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RIO CONSERVATION AND SUSTENTABILITY SCIENCE CENTRE

# Global opportunities, priority areas and impacts of restoration

## Rio Coventions Pavilion
## CBD COP14

**Bernardo B. N. Strassburg**

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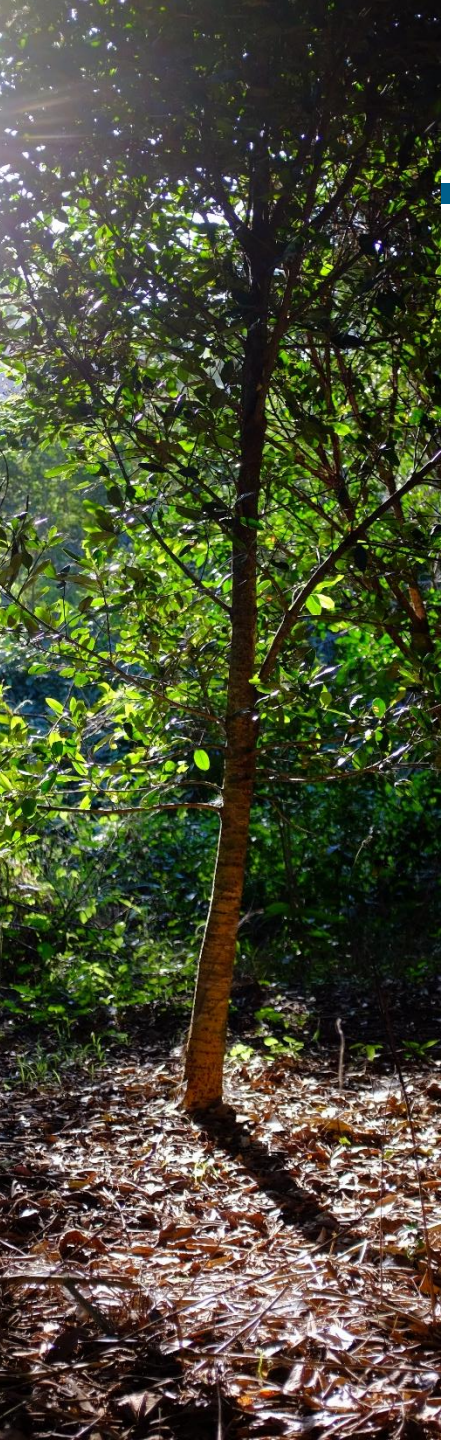


# About the International Institute for Sustainability

IIS

- An independent research organisation based in Rio de Janeiro

- Focused on providing research, capacity building and tools to support the understanding and implementation of policy related to:
  - biodiversity conservation;
  - climate change mitigation;
  - land degradation; and
  - associated sustainable development challenges

- Has provided the UNFCCC, CBD, several national and local governments support on these topics since 2009.

- Co-led the development of Brazil's National Restoration Plan, Executing Agency of a 2018-2023 GEF project with UNEnv

Convention on Biological Diversity

ipbes Science and Policy for People and Nature

United Nations Climate Change

gef

UN environment United Nations Environment Programme

# A strategic approach to restoration planning - Introduction

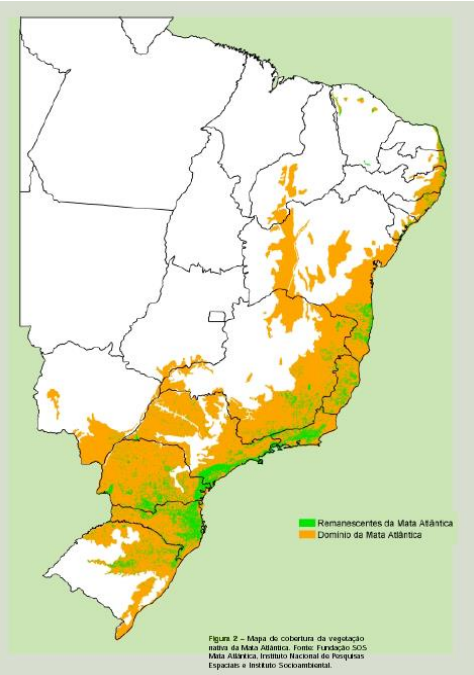
In 2013, Brazil approved its Native Vegetation Protection Law, resulting in legal requirements to restore 12 million hectares.

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);

# A strategic approach to restoration planning - Introduction




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 governement as official priority maps for restoration of the Atlantic Forest

**In 2018, Brazil comissioned IIS to prepare similar analysis, prioritity maps and impact assessments for all six biomes of Brazil, to be used as official priority maps of restoration**

# A strategic approach to restoration planning - Introduction

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In 2018, the scientific journal *Nature Ecology and Evolution* accepted a scientific paper detailing this tool and its application for the Atlantic Forest, based on the scientific advances developed and usefulness for policy implementation; The academic paper will be published in December 2018

**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**

# A first application: Brazil's Atlantic Forest

nature ecology & evolution

ARTICLES

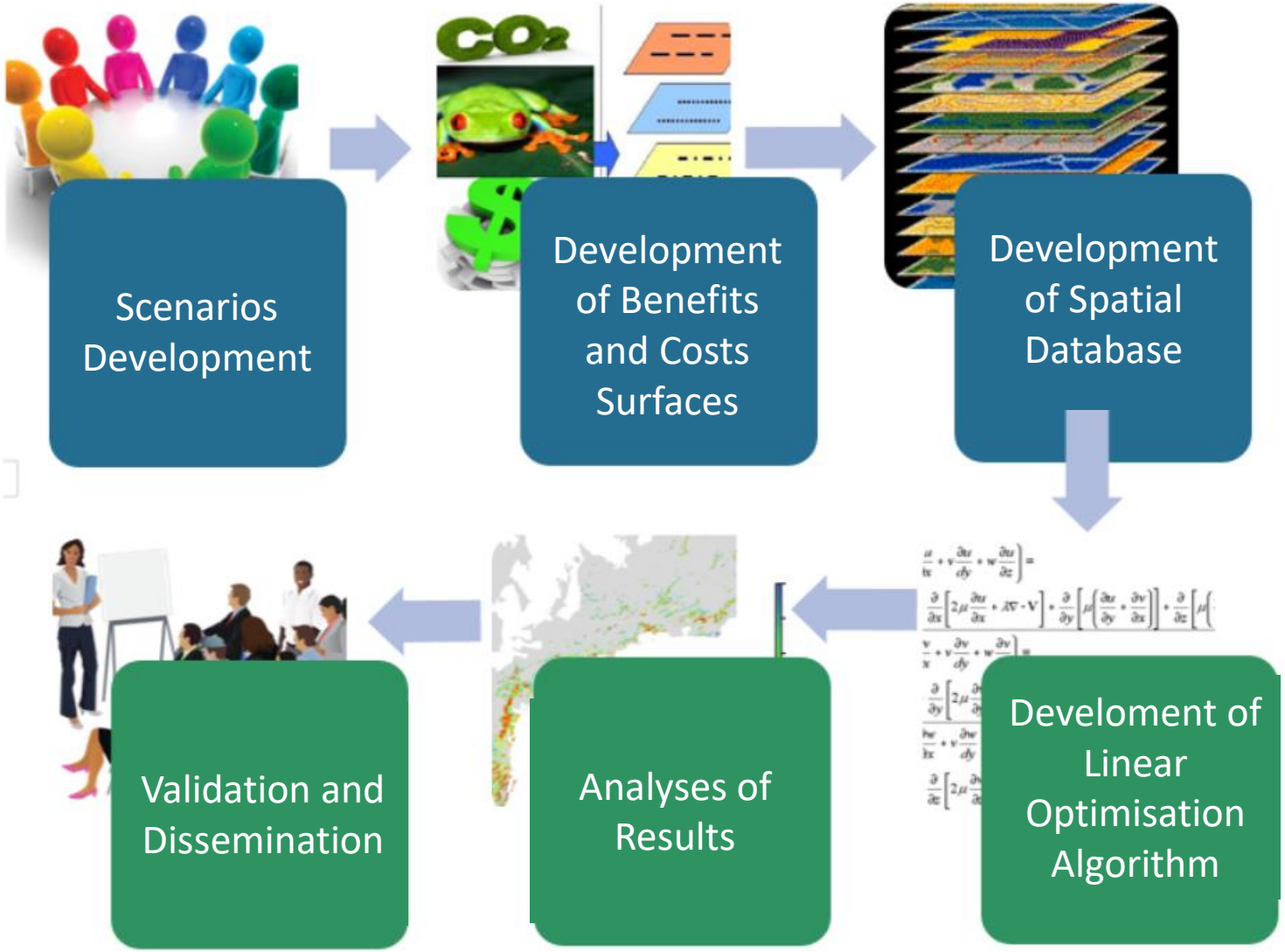
https://doi.org/10.1038/s41559-018-0743-8

## Strategic approaches to restoring ecosystems can triple conservation gains and halve costs

Bernardo B. N. Strassburg[1,2,3*], Hawthorne L. Beyer[4], Renato Crouzeilles[1,2,3], Alvaro Iribarrem[1,2], Felipe Barros[2], Marinez Ferreira de Siqueira[5], Andrea Sánchez-Tapia[5], Andrew Balmford[6], Jerônimo Boelsums Barreto Sansevero[7], Pedro Henrique Santin Brancalion[8], Eben North Broadbent[9], Robin L. Chazdon[2,10,11], Ary Oliveira Filho[12], Toby A. Gardner[2,13], Ascelin Gordon[14], Agnieszka Latawiec[1,2,15,16], Rafael Loyola[17], Jean Paul Metzger[18], Morena Mills[19], Hugh P. Possingham[20,21], Ricardo Ribeiro Rodrigues[22], Carlos Alberto de Mattos Scaramuzza[23], Fabio Rubio Scarano[3,24], Leandro Tambosi[25] and Maria Uriarte[26]

**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 $CO_2$-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 – Methodology



# A strategic approach to restoration planning – Context

First large scale application of Interger Linear Programming to planning of large-scale restoration.

