

# Maintaining Life on Land (SDG15) under Scenarios of Land Use and Climate Change in Colombia, Ecuador, and Peru

NASA Biodiversity and Ecological Forecasting Meeting  
College Park, MD  
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# Team



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NASA HQ

# NASA Life on Land Project



## Project Objectives

1. Develop indicators of ecosystem quality for SDG 15 (sustainable use of terrestrial ecosystems) reporting
2. Project change in indicators under climate and socioeconomic scenarios
3. Use results to inform national reporting and policymaking for SDG15





# Topics

- Collaborations and outreach
- Indicators
- Forecasting of scenarios
- Broader impacts

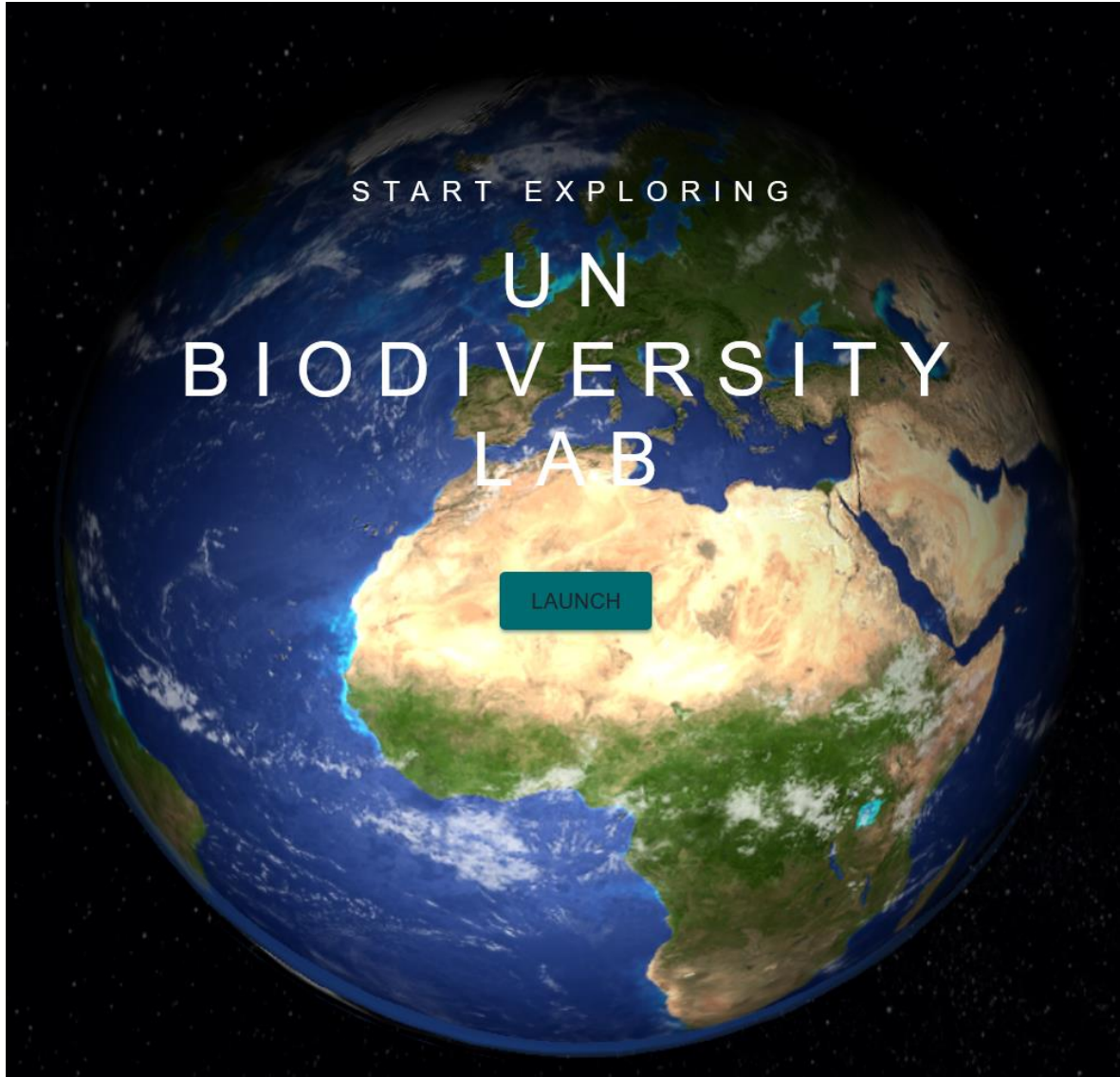


# KEY PARTNERS

COLOMBIA	ECUADOR	PERU
<ul style="list-style-type: none"> <li>· <b>UNDP Colombia</b></li> <li>· <b>Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH)</b></li> <li>· <b>Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM)</b></li> <li>· <b>Ministry of Environment and Sustainable Development (MADS)</b></li> <li>· <b>Departamento Administrativo Nacional de Estadística (DANE)</b></li> <li>· <b>Universidad Nacional de Colombia</b></li> <li>· Instituto Amazónico de Investigaciones Científicas (SINCHI)</li> <li>· Instituto de Investigaciones Marinas y Costeras José Benito Vives de Andrés (INVEMAR)</li> <li>· Instituto Geográfico Agustín Codazzi (IGAC)</li> <li>· Instituto de Investigaciones Ambientales del Pacífico (IIAP)</li> </ul>	<ul style="list-style-type: none"> <li>· <b>UNDP Ecuador</b></li> <li>· <b>Ministerio del Ambiente</b></li> <li>· <b>Instituto Nacional de Estadísticas y Censo</b></li> <li>· Instituto Nacional de Meteorología e Hidrología</li> <li>· Ecociencia</li> <li>· Instituto Geográfico Militar</li> <li>· Agencia de Regulación y Control Minero</li> <li>· Ministerio de Agricultura y Ganadería</li> <li>· Agencia de Regulación y control de electricidad</li> <li>· Ministerio de Gobierno</li> <li>· Ministerio de Energía y Recursos Naturales no Renovables</li> </ul>	<ul style="list-style-type: none"> <li>· <b>UNDP Ecuador</b></li> <li>· <b>Ministerio del Ambiente (MINAM)</b></li> <li>· <b>Servicio Nacional de Áreas Naturales Protegidas por el Estado Peruano (SERNANP)</b></li> <li>· <b>Servicio Nacional Forestal y de Fauna Silvestre (SERFOR)</b></li> <li>· <b>Instituto Nacional de Estadística e Informática (INEI)</b></li> <li>· <b>Programa Nacional de Conservación de Bosques para la Mitigación del Cambio Climático (MINAM/PNCBMCC)</b></li> <li>· Comisión Nacional de Investigación y Desarrollo Aerospacial (CONIDA)</li> <li>· Ministerio de Transportes y Comunicaciones (MTC)</li> <li>· Centro de Datos para la Conservación de la Universidad Nacional Agraria La Molina (CDC-UNALM)</li> <li>· Autoridad Nacional del Agua (ANA)</li> <li>· Instituto del Bien Común (IBC)</li> <li>· Instituto Geográfico Nacional (IGN)</li> <li>· Ministerio de Cultura (MINCU)</li> <li>· Organismo de Supervisión de los Recursos forestales y de Fauna Silvestre (OSINFOR)</li> <li>· PerúPetro</li> <li>· Instituto Geológico, Minero y Metalúrgico</li> </ul>

