Opportunities for Low Cost Restoration

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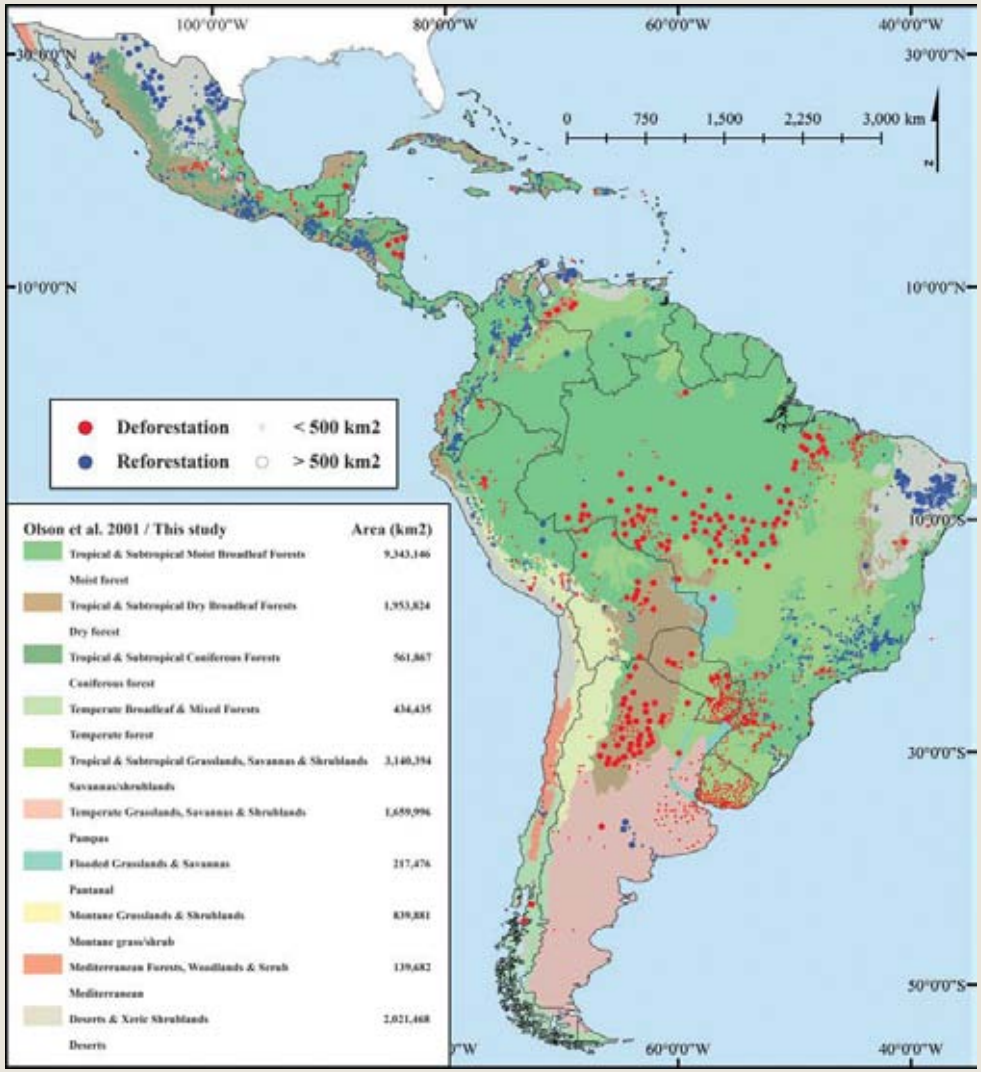
Outline

1. Definition and features of natural regeneration
2. Advantages of natural regeneration as a restoration approach
3. Conditions that promote natural regeneration
4. Landscape-scale natural regeneration
5. Challenges to monitoring and assessing natural regeneration

Forest transitions are occurring across the tropics

In the Neotropics, between 2000–2010, reforestation exceeded deforestation in Mexico, Colombia, Venezuela, Honduras, Cuba, Costa Rica, El Salvador, Suriname, Puerto Rico, Haiti, Guyana, and French Guiana (Aide et al. 2012).



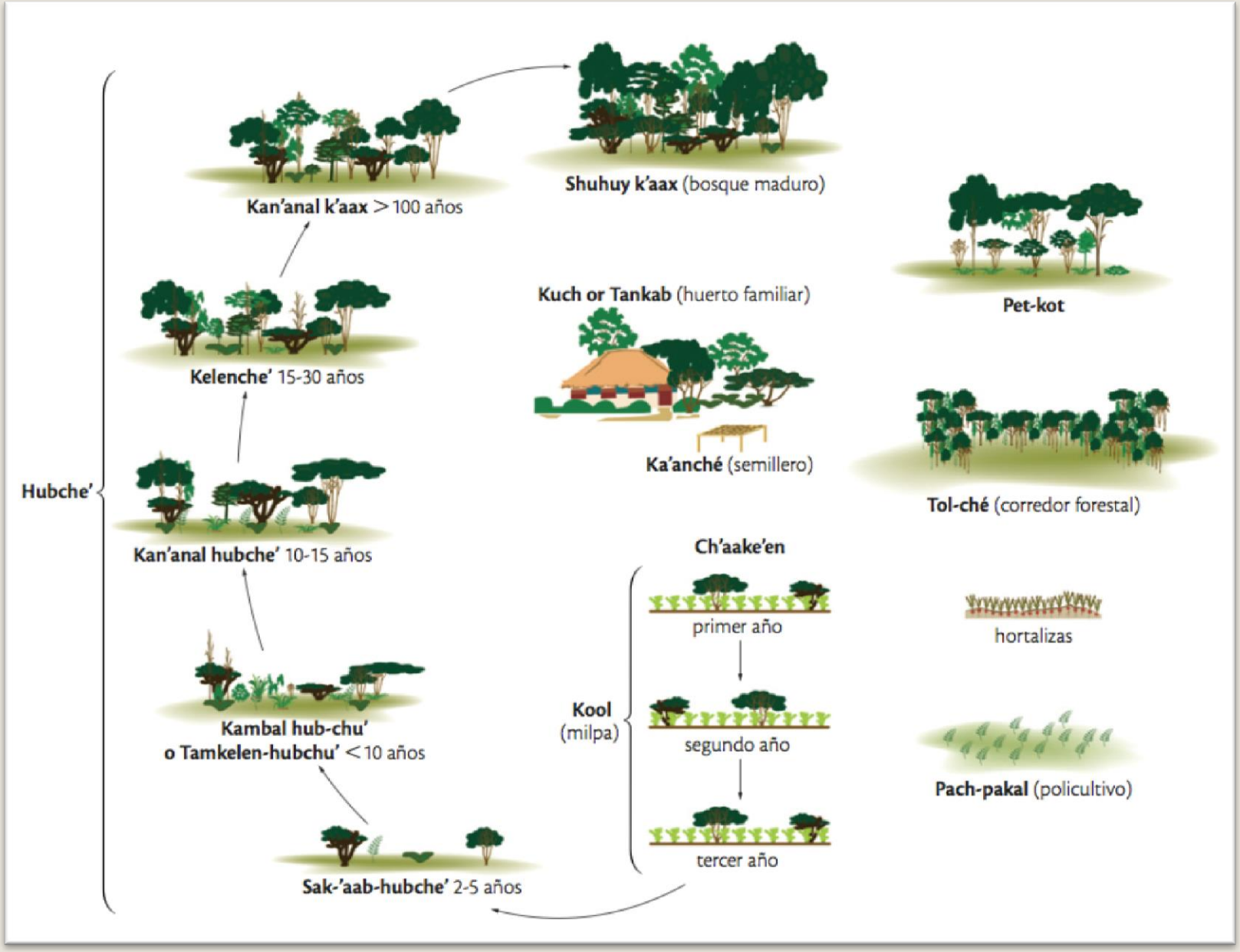
Four major paths to reforestation

Coffee agroforestry in India.
Photo by: Shonil Bhagwat.

Natural regeneration is a process of self-reorganization

Natural Regeneration/Secondary Succession

- Occurs following natural disturbances (hurricane, landslide, fire) and human disturbances
- A gradual process that occurs in stages
- Strongly influenced by local and landscape conditions
- Sites show variable trajectories, even within the same region, climate, and former land use
- Regrowth may take many decades to regain properties of old-growth forest

