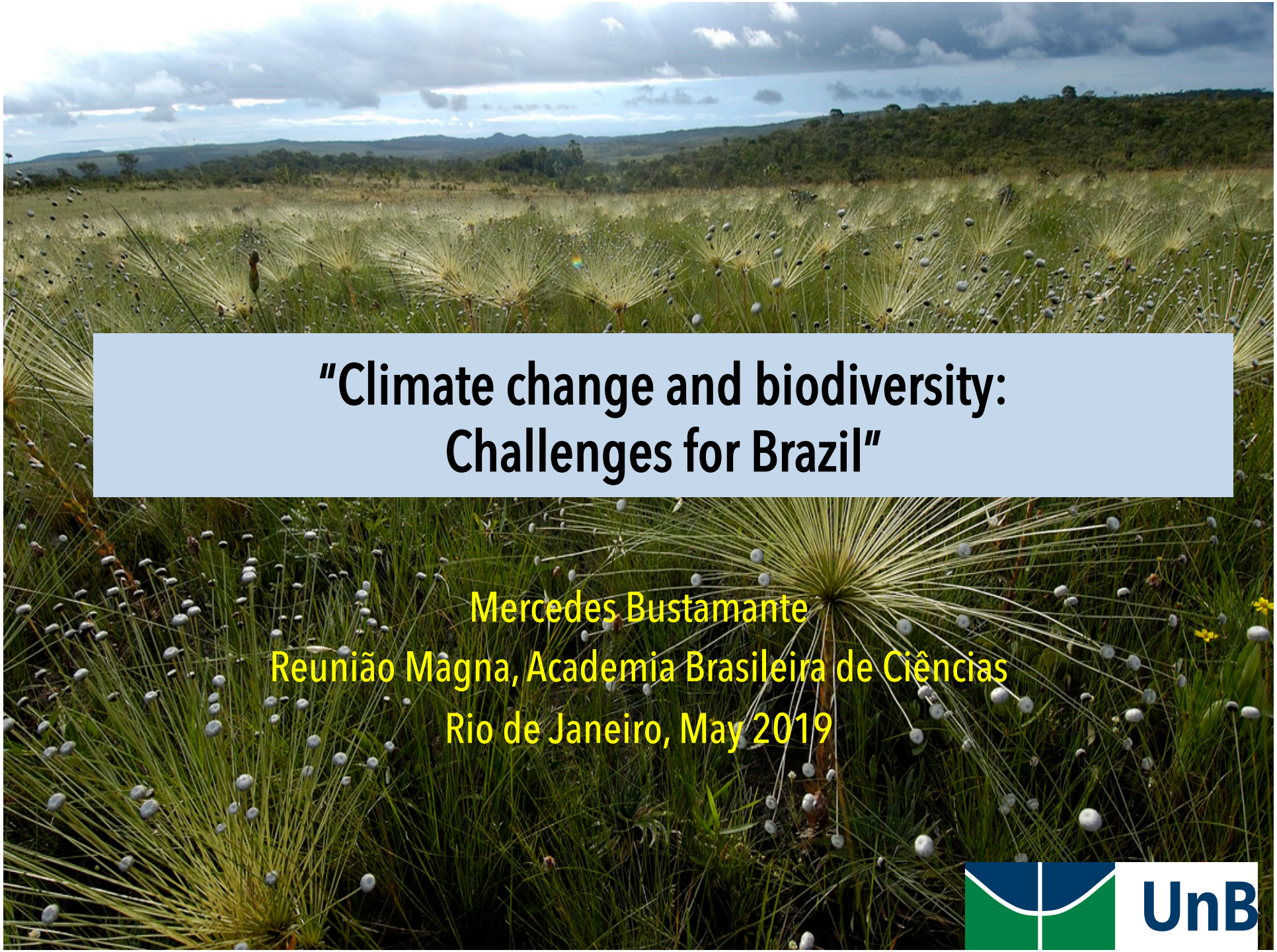


"Climate change and biodiversity: Challenges for Brazil"

Mercedes Bustamante

Reunião Magna, Academia Brasileira de Ciências

Rio de Janeiro, May 2019

UnB

Global Context

Two of the greatest challenges facing humanity:

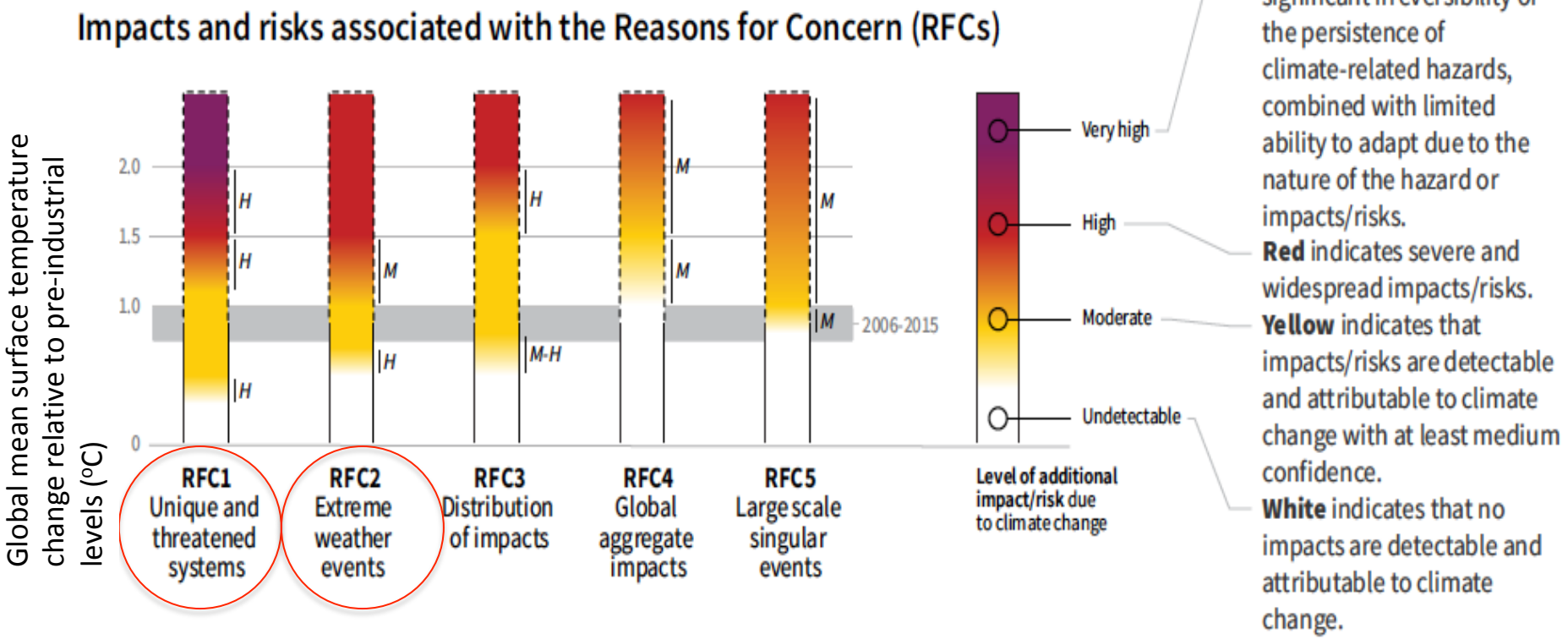
- Feeding 9–10 billion people by 2050
- Preventing dangerous climate change

Both challenges must be met while **reducing the impact of land management on ecosystem services.**

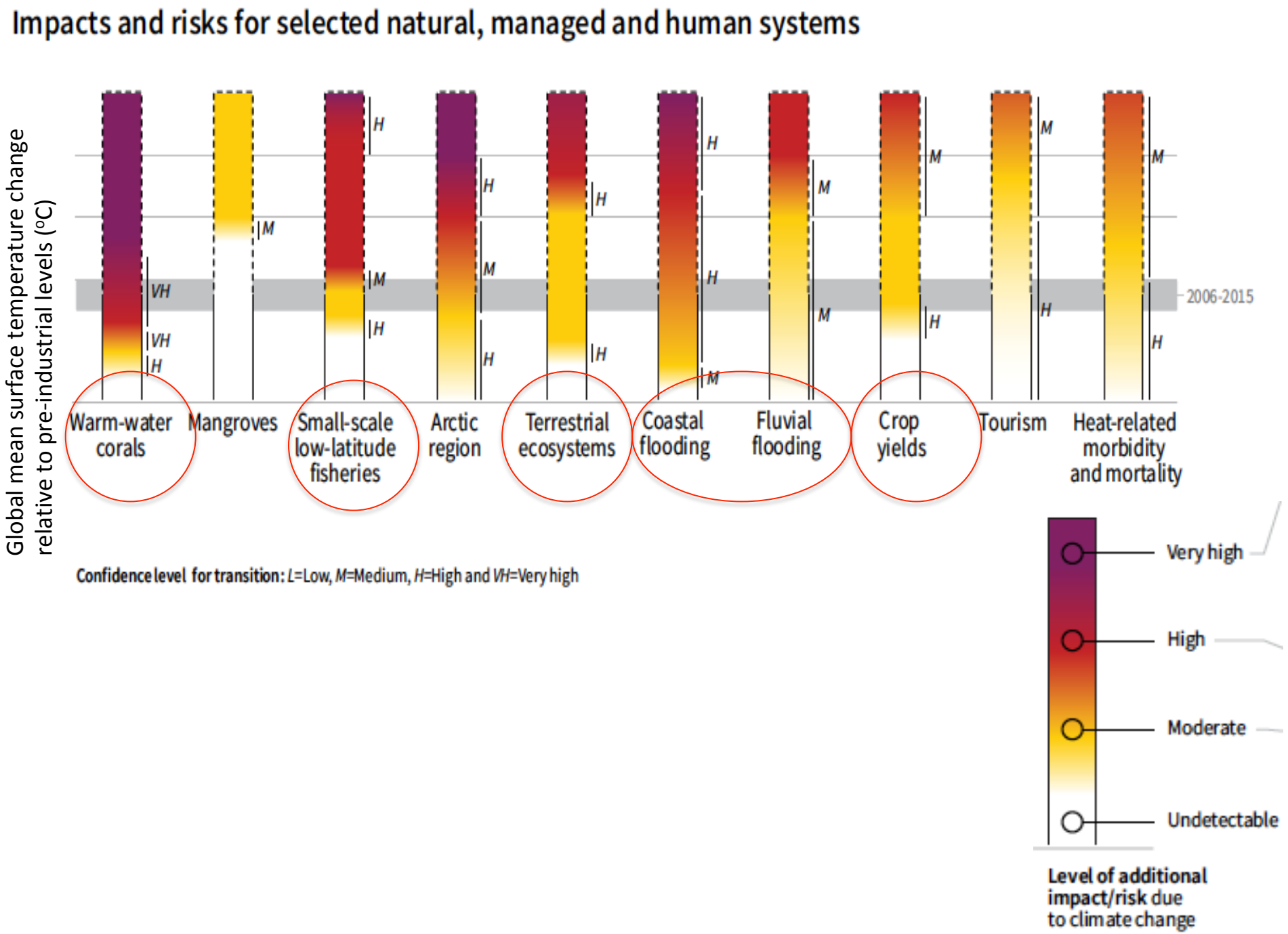
IPCC Special Report – 1.5°C

How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.



