UN Decade on Ecosystem Restoration

At the request of El Salvador, on March 1st, 2019 the UN General Assembly declared that 2021-2030 would be the UN Decade on Ecosystem Restoration.

It aims to massively scale up the restoration of degraded and destroyed ecosystems as a proven measure to fight the climate crisis and enhance food security, water supply and biodiversity.

Ecosystem restoration provides multiple benefits but also incurs potential costs.

Identifying areas where these benefits can be jointly optimized at the same time that costs are minimized will increase the chances of restoration success.
Current Global Restoration Goals

- 15% of degraded lands (Aichi 15)
- 350 million hectares equivalent area of ecosystem restoration in one human generation

The fastest reshaping of land surface in human history
Current Global Restoration Goals

**SDG 15: Life on Land**

**TARGET 15.1**
Conserve and restore terrestrial and freshwater ecosystems.

**TARGET 15.2**
End deforestation and restore degraded forests.

**TARGET 15.3**
End desertification and restore degraded land.
Restoring landscapes for a sustainable future

Forest landscape restoration contributions to the SDGs can be grouped by the different benefits provided:

- Sustainable supply of forest-based products for energy, consumption and production
- Food security and health benefits
- Water security and healthy ecosystems
- Improved livelihoods, economic opportunities and jobs
- Gender equality and empowerment
- Climate change mitigation and adaptation
- Policy coherence and partnerships
SUMÁRIO PARA TOMADORES DE DECISÃO
Relatório Técnico sobre Restauração de Paisagens e Ecosistemas

GESTÃO INTEGRADA DA PAISAGEM

BENEFÍCIOS DA RESTAURAÇÃO

RESTAURAÇÃO DA VEGETAÇÃO NATIVA DE FORMA CUSTO-EFETIVA

EMPoderamento e IGUALDADE de gênero e raça

Bernardo B. N. Strassburg
Sustainable Development Goals (SDGs) in relation to forest/water relations

- **Demand sufficient water for 'development'**
  - 1 No Poverty
  - 2 Zero Hunger
  - 3 Good Health and Well-being
  - 6 Clean Water and Sanitation
  - 7 Affordable and Clean Energy
  - 8 Decent Work and Economic Growth
  - 9 Industry, Innovation and Infrastructure
  - 10 Reduced Inequalities
  - 11 Sustainable Cities and Communities
  - 12 Responsible Consumption and Production

- **Demand forest & water access for equity**
  - 4 Quality Education
  - 5 Gender Equality
  - 13 Climate Action
  - 14 Life Below Water
  - 15 Life on Land

**Balancing development and equity**

**Matching demand- and supply-side controls**

- **Forest/water interface with UNFCCC (SDG13)**
  - Paris Agreement climate change

- **Forest/water interface with UNCCD (SDG1+15)**
  - Bonn Challenge on forest landscape restoration

- **Forest/water interface with UN CBD (SDG14+15)**
  - Aichi Targets for biodiversity conservation

*Source: Authors’ own elaboration*
In 2013, Brazil approved its Native Vegetation Protection Law, resulting in legal requirements to restore 12 million hectares.

From 2013 to 2017, IIS coordinated an international multidisciplinary team to develop a tool to identify priority areas for restoration and quantify their impacts.

This tool should:

1. Be flexible, to integrate multiple criteria chosen by decision makers;
2. Be precise, identifying the exact priority areas for those criteria;
3. Be able to measure the impacts of the restoration in units decision makers can use (tonnes of CO2 sequestered, number of species extinctions avoided, monetary cost etc); quantify synergies and trade-offs.
A strategic approach to restoration planning

In 2017, we applied this tool for the first time to the Atlantic Forest in Brazil, a global biodiversity hotspot that already lost 80% of its original area and has a restoration target of approximately 5 million hectares;
These maps are going to be launched by the Brazilian government as official priority maps for restoration of the Atlantic Forest

In 2018, Brazil commissioned IIS to prepare similar analysis, priority maps and impact assessments for all six biomes of Brazil, to be used as official priority maps of restoration
In December 2018, the scientific journal Nature Ecology and Evolution published a scientific paper detailing this tool and its application for the Atlantic Forest, based on the scientific advances developed and usefulness for policy implementation;

