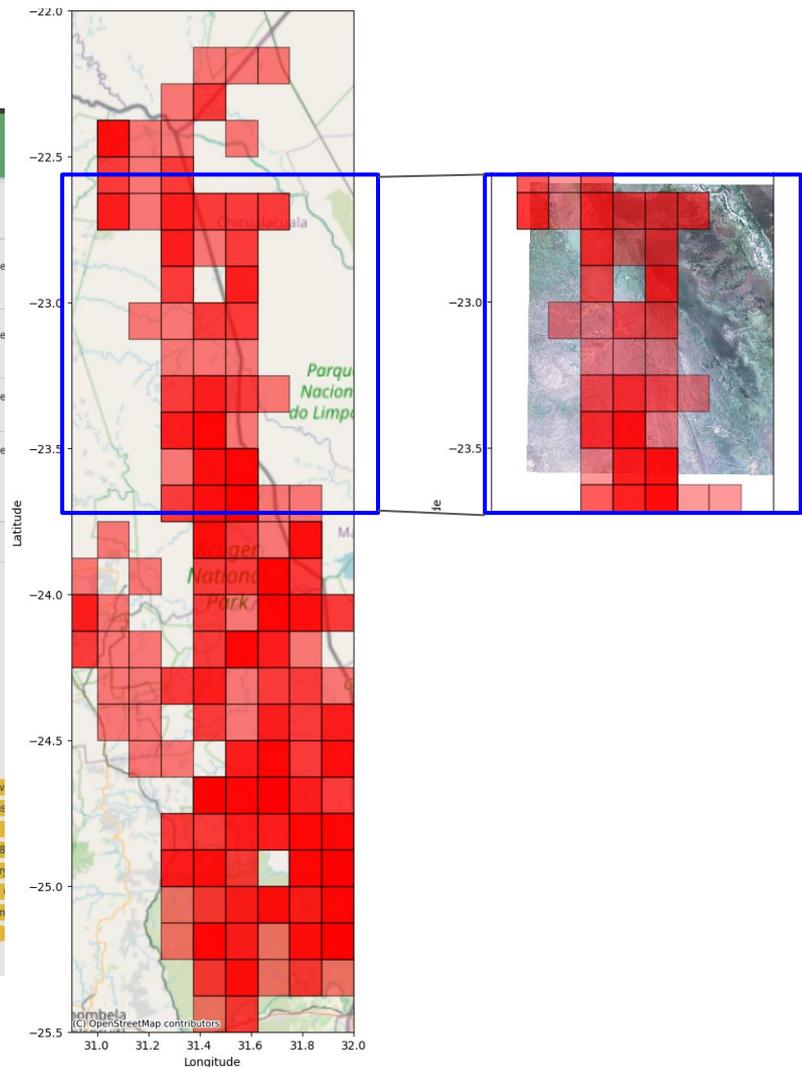
259 Count

106

Coordinate mismatch

SUSPECTED\_TYPE

Ambiguous



# CBD targets on invasive alien species

Practical use of the data cubes

# Convention on Biological Diversity (CBD)



Kunming-Montreal  
**GLOBAL BIODIVERSITY**

[GBF HOME](#) // TARGET 6

## Target 6

### Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their Impact

*Eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent, by 2030, eradicating or controlling invasive alien species especially in priority sites, such as islands.*

Following are the guidance notes prepared by the Secretariat for Target 6

#### E. Indicators

The [monitoring framework](#) for the Kunming-Montreal Global Biodiversity Framework identifies the following indicators for this target:

##### Headline indicators:

- 6.1 Rate of invasive alien species establishment

##### Component indicators:

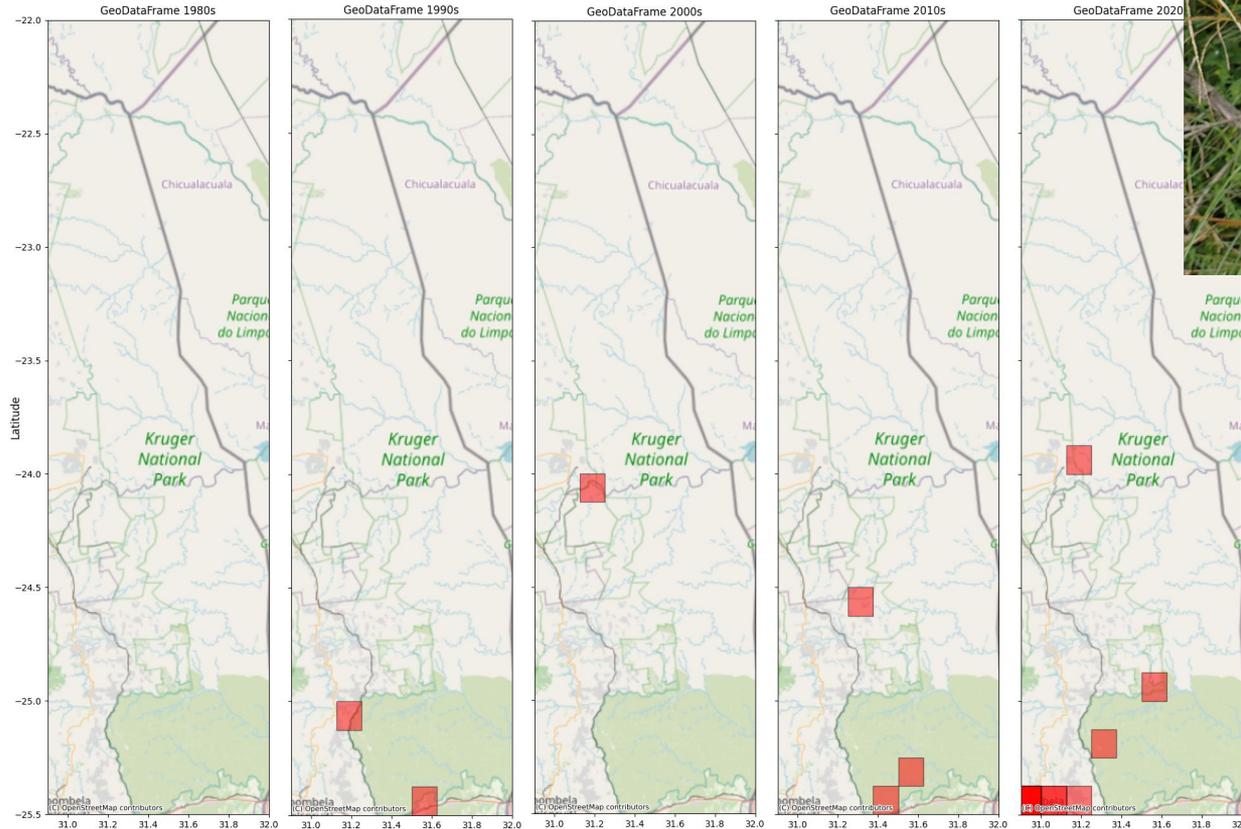
- Rate of invasive species impact and rate of impact
- Rate of invasive alien species spread
- Number of invasive alien species introduction events

##### Complementary indicators:

- Number of invasive alien species on national lists as per the Global Register of Introduced and Invasive Species
- Trends in abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (in relation to the main vectors and pathways of spreading of such species)
- Red List Index (impacts of invasive alien species)

Reduce the  
Introduction and  
Impact of Invasive  
Alien Species

# Data cubes to monitor invasions



***Chromolaena odorata* (L.)**

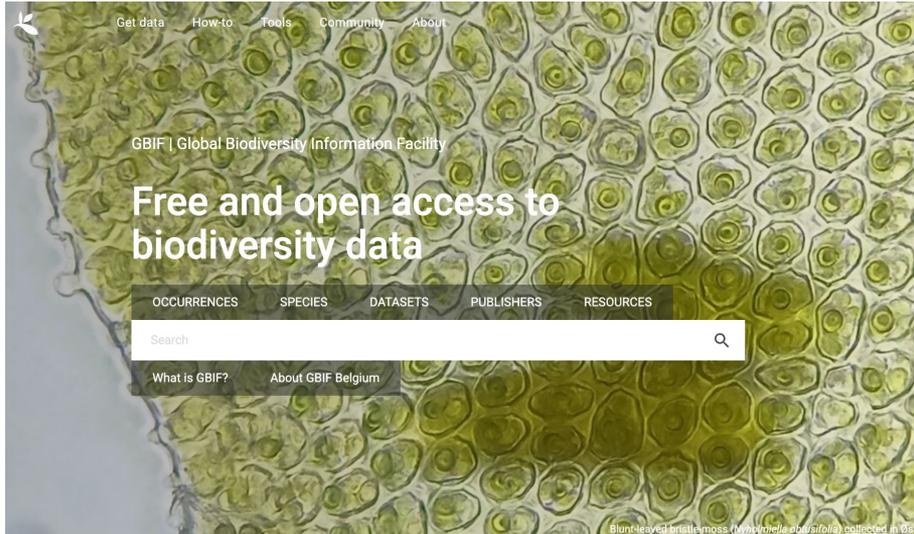
**R.M.King & H.Rob.**

Observed in South Africa

by Mahomed Desai (licensed under

<http://creativecommons.org/licenses/by/4.0/>)