# ENGAGEMENT OF KEY PARTNERS

- **Monthly Project Calls (2019-2020)**
  - ~30 participants up to the Director level
- **Virtual Annual Workshops (2019-2020)**
  - ~50 participants up to the Director level
- **Technical Roundtables (2021-2022)**
  1. Overview of data and metrics
  2. Deforestation rate and fragmentation
  3. Human footprint and natural habitat
  4. Forest structural condition and select vertebrate species
  5. Riparian forests and hydrology
  6. Review of progress to date on all indicators and next steps
  7. UN Biodiversity Lab & comms
  8. Comparing methods & applications of human footprint.
  9. Final year & scenario planning



# Launch of UNBL 2.0

- **Site views:** 37,000+
- **Registered users:** 1,200+
- **Workspaces:** 100+ created
- **Events/trainings:** 10 events | 11,000 live participants
- **Social media:** Reach 7 million; 35 million impressions (*Oct-Nov 2021 data only*)





TRAINING

# ARSET - Using the UN Biodiversity Lab to Monitor the Pulse of the Planet

## NASA ARSET TRAINING ON UNBL 2.0

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- **Participants:** 958
- **Organizations:** 400
- **Countries:** 121
- **US States:** 23



United Nations Statistical Commission



Target	Indicator	UN Sub-indicators
<b>TARGET 15.1:</b> Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems...	<b>INDICATOR 15.1.1: Forest area</b> as a proportion of total land area	Percentage of <b>forest area</b> of the total land area of a country
	<b>INDICATOR 15.1.2: Proportion of important sites</b> for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	Mean <b>percentage of</b> each terrestrial and freshwater Key Biodiversity Area covered by protected areas and/or Other Effective Area-based Conservation Measures.
<b>TARGET 15.2:</b> Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests...	<b>INDICATOR 15.2.1:</b> Progress towards sustainable forest management	Annual average percent <b>change in forest area</b>
		Annual average percent change in stock of
		Share <b>of forest area</b> whose primary designated function is biodiversity conservation
		Proportion of forest area under a long-term forest management plan
		<b>Forest area</b> under an independently verified forest management certification scheme

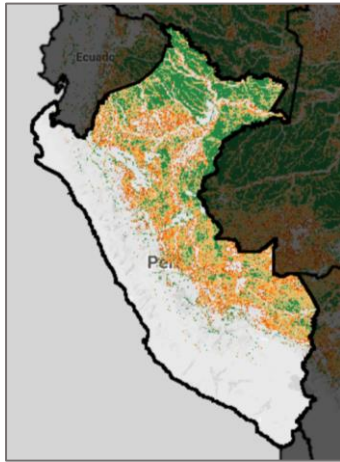
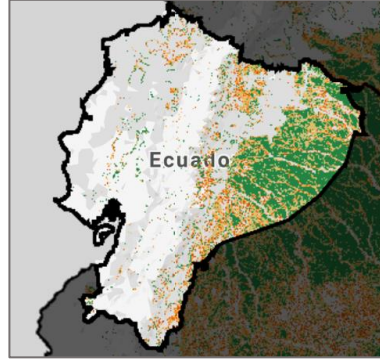
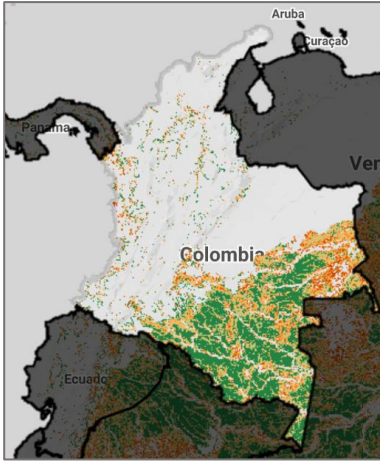


