GUIDANCE ON SEA-LEVEL RISE RISK ASSESSMENT USING THE *NON-PERMANENCE RISK ASSESSMENT CALCULATOR, V4.2*

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V1.0

CONTENTS

1 INTRODUCTION AND SCOPE

This document provides guidance for project proponents of WRC tidal wetland projects to assess the impacts of sea-level rise (SLR) using Verra's *AFOLU Non-Permanence Risk Tool, v4.2* (NPRT). This guidance document should only be applied to projects or parts of projects that are in the intertidal zone at the time of assessment. This document was prepared by Silvestrum Climate Associates.

2 BACKGROUND

The AFOLU Non-Permanence Risk Tool (NPRT) provides the procedures for conducting the non-permanence risk analysis and buffer determination required for AFOLU projects which enhance or protect carbon stocks. SLR risk is one component of v4.2 of the NPRT. The SLR risk assessment is based on predicted changes at a regional level using coastal Climatic Impact Drivers (CIDs) and a local evaluation to select the significance level based on a set of four criteria: ecosystem degradation, coastal flooding, coastal erosion, and salinization.

3 PROCESS

1.1 Ecosystem Degradation

This category evaluates how the level of degradation of the tidal wetland ecosystem will affect its resilience to SLR. For a value to be assigned for this criterion, coastal flooding and erosion need to be assessed first, both of which contribute to the degradation of an ecosystem. Hence, the level of degradation to be chosen, as defined in the NPRT, is dependent on the value assessed for coastal flooding and erosion.

1.1.1 Instruction

For tidal wetland projects, the value chosen for ecosystem degradation should be equal to the higher value of either coastal flooding or coastal erosion. For example, if a value of 3 is determined for coastal flooding, and a value of 0 is determined for coastal erosion, then the value for ecosystem degradation should be set to equal 3.

1.2 Coastal Flooding

For this criterion, projects should model how the area suitable for tidal wetland vegetation will change between t=0 and t=100 using the IPCC Representative Concentration Pathway (RCP) 8.5 for consistency with the data used for future climate impacts within the NPRT. The following information is required:

1) Sediment accretion rates in the project area, i.e., in meters/year.

2) Tidal elevation range suitable for vegetation growth, i.e., the elevation capital for tidal wetland vegetation growth at t=0.

3) An elevation map, derived from a digital terrain model (DTM), other site-specific data sources, or expert knowledge.

If sediment accretion outpaces SLR (using conservative sedimentation estimates), then the value of this criterion should be set to equal 0. For example, if the anticipated SLR is 1 m from t=0 and t=100, and the anticipated sediment accretion is > 1 m in the same time frame, the risk of coastal flooding does not need to be assessed.

Where project-level sediment accretion rates do not exist, sub-regional rates may be used to determine whether sediment accretion rates will outpace sea level rise. One potential dataset is published by Schuerch et al. (2018)[1], which calculates relative sediment deficit or surplus compared to rates of SLR under multiple climate and coastal population density scenarios. The model tends to underestimate where wetlands have a sediment surplus, producing conservative estimates of wetlands' ability to survive SLR. Other studies such as Saintilan et al. (2020)[2] and Krauss et al. (2013)[3] also present data on various worldwide sedimentation rates.

Where sediment accretion does not outpace SLR, a digital terrain model (DTM), such as the publicly-available DeltaDTM[4], should be used to determine areas of suitable tidal elevation for vegetation growth at t=100. Projects should assess the percentage of the project area where vegetation can still grow at t=100 given SLR and sediment accretion.

1.2.1 Instruction

1. Assess the sediment accretion rates in the project area. If sedimentation in the project area outpaces SLR (e.g., sedimentation is > 1 m and SLR of 1 m), the value of coastal flooding should be set to equal 0. This means that the impact of coastal flooding due to SLR will be countered by sedimentation in the project area. A project does not need to perform a coastal flooding assessment using a DTM under this scenario.

2. If the rate of SLR is greater than or equal to sedimentation rates, the change in area suitable for tidal wetland vegetation growth between t=0 and t=100 should be modeled using the IPCC RCP 8.5 scenario and a DTM, other site-specific data sources, or expert knowledge.

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[1] Schuerch, M., et al. (2018).

[2] Saintilan, N., et al. (2020).

[3] Krauss, K. W., et al. (2014).

[4] Pronk, M., et al. (2024).

3. Project proponents should determine the percentage of the project area that will no longer be suitable for tidal wetland vegetation. This percentage should be used to determine the risk value according to Table 1.

4. The higher of the values determined for coastal flooding and coastal erosion should be used as the value for ecosystem degradation in section 3.1.