# Data sources



Get data How-to Tools Community About

GBIF | Global Biodiversity Information Facility

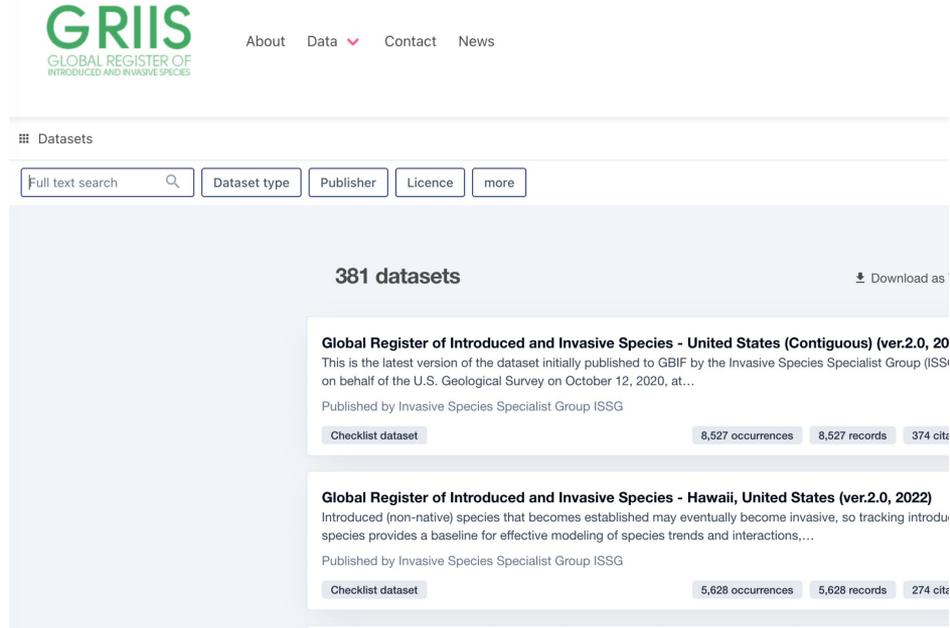
## Free and open access to biodiversity data

OCCURRENCES SPECIES DATASETS PUBLISHERS RESOURCES

Search

What is GBIF? About GBIF Belgium

*Bluntleaved bristlegrass (Vilfa (Vilfa) parvifolia) collected in GBIF*



**GRIIS**  
GLOBAL REGISTER OF  
INTRODUCED AND INVASIVE SPECIES

About Data Contact News

### Datasets

Full text search Dataset type Publisher Licence more

## 381 datasets

Download as

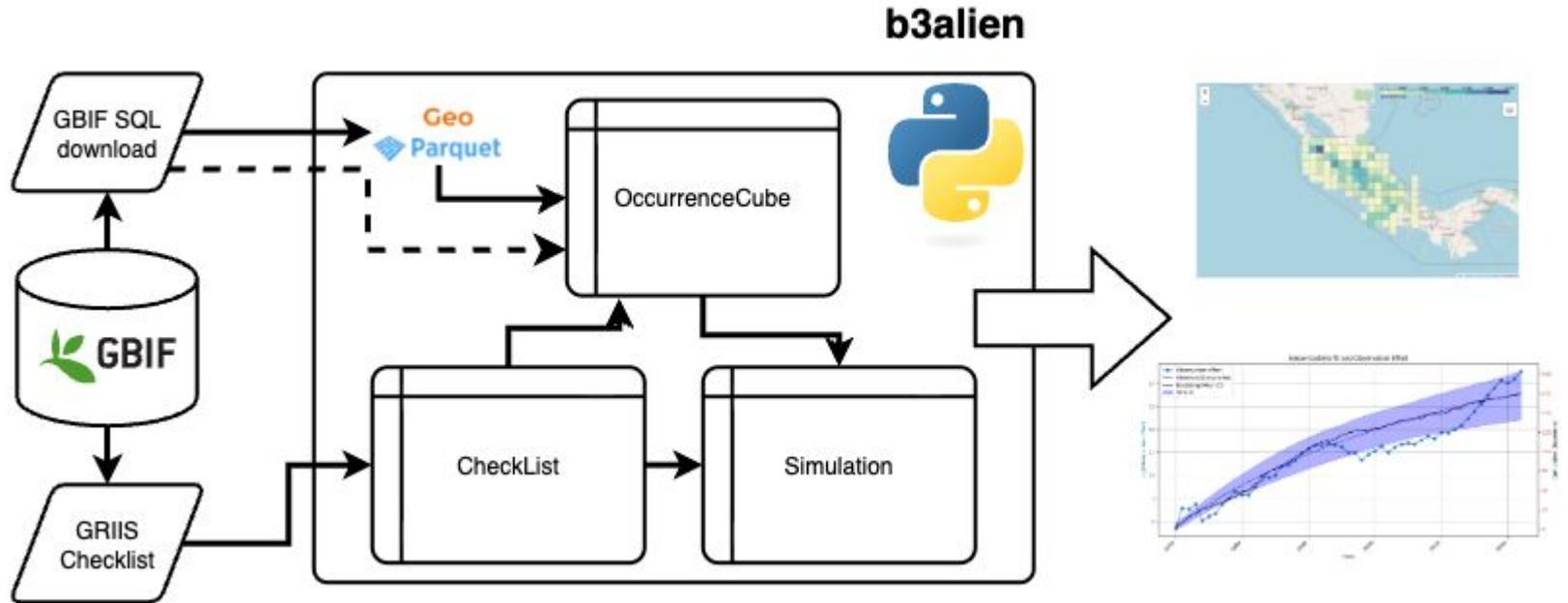
**Global Register of Introduced and Invasive Species - United States (Contiguous) (ver.2.0, 2020)**  
This is the latest version of the dataset initially published to GBIF by the Invasive Species Specialist Group (ISSG) on behalf of the U.S. Geological Survey on October 12, 2020, at...  
Published by Invasive Species Specialist Group ISSG

Checklist dataset 8,527 occurrences 8,527 records 374 citations

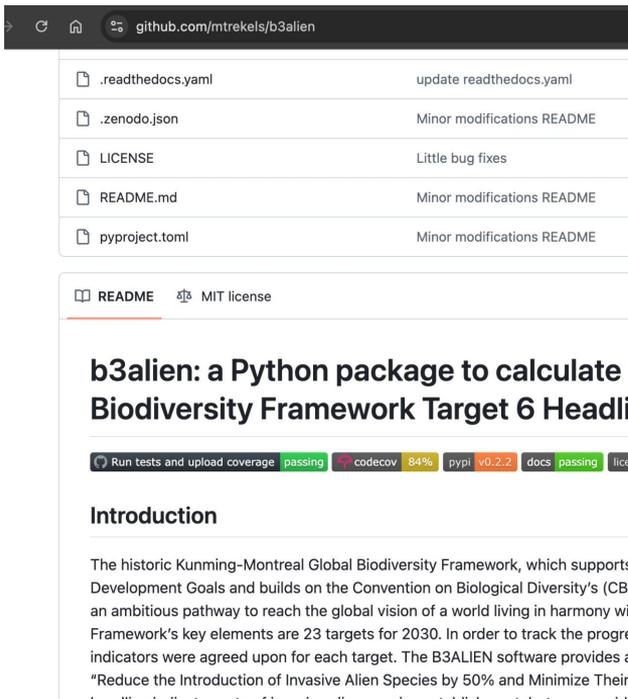
**Global Register of Introduced and Invasive Species - Hawaii, United States (ver.2.0, 2022)**  
Introduced (non-native) species that becomes established may eventually become invasive, so tracking introduced species provides a baseline for effective modeling of species trends and interactions, ...  
Published by Invasive Species Specialist Group ISSG

Checklist dataset 5,628 occurrences 5,628 records 274 citations

# b3alien as a practical implementation



# b3alien as a practical implementation



The screenshot shows the GitHub repository for b3alien. The top navigation bar includes the GitHub logo and the repository name. Below the navigation bar, there is a list of files and folders with their respective descriptions:

- `.readthedocs.yaml`: update readthedocs.yaml
- `.zenodo.json`: Minor modifications README
- `LICENSE`: Little bug fixes
- `README.md`: Minor modifications README
- `pyproject.toml`: Minor modifications README

Below the file list, there are tabs for `README` and `MIT license`. The `README` tab is active, showing the title `b3alien: a Python package to calculate Biodiversity Framework Target 6 Headli`. Below the title, there are several status badges: `Run tests and upload coverage` (passing), `codecov` (84%), `pypi` (v0.2.2), `docs` (passing), and `licen`.

## Introduction

The historic Kunming-Montreal Global Biodiversity Framework, which supports Development Goals and builds on the Convention on Biological Diversity's (CBD) an ambitious pathway to reach the global vision of a world living in harmony with Framework's key elements are 23 targets for 2030. In order to track the progress indicators were agreed upon for each target. The B3ALIEN software provides a "Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their

## APPENDIX B: Exemplar workflow to determine the Rate of Establishment

This Jupyter notebook will guide the user of the b3alien Python package to generate a measure of the rate of establishment of alien species in a specific region or country. This workflow can be modified to match the needs of the user.

### Install the b3alien Python package

```
[ ]: %pip install b3alien
```

### Load the software package and additional libraries

```
[1]: from b3alien import b3cube
from b3alien import simulation
from b3alien import griis

import pandas as pd
import geopandas as gpd

import folium
from folium import Choropleth
from IPython.display import display

import matplotlib.pyplot as plt

%matplotlib inline
```

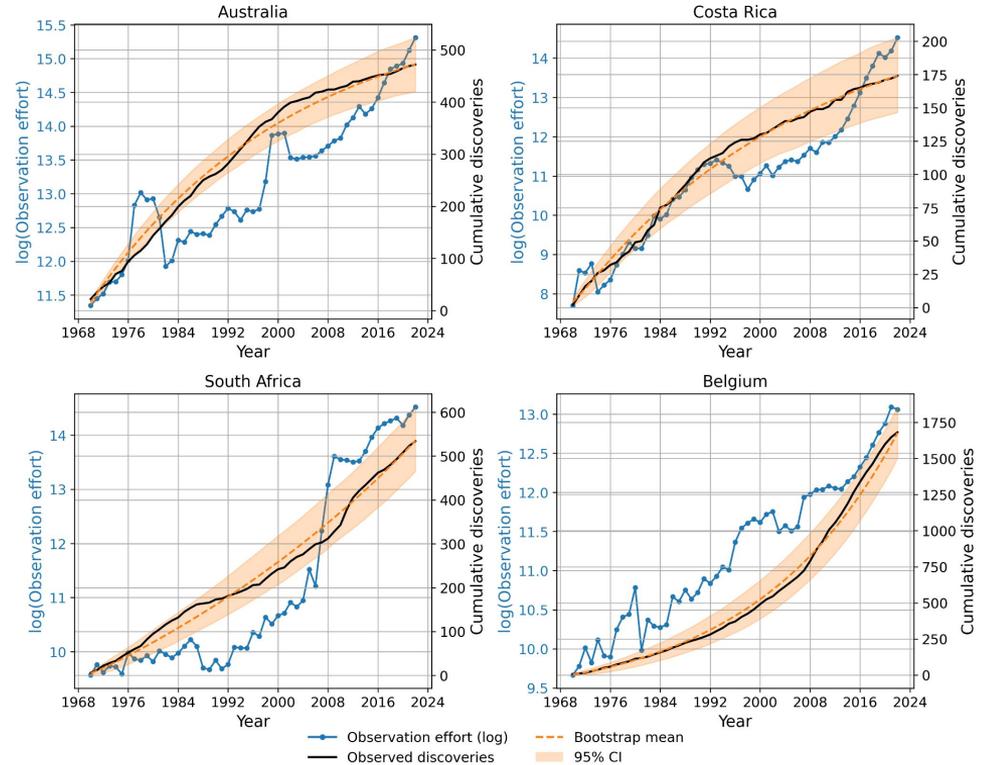
### Step 1: Generate a Biodiversity Data Cube from GBIF

This step can be skipped if you already have generated a GeoParquet file with your data cube.

