RISK REPORT CALCULATION TOOL GUIDANCE

1 INTRODUCTION AND SCOPE

The *AFOLU* and *JNR Non-Permanence Risk Tools* (NPRTs) provide the procedures for conducting the non-permanence risk analysis and buffer determination required for Agriculture, Forestry and Other Land Use (AFOLU) projects and Jurisdictional and Nested REDD+ (JNR) programs. One component of the non-permanence risk analysis included in the NPRTs is the assessment of natural risk, which consists of an assessment of historical natural risk and projected future impacts from climate change.

This *Risk Report Calculation Tool Guidance* document provides information on the approach to assessing projected future impacts from climate change and instructions for using the *AFOLU* and *JNR Non-Permanence Risk Calculation Tools*.

This document includes guidance for both the *AFOLU* and *JNR NPRTs* and *Calculation Tools,* though to aid readability, this document refers to projects. For jurisdictional programs, "project" should be substituted with "jurisdictional program".

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1.1 Scope

1.1.1 This guidance document provides information about the approach used to assess the projected future climate change impacts, including sea level rise (SLR), on AFOLU project and JNR program natural risk scores and the procedures for using the *AFOLU* and *JNR Risk Report Calculation Tools* (*Calculation Tools)* to conduct the assessment of natural risk.

1.1.2 The requirements for assessing natural risk are set out in the *AFOLU and JNR Non-Permanence Risk Tools (NPRTs)* and *Calculation Tools*. This guidance document must be used together with the *NPRTs and Calculation Tools*.

1.1.3 Section 2 sets out the approach and procedures for AFOLU projects and JNR programs to assess projected future impacts on natural risk from climate change using the *Calculation Tools.* Section 3 sets out the approach and procedures for AFOLU projects and JNR programs located in coastal areas to assess impacts from SLR on natural risk using the *Calculation Tools.* Section 4 provides guidance on how to incorporate expected future impacts from climate change and SLR into the natural risk score.

2 FUTURE CLIMATE IMPACT ASSESSMENT

2.1 General Approach

2.1.1 As set out in the *NPRTs,* the projected future climate impact on the natural risk shall be assessed using the *Calculation Tools*, noting the following:

1) The future state of climate may have an impact (detrimental or beneficial) on the permanence of projects. For this reason, the concept of Climatic Impact Drivers (CIDs) from IPCC-AR6[1] was used to evaluate the projected impact of climate change on projects by amplifying, where appropriate, the historic natural risk score.

[1] CID concept provides information about the natural or human-induced climate events or trends that may have an impact, either beneficial or detrimental, on an element of society or ecosystems. For more information consult: Reisinger, A., M. Garschagen, K.J. Mach, M. Pathak, E. Poloczanska, M. van Aalst, A.C. Ruane, K. Mintenbeck, R. Pedace, M. Rojas Corradi, D. Viner, C. Vera, B O'Neill, H.-O. Pörtner, J. Sillmann, R. Jones, and R. Ranasinghe, 2020: *The Concept of Risk in the IPCC Sixth Assessment Report: A Summary of Cross-Working Group Discussions: Guidance for IPCC Authors*. Intergovernmental Panel on Climate Change.

2) Based on the work presented by the Working Group I Chapter 12[2] of the IPCC-AR6, 14 CID categories were selected and grouped into four types[3] (see Appendix II) that could impact AFOLU projects. These CIDs characterize a climate system condition under the following parameters:

   a) Climate change scenario: SSP5-8.5 (worst-case scenario)[4];

   b) Projected period: mid-term (2050) as the time horizon where the changes in climatic variables are projected;

   c) Baseline period: 1995-2014 as the reference baseline period from which changes in climate are calculated (see Appendix II).

3) The concept of reference regions[5] was used for regional synthesis of simulated climate change datasets around the globe. The regions are defined as polygons that can be accessed at the ATLAS GitHub repository and set out 46 land regions[6] that summarize CID impacts information.

4) The projected change value for each CID represents a default mean value for the selected reference region, synthesizing the output of approximately 35 climate models from the Coupled Model Intercomparison Projects Phase 6 (CMIP6).

5) According to the IPCC-AR6, the uncertainty of the CID projections is presented in terms of confidence levels (high, medium, low) that represent the evidence of the process, the models' agreement, and the understanding of the physical process. To take this into account, a set of weighted factors is used for each confidence level (1.0, 0.75, 0.5 respectively).