In 2018, in collaboration with members of the Convention on Biological Diversity, the International Union for the Conservation of Nature (IUCN), among others, IIS applied its tool to produce the first global prioritization for restoration and assessment of the outcomes of global restoration targets.
Strategic approaches to restoring ecosystems can triple conservation gains and halve costs


International commitments for ecosystem restoration add up to one-quarter of the world’s arable land. Fulfilling them would ease global challenges such as climate change and biodiversity decline but could displace food production and impose financial costs on farmers. Here, we present a restoration prioritization approach capable of revealing these synergies and trade-offs, incorporating ecological and economic efficiencies of scale and modelling specific policy options. Using an actual large-scale restoration target of the Atlantic Forest hotspot, we show that our approach can deliver an eightfold increase in cost-effectiveness for biodiversity conservation compared with a baseline of non-systematic restoration. A compromise solution avoids 26% of the biome’s current extinction debt of 2,864 plant and animal species (an increase of 257% compared with the baseline). Moreover, this solution sequesters 1 billion tonnes of CO₂-equivalent (a 105% increase) while reducing costs by US$28 billion (a 57% decrease). Seizing similar opportunities elsewhere would offer substantial contributions to some of the greatest challenges for humankind.
A strategic approach to restoration planning – Going Global

- First global prioritisation effort
- 2.9 billion hectares of restorable lands identified
- Inclusion of forests, grasslands, shrublands, wetlands, deserts
- Individual focus for 22,431 species, estimates of conservation impact for them; IUCN -> ESH
- Estimates of carbon sequestration (ABGB + soil C)
- Estimates of agriculture opportunity costs
- Aichi Targets 15, NDCs, Bonn Challenge, NY Declaration on Forests
- Multiple collaborators
A strategic approach to restoration planning – Going Global

Restoration only back to original ecosystem type (no forests into grasslands...)

Estimates of original natural cover

Forests

Shrublands

Wetlands

Grasslands

Deserts and semi-deserts

[Embargoed]
Validation using 25 years of observed data vs estimated RMSE=6.73%
Global priority areas for restoration – Focus on Biodiversity only

[Bernardo B. N. Strassburg]
Global priority areas for restoration – Focus on Carbon only

[Embargoed]
Global priority areas for restoration – Focus on Minimising opportunity costs only

[Embargoed]
Global priority areas for restoration – Multicriteria (inc costs)

[Embargoed]
Huge differences in outcomes for the same area target, depending on where restoration takes place.

(Example: The same 5% target can reduce extinctions by 4% or by 43%)

**Multiple restoration goals – the importance of Where**
Huge differences in outcomes for the same area target, depending on where restoration takes place.

(Example: The same reduction in extinctions would require 5% or 35% of the world's converted lands.)

Bernardo B. N. Strassburg
Restoration is a very powerful tool for global challenges, with Aichi Target 15 resulting in major gains for:

i) biodiversity conservation (saving up to 67% of species)

ii) offering major contributions for climate change mitigation (327 bill. tCO2, 91% of remaining budget for 1.5°C) and adaptation, (cost-effective, <USD10-15/tCO2)

iii) land degradation

Quantifying outcomes and trade-offs (Aichi 15)
Quantifying outcomes and trade-offs (Aichi 15)

Biodiversity focused delivers 70% of Max Carbon

Climate focused delivers 61% of max biodiversity

Multicriteria delivers 94% (Biodiversity) and 91% (Carbon)
Quantifying outcomes and trade-offs (Aichi 15)

Focusing on minimising costs provides very weak environmental outcomes.
Including costs in the optimisation reduces absolute benefits for biodiversity and climate, but increase cost-effectiveness.
Reaching the 15% restoration target within national boundaries reduces further the global benefits, but costs remain approximately constant.