The basic workflow assumes as an input a basic occurrence cube generated on the GBIF infrastructure. It uses the SQL API interface to GBIF data. How to generate this cube is described in Appendix A.

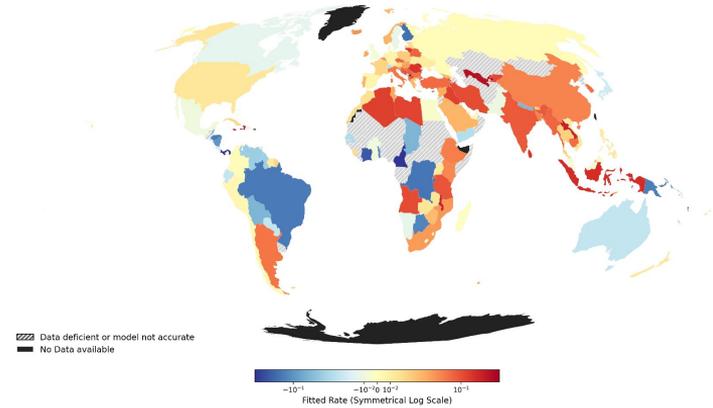
# b3alien as a practical implementation

Country	Change in Rate of Establishment (Year <sup>-1</sup> )	95% confidence interval
Belgium	+ 4.3 %  +6.5%	2.7% ; 7.0%  3.8% ; 7.9%
South Africa	+ 1.6 %	0.2% ; 8.7%
Australia	- 0.31 %	- 3.9% ; - 0.29%
Costa Rica	- 2.7 %	- 4.7% ; - 1.3%

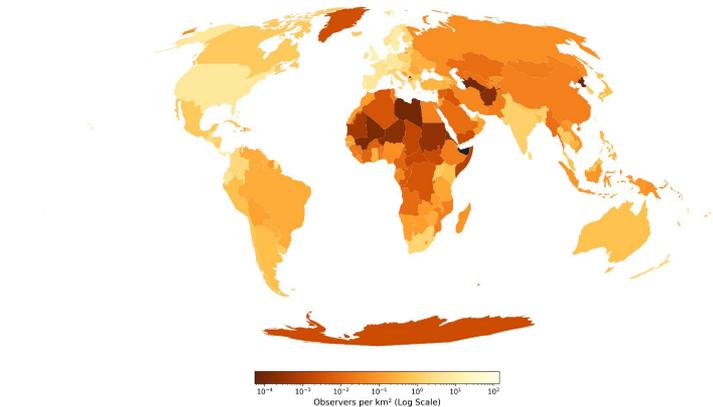


# Rapid and repeatable workflow

## A. Fitted Change of Rate of Establishment



## B. Observer Density (Distinct Observers per km<sup>2</sup>) in 2022



- Simple workflow, readily usable by any country
- Heavily relying on the GRIIS checklist (GBF data source): high demand for updated checklists on alien species
- Easy to integrate in existing workflows
- Future plans: optimize the handling of the data cubes, faster reporting for more countries.
- Report on the complementary indicators

[https://github.com/mtrekels/b3alien\\_training](https://github.com/mtrekels/b3alien_training)

# Occurrence Cubes & Biological Invasions - b3alien

Maarten Trekels

Questions?

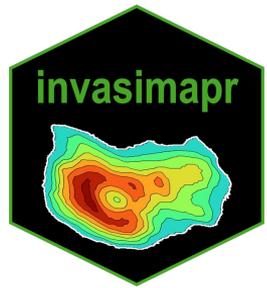


# QUICK BODY BREAK

## Occurrence Cubes & Biological Invasions

Examples using Python and R

**b3alien** & **invasimapr**



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## Part 2: **invasimapr**

A framework to visualise trait dispersion and assess species **invasiveness** & site **invasibility**

**Dr Sandra MacFadyen**

macfadyen@sun.ac.za



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# invasimapr

## An R Package to assess Species Invasiveness and Site Invasibility Analyses



## Trait dispersion to assess species invasiveness and site invasibility

https://b-cubed-eu.github.io/invasimapr/

invasimapr 0.1.0 Reference Changelog Articles

Search for

### invasimapr



A Novel Framework to visualise trait dispersion and assess species invasiveness or site invasibility

### Introduction

Biological invasions are a leading driver of biodiversity loss. Establishment success depends on a species' functional traits, local environments, and the competitive pressure from resident communities—so ad-hoc, single-component analyses are insufficient. **invasimapr** provides a transparent, trait- and site-specific framework that integrates these components into a single, reproducible workflow to estimate **invasion fitness** and derive decision-ready indicators of **species invasiveness** and **site invasibility**.

At its core, the package (i) models **intrinsic growth potential** from trait-environment responses, (ii) quantifies **competitive penalties** imposed by resident communities via trait overlap and environmental filtering, and (iii) combines these to compute a site- and species-resolved fitness surface that can be summarised and mapped. It relies on standard statistical tools (e.g., GLMM/GAM) and explicit distance/kernels, making it accessible and extensible for applied invasion ecology and conservation planning.

### Core concepts (what the framework estimates)

- Invasion fitness** ( $\lambda$ ) - Net potential for a species to increase when rare at a site:  $\lambda = \Gamma r - \alpha C - \beta S + k$ , where  $r$  is intrinsic (abiotic) performance,  $C$  niche crowding,  $S$  site saturation, and  $\Gamma, \alpha, \beta$  are sensitivities.
- Invasiveness** ( $V_i$ ) - Propensity of a species to establish across sites (spatial aggregation of  $\lambda$ ).
- Invasibility** ( $V_s$ ) - Openness of a site to establishment by newcomers (aggregation of  $\lambda$  over candidate invaders).

### Links

[Browse source code](#)

[Report a bug](#)

### License

[MIT](#) + file [LICENSE](#)

### Community

[Code of conduct](#)

### Citation

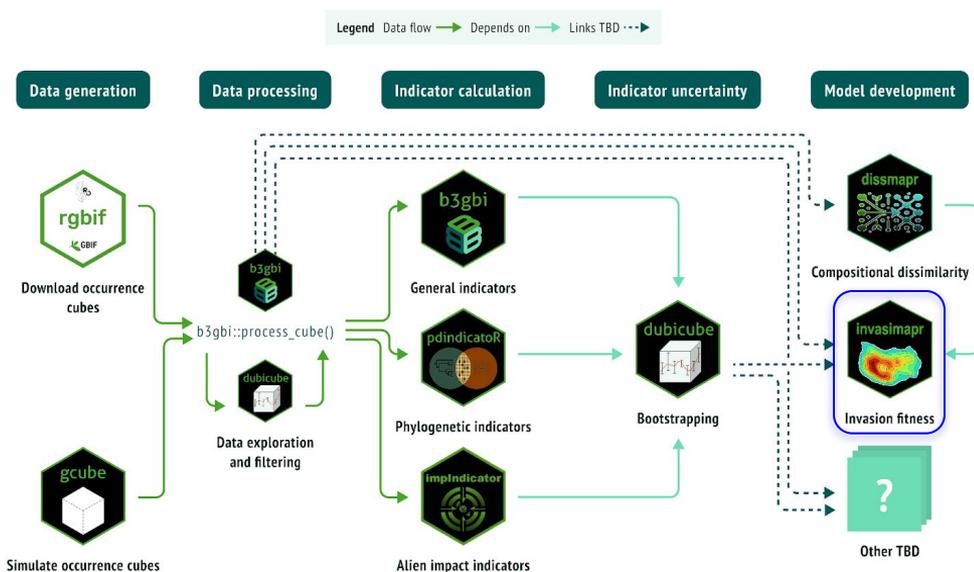
[Citing \*\*invasimapr\*\*](#)

### Developers

Sandra MacFadyen  
Author, maintainer

### Dev status

repo status	Active
release	v0.1.0
r-universe	0.1.0
CRAN	not published
R-CMD-check_yaml	failin
codecov	0%
DOI	awaiting upload to zenodo
r-universe	b-cubed-eu
license	MIT

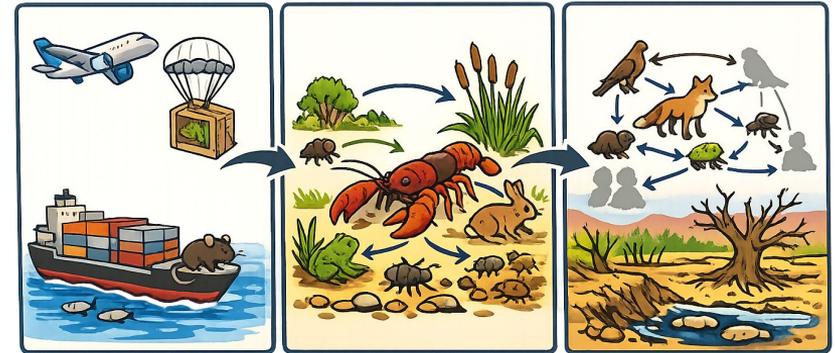


# Invasive Alien Species (AIS)

Biological invasions are a major driver of biodiversity loss

Altering ecosystem processes, and displacing native taxa

- Biological invasions are a leading driver of biodiversity loss worldwide
- Impacts cascade through food webs and ecosystem functioning