[2] Ranasinghe, R., A.C. Ruane, R. Vautard, N. Arnell, E. Coppola, F.A. Cruz, S. Dessai, A.S. Islam, M. Rahimi, D. Ruiz Carrascal, J. Sillmann, M.B. Sylla, C. Tebaldi, W. Wang, and R. Zaaboul, 2021: Climate Change Information for Regional Impact and for Risk Assessment. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[3] Bojinski, S. et al., 2014: The Concept of Essential Climate Variables in Support of Climate Research, Applications, and Policy. Bulletin of the American Meteorological Society, 95(9), 1431–1443, doi:10.1175/bams-d-13-00047.1.

[4] This scenario stands for: (I) the alternative shared socio-economic pathway (SSP5) comprising a fossil-fuelled development (SSP5), and (II) radiative forcing of 8.5 W/m2 at the end of the century which corresponds to the representative concentration pathway with the highest greenhouse gas emissions (RCP8.5)

[5] Reference regions represent consistent climatic regimes and physiographic settings while maintaining an appropriate size of the models' representation. Giorgi, F., Francisco, R. Uncertainties in regional climate change prediction: a regional analysis of ensemble simulations with the HADCM2 coupled AOGCM. Climate Dynamics 16, 169–182 (2000). https://doi.org/10.1007/PL00013733

[6] Iturbide, M., Gutiérrez, J. M., Alves, L. M., Bedia, J., Cerezo-Mota, R., Cimadevilla, E., Cofiño, A. S., Di Luca, A., Faria, S. H., Gorodetskaya, I. V., Hauser, M., Herrera, S., Hennessy, K., Hewitt, H. T., Jones, R. G., Krakovska, S., Manzanas, R., Martínez-Castro, D., Narisma, G. T., Nurhati, I. S., Pinto, I., Seneviratne, S. I., van den Hurk, B., and Vera, C. S.: An update of IPCC climate reference regions for subcontinental analysis of climate model data: definition and aggregated datasets, Earth Syst. Sci. Data, 12, 2959–2970, https://doi.org/10.5194/essd-12-2959-2020, 2020.

6) The CID impact level is calculated automatically by the *Calculation Tools.* The *Calculation Tools associate* the projected change value of each CID with one of five categories of impact (See Table 12.3). These categories represent subdivisions of the total range of projected variation of each CID (see Annex II).

7) The overall projected future climate impact value[7] corresponds to the mean value of each CID impact level multiplied by their respective uncertainty weighted factor. In the end, the mean value is weighted according to the percentage of the project area located within each reference region selected.

8) Only those CIDs evaluated as having a "negative impact" on the project are considered in the weighted mean value calculation.

9) To take mitigation activities into account in the natural risk score, seven criteria were adapted from the adaptive capacity concept (see Table 3) that represent a project's ability to adjust to potential damage, take advantage of opportunities, or respond to consequences[8]. The project can reduce the amplifying factor representing the projected future climate impact on natural risk score if there is evidence that any of the adaptive capacity criteria have been implemented or planned to implement in the project management.

Table 12.3: Equivalence of the CID Level and the Amplifying Factor of Historical Risk Due to the Future Climate Impact

CID		Amplifying Factor of the Historical Risk
Impact Level	Future Impact	
High	5	1.4
Major	4	1.3
Minor	3	1.2
Low	2	1.1
Insignificant	1	1

[7] Note that there are two weights: by confidence level and by area percentage within each reference region. On the contrary, there is no important factor between the DIC categories, that is, they all have the same weight.
[8] Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., and Bergsma, E. 2010. The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environmental science & Policy 13, 459-471.

Note – The Table numbers in this document correspond to the table numbers in the AFOLU Risk Report Calculation Tool.

2.2 Procedures

2.2.1 Projected future climate impact is assessed using the following procedure:

1) Intersect the provided reference region shapefile with the project area map using any GIS software;

2) Select all the reference regions that overlap with the project area and indicate the percentage of the project area located in each reference region in Table 12.1. Note that where the project area intersects with more than three reference regions, you must select the three reference regions that intersect with at least 90% of the project area.

3) For each CID category, based on its projected change value and sign of change (increase or decrease), indicate in Table 12.1 if this is expected to have a positive or negative impact on the project. If the CID is not relevant to the project, select "Does not apply".