Source: IPCC, SR 1.5°C


Impacts and risks for selected natural, managed and human systems
Global mean surface temperature change relative to pre-industrial levels (°C)
2006-2015
VH
VH
H
M
H
M
H
H
M
H
H
H
M
H
M
M
H
M
M
H
M
H
Warm-water corals
Mangroves
Small-scale low-latitude fisheries
Arctic region
Terrestrial ecosystems
Coastal flooding
Fluvial flooding
Crop yields
Tourism
Heat-related morbidity and mortality
Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high
Very high
High
Moderate
Undetectable
Level of additional impact/risk due to climate change

Findings of 1.5°C report related to Agriculture, Forests and Other Land Uses - AFOLU

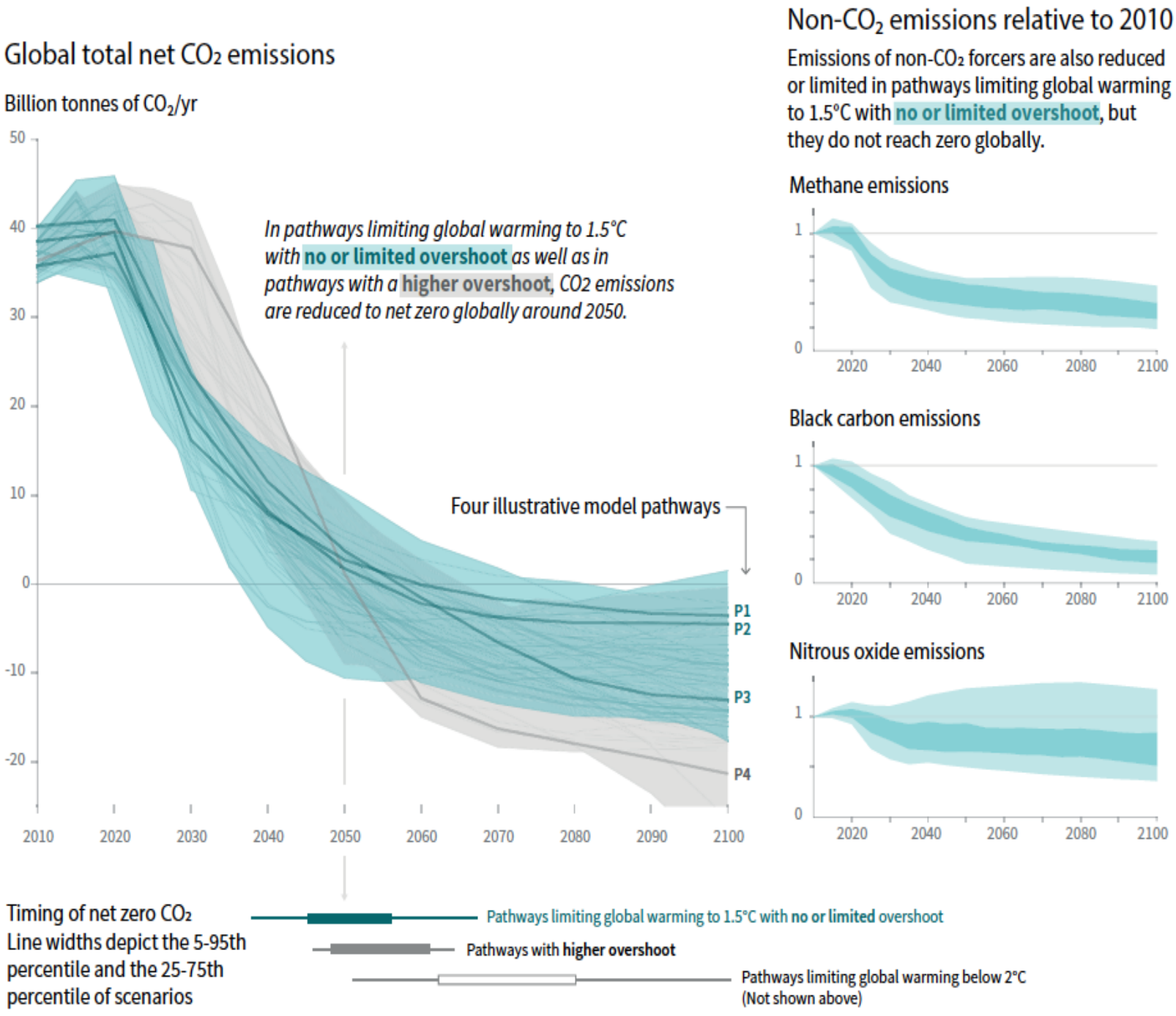
- Limiting global warming to 1.5°C with no or limited overshoot = **Transitions in global and regional land use in all pathways**
- **But,** their scale depends on the pursued mitigation portfolio.

Transitions in Model pathways :

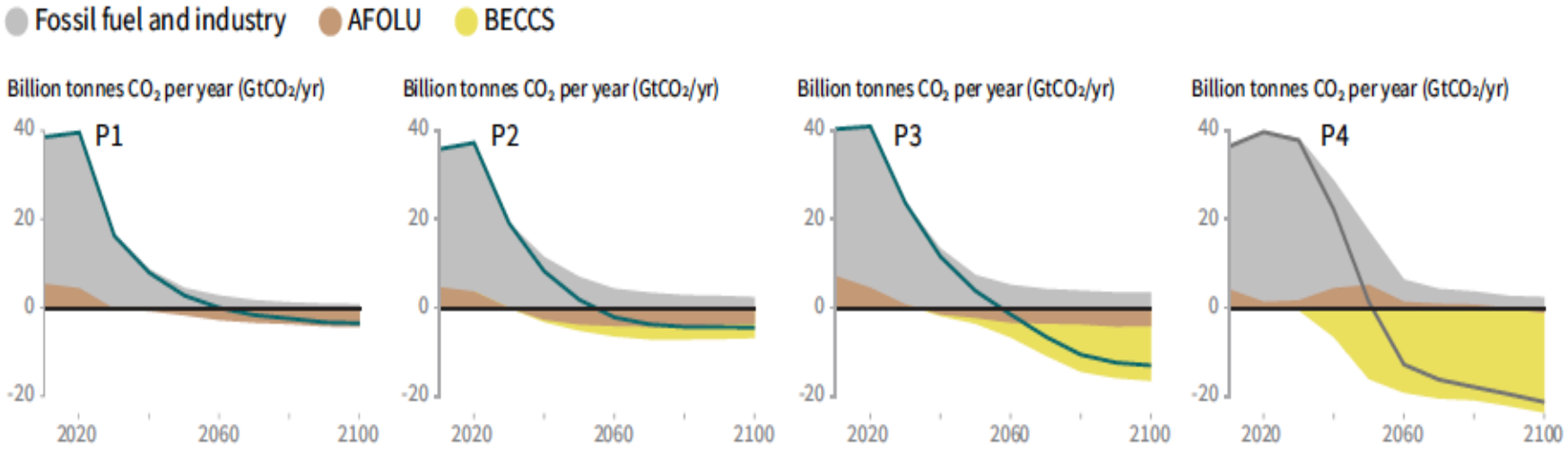
Non-pasture agricultural land for food and feed crops

Pasture land to be converted in agricultural land for energy crops

Changes in forest cover


Global total net CO_2 emissions
Billion tonnes of CO_2/yr
50
40
30
20
10
0
-10
-20
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
In pathways limiting global warming to 1.5°C with no or limited overshoot as well as in pathways with a higher overshoot, CO2 emissions are reduced to net zero globally around 2050.
Four illustrative model pathways
P1
P2
P3
P4
Non-CO_2 emissions relative to 2010
Emissions of non-CO_2 forcers are also reduced or limited in pathways limiting global warming to 1.5°C with no or limited overshoot, but they do not reach zero globally.
Methane emissions
Black carbon emissions
Nitrous oxide emissions
1
0
2020
2040
2060
2080
2100
Timing of net zero CO_2
Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios
Pathways limiting global warming to 1.5°C with no or limited overshoot
Pathways with higher overshoot
Pathways limiting global warming below 2°C
(Not shown above)

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways



Rapid decabornization

2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor B

Focus on sustainability

economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with

Middle-of-the road scenario

patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

Resource and energy-intensive

adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR

- The **later mitigation efforts** are implemented, the greater should be the role of negative emissions to offset past emissions.
- With this there is a greater weight of mitigation in bioenergy and carbon capture - strong impacts on future land uses.

Environmental Research Letters

LETTER

Large-scale bioenergy production: how to resolve sustainability trade-offs?

Florian Humpenöder[1,4,5], Alexander Popp[1,5], Benjamin Leon Bodirsky[1], Isabelle Weindl[1,3], Anne Biewald[1], Hermann Lotze-Campen[1,3], Jan Philipp Dietrich[1], David Klein[1], Ulrich Kreidenweis[1,2], Christoph Müller[1], Susanne Rolinski[1] and Miodrag Stevanovic[1]

[1] Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany
[2] Technische Universität Berlin (TU Berlin), Economics of Climate Change, Berlin, Germany
[3] Humboldt-Universität zu Berlin, Berlin, Germany
[4] Author to whom any correspondence should be addressed.
[5] Co-first authors.

