Landscape structure influences niche-based and neutral mechanisms of community assembly in a fragmented insular dry forest

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Islands VS. landscape changes

Unique and rich biodiversity...

...within small areas

⇒ High vulnerabilty to habitat loss and fragmentation !

photo credits : GIldas Gateblé, Hervé Vandrot, Remy Amice, Julien Barraut, Elissa Agudo Del Pozo, Guillaume Foussard

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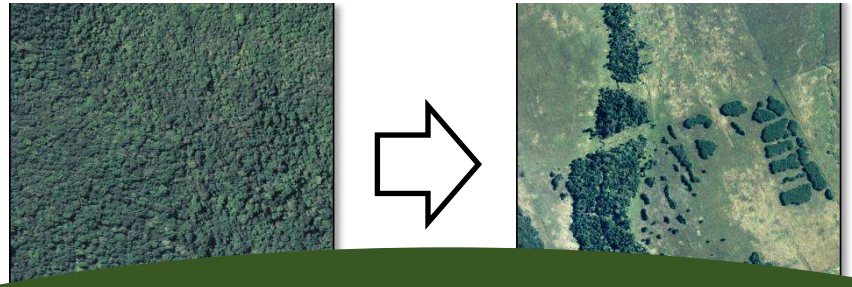


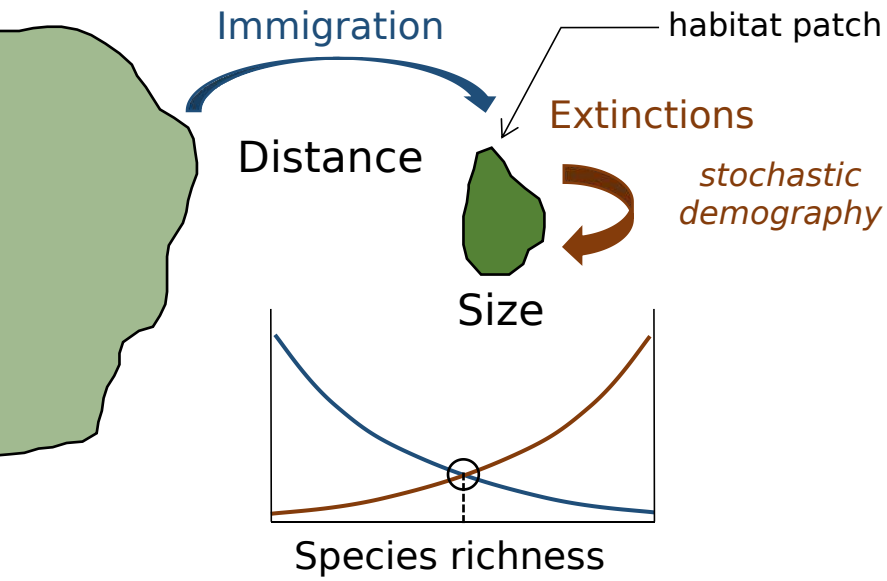
How landscape changes influence ecological mechanisms ?

How does this impact island biodiversity?

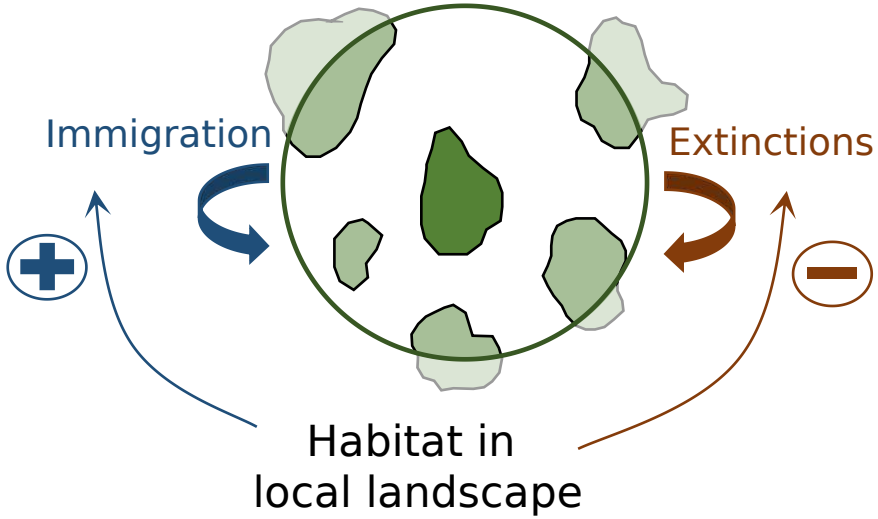
photo credits : GIldas Gateblé, Hervé Vandrot, Re
Julien Barraut, Elissa Agudo Del Pozo, Guillaum

Landscape structure & ecological mechanisms : 1) Neutral mechanisms

Island Theory of Biogeography



Habitat amount hypothesis



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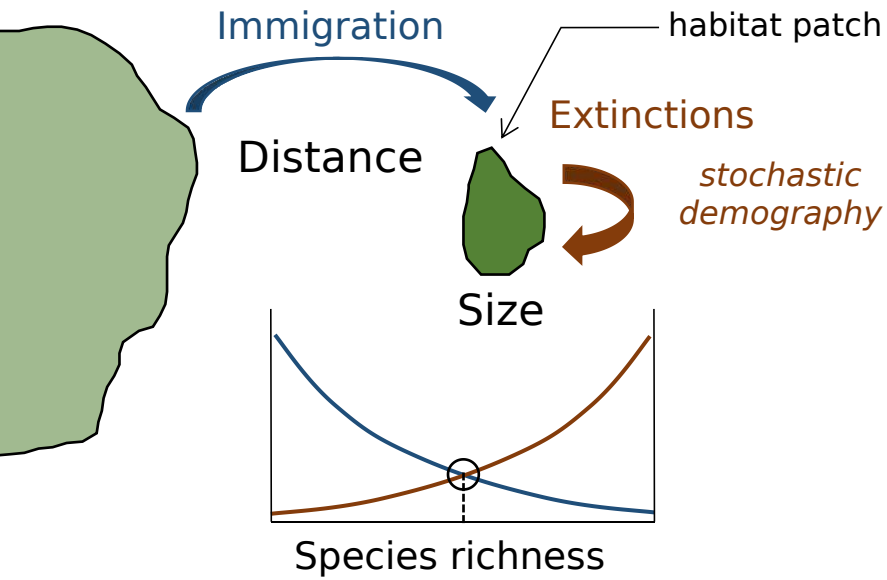

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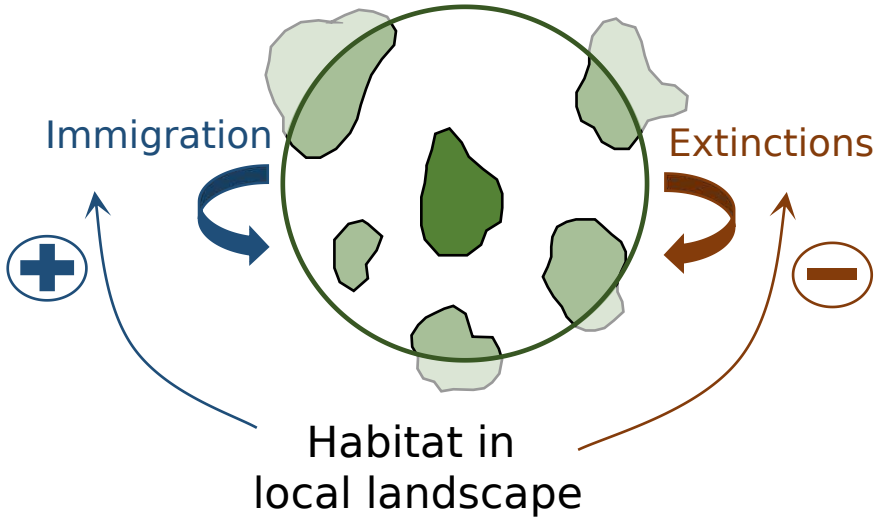