   For example, increasing mean air temperature can be a risk to the successful establishment of seedlings in a reforestation project (negative impact), but it could promote better crop yields for certain types of crops in an ALM project (positive impact).

   a) Unlike the other CIDs, fire weather is measured as the mean value of the CID impact level of those climatic conditions represented by the following CID indices: extreme heat, mean wind speed and, agricultural and ecological drought. In this sense, the fire weather CID index does not have a projected change value.

4) The overall future climate impact level is automatically calculated by the *Calculation Tools* only for the following CID types: heat and cold (hc), wet and dry (wd) and wind (w), as set out above in Section 2.1.1(7).

5) Indicate in Table 12.1 of the *Calculation Tool* if the criterion for adaptive capacity is met or not (see Table 12.2). If it is met, the amplifying factor fraction is reduced by 40%. For example, if the amplifying factor is 1.4 (with an amplifying factor fraction of 0.4) and if the adaptive capacity criterion is met, the future climate impact is equal to: 1.4 - (0.4 x 0.4) = 1.24.

Table 12.1: CID Assessment

	CID Assessment					
	Reference Region 1					
	Project Area (%) Associated					
	Type	Category Index	Projected Change Value	CID Impact Level	Uncertainty and Sign of Change	Project Impact
Projected Future Climate Impact Level	Heat and cold (hc)	Mean air temperature				
		Extreme heat				
		Cold spells				
	Wet and dry (wd)	Mean precipitation				
		River flood				
		Landslide				
		Aridity				
		Agricultural and ecological drought				
		Fire weather*				
	Wind (w)	Severe windstorm				
		Tropical cyclone				
SLR Impact Level	Coastal (co)	Relative sea level				
		Coastal flood				
		Coastal erosion				

*Fire weather is a CID impact score based on the average of the following CIDs: extreme heat, mean wind speed, and agricultural and ecological drought.

Table 12.1: CID Assessment

Overall Future Climate Impact Level (hc; wd; w)	Amplifying Factor	Adaptive Capacity Criterion			Future Climate Impact
		Does the project proponent demonstrate at least 5 criteria of adaptive capacity? (See Table 13)	x	0.6	

Table 12.2: Adaptive Capacity Criterions to Future Climate Change[9]

Criterions	Adaptive Capacity Description
1) Variety	i) Participation of different actors, levels, and sectors in the climate change governance process. ii) Availability of a wide range of different policy options to address climate change.
2) Learning capacity	i) Ability to learn from past experiences and improve routines regarding climatic experiences. ii) Evidence of changes in assumptions that support actions regarding climate change experiences. iii) Openness to uncertainties in the face of climate change.
3) Room for change	i) Continuous access to climate information at different spatial-temporal scales (e.g., early warning systems, climate change projections). ii) Act according to plans, especially in case of disasters.
4) Leadership	i) Long-term vision for climate change. ii) Stimulus for action, entrepreneurship, collaboration from different stakeholders.
5) Resources	i) Availability of climate change expertise, knowledge, and human labor force in the field of environmental sciences. ii) Availability of financial resources to support policy measures and financial incentives to address climate change.
6) Fair governance	i) Evidence of policies, practices, and behaviors that address climate change effectively. ii) Availability of accountability procedures to implement climate change-orientated actions (e.g., public access to annual management reports where climate change actions are presented).
7) Innovation	i) Availability of novel solutions to reduce the threat or take advantage of climate change.

[9] Adapted from Gupta et al, 2010. See footnote 8.

3 SEA-LEVEL RISE RISK ASSESSMENT

3.1 General Approach

3.1.1 As set out in the *NPRTs*, the projected future impact from SLR on the natural risk shall be assessed using the *Calculation Tools*, noting the following:

1) SLR risk assessment is based on both future information (impact level of coastal CID's, see section 2.1.1, above) and a local evaluation to select the significance level based on a set of four criteria adapted from scientific literature[10] (see Table 12.4).

2) Since SLR is expected to impact all projects located in coastal areas to some extent, the mitigation measures for reducing SLR risk were based on three main adaptive criteria for this type of risk. Projects can mitigate the SLR risk if they implement or plan to implement any of the adaptive criteria in the project area (see Table 7).