Environ. Res. Lett. **13** (2018) 024011

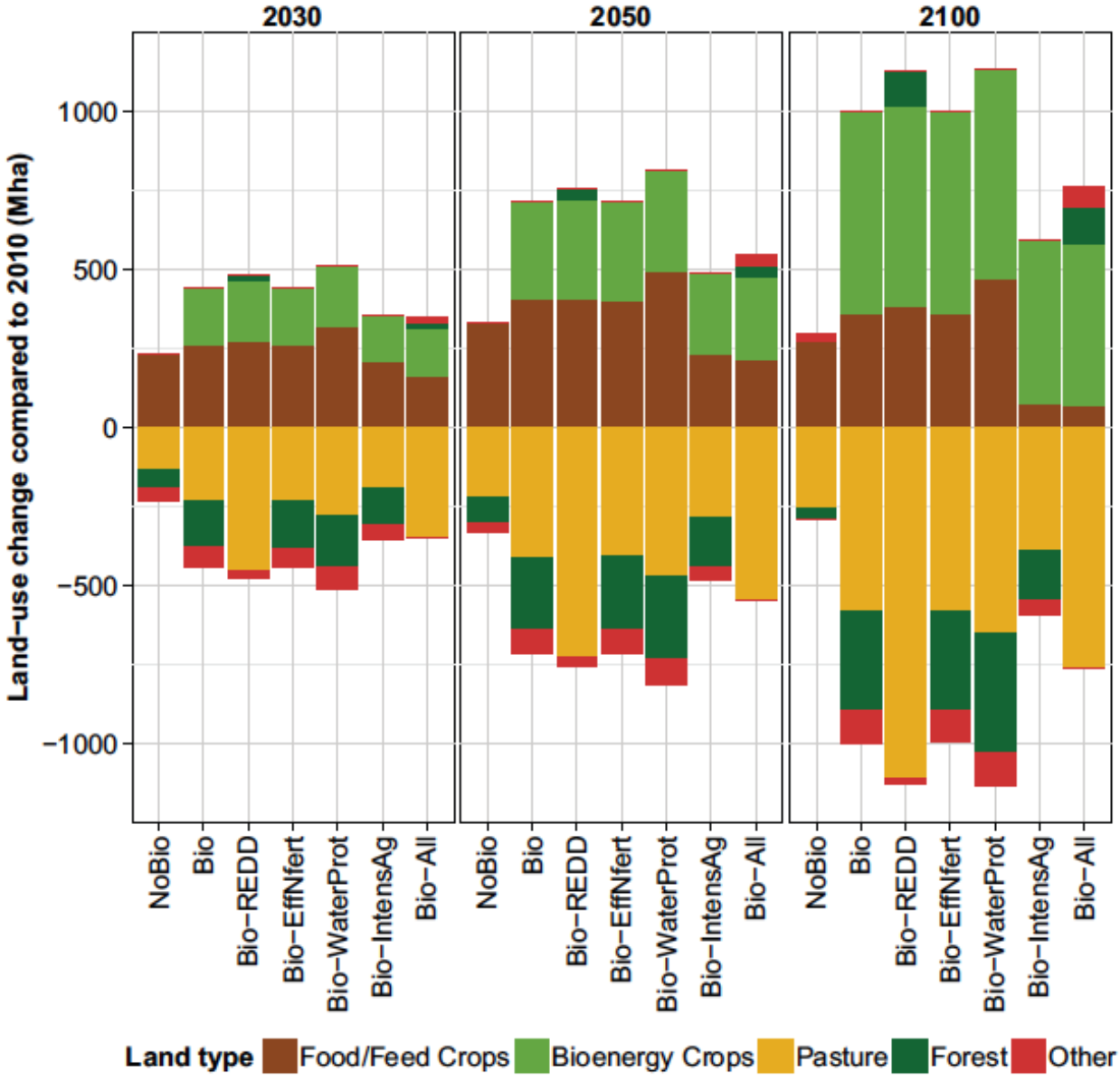
Scenario results for global land-use change in 2030, 2050 and 2100 compared to 2010.

Colors depict different land types.

Global land cover in 2010:

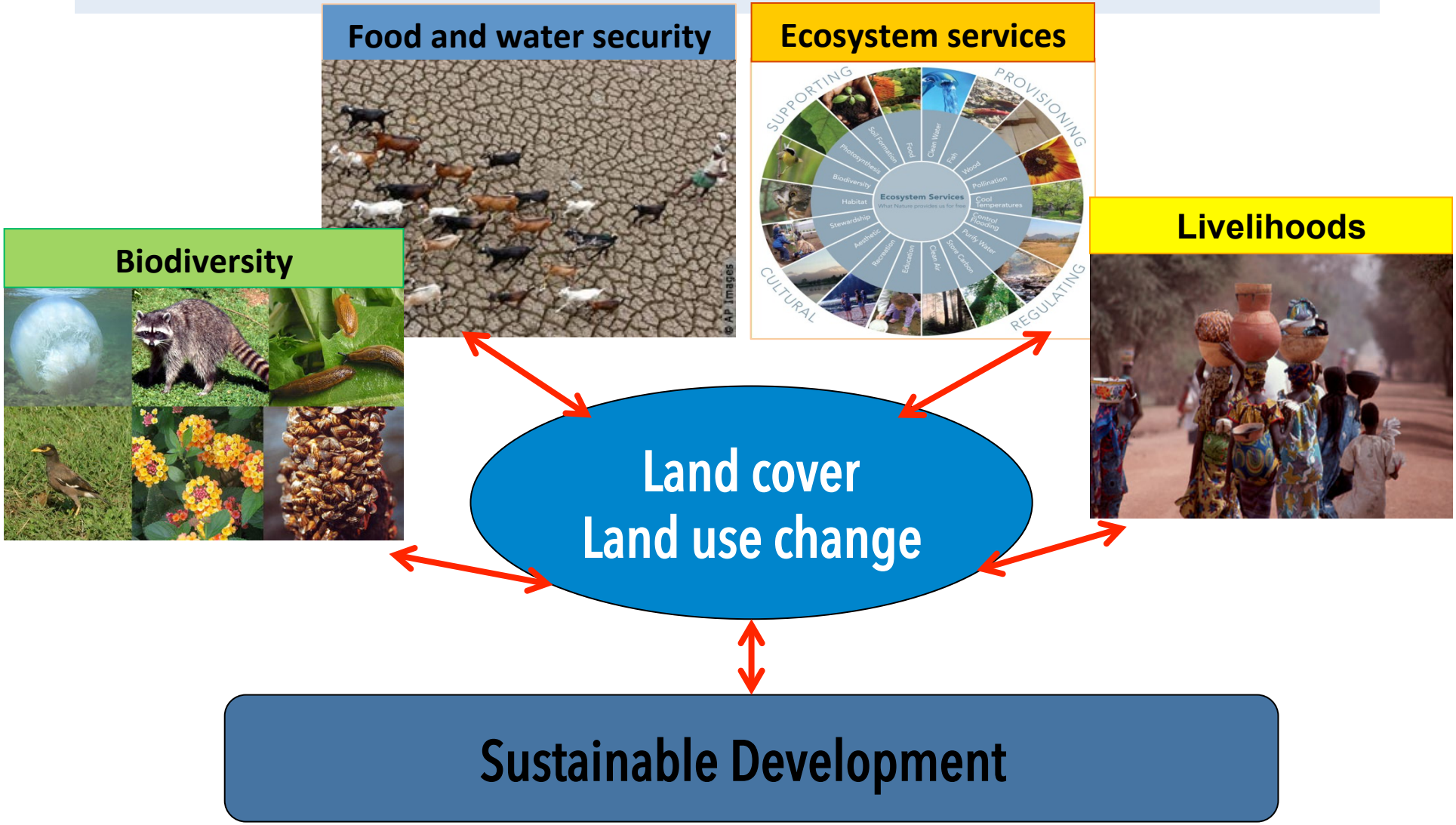
Total - 12907 Mha

Cropland (food/feed crops) 1581 Mha
Pasture 2994 Mha
Forest 4157 Mha
Other land 4175 Mha



Environ. Res. Lett. **13** (2018) 024011

Such large transitions pose profound challenges for sustainable management



nature climate change

LETTERS

https://doi.org/10.1038/s41558-017-0064-y

Corrected: Author correction

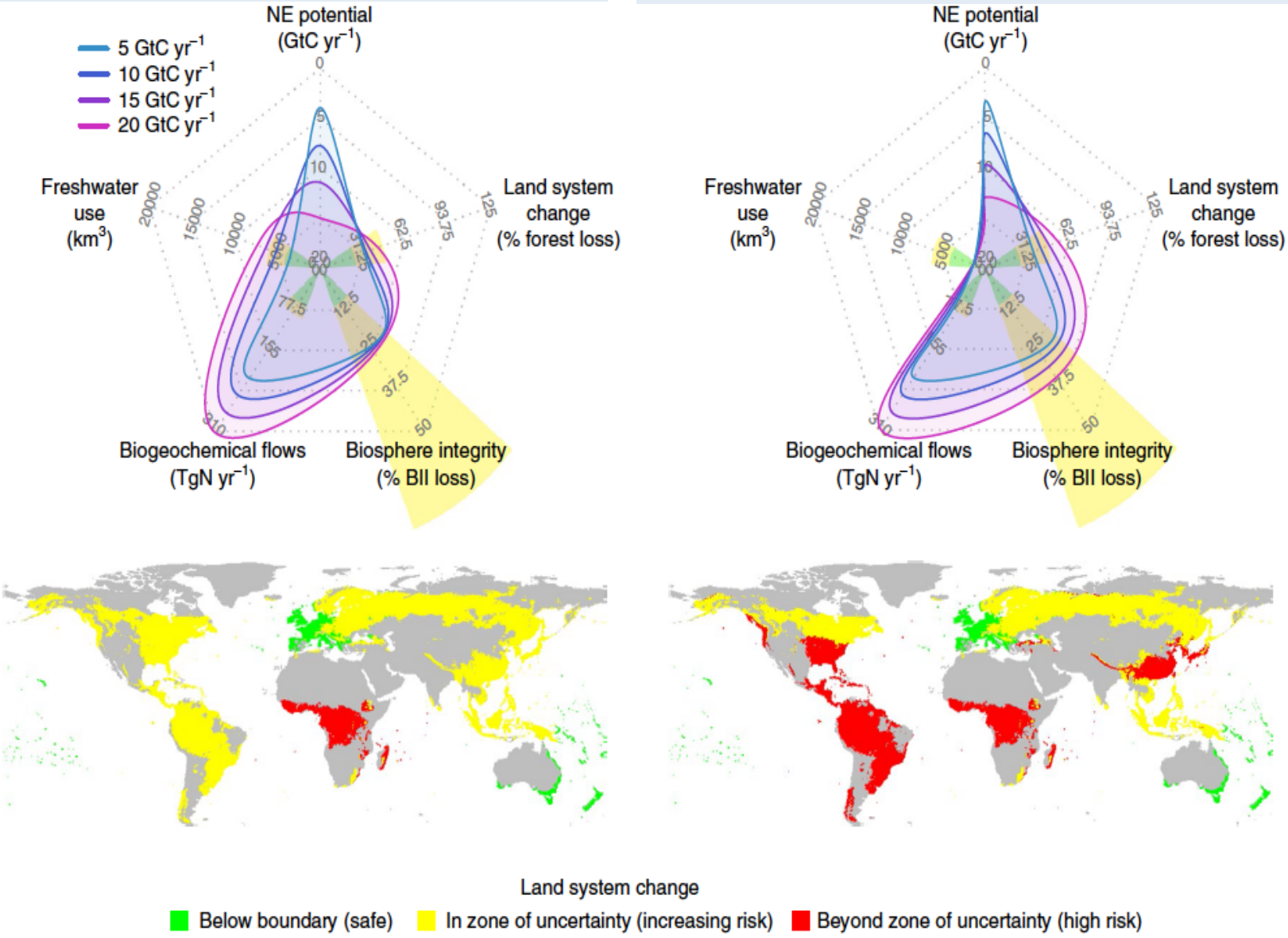
Biomass-based negative emissions difficult to reconcile with planetary boundaries

Vera Heck[1,2*], Dieter Gerten[1,2*], Wolfgang Lucht[1,2,3] and Alexander Popp[1]

- Effect of biodiversity and freshwater conservation objectives for fixed biomass production targets.
- Biomass plantations are distributed around the SSP1xRCP2.6 agricultural baseline with a global warming of 1.5 °C.
- Negative Emission potentials are depicted for the highly efficient biomass conversion pathway to hydrogen (B2H2).
- Maps show exemplarily the regional status of the control variable for land-system change optimized for a global biomass production of 15 GtC yr−1 under the respective conservation objective.