# National Sub Indicators of Forest Quality

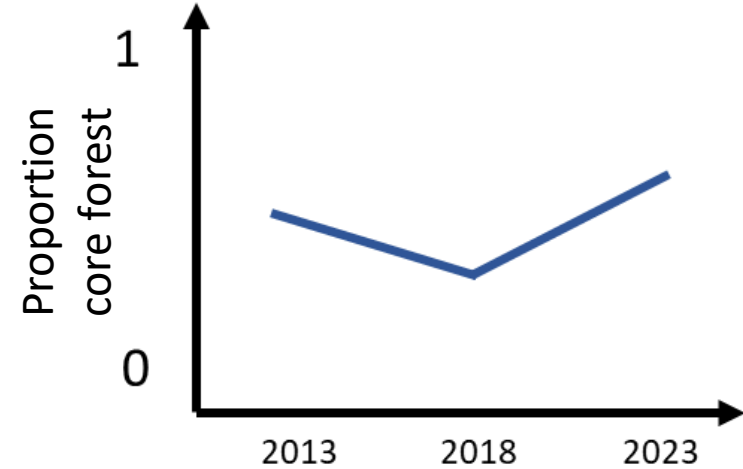
Indicator	Enhanced sub-indicators	Element of forest quality
INDICATOR 15.1.1: Forest area as a proportion of total land area	15.1.1.2 Forest area as a proportion of total land area by ecoregion type	Ecoregion type
	15.1.1.3 Natural forest area and proportion by ecoregion type	Naturalness
INDICATOR 15.1.2: Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	15.1.2.2 Average proportion of important ecoregion types covered by protected areas	Ecoregion type
	15.1.2.3 Average proportion of high Forest Structural Integrity Index areas covered by protected areas	Forest structure
	15.1.2.4 Human Footprint change in and around protected areas	Naturalness
INDICATOR 15.2.1: Progress towards sustainable forest management	15.2.1.5 Proportional distribution of forest structural integrity condition classes by ecosystem type	Forest structure
	15.2.1.6 Forest fragmentation index by ecosystem type (all forest, high FSII forest)	Landscape pattern
	15.2.1.7 Forest connectivity index by ecosystem type (all forest, high FSII forest)	Landscape pattern
15.5.1: Red List Index	15.5.1.2 Area of suitable habitats for selected vertebrate species	Habitat suitability



# Indicator: Fragmentation



Time: 2013-2018, annual > 2018  
Resolution: 30m national forests, 1 km FSII  
Availability: Forested ecosystems  
Aggregation: Yes. Basins, states, etc.  
Interpretation: Proportion of core forest. Higher values indicate better spatial configuration of forested areas



$$Fg = \left( 1 - \frac{A_n + A_p + A_b}{A_t} \right) \times 100$$

$Fg$ :	Fragmentation
$A_n$ :	Core area
$A_p$ :	Perforation area
$A_b$ :	Interface area
$A_t$ :	Total area

Source: Hansen *et al.* 2013  
 Vogt *et al.* 2017  
Algorithm: GEE, Python, Guidos  
Repository: UNBiodiversityLab

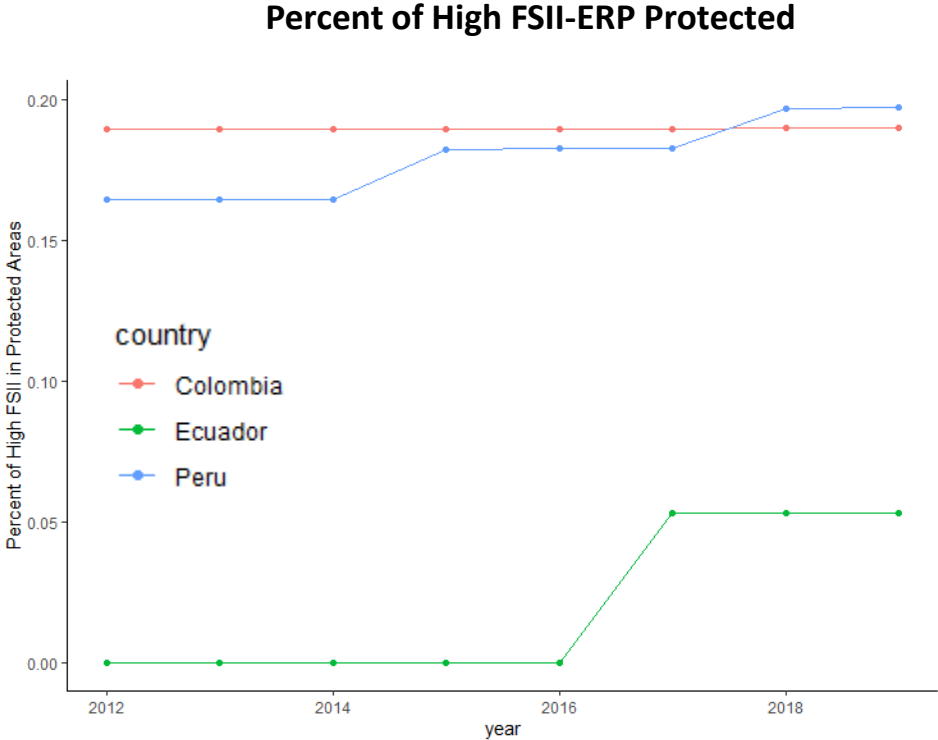
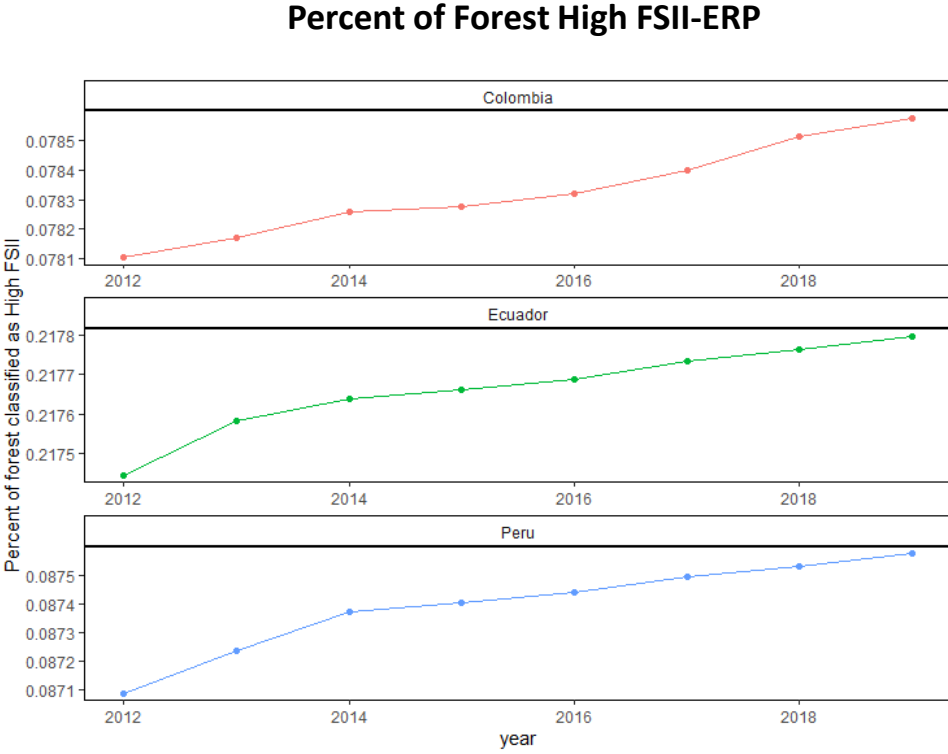
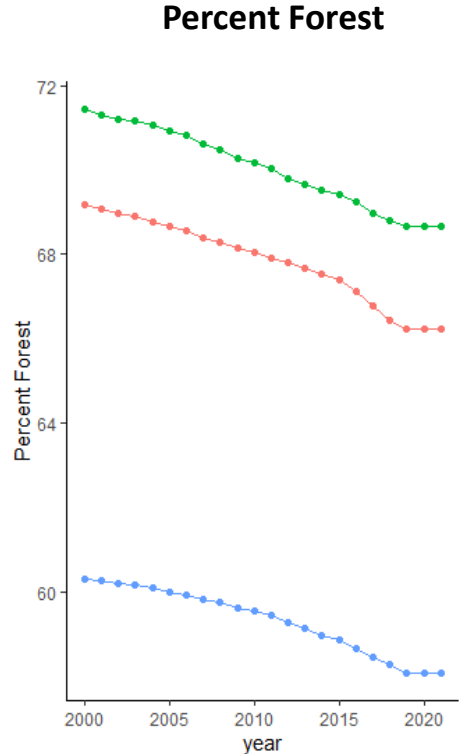
Limitations: Doesn't distinguish between different fragmentation types. Regional borders can indicate non real fragmentation.