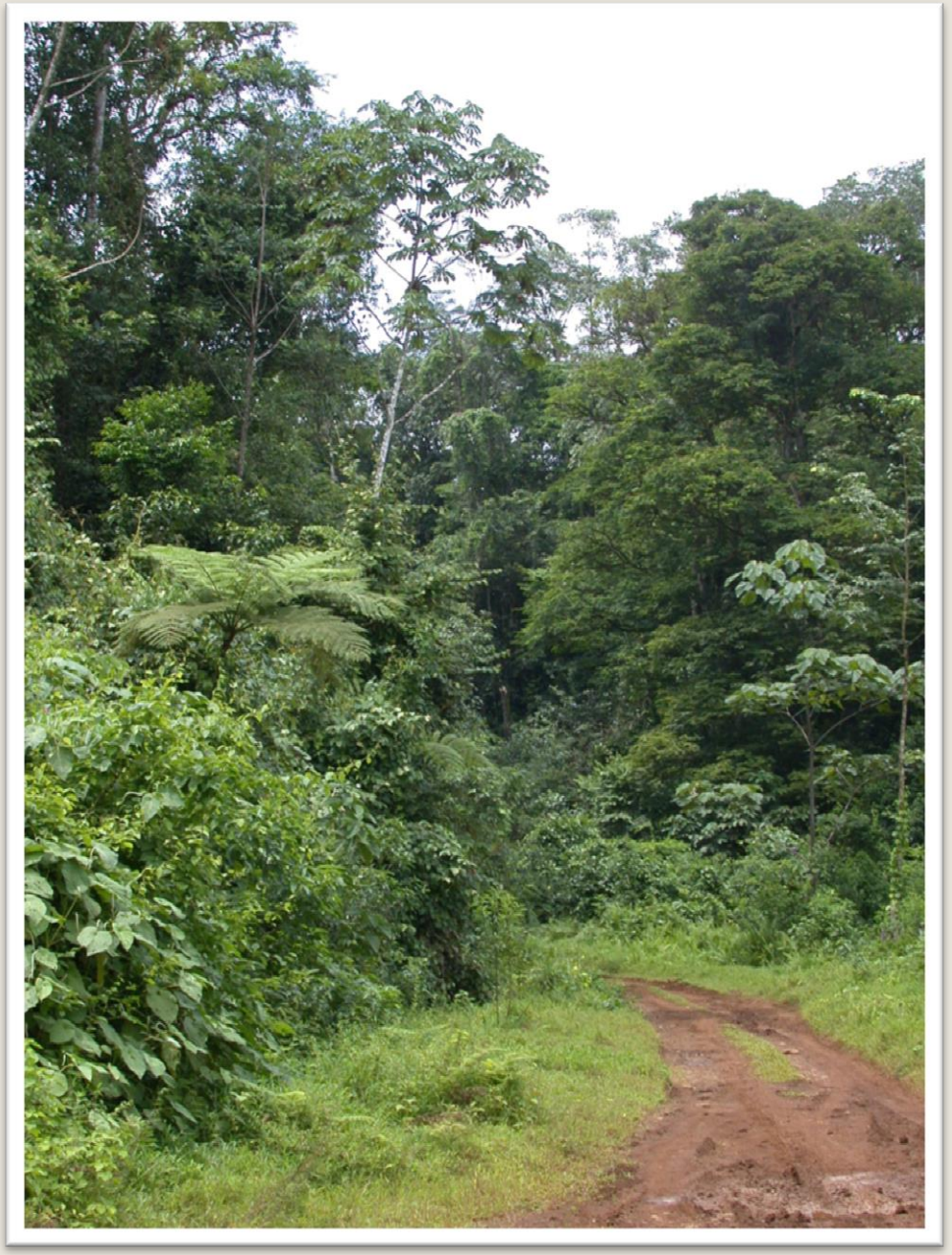


Barrera-Bassols and Toledo 2005. Journal of Latin American Geography

Good Soil
Moderate Soil
Poor Soil
Primary Forest
(Hutan Bengkar)
> 110 Years
> 140 Years
> 180 Years
Old Secondary Forest
(Kurat batang Tuha)
9-110 Years
11-140 Years
16-180 years
Young Secondary Forest
(Kurat batang Muda)
3-8 years
5-10 years
6-15 years
Old Scrub
(Kurat Tuha)
2-3 Yrs
3-5 Yrs
5+ Yrs
Young Scrub
(Kurat Uraq)
1-2 Yrs
2-3 Yrs
3 Yrs
Swidden Fields
< 1 Yr
< 1 Yr
< 1 Yr

acahual,
charral,
barbecho,
capoeira,
bosque
secundario

fallow, scrub,
old-field,
secondary
forest



Alternative Sucessional Pathways in Central Amazonia

Mesquita *et al* 2001

Low → **Land-use intensity** → **High**

***Cecropia* spp.**

34% of BA is *Cecropia* spp.

Fast regrowth

Approximate regeneration in light gaps

***Vismia* spp.**

47% of BA is *Vismia* spp.

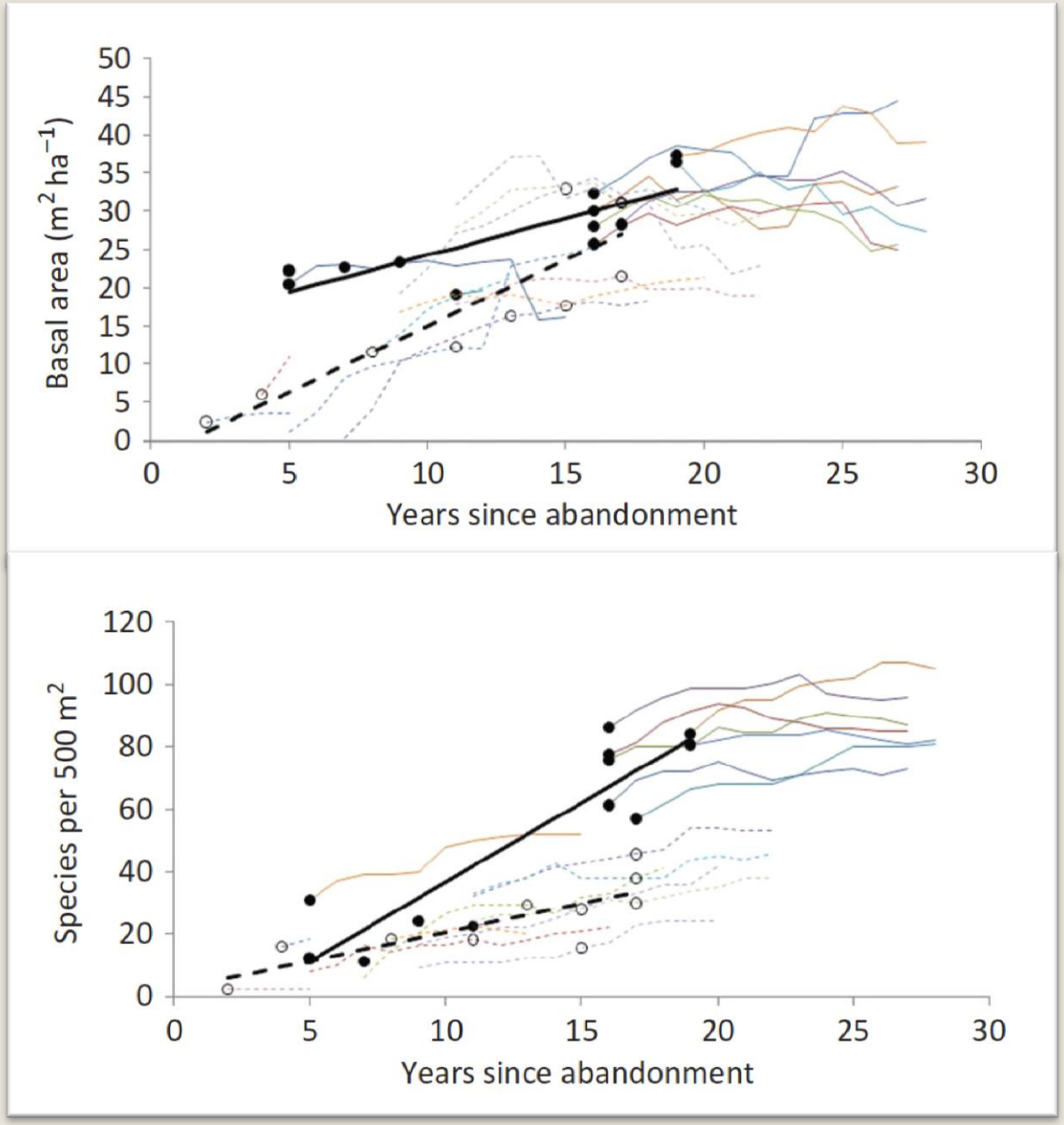
Slow regrowth

Lower height

Photo credit: Ana Catarina C. Jakovac

Cecropia spp.
0–2 burns

Vismia spp.
≥ 2 burns



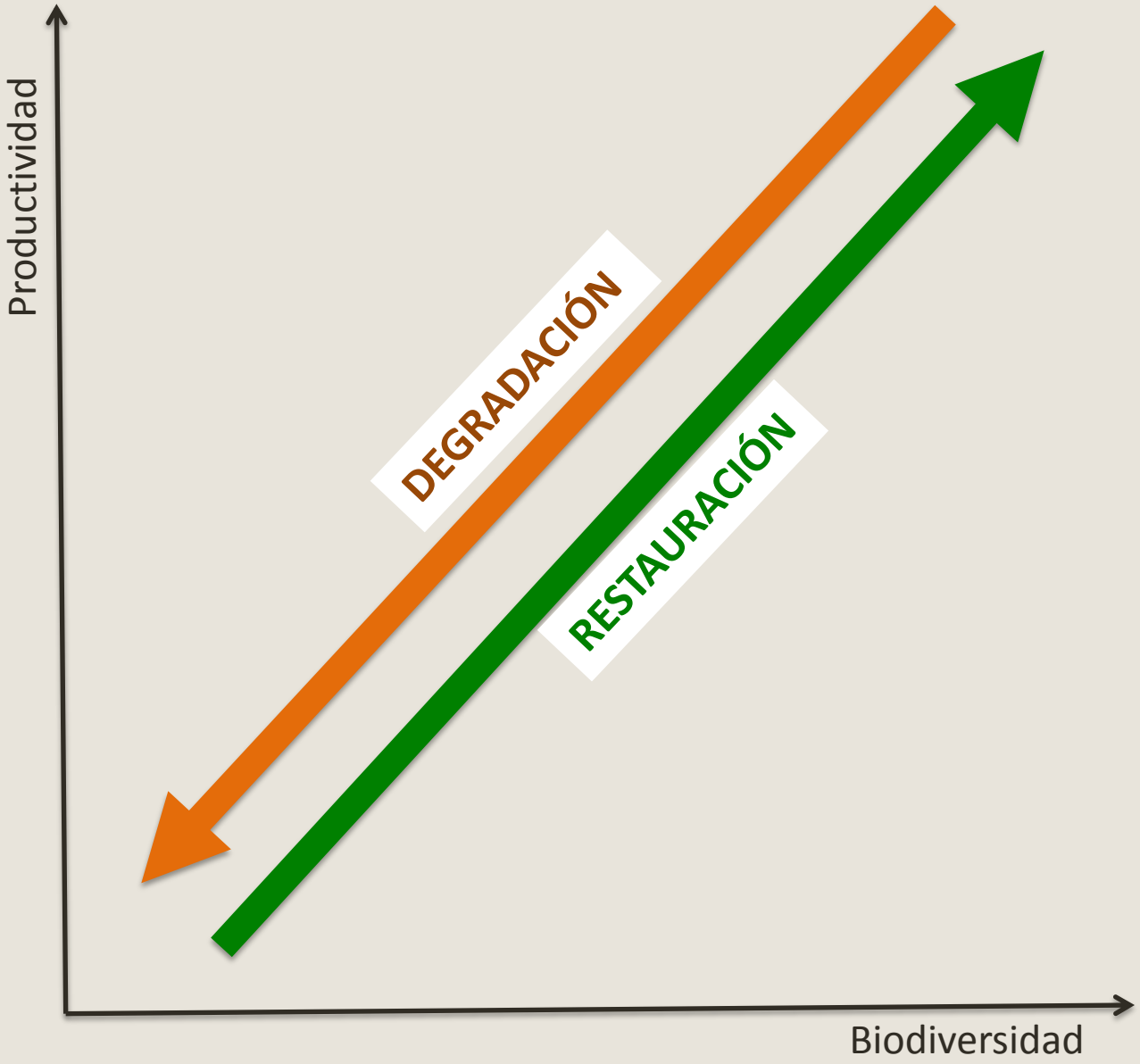
Williamson et al. 2013. Convergence and divergence in alternative successional pathways in Central Amazonia. Plant Ecology & Diversity