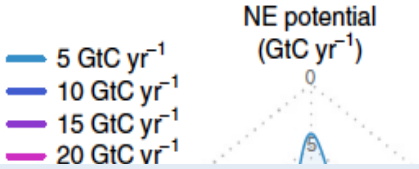
A. Prioritization of biodiversity conservation

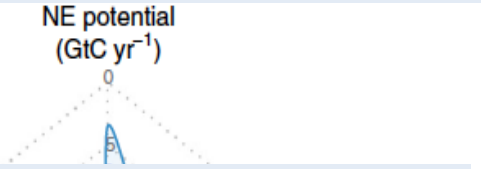
B. Prioritization of freshwater conservation



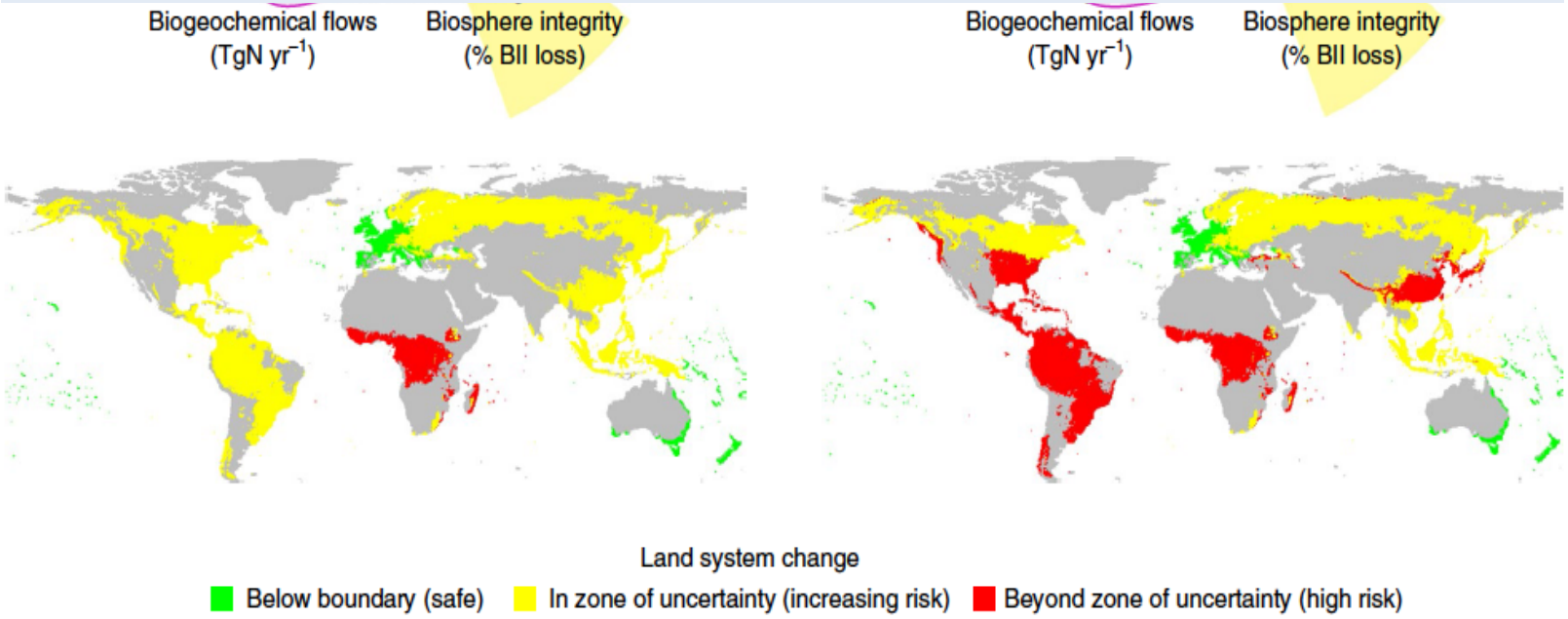
A. Prioritization of biodiversity conservation

B. Prioritization of freshwater conservation





The pressure added to the boundaries of freshwater use, biosphere integrity and land-system change is sensitive to the prioritization of different conservation objectives, **indicating trade-offs between the individual priorities.**



Land-based Carbon Dioxide Removal – scale-dependent

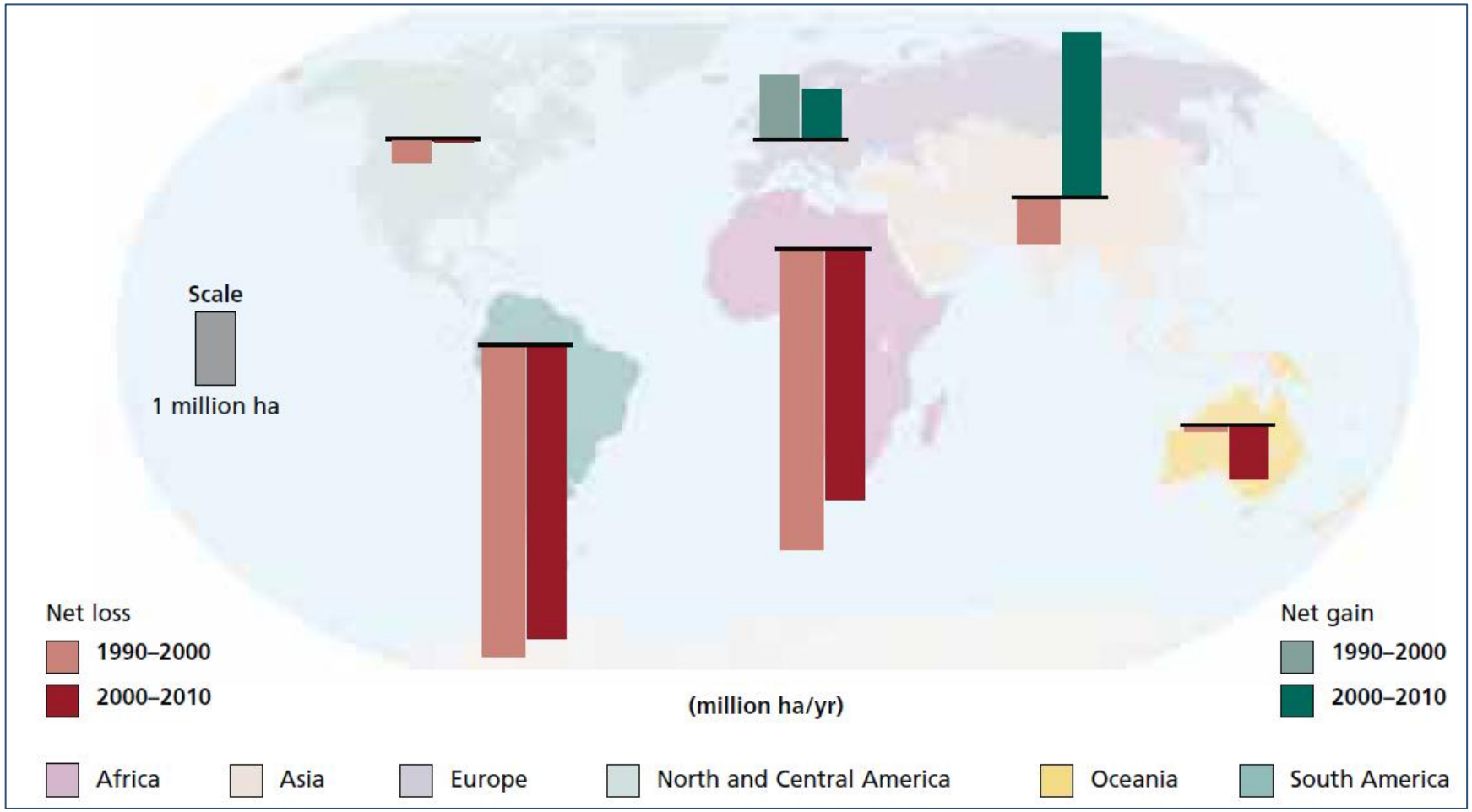
- **If if deployed at large scale,**
- **Most current and potential CO_2 removal (CDR) measures could have significant impacts on:**
- **land,**
- **energy,**
- **water or nutrients**

- **Some AFOLU-related CDR measures** (e.g. restoration of natural ecosystems and soil carbon sequestration) **could provide co-benefits** (improved biodiversity, soil quality, and local food security).

- **If deployed at large scale,**
- **they would require** governance systems enabling sustainable land management to conserve and protect land carbon stocks and other ecosystem functions and services.

What about Brazil in this global context?

Forest area change 1990-2010



(FAO data)

Brazil – facing many challenges…

Water resources

Carbon stocks

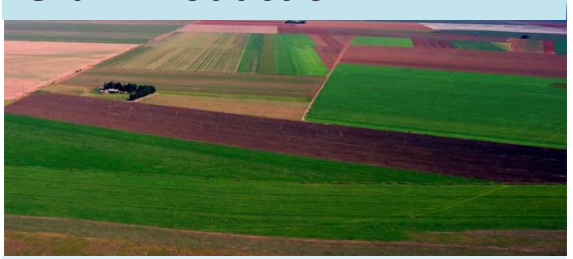
Biodiversity

Social diversity

Changes in fire regime

Meat production

Grain Production



Bioenergy expansion

Brazil: Biodiversity in numbers

Megadiversity and continental dimension that provide spatial and resource heterogeneity.

~42.000 plant species	~9.000 vertebrates	min. 129.840 invertebrates

- High levels of endemism.
- However...
- Threathned species – 1.173 species of animals and 2.118 of plants.

Drivers of change in Biodiversity and Ecosystems

		Vetores Diretos de Degradação da Biodiversidade e Serviços Ecossistêmicos								
Bioma	Ambiente	Mineração	Superexploração de Recursos Naturais	Uso do solo	Poluição	Infraestrutura e Urbanização	Mudanças Climáticas	Regimes de Inundação	Regimes do Fogo	Invasões Biológicas
Amazônia	Terrestre	↗	↗	↗	→	↗	↗	↗	↑	↗
	Aquático	↗	↗	↗	↗	↗	↗	↗	↗	↗
Caatinga	Terrestre	↗	↗	↗	↗	↗	↗	→	→	→
	Aquático	→	→	→	→	↗	↗	→	→	→
Cerrado	Terrestre	↗	↗	↗	↗	↗	↗	→	↗	↑
	Aquático	↗	→	↗	↗	↗	↗	→	↗	↗
Mata Atlântica	Terrestre	↗	→	→	↗	↗	↗	↗	→	↗
	Aquático	↗	↗	↗	↗	↗	↗	↗	?	↗
Pampa	Terrestre	↗	↗	↗	↗	↗	↗	→	↘	↗
	Aquático	↗	↗	↗	→	↗	→	→	→	→
Pantanal	Terrestre	→	↗	↗	↗	↗	↗	↗	→	↗
	Aquático	→	↗	↗	↗	↗	↗	↗	→	↗
Bioma Marinho e Costeiro	Terrestre	→	→	↗	↗	↗	↗	↗	→	↗
	Aquático	↗	↗	↗	↗	↗	↗	NA	NA	↗

Impacto do vetor (cores)