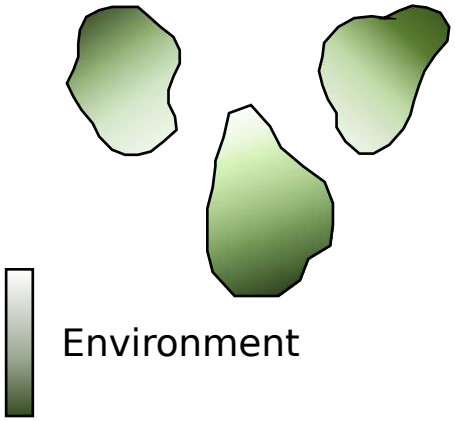
Neutral mechanisms :

Species composition = Immigration + Local stochastic extinctions

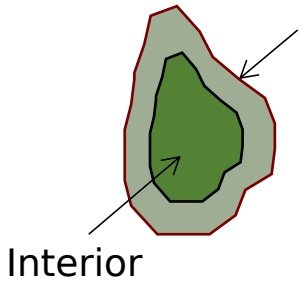
Landscape structure & ecological mechanisms : 2) Niche-based mechanisms

Environmental heterogeneity

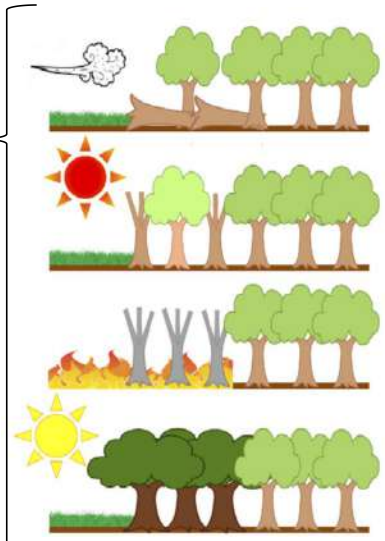
within patches



Edge effects



Affect environmental conditions



Adapted from Smith et al. 2017

Landscape structure & ecological mechanisms : 2) Niche-based mechanisms

Environmental heterogeneity

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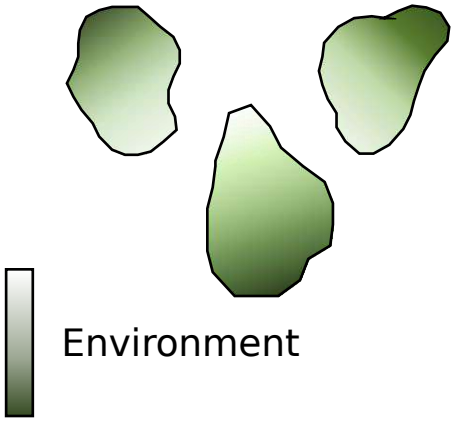

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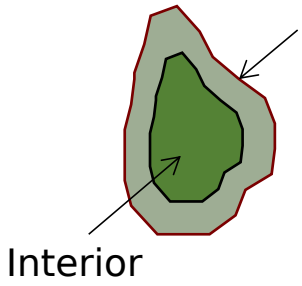

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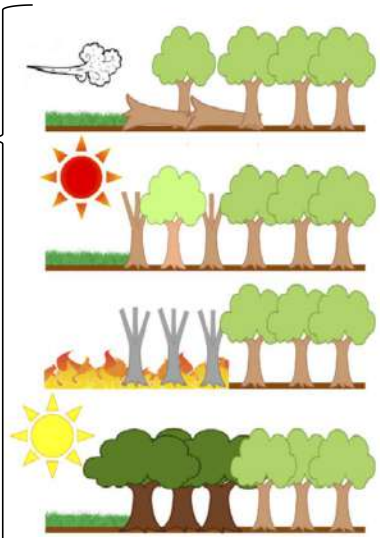


Adapted from Smith et al. 2017

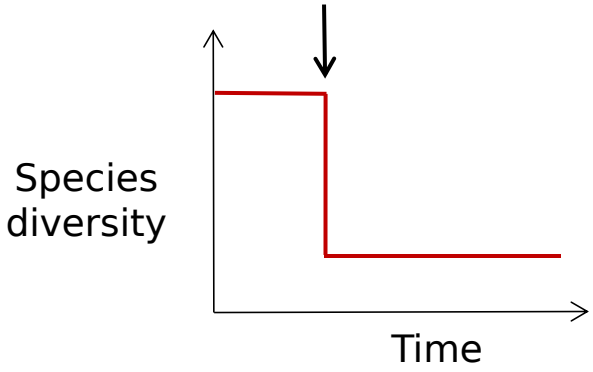
Niche-based mechanisms :

Species composition = Species ecological strategies + Local environment

Landscape changes & ecological mechanisms

Rapid response

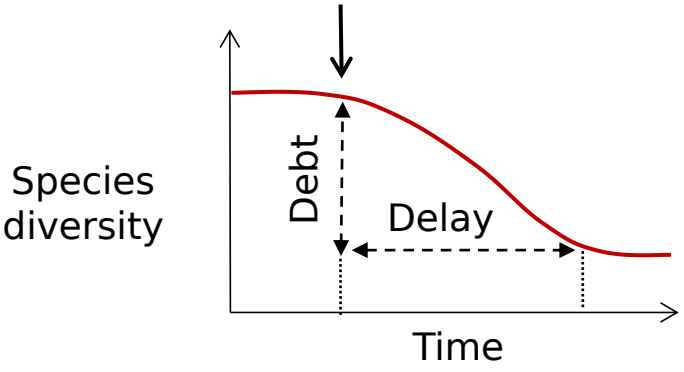
Landscape change



?

Slow response

Landscape change



Landscape changes & ecological mechanisms

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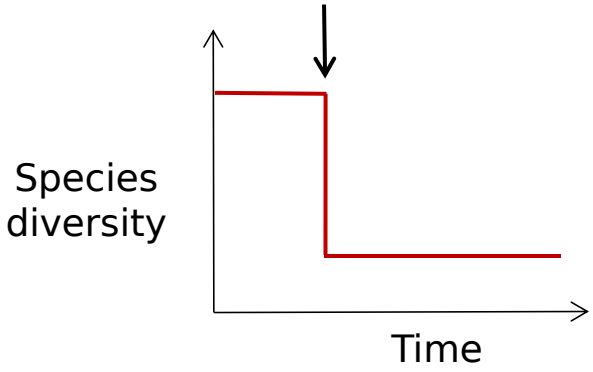

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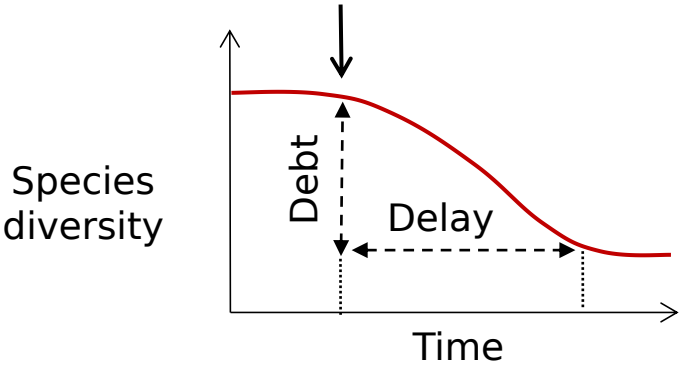
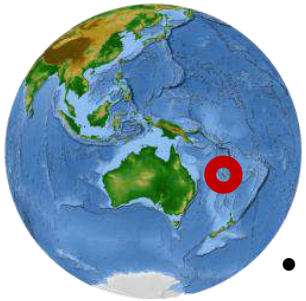