3.2 Procedures

3.2.1 SLR risk is assessed using the following procedure only if the project is in a coastal area:

1) Complete the future climate impact assessment first (see Section 2.2);

2) Based on local information, indicate the equivalent score to the different categories of significance that best represent the physical and natural conditions of the project (see Tables 12.7 – 12.10);

3) The equivalent level of significance is calculated automatically based on Table 12.4;

4) Based on the overall SLR impact level and the significance level, select the applicable SLR risk from Table 12.5;

5) If the project meets the adaptation criteria set out in Table 12.6, select the adaptation score;

6) The total SLR risk is automatically calculated in Table 12.11 as the multiplication of SLR risk and the adaptation factor.

[10] Criteria adapted from: Oppenheimer, M., B.C. Glavovic, J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari. 2019. Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]

Table 12.4: SLR CID Assessment

SLR Impact Level	Significance			SLR Risk	Adaptation Factor	Total SLR Risk
	Category	Score	Level			
	Degradation level					
	Coastal flooding					
	Coastal erosion					
	Degree of salinization					
Total						

Table 12.5: SLR Risk Assessment

Significance	SLR Impact Level				
	High (5)	Major (4)	Minor (3)	Low (2)	Insignificant (1)
Catastrophic (70% or more loss of carbon stocks)	FAIL	30	20	5	0
Devastating (50% to less than 70% loss of carbon stocks)	30	20	5	2	0
Major (25% to less than 50% loss of carbon stocks)	20	5	2	1	0
Minor (5% to less than 25% loss of carbon stocks)	5	2	1	1	0

Significance	SLR Impact Level				
Insignificant (less than 5% loss of carbon stocks) or transient (full recovery of lost carbon stocks expected within 10 years of any event)	2	1	1	0	0
No Loss	0	0	0	0	0

Table 12.6: SLR Adaptation Score

Type of measure	Description	Reduction Score
Ecosystem-based adaptation (EbA)	Restoration strategies, creation of new natural buffer areas, preservation	0.5
Land use planning, public participation, and conflict resolution approaches	Decision analysis, land use planning, public participation, livelihood support, and conflict resolution approach	0.5
Protection barriers (bioengineering)	Filling of beaches, piers, breakwaters, structures, and barriers against flooding, for protection and prevention of erosion, green and blue infrastructure	0.6
Application of the three measures or two out of three		0.25
None of the above		1

Table 12.7: Degradation Level of Marine and Terrestrial Natural Ecosystems

Category Level	Description	Value
No degradation	The ecosystem is in good condition, favoring the capture, storage, and conservation of CO_2 in the area	0
Low degradation	Ecosystem presents alterations in one structural attribute (density, height, coverage, stability in sediments, health status, biological feedbacks), but it has the possibility of retreating towards land and the potential to maintain and even increase its extension	1

Medium degradation	Alterations in two or more structural attributes of the ecosystem (density, height, coverage, stability in sediments, health status, biological feedback) but it has the possibility of retreating towards land and the potential to maintain and even increase its extension	2
High degradation	Important alterations in the structural attributes of the ecosystem (density, height, coverage, stability in sediments, state of health) without the possibility of retreating towards land and the potential to maintain and even increase its extension	3

Table 12.8: Relative Extent of Coastal Flooding

Category Level	Definition	Value
Without flooding	Flooding is not present due to the geomorphological features or other characteristics that prevent it; therefore, it does not affect the capture, storage, and conservation of carbon in the area	0
Low flooding	Floods due to SLR in less than 10% of the area, with low impact on the capture, storage, and conservation of carbon	1
Medium flooding	Floods in between 10% and 50% of the area affect the capture, storage, and conservation of carbon	2
High flooding	More than 50% of the area presents flooding due to increased water levels, causing serious inconvenience in the storage, capture, and conservation of carbon contents	3

Table 12.9: Degree of Coastal Erosion

Category Level	Definition	Value
No erosion	No coastal erosion, no loss of coastal ecosystems and/or elements of interest for AFOLU activities, and no impact on the capture, storage, and conservation of CO_2	0
Low erosion	The retreat of the coastline of less than 1 m yr-1 with little or no impact on AFOLU activities and/or ecosystems present in the area	1
Medium erosion	The retreat of the coastline of between 1 m - 3 m yr-1 with an impact on AFOLU activities and/or ecosystems present in the area	2

High erosion	Retreat of the coastline of over 3 m yr-1 affecting important AFOLU activities and/or ecosystems present in the area, and impacting the capture, storage, and conservation of CO_2	3