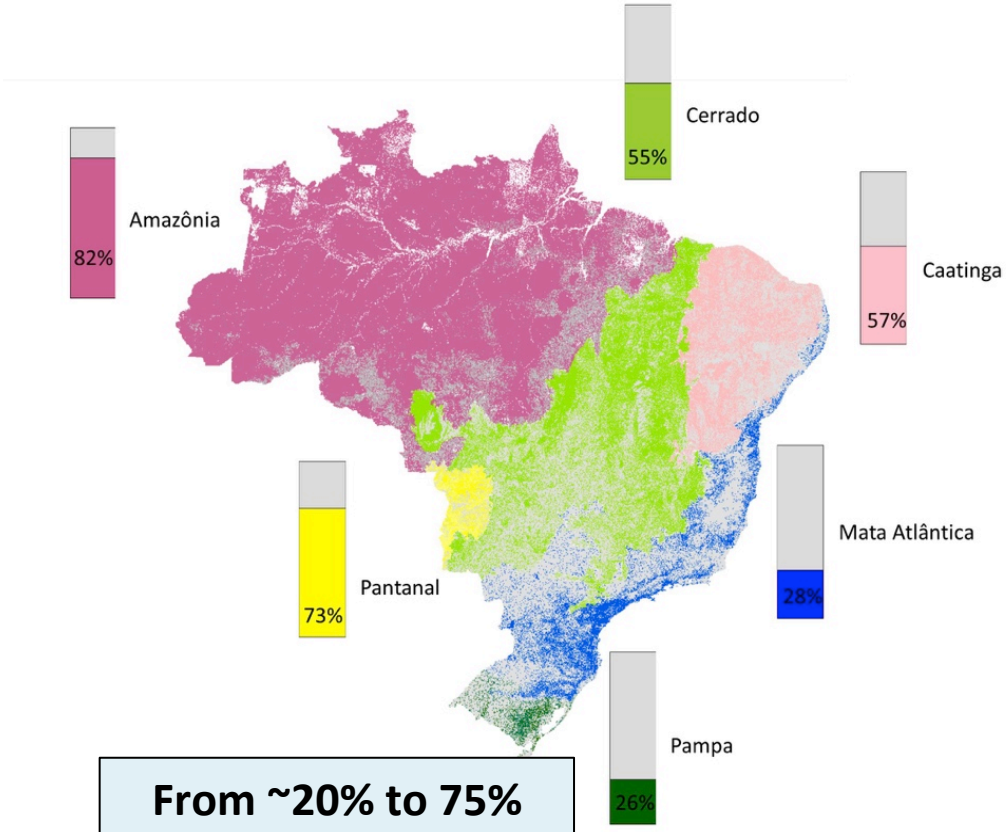
Alto	
Médio	
Baixo	

Tendência atual e de um futuro próximo do vetor (setas)

↗	Aumentando	O impacto do vetor de transformação está aumentando continuamente ao longo dos últimos anos
→	Estável	O impacto do vetor de transformação permanece estável nos ultimos anos, sem aumentar ou diminuir
↘	Diminuindo	O impacto do vetor de transformação está diminuindo continuamente ao longo dos últimos anos
↑	Aumentando muito rápido	O impacto do vetor de transformação está aumentado em um ritmo cada vez maior, ano após ano
?	Desconhecido	Faltam informações acerca do impacto do vetor de transformação no bioma
NA	Não se aplica	

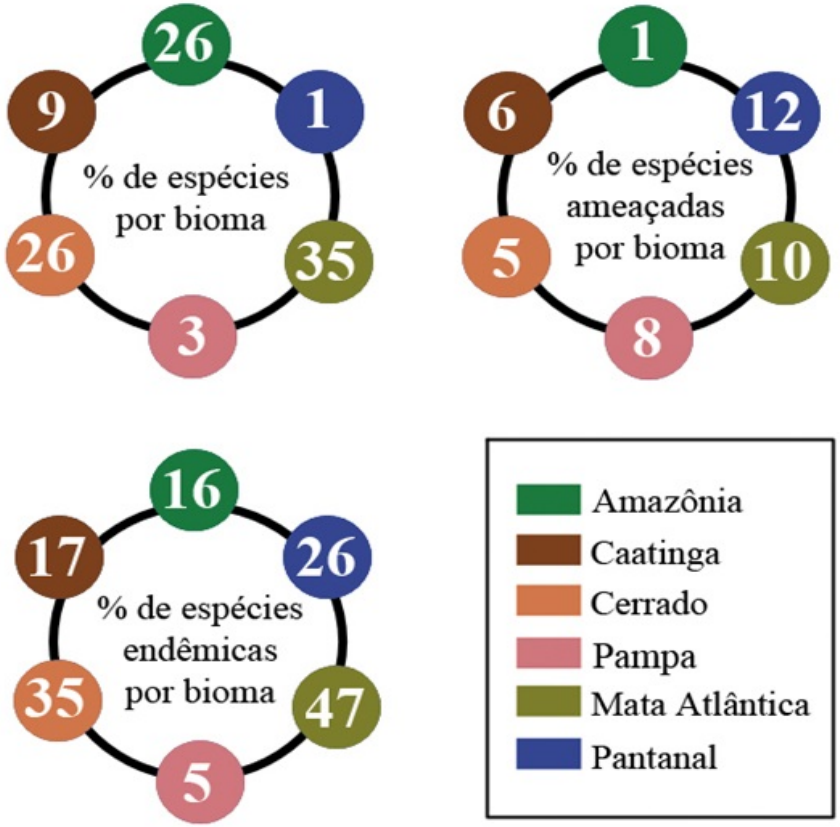
Biomes - threat level

% Remaining native area



From ~20% to 75% loss of original cover

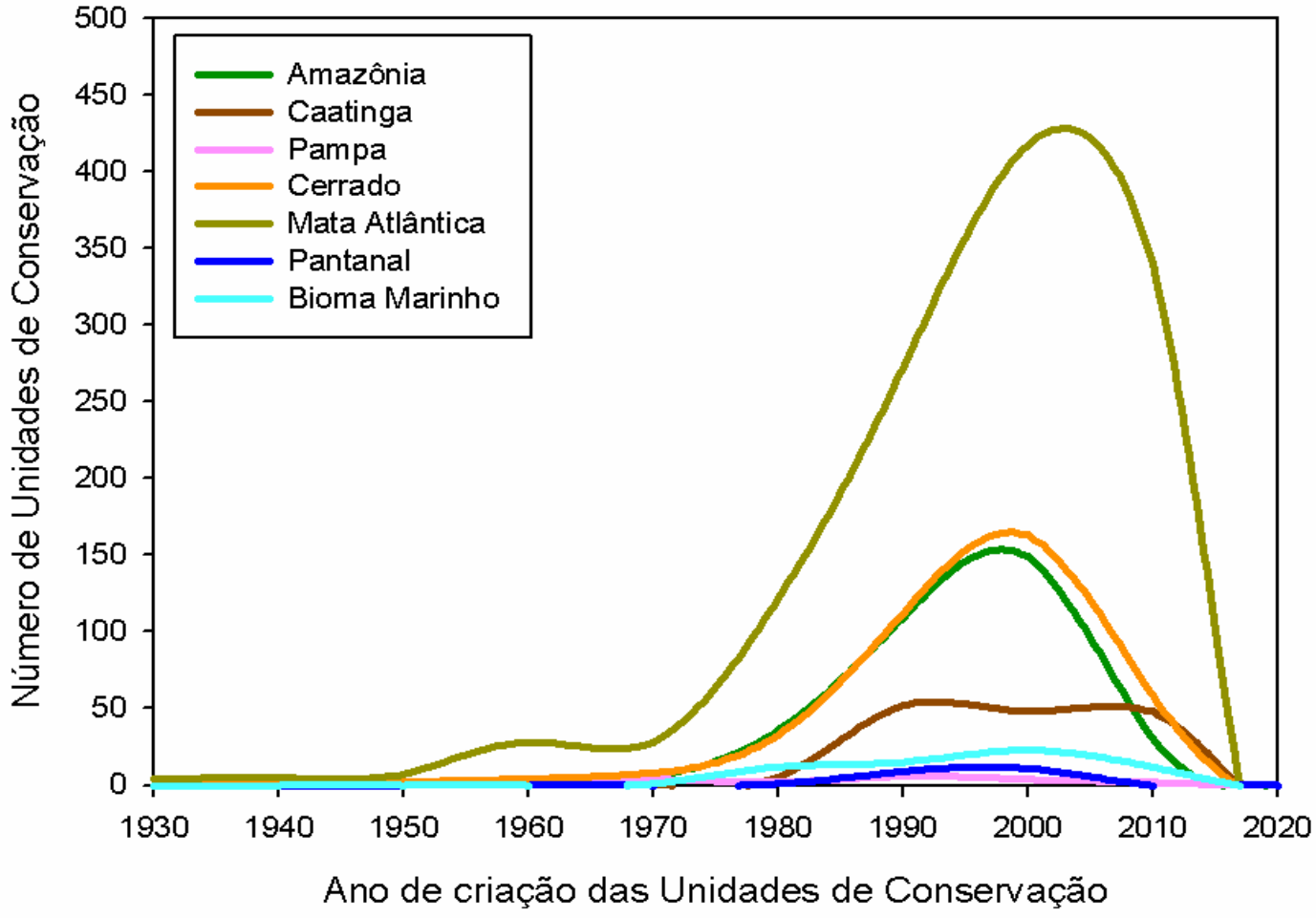
% Endangered species and endemism



Particularly critical situation in the Atlantic Forest and Cerrado

Response Initiatives

Creation of Conservation Units between 1930 and 2018



Pressures on biodiversity and ecosystems

- The current unsustainable use of natural resources needs to be urgently stopped in the face of various signs of environmental collapse.
  - For example, the current rate of destruction and degradation of Brazilian forests is already putting at risk the hydrological cycle that largely maintains agricultural production.

- Currently, two factors put particular pressure on the loss of biodiversity and ecosystem services:
- *1) land use change;*
- *2) climate change*

- Over the course of this century, the intensification of climate change will accentuate the current trend of biodiversity loss and compromised ecosystem services.

Impacts on Brazilian biomes

Brazilian Atlantic Forest lato sensu: the most ancient Brazilian forest, and a biodiversity hotspot, is highly threatened by climate change

Colombo, AF.[a] *and Joly, CA.*[b]*

[a]Programa de Pós-graduação em Ecologia, Instituto de Biologia – IB,
Universidade Estadual de Campinas – UNICAMP, CP 6109, CEP 13083-970, Campinas, SP, Brazil

[b]Departamento de Biologia Vegetal, Instituto de Biologia – IB,
Universidade Estadual de Campinas – UNICAMP, CP 6109, CEP 13083-970, Campinas, SP, Brazil

*e-mail: cjoly@unicamp.br

Received January 8, 2010 – Accepted July 5, 2010 – Distributed October 31, 2010

(With 6 figures)

Biodivers Conserv (2012) 21:2913–2926
DOI 10.1007/s10531-012-0346-7

ORIGINAL PAPER

Conserving the Brazilian semiarid (Caatinga) biome under climate change

Guilherme de Oliveira · Miguel Bastos Araújo · Thiago Fernado Rangel · Diogo Alagador · José Alexandre Felizola Diniz-Filho

Impacts on Brazilian biomes

Ecological Complexity 22 (2015) 65–75

Contents lists available at ScienceDirect

Ecological Complexity

journal homepage: www.elsevier.com/locate/ecocom

Original Research Article

Synergistic effects of drought and deforestation on the resilience of the south-eastern Amazon rainforest

Arie Staal [a,b,*], Stefan C. Dekker [b], Marina Hirota [c], Egbert H. van Nes [a]

