TERMS OF REFERENCE

FOR CONSULTING SERVICES

Modelling and Assessment of Coastal Climate Change Impacts in Saint Lucia

1. Introduction

The Government of Saint Lucia has been awarded a Green Climate Fund (GCF) Readiness and Preparatory Support Programme Grant[1] to assist in advancing the country's national adaptation planning process. This grant will be implemented with the support of the International Institute for Sustainable Development as the nominated Delivery Partner.

Saint Lucia initiated its national adaptation plan (NAP) process in 2017 and finalized its NAP document in 2018. Since the launch of the NAP, the government has developed–and Cabinet has approved–several key policies, strategies, and action plans outlined in the NAP document. This process includes the development of four Sectoral Adaptation Strategies and Action Plans (for water, agriculture, fisheries, and resilient ecosystems). Notwithstanding, more work remains to be done to ensure the successful implementation of the actions identified within the NAP document. The awarded Readiness Grant seeks to further enhance the country's 10-year goal under the NAP process by addressing the outstanding priority sectors, information gaps, and barriers that remain.

One of the three barriers that the GCF Readiness Grant will seek to address is the limited understanding of the scale and scope of risk that Saint Lucia's coastal populations, settlements, infrastructure, and economic activities are exposed to. The majority of Saint Lucia's population and economic activity takes place on or near its coast; many of the country's houses, towns, hotels, fisheries, roads, and ports, among other key infrastructure, are closely tied to the water. As sea levels rise, rainfall becomes more erratic and unpredictable, and storms and their surges increase in intensity, many Saint Lucians and their homes, towns, livelihoods, and critical infrastructure are increasingly exposed to flood risk. However, the extent of this exposure and its associated vulnerabilities remain unclear, as does the distribution of risks across different genders and social groups. Saint Lucia's NAP has highlighted a pressing need to establish this baseline information to develop adequate adaptation and resilience-building responses.

Macro-scale sea level rise (SLR) modelling and SLR plus storm surge modelling were conducted for Saint Lucia as part of the regional study, *Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of SLR in the Caribbean*.[2] While the National Integrated Planning and Programme Unit (NIPP-Unit) within the Government of Saint Lucia (GoSL) has recently conducted geographic information system (GIS) mapping and modelling for Saint Lucia to better understand the impact of a 1-metre SLR on the city of Castries as part of Castries Vision 2030, the understanding of island-wide impacts remains limited.

[1] LCA-RS-005 'Enhancing Saint Lucia's National Adaptation Plan Process through the Elaboration of Sector Strategies and Action Plans, a Strengthened Evidence Base, and Improved Private Sector Engagement', https://www.greenclimate.fund/document/enhancing-saint-lucias-national-adaptation-plan-process-through-elaboration-sector, Approved February 2023.

[2] Simpson, M. C. Scott, D., Harrison, M, Sim, R., Silver, N., O'Keeffe, E., Harrison, S., Taylor, M., Lizcano, G., Rutty, M., Stager, H., Oldham, J., Wilson, M., New, M., Clarke, J., Day, O. J., Fields, N., Georges, J., Waithe, R., & McSharry, P. (2010) *Quantification and magnitude of losses and damages resulting from the impacts of climate change: Modelling the transformational impacts and costs of sea level rise in the Caribbean*. United Nations Development Programme

Through the awarded Readiness Grant, the GoSL currently seeks to engage consulting services to build upon these efforts. The goals will include producing more refined modelling of the exposure to SLR hazards and tropical cyclone coastal hazards enhanced by SLR with accompanying vulnerability, risk, and economic impact assessments, including disaggregated analysis by gender and different social groups. The outputs of the consultancy will be used to inform future adaptation planning.

Rationale for the Assignment

SLR is projected to continue throughout the 21st century and well beyond.[3] Current projections by the Intergovernmental Panel on Climate Change (IPCC) estimate another 30–60 cm (0.3–0.6 m) of global mean SLR by 2100, even if greenhouse gas (GHG) emissions are sharply reduced and global warming is limited to well below 2°C. If GHG emissions continue to significantly increase, the IPCC estimates a rise of around 60–110 cm (0.6–1.1 m) by 2100.[4] Additionally, several studies suggest that future SLR may have been significantly underestimated by IPCC projections.[5] In particular, current research indicates that future SLR projections may have to be corrected upward due to a larger contribution from the Antarctic ice sheet.[6] The magnitude of the Antarctic response currently represents the biggest uncertainty for SLR projections. These uncertainties, however, strengthen the case for serious, comprehensive, and urgent action to address the challenges of adapting to SLR. The IPCC notes that expert elicitation studies show that a global mean SLR of 2 m in 2100 cannot be ruled out.[7]

