Authors: Rafaela Lorena da Silva Santos, Eduardo Freitas Moreira, Danilo Boscolo, Lucas A. Garibaldi e Raíssa Silva Fernandes

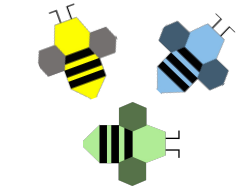
Effect of Landscape Heterogeneity on Bee Populations and Communities

Objective

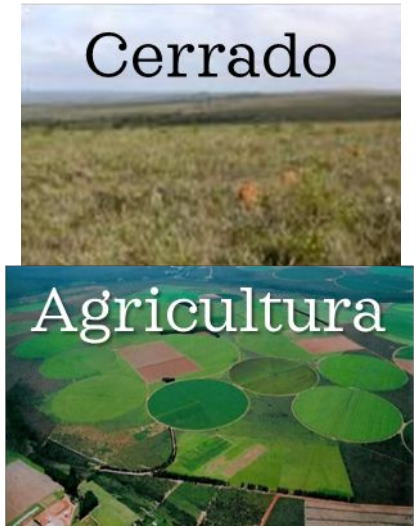
General objective: Model a possible cause and effect mechanism by which landscape heterogeneity influences populations and communities of bees with different characteristics

Agricultural landscapes interspersed with natural environments

affects

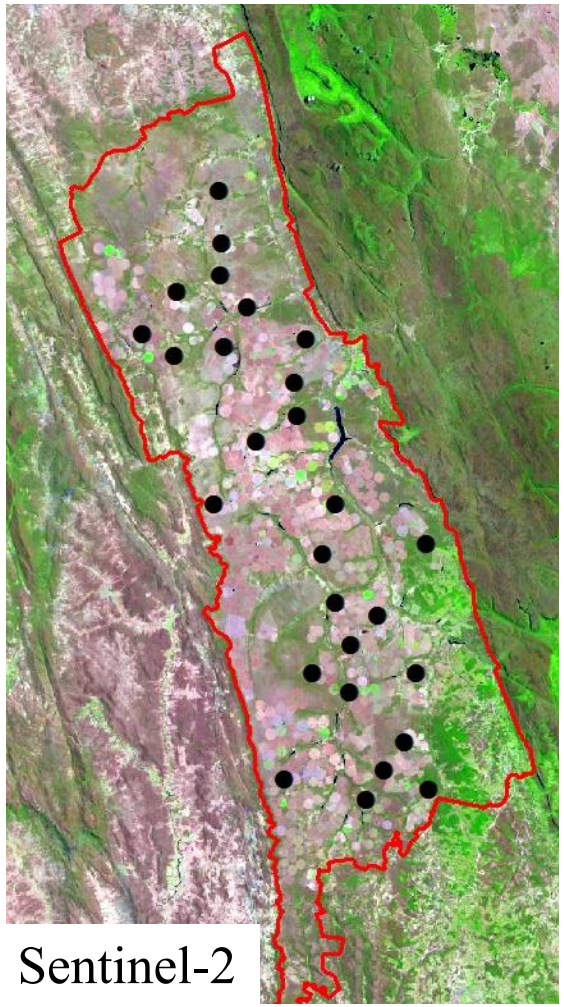


Diversity

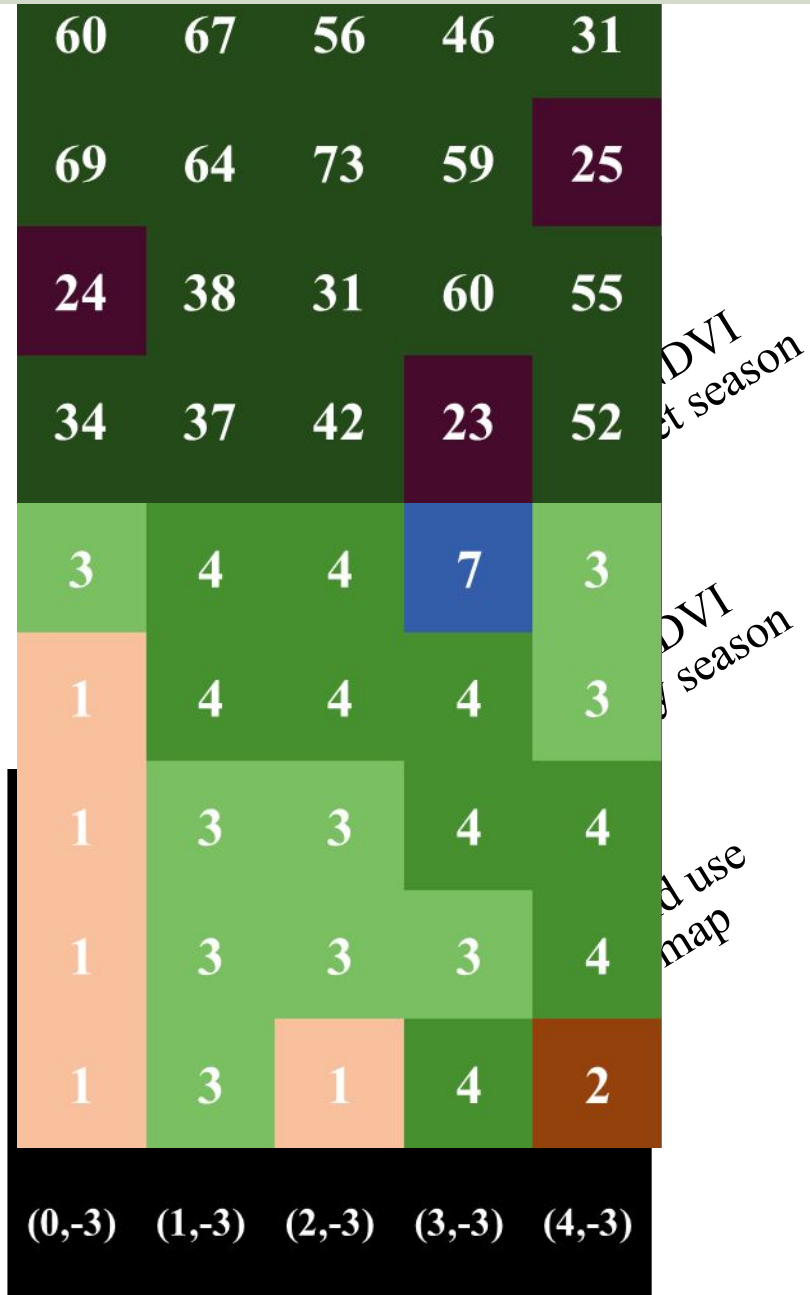


Mediated by foraging and dispersal

Methods



Sentinel-2

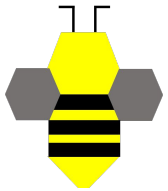


NetLogo world layers

- Closed square world