# Forest Structural Integrity Index – Ecoregional Potential

## Indicators





# VALIDATION OF INDICATORS FOR NATIONAL USE

Photo: Amazon Watch

- 1 Use of national data to develop project data sets where possible**
- 2 Commitment to update data/indicators until 2030**
- 3 Technical roundtables to share indicator production methods**
- 4 Bilateral meetings with key government agencies**
- 5 Capacity development workshops around the calculation of indicators**



# National Sub Indicators of Forest Quality

Indicator	Enhanced sub-indicators	Use by Country		
		Colombia	Ecuador	Peru
INDICATOR 15.1.1: Forest area as a proportion of total land area	15.1.1.2 Forest area as a proportion of total land area by ecoregion type			
	15.1.1.3 Natural forest area and proportion by ecoregion type			
	15.1.1.4 Natural habitat area as a proportion of ecosystem type			
INDICATOR 15.1.2: Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	15.1.2.2 Average proportion of important ecoregion types covered by protected areas			
	15.1.2.3 Average proportion of high Forest Structural Integrity Index areas covered by protected areas			
	15.1.2.4 Human Footprint change in and around protected areas			
	15.1.2.6 Proportion of riparian areas covered by vegetation			
INDICATOR 15.2.1: Progress towards sustainable forest management	15.2.1.5 Proportional distribution of forest structural integrity condition classes by ecosystem type			
	15.2.1.6 Forest fragmentation index by ecosystem type (all forest, high FSII forest)			
	15.2.1.7 Forest connectivity index by ecosystem type (all forest, high FSII forest)			
15.5.1: Red List Index	15.5.1.2 Area of suitable habitats for selected vertebrate species			

	Reporting prior to project
	No Interest
	Interest in methods
	Potentially reporting in 2023



## **NEXT STEPS**

**Continuous refinement of indicator data and methods**

**Training workshops**

**Official validation and use in the SDG15 report**

**Coordinate with the UN IAEG to include these indicators in its official recommendations**



# Scenario Planning and Forecasting

Scenarios provide a structured way for envisioning, exploring and improving decisions.

## Project Flow

**Goals**  
SDG15 Targets

**Historic patterns**  
SDG15 metrics 2000-2020

**Develop models**  
Biodiversity response to climate and human footprint

**Potential future patterns**  
Forecasts under scenarios 2020-2050

**Conservation planning**  
Develop and implement plans to meet SDG15 targets based on what is learned from forecasts

## SDG15 indicators, metrics

Target	Indicator	Metric
TARGET 15.1: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.1 Forest area and natural forest area by ecosystem type	Forest area as proportion of ecosystem type area Natural forest area as proportion of ecosystem type area
TARGET 15.2: By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.2.1: Progress towards sustainable forest management by ecosystem type	Average proportion of Terrestrial Key Biodiversity Areas (KBAs) covered by protected areas Average proportion of ecosystem types covered by protected areas Average proportion of high forest structural integrity areas covered by protected areas Proportional distribution of forest integrity condition classes by ecosystem type
TARGET 15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	15.3.1: Proportion of land that is degraded by ecosystem type	Forest fragmentation index by ecosystem type (all forest, high forest) Forest connectivity index by ecosystem type (all forest, high forest)
TARGET 15.4: By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	15.4.1: Coverage by protected areas of mountain ecosystems, including their biodiversity, important sites for mountain biodiversity	Water quality and quantity As above for all ecosystem types
TARGET 15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	15.5.1: Protection of species habitats	Area of suitable habitats for selected vertebrate species Average proportion of forest dependent species ranges covered by protected areas