Table 12.10: Evaluation of the Degree of Salinization

Category Level	Definition	Value
Without saline intrusion	Absence of saline intrusion, no salinization of soils; therefore, does not affect the conservation of carbon on the area	0
Low saline intrusion	Saline intrusion causes minor effects on the production of plant biomass and the germination of crops, with few modifications in the carbon dynamics of the ecosystems influenced by freshwater discharges, and/or there are species tolerant to the salinity levels of the area	1
Medium saline intrusion	Levels of saline intrusion are close to the tolerance limits of crops and ecosystems, but with sufficient freshwater discharges to allow self-regulation	2
High saline intrusion	Levels of saline intrusion have a significant effect on the production of plant biomass and crop germination, causing modifications in the carbon dynamics of present ecosystems, with little freshwater discharge	3

Table 12.11: Significance Score Range Equivalence

Category	Score Range
Catastrophic	11-12
Devastating	9-10
Major	7-8
Minor	5-6
Insignificant	3-4
No loss	0-2

4 INTEGRATING CLIMATE CHANGE ASSESSMENT ON NATURAL RISKS

4.1.1 For any geological risk or other natural risks identified, indicate in Table 13 if the risk is affected or not by climate change (e.g., based on whether the risk is affected by changes in climatic variables such as temperature or precipitation).

For example, within geological risks, landslides are directly influenced by extreme precipitation events. In this case, this risk should be indicated as “Yes” it is affected by climate change since variations in future precipitation levels are expected.

Note that some of the natural risks (e.g., fire and extreme weather) are marked by default as “Yes” (e.g., they are affected by climate change) since there is no scientific doubt of the relationship between the natural risk type and changes in climatic impact drivers.

4.1.2 The *Calculation Tool* aggregates the sub-total risk rating into two groups by summing the individual risk rating of natural risks associated with climate change impacts and natural risks not associated with climate change impacts (see Table 12). The total risk rating of each group corresponds to the multiplication of the aggregated sub-total risk and the future climate impact factor (see Table 12). A future climate impact factor of one means that there is no change expected in the future due to climate change.

4.1.3 The total risk rating is the sum of SLR risk, natural risk affected by climate change, and natural risk not affected by climate change.

Table 12: Natural Risk Assessment

Natural Risk		Historic Natural Risk Score (LS)	Mitigation (M)	Sub-total Risk (LS × M)	Affected by Climate Change?
a)	Fire (F)				Yes
b)	Pest and disease outbreaks (PD)				Yes
c)	Extreme weather (W)				Yes
d)	Geological risk (G)				
e)	Other natural risk (ON1)				
f)	Other natural risk (ON2)				
g)	Other natural risk (ON3)				
h)	Sea-level rise risk (SLR)				

Projected Future Climate Impact on Natural Risk	Aggregated Sub-total Risk	Future Climate Impact Factor	Total
Natural risk associated with climate change impact (NR-c)			
Natural risk NOT associated with climate change impact (NR-nc)		1	

Total Natural Risk	
Total Natural Risk (SLR + NR-c + NR-nc)	
Total may not be less than zero	

APPENDIX 1: CLIMATIC IMPACT-DRIVER DESCRIPTION

This appendix summarizes the CID information (Tables A.1 and A.2) used to define the CID impact level associated with the projected change value of each CID according to the information provided by the Working Group I of IPCC-AR6 Chapter 12.

Table A.1: CID Description and Interpretation

Type	Category	Index	Description/Interpretation
Heat and cold	Mean air temperature	Multi-model mean change, relative to the base period 1995-2014, in mean annual near-surface air temperature, for the prospective period 2041-2060, under SSP5-8.5 climate change scenario **Index:** ∆MeanAnnualTair **Range of change:** [-6; +6] **Impact level equivalence:** Index > +4°C (~Very high) +3°C < Index <+4°C (~High) +2°C < Index <+3°C (~Moderate) +1°C < Index <+2°C (~Low-to-moderate) Index < +1°C (~Low)	Mean annual near-surface air temperature, expressed in °C
Heat and cold	Extreme heat	Median projected change in the mean number of days per year with maximum temperature exceeding +35°C based on CMIP6 simulation outputs, relative to the base period 1995-2014, for the prospective period 2041-2060, under SSP5-8.5 climate change scenario **Index:** ∆NumberDaysTmax exceeding +35°C **Range of change:** [-15; +200] **Impact level equivalence:** Index > 120 days (~Very high) 80 days < Index < 120 days (~High) 40 days < Index < 80 days (~Moderate)	Mean number of days per year with maximum temperature exceeding +35°C (episodic high air temperature events)