Table 1. Relative Extent of Coastal Flooding

Category level	Description	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

1.3 Coastal Erosion

The value for coastal erosion should be set to 0 if the entire project area is sufficiently far away from the coastline and channel edges, such that erosion is not anticipated to reach the project area within the 100-year time period required by the NPRT. A practical approach to estimate the coastal erosion rate is to do an analysis of historical shoreline imagery using platforms such as Google Earth. Digital platforms such as Digital Earth Africa[5] and Digital Earth Australia[6] provide analysis-ready annual shoreline change from 2000 to 2022. Other platforms such as the Global Surface Water Explorer[7] map the location and temporal distribution of water surfaces at the global scale between 1984 and 2018, that could be used as a proxy for the erosion assessment.

1.3.1 Instruction

[5] https://maps.digitalearth.africa/

[6] https://maps.dea.ga.gov.au/story/DEACoastlines

[7] https://global-surface-water.appspot.com/

1. Determine the historical coastal erosion rate based on an analysis of historical imagery or shoreline change assessment.

4) If a project area is far enough from the coastline and channel edges that erosion is not anticipated to reach it during the 100-year permanence period, the coastal erosion value should be set to equal 0 (Table 2). For example, if the erosion rate in the project area is 3 m yr^1, in 100 years only 300 m of the coastline would be eroded. If the project area is located 1,000 m from the coastline, erosion would not affect the project area.

2. The higher of the coastal flooding and coastal erosion values should be used as the value for ecosystem degradation in section 3.1.

Table 2. Degree of Coastal Erosion.

Category level	Description	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 to 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

1.4 Salinization

By definition, tidal wetland ecosystems are regularly inundated and exposed to high-salinity ocean tides, leading to salinization. Tidal wetland ecosystems experience varying levels of salinity, based on their proximity to the ocean, freshwater inflows, tidal patterns, and climate conditions. In regions like the Sundarbans in India, salinity in tidal wetlands ranges between 9-31 ppt[8] while in the Gulf of Mexico in the USA, salinity in tidal wetlands range between 20-25 ppt[9]. In hypersaline tidal wetlands or arid regions such as the Red Sea, salinity can range from 35-41 ppt[10,11]. In summary, salinization happens naturally in

[8] Sarkar, S., et al. (2013).

[9] Swanson, V. E., et al. (1972).

[10] Mitsch, W. J., & Gosselink, J. G. (2015).

[11] Almahasheer, H., et al. (2016).

tidal wetland ecosystems due to constant flooding from tides; hence rising sea levels would not lessen salinity levels in the project scenario.

1.4.1 Instruction

The value for this criterion should be set to equal 3 for projects taking place in tidal wetlands. The value of 3 does not relate to the impact of SLR-induced salinization on tidal wetlands, but instead appropriately adjusts the risk score in the tool for projects with high rates of coastal flooding and erosion.

4 REFERENCES

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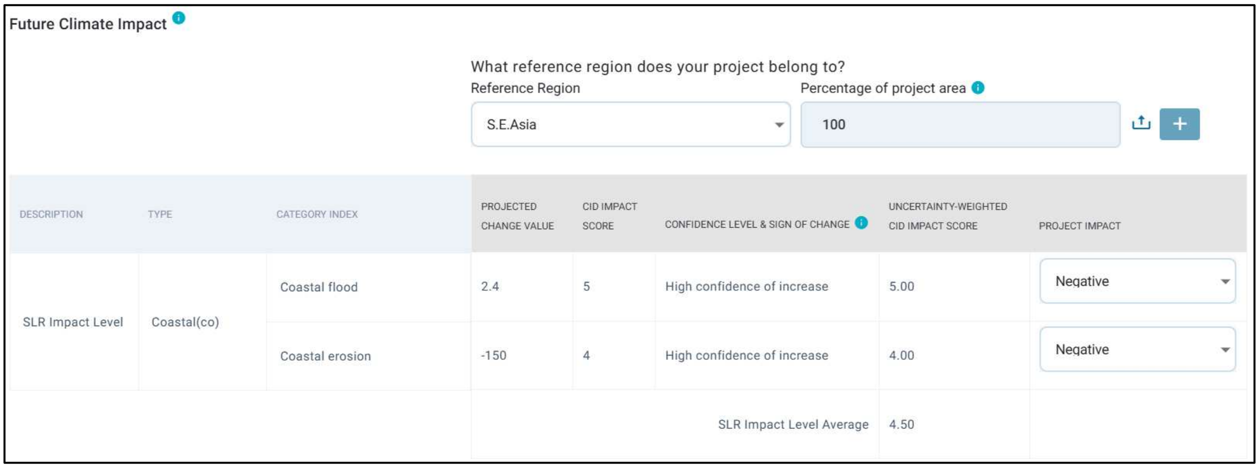
Swanson, V. E., Love, A. H., & Frost, I. C. (1972). *Geochemistry and diagenesis of tidal-marsh sediment, northeastern Gulf of Mexico* (No. 1360). US Govt. Print. Off.,.