[a] Aquatic Ecology and Water Quality Management Group, Wageningen University, P.O. Box 47, 6700 AA, Wageningen, The Netherlands
[b] Department of Environmental Sciences, Copernicus Institute for Sustainable Development, Utrecht University, P.O. Box 80115, 3508 TC Utrecht, The Netherlands
[c] Department of Physics, Federal University of Santa Catarina, P.O. Box 476, 88040-970, Florianópolis, Brazil

Potential impacts of climate change on biogeochemical functioning of Cerrado ecosystems

Bustamante, MMC.[a], Nardoto, GB.[b], Pinto, AS.[a], Resende, JCF.[c], Takahashi, FSC.[a] and Vieira, LCG.[b]*

[a]Laboratório de Ecologia de Ecossistemas, Departamento de Ecologia, Instituto de Ciências Biológicas, Universidade de Brasília – UnB, CEP 70919-900, Brasília, DF, Brazil
[b]Faculdade UnB Planaltina – FUP, Universidade de Brasília – UnB, Campus de Planaltina, CEP 73345-010, Brasília, DF, Brazil
[c]Unidade de Desenvolvimento Urbano, Rural e Meio Ambiente, Câmara Legislativa do Distrito Federal, Praça Municipal – Eixo Monumental, Quadra 2, Lote 5, CEP 70070-550, Brasília, DF, Brazil
*e-mail: mercedes@unb.br

Received February 13, 2012 – Accepted July 23, 2012 – Distributed August 31, 2012
(With 2 figures)

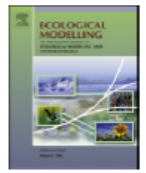
Impacts on ecosystem services

Ecological Modelling 244 (2012) 127–131

Contents lists available at SciVerse ScienceDirect

Ecological Modelling

journal homepage: www.elsevier.com/locate/ecolmodel



Pollination services at risk: Bee habitats will decrease owing to climate change in Brazil

Tereza C. Giannini[a,*], André L. Acosta[a], Carlos A. Garófalo[b], Antonio M. Saraiva[c], Isabel Alves-dos-Santos[a], Vera L. Imperatriz-Fonseca[a,d]

[a] Instituto de Biociências da Universidade de São Paulo, Rua do Matão, 321, 05508-900 São Paulo, São Paulo, Brazil
[b] Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo, Av. Bandeirantes, 3900, 14040-901 Ribeirão Preto, São Paulo, Brazil
[c] Escola Politécnica da Universidade de São Paulo, Av. Prof. Luciano Gualberto, 380, 05508-970 São Paulo, São Paulo, Brazil
[d] Universidade Federal Rural do Semi-Árido, Av. Francisco Mota, 572, 59625-900 Mossoró, Rio Grande do Norte, Brazil

Biodivers Conserv (2013) 22:483–495
DOI 10.1007/s10531-012-0424-x

ORIGINAL PAPER

A straightforward conceptual approach for evaluating spatial conservation priorities under climate change

Rafael D. Loyola · Priscila Lemes · João Carlos Nabout · Joaquim Trindade-Filho · Maíra Dalía Sagnori · Ricardo Dobrovolski · José Alexandre F. Diniz-Filho

Impacts on conservation strategies

Biological Conservation 158 (2013) 248–257

Contents lists available at SciVerse ScienceDirect

Biological Conservation

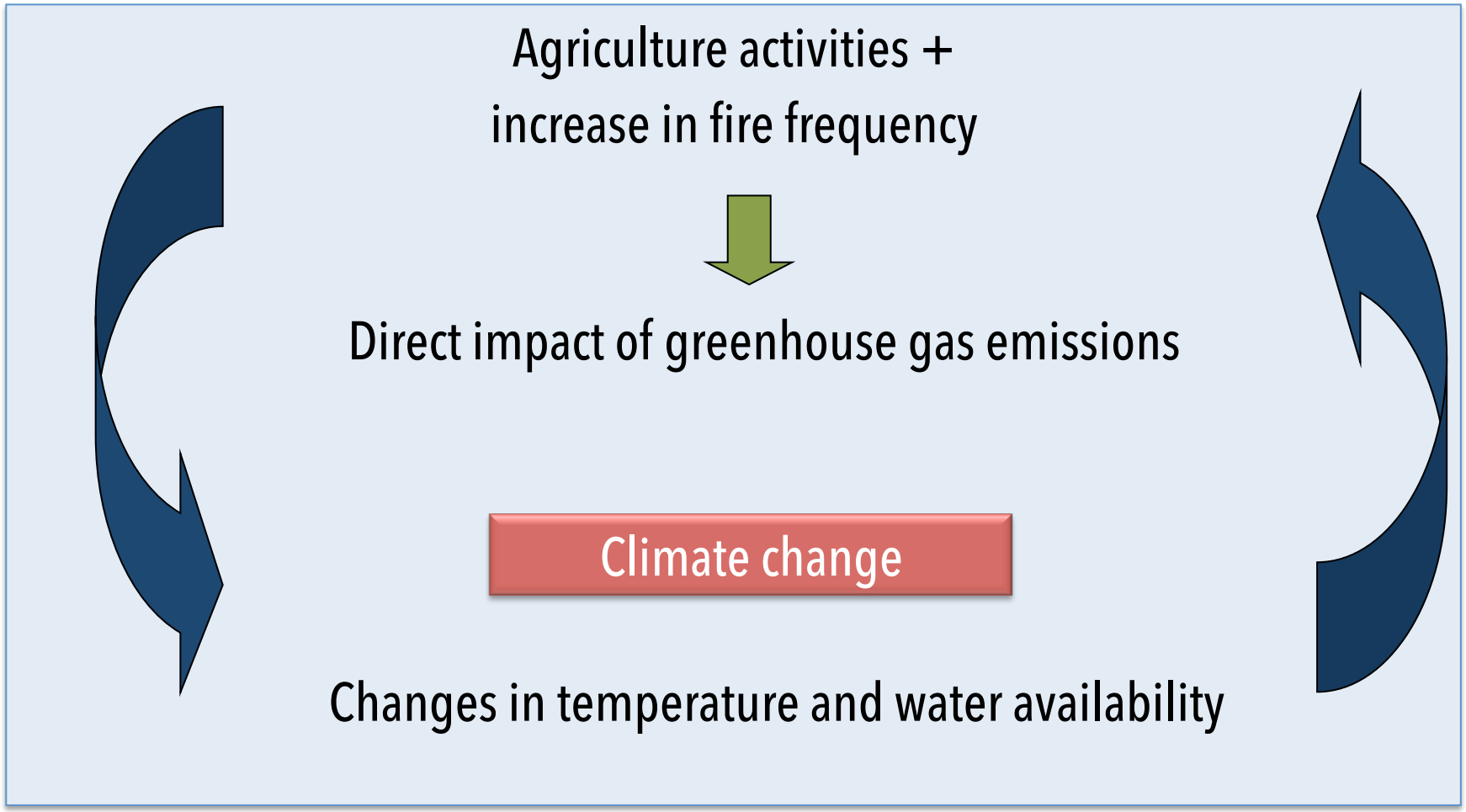
journal homepage: www.elsevier.com/locate/biocon

Defining spatial conservation priorities in the face of land-use and climate change

Frederico V. Faleiro[a,b], Ricardo B. Machado[c], Rafael D. Loyola[a,*]

[a] Departamento de Ecologia, Universidade Federal de Goiás, Brazil
[b] Programa de Pós-graduação em Ecologia & Evolução, Universidade Federal de Goiás, Brazil
[c] Departamento de Zoologia, Universidade de Brasília, Brazil

Land use changes in Brazil: a two-way road...



Projections for Brazil in 2024

- **The use of land for major crops in 2024** (oilseeds, rice, wheat, sugar cane and cotton) should reach 69.4 million of hectares (Mha),

- **A growth of 20%** in relation to average used during the 2012-14 and a growth rate of about 1.5% per year.

- Additional land for soybean expansion would come mainly from the MATOPIBA region (Maranhão, Tocantins, Piauí and Bahia).

Source: Agricultural Outlook 2015-2014 – OECD and FAO report

Paris Agreement - Brazil´s NDC

- **September 2015 - Nationally Determined Contribution (NDC)**
- Reduction of greenhouse gas (GHG) emissions of 37% below 2005 levels by 2025; 43 % by 2030.

Forestry and Land use sector

- to restore 12 million hectares of forest, by 2030, for **multiple uses (?)**;
- to eliminate illegal deforestation in the Amazon by 2030.
- to reinforce efforts to implement the Forest Code

Compliance with the Forest Code Restoration

- Today in Brazil, areas of APP and RL that need to be recovered under current legislation = about **21 million hectares** (Mha)

(SAE 2013).

- **These areas are concentrated in:**
- Amazon (8 Mha) – transition to the Cerrado
- Atlantic Forest (6 Mha) – almost entire length
- Cerrado (5 Mha) – Southern part

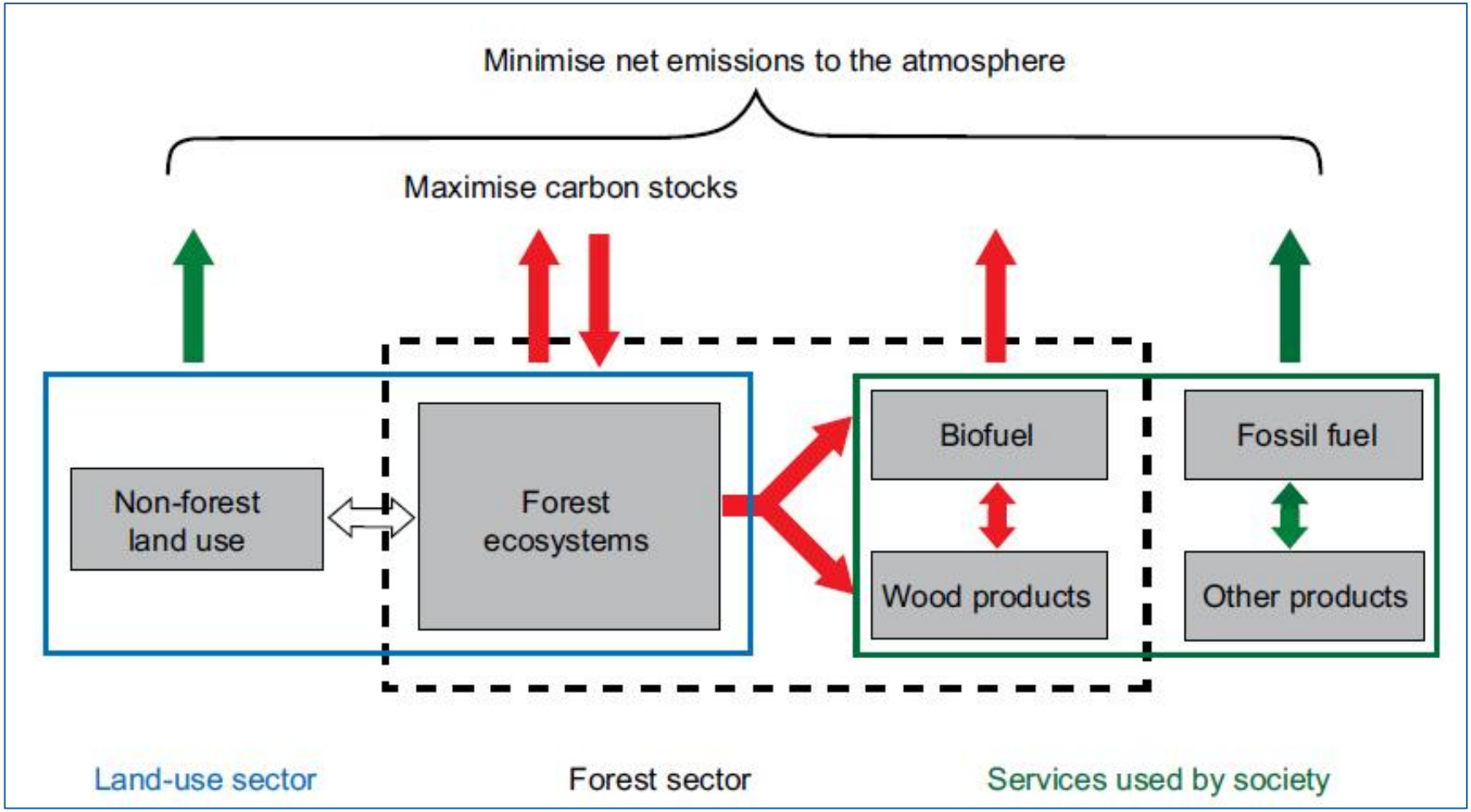
- **Considering only APPs to be restored = 4.8 Mha**
- Cerrado (≈1,7 Mha)
- Atlantic Forest (≈1,5 Mha)
- Amazon (≈1 Mha).

