Considering habitat fragmentation in LCIA

First proposals

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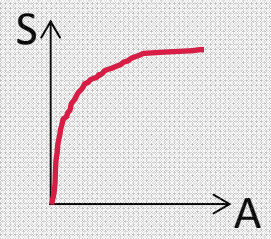
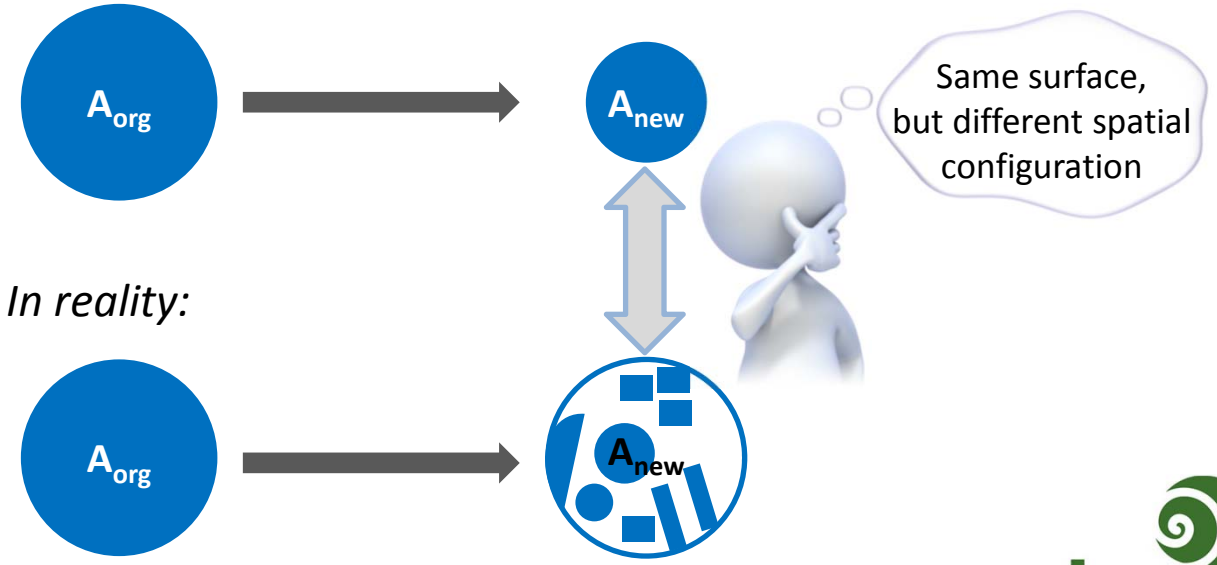
Stating the problem

Impact of land-use on biodiversity

	Midpoint indicators	Endpoint indicators
Habitat loss	*Occupation and transformation m^2 (≈ LCI?)*	*Species Loss**  **SAR** **Species Area Relationship** $S = c \times A^z$ **other indic. i.e. Functional diversity…*

How can we take into account the **fragmentation of a landscape**? …

… One possibility is to use the **metapopulation approach**

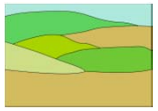


Metapopulation & Fragmentation

Metapopulation capacity λ*

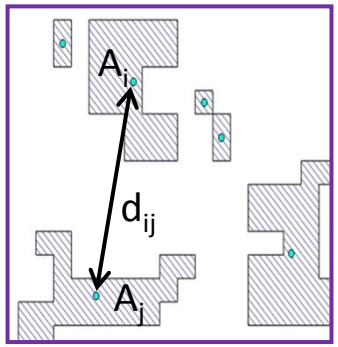
**(1) Hanski and Ovaskainen, 2000*

Landscape attributes



A_i: area of fragments

d_{ij}: distances between fragments



Spatial processing (GIS)