5 WORKING EXAMPLE

An Afforestation, Reforestation, and Revegetation (ARR) + Restoring Wetland Ecosystems (RWE) project plans to restore 1,500 ha of degraded mangrove habitats in a mangrove forest in Southeast Asia, with a project start date of 2020. The steps below walk through the process of assessing the impact of SLR on the project area in the NPRT. Here, the **Sea Level Rise (SLR)** section found under **'NATURAL RISK'** on the Verra Project Hub must be completed.

Step 1: Determine the overall SLR impact level

To determine the overall SLR impact level, the **Future Climate Impact** section must be completed. In this section, the Reference Region must first be selected. In this case, **S.E. Asia** is selected. The projected CID Impact Score based on this Reference Region is then automatically populated through the table as shown in Figure 1. The SLR impact level is automatically calculated as the average between the uncertainty-weighted CID Impact Score for coastal flood and coastal erosion. In this case, the average SLR impact level is 4.5. This number is automatically rounded to 5 under the SLR Risk Assessment section (see Figure 2).


Future Climate Impact

What reference region does your project belong to?

Reference Region: S.E.Asia

Percentage of project area: 100

DESCRIPTION	TYPE	CATEGORY INDEX	PROJECTED CHANGE VALUE	CID IMPACT SCORE	CONFIDENCE LEVEL & SIGN OF CHANGE	UNCERTAINTY-WEIGHTED CID IMPACT SCORE	PROJECT IMPACT
SLR Impact Level	Coastal(co)	Coastal flood	2.4	5	High confidence of increase	5.00	Negative
		Coastal erosion	-150	4	High confidence of increase	4.00	Negative
					SLR Impact Level Average	4.50	

Figure 1. Determination of the average SLR impact level

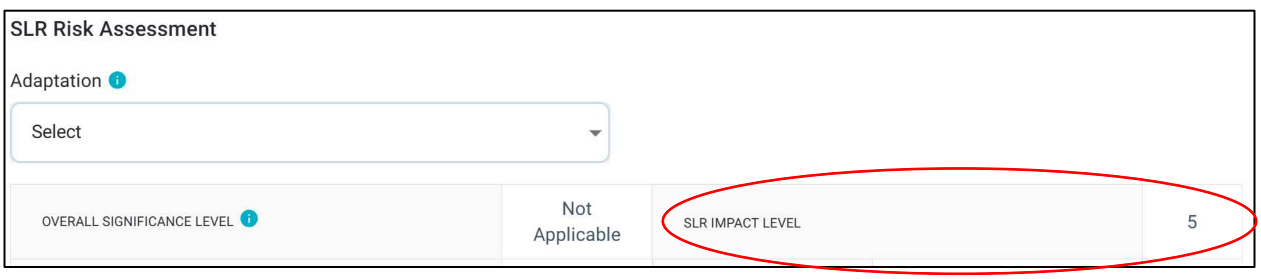


Figure 2. The SLR Impact Level is automatically populated under the SLR Risk Assessment section

Step 2: Determine the score for each criterion for the SLR risk assessment

This step involves the determination of an appropriate score for each of the four criteria used to determine the Significance of the SLR risk. The **SLR CID Assessment** section must be completed (Figure 3).

Salinization is set to equal a value of 3 (High saline intrusion; Figure 3) because the project involves restoration of a tidal wetland ecosystem where salinization occurs naturally due to tidal flooding.

Then a value must be determined for **coastal flooding.** An average accretion rate of 1.06 cm yr^{-1} in the mangrove forests of Southeast Asia was assumed based on data from Chaudhuri et al 2019[12] for several

[12] Chaudhuri, P., Chaudhuri, S., & Ghosh, R. (2019). The role of mangroves in coastal and estuarine sedimentary accretion in Southeast Asia. *Sedimentary Processes-Examples from Asia, Turkey and Nigeria*, 203-218.

countries in the region. At this rate, the total accretion between 2020 and 2120 will be 1.06 m. According to IPCC projections under the SSP5-8.5 RCP scenario[13], sea level will rise 0.98 m by 2120 in this region. Given that accretion exceeds the amount of SLR, no flooding assessment is needed for this case study. Therefore, the value for coastal flooding is set to equal 0 (Without flooding; Figure 3).