Regenerating or successional forests are not degraded forests

- Term “secondary forests” is also used to described forests that were formerly logged or selectively logged, but still had some remaining trees
- A better term is “young” or “second-growth” forests (in contrast to “old-growth”)
- Remote sensing methods cannot distinguish regenerating forests from plantations or from severely degraded forests

Regeneration is a commonly used term to describe regrowth and restablishment following forest disturbance at a range of spatial scales, analogous with the regeneration, regrowth, or reconstitution of tissues or organs following damage or loss. Natural regeneration of populations, species, and assemblages occurs throughout all stages of succession.

The Convention on Biological Diversity (CBD 2005) states that "a degraded forest is a secondary forest that has lost, through human activities, the structure, function, species composition or productivity normally associated with a natural forest type expected on that site."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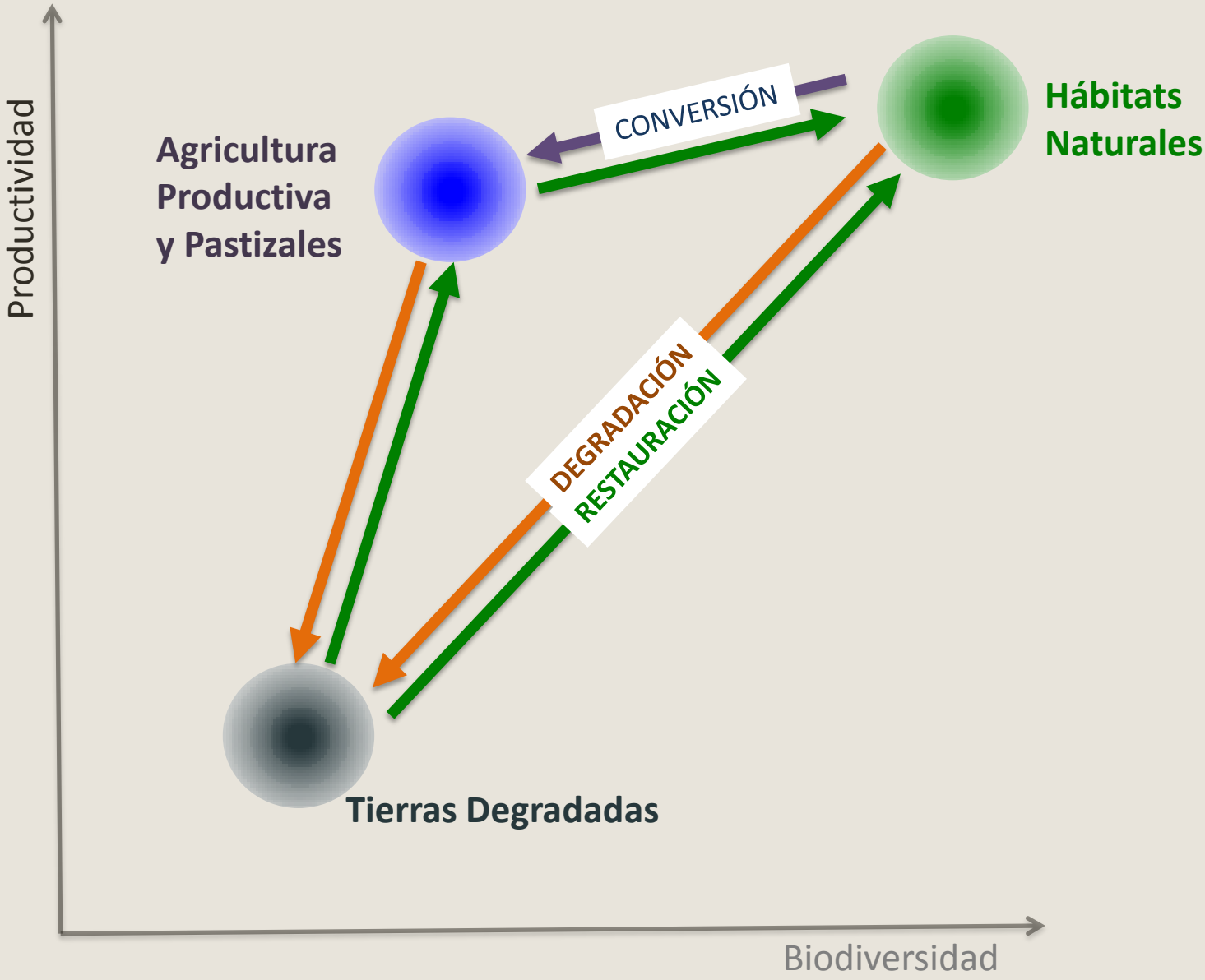
DEGRADACIÓN
RESTAURACIÓN
Biodiversidad