		0 < Index <40 days (~Low-to-moderate) Index < 0 (~Low)	
Heat and cold	Cold spell	Median projected change in annual minimum temperature at 2°C global warming level (GWL) compared to the 1851-1900 baseline. Results are based on simulations from the CMIP6 multi-model ensemble under the SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-9 7.0, and SSP5-8.5 scenarios **Index:** $\Delta AnnualTN_n$ **Range of change:** [0; +8] **Impact level equivalence:** Index > +4°C (~Very high) +3°C < Index <+4°C (~High) +2°C < Index <+3°C (~Moderate) +1°C < Index <+2°C (~Low-to-moderate) Index < +1°C (~Low)	Annual minimum near-surface air temperature, expressed in °C (episodic cold air temperature events)
Wet and dry	Mean precipitation	CMIP6 multi-model near-term (2021-2040) mean change (%), relative to 1995-2014, in DJF or JJA seasonal mean precipitation (summer season in the southern and northern hemispheres, respectively) under SSP3-7.0 **Index:** ΔSeasonalMeanP **Range of change:** [-50%; +50%] **Impact level equivalence:** Index > ±40% (~Very high) ±30% < Index <±40% (~High) ±20% < Index <±30% (~Moderate) ±10% < Index <±20% (~Low-to-moderate) Index < ±10% (~Low)	Seasonal mean precipitation, expressed in millimeters (mm)
Wet and dry	River flood	Mean change in 1-in-100-year river discharge per unit catchment area (Q_{100}, expressed in m^3	1-in-100 year river discharge per unit catchment area (episodic high-water levels

		s^{-1} km^{-2}) for 2041-2060, relative to 1995-2014, and under RCP8.5 **Index:** ΔQ_{100} **Range of change:** [-0.2; +0.2] **Impact level equivalence:** Index > ±0.1 (~Very high) 0.05% < Index <±0.1 (~High) 0.02% < Index <±0.05 (~Moderate) ±0.01 < Index <±0.02 (~Low-to-moderate) Index < ±0.01 (~Low)	and flow rates in streams and rivers driven by basin runoff)
Wet and dry	Landslide	Projected changes in the frequency of extreme precipitation events (fEP) under 1°C, 1.5°C, 2°C, 3°C, and 4°C GWLs, relative to the 1951-1990 baseline. Extreme precipitation is defined as the maximum daily precipitation that was exceeded on average once during a 10-year period (10-year event) and once during a 50-year period (50-year event) over the 1851-1900 base period. **Index:** fEP **Range of change:** [1; 8 number of times as frequent] **Impact level equivalence:** Index > 5 (~Very high) 3 < Index <5 (~High) 2 < Index <3 (~Moderate) 1 < Index <2 (~Low-to-moderate) Index < 1 (~Low)	The umbrella term 'geological mass movements' comprises landslides, mudslides, and rockfalls. Included in this category are the extreme precipitation events that could prompt the occurrence of landslides in mountainous regions (see Table 2 below).
Wet and dry	Aridity	Change in mean soil moisture, expressed in %, for the period 2041-2060, relative to 1995-2014, under SSP5-8.5 **Index:** Δsoil moisture	Mean conditions of precipitation and evapotranspiration compared to potential atmospheric and surface water demand, resulting in low mean surface

		Range of change: [-5%; +5%] **Impact level equivalence:** Index > ±5% (~Very high) ±3% < Index <±5% (~High) ±2% < Index <±3% (~Moderate) ±1% < Index <±2% (~Low-to-moderate) Index < ±1% (~Low)	water, soil moisture and or relative humidity
Wet and dry	Agricultural and ecological drought	Change in the number of droughts, expressed in events per decade, projected for the period 2041-2060, relative to 1995-2014, for SSP5-8.5 **Index:** Δ#droughts **Range of change:** [-3.5; +3.5] **Impact level equivalence:** Index > 2 (~Very high) ±1.5 < Index <2 (~High) ±1 < Index <±1.5 (~Moderate) ±0.25 < Index <±1 (~Low-to-moderate) Index < ±0.25 (~Low)	Episodic combination of soil moisture supply deficit and atmospheric demand requirements that challenge plants' ability to meet water needs for transpiration and growth
Wet and dry	Fire weather	It does not have a defined projected value. Its impact level corresponds to the average value associated with the CID impact level of the indices: extreme heat, mean wind speed, and agricultural and ecological drought	Conditions that increase the likelihood, spread, and seasonality of wildfire, potentially including combined measures of wind, temperature, and drought.
Wind	Mean wind speed	Change in the surface mean wind speed (m/s), expressed in %, for the period 2041-2060, relative to 1995-2014, under SSP5-8.5 **Index:** Δwindspeed **Range of change:** [-10; 10] **Impact level equivalence:** Index > 8 (~Very high)	Mean wind speeds and transport patterns.