Four important advantages:

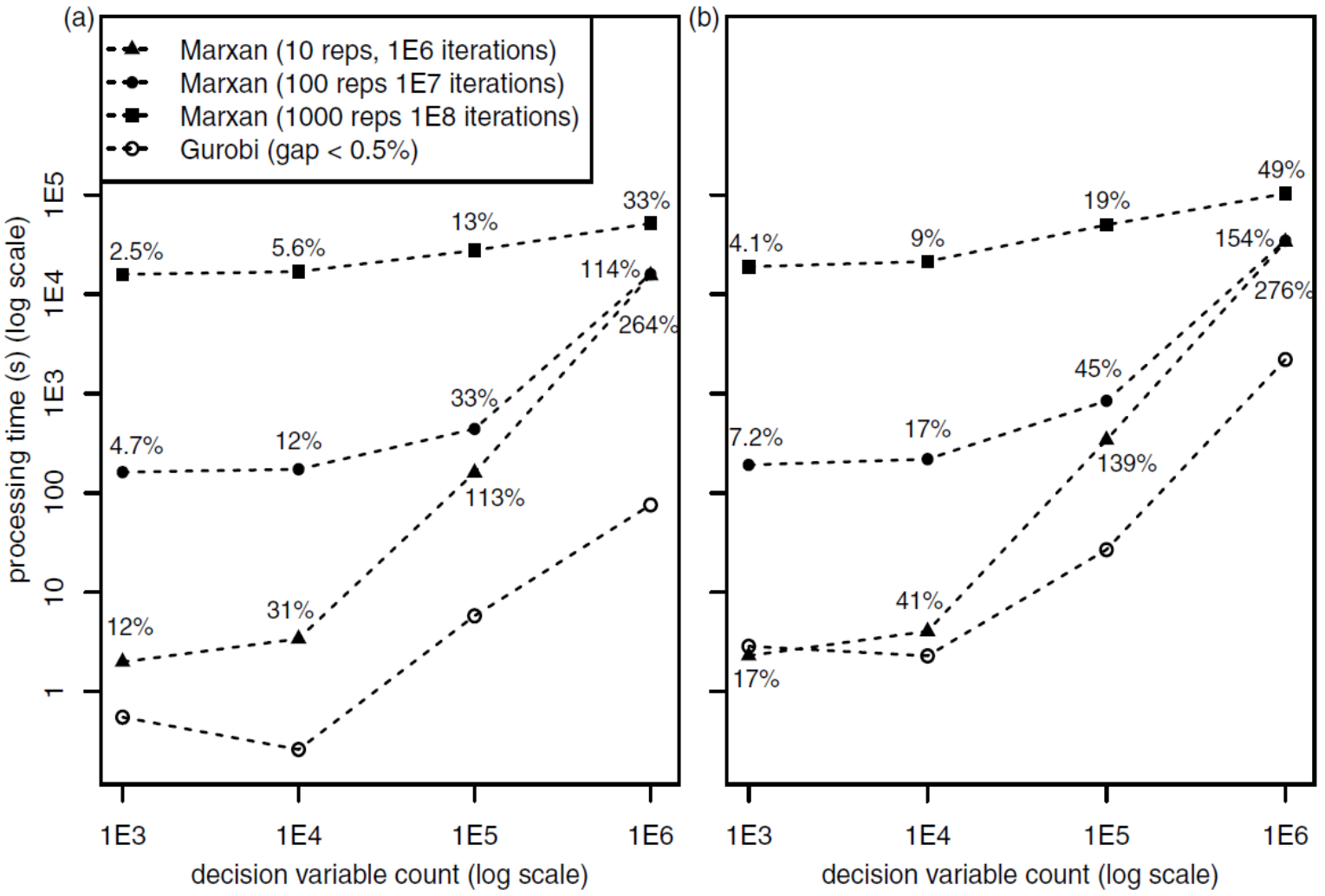
1. **Capable of finding exact solutions to the optimization problem**

2. **Dynamic feedbacks;**

3. **Full customisation;**

4. **Processing time**

# A strategic approach to restoration planning – Methodology




## 1. Capable of finding exact solutions to the optimization problem

Using LP, our algorithm is **capable of finding exact solutions to the optimization problem**. This solution is at least 30% more efficient than alternative packages commonly used internationally (e.g. Marxan and Zonation, both approximations of optimal solutions).

# A strategic approach to restoration planning – Methodology

What **33%** difference in efficiency means at the Atlantic Forest scale:

450 million tonnes of extra tonnes of CO2 sequestered

308 less extinctions of plants and animals


USD 4 billion reduction in costs

# A strategic approach to restoration planning – Methodology

**2. Dynamic feedbacks**

As we restore in interactive steps, each new optimisation takes into account changes in forest cover from previous alocation rounds;

**3. Full customisation**

If the relationship between restoring a given area and its marginal contribution for a given goal can be represented as a function, it can be incorporated into our approach. The same flexibility allows for incorporating complex scenarios developed by stakeholders, and for weighting the relative importance of individual costs and benefits.

# A strategic approach to restoration planning – Methodology

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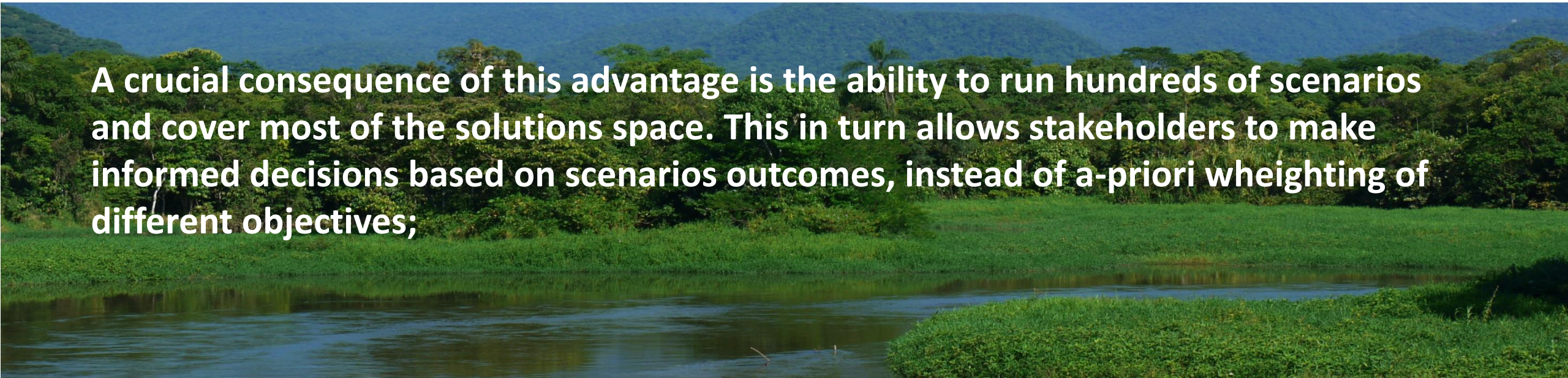
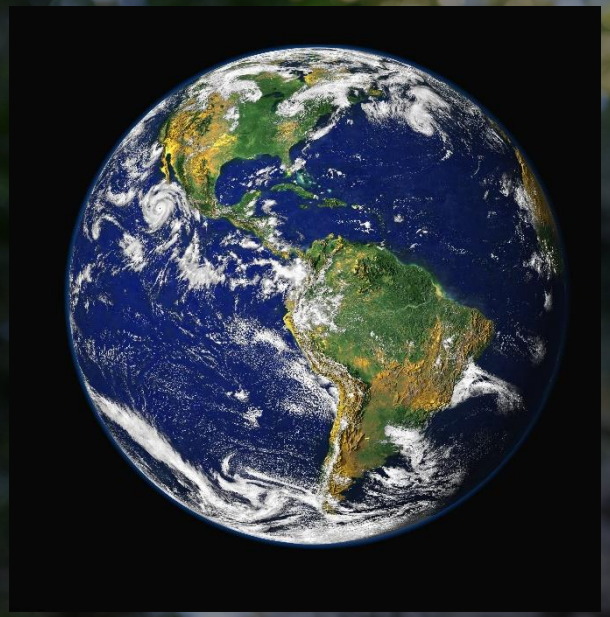
## 4. Processing time

Using LP, it took **1,5**hrs to process **150** scenarios for **1,3** million planning units. The same exercise using Marxan, for instance, would take **90** days.



**A crucial consequence of this advantage is the ability to run hundreds of scenarios and cover most of the solutions space. This in turn allows stakeholders to make informed decisions based on scenarios outcomes, instead of a-priori wheighting of different objectives;**

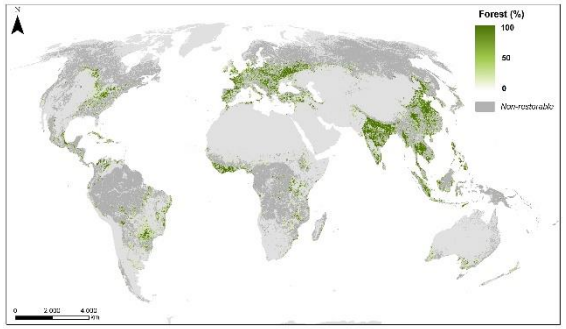
# A strategic approach to restoration planning – Going Global

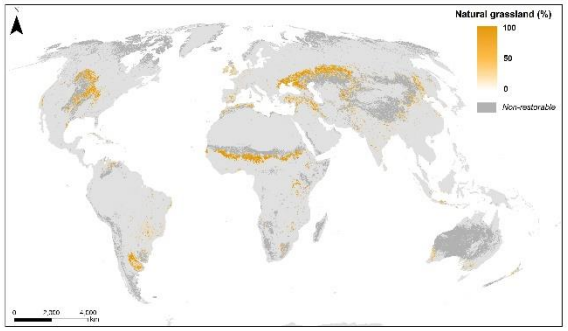


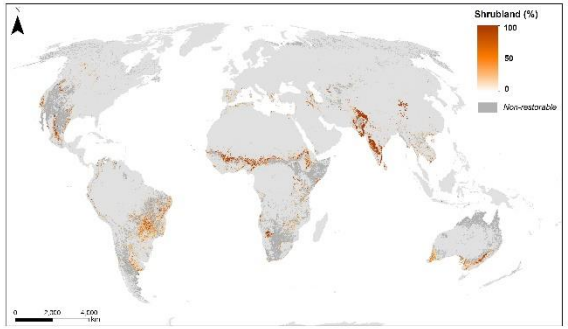
- First global prioritisation effort
- 2.9 billion hectares of restorable lands identified
- Inclusion of forests, grasslands, shurblands, wetlands, deserts
- Individual focus for 22,431 species, estimates of conservation impact for them
- Estimates of carbon sequestration
- Estimates of agriculture opportunity costs
- Aichi Tragets 15, NDCs, Bonn Challenge, NY Declaration on Forests

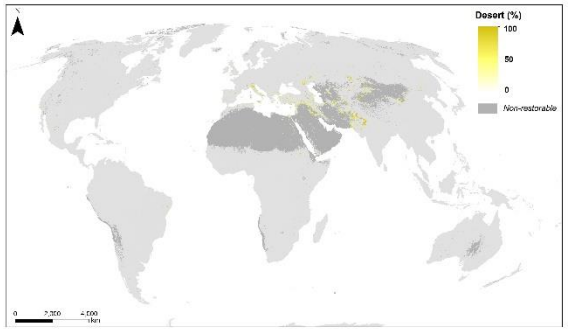
# A strategic approach to restoration planning – Going Global

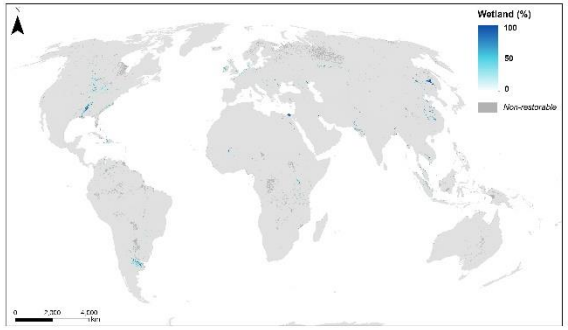
[Embargoed]