**Monitor and evaluate**  
SDG15 Indicators  
SDG15 Metrics

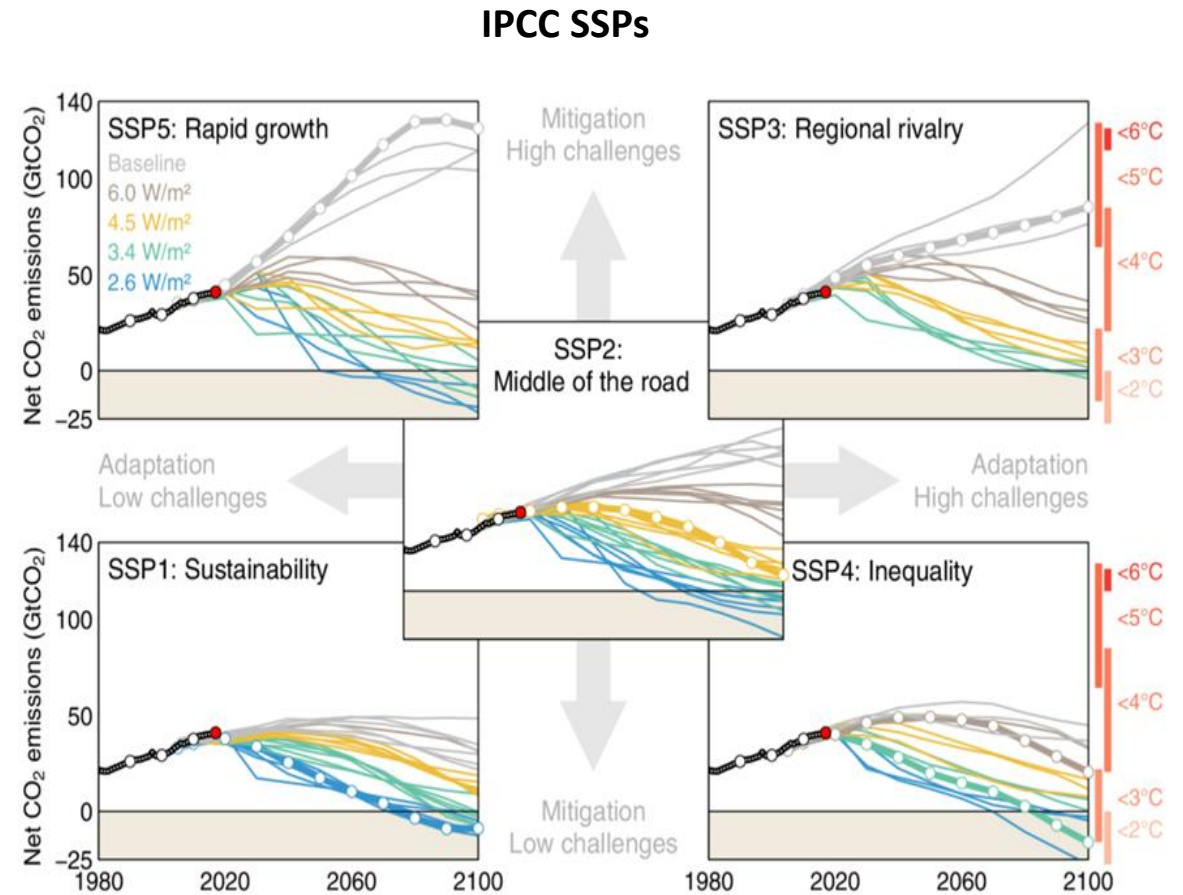
**Report**  
Status and change in  
SDG15 Indicators

Climate	Scenarios		
	Policy		
	SSP1: Sustainability Scenario	SSP2: Business as Usual Scenario:	SSP3: Regional Rivalry:
Low change (RCP 2.6)	x		
Mod change (RCP 4.5)		x	
High change (RCP 8.5)			x

# Scenarios

Our Scenarios

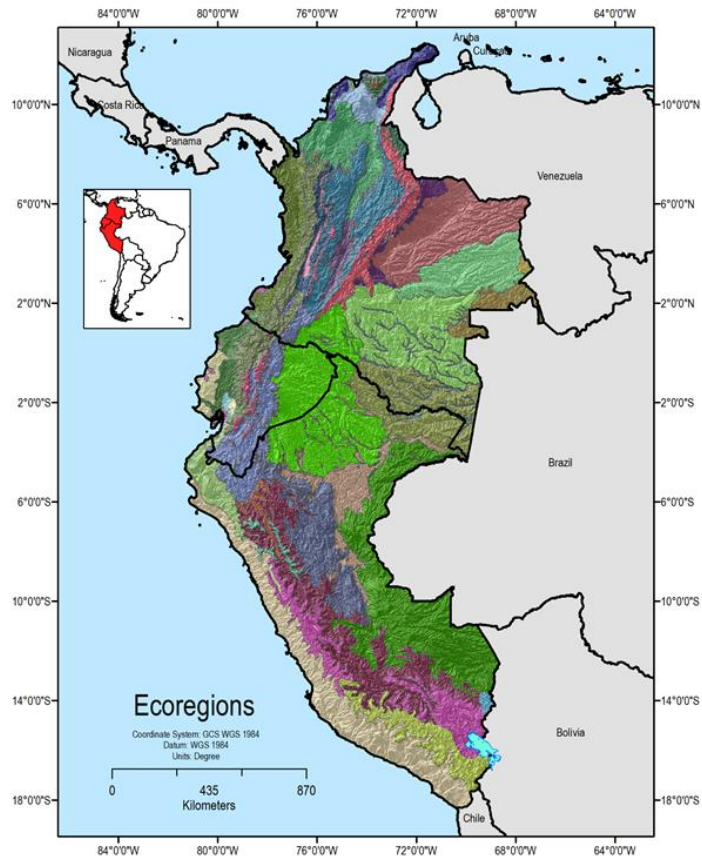
Climate	Human Footprint		
	<u>SSP1:</u> <u>Sustainability</u> <u>Scenario</u>	<u>SSP2:</u> <u>Business as</u> <u>Usual</u> <u>Scenario:</u>	<u>SSP3:</u> <u>Regional</u> <u>Rivalry:</u>
Low change (RCP 2.6)	<b>x</b>		
Mod change (RCP 4.5)		<b>x</b>	
High change (RCP 8.5)			<b>x</b>