Regional SLR modelling efforts have shown that the Caribbean region generally responds in line with the projected global mean SLR signal.[8,9] Therefore, it is clear that SLR will pose a serious and chronic threat to the sustainable management of coastal zones in Caribbean Community (CARICOM) nations, including Saint Lucia. This threat remains significant even if we meet the Paris Agreement aspirations of keeping global temperature rise this century well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase even further to 1.5°C.

Saint Lucia belongs to the volcanic group of islands, which also includes Saint Kitts and Nevis, Saint Vincent and the Grenadines, Grenada, Dominica, and Montserrat. These islands' narrow coastal areas are vulnerable to beach erosion and local coastal landslides while being heavily dependent on fragile coastal resources to support the main tourism industry. SLR will increase rates of cliff, beach, dune, and shoreline erosion and could destabilize some areas of coastline. SLR may also change sediment transport patterns, affecting beach health. Some data already indicates erosion under observed SLR within the 45 years prior to the project start year. For some islands, mangroves, seagrass beds, coral reefs, and agricultural soils are also threatened by SLR.

In addition, development in Saint Lucia—including housing; commercial, tourism, and industrial activity; and critical infrastructure investments—are concentrated in the low-lying coastal zone, increasing exposure to SLR impacts. These tectonically active islands may also be experiencing land movement, which could mitigate or exacerbate SLR.

Adaptation to hazards associated with future SLR, including permanent coastal inundation, accelerated erosion, shoreline retreat, and enhanced temporary flooding and erosion in coastal areas during tropical cyclones, and other extreme weather events, will involve considerable revisions to development plans and major investment decisions. These plans and decisions must be based on the best available information about the relative vulnerability of and

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[3] Church, J. A., Clark, P. U., Cazenave, A., Gregory, J. M., Jevrejeva, S., Levermann, A., Merrifield, M. A., Milne, G. A., Nerem, R. S., Nunn, P. D., Payne, A. J., Pfeiffer, W. T., Stammer, D., & Unnikrishnan, A. S. (2013). Sea level change. In IPCC, *Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1137–1216). Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf

[4] Oppenheimer, M., Glavovic, B. C., Hinkel, J., van de Wal, R., Magnan, A. K., Abd-Elgawad, A., Cai, R., Cifuentes-Jara, M., DeConto, R. M., Ghosh, T., Hay, J., Isla, F., Marzeion, B., Meyssignac, B., & Sebesvari, Z. (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*. https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

[5] Simpson et al. (2010).

[6] DeConto, R. M., & Pollard, D. (2016). Contribution of Antarctica to past and future sea-level rise. Nature, 531(7596), 591–597.

[7] Oppenheimer et al., 2019.

[8] Carson, M., Köhl, A., Stammer, D., A. Slangen, A. B., Katsman, C. A., W. van de Wal, R. S., Church, J., & White, N. (2016). Coastal sea level changes, observed and projected during the 20th and 21st century. *Climatic Change, 134*(1), 269–281. https://doi.org/10.1007/s10584-015-1520-1

[9] Climate Studies Group Mona. (2020). *The state of the Caribbean climate report*. Produced for the Caribbean Development Bank. http://dx.doi.org/10.13140/RG.2.2.16732.92808

risk to specific coastal lands; infrastructure and assets; ecosystems and sensitive habitats, such as beaches and mangroves; and heritage resources—and the resulting market and non-market economic impacts.

Tropical cyclones are a well-known feature of Caribbean meteorology. Hurricanes have impacted Saint Lucia in the past, with the latest being Hurricane Tomas in 2010. The National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center estimates that, on average, the island is brushed every 3.63 years and hit every 19.71 years by hurricanes. Hurricanes have passed within 60 miles of Saint Lucia 38 times in the last 138 years. Considerable damage has been caused by these hurricanes, as well as loss of life.

Storm surges precede the arrival of hurricanes and continue during the hurricane, sometimes affecting larger areas. In addition to elevated water levels due to storm surges, wind-driven wave runup and wave setup are major concerns. The increasing intensity of Caribbean hurricanes will cause a corresponding increase in storm surges and significant wave heights, increasing the vulnerability of coastal communities.