- Each patch measuring 10m x 10m
- Each side 10km
- Grid Cells:
  - Floral feature (NDVI: 2 layers or more)
  - Type of environment (land use map)

Methods

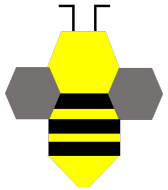
NetLogo mobile agents



- **Mobile agents are incorporated into the model representing 1 bee profile:**
  - Bee size: DIT □ field data (20 individuals of each species)
    - Small bees: 2mm
    - Average bees: 4mm
    - Big bees: 6mm

Methods

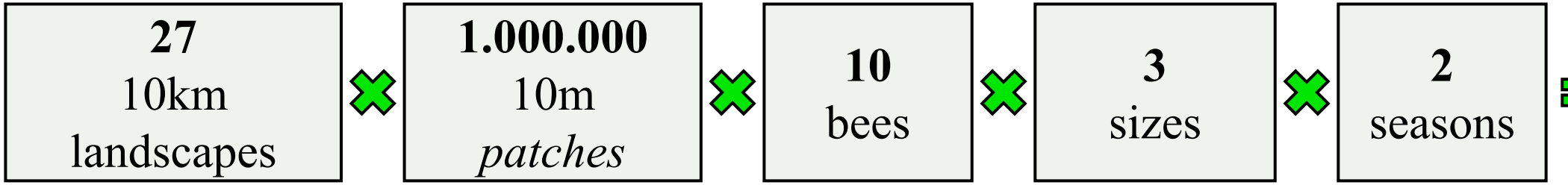
Agent behavior



- Bees move from the patch of origin collecting floral resources until they reach their maximum resource carrying limit or their maximum flight distance.
- When one of these conditions is reached, the bee returns and deposits the energy balance (energy collected – energy consumed) in the nest.