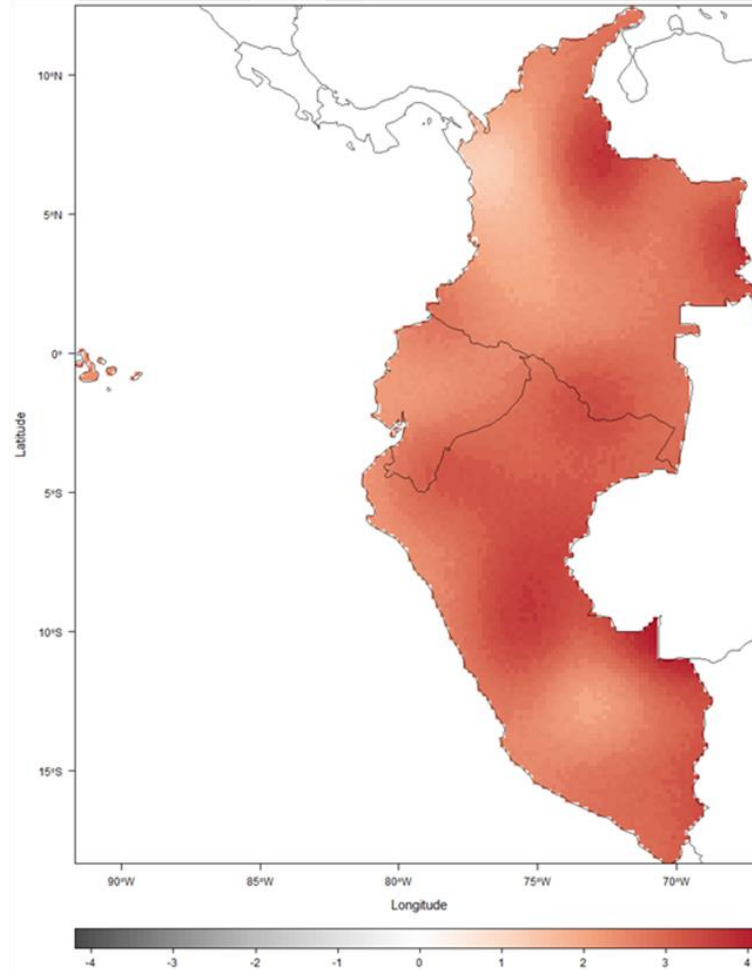


## Ecoregions

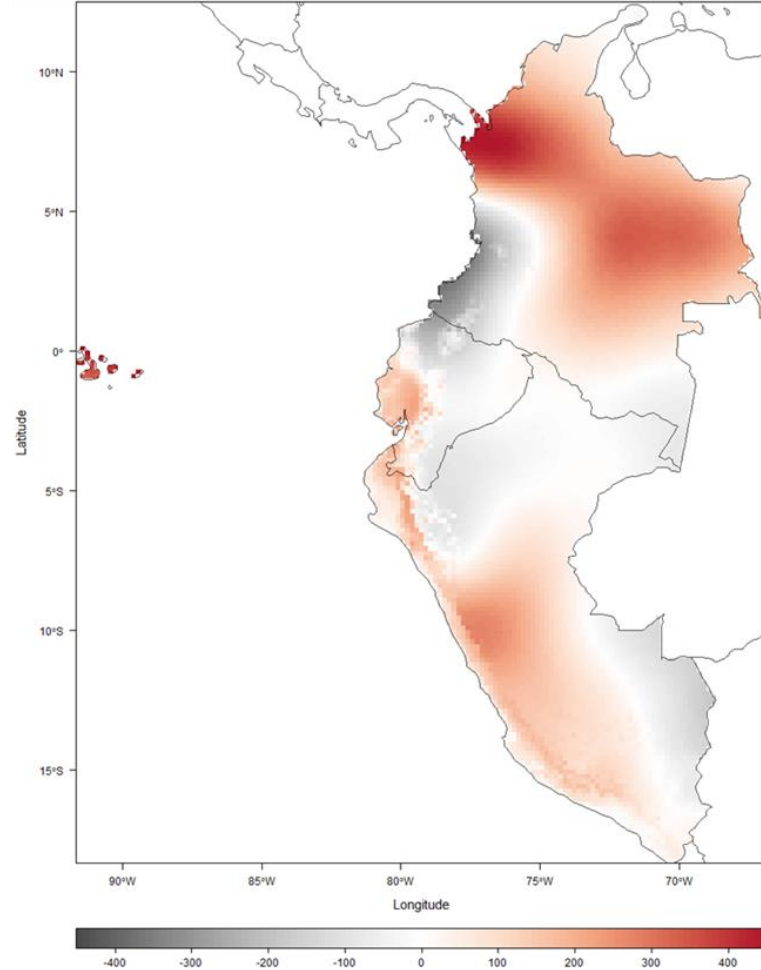
49 in total (Resolve 2017)



## Temperature °C (RCP 8.5-2050) - Baseline



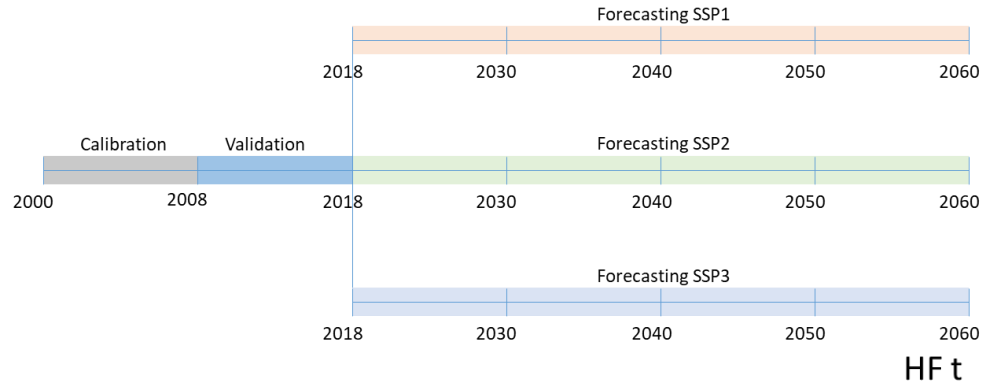
## Precipitation mm (RCP 8.5-2050) - Baseline