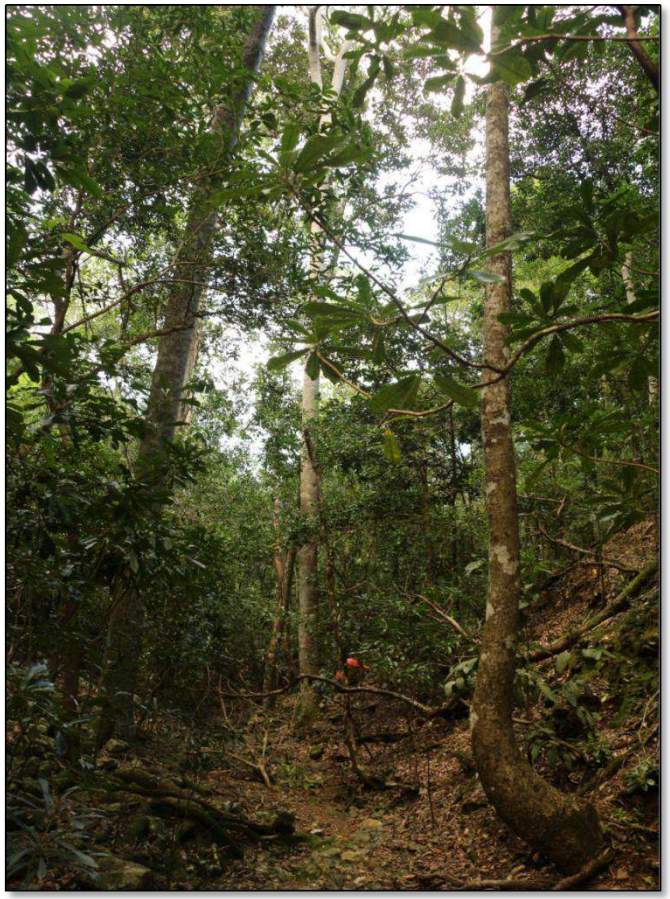
Question :

How landscape changes influence neutral and niche-based mechanisms over time?

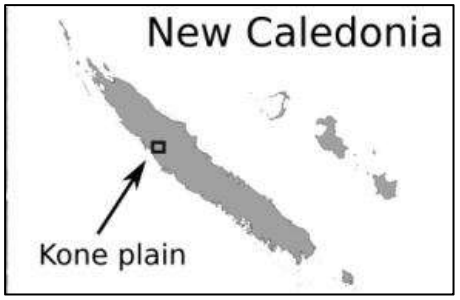


New Caledonia's dry forest

- Fires, logging, urbanisation...
- <2% original extent
- The "*world's most endangered tropical dry forest*" Gillespie & Jaffré 2003

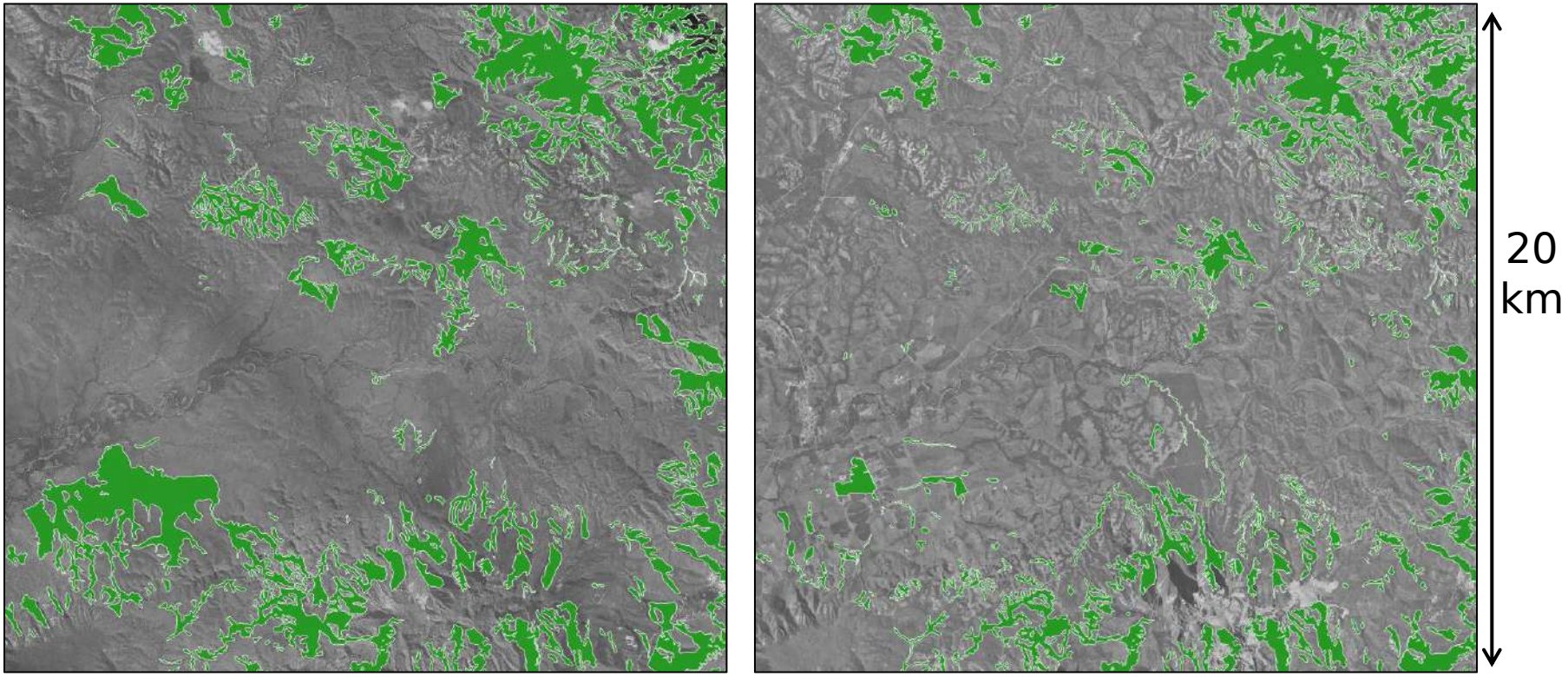


Material & Methods : Forest cover



Past (1954)

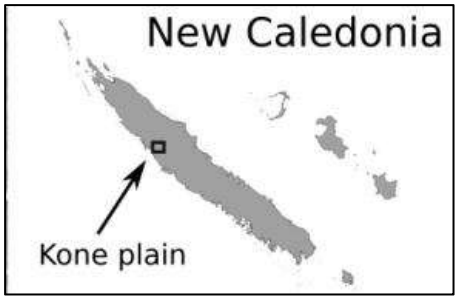
Present



- 37% reduction of forest cover
- number of forest patches have doubled

⇒ ***Recent habitat loss and fragmentation***

Material & Methods : Sampling design



Past (1954)