Potential for international win-win collaborations.
Global x National level priorities
Relative importance of different biomes
Relative importance of different biomes
Global maximum single benefit scenarios:

**Biodiversity**

<table>
<thead>
<tr>
<th>Reduction in Global Extinctions</th>
<th>CO2 Sequestered (Billions Tonnes)</th>
<th>Costs (USD / hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>67%</td>
<td>231</td>
<td>5,588</td>
</tr>
</tbody>
</table>
Global maximum single benefit scenario:

**Climate**

<table>
<thead>
<tr>
<th>Reduction in Global Extinctions</th>
<th>CO2 Sequestered (Billions Tonnes)</th>
<th>Costs (USD / hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41%</td>
<td>326</td>
<td>5,538</td>
</tr>
</tbody>
</table>

[Embargoed]
Global maximum single benefit scenario:

**Climate**

<table>
<thead>
<tr>
<th>Reduction in Global Extinctions</th>
<th>CO2 Sequestered (Billions Tonnes)</th>
<th>Opportunity Costs (USD / hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41%</td>
<td>326</td>
<td>5,538</td>
</tr>
</tbody>
</table>

**CO2 emissions [tons/sec]**

- **1.5°C scenario**
  - CO2 budget left [tons]: 357'049'405'658
  - Year: 2025, Month: 05, Day: 29, Hour: 18, Minute: 42, Second: 88

**Bernardo B. N. Strassburg**
Global Opportunity cost scenario

Reduction in Global Extinctions | CO2 Sequestered (Billions Tonnes) | Costs (USD / hectare)
---|---|---
13% | 122 | 2,682
Global Compromise scenario

<table>
<thead>
<tr>
<th>Reduction in Global Extinctions</th>
<th>CO2 Sequestered (Billions Tonnes)</th>
<th>Costs (USD / hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>59%</td>
<td>271</td>
<td>4,213</td>
</tr>
</tbody>
</table>
Restoration in spared lands

Rainfed yield gaps

- Closing 75% of yield gaps
- Maintaining current agricultural production
- Restoring on spared lands
- If implemented at landscape level
  - 90% of Biodiversity and 76% of Climate
- If implemented an country level
  - 96% of both Biodiversity and Climate

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Restoration in spared lands

- Closing 75% of yield gaps
- Maintaining current agricultural production
- Restoring on spared lands

At the global level, 55% of current agricultural lands could be restored without compromising agricultural production (1.4 billion hectares)

Bernardo B. N. Strassburg
Cost-effectiveness of restoration for climate mitigation
For each 300m pixel

**Biodiversity Impact**
- List of species protected
- Red List Classification
- Reduction in Extinctions

**Climate Change Impact**
- Tonnes of CO2Eq Sequestered per hectare restored

**Opportunity Costs**
- Quantity and value of agricultural production displaced ($/hectare)

Prioritisation can be focused on
- Farms
- Microwatersheds
- Municipalities
- Provinces
- Countries
- Regions
- Globe
Biodiversity
Some LatAm results