## Scenario Planning

# Human Footprint/SSP

### Calibration, validation and forecasting periods

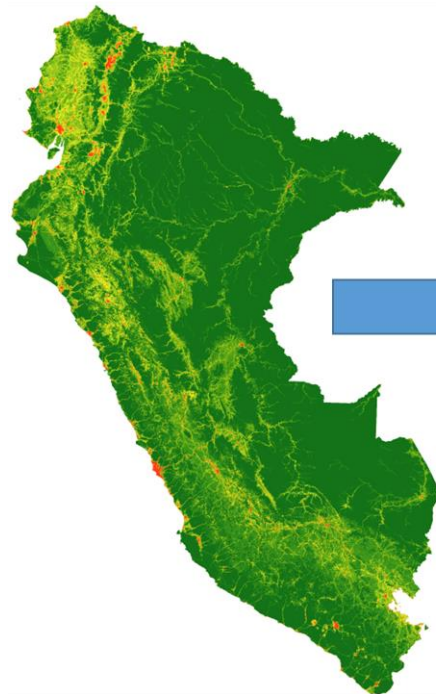


SSPs will be represented by rates of change in the Human Footprint.

### Methods

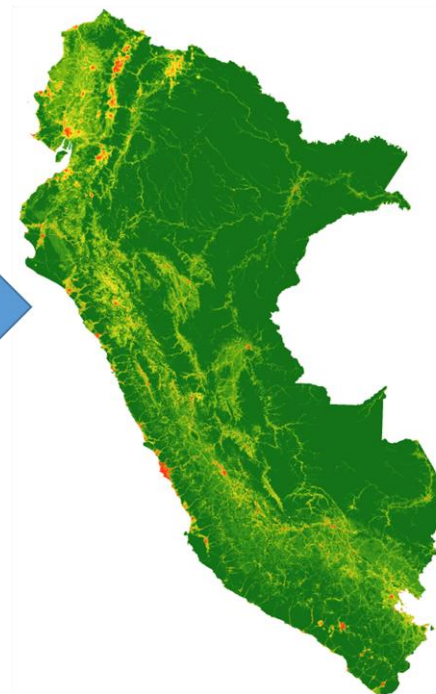
Adaptation of land use change models (Verburg et al. 2005).

Variable to model: HF increase.



- 1 How much?
  - Area (# pixels) of HF change
- 2 Where?
  - Location of changing pixels
- 3 What intensity?
  - Intensity of changing pixels