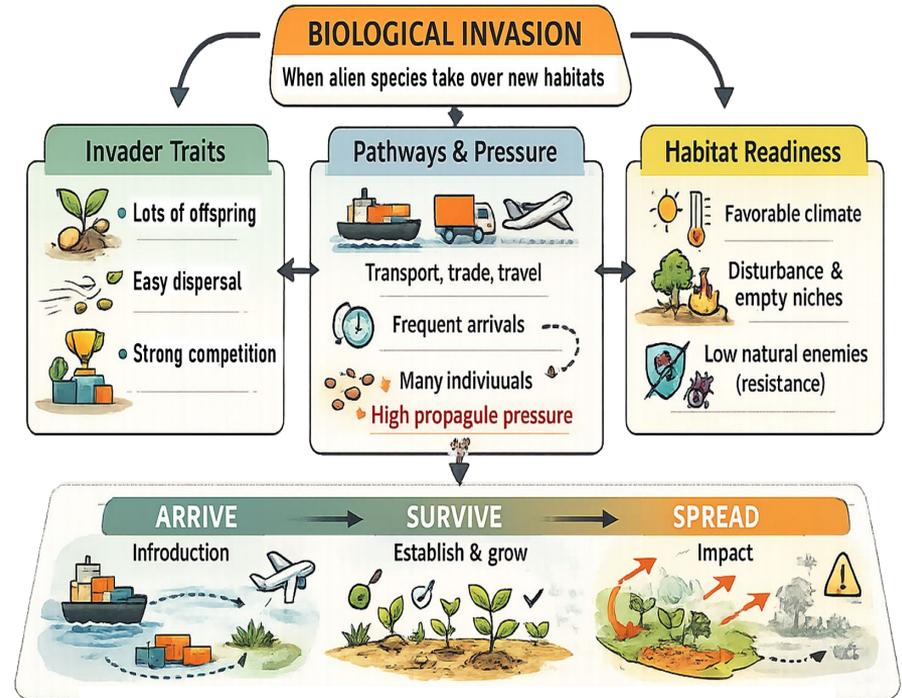
- **Understanding establishment is key to prevention and mitigation**
- **Forecasting enables proactive, evidence-based management**

# Invasive Alien Species (AIS)

Biological invasions are a major driver of biodiversity loss

## Why Predict Establishment and Spread?

- Only a subset of introduced species successfully establish
- Risk varies across environmental gradients and communities
- How can we make reliable predictions?

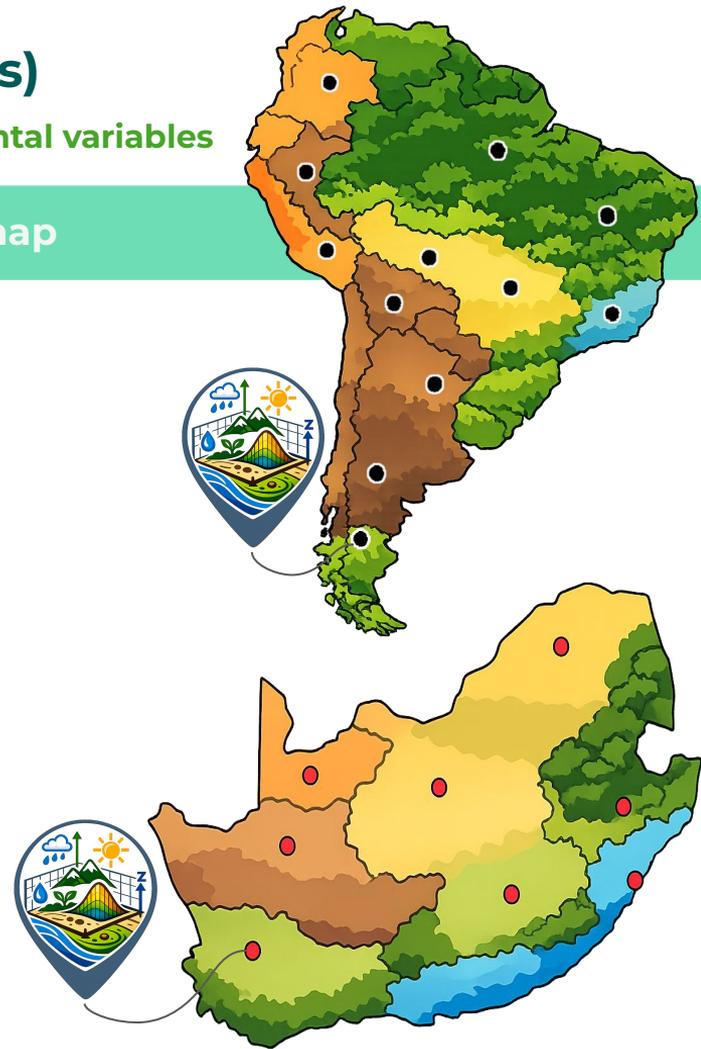


# Traditional Species Distribution Models (SDMs)

Looks at where a species is now and correlate that with environmental variables

SDMs project discovered 'niche' onto a new distribution map

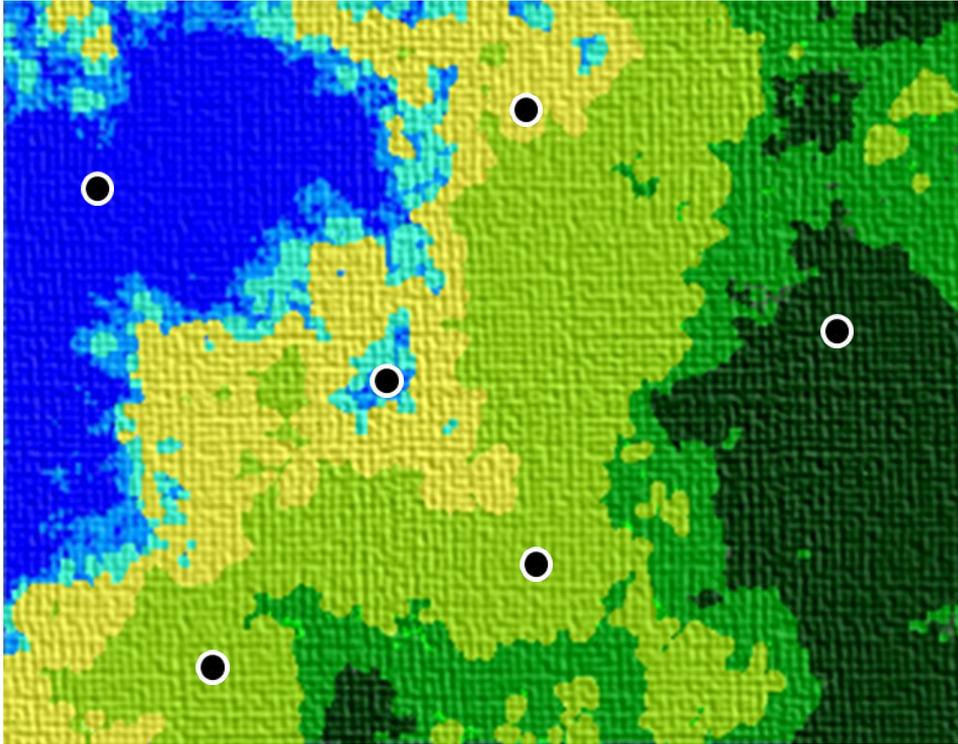
- Correlate species occurrences with environmental variables
- Infer ecological niche and project habitat suitability
- Assume distributions reflect environmental equilibrium
- **Predict geographic suitability from abiotic conditions**



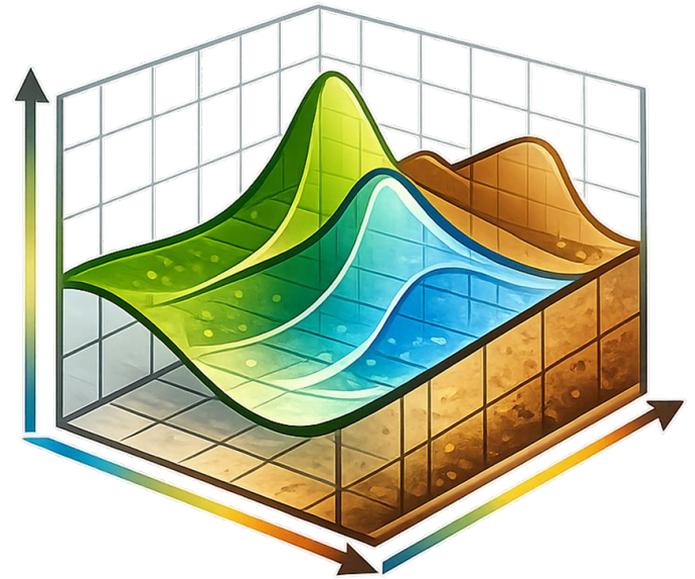
# Traditional Species Distribution Models (SDMs)