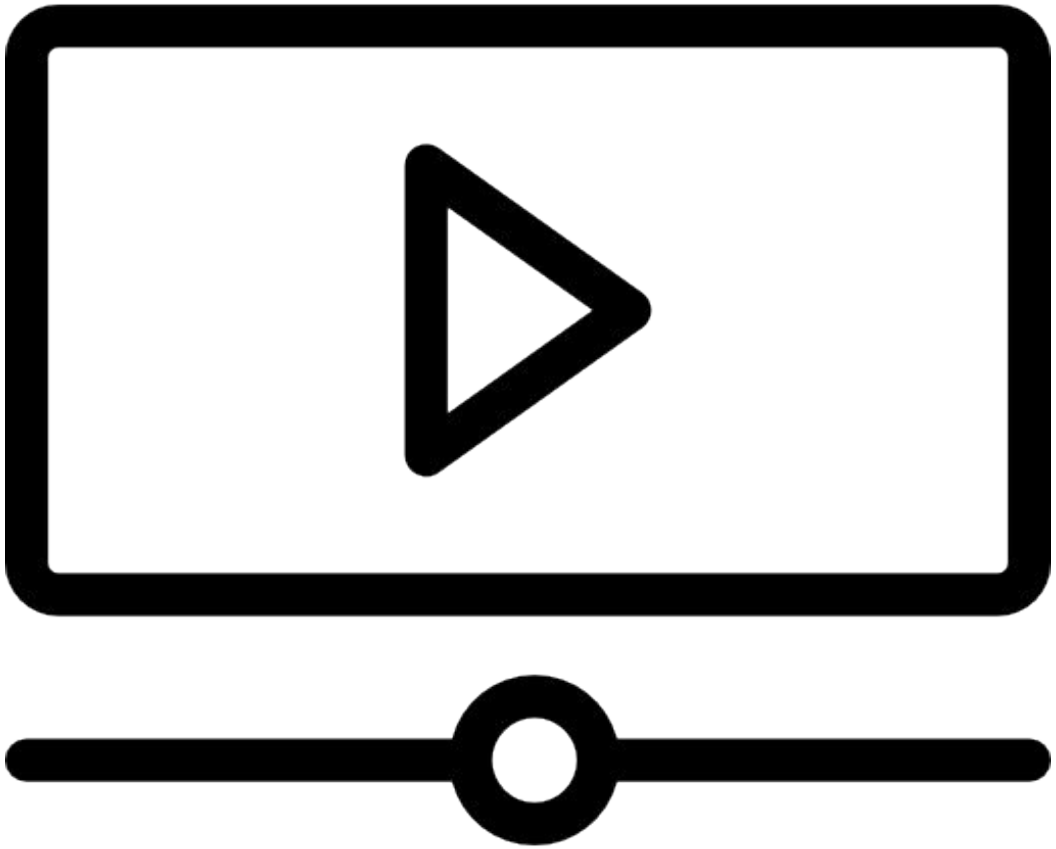
Methods

Model simulations



1.620.000.000 simulated bees

Methods

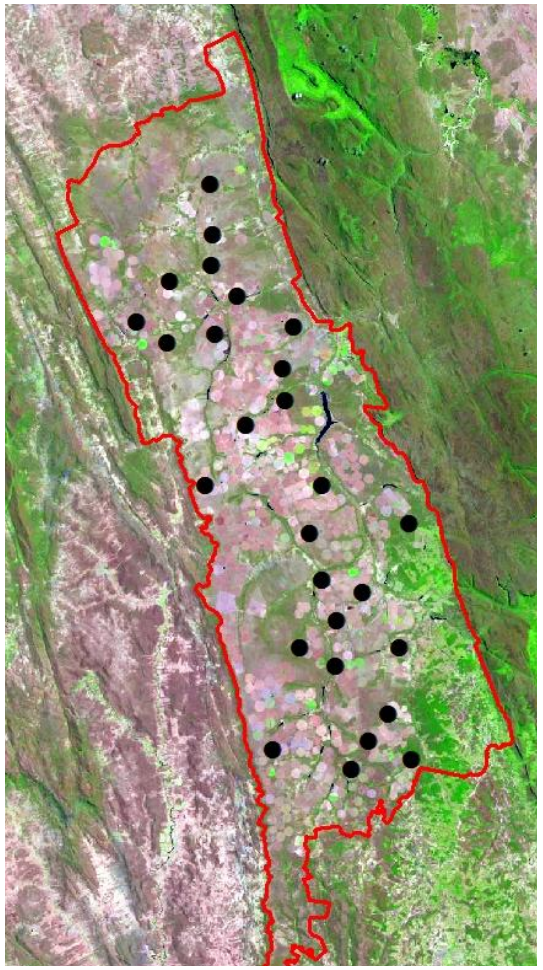