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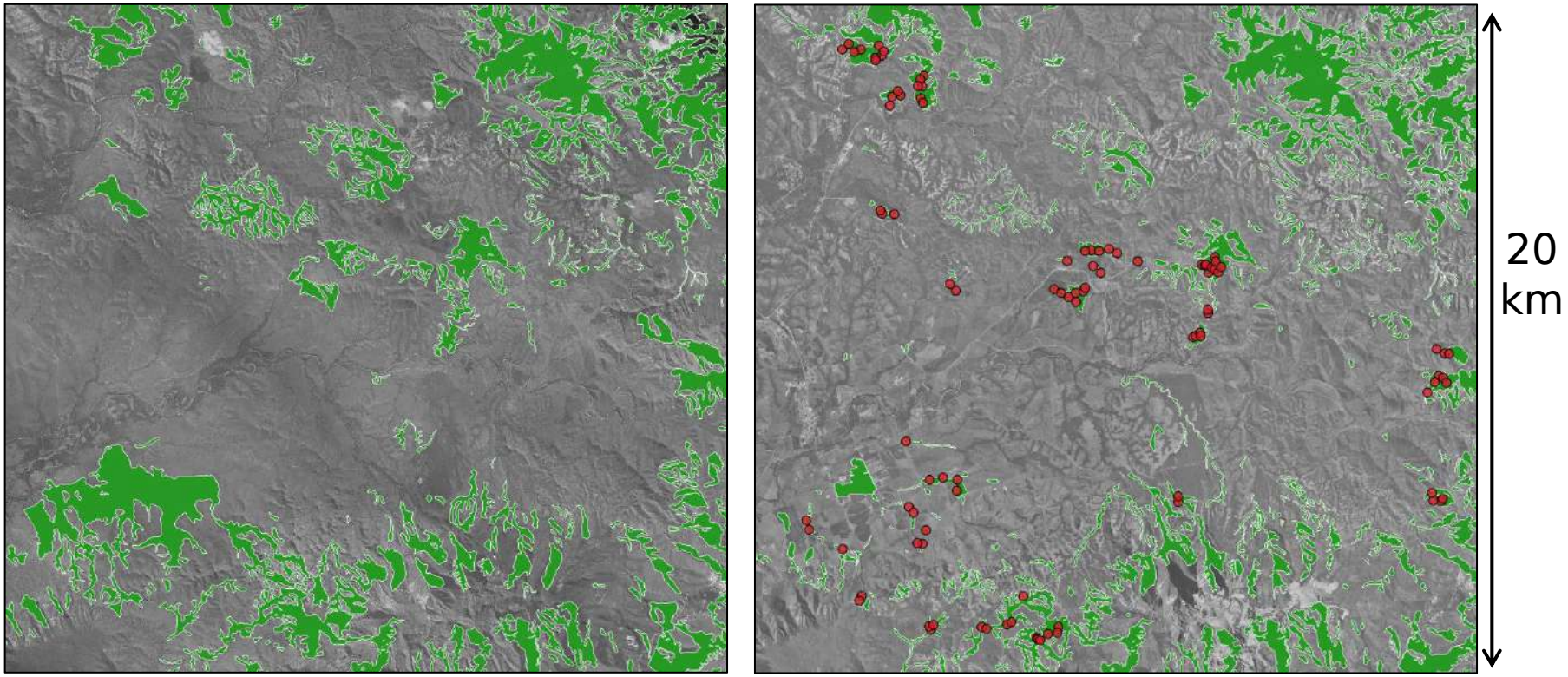
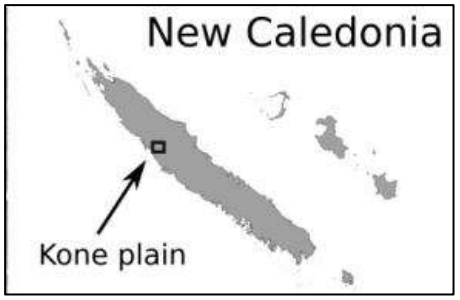


- 100 tree communities (400m², >10cm DBH)
- 36 patches
- 99 species (3069 individuals)

Material & Methods : Landscape metrics



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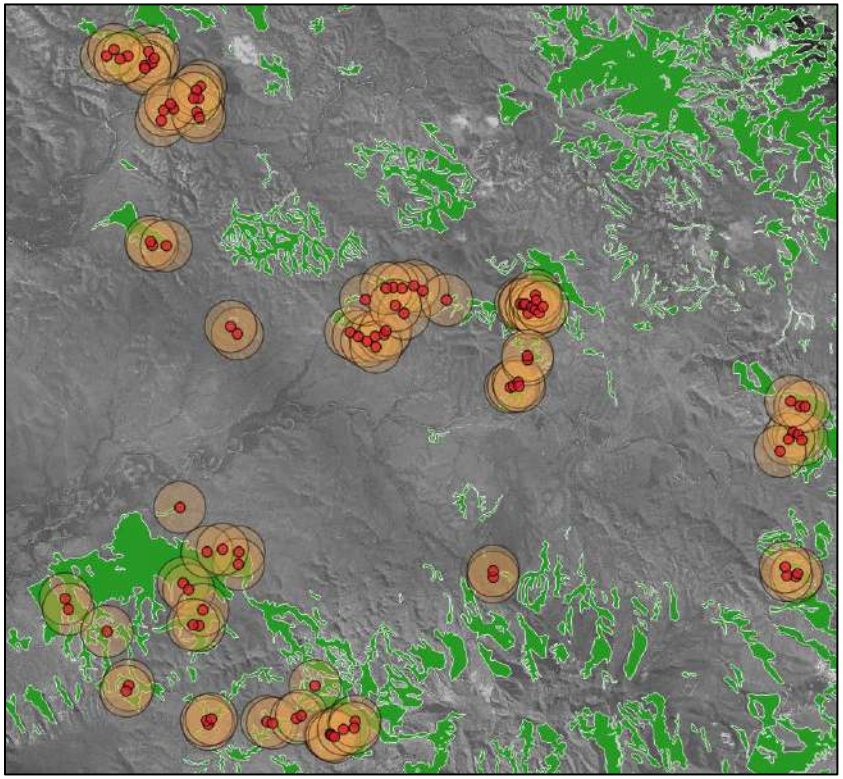
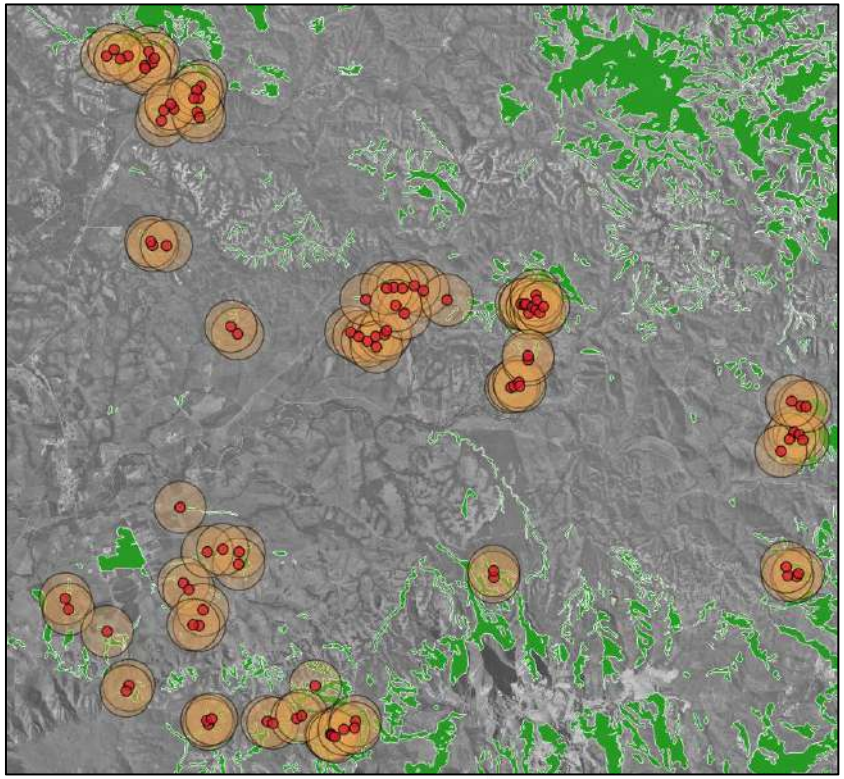
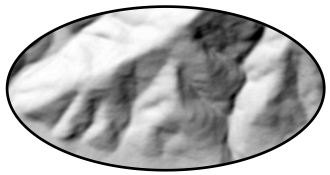