Climate change and resilience of ecosystems

- Climate change triggers ecosystem transformation, loss of biodiversity and substantial changes in ecosystem services.
- Good Ecosystem management - maintain health and increase resilience, while reducing vulnerability to climate change.

- Resilient ecosystems have greater potential to mitigate and adapt to climate change and to reverse global warming.

Designated functions of forests in forest management plans and forest action plans



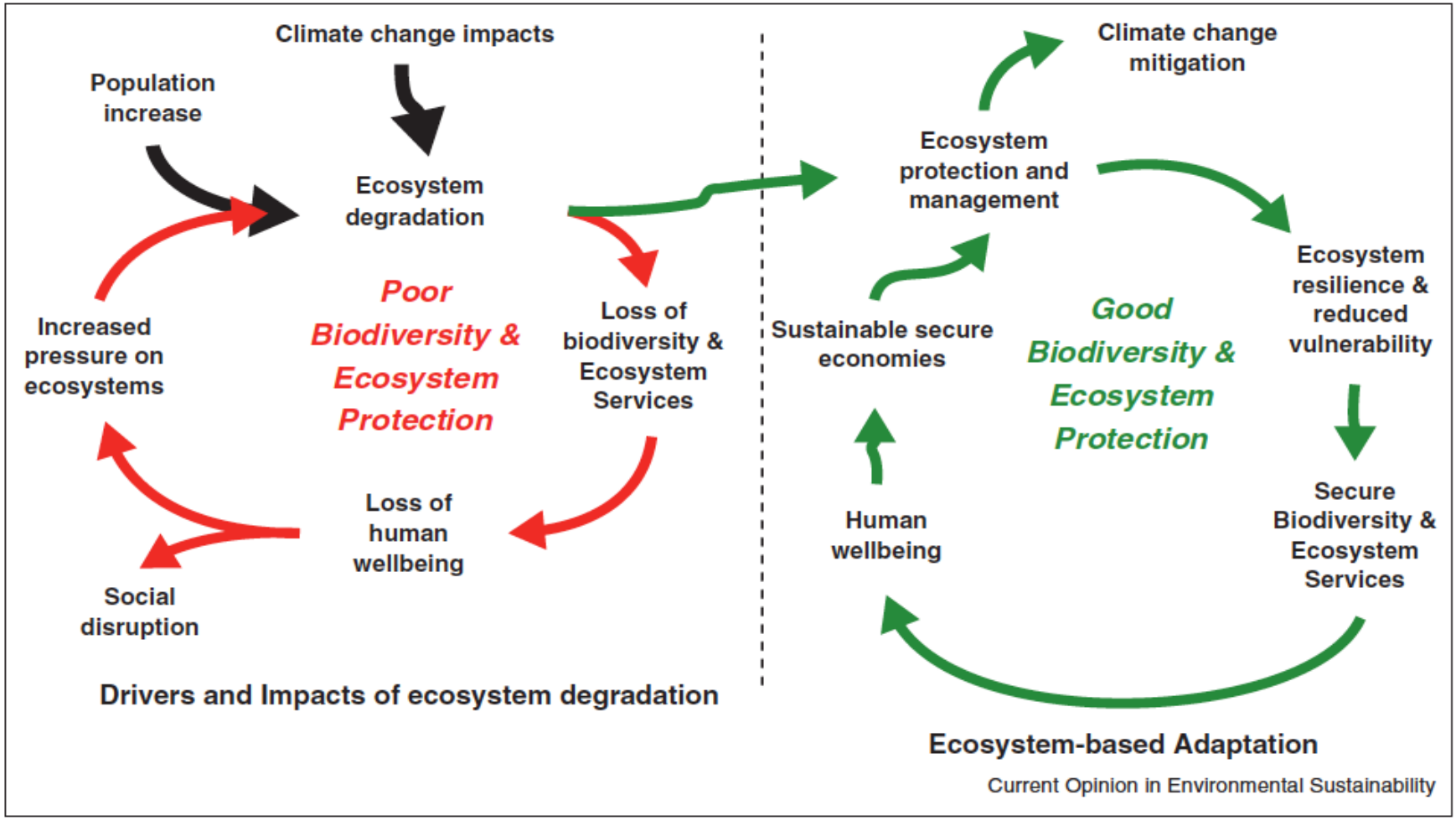
Source: FAO, 2010

Climate change and resilience of ecosystems

- Resilient ecosystems can recover more easily from extreme weather events and provide a wide range of ecosystem services.

- Ecosystems well conserved and managed for rational use provide regulating environmental services, such as:
  - temperature regulation,
  - flood control by absorbing excess water and mitigating extreme runoff,
  - protection from tropical storms and landslides, capable of causing damage to the most exposed and vulnerable social actors.

Beating the vicious cycle of poverty, ecosystem degradation and climate change



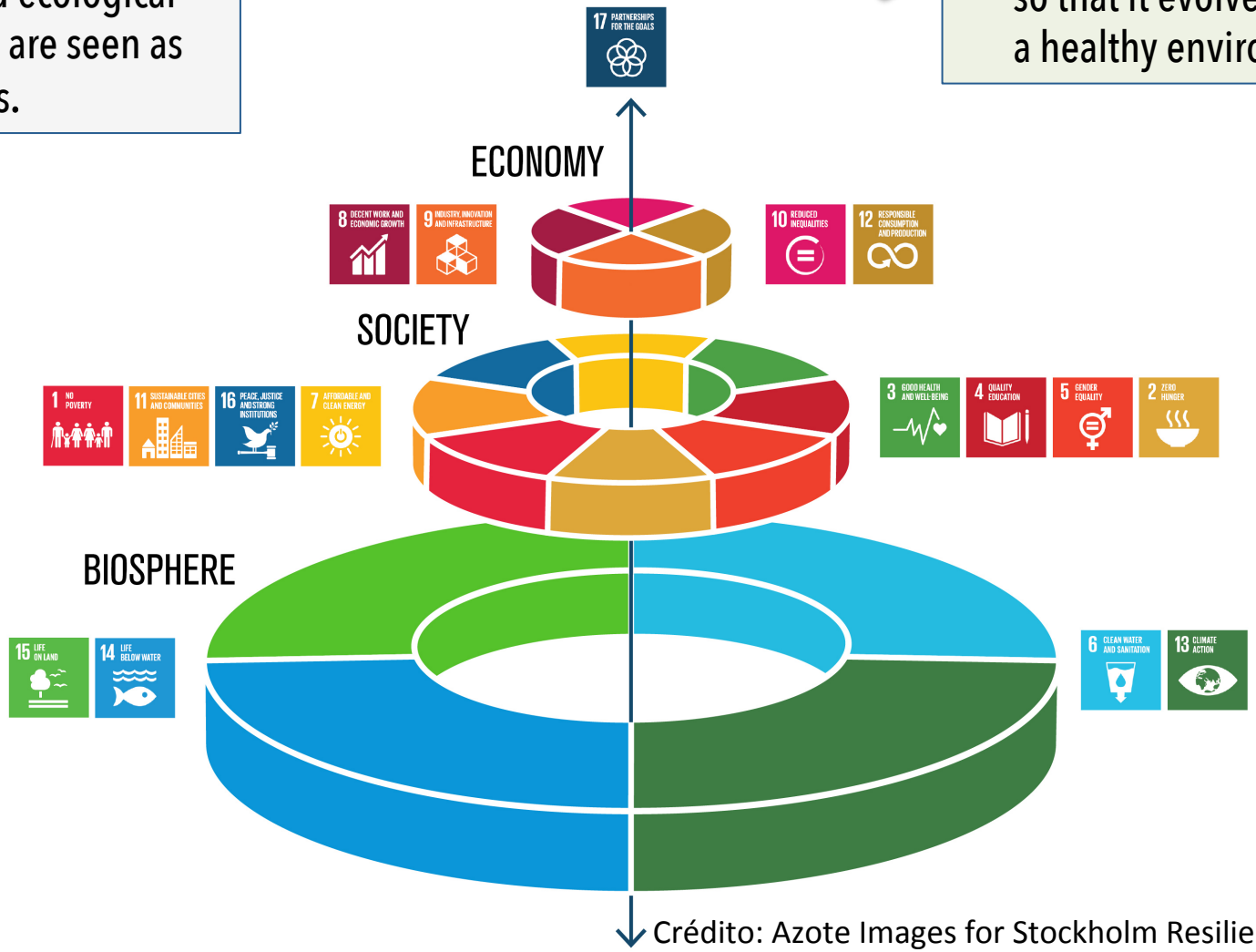
R. Munang, I. Thiaw, K. Alverson, M. Mumba, J. Liu, and M. Rivington, Climate change and Ecosystem-based Adaptation: a new pragmatic approach to buffering climate change impacts, Curr Opin Environ Sustain, 2013.

Biosphere: basis of sustainable development goals

- **from the current sectoral approach,** where social, economic and ecological development are seen as separate parts.

Paradigm shift to another development pattern

- to a logic in which the economy serves society so that it evolves within a healthy environment.