Productividad
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y Pastizales
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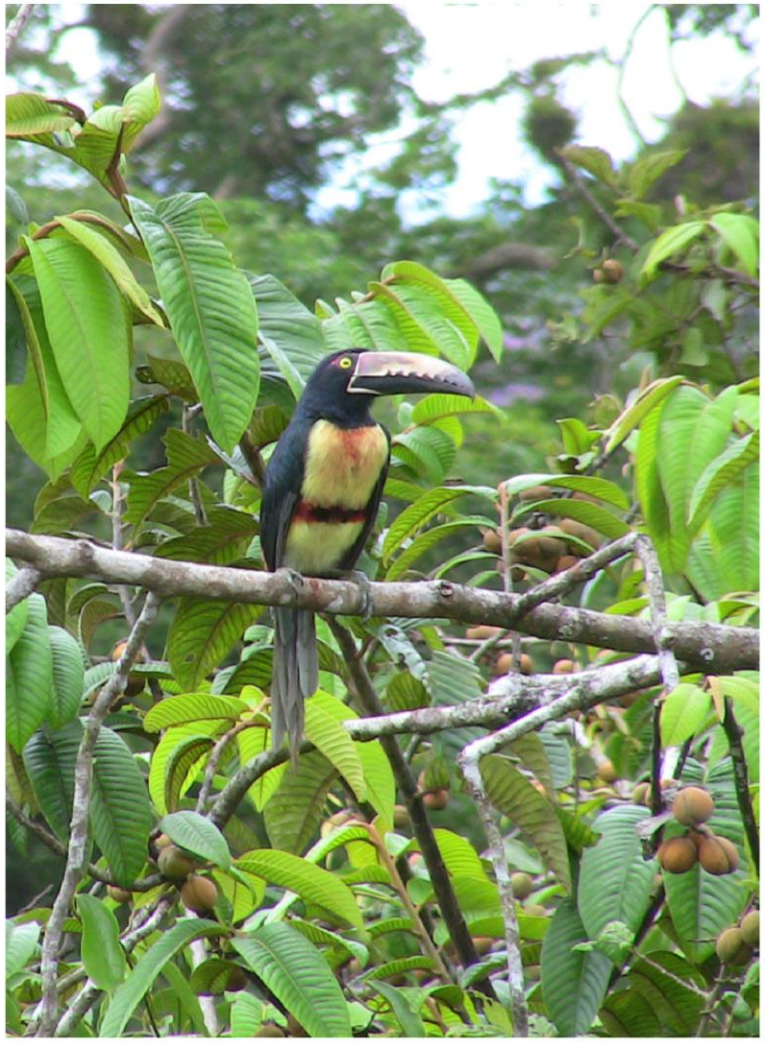
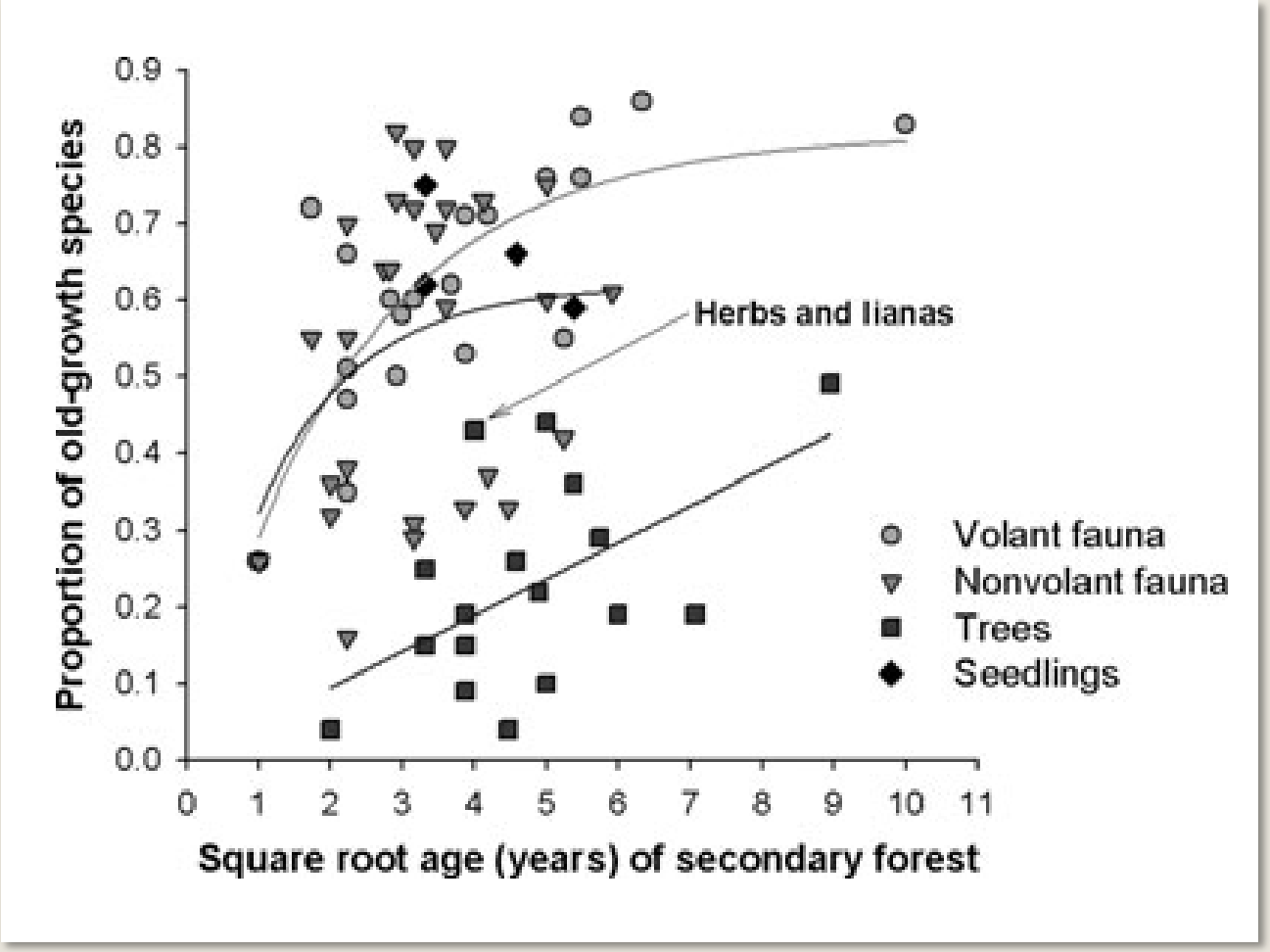
Hábitats
Naturales
DEGRADACIÓN
RESTAURACIÓN
Tierras Degradadas
Biodiversidad

Advantages of natural regeneration as a restoration pathway

- Species colonize from local area and are adapted to local conditions and other species (local genotypes)
- Restoration of multiple ecosystem services (soil organic matter, carbon sequestration, hydrologic storage, nutrient cycling, provisioning services)
- Associated biodiversity also attracted to the area (birds, mammals, insects, microflora)



Forest biodiversity increases during natural regeneration

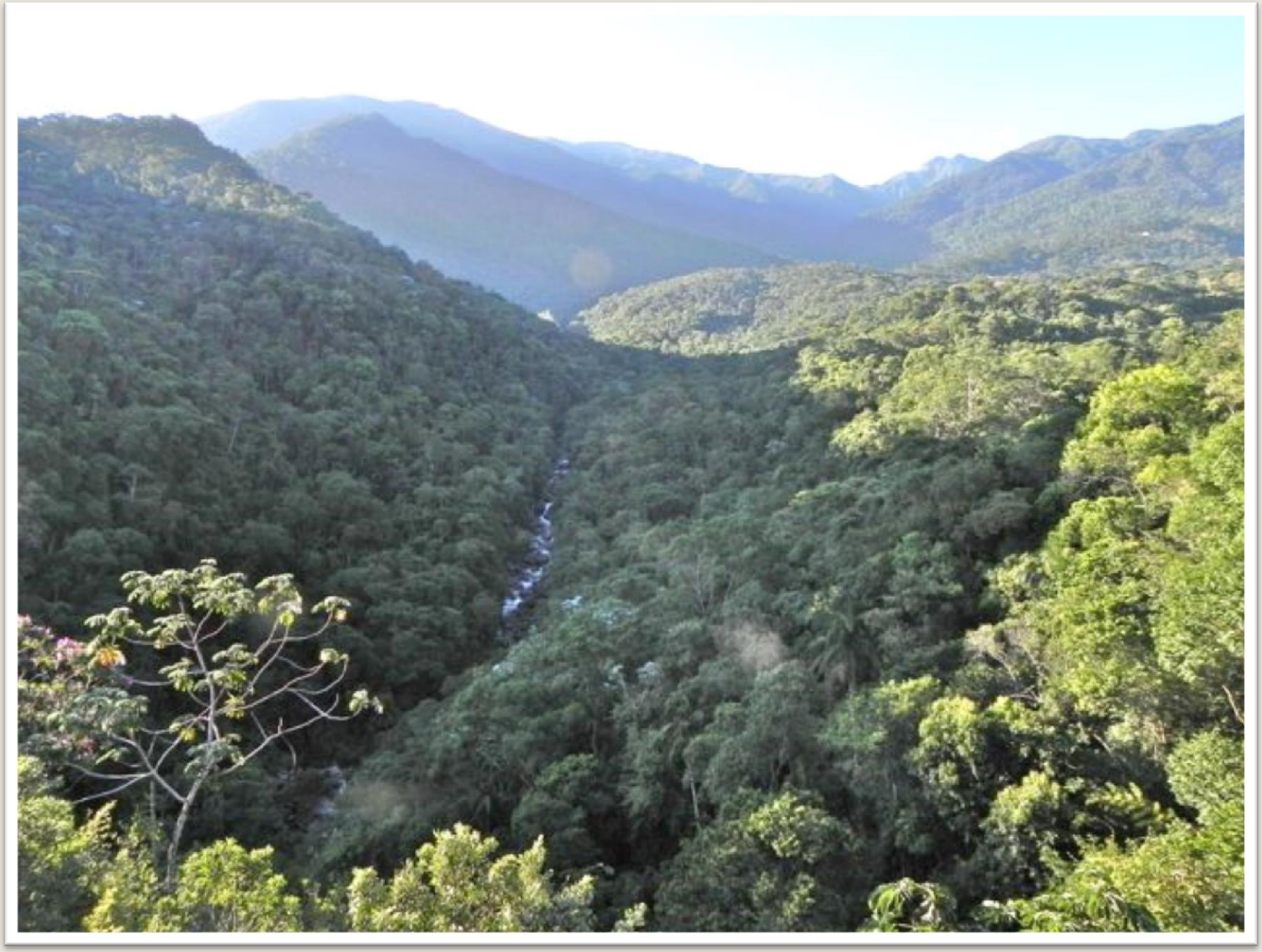


Chazdon et al. 2009

More advantages

- Restoration of species familiar to and used by local people for timber, medicine, foods, and crafts (thus supporting local livelihoods and cultural practices)
- Regrowth forests contribute to landscape heterogeneity, biodiversity, and resilience
- The “next best thing” to original vegetation cover; keeps open future options for forested land