The storm surges associated with hurricanes can cause considerable damage and flooding in communities and exacerbate the loss of beaches. Research undertaken for Saint Lucia has shown that beaches do not fully replenish after these events due to a multitude of factors, including a general increase in local sea levels combined with an increase in hurricane intensity, the extraction of sand for building purposes, and the selective construction of groynes.

The anticipated increase in storm intensity and storm surge combined with SLR is expected to result in increased coastal flooding, the permanent loss of some coastline areas, and shorter flood return periods in some coastal areas. As such, it is important to understand the effects of SLR on its own, as well as the combined effect of SLR, storm surge, wave runup, wave setup and fluvial flooding during hurricanes, tropical storms, or other severe weather events. The geographic extent of SLR and storm surges, wave runup, and wave setup will greatly depend upon local topography, bathymetry, spatial planning, and infrastructure developments, necessitating refined modelling and assessment to inform adaptation measures and planning. The impact will depend on the vulnerability of ecosystems, infrastructure, and people, taking into account gender and social differences.

Beneficiaries

The information generated from this assignment is intended to benefit:

- coastal landowners nationwide, including government (Queen's Chain) lands—i.e., lands 187.5 ft from the highwater mark around the entire shoreline of Saint Lucia;
- citizens at risk in targeted priority coastal communities;
- stakeholders of major economic sectors (tourism, agriculture, transportation/shipping, etc.);
- infrastructure and community planners;
- ecosystems and conservation mandates; and
- coastal ecosystem stakeholders, including citizens who access the beaches and other coastal areas for livelihood, recreation, cultural, and religious purposes.

2. The Objective of the Assignment

The assignment will aim to increase the resilience of coastal ecosystems, critical infrastructure and facilities, economic sectors, and coastal communities in Saint Lucia to the combined effects of SLR, stronger tropical cyclones, and other extreme weather events through

- the collection of baseline data on coastal risks and the analysis of this data;
- modelling the extent of permanent coastal inundation, erosion, and shoreline retreat under various SLR scenarios and the extent of these SLR hazards, combined with tropical cyclone and extreme weather hazards, including temporary coastal flooding and erosion (from storm surge, wave runup, and wave setup) and fluvial flooding;
- the development of a climate vulnerability and risk assessment for exposed natural and human-made assets: ecosystems, critical infrastructure, critical facilities, critical assets (e.g., economic and cultural assets), and communities, including, as appropriate, disaggregation by gender and social groups. This assessment should consider overlaps between economic and non-economic losses where the former typically refers to income-generating and physical assets, such as infrastructure and property, while the latter typically refers to impacts on individuals (e.g., life), society (e.g., culture), and environment (e.g., ecosystem services); and

- the development of an economic impact assessment, including expected loss and damage, for Saint Lucia's coastline, focusing on the combined effect of SLR, tropical cyclones, and other extreme weather events.

These goals will enable the GoSL to design appropriate adaptation responses and interventions across a host of sectors, including infrastructure, tourism, and fisheries, ensuring the inclusion of equitable benefits for people of all genders and social groups. This work would build on the regional level work being undertaken through the Organization of Eastern Caribbean States Climate Change Strategy and Action Plan and associated country analysis, in particular, the regional climate change risk profile developed in 2020.[10] The risk profile documented the shared socio-economic, structural, and climate vulnerabilities of the territories and countries of the Eastern Caribbean and recommended adaptation strategies that can be implemented to build resilience to climate risks, both now and in the future.

3. Scope of Work

This assignment will cover the entire coastline of Saint Lucia and include three indicative phases, as described below. Capacity building and knowledge transfer are priorities for the GoSL. As such, the Consulting Firm will be expected to provide a training workshop at the end of each phase of the project, as well as reasonable ongoing opportunities for GoSL staff to partake in the work of each phase.

PHASE 1: DATA COLLECTION AND ANALYSIS *(GCF Readiness Output 3.2.1: Baseline understanding of the current state of information on climate change risks to Saint Lucia's coastlines is enhanced.)*

There is an urgent need to improve the information base with regard to the risks posed by climate change impacts that will allow informed decisions. In Phase 1, the information available for Saint Lucia will be collected, collated, and assessed to determine its suitability and limitations in enabling a quality study. Any additional data critical to the assignment will be collected, or suitable alternatives will be identified. Preliminary data processing will also be conducted during this phase.