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

Estimates of original natural cover

Forests

Shrublands

Wetlands

Grasslands

Desert

# Global priority areas for restoration – Focus on Biodiversity only

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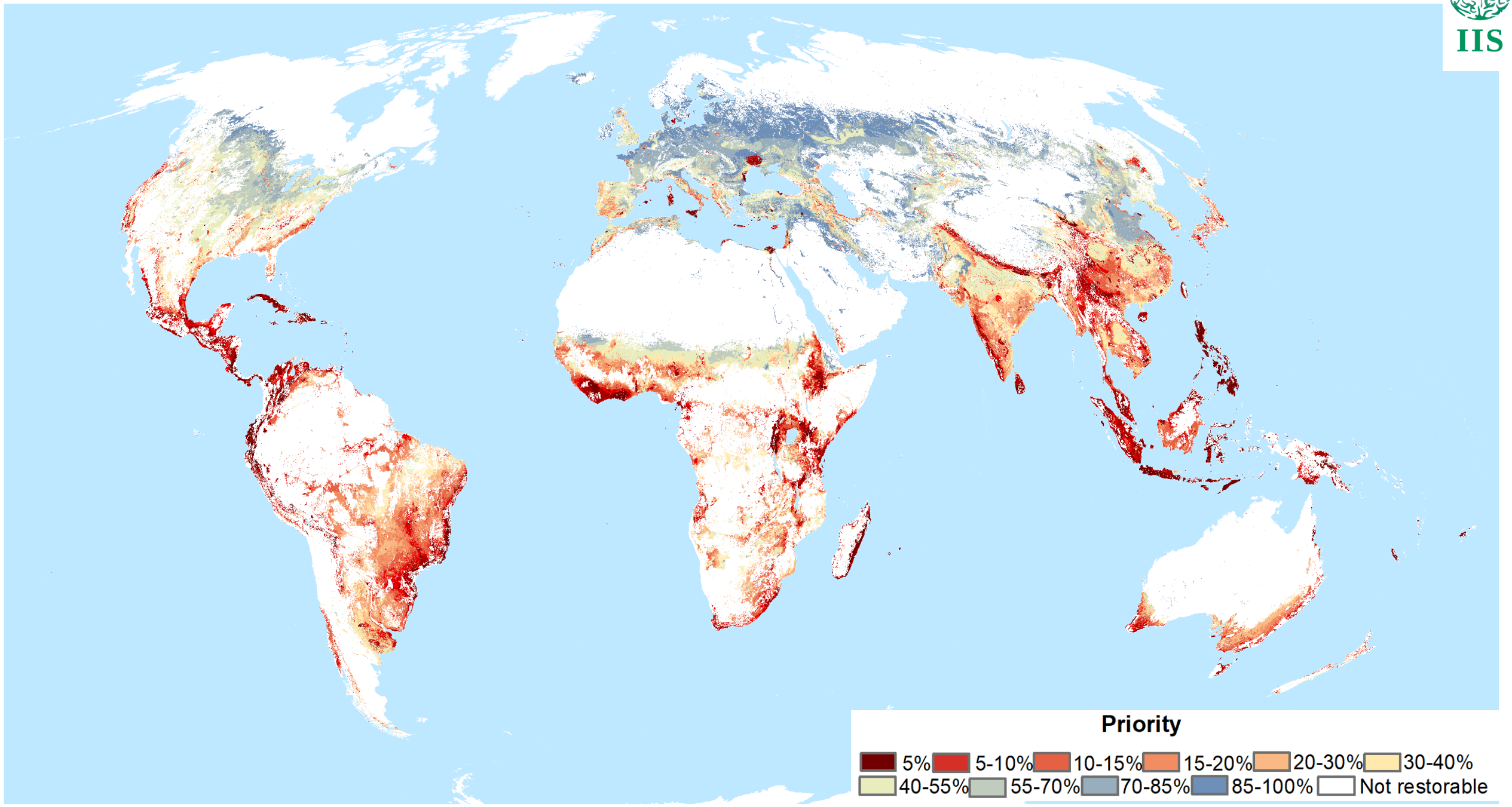

# Global priority areas for restoration – Focus on Carbon only

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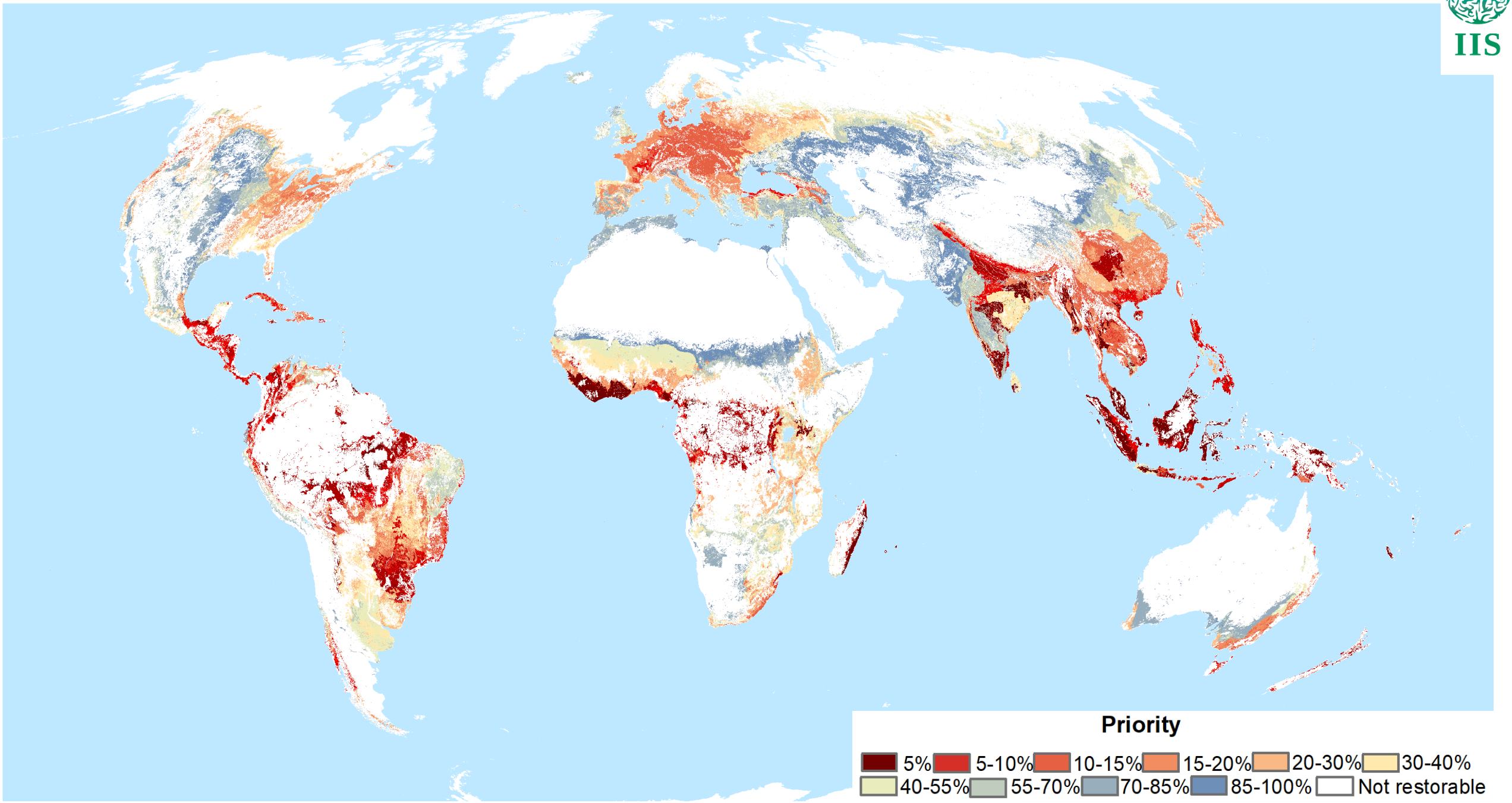

# Global priority areas for restoration – Focus on Minimising opportunity costs only

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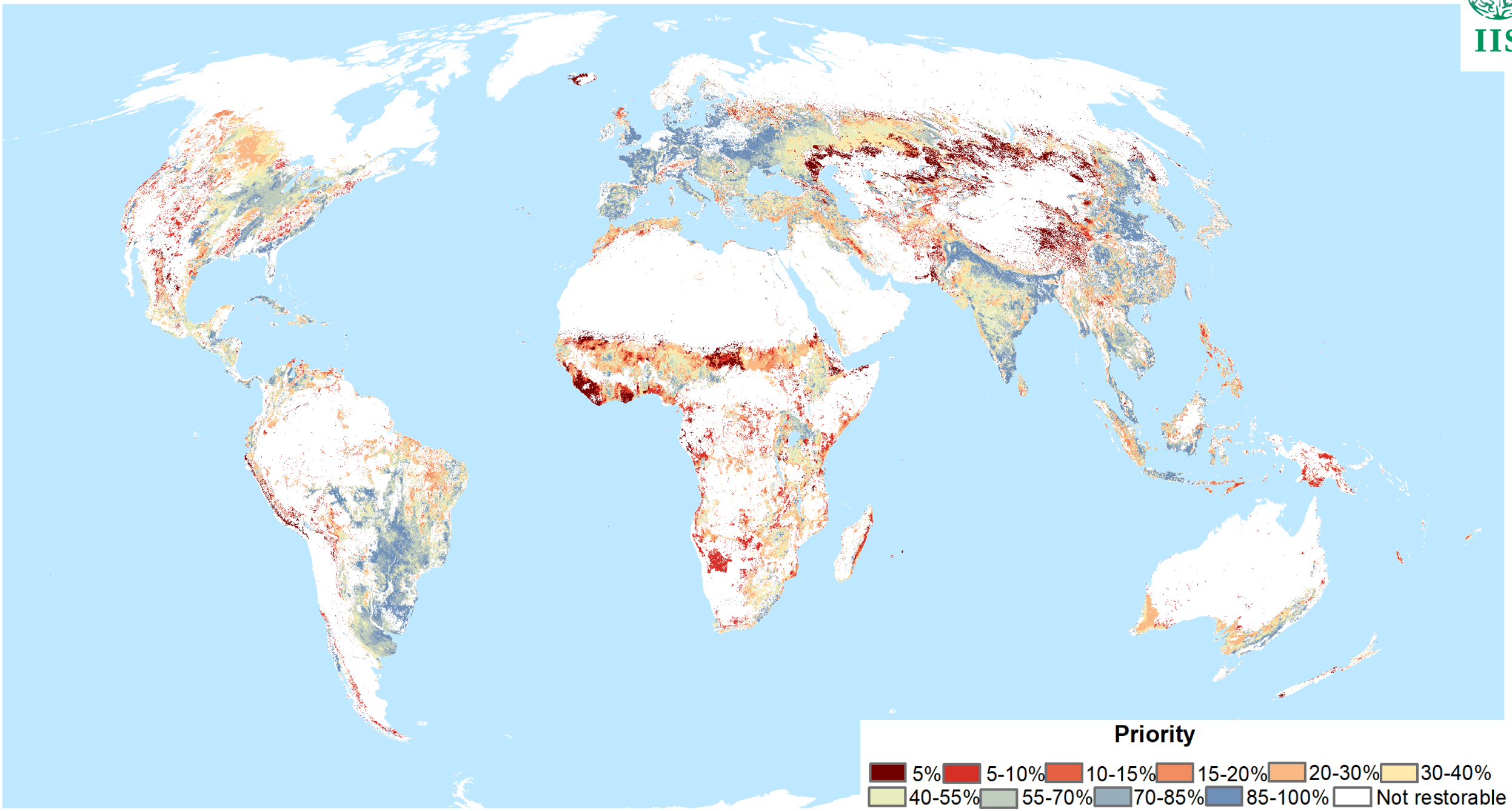