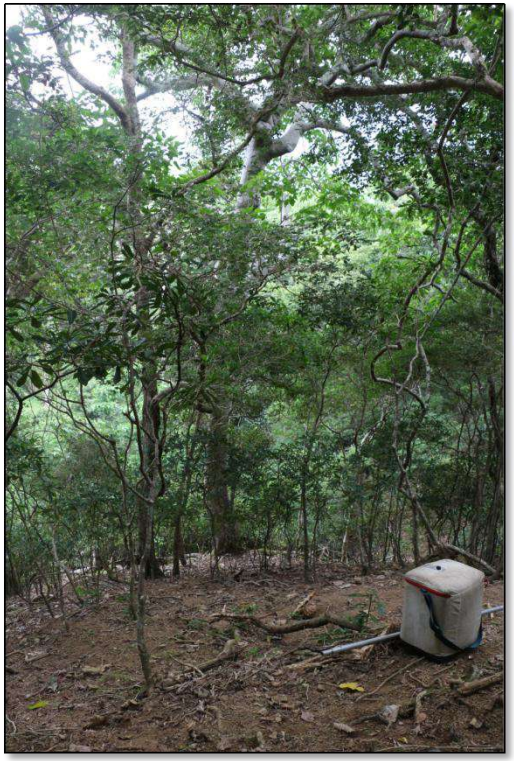
20 km

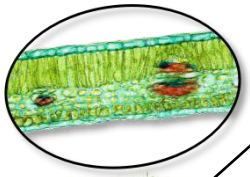
- 100 tree communities
- 3 **landscape metrics** (**past & present**)
  - Distance to edge
  - Patch area
  - Habitat amount in a 500m buffer
- Topography



Material & Methods : Functional traits

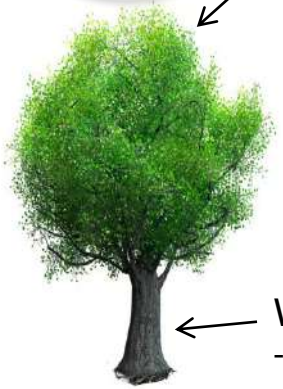
99 tree species

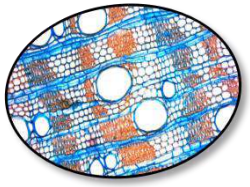




Functional traits

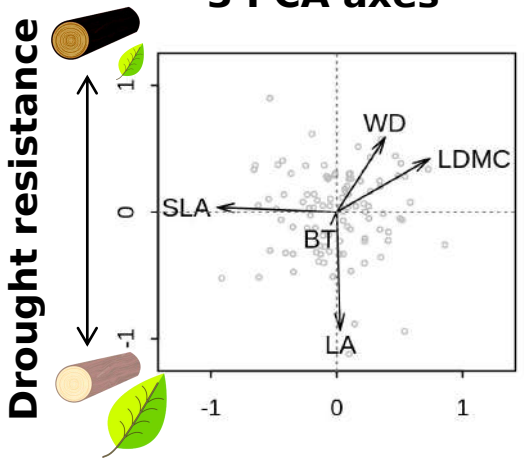
Leaf traits :
- Leaf area
- Leaf specific area
- Leaf dry matter content