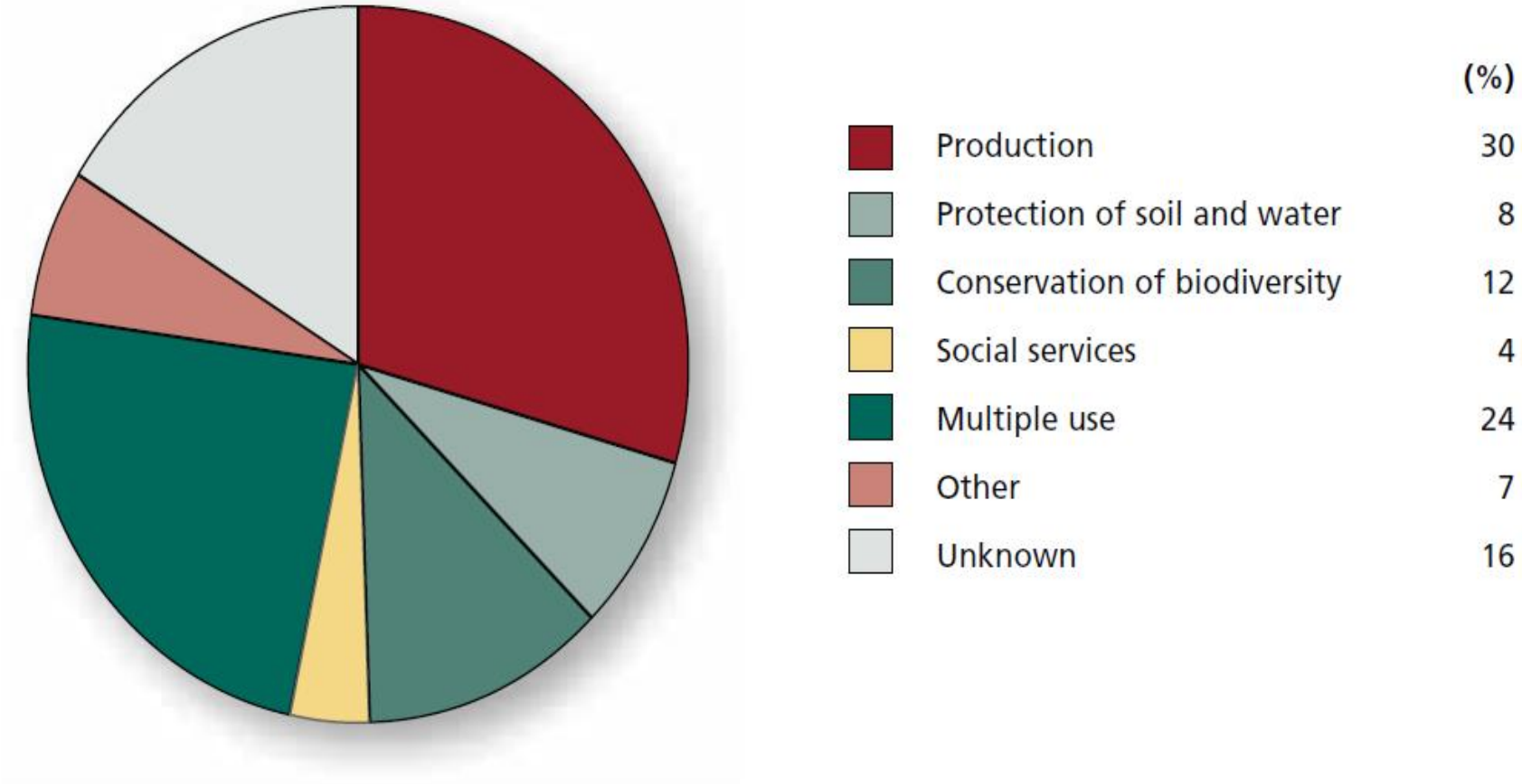


Crédito: Azote Images for Stockholm Resilience Centre

Graphics by Jerker Lokrantz/Azote

Climate mitigation policies – benefits beyond global climate protection and actually accrue at the local level

Approximately **ten million people** are employed in the forest management and conservation sector and many more are directly dependent on forests for their livelihoods (FAO, 2010).



Estimated value of non-wood forest product removals in millions of dollars by category and region in 2005

NWFP categories	Total (million US$)	Share of each category in total value (%)					
		World	Europe	Asia	Americas	Oceania	Africa
Food	8 614	51	48	67	23	47	39
Other plants products	2 792	17	3	22	61	3	7
Wild honey and beeswax	1 805	11	21	n.s.	n.s.	12	n.s.
Ornamental plants	984	6	10	1	3	4	0
Exudates	631	4	1	7	5	0	25
Plant materials for medicine, etc.	628	4	5	2	1	9	18
Wild meat	577	3	7	n.s.	n.s.	1	2
Materials for utensils, construction, etc.	427	3	3	1	3	18	n.s.
Hides, skins and trophies	183	1	1	n.s.	3	7	n.s.
Living animals	154	1	2	n.s.	n.s.	0	7
Fodder	21	n.s.	n.s.	n.s.	n.s.	0	2
Colorants and dyes	18	n.s.	n.s.	n.s.	n.s.	0	n.s.
Other non-edible animal products	6	n.s.	0	n.s.	0	0	n.s.
Other edible animal products	1	n.s.	n.s.	0	0	0	n.s.
Raw animal material for medicine	0	n.s.	n.s.	0	0	0	0
Total value (million US$)	**16 839**	**16 839**	**8 389**	**5 655**	**2 132**	**402**	**261**

n.s.= not significant

Source: FAO, 2010

Brazil: Biosphere, the basis of sustainable development objectives

- Brazil's environmental assets - the supply of nature goods and associated ecosystem services - represent the basis for sustaining the demands of Brazilian society.

- Food, water, climate and energy security, as well as human health, depend on ecosystem services, such as:
  - pollination
  - maintenance of water resources
  - climate regulation
  - disease vector control

Brazil: Biosphere, the basis of sustainable development goals

Of the 141 Brazilian agricultural crops analyzed, 85 depend on pollination by animals.

More than 40% of primary energy production in the country comes from renewable sources
2/3 of the electricity consumed comes from hydropower plants that depend on the integrity of ecosystems.

About 80 botanical families and 469 plant species are cultivated in agroforestry systems.

More than 245 species of the Brazilian flora are based on cosmetic and pharmaceutical products and at least 36 native botanical species have phytotherapic register.

Brazil: the opportunity of sociobiodiversity

The country's biological diversity is also expressed in its immense cultural diversity.

The country is also home to 305 contacted indigenous peoples , speakers of 274 languages.

Brazil is home to more than 500 sacred natural sites associated with multiple cultural manifestations.

Dozens of other traditional populations, such as caiçaras, quilombolas, seringueiros, ribeirinhos, quebradeiras de coco-babaçu, pantaneiros, vazanteiros.

Historically, we have received migratory flows from various parts of the world.

Moment of decision: A prosperous future for the Brazilian population will depend on the choices and actions taken in the present.

- An understanding of the inestimable value of biodiversity and ecosystem services for generating employment and income and reducing social and economic inequalities is fundamental.

- This scenario will only be possible, however, if the role of conservation of natural resources in leveraging social and economic development is recognized and encouraged.

The role of science: dialogue and knowledge at the service of society

Science is of fundamental importance to:

- to help us to read and better understand the world and its dynamics,
- point out and plan options for future trajectories.

Science: filling in the gaps

- **Knowledge about Brazilian biodiversity and ecosystems, with long-term research programs.**
- **In the last decade, there have been significant advances:**

Sharing, transparency of data and public information on biodiversity and ecosystem services

Repatriation of knowledge of Brazilian biodiversity

Advances in the development of lists of species, including threatened and invasive species

Use of open access geospatial tools

Final considerations

The current global and national pressures, in the social, economic and environmental fields, are numerous and growing and the current development model is prescribing.

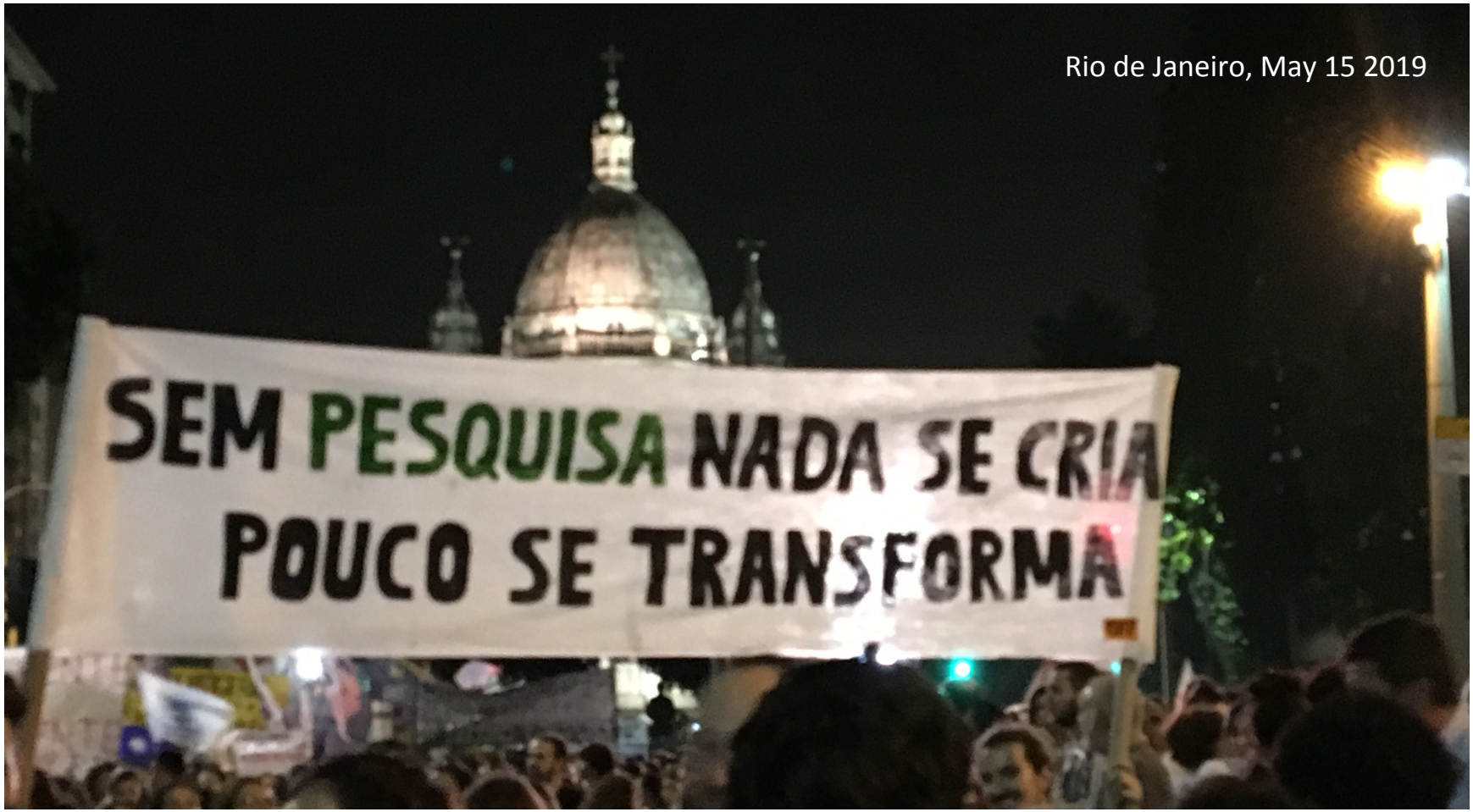
Brazilian biodiversity and ecosystems are the basis for the social welfare and economic development of the country, although often poorly recognized.

However, unsustainable practices are leading to the irreversible depletion of this natural wealth, without its economic potential having been realized.

Sustainability is no longer an option
It is an imperative for Brazil

Photo: Panoramio, 2012

But…Implementation would require **overcoming significant socio-economic, technological, financing, and institutional, barriers**



Thank you!

Mercedes Bustamante
mercedes@unb.br