<table>
<thead>
<tr>
<th>Country</th>
<th>Area available (km²)</th>
<th>Priority areas (km²)</th>
<th>% of area available that is top global priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>2,435,604</td>
<td>494,046</td>
<td>20%</td>
</tr>
<tr>
<td>Mexico</td>
<td>461,592</td>
<td>201,075</td>
<td>44%</td>
</tr>
<tr>
<td>Colombia</td>
<td>165,905</td>
<td>121,684</td>
<td>73%</td>
</tr>
<tr>
<td>Peru</td>
<td>123,411</td>
<td>82,491</td>
<td>67%</td>
</tr>
<tr>
<td>Argentina</td>
<td>657,091</td>
<td>76,497</td>
<td>12%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>183,308</td>
<td>67,483</td>
<td>37%</td>
</tr>
<tr>
<td>Cuba</td>
<td>57,954</td>
<td>57,619</td>
<td>99%</td>
</tr>
<tr>
<td>Ecuador</td>
<td>41,532</td>
<td>40,824</td>
<td>98%</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>42,649</td>
<td>40,055</td>
<td>94%</td>
</tr>
<tr>
<td>Guatemala</td>
<td>33,653</td>
<td>32,903</td>
<td>98%</td>
</tr>
<tr>
<td>Bolivia</td>
<td>109,469</td>
<td>28,014</td>
<td>26%</td>
</tr>
<tr>
<td>Honduras</td>
<td>27,427</td>
<td>26,381</td>
<td>96%</td>
</tr>
<tr>
<td>Panama</td>
<td>23,210</td>
<td>21,833</td>
<td>94%</td>
</tr>
<tr>
<td>Dominican Rep.</td>
<td>21,373</td>
<td>20,309</td>
<td>95%</td>
</tr>
<tr>
<td>Haiti</td>
<td>18,749</td>
<td>16,057</td>
<td>86%</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>13,696</td>
<td>13,654</td>
<td>100%</td>
</tr>
<tr>
<td>Chile</td>
<td>52,781</td>
<td>11,706</td>
<td>22%</td>
</tr>
<tr>
<td>Paraguay</td>
<td>98,139</td>
<td>11,269</td>
<td>11%</td>
</tr>
<tr>
<td>El Salvador</td>
<td>4,851</td>
<td>4,736</td>
<td>98%</td>
</tr>
<tr>
<td>Uruguay</td>
<td>35,000</td>
<td>3,855</td>
<td>11%</td>
</tr>
<tr>
<td>Belize</td>
<td>3,069</td>
<td>3,067</td>
<td>100%</td>
</tr>
<tr>
<td>Jamaica</td>
<td>2,701</td>
<td>2,690</td>
<td>100%</td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>1,130</td>
<td>1,109</td>
<td>98%</td>
</tr>
<tr>
<td>Suriname</td>
<td>923</td>
<td>330</td>
<td>36%</td>
</tr>
<tr>
<td>Guyana</td>
<td>3,165</td>
<td>234</td>
<td>7%</td>
</tr>
<tr>
<td>Barbados</td>
<td>229</td>
<td>215</td>
<td>94%</td>
</tr>
<tr>
<td>Bahamas</td>
<td>181</td>
<td>135</td>
<td>75%</td>
</tr>
<tr>
<td>Antigua and Barb.</td>
<td>132</td>
<td>125</td>
<td>95%</td>
</tr>
<tr>
<td>St. Kitts and Nevis</td>
<td>46</td>
<td>45</td>
<td>100%</td>
</tr>
<tr>
<td>Saint Lucia</td>
<td>32</td>
<td>32</td>
<td>100%</td>
</tr>
<tr>
<td>St. Vin. and Gren.</td>
<td>22</td>
<td>22</td>
<td>100%</td>
</tr>
<tr>
<td>Grenada</td>
<td>16</td>
<td>16</td>
<td>100%</td>
</tr>
<tr>
<td>Dominica</td>
<td>2</td>
<td>2</td>
<td>100%</td>
</tr>
</tbody>
</table>
Key messages

• Strategic approaches can provide an eightfold increase in conservation cost-effectiveness.
• *Where* restoration happens makes a vast difference for its costs and benefits
• Spatial optimisation, Natural regeneration and Project Size play a key role in reducing restoration costs, if its potential is taken into consideration when planning restoration indicatives; Reduction of over 60% in costs
• Revenues can also be generated, and synergies with agriculture production (pollination, water, soil conservation)
• Our flexible tool can be applied at any resolution, using multiple criteria, identify and measure the impacts of restoration prioritisation, to offer support for decision makers
Next steps

• Ongoing conversations with the CBD and other partners to provide support to countries, NGOs, businesses with a decision support assisted platform for integrating restoration with conservation and land-use planning Capacity building

• Partnership with NatureMaps (UNSDSN, IIASA, UNEP-WCMC & IIS) to apply our algorithm to priority maps for restoration;

• Integrated analysis with Marine and Freshwater systems, inc. associated telecouplings

• Ongoing implementation at country, state, city and farm levels, with custom benefits and costs

Bernardo B. N. Strassburg
Also, for your information, the International Institute for Sustainability will host a workshop on 5 November 2019, in Rio de Janeiro, for selected participants to interact with its restoration planning platform that includes integrated spatial planning and estimates of impacts for species conservation and climate change mitigation. Interested Parties are encouraged to nominate experts to attend this workshop.