# Global priority areas for restoration – Multicriteria (inc costs)

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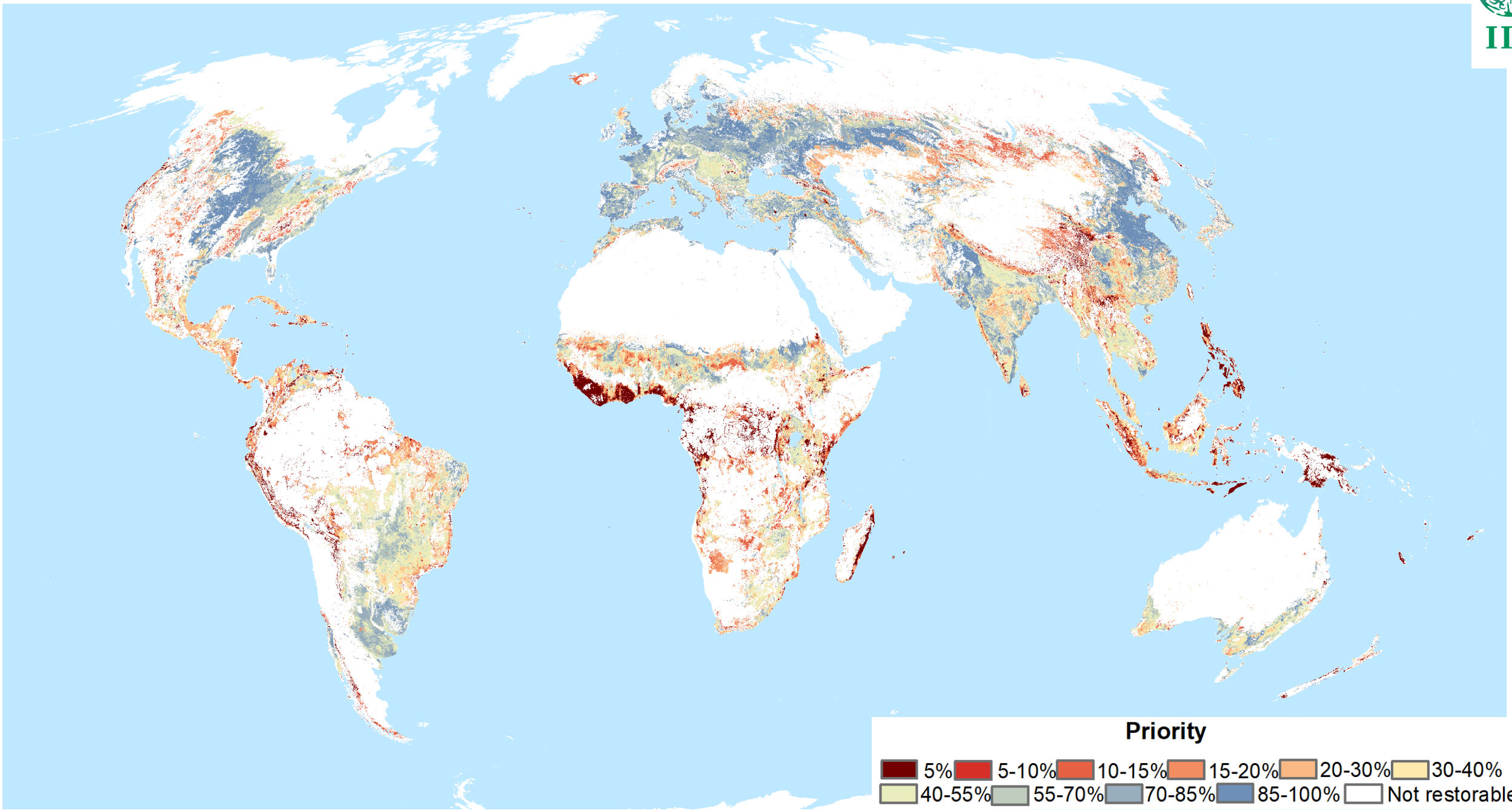
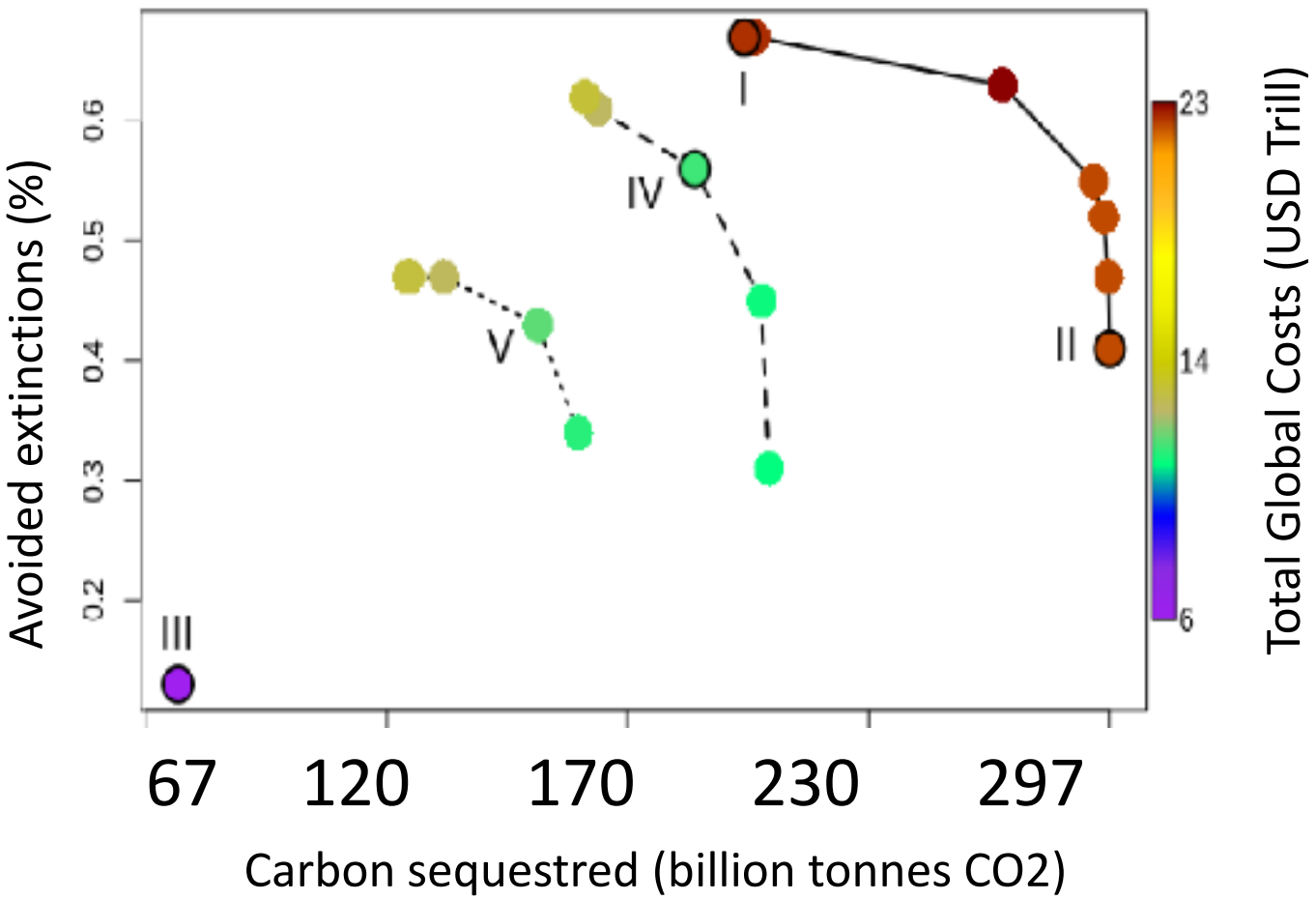


# Aichi Target 15 - Outcomes for multiple goals, in multiple scenarios



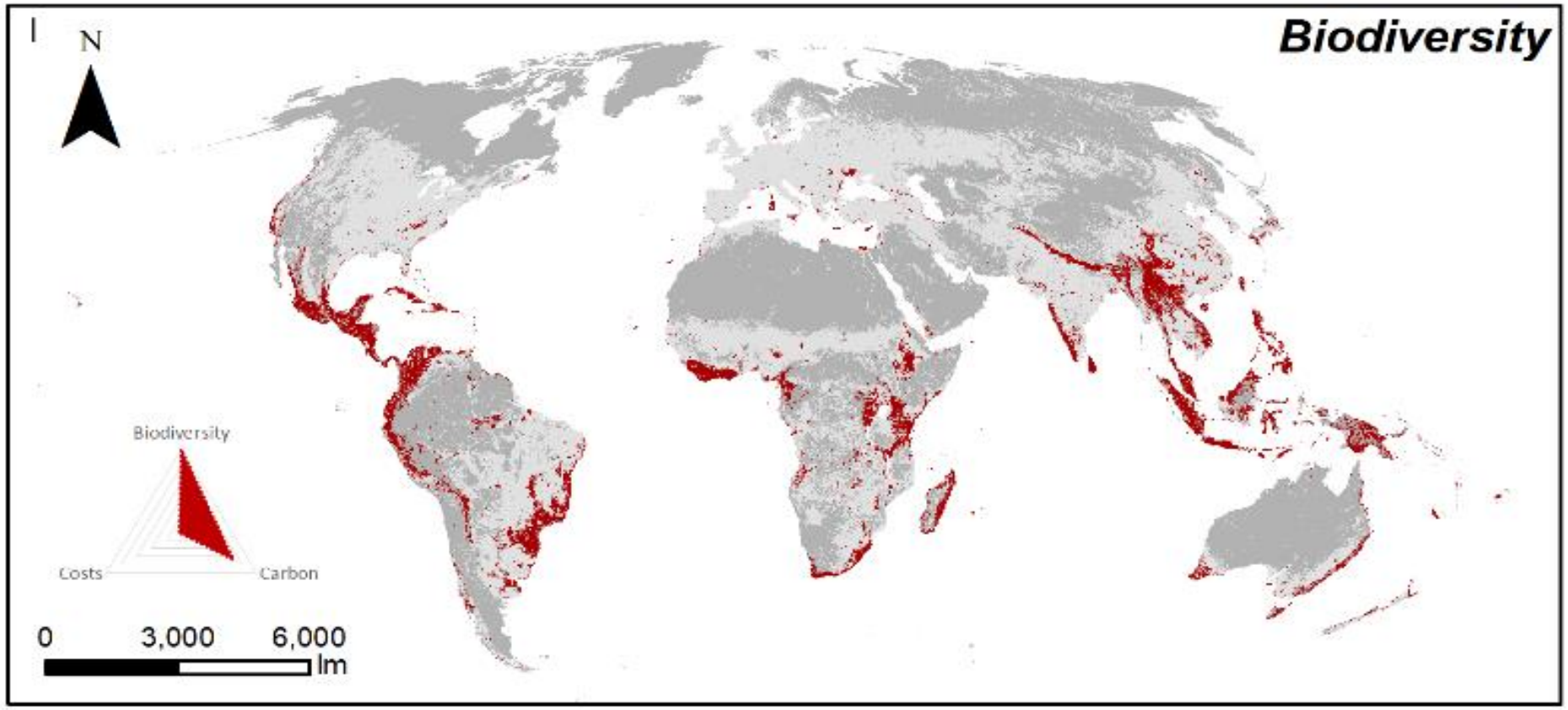

Restoration is a very powerful tool for global challenges, with Aichi Target 15 resulting in major gains for:

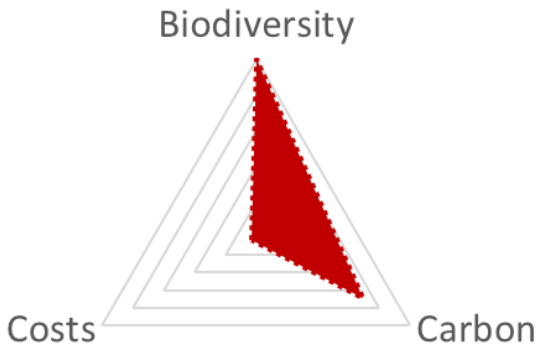
**i)biodiversity conservation (saving up to 67% of species)**

**ii)offering major contributions for climate change mitigation (297 bill. tCO2, half of remaning budget for 2C) and adaptation, (cost-effective, <USD10-15/tCO2)**

**iii) land degradation**

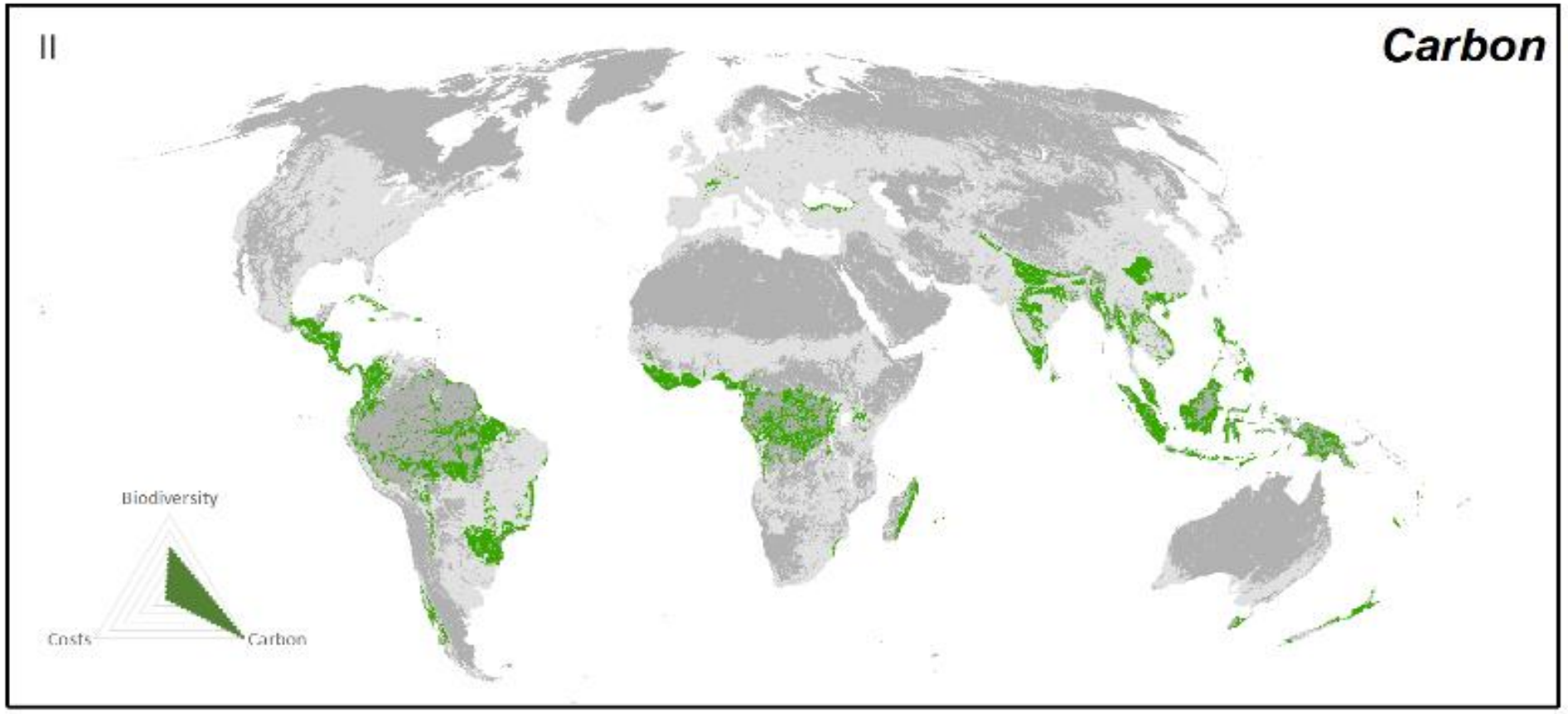
# Global maximum single benefit scenarios: Biodiversity

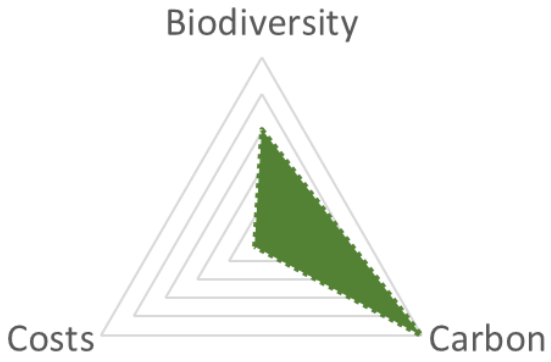



| Reduction in Global Extinctions | CO2 Sequestered (Billions Tonnes) | Opportunity Costs (USD / hectare) |
|---|---|---|
| 67% | 207 | 5,279 |

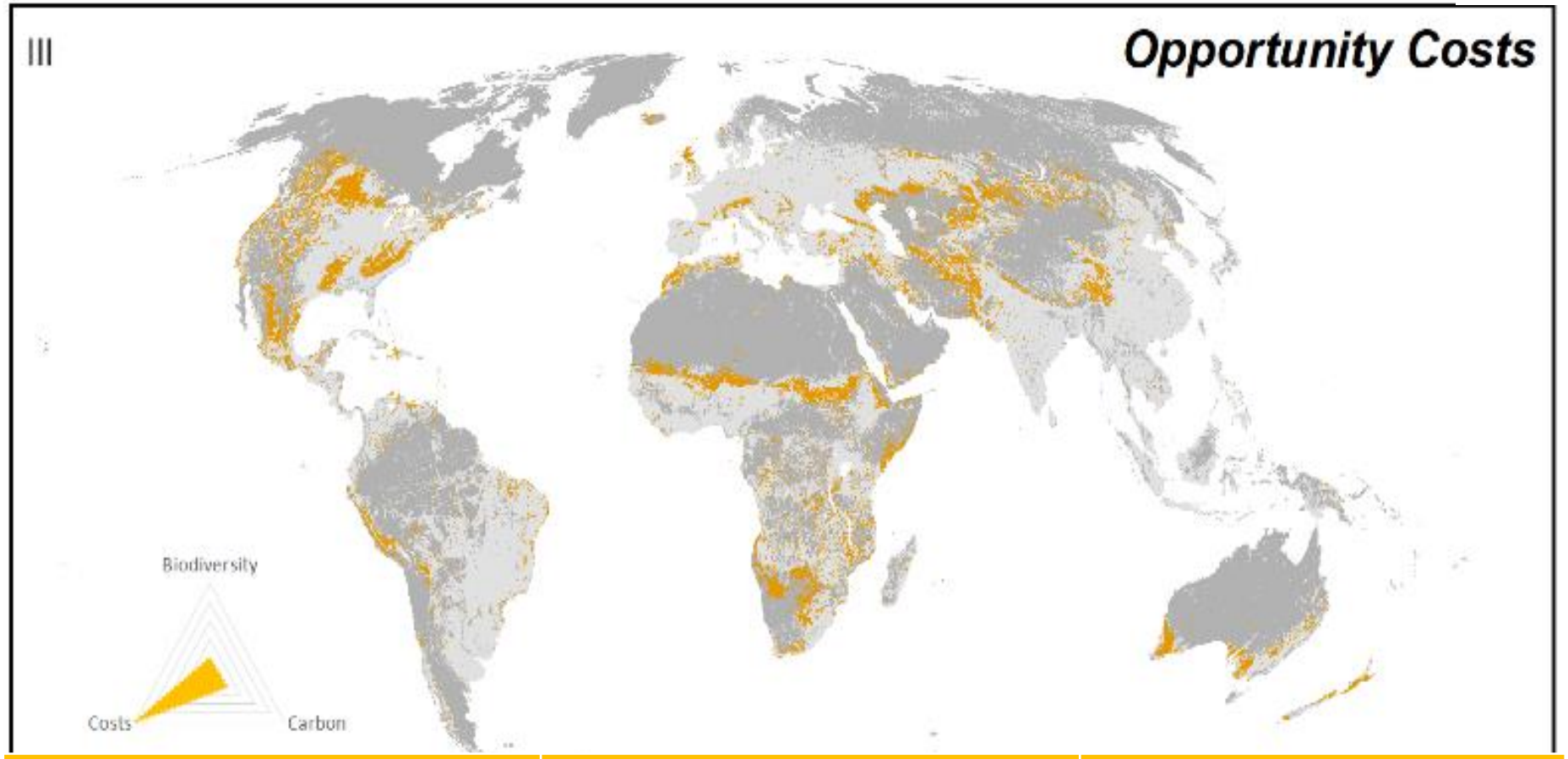
# Global maximum single benefit scenario: Carbon

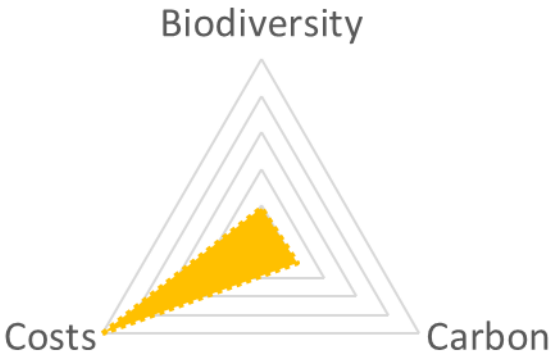



| Reduction in Global Extinctions | CO2 Sequestered (Billions Tonnes) | Opportunity Costs (USD / hectare) |
|---|---|---|
| 41% | 297 | 5,221 |