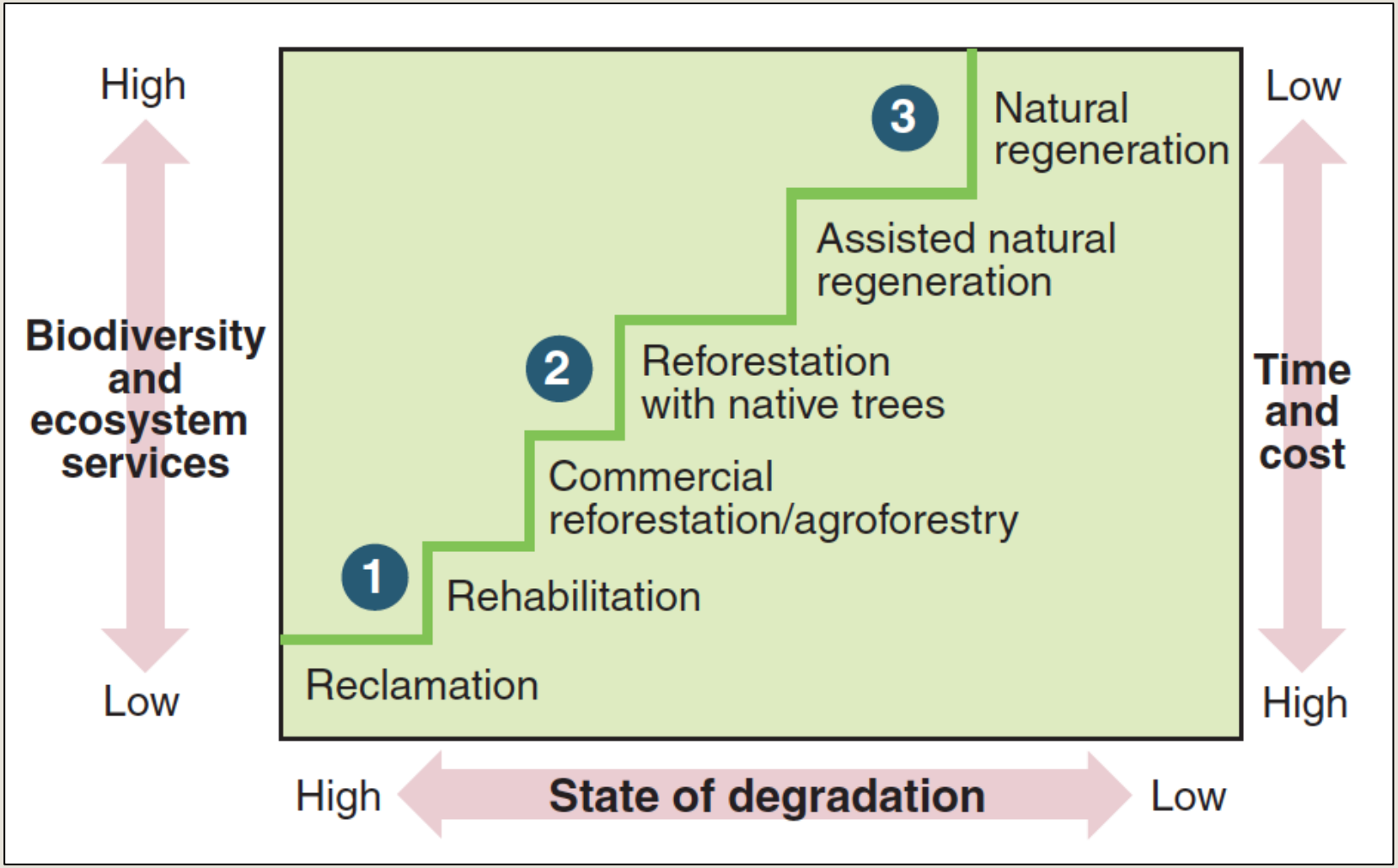
Natural regeneration can also promote ecotourism



Conditions for forest restoration scenarios

Site conditions	Soil is not disturbed (has topsoil and soil microbes)	Soil disturbed; little organic matter or soil microbes
Close seed sources and visitation by seed dispersing animals	Natural regeneration (Low-cost)	Soil amendments; plant with N-fixing nurse trees (moderate cost)
Few or distant seed sources and few seed dispersing animals can reach site	Tree planting or seeding; enrichment planting (moderate cost)	Soil amendments, tree planting, enrichment planting (high cost)

The restoration staircase



Chazdon 2008 Science

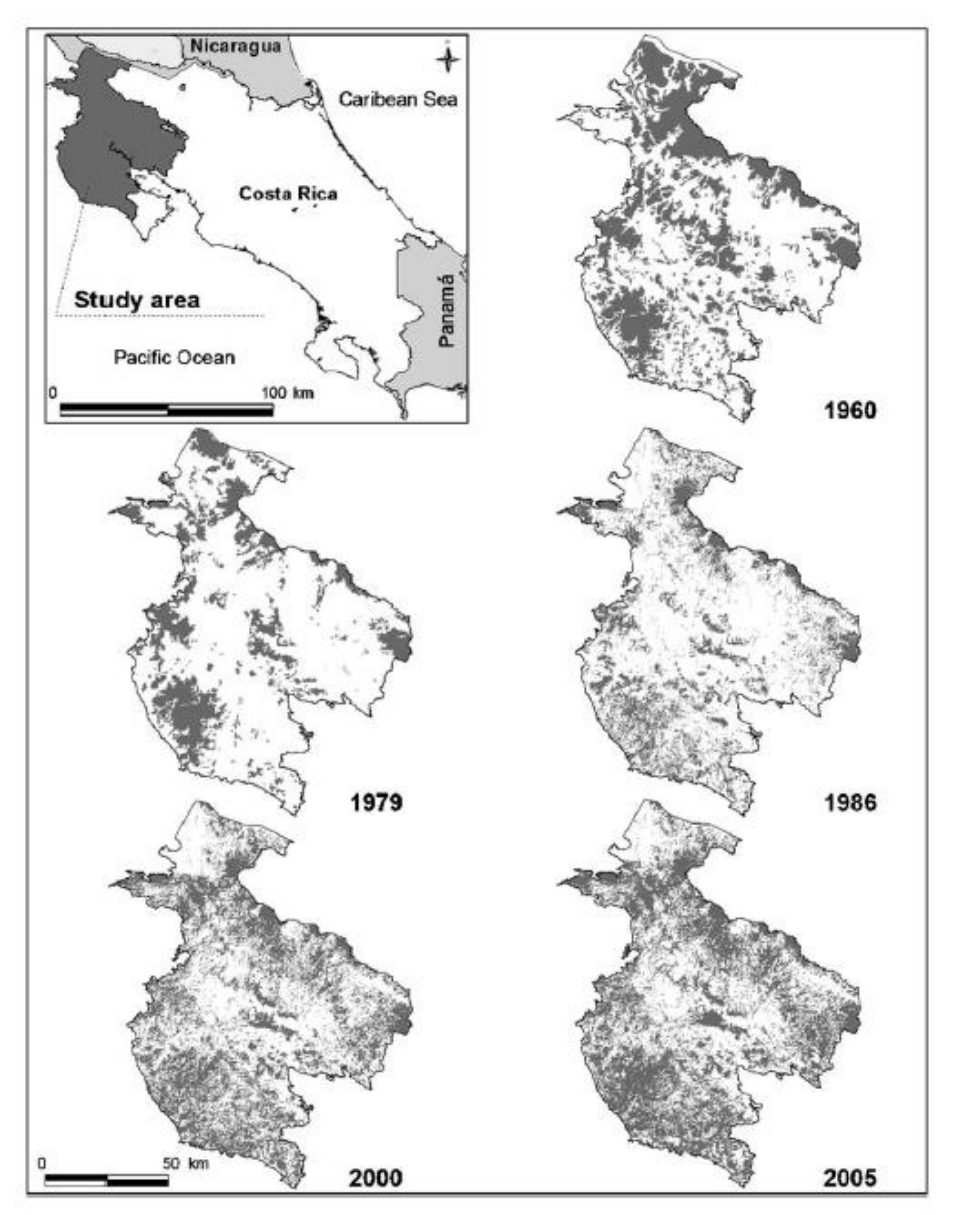
Local and landscape conditions that favor rapid and diverse natural regeneration

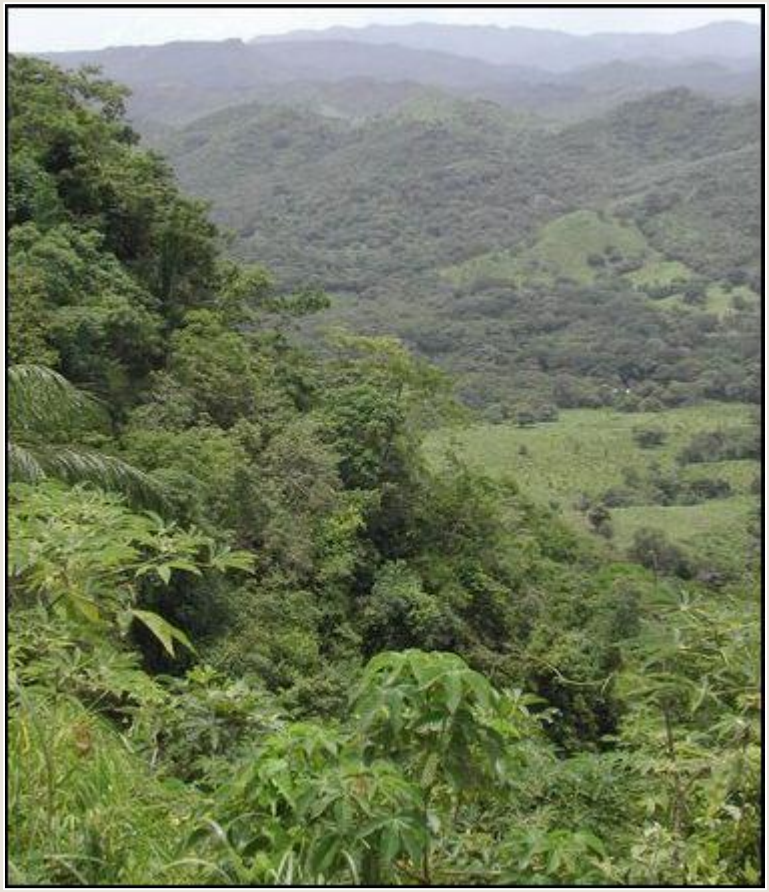
1. Retention of topsoil
2. Proximity to forest fragments
3. Resprouting from tree roots or stems
4. Intact soil seed bank
5. Presence of seeds of early and late successional woody species in the seed rain
6. Continuous colonization of native species from surrounding areas
7. Weed suppression by pioneer shrub or tree colonization
8. Animal and microbial diversity (insects, vertebrates, soil fungi)
9. Protection from recurrent fire
10. Protection from hunting and excessive harvesting of litter and forest products

Chazdon (2013 Journal of Sustainable Forestry)

Ecological memory: connects regenerating forests with the past and with the surrounding landscape