Species characteristics

Empirical data

Matrix M

↓

λ

= the leading eigenvalue of matrix M

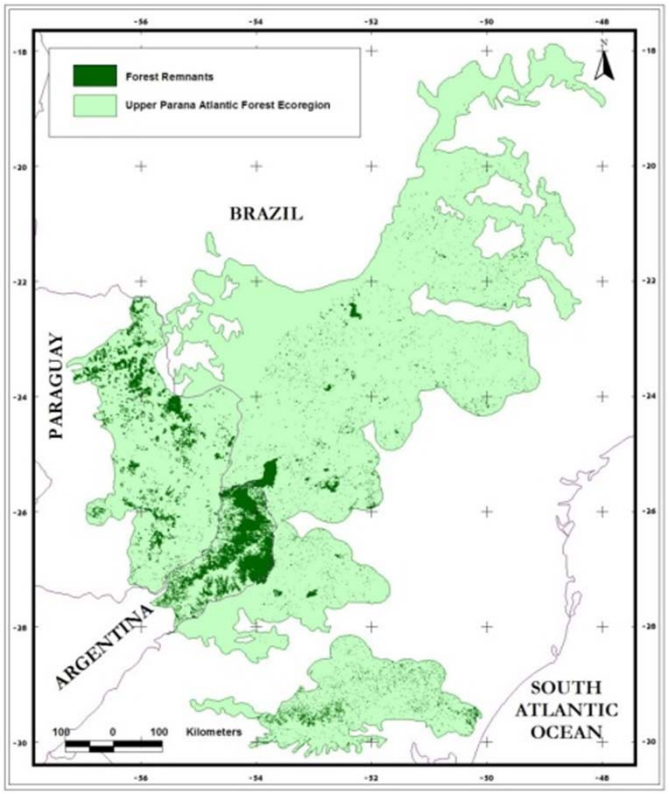
Matrix calculation python

Application to a case-study

- Ecoregion WWF : Alto Parana Atlantic (NT0150)
- Land-cover maps – resolution 30m*

Highly fragmented ecoregion

Species characteristics available



Forest Remnants of the Upper Paraná Atlantic Forest (2) Bitetti et al., 2003

**South America 2010: (3) Giri and Long, 2014*

Application to a case-study

- Comparison of 2 contrasted zones (part 1):

Same area but **different number of fragments**

	Zone A		Zone B
Total area A_{tot} (km^2)	100		
Ratio forest/total	31.0%		
Number of forest fragments N_f	**396**	x3 →	**1262**
Mean fragment area (ha)	7.8		2.5
Metapopulation capacity λ	**1.22**	÷5 →	**2.42E-01**

Application to a case-study

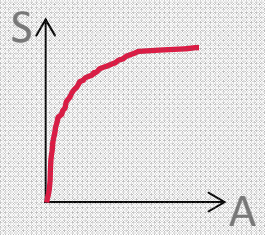
- Comparison of 2 contrasted zones (part 1):

Same number of fragments but **different area**

	Zone C		Zone D
Total area A_{tot} (km^2)		100	
Ratio forest/total	40.8%	÷2 →	21.4%
Number of forest fragments N_f		**≈450**	
Mean fragment area (ha)	9.5		4.7
Metapopulation capacity λ	**4.95**	÷14 →	**3.44E-01**

Short-term perspectives

Impact of land-use on biodiversity

	Midpoint indicators	Endpoint indicators
Habitat loss	*Occupation and transformation m²* *(≈ LCI?)*	*Species Loss*  **SAR** **Species Area Relationship** $S = c \times A^z$
Habitat loss and fragmentation	LANDSCAPE (morphological features)  + ECOLOGICAL MODEL (species characteristics)  **λ** **1) Calculation of λ for an ecoregion** **2) Proposal of a midpoint indicator** ***-> Fragmentation "stress"***	*Species loss* **SFAR*** **Species-Fragmented Area Relationship** $S = c \times A^z \times e^{-\frac{b}{\lambda}}$ **3) Enhance top-down indicators:** **- Feasibility?** **- Relevance?** **(4) Hanski et al., 2013*

Long-term perspectives

- Explore and develop bottom-up approaches

SAR or SFAR → Top-down approach
Based on measured biodiversity loss for different typologies of land-use

→ Need to isolate the different effects of fragmentation (edge effect, barrier effect…)

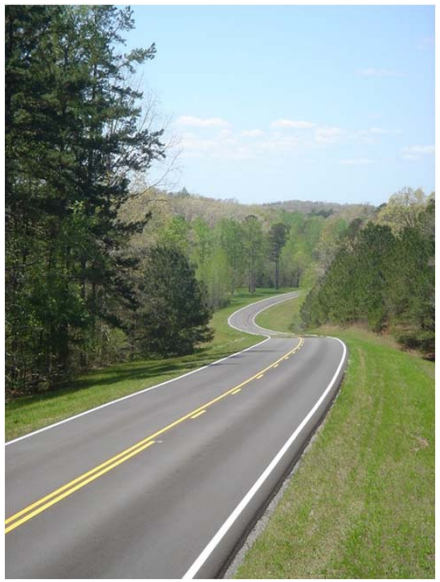


Image source: Pixabay

References

1. Hanski, I.; Ovaskainen, O. The metapopulation capacity of a fragmented landscape. Nature 2000, 404 (6779), 755–758.
2. Di Bitetti, M. S.; Placci, G.; Dietz, L. A. A biodiversity vision for the Upper Parana Atlantic Forest ecoregion: designing a biodiversity conservation landscape and setting priorities for conservation action; 2003.
3. Giri, C.; Long, J. Land Cover Characterization and Mapping of South America for the Year 2010 Using Landsat 30 m Satellite Data. Remote Sens. 2014, 6, 9494–9510.
4. Hanski, I.; Zurita, G. A.; Bellocq, M. I.; Rybicki, J. Species-fragmented area relationship. In Proceedings of the National Academy of Sciences of the United States of America; 2013; Vol. 110, pp 12715–12720.

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