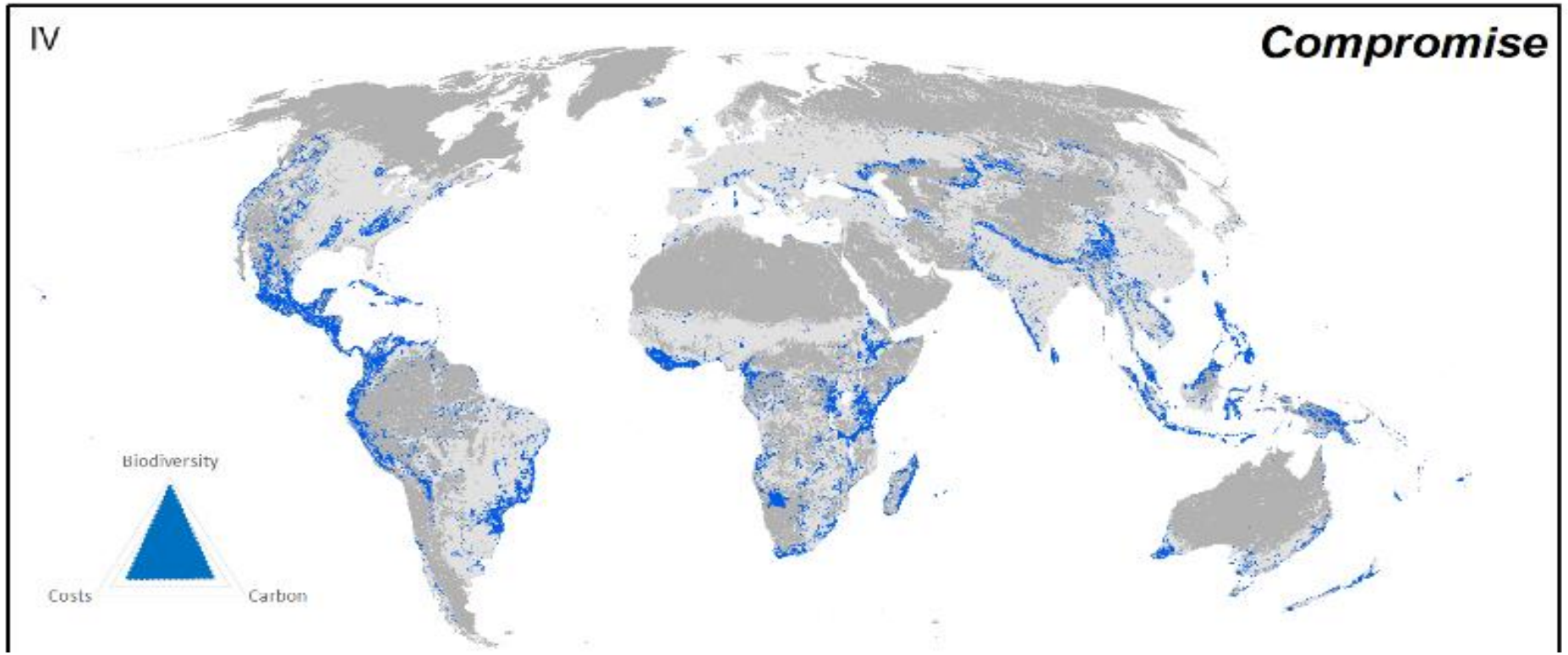
# Global Opportunity cost scenario

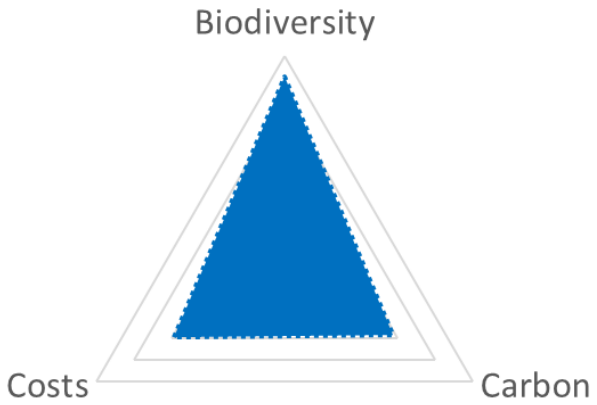



| Reduction in Global Extinctions | CO2 Sequestered (Billions Tonnes) | Opportunity Costs (USD / hectare) |
|---|---|---|
| 13% | 67 | 1,534 |

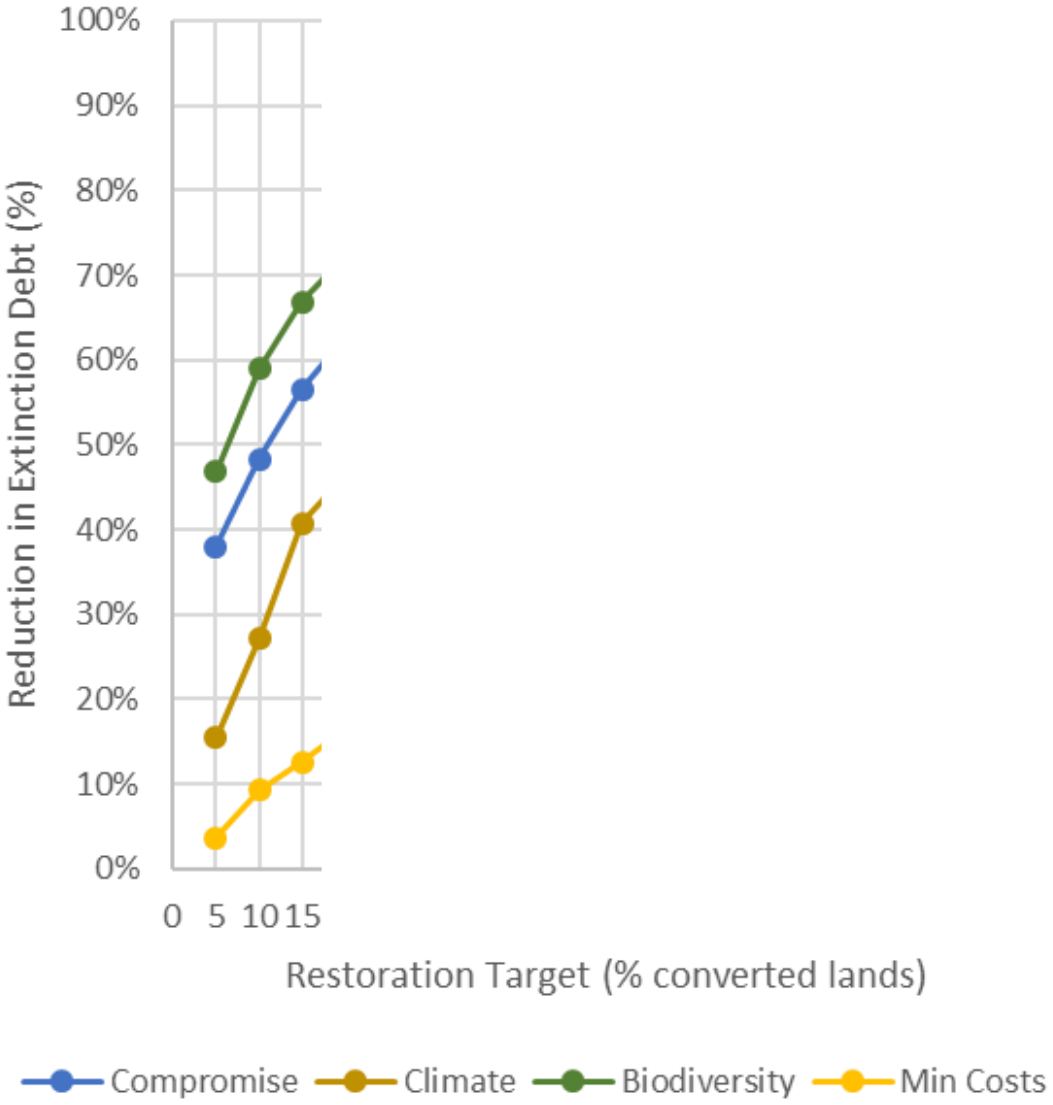
# Global Compromise scenario



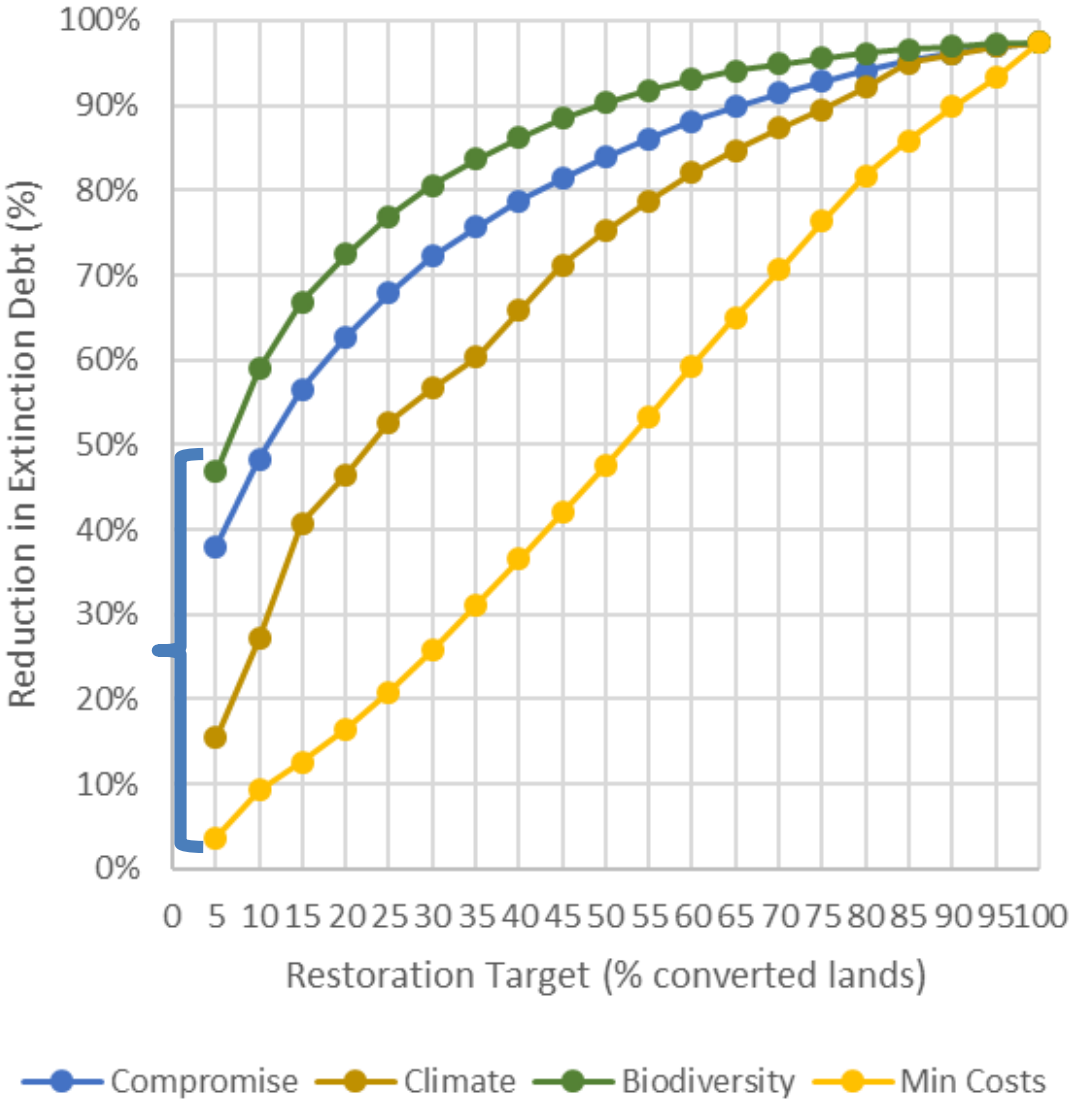

| Reduction in Global Extinctions | CO2 Sequestered (Billions Tonnes) | Opportunity Costs (USD / hectare) |
|---|---|---|
| 61 | 171 | 3,114 |