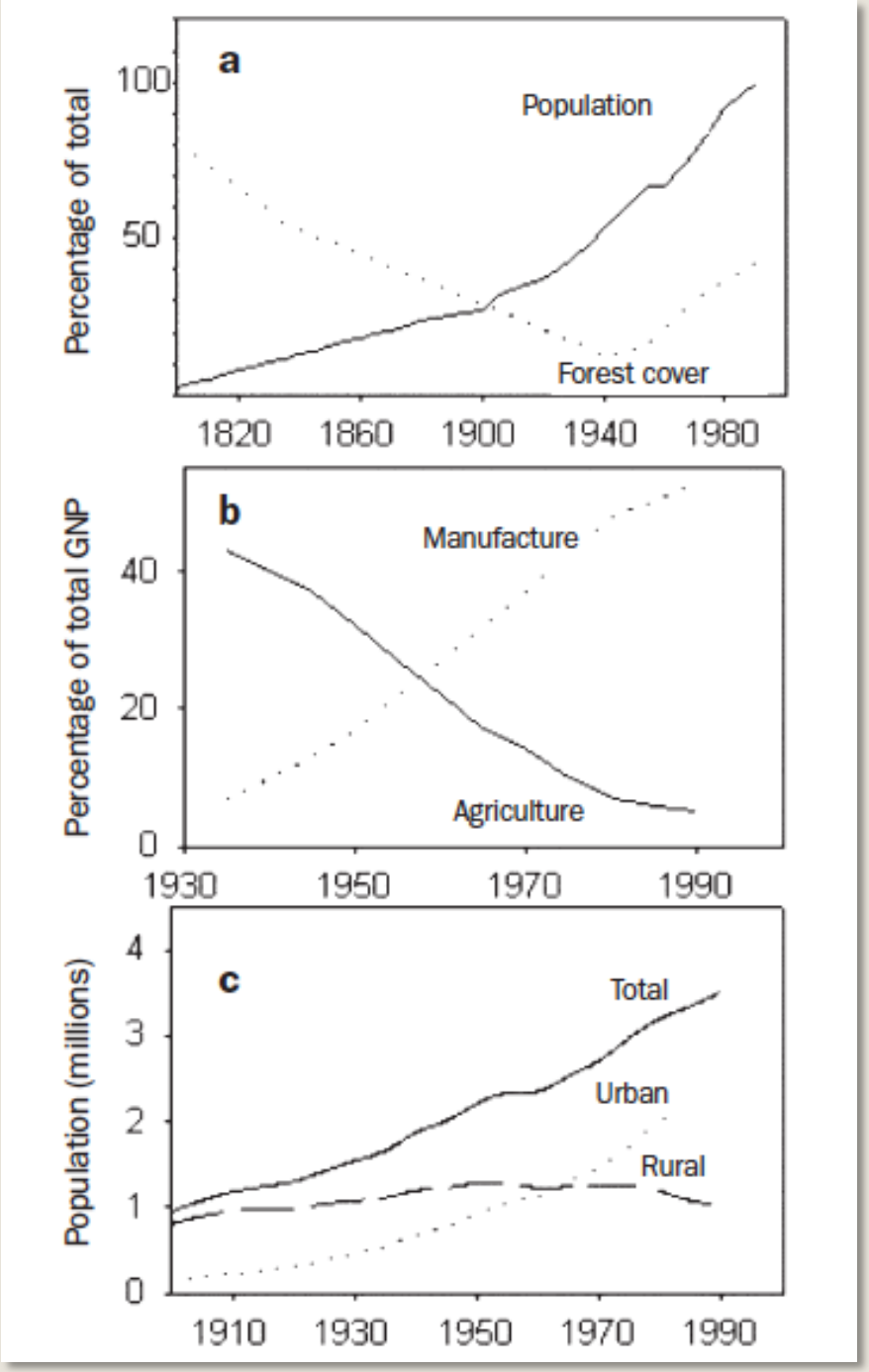
Landscape scale natural regeneration



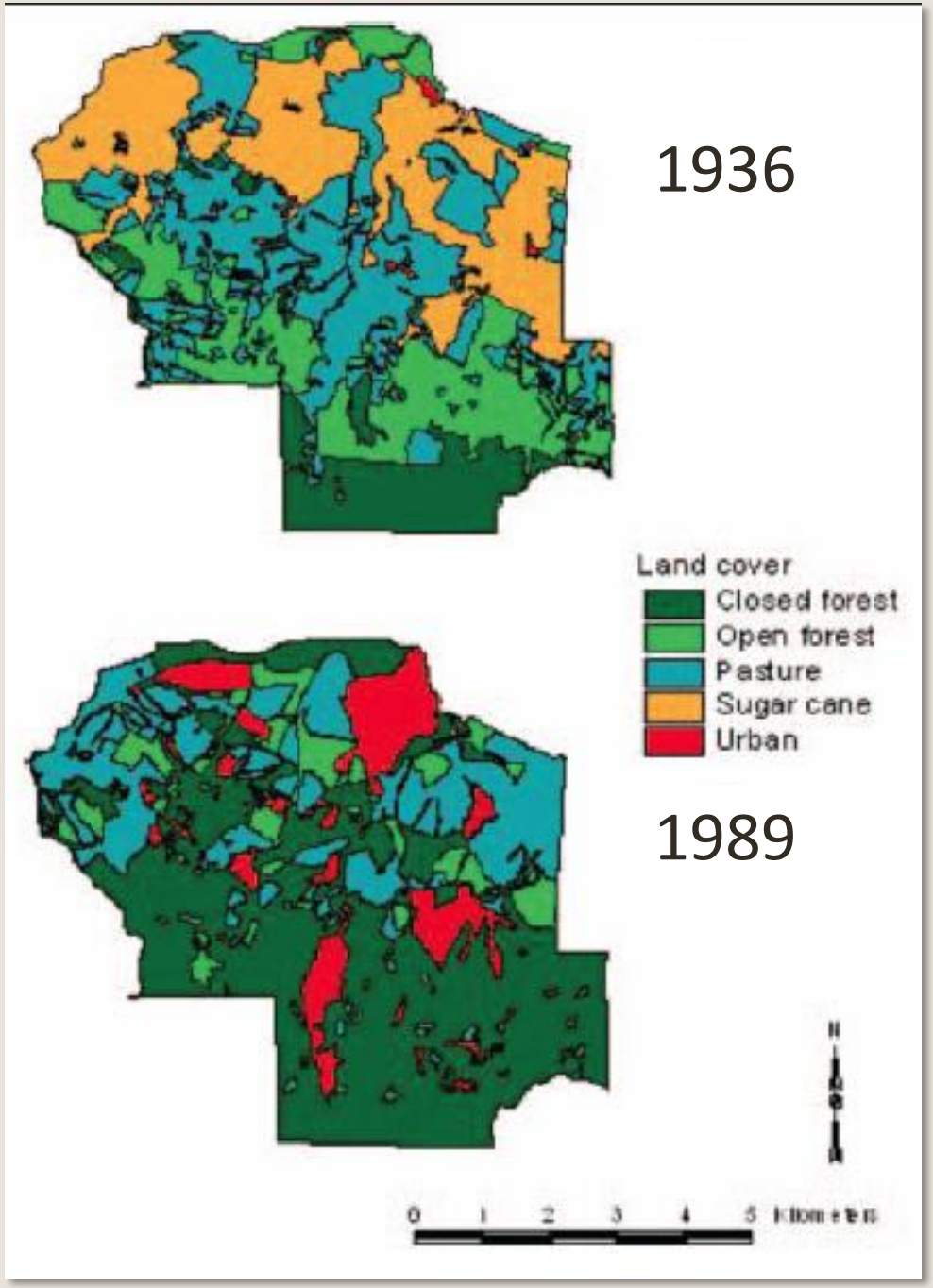


Calvo-Alvarado et al. (2009)

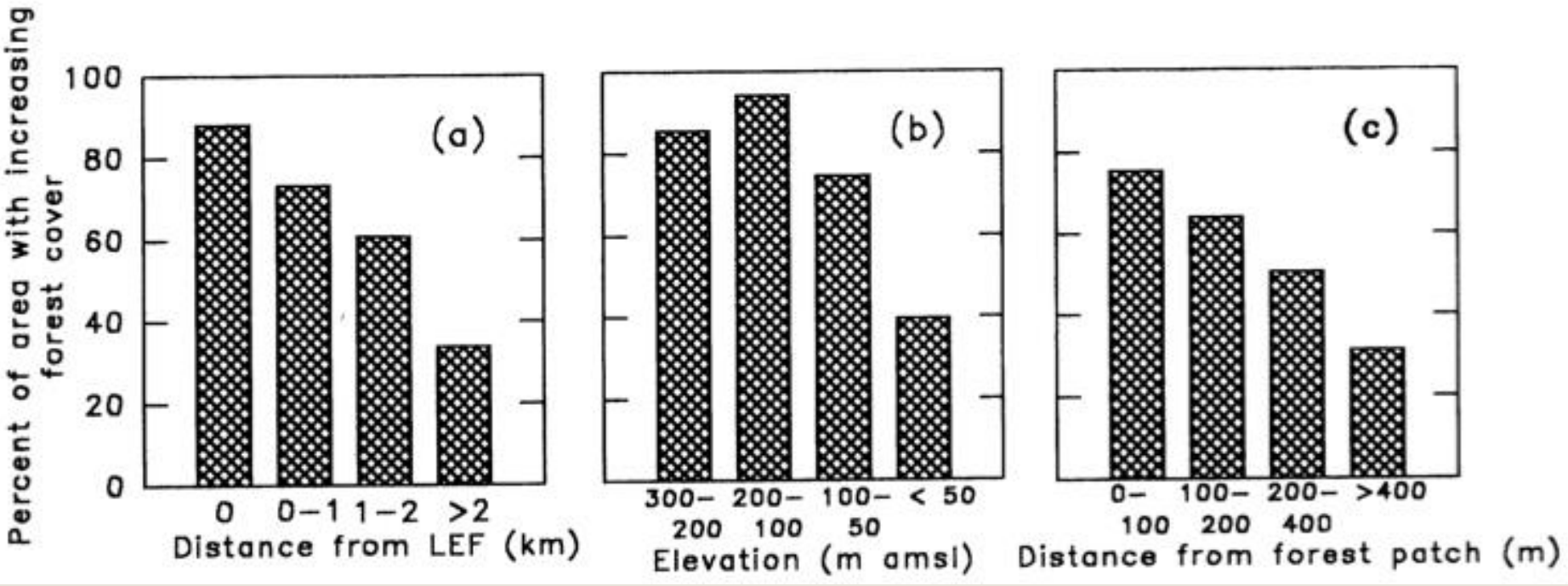
Forest transition in Puerto Rico:
From 1948 to 1991 forest cover increased from 10% to 42% of the island, despite continuous population growth
(Grau et al. 2003)