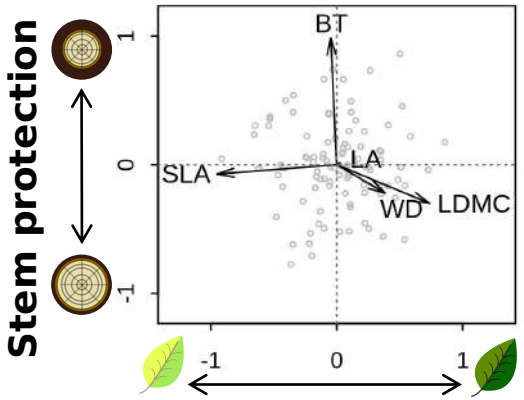




Wood traits :
- Wood density
- Bark thickness

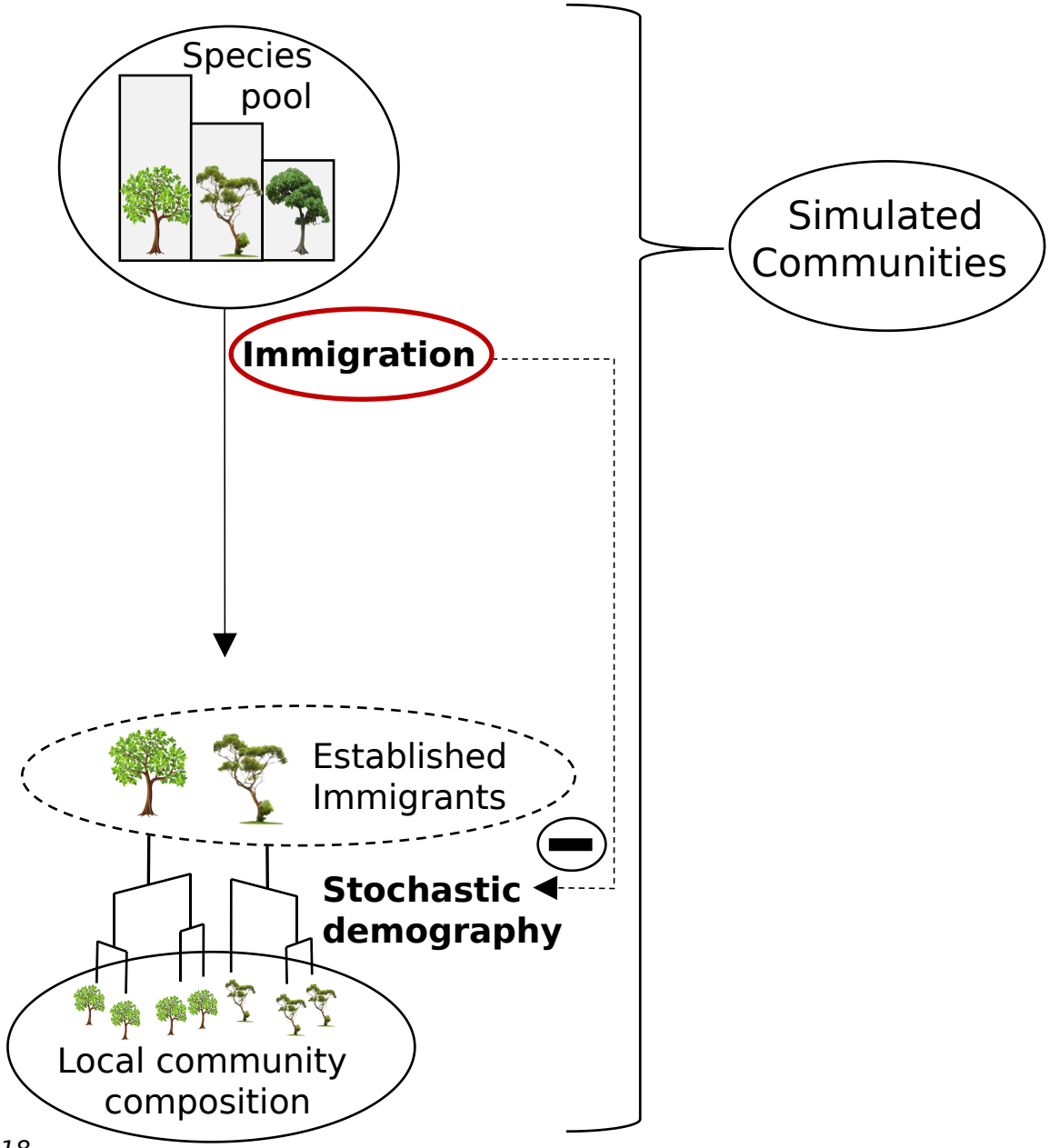
Functional dimensions :
3 PCA axes





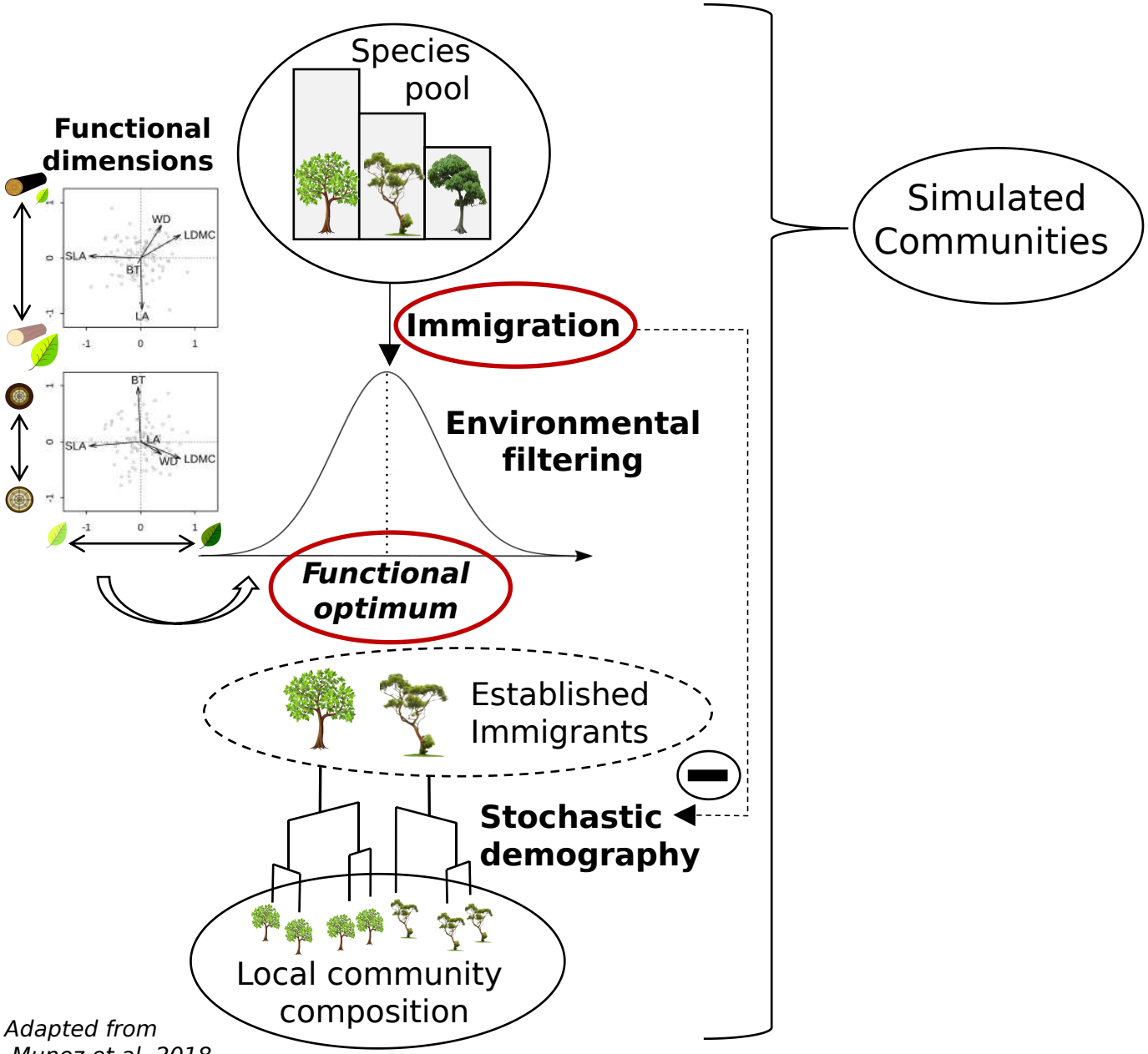
Acquisitive - Conservative

Material & Methods : Assembly model



Adapted from Munoz et al. 2018

Material & Methods : Assembly model



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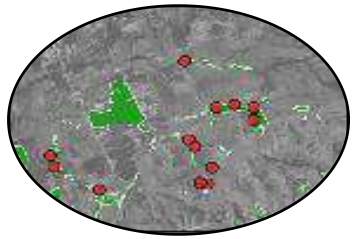
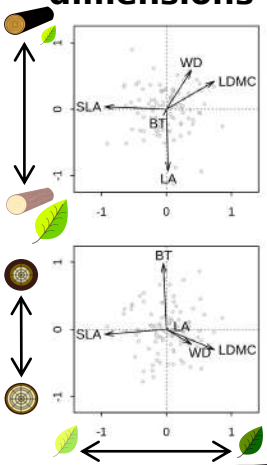


Species pool

Functional dimensions



Immigration

Environmental filtering

Functional optimum

Established Immigrants

Stochastic demography

Local community composition

Simulated Communities

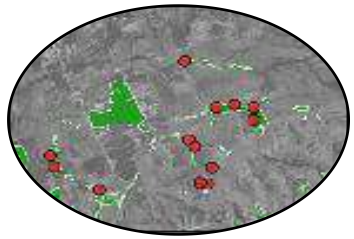
Observed Communities

Parameter inference
(Approximate Bayesian Computation)

Immigration ***Functional optimums***

Adapted from Munoz et al. 2018

Material & Methods : Assembly model



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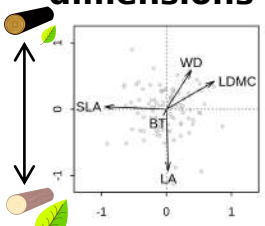

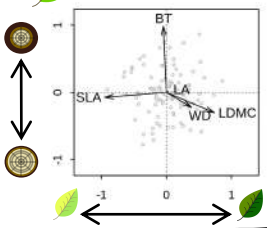

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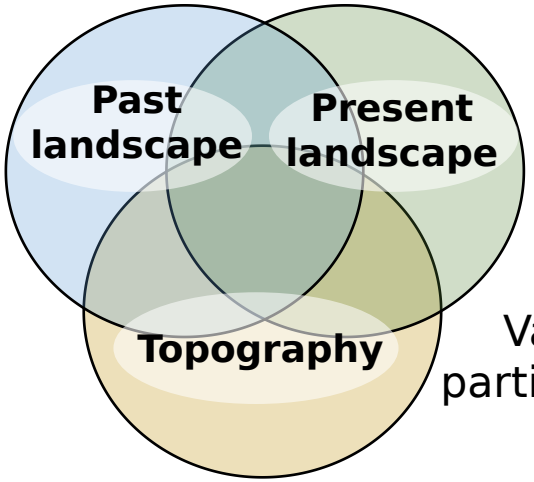
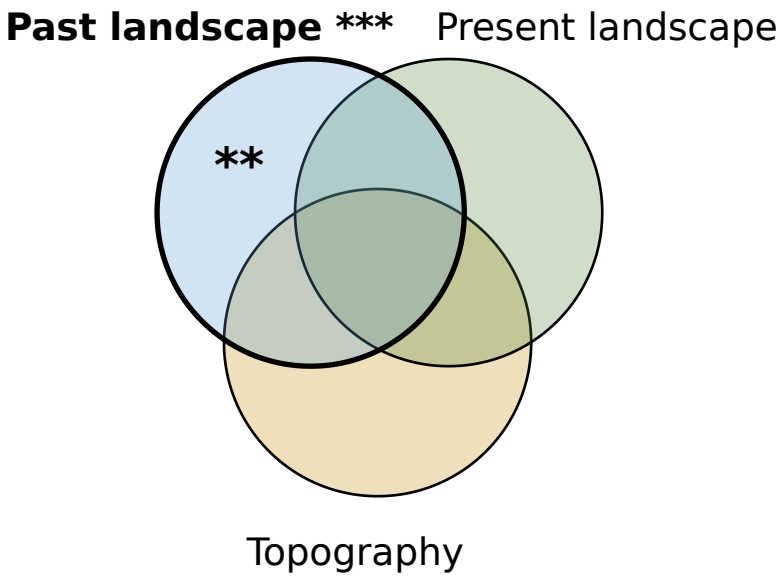
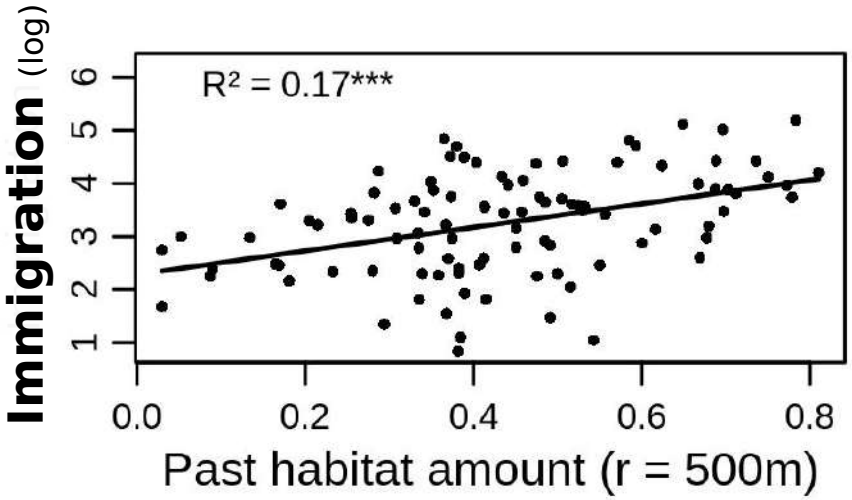