# Multiple restoration targets




We can also use any target, providing input for more ambitious ones (Post-2020)

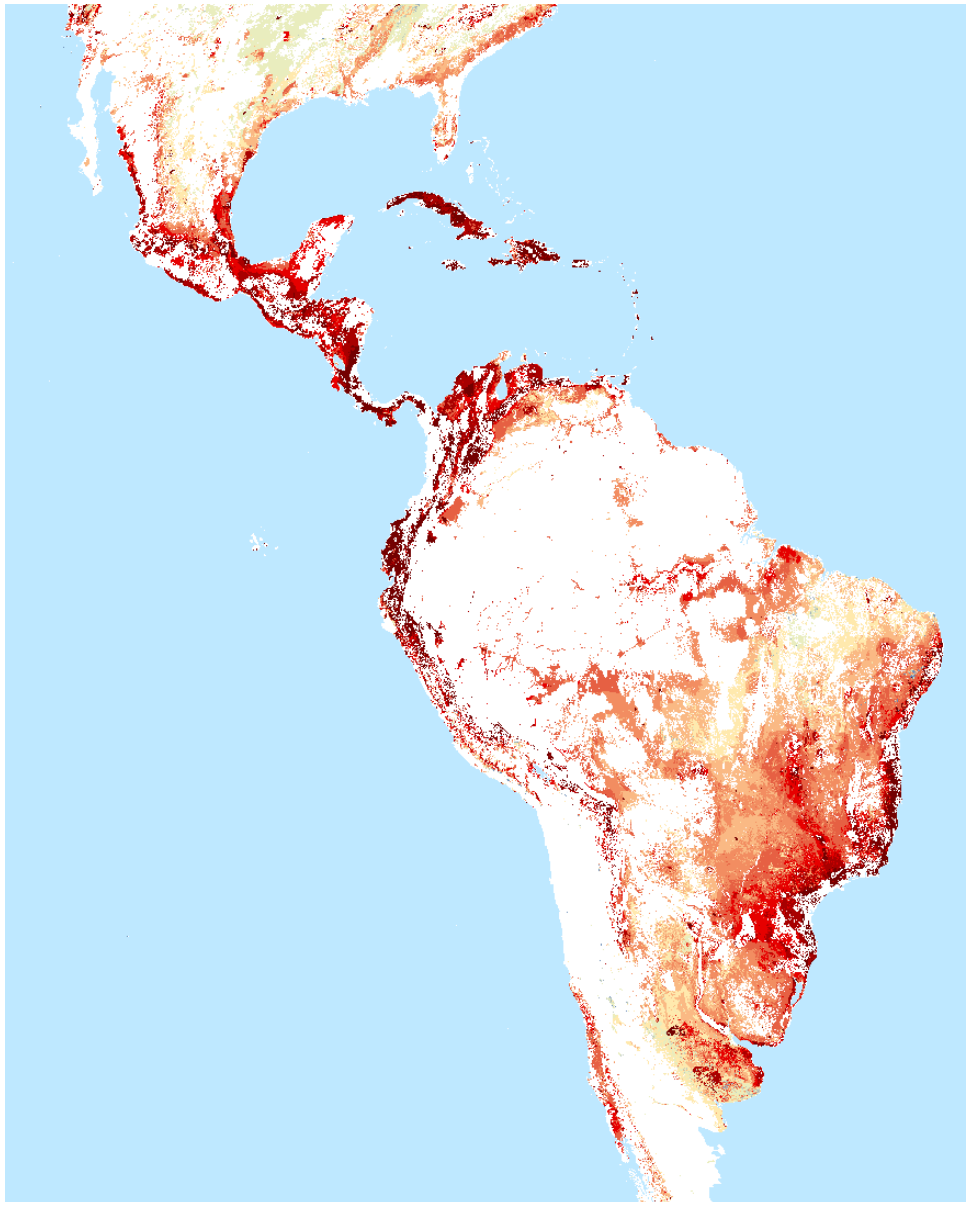
# Multiple restoration targets




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

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

# Biodiversity – Some GRULAC results



Priority

5% 5-10% 10-15% 15-20% 20-30% 30-40%
40-55% 55-70% 70-85% 85-100% Not restorable

**Criteria 1: Absolute area (km2) restored in the Scenario focused on Biodiversity only**

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

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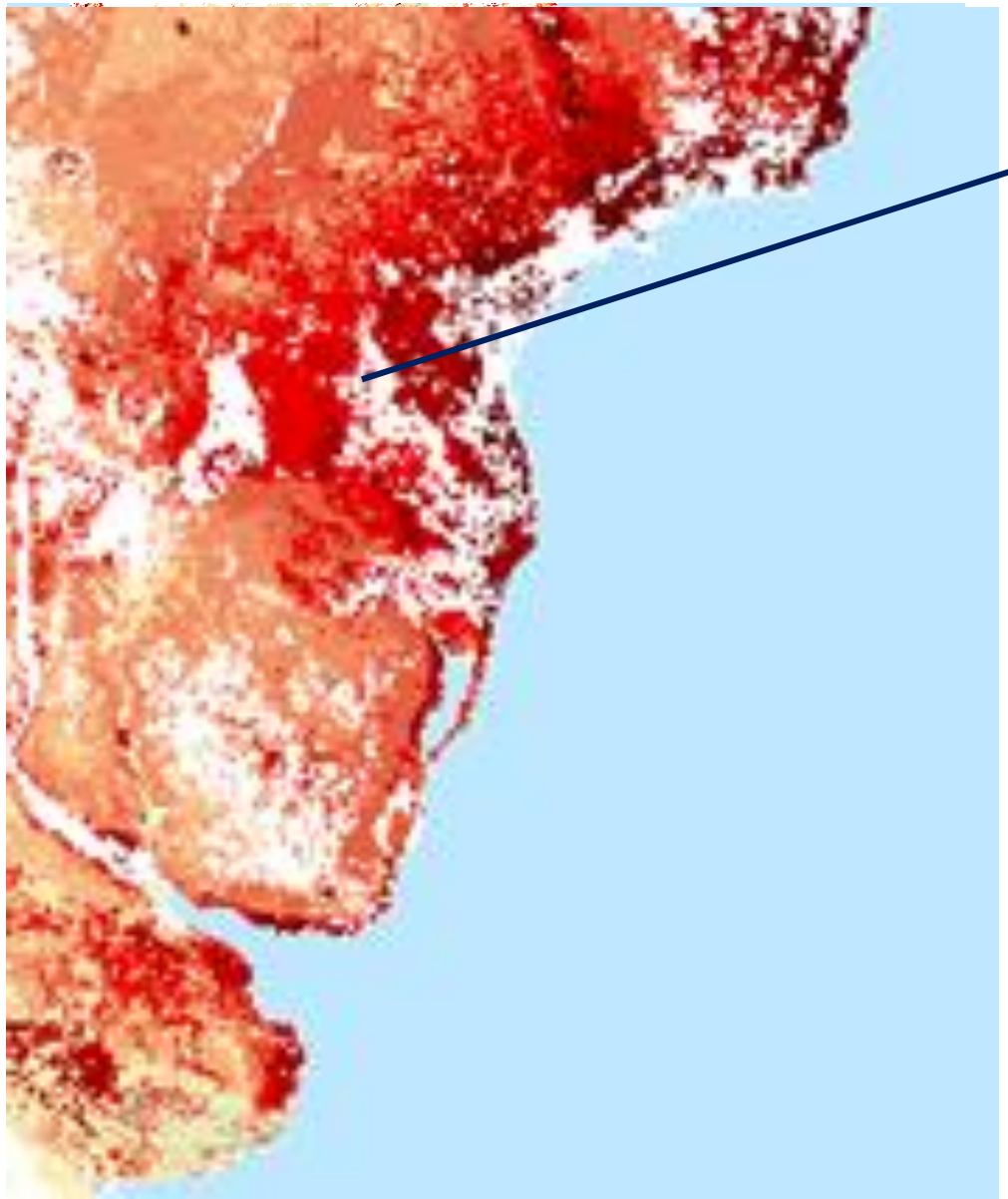
# Biodiversity – Some GRULAC results



Priority

5% 5-10% 10-15% 15-20% 20-30% 30-40%
40-55% 55-70% 70-85% 85-100% Not restorable

## For each 300m pixel:

| Biodiversity Impact | Climate Change Impact | Opportunity Costs |
|---|---|---|
| • List of species protected<br>• Red List Classification<br>• Reduction in Extinctions | • Tonnes of CO2 Sequestered per hectare restored | • Value of agricultural production displaced ($/hectare) |

**Prioritisation can be focused on**

**Farms**
**Microwatersheds**
**Municipalities**
**Provinces**
**Countries**
**Regions**
**Globe**

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# Conclusions

- Strategic approaches can provide an eightfold increase in conservation cost-effectiveness.
- 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
- Early conversations with the CBD to provide support to countries

# Conclusions

- **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 (297 bill. tCO2, half of remaning budget for 2C) and adaptation, (cost-effective, <USD10/tCO2)

  iii) land degradation

- **Very strong synergies among Rio conventions, SGDs - need to integrate and seize synergies for cost-effectiveness plans;**
- **Strong synergies between Aichi 15 and other Aichi Targets (example here Aichi 12)**
- **Following the UNFCCC (NDCs, REDD+ etc), international finance can be used to compensate countries for their efforts; as in the NDC, more basic commitments can be unconditional, coupled with more ambitious ones conditional on international finance;**
- **Large room for Restoration in post-2020 agenda**

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## Muchas Gracias !