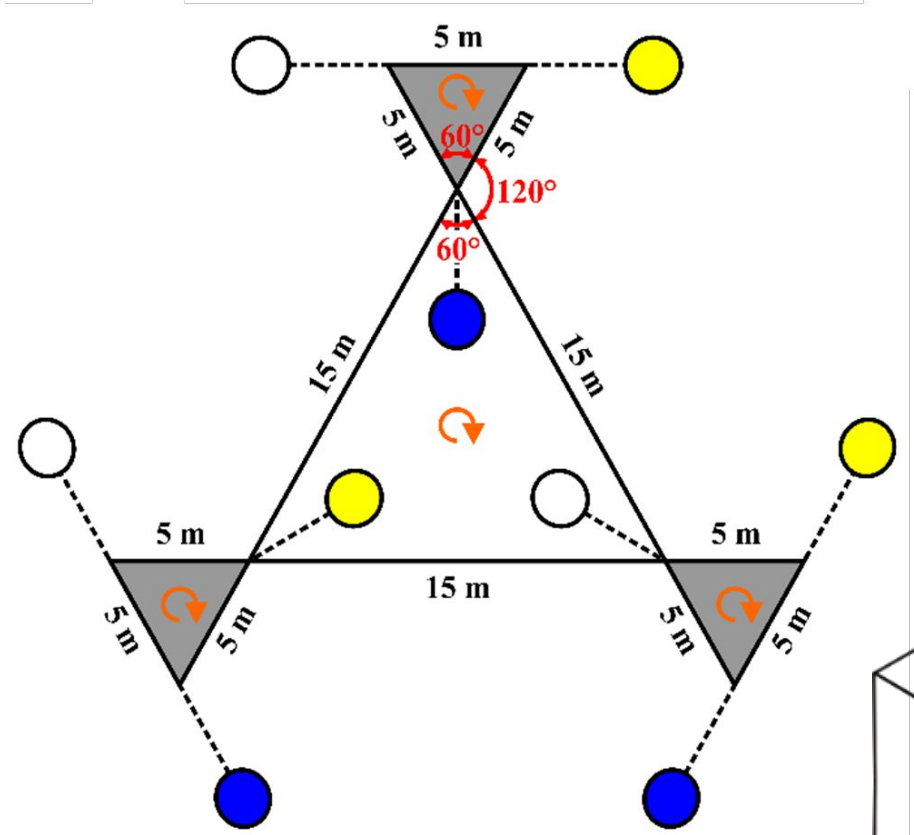
BEEFOR-ABM: an agent-based simulation to model bee foraging movement in heterogeneous landscapes