The **coastal erosion** rate in the region based on data from 1972 to 2016[14] in Indonesia was assumed to be 5.54 m yr^{-1}. At this rate, the total coastal erosion between 2020 and 2120 will be 554 m. The project area is located 500 m inland from the coastline, which means that the project area will be affected by coastal erosion in a 100-years' time at this rate. Hence, the value for erosion is set to equal 3 (High erosion; Figure 3).

Ecosystem degradation is then set to the higher value of coastal flooding (0) and coastal erosion (3), which is a value of 3 (High degradation; Figure 3).

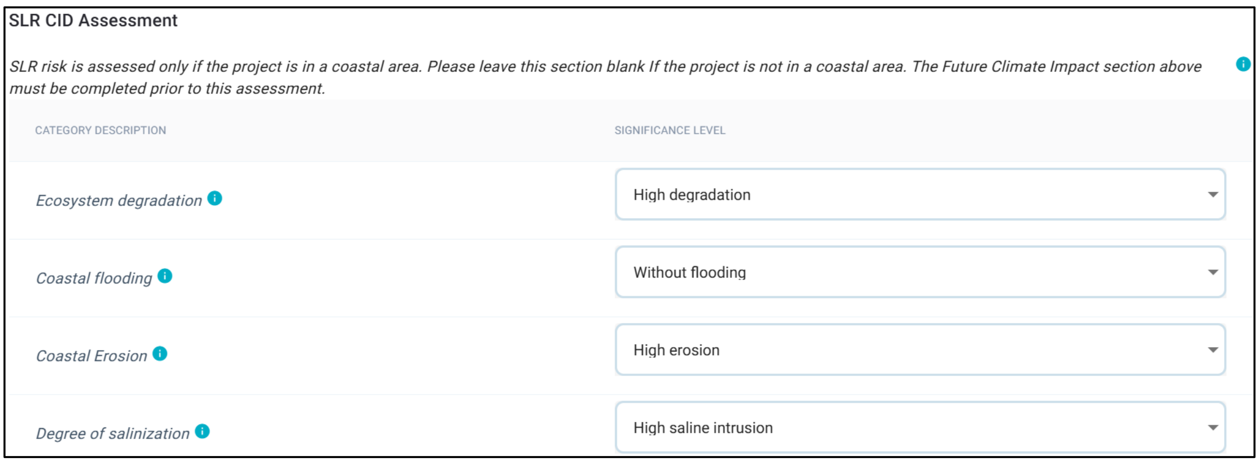


Figure 3. SLR CID Assessment

A total score of 9 is obtained which is equivalent to a Significance level of 'Devastating' (Figure 4). This is automatically populated under the **SLR Risk Assessment** section (Figure 5).

[13] https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

[14] Fuad, M. A. Z., & DA, M. F. (2017, December). Automatic detection of decadal shoreline change on northern coastal of Gresik, East Java–Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 98, No. 1, p. 012001). IOP Publishing.

Overall Significance Level

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

Figure 4. Overall Significance Level

Figure 5. Overall Significance Level automatically populated under the SLR Risk Assessment section

Step 3: Determine the SLR Risk based on the SLR impact and Significance levels

Based on an **SLR impact level of 5** (4.5 rounded to 5) from Step 1 and an **Overall Significant level of Devastating** from Step 2, an **SLR risk score of 30** is automatically populated into the SLR Risk Assessment section (Figure 6).

Figure 6. SLR Risk Score obtained based on the SLR impact and Significance levels

Step 4: Determine the SLR Adaptation Score

Under **Adaptation**, an SLR adaptation score is selected for the project area. The project area has identified potential future areas of mangroves due to landward migration from SLR. The project also involves the participation of the local communities as local stakeholders with the project supporting their livelihood. The project hence falls under **'Application of two or more measures listed above'**, making it eligible for a reduction score of 0.25 (Figure 7). The overall risk of non-permanence from SLR for the project area is then **7.5%.**

Figure 7. Completed SLR Risk Assessment table as seen in the Verra Project Hub

References

Chaudhuri, P., Chaudhuri, S., & Ghosh, R. (2019). The role of mangroves in coastal and estuarine sedimentary accretion in Southeast Asia. *Sedimentary Processes-Examples from Asia, Turkey and Nigeria*, 203-218.

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APPENDIX 1 DOCUMENT HISTORY

Version	Date	Comment
v4.0	3 March 2025	Initial version released