Predict geographic suitability from abiotic conditions

How SDMs work



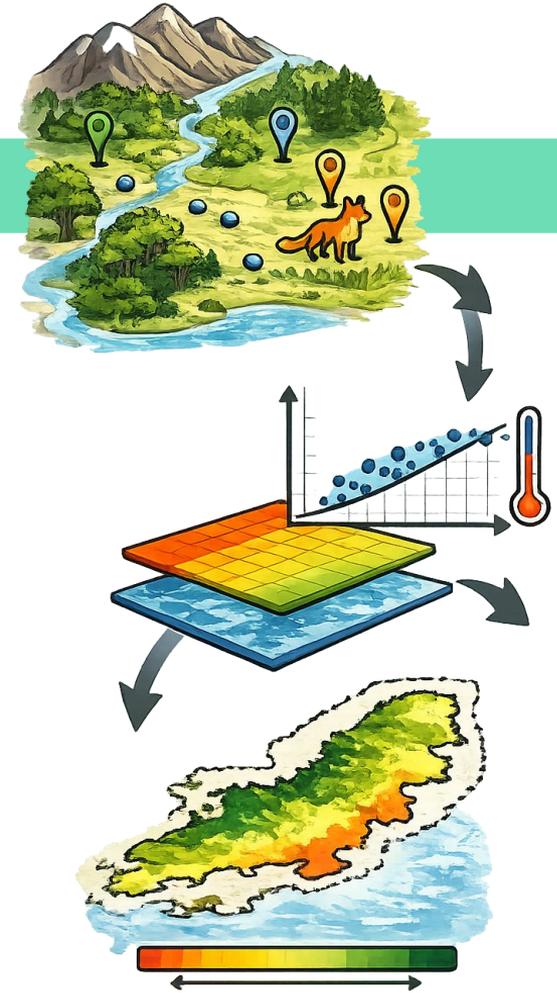
Unique ecological signature or *niche*



# Traditional Species Distribution Models (SDMs)

Predict geographic suitability from abiotic conditions

Correlate species occurrences with environmental variables



# Traditional Species Distribution Models (SDMs)

Predict geographic suitability from abiotic conditions

## Limitations of SDMs for Invasions

- Often ignore resident community interactions (biotic resistance)
- Assume equilibrium with environment (rare for invaders)
- Risk of misleading forecasts when time and adaptation are ignored
- May overpredict suitability in novel environments



**Ecologists must be cautious when applying equilibrium SDMs to dynamic invasions.**



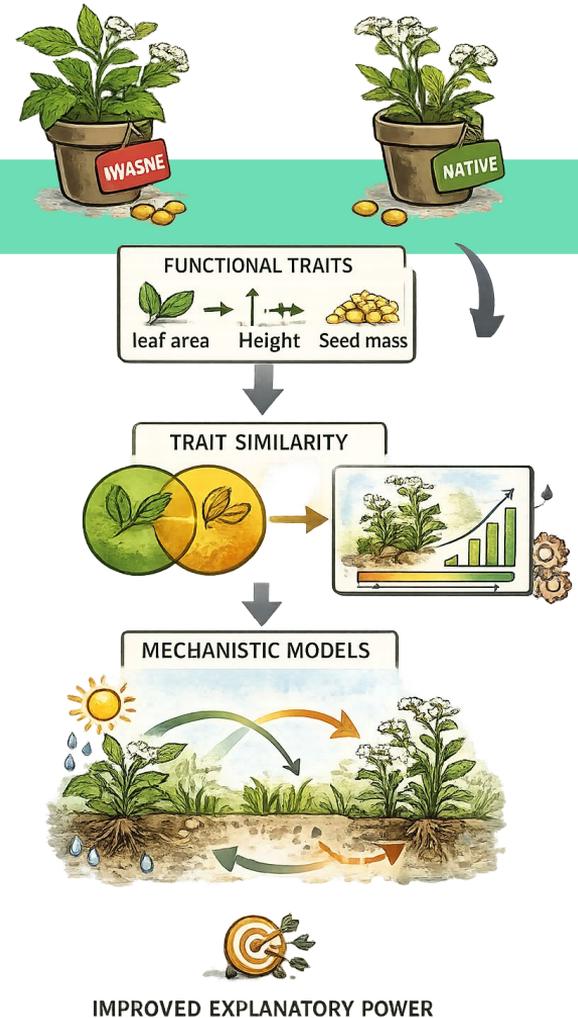
# Moving Beyond Environment-Only Models

Biological invasions are a major driver of biodiversity loss

Functional traits describe ecological strategies

- Functional traits determine growth, survival, and competition
- Trait similarity mediates coexistence and competitive exclusion
- Mechanistic models improve explanatory power

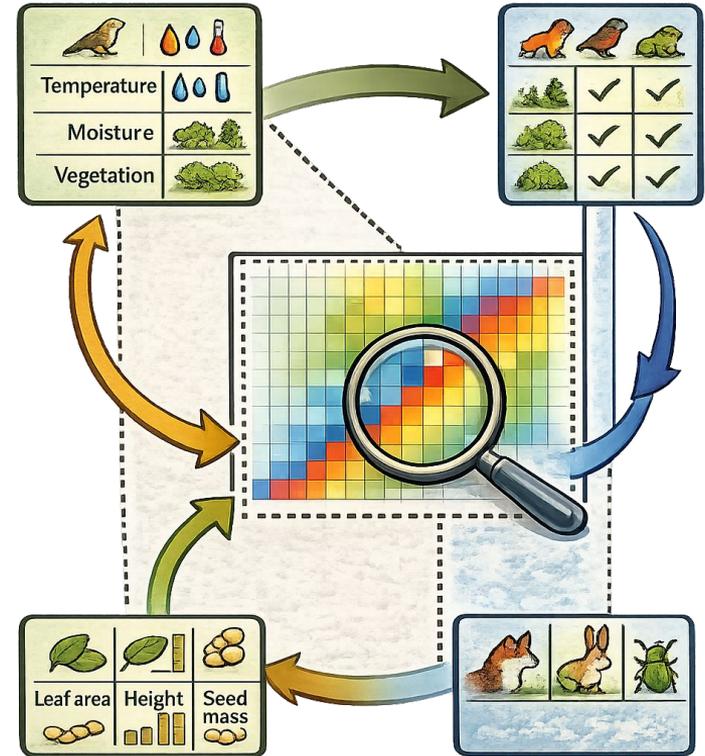
Linking traits to environment is a “fourth-corner” problem



# The Fourth-Corner Problem

## Linking Environment and Traits

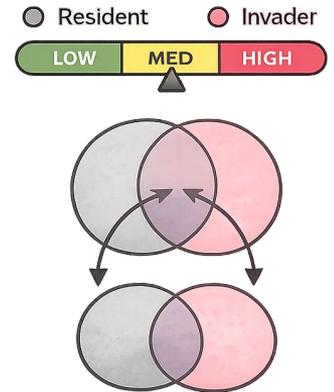
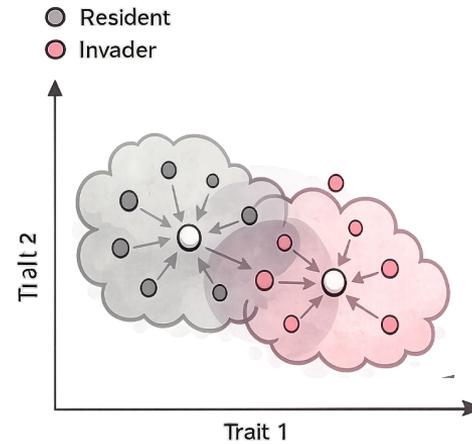
Connecting environmental gradients to trait responses



# The Fourth-Corner Problem

## Linking Environment and Traits

### Shared trait-space to predict invader success



# invasimapr

An R Package to assess Species Invasiveness or Site Invasibility Analyses

## Trait dispersion to assess species invasiveness or site invasibility

- **invasimapr** helps quantify **establishment potential** at specific sites and to compare that potential **across species and landscapes**.
- It is a **trait-based, site-specific** R package that estimates **invasion fitness** for candidate invaders, assembles the resident community context that constrains establishment, and turns these quantities into mappable indicators for decision making. The workflow links three pillars:
  1. **Functional trait space**, which governs competitive overlap.
  2. **Environmental suitability**, which determines how well species perform at a site.
  3. **Biotic competition**, which reduces the chance of establishment.

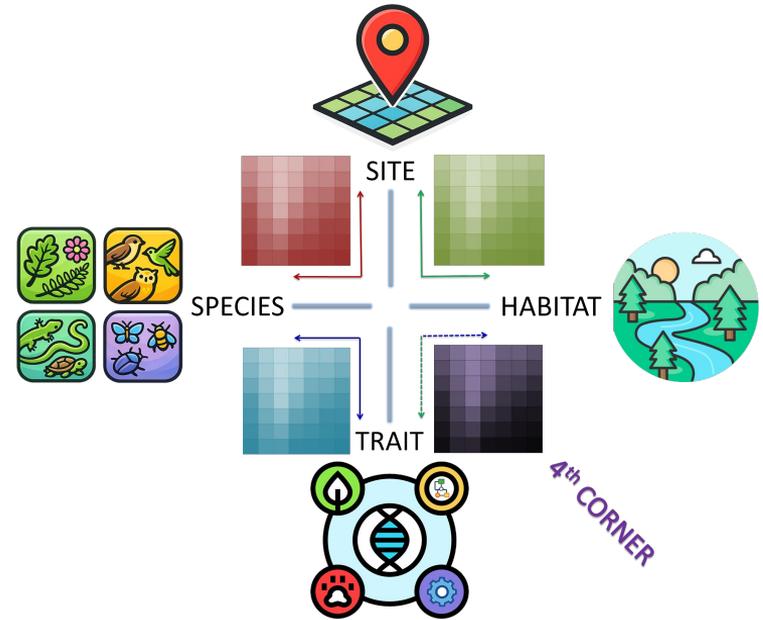
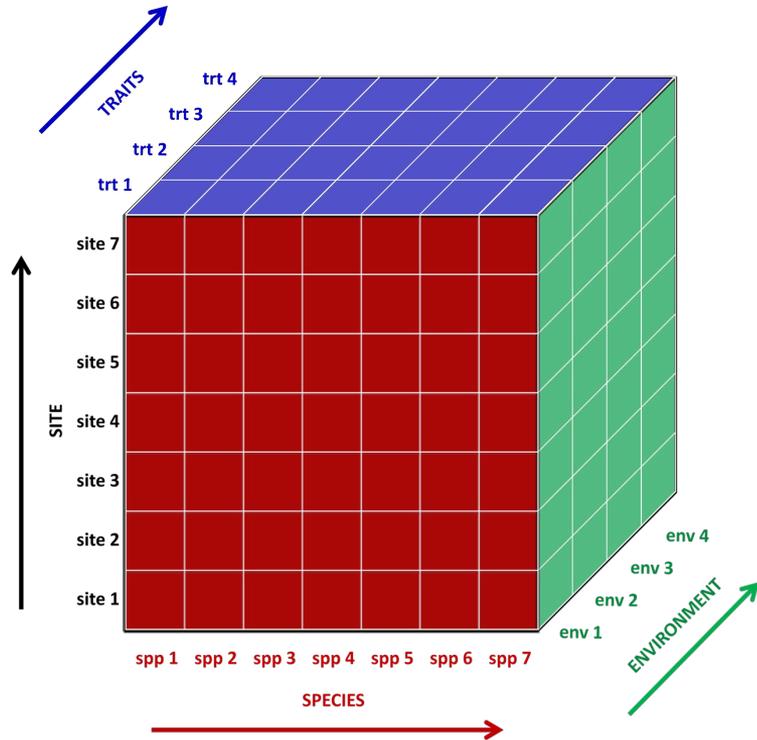
<https://b-cubed-eu.github.io/invasimapr/>