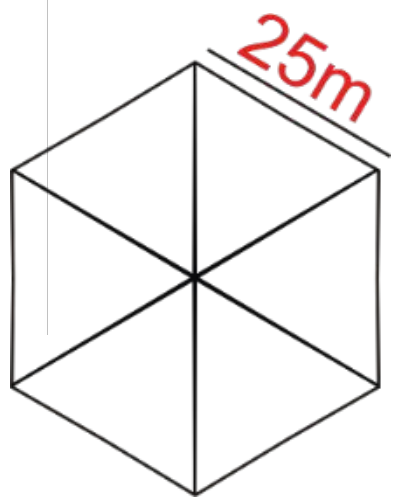
Rafaela Lorena da Silva Santos
Eduardo Freitas Moreira
Raíssa Silva Fernandes
Lucas Alejandro Garibaldi
Danilo Boscolo

Methods

ABM predictive power







Results and Discussion

Bees' Abundance

$\Delta AICc = 0$ $W_i = 0,49$ $R^2 = 0,46$

(−) mAccumRes(2mm) **(0,25km)** + (+) mAccumRes(4mm) **(0,25km)** + (−) PlandNat **(1km)** + (−) SHDI **(1,5km)**

Bees' Richness

$\Delta AICc = 0$ $W_i = 0,24$ $R^2 = 0,42$

(+) mAccumRes(2mm) **(1km)** + (−) SHDI **(1,5km)** + (+) ED **(4,25km)**

Results and Discussion

Bees' Abundance

$\Delta AICc = 0$ $W_i = 0,49$ $R^2 = 0,46$

- mAccumRes(2mm) (0,25km)
+ mAccumRes(4mm) (0,25km)
- PlandNat (1km)
- SHDI (1,5km)

Bees' Richness

$\Delta AICc = 0$ $W_i = 0,24$ $R^2 = 0,42$

+ mAccumRes(2mm) (1km)
- SHDI (1,5km)
+ ED (4,25km)

- Greater resource variability penalizes smaller bees due to lower probability of finding resources within their foraging range
- Contrary pattern for larger bees
- Landscape complexity favors species richness
- Complementation and supplementation effects

Results and Discussion

Bees' Abundance

$\Delta AICc = 0$ $W_i = 0,49$ $R^2 = 0,46$

- mAccumRes(2mm) **(0,25km)**
+ mAccumRes(4mm) **(0,25km)**
- PlandNat **(1km)**
- SHDI **(1,5km)**

Bees' Richness

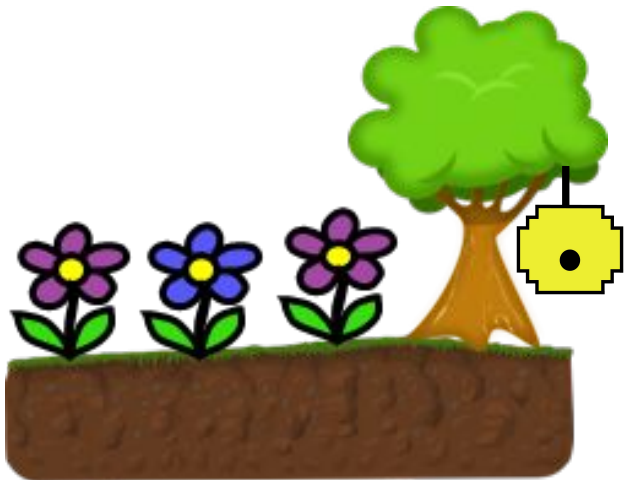
$\Delta AICc = 0$ $W_i = 0,24$ $R^2 = 0,42$

+ mAccumRes(2mm) **(1km)**
- SHDI **(1,5km)**
+ ED **(4,25km)**

- Greater resource variability penalizes smaller bees due to lower probability of finding resources within their foraging range
- Contrary pattern for larger bees
- Landscape complexity favors species richness
- Complementation and supplementation effects

DecisionES 2025
Porto Seguro
Jun 30th to Jul 4th BR
Symposium on Ecosystem Services, Forest Management and Decision Making

Thank you!



rafaelalorena@gmail.com