An indicative list of datasets to be collated and analyzed for the modelling and assessment will be provided.

PHASE 2: COASTAL INUNDATION, EROSION, RETREAT, AND FLOOD MODELLING AND MAPPING *(GCF Readiness Output 3.2.2: Coastal mapping and modelling developed)*

This phase will model and map the geographic extent and severity of SLR hazards, including permanent inundation, erosion, and shoreline retreat, and SLR hazards plus temporary flooding and erosion in coastal areas from storm surges, wave runup, and wave setup during defined tropical cyclone events. For a limited set of flood-prone coastal communities where hydrologic modelling has already been done/is being done (Downtown Castries, Dennery, and Soufriere), the combined effect of fluvial flooding during defined tropical cyclone events will also be modelled.

This phase should build upon and enhance previous SLR and storm surge modelling work described in the background section. Using three SLR projections (as defined under the Specific Tasks section), the Consulting Firm will undertake modelling and mapping to estimate

i. the extent and depth of permanent inundation of coastal areas as a result of SLR to 2050 and 2100;
ii. the potential extent of coastal erosion and shoreline retreat in unconsolidated areas as a result of SLR to 2050 and 2100, considering historic shoreline erosion rates and anticipated accelerated erosion rates. This analysis should consider the potential permanent erosion impact from hurricane storm surge events that may be expected during the period based on return probabilities;
iii. the combined extent and depth of temporary flooding from coastal flooding (storm surge, wave runup, and wave setup) and fluvial flooding during two defined tropical cyclone events as enhanced by SLR to 2050 and 2100.

This process should result in model outputs and maps for each (i to iii) under all SLR projections and tropical cyclone scenarios.

[10] Organisation of Eastern Caribbean States. (2020). *Climate change risk profile for the OECS region*. https://sidsport-climateadapt.unctad.org/wp-content/uploads/2022/06/OECS-Climate-Report.pdf

PHASE 3: VULNERABILITY, RISK, AND ECONOMIC IMPACT ASSESSMENT *(GCF Readiness Output 3.2.3: Vulnerability, risk, and economic impact assessment for Saint Lucia is finalized.)*

This phase will build upon the datasets and analyses produced in phases 1 and 2 to produce a climate vulnerability and risk assessment and an economic impact assessment of exposed ecosystems, critical infrastructure, critical facilities, critical assets, and communities (please refer to the description under the Objective of the Assignment section). "Vulnerability" is understood as a function of exposure, sensitivity, and adaptive capacity, while "risk" is understood as a function of the likelihood of a hazard and the expected impacts and consequences. Risk results from the interaction of vulnerability and hazard.

The work of this phase will, therefore, assess who and what is vulnerable, to what extent, why, and associated risks by exploring exposure, sensitivities, adaptive capacities, impacts, and consequences. This phase will also cost expected loss and damage at the community, sector, and national levels. Finally, the outputs of this phase will broadly discuss policy and planning implications to inform future adaptation planning.

Specifically, the climate vulnerability and risk assessment will

i. map and inventory the ecosystems, critical infrastructure, critical facilities, critical assets, and communities exposed to SLR hazards and SLR plus tropical cyclone coastal hazards under all SLR scenarios to 2050 and 2100 and a select tropical cyclone scenario;
ii. describe and quantify the impacts of permanent inundation, erosion, shoreline retreat, and temporary flooding on ecosystems, critical infrastructure, critical facilities, critical assets, and communities under one select combined SLR and tropical cyclone scenario to 2050 and 2100;
iii. Assess, describe, and rate the sensitivity and adaptive capacity of impacted ecosystems, critical infrastructure, critical facilities, critical assets, and communities (noting that each may require its own methodology and consider the differences and overlaps between potential economic and non-economic losses) under one select combined SLR and tropical cyclone scenario to 2050 and 2100; and
iv. determine and describe the consequences of these impacts. Consequences refer to the wider set of implications that result from a particular impact or impacts and incorporate numerous factors, including the scale and potential severity of the impact, what and who is affected, and their adaptive capacity.

The economic impact assessment will cost expected loss and damage due to SLR and SLR plus tropical cyclone impacts, as well as consequences under the selected combined SLR and tropical cyclone scenario.

4. Specific Tasks

The following are the indicative tasks associated with the assignment to be undertaken by the Consulting Firm.