# Data Cubes

Biodiversity data cubes for monitoring

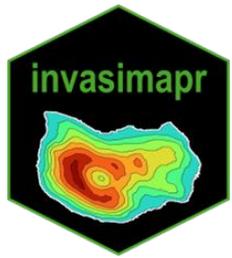


Site-by-Species | Site-by-Environment | Species-by-Trait



# Introducing invasimapr

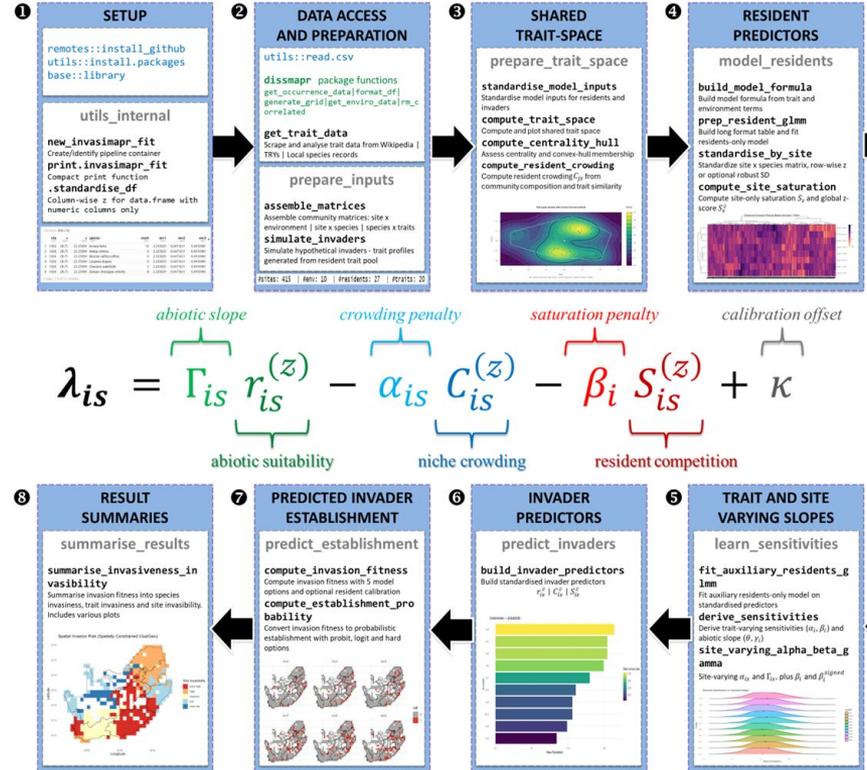
Biological invasions are a major driver of biodiversity loss



## Workflow

- Modular, transparent **R workflow**
- **Prepare resident community and trait data**
- Constructs a **shared multidimensional trait space**
- Estimate **environmental and competitive sensitivities**
- Estimates **invasion fitness** and **establishment probability**
- Summarise indicators like **Invasiveness** and **Invasibility**

## invasimapr Workflow



# Invasion Fitness: A Conceptual View

An R Package to assess Species Invasiveness or Site Invasibility Analyses



## Decomposing Invasion Fitness

- $\lambda$ : Can an invader  $i$  grow/establish at site  $S$ ?
- **Environmental match increases potential growth**
- Resident **competition reduces growth potential**

$$\lambda_{is} = \underbrace{\Gamma_{is}}_{\text{abiotic slope}} \underbrace{r_{is}^{(z)}}_{\text{abiotic suitability}} - \underbrace{\alpha_{is}}_{\text{crowding penalty}} \underbrace{C_{is}^{(z)}}_{\text{niche crowding}} - \underbrace{\beta_i}_{\text{saturation penalty}} \underbrace{S_{is}^{(z)}}_{\text{resident competition}} + \underbrace{\kappa}_{\text{calibration offset}}$$

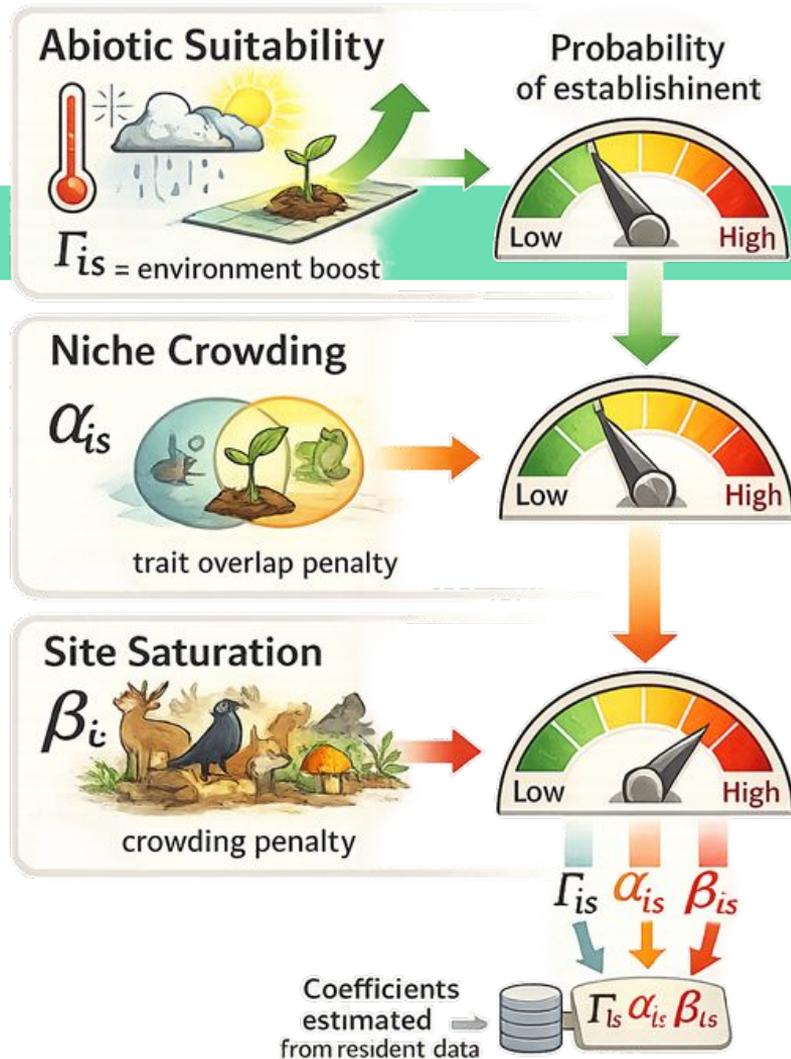
- **Abiotic suitability**: Trait fit to environmental conditions
- **Niche crowding**: Competition from trait-similar residents
- **Site saturation**: Overall competitive pressure

# Invasion Fitness: A Conceptual View

Assess Species Invasiveness or Site Invasibility Analyses

## Decomposing Invasion Fitness

$$\lambda_{is} = \underbrace{\Gamma_{is}}_{\text{abiotic slope}} \underbrace{r_{is}^{(z)}}_{\text{abiotic suitability}} - \underbrace{\alpha_{is}}_{\text{crowding penalty}} \underbrace{C_{is}^{(z)}}_{\text{niche crowding}} - \underbrace{\beta_i}_{\text{saturation penalty}} \underbrace{S_{is}^{(z)}}_{\text{resident competition}} + \underbrace{\kappa}_{\text{calibration offset}}$$