Variance partitioning

Adapted from Munoz et al. 2018

Results : 1) Neutral mechanisms





⇒ ***Time delay in the response to landscape changes***

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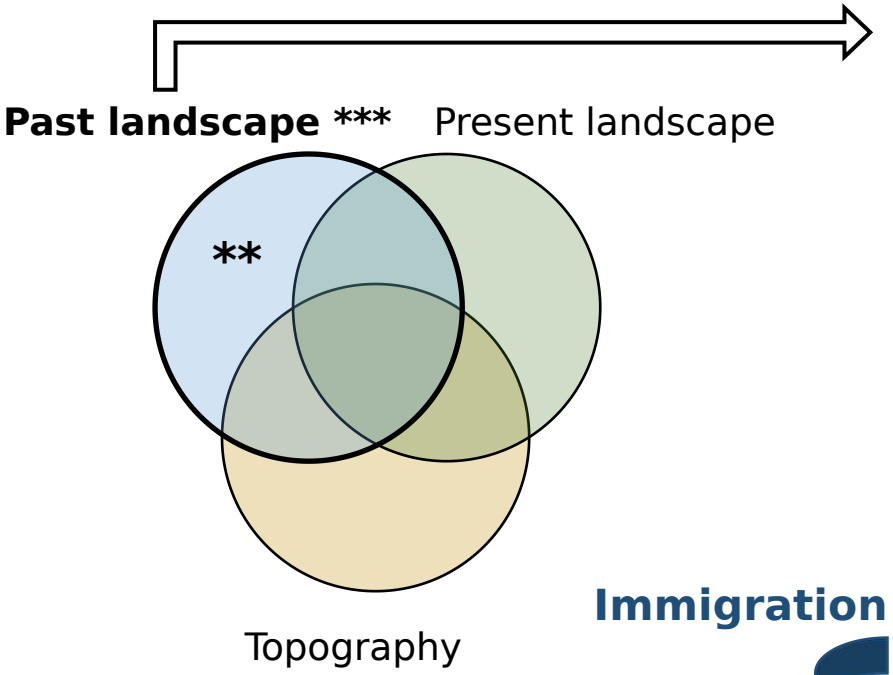
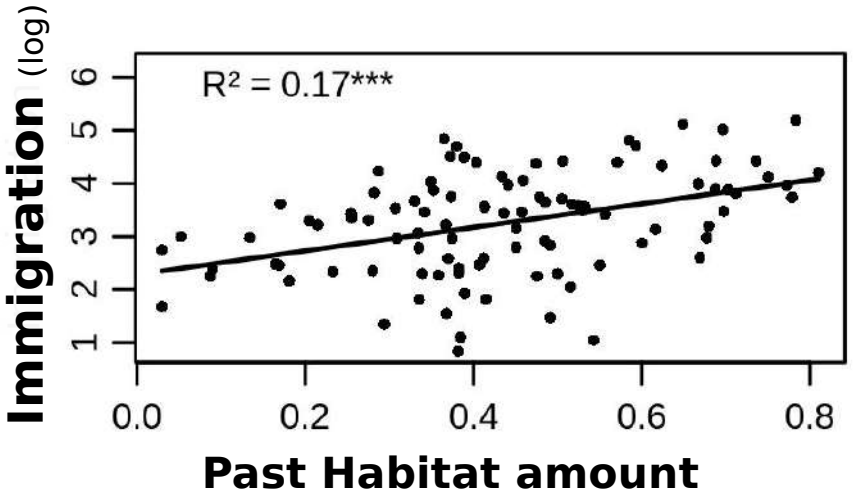
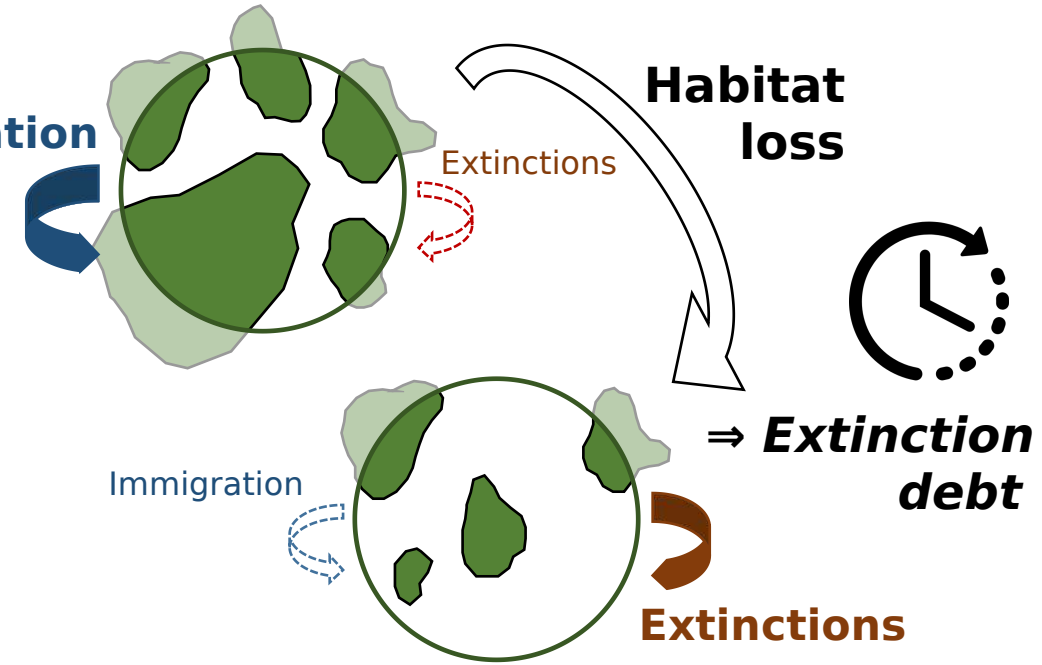
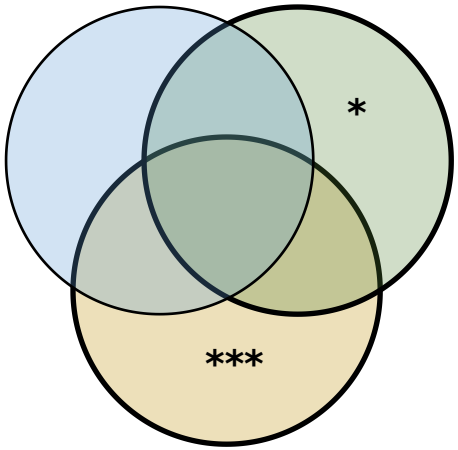