Luquillo municipality, northeastern Puerto Rico (Grau et al. 2003)



Luquillo Experimental Forest, Puerto Rico 1936-1988



Thomlinson et al. 1996

Factor	Explanation	Reference
High annual precipitation	Promotes tree regeneration and reduces fire frequency	Daly et al. 2003; Brandeis et al. 2007
Steep slopes, high elevation	Marginal land for agriculture	Helmer et al. 2008; Crk et al. 2009
Low or intermediate soil fertility	Marginal land for agriculture	Chinea 2002; Arroyo-Mora, Sanchez-Azofeifa, Rivard, et al. 2005
Less surrounding pasture	Marginal land for grazing	Helmer et al. 2008
Serpentine soils	Marginal land for agriculture	Helmer et al. 2008
Total forest cover	Facilitates seed dispersal, colonization, conservation of wildlife populations	Thomlinson et al. 1996; Helmer et al. 2008; Crk. et al. 2009
Poor access, far from roads	Agricultural land more likely to be abandoned	Thomlinson et al. 1996
Proximity to old-growth forest fragments or protected areas	Facilitates seed dispersal, colonization, conservation of wildlife populations	Thomlinson et al. 1996; Helmer et al. 2008; Crk et al. 2009

Source: Modified from Yackulic et al. (2011, table 1).

Socio-economic and cultural obstacles to natural regeneration

- Land tenure
- Looks like irresponsible land use or abandonment
- Could attract squatter invasion of land
- Perceived as backward or not modern
- Slow, patchy, and unpredictable
- No financial incentive for early successional land
- Greater financial incentives for planting native tree plantations
- Unlikely to occur in regions with high demand for export crops

Passive restoration does have costs

Extrema municipality, Minas Gerais

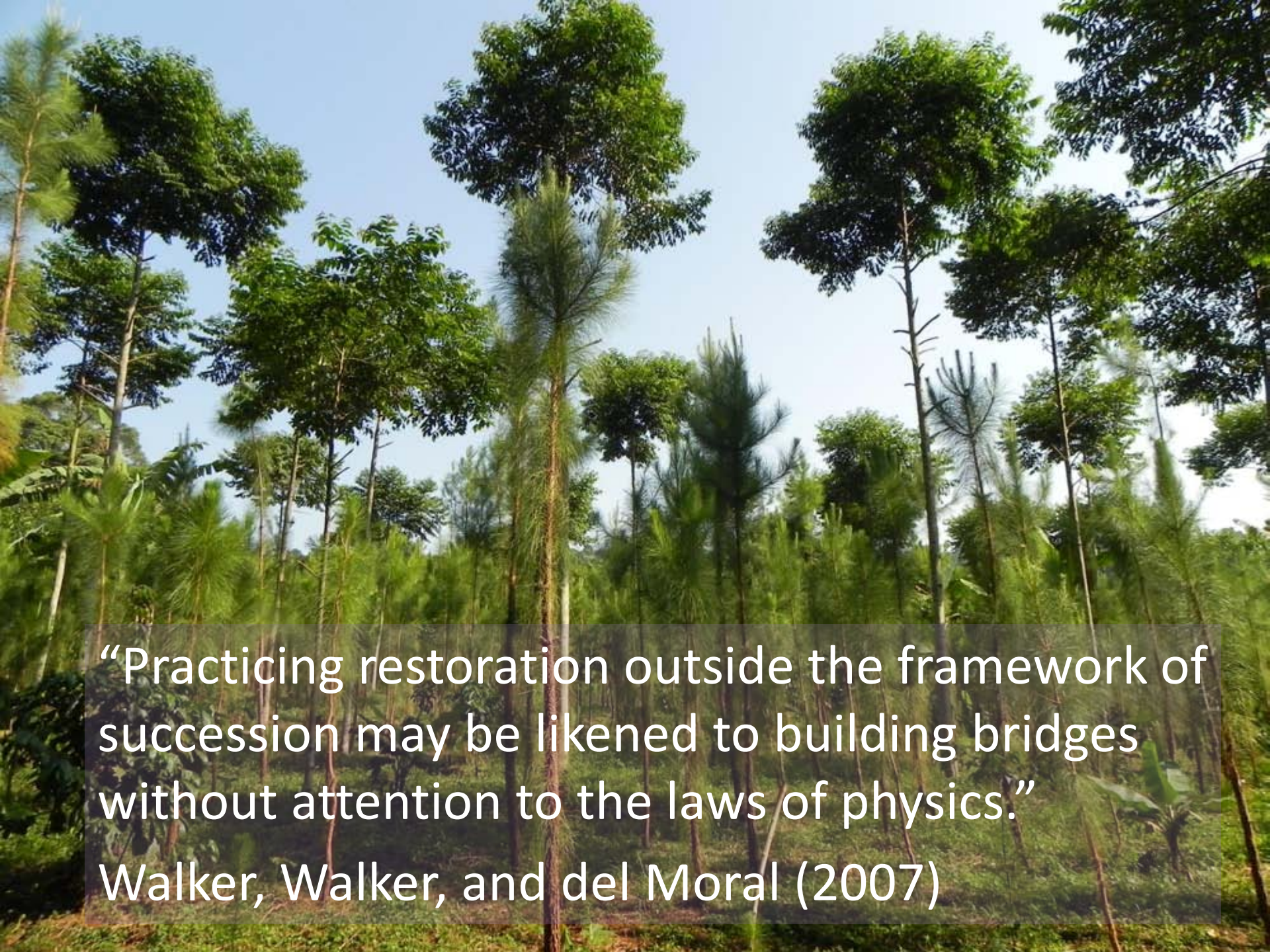
- Opportunity costs of loss of agricultural land use for many years
- May require subsidies to landowners
- Fencing/fire protection
- Patrolling/hunting protection
- Costs may be lower if areas are around existing protected areas

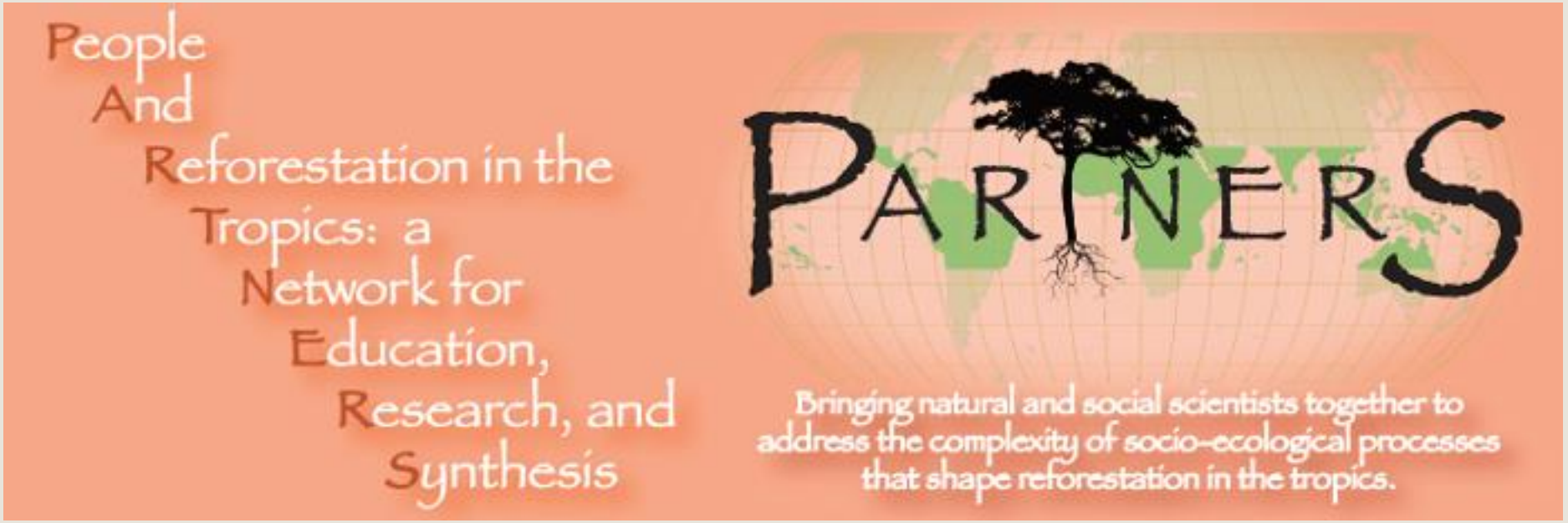
Challenges to policy, monitoring, and assessment of natural regeneration

- Regeneration often occurs in small patches (< 5 ha) that are not detected using remote sensing techniques
- “Reference” forest may not exist in the area
- Reforestation policies emerge from forestry sector with little contribution from ecologists, local communities, or other stakeholders

Payments for Environmental Services often do not apply to early stages of forest regeneration


The “best” way is not always the “fastest” way


“Practicing restoration outside the framework of succession may be likened to building bridges without attention to the laws of physics.”
Walker, Walker, and del Moral (2007)



Goal: to bring natural and social scientists together to address the complexity of socio-ecological processes that shape reforestation in the tropics.

http://partners-rcn.uconn.edu

Research Coordination Network

- Provide interdisciplinary, peer-reviewed scholarly syntheses.
- Create a web-based platform for communication among researchers, educators, policy-makers, and to inform general public.
- Stimulate integrated socio-ecological research within and across different regions.
- Provide information and reviews for policy-makers and educators.