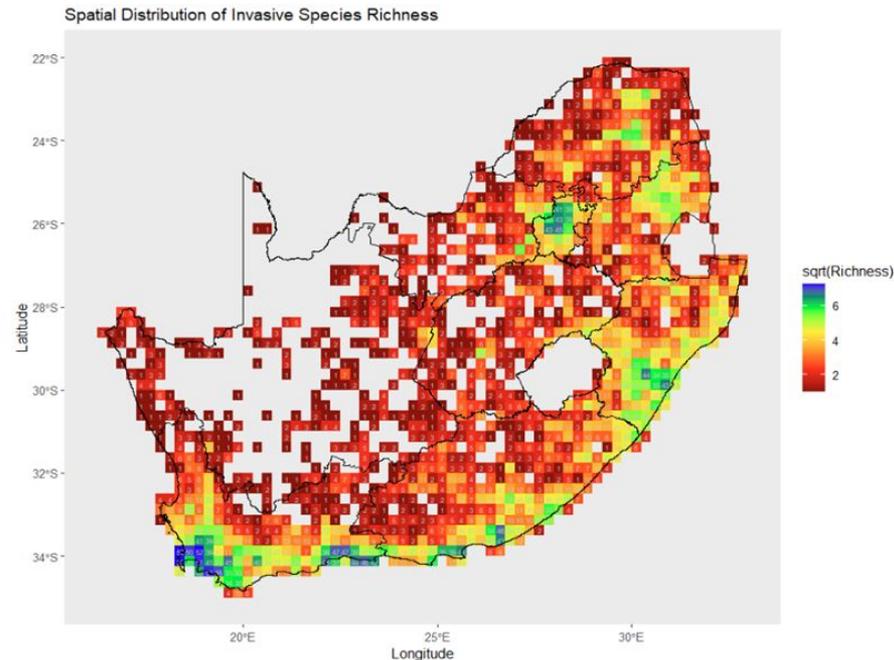
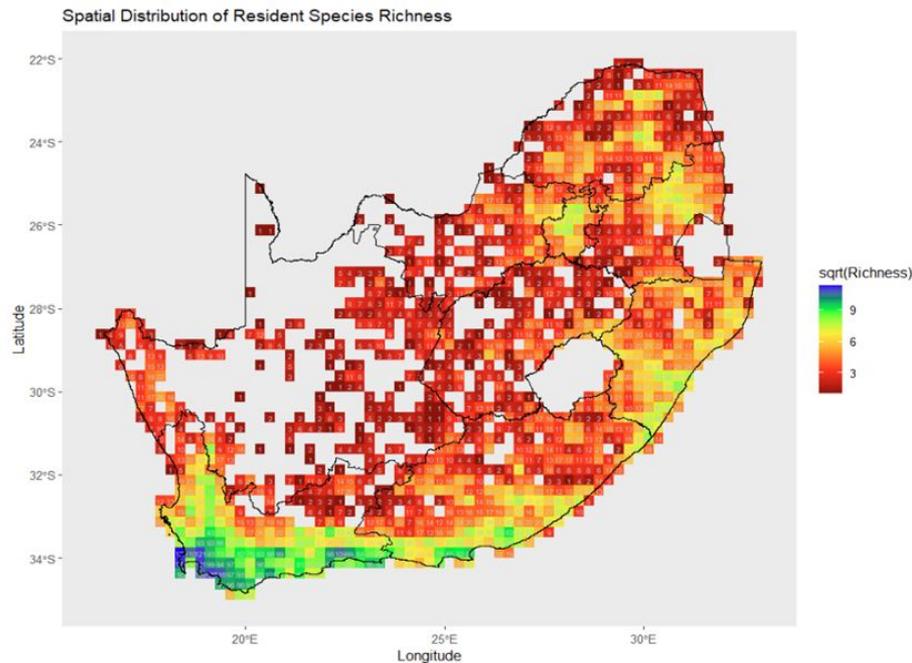


# invasimapr

An R Package to assess Species Invasiveness and Site Invasibility Analyses



Trait dispersion to assess species invasiveness and site invasibility

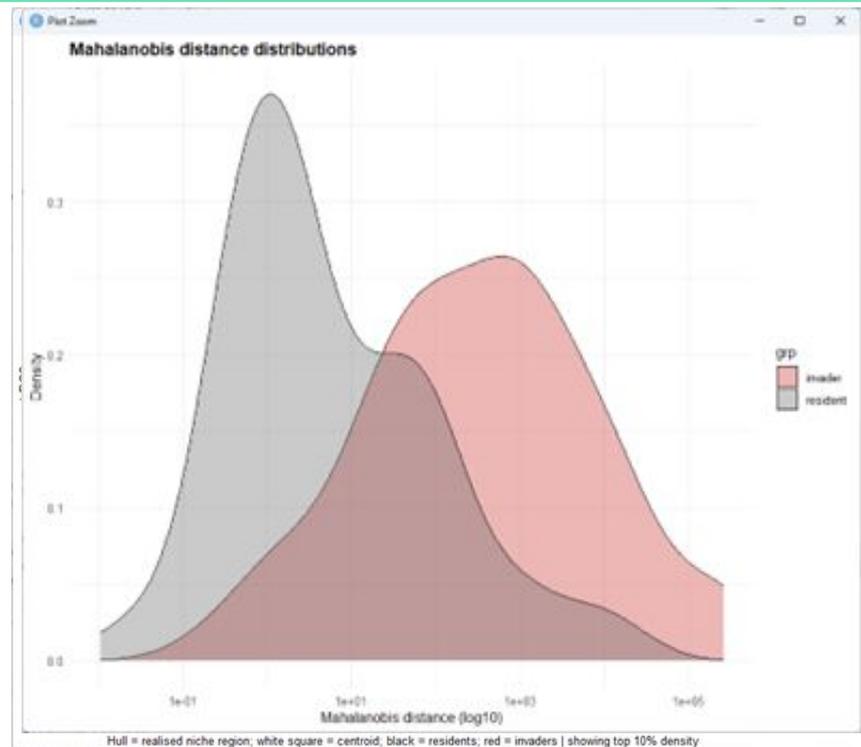


# invasimapr

An R Package to assess Species Invasiveness and Site Invasibility Analyses



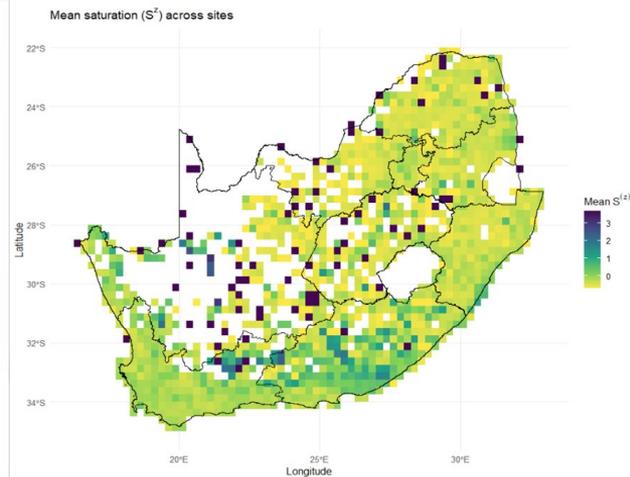
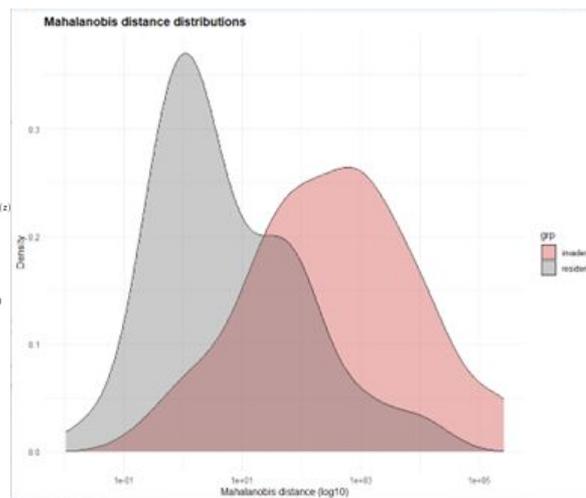
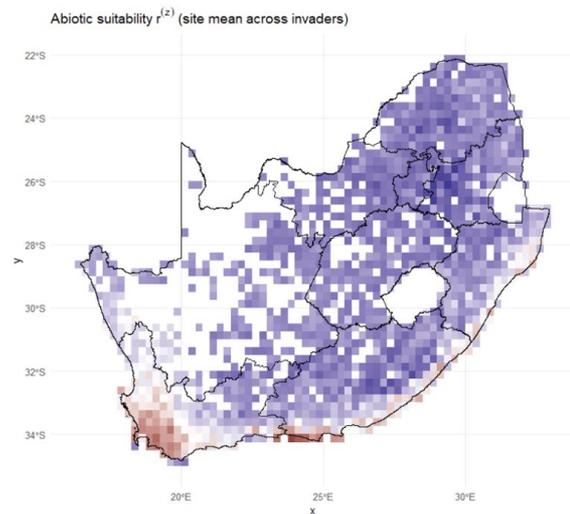
Shared trait-space to predict invader success





### Decomposing Invasion Fitness

$$\lambda_{is} = \underbrace{\Gamma_{is}}_{\text{abiotic slope}} \underbrace{r_{is}^{(z)}}_{\text{abiotic suitability}} - \underbrace{\alpha_{is}}_{\text{crowding penalty}} \underbrace{C_{is}^{(z)}}_{\text{niche crowding}} - \underbrace{\beta_i}_{\text{saturation penalty}} \underbrace{S_{is}^{(z)}}_{\text{resident competition}} + \underbrace{\kappa}_{\text{calibration offset}}$$