		6 < Index <8 (~High) 4 < Index <6 (~Moderate) 2 < Index <4 (~Low-to-moderate) Index <1(~Low)	
Wind	Tropical cyclone	Frequency of median proportion of category 4-5 tropical cyclones increases by 13% under a 2 degrees C global warming **Index:** ∆tropical cyclone **Range of change:** [0; 16] **Impact level equivalence:** Index > 13 (~Very high) 10 < Index <13 (~High) 5 < Index <10 (~Moderate) 3 < Index <5 (~Low-to-moderate) Index <1(~Low)	Tropical cyclone category
Coastal	Coastal flood	Change in extreme total water level – ETWL (1:100 yr return period total water level, based on CMIP5 outputs), expressed in meters, ~2050, relative to 1980-2014, under RCP8.5 **Index:** ∆ETWL **Range of change:** [0; +1.0] **Impact level equivalence:** Index > 0.6 (~Very high) 0.4 < Index <0.6 (~High) 0.2 < Index <0.4 (~Moderate) 0.1 < Index <0.2 (~Low-to-moderate) Index < 0.1 (~Low)	Extreme total water level, expressed in meters, that may result from a combination of mean sea level, tides, storm surge, and wave setup at coastlines.
Coastal	Coastal erosion	Shoreline position change (∆shoreline) along sandy coasts, expressed in meters, by 2100 relative to present-day (2010), CMIP5 outputs, RCP 8.5	Rate of shoreline retreat (negative value) or progradation (positive value) caused by relative sea level,

		Index: ∆shoreline **Range of change:** [-200; +200] **Impact level equivalence:** Index > ±150 (~Very high) ±100 < Index <±150 (~High) ±50 < Index <±100 (~Moderate) ±10 < Index <±50 (~Low-to-moderate) Index < ±10 (~Low)	currents, waves, and storm surges.

Source: Chapter 12 of IPCC, 2021[11]

Table A.2: Selected Mountains Range and Reference Region Located

Mountain Range	IPCC WGI AR6 Reference Region(s)
Brooks Range (Alaska)	NWN
Rocky Mountain Range (assuming its extent from US to Panama)	NWN, WNA, NCA, SCA
Appalachian Highlands (US)	ENA
Andes Mountain Range (South America)	NWS, SWS, SSA
Scandinavian Mountains	NEU
Cantabrian Mountains	MED
Eastern African Highlands (Ethiopian Highlands to the north and Kenyan Highlands to the south)	NEAF to the north and SEAF to the south
The Alps (full extent from NE Austria to Sicily)	WCE, MED

[11] Ranasinghe, R., A.C. Ruane, R. Vautard, N. Arnell, E. Coppola, F.A. Cruz, S. Dessai, A.S. Islam, M. Rahimi, D. Ruiz Carrascal, J. Sillmann, M.B. Sylla, C. Tebaldi, W. Wang, and R. Zaaboul, 2021: Climate Change Information for Regional Impact and for Risk Assessment. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

Mountain Range	IPCC WGI AR6 Reference Region(s)
Carpathian Mountains (comprising Slovakia, south Poland, western Ukraine, and Romania)	WCE
Balkan Mountains	MED
Pontic Mountains	MED, WCA
Caucasus Mountains	WCA
Ural Mountains	EEU
Hindu Kush Range (Afghanistan)	WCA
Karakoram Range	ECA, TIB
The Himalayas	TIB, SAS
Tanen-Taung-Gyi Mountain Ranges	SAS, EAS
Great Dividing Range (Australian Alps)	EAU, SAU
Southern Alps Mountains (New Zealand)	NZ

Source: Chapter 12 of IPCC, 2021

APPENDIX 2: EXAMPLES OF ADAPTATION TO SLR RISK

This appendix provides further information about which measures can be related to the three criteria of adaptation defined in Section 3.1 to reduce the SLR risk.