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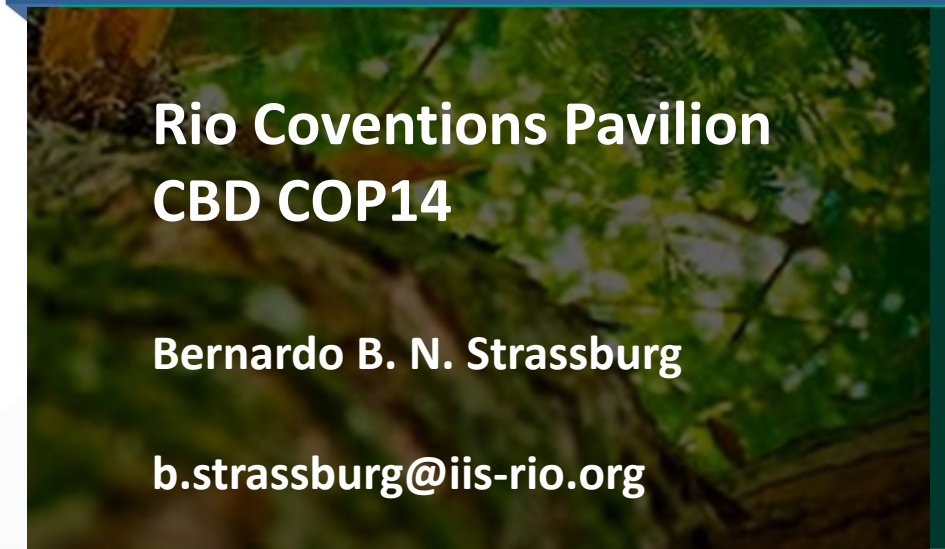

**Rio Coventions Pavilion**
**CBD COP14**

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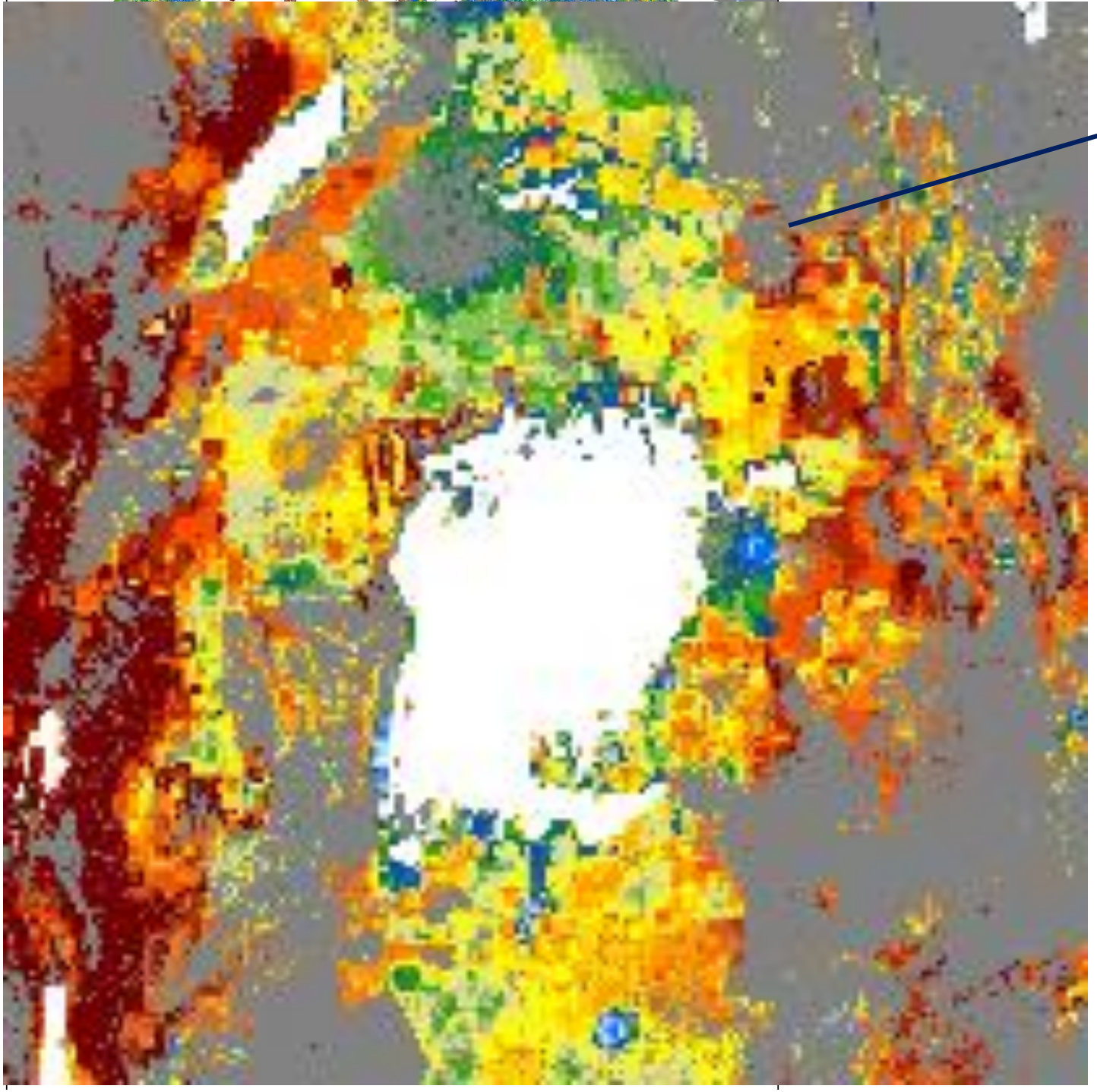

| Biodiversity Impact | Climate Change Impact | Opportunity Costs |
| --- | --- | --- |
| • List of species protected<br>• Red List Classification | • Tonnes of CO2 Sequestered per hectare restored | • Value of agricultural production displaced ($/hectare) |

(above a 300m pixel in the border of Mount Elgon NP)

Up to 300m resolution

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| St. Kitts and Nevis | 46 | 45 | 100% |
| Saint Lucia | 32 | 32 | 100% |
| St. Vin. and Gren. | 22 | 22 | 100% |
| Grenada | 16 | 16 | 100% |
| Dominica | 2 | 2 | 100% |

| | | |
|---|---|---|
| 4,619,043 | ########## | 0.298874 |

## Criteria 1: Absolute area (km2) restored in the Scenario focused on Carbon only

| Country | Area available (km2) | Priority areas (km2) | % of area available that is top global priority |
|---|---|---|---|
| Brazil | 2,435,604 | 844,200 | 35% |
| Colombia | 165,905 | 124,291 | 75% |
| Mexico | 461,592 | 47,752 | 10% |
| Paraguay | 98,139 | 43,604 | 44% |
| Venezuela | 183,308 | 42,399 | 23% |
| Peru | 123,411 | 38,118 | 31% |
| Bolivia | 109,469 | 28,537 | 26% |
| Nicaragua | 42,649 | 24,465 | 57% |
| Guatemala | 33,653 | 23,763 | 71% |
| Panama | 23,210 | 17,162 | 74% |
| Ecuador | 41,532 | 16,867 | 41% |
| Argentina | 657,091 | 8,260 | 1% |
| Costa Rica | 13,696 | 7,567 | 55% |
| Honduras | 27,427 | 6,789 | 25% |
| Chile | 52,781 | 6,351 | 12% |
| Cuba | 57,954 | 6,177 | 11% |
| Guyana | 3,165 | 2,813 | 89% |
| Belize | 3,069 | 2,563 | 83% |
| Jamaica | 2,701 | 2,032 | 75% |
| Trinidad and Tobago | 1,130 | 84 | 7% |
| Suriname | 923 | 81 | 9% |
| El Salvador | 4,851 | 57 | 1% |
| Haiti | 18,749 | 39 | 0% |
| Saint Lucia | 32 | 17 | 55% |
| St. Vin. and Gren. | 22 | 14 | 62% |
| Dominican Rep. | 21,373 | 14 | 0% |
| Grenada | 16 | 12 | 77% |
| St. Kitts and Nevis | 46 | 10 | 23% |
| Dominica | 2 | 1 | 38% |
| Antigua and Barb. | 132 | - | 0% |
| Bahamas | 181 | - | 0% |
| Barbados | 229 | - | 0% |
| Uruguay | 35,000 | - | 0% |

| | Criteria 1: Absolute area (km2) restored in the Scenario focused on Biodiversity only | | | |
|---|---|---|---|---|
| | Country | Area available (km2) | Priority areas (km2) | % of area available that is priority |
| 1 | Brazil | 2,435,604 | 494,046 | 20% |
| 2 | Mexico | 461,592 | 201,075 | 44% |
| 3 | Colombia | 165,905 | 121,684 | 73% |
| 4 | Peru | 123,411 | 82,491 | 67% |
| 5 | Argentina | 657,091 | 76,497 | 12% |
| 6 | Venezuela | 183,308 | 67,483 | 37% |
| 7 | Cuba | 57,954 | 57,619 | 99% |
| 8 | Ecuador | 41,532 | 40,824 | 98% |
| 9 | Nicaragua | 42,649 | 40,055 | 94% |
| 10 | Guatemala | 33,653 | 32,903 | 98% |
| 11 | Bolivia | 109,469 | 28,014 | 26% |
| 12 | Honduras | 27,427 | 26,381 | 96% |
| 13 | Panama | 23,210 | 21,833 | 94% |
| 14 | Dominican Rep. | 21,373 | 20,309 | 95% |
| 15 | Haiti | 18,749 | 16,057 | 86% |
| 16 | Costa Rica | 13,696 | 13,654 | 100% |
| 17 | Chile | 52,781 | 11,706 | 22% |
| 18 | Paraguay | 98,139 | 11,269 | 11% |
| 19 | El Salvador | 4,851 | 4,736 | 98% |
| 20 | Uruguay | 35,000 | 3,855 | 11% |
| 21 | Belize | 3,069 | 3,067 | 100% |
| 22 | Jamaica | 2,701 | 2,690 | 100% |
| 23 | Trinidad and Tobago | 1,130 | 1,109 | 98% |
| 24 | Suriname | 923 | 330 | 36% |
| 25 | Guyana | 3,165 | 234 | 7% |
| 26 | Barbados | 229 | 215 | 94% |
| 27 | Bahamas | 181 | 135 | 75% |
| 28 | Antigua and Barb. | 132 | 125 | 95% |
| 29 | St. Kitts and Nevis | 46 | 45 | 100% |
| 30 | Saint Lucia | 32 | 32 | 100% |
| 31 | St. Vin. and Gren. | 22 | 22 | 100% |
| 32 | Grenada | 16 | 16 | 100% |

| Criteria 1: Absolute area (km2) restored in the Scenario focused on Biodiversity only | | | |
|---|---|---|---|
| Country | Area available (km2) | Priority areas (km2) | % of area available that is priority |
| Brazil | 2,435,604 | 494,046 | 20% |
| Mexico | 461,592 | 201,075 | 44% |
| Colombia | 165,905 | 121,684 | 73% |
| Peru | 123,411 | 82,491 | 67% |
| Argentina | 657,091 | 76,497 | 12% |
| Venezuela | 183,308 | 67,483 | 37% |
| Cuba | 57,954 | 57,619 | 99% |
| Ecuador | 41,532 | 40,824 | 98% |
| Nicaragua | 42,649 | 40,055 | 94% |
| Guatemala | 33,653 | 32,903 | 98% |
| Bolivia | 109,469 | 28,014 | 26% |
| Honduras | 27,427 | 26,381 | 96% |
| Panama | 23,210 | 21,833 | 94% |
| Dominican Rep. | 21,373 | 20,309 | 95% |
| Haiti | 18,749 | 16,057 | 86% |
| Costa Rica | 13,696 | 13,654 | 100% |

| Criteria 1: Absolute area (km2) restored in the Scenario focused on Biodiversity only | | | |
|---|---|---|---|
| Country | Area available (km2) | Priority areas (km2) | % of area available that is priority |
| Chile | 52,781 | 11,706 | 22% |
| Paraguay | 98,139 | 11,269 | 11% |
| El Salvador | 4,851 | 4,736 | 98% |
| Uruguay | 35,000 | 3,855 | 11% |
| Belize | 3,069 | 3,067 | 100% |
| Jamaica | 2,701 | 2,690 | 100% |
| Trinidad and Tobago | 1,130 | 1,109 | 98% |
| Suriname | 923 | 330 | 36% |
| Guyana | 3,165 | 234 | 7% |
| Barbados | 229 | 215 | 94% |
| Bahamas | 181 | 135 | 75% |
| Antigua and Barb. | 132 | 125 | 95% |
| St. Kitts and Nevis | 46 | 45 | 100% |
| Saint Lucia | 32 | 32 | 100% |
| St. Vin. and Gren. | 22 | 22 | 100% |
| Grenada | 16 | 16 | 100% |
| Dominica | 2 | 2 | 100% |