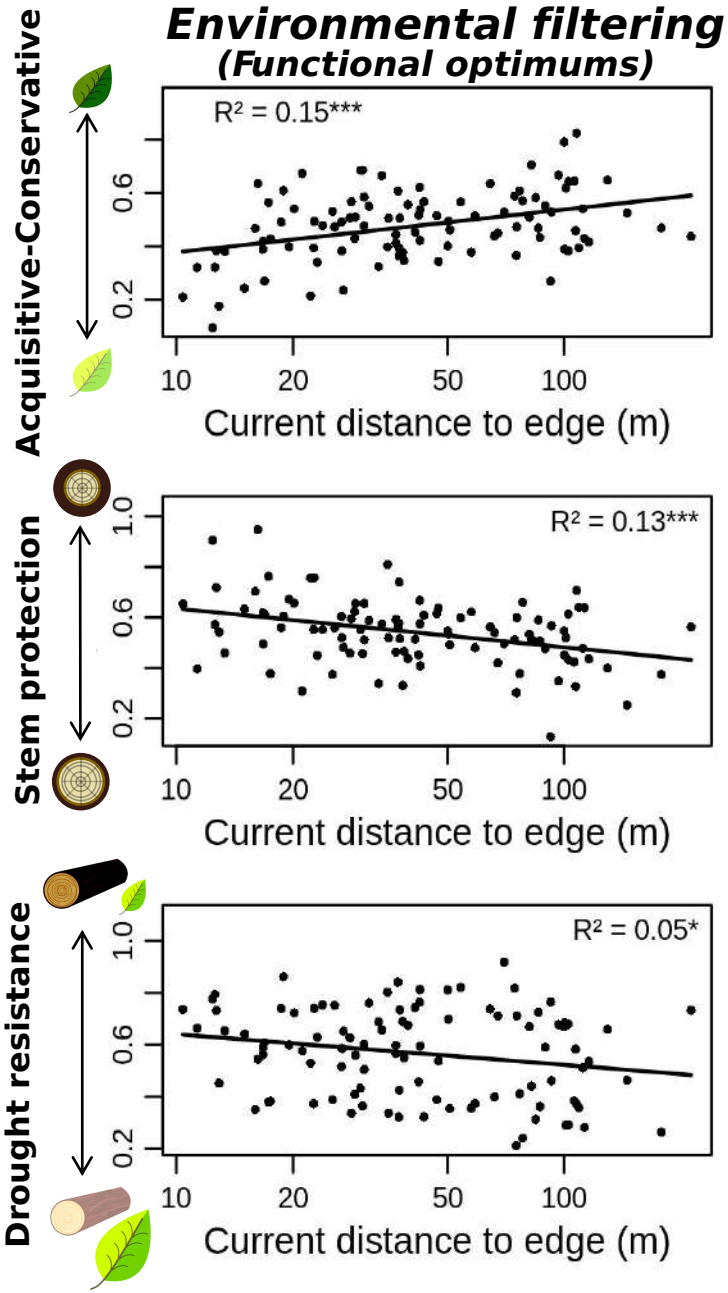


⇒ ***Time delay in the response to landscape changes***

Results : 2) Niche-based mechanisms



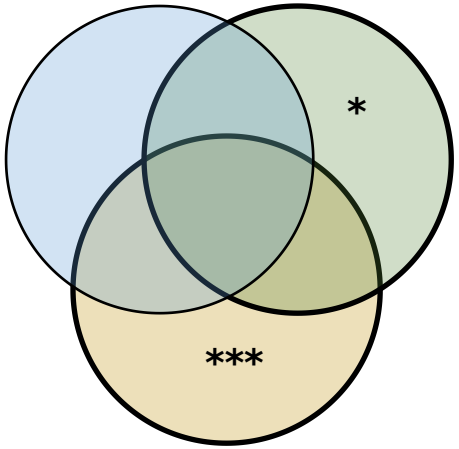
⇒ Rapid response to landscape changes



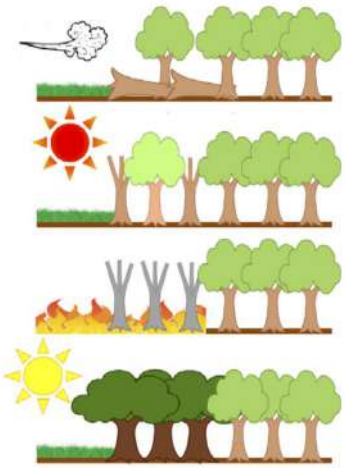
Results : 2) Niche-based mechanisms

Past landscape ***

Present landscape *



Topography *



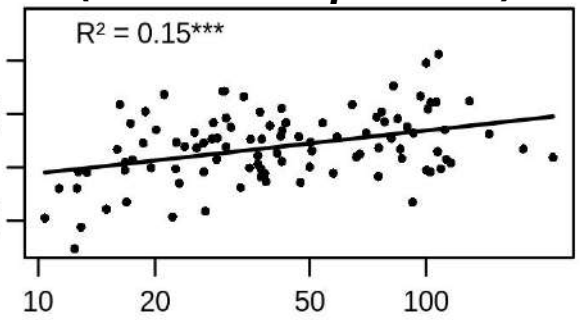
Adapted from Smith et al. 2017

⇒ *Rapid response to landscape changes*

⇒ *Strong influence of edge effects*

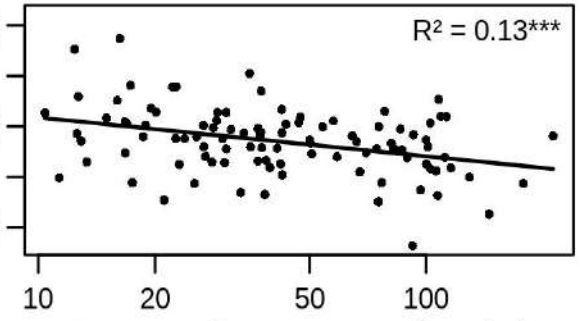
Acquisitive-Conservative

Environmental filtering
(Functional optimums)



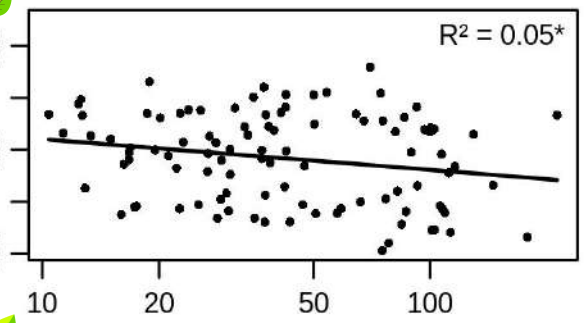
Current distance to edge

Stem protection



Current distance to edge

Drought resistance



Current distance to edge

Conclusion

Landsape history + functional ecology + ecological modeling :

⇒ Neutral and niche-based mechanisms are impacted by landscape changes

⇒ *but not in the same way over time!*

- ***Neutral mechanisms:***

⇒ Depend on landscape-scale context

Immigration-Extinction dynamics ~ Habitat amount

⇒ Time delay to reach Immigration-Extinction equilibrium

Possible extinction debt following habitat loss

- ***Niche-based mechanisms :***

⇒ Depend on local environmental conditions

Edge-effects, topography

⇒ Rapid effect of landscape changes on environmental filtering

Selection of species with edge-adapted strategies

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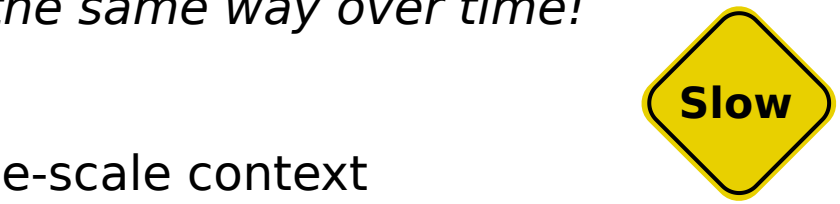
⇒ Time delay to reach Immigration-Extinction equilibrium

Possible extinction debt following habitat loss



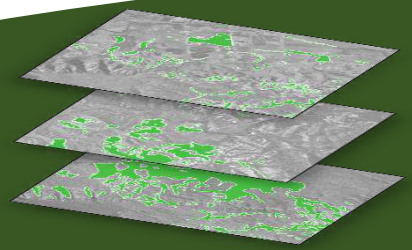
- ***Niche-based mechanisms :***

⇒ Depend on local environmental conditions

Edge-effects, topography

⇒ Rapid effect of landscape changes on environmental filtering

Selection of species with edge-adapted strategies



Importance of integrating landscape history to improve conservation planing of island's biodiversity

Thank you

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