Research themes

(1) What social and ecological factors drive the forest transitions that generate tropical regrowth?

(2) How can we measure and explain variations in the resilience of forests across tropical landscapes?

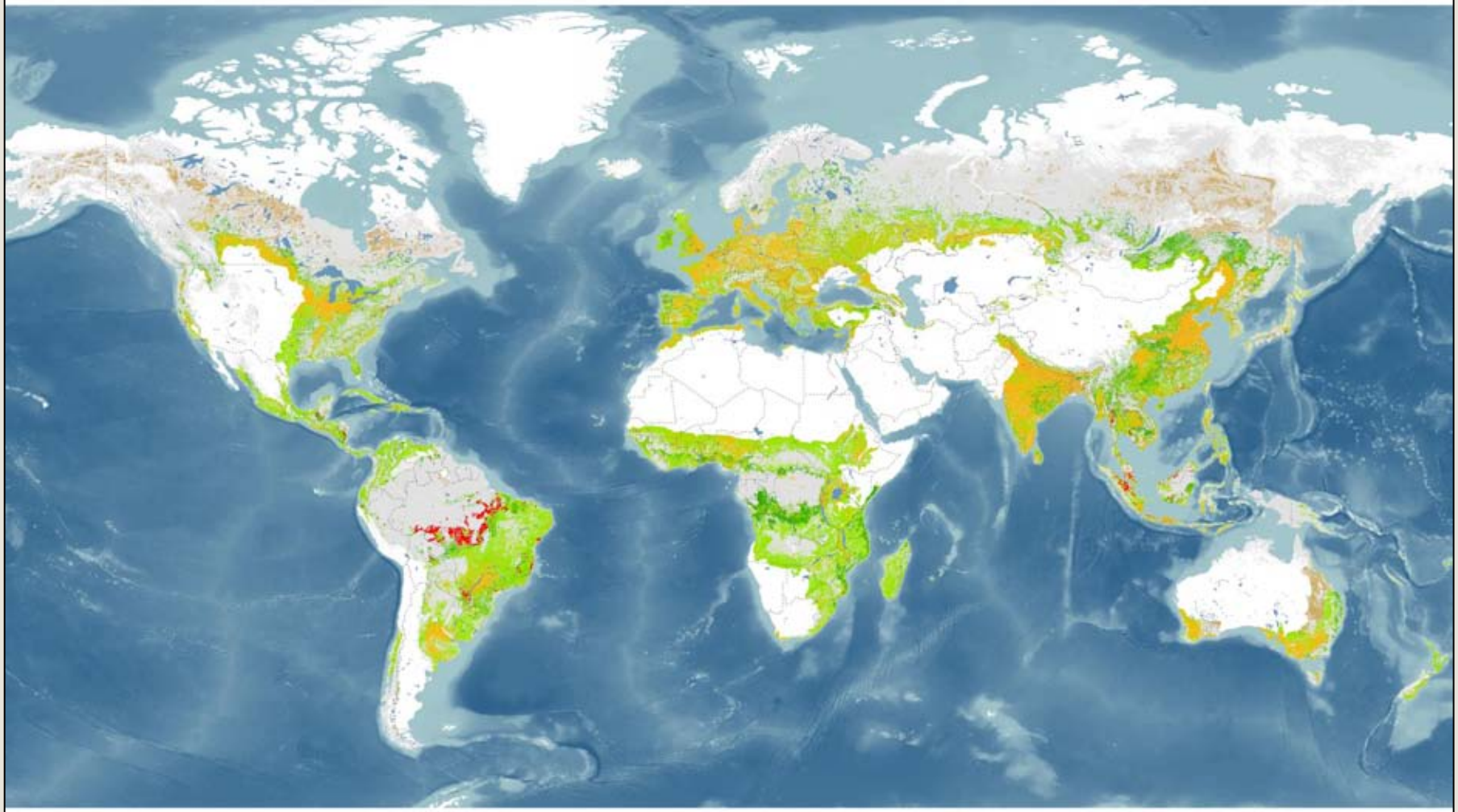
(3) How do climatic changes or their variability affect tree growth, reforestation success, agricultural production, and water availability in tropical regions?

(4) What are the socio-economic and ecological costs and benefits (tradeoffs) of different forms of reforestation (natural regeneration, ecological restoration, commercial plantations, agroforestry) in tropical regions?

Network Partners

BONN CHALLENGE
on forests, climate change and biodiversity 2011

A World of Opportunity
for Forest and Landscape Restoration



FOREST AND LANDSCAPE RESTORATION OPPORTUNITIES

- Wide-scale restoration
- Mosaic restoration
- Remote restoration

OTHER AREAS

- Agricultural lands
- Recent tropical deforestation
- Urban areas
- Forest without restoration needs

THE GLOBAL PARTNERSHIP ON FOREST LANDSCAPE RESTORATION
WORLD RESOURCES INSTITUTE
South Dakota State University
IUCN
PROFOR
Forestry Commission

Thank you!

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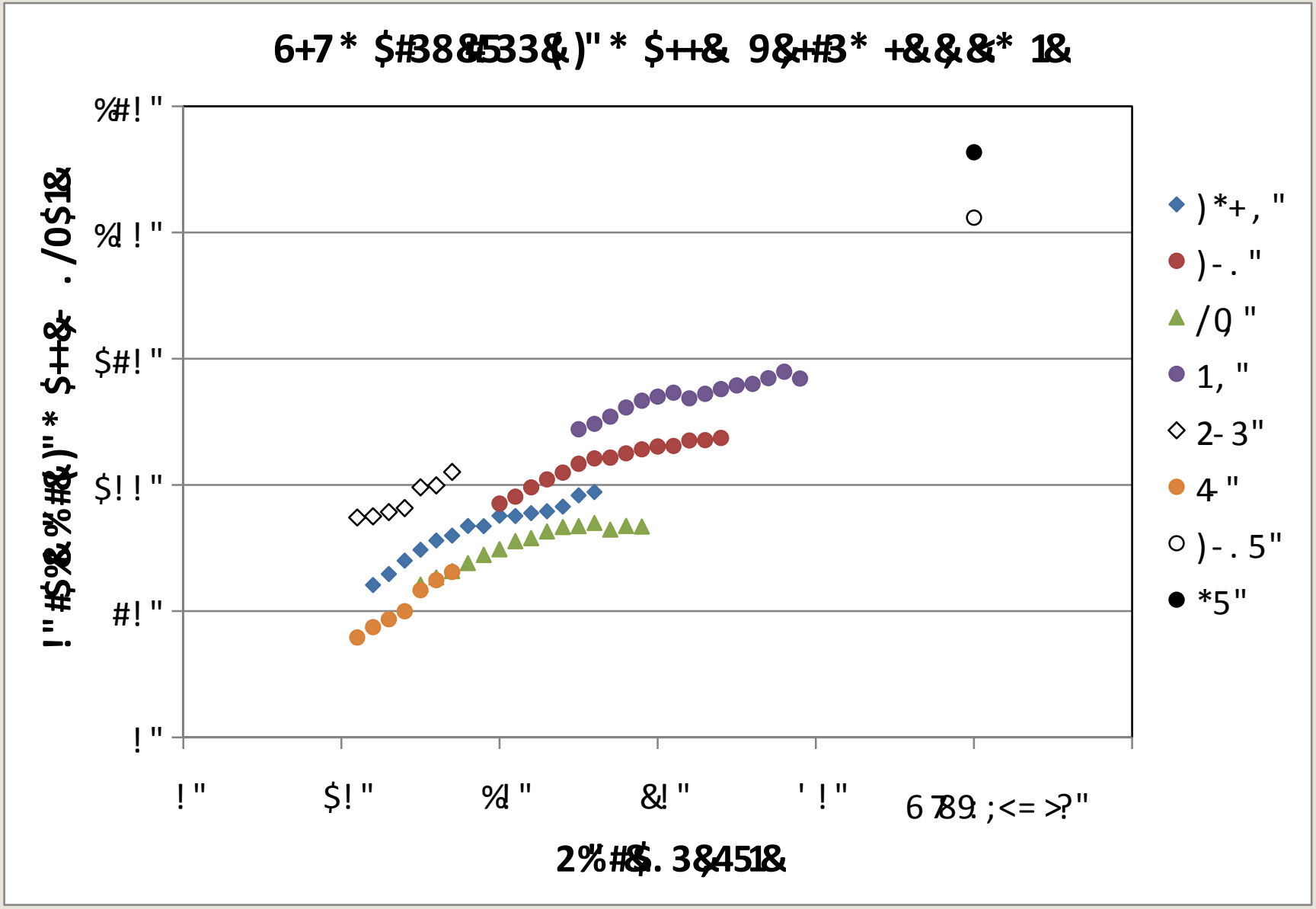
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