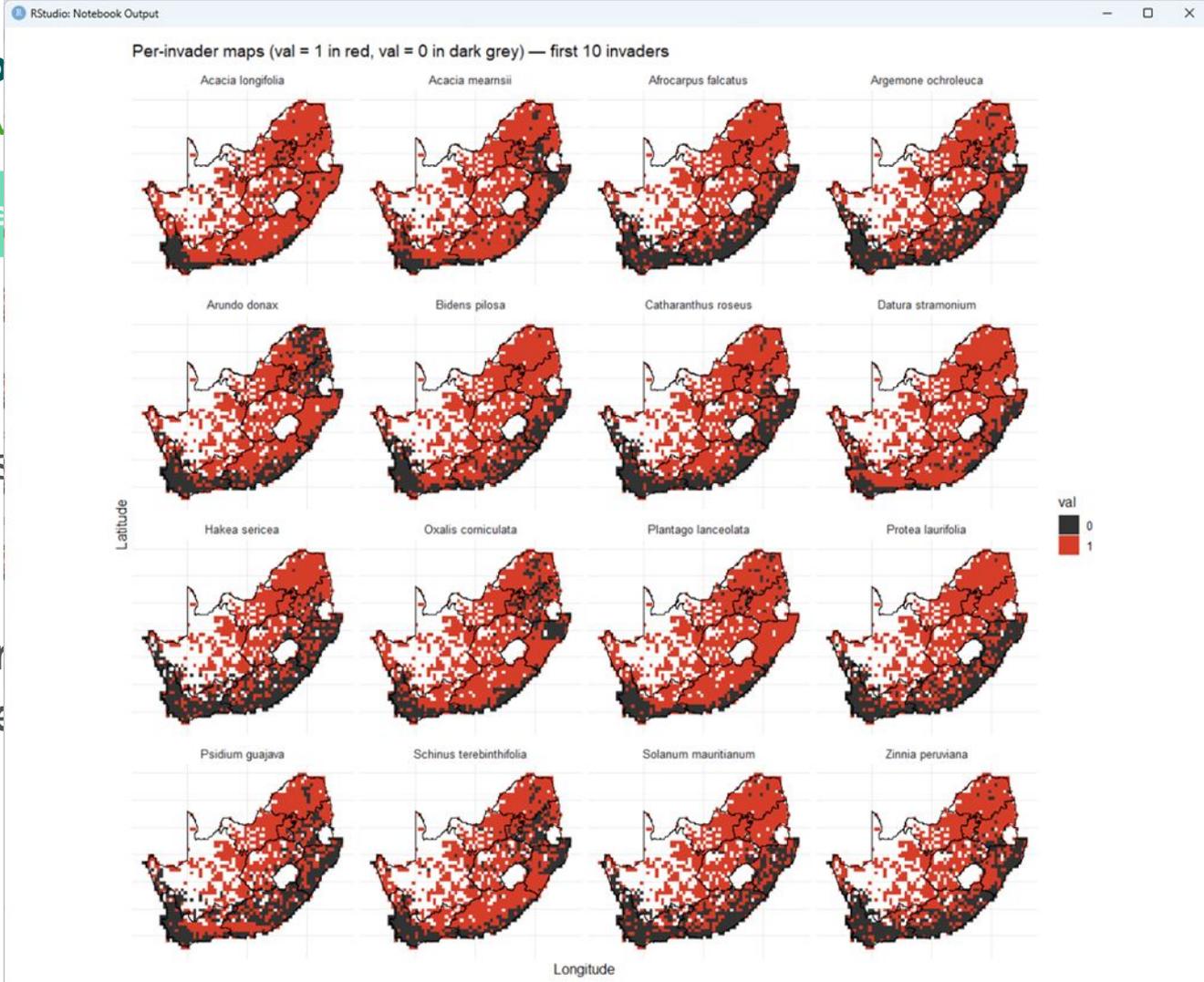


# From Fitness to Estab

An R Package to assess Species Inv

Invasion Fitness, Invasivene

- Positive  $\lambda$  indicates establishment
- Negative  $\lambda$  indicates competition
- Logit/probit transform probability estimate



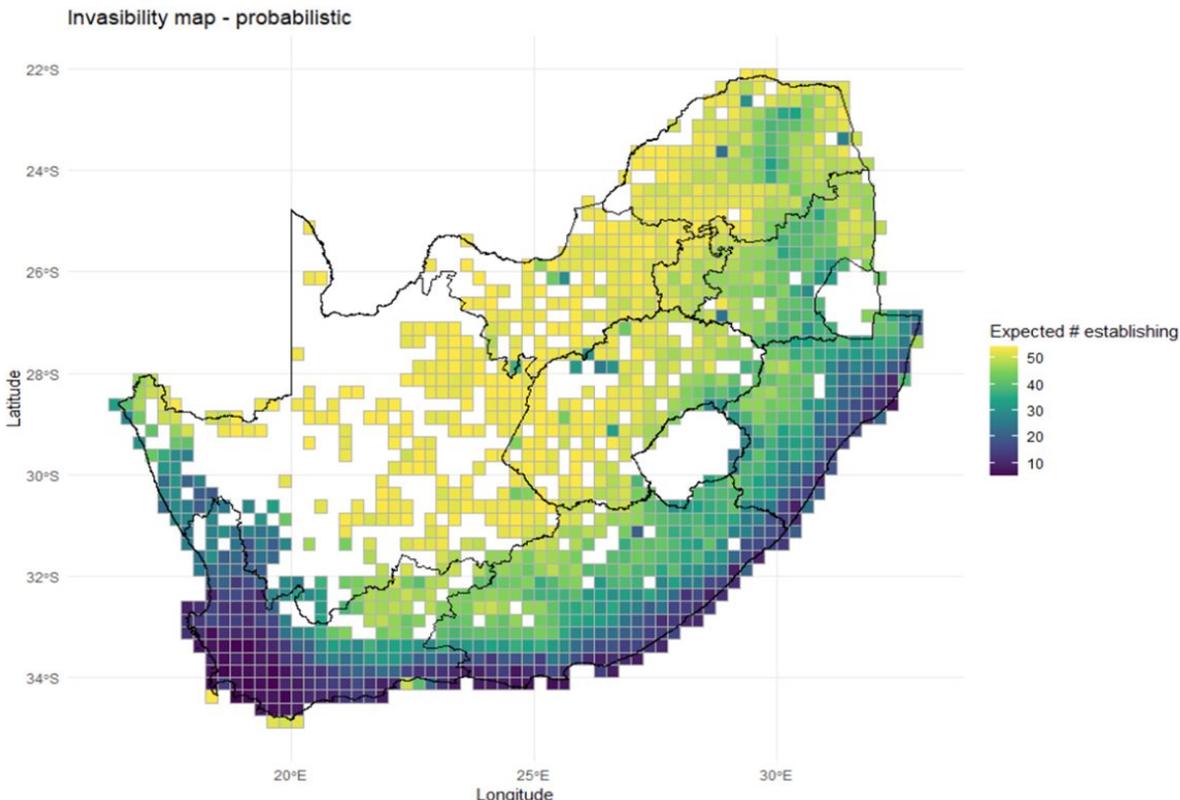
# Species Invasiveness and Site Invasibility

An R Package to assess Species Invasiveness or Site Invasibility Analyses



## Invasion Fitness, Invasiveness vs. Invasibility

- **Invasiveness:**  
Species/trait-level tendency to establish across sites
- **Invasibility:** site-level openness to newcomers
- Both derived from aggregated **invasion fitness** values



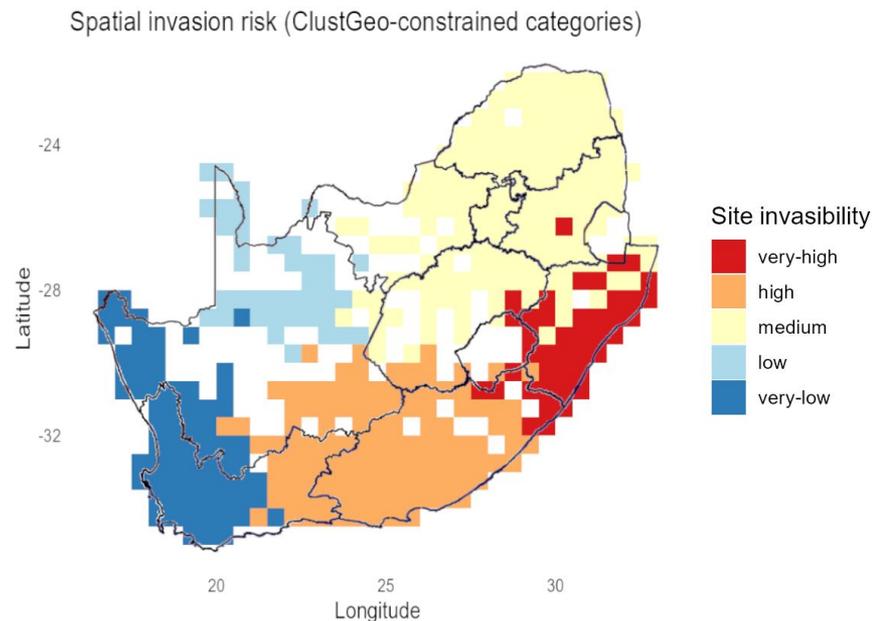
# Outputs & Decision-Ready Indicators

An R Package to assess Species Invasiveness or Site Invasibility Analyses



## Invasion Fitness

- Site  $\times$  invader *invasion-fitness matrices*
- **Establishment probability maps**
- **Rankings of high-risk species/traits and vulnerable sites**
- Identifies **invasion hotspots** and priority regions
- Supports targeted pathway control and monitoring
- Enables transparent, comparable risk assessments



# Useful references and links

## Occurrence Cubes & Biological Invasions

- **b-cubed**: <https://b-cubed.eu/>
- **b-cubed documentation**: <https://docs.b-cubed.eu/>
- **b3alien package**: <https://b3alien.readthedocs.io/en/latest/>
- **b3alien** exemplar **workflow**:  
[https://github.com/mtrekels/b3alien\\_training](https://github.com/mtrekels/b3alien_training)
- **invasimapr package**:  
<https://b-cubed-eu.github.io/invasimapr>

# Occurrence Cubes & Biological Invasions

Maarten Trekels | Sandra MacFadyen

Questions?



# From Biodiversity Observations to Insights

## Hands-on Training

FEBRUARY TO MARCH

### FROM BIODIVERSITY OBSERVATIONS TO INSIGHTS: HANDS-ON TRAINING

Registration open

Start date: 20 February, 15:00 CET

Six live sessions, held on consecutive Fridays at 15:00 CET.



### Programme

#### 20 February, 15:00 CET - Species occurrence cubes

Andrew Rodrigues (GBIF) and Lina Estupinan Suarez (Martin Luther University Halle-Wittenberg)

#### 27 February, 15:00 CET - Occurrence cubes and biological invasions

Maarten Trekels (Meise Botanic Garden) and Sandra MacFadyen (Stellenbosch University)

#### 6 March, 15:00 CET - Indicators for national invasion reporting

Tsungai Alfred Zengeya (South African National Biodiversity Institute)

#### 13 March, 15:00 CET - Mapping biodiversity turnover with dissmapr

Sandra MacFadyen (Stellenbosch University).

#### 20 March, 15:00 CET - Making use of colorblind friendly maps

Duccio Rocchini (University of Bologna).

#### 27 March, 15:00 CET - b3verse: an R package suite to process cubes and calculate indicators

Shawn Dove (Justus Liebig University), Ward Langerlaert (Research Institute for Nature and Forest) and Jasmijn Hillaert (Research Institute for Nature and Forest).

# Thank you!

**Maarten Trekels | Sandra MacFadyen**

maarten.trekels@plantentuinmeise.be | macfadyen@sun.ac.za



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