Table A.3: Examples of Ecosystem-based Adaptation Measures

Measure	Benefits
Restoration of aquatic ecosystems, including marine and coastal zones Recovery of water canals Recovery of bodies of water Restoration, reforestation, rehabilitation, enrichment, and assisted regeneration Forest management Integrated landscape management	i) Reduced sensitivity to rising sea levels ii) Reduced risk of contamination of aquifers by marine intrusion iii) Protection and recovery of biodiversity, including ecosystem functionality iv) Reduction of erosion, landslides, and subsurface faults v) Promoting natural regeneration processes
Community exchange programs participating in EbA projects or actions (lessons learned)	i) Creation or strengthening of response capacities to different threats ii) Multi-stakeholder trust iii) Creation of innovative and efficient actions
Incentives for conservation	i) Payment for forest conservation ii) Payment for actions of protection, conservation, restoration, and

	assisted or active regeneration iii) Pressure on ecosystem reduced
Early alerts	i) Increased adaptive capacity in the face of sudden flood risk ii) Creation and/or strengthening of preventive and response actions iii) Impact and sensitivity reduction
Monitoring and surveillance against phenomena	

Source: MINAMBIENTE, 2018[12]

Table A.4: Examples of Measures of Approaches to Land Use Planning, Public Participation, and Conflict Resolution

Measure	Benefits
Community-based disaster risk reduction	i) Creation or strengthening of response capacities to different threats ii) Recognition and value of comprehensive knowledge: joint vision of local history plus traditional scientific contribution iii) Multi-stakeholder trust iv) Creation of innovative and efficient actions
Planning of land use, delimitation of risk areas	
Promote a balance between the conservation of marine fisheries, coral reefs, and mangroves	
Incorporate anticipated impacts of climate change into management plans, programs, and activities	
Land use and zoning change	
Organization, planning and integrated management of the littoral space	
Protection of coastal wetlands	
Increase the number of protected areas	

[12] Ministerio de Ambiente y Desarrollo Sostenible - MINAMBIENTE. 2018. AbE. Guía de adaptación al cambio climático basada en ecosistemas en Colombia. Dirección de Cambio Climático, - textos: Álvarez Grueso, Eliana; Florian Buitrago, Martiza; Peñuela Zamudio, Lina; Cortés Ospina, Erika. Bogotá, D.C. 81 p.

Improve the management and restoration of existing protected areas to facilitate resilience	v) Protection of cultural and ecological heritage vi) Recognition of peasant, Indigenous, and Afro practices, and knowledge vii) Increase in social and ecosystem resilience
Declaration of protected areas and other conservation figures	
Promote dialogue and exchange of knowledge for the formulation, implementation, and monitoring of EbA actions	
Protection and strengthening of local knowledge	i) Long-term provision of ecosystem services ii) Protection and recovery of biodiversity
Coordination of areas for conservation, exclusion, and use	

Source: Sánchez & Reyes, 2015[13]; MINAMBIENTE, 2018.

Table A.5: Examples of Bioengineering Measures

Measure	Benefits
Bioengineering	i) Reduction of erosion, landslides, and subsurface faults ii) Promoting natural regeneration processes iii) Cost reduction in works
Living retaining walls with selected plantations	
Stabilization of slopes through the construction of bioengineering works	
Strengthening the soil through the sowing of suitable plants and renaturation of the covers	
Natural retaining walls of vegetation, rocks	i) Reduced risk related to landslides and sea-level rise

Source: Mickovski, 2021[14]; MINAMBIENTE, 2018.

[13] Sánchez, L., O. Reyes. 2015. Medidas de adaptación y mitigación frente al cambio climático en América Latina y el Caribe Una revisión general. Comisión Económica para América Latina y el Caribe (CEPAL) y Unión Europea. Santiago de Chile. 75 p.
[14] Mickovski, S. 2021. Re-Thinking Soil Bioengineering to Address Climate Change Challenges. Sustainability. 13 (6), 3338. https://doi.org/10.3390/su13063338.

APPENDIX 3: DOCUMENT HISTORY

Version	Date	Comment
DRAFT v4.0	07 Feb 2022	Draft version released for public consultation