Please accept, Madam/Sir, the assurances of my highest consideration.

Cristiana Pașca Palmer, PhD
Executive Secretary
TEEB: Paraíba do Sul River Basin – São Paulo State

**BAU (Business As Usual)**
- No forest restoration

**LC (Legal Compliance)**
- Forest restoration scattered across the landscape

**SS (Sustainable Scenario)**
- Forest restoration seeking connectivity landscape

The Economics of Biodiversity

InVEST: integrated valuation of ecosystem services and tradeoffs

Bernardo B. N. Strassburg
Biophysical and ecological valuation: Pollination

• Almost 90% of plant species require some animal pollinator
• About 1/3 of world agricultural production depends on pollinators
• Agricultural yield, quality and stability
• Human nutritional quality (IPBES 2016)
Biophysical and ecological valuation: Pollination

InVest

• Focused on wild bees - main pollinators in natural ecosystems and essential for many crops (Kremen and Chaplin-Kramer 2007).
• The model is based on estimates of nesting places and floral resources availability and on the flight capacity of bees.

Inputs:
• Land use and coverage maps
• Landscape Parameter Table
• Pollinator table

Outputs:
• Abundance Index
• Visitation Potential
Biophysical and ecological valuation: Pollination
Biophysical and ecological valuation: Pollination
Biophysical and ecological valuation: Pollination

Production yield (IBGE) \( \times \) Pollinator dependence on crop (Giannini et al 2015) \( \times \) Visitation potential

What is the impact on production in different scenarios?
Restoration and Water Quality - Sedimentation

Legal Compliance

Sustainable Scenario

Comparisons

Forest Cover (millions of ha)

Soil Loss (t/ha/y)

Sediment Exportation (t/ha/y)

Forest cover; Very Low, Low, Medium, High, Very High

InVEST
integrated valuation of ecosystem services and tradeoffs
Restoration and Groundwater Recharge
Restoration and Water Quality - Pollution
Restoration and Rain

Precipitation Changes (mm)

Dib et al., in prep.
Bernardo B. N. Strassburg
Estimating benefits via:

- Job creation in restoration projects
- Income generation in sustainable forest management
Plano Nacional de Recuperação da Vegetação Nativa

Brasília, 2017
Agroforestry and Landscape Restoration

TARGET 2.4

Sustainable food production and resilient agricultural practices

Bernardo B. N. Strassburg

Tubenchlak et al, in press
Ecosystem-based Adaptation

**EbA Plan**

- Increase Protection
- Strengthening Management
- Poverty Alleviation
- Infrastructure and Land Use planning
- Participative Management
- Natural Capital Restoration
- Recognition and valuation of carbon stocks
- Prevention, integration, and strengthening of protected areas
- Promotion of social biodiversity products
- Promotion of important local transfer chains (eco-toursism)
- Capacity Building
- Priority of river basin governance
- Sustainable infrastructure
- Support to implementation
- Prioritize conservation areas
- Fiscal incentives
- Social environmental incentives

**Figure kindly provided by Thais P. Kasecker**

**Social vulnerability**

**Extreme weather events**

**Land use**
Economic Analysis of the Restoration supply chain in Central Rio de Janeiro State

- Socio-ecological diagnosis
- Economic valuation of different restoration models, including agroforestry systems
Economic Analysis of the Restoration supply chain in Central Rio de Janeiro State

- Spatial allocation of the different models according to ecological, social and economic factors: natural regeneration potential, ecological connectivity, opportunity costs, labour availability, and food demand;
- Niche models for native tree species
Key Messages

• Restoration is a very powerful tool for global challenges and SDGs, with Aichi Target 15 resulting in major gains for
  i) biodiversity conservation (saving up to 67% of species)
  ii) offering major contributions for climate change mitigation (326 bill. tCO2, 91% of remaining budget for 1.5C) and adaptation, (cost-effective, <USD10-15/tCO2)

• Trade-offs and very strong synergies among Rio conventions, SGDs - integrated systems analyses can illuminate, map, quantify and offer actionable evidence
Thank you

Systems Analysis and the Americas
2019

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