HF t+1

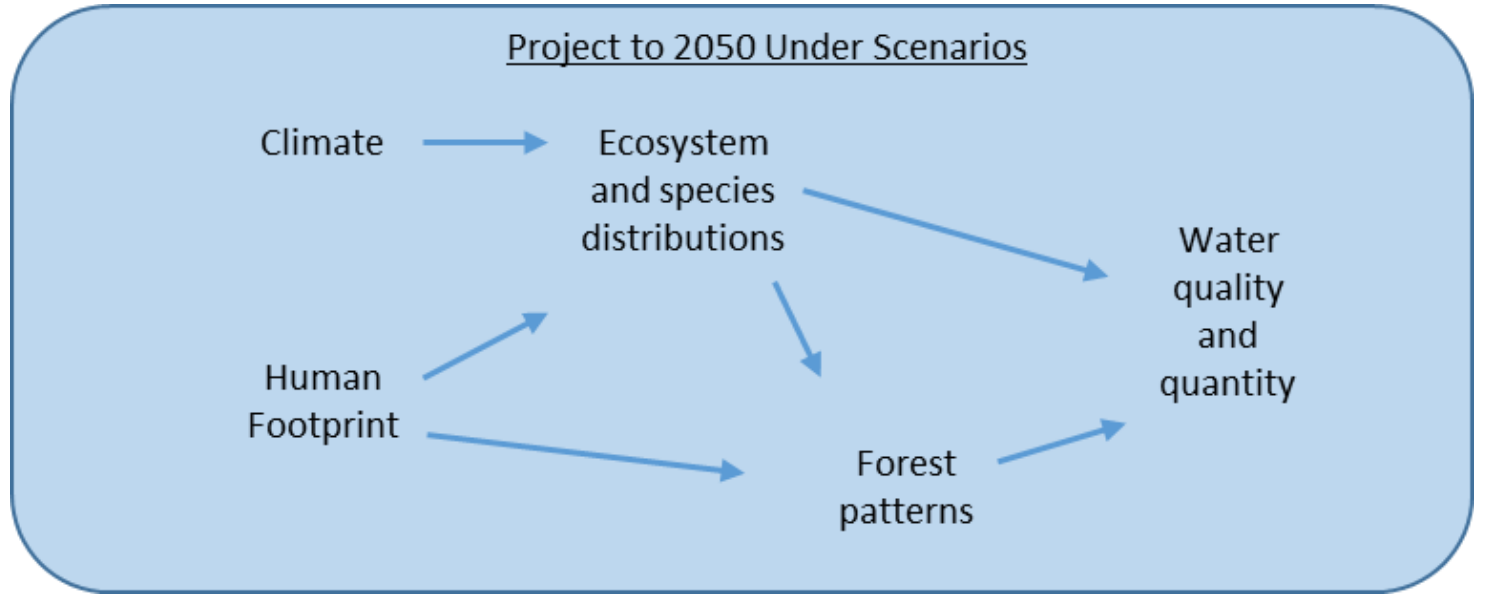




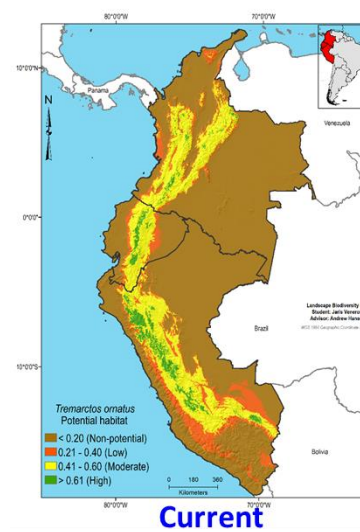
# Forecasting Under the Scenarios

Climate Scenarios →

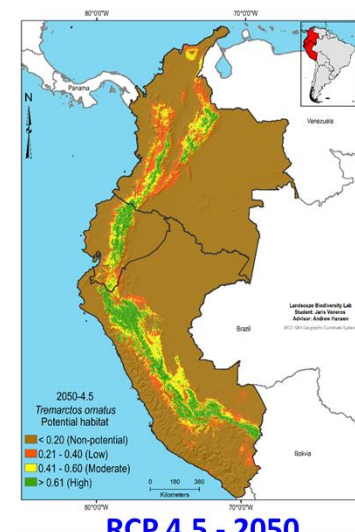
Policy Scenarios →



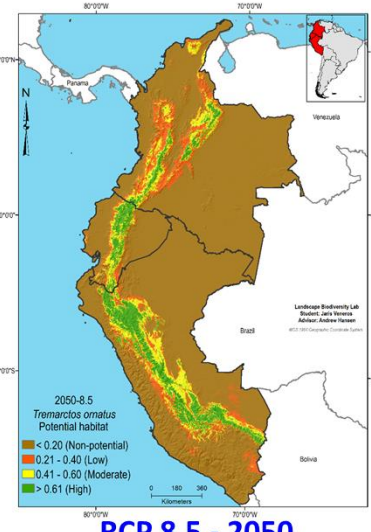
Spectacled bear  
*Tremarctos ornatus*



Current



RCP 4.5 - 2050

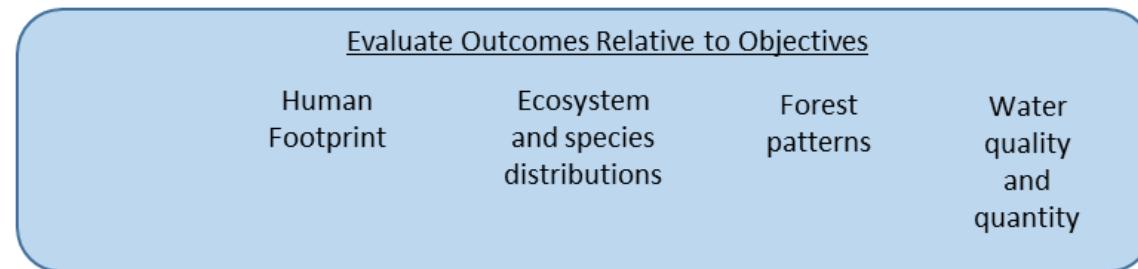
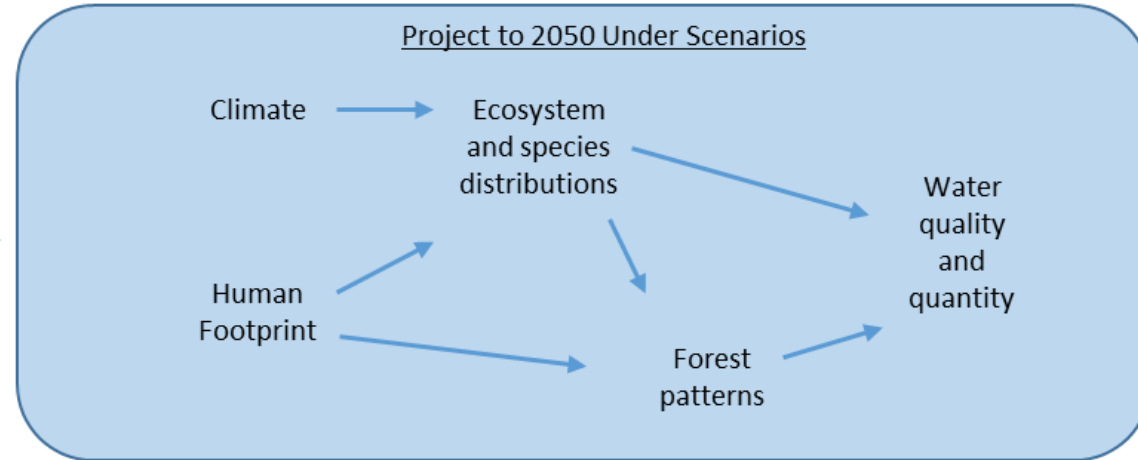


RCP 8.5 - 2050

# Using Results to Refine Policy

Develop Scenarios

Climate	Policy		
	SSP1: Sustainability Scenario	SSP2: Business as Usual Scenario:	SSP3: Regional Rivalry:
Low change (RCP 2.6)	x		
Mod change (RCP 4.5)		x	
High change (RCP 8.5)			x



Inform SDG15  
Planning and Policy



# Project Impacts

- NASA-based indicators included in official SDG reports
- Assessment of project success based on pre/post collaborator surveys
- Forest Structure indicators recommended by GEO BON as component indicators for Post 2020 Global Biodiversity Framework
- GEO SDG Award
- Story map published by NASA [bit.ly/NASA\\_ProjectSDG15](https://bit.ly/NASA_ProjectSDG15) (*country-specific versión in process*)
- Ph.D. to be awarded to students from each country



# Capacity building



Jaris Veneros (Montana State University) - Peru



Iván González (Colombia) - Northern Arizona University



José Aragón-Osejo (Ecuador) - Univ. of Northern British Columbia







# Acknowledgements

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**Global Environmental Fund (for ELSA)**

**Ministries and partners in Colombia, Ecuador, and Peru**