Phase 1: Data Collection and Analysis

Task 1: Conduct an Inception Mission
Upon commencement of the assignment, conduct an in-country Inception Mission, including site reconnaissance visits and consultations with the Client and other government/municipal agencies and key stakeholders to (i) receive and review available data and information relevant to the assessment and preliminarily identify data gaps; (ii) preliminarily identify vulnerability issues through agencies, consultations, and site visits; and (iii) discuss and agree upon capacity-building/training opportunities for government officers during the modelling and assessment.

Task 2: Collect, Process, and Collate Data in a Geodatabase and Other Appropriate Databases
The Consulting Firm shall collect, process, and collate the following types of datasets to inform the modelling, climate vulnerability and risk assessment, and economic impact assessment:

- Current, high-resolution topographic and bathymetric data
    - *Required to conduct community-scale storm surge, wave runup, wave setup, and SLR hazard mapping and to assess erosion processes. While LiDAR data (topographic and bathymetric) is anticipated to become available for Saint Lucia before the start of the consultancy, additional topographic or bathymetric data may have to be collected in some specific areas to facilitate the study.*
- Coastal morphology data
    - *Required for modelling, as coastal morphology directly impacts the extent and level of coastal inundation, erosion, and flooding expected.*
- Geologic data

    - *Saint Lucia is a volcanic island and is tectonically active. As a result, certain land areas may be experiencing land movement, which could either mitigate or exacerbate SLR. Therefore, the Consulting Firm must consider the non-climatic components of relative sea level change. Possible subsidence or emergence of certain parts of Saint Lucia and implications on local SLR must be determined.*
- Oceanographic and hydro-meteorological data, including in relation to past climatic events
    - *Required to inform storm surge and fluvial flood modelling.*
- Hazard, risk, and impact data
    - *Required to inform the vulnerability, risk, and economic impact assessment.*
- Coastal and marine habitat data
    - *Required to inform the vulnerability, risk, and economic impact assessment.*
- Socio-economic and socio-cultural data
    - *Required to inform the vulnerability, risk, and economic impact assessment. The Consulting Firm shall coordinate with the Central Statistics Office as to details of data availability and what standards need to be followed to collect potentially sensitive data. Wherever possible, the data should be georeferenced, collated, and presented in a GIS database.*
- Land, land-use, and soil data
    - *The Consulting Firm shall obtain land and survey data from the Land Registry and Physical Planning Sections of the Department of Physical Development. Land uses and activities (e.g., agriculture, natural vegetation, and sand mining) will be inventoried, as these influence differential erosion rates and inform the vulnerability, risk, and economic impact assessment. Targeted GPS surveying will be used for ground-truthing the land-use classifications, soil information, and ground cover data where necessary, especially in high-hazard susceptibility areas.*
- Critical coastal infrastructure, facilities, and buildings data
    - *Required to inform the vulnerability, risk, and economic impact assessment.*

A list of detailed datasets and a description of available data—with an indication of where new primary data is expected to be collected as a part of the assignment—will be produced by the Consulting Firm. The Consulting Firm is responsible for identifying, collecting, processing, and collating all datasets required to fulfill the modelling and assessment requirements of this Terms of Reference (TOR), including through consultation with relevant local authorities and regional/international sources, primary data collection, or the use of surrogate data.

Task 3: Analyze Available Datasets to Determine Their Suitability for the Required Modelling and Assessment and Development of a Strategy to Address Data Gaps and Constraints

The Consulting Firm shall assess the quality of datasets collected, processed, and collated under Task 2 to determine their suitability for the required modelling and assessments. In assessing the quality of each dataset, the Consulting Firm shall consider how the data was collected (methodology), its accuracy and reliability, its resolution or level of detail, and its age and completeness, among other relevant characteristics.

As a result of the assessment, the Consulting Firm shall identify critical data gaps or data constraints and provide recommendations for enhanced data collection (which may include participatory methods to involve typically under-represented groups) going forward to enable further studies. The Consulting Firm shall further describe a strategy for addressing each gap or constraint in such a manner as to minimize the impacts on the quality of the modelling and assessments. The strategy shall clearly identify where new data will be collected as a part of the assignment in keeping with the TOR requirements (with the proposed method indicated), where surrogate data will be used (with the proposed source and licensing terms), assumptions will be made (with the basis for the same), literature norms will be applied (with the source), or other approaches will be used to address the gaps/constraints with a justification for each approach. The impact on the overall quality of the modelling and assessment based on the proposed strategy shall be presented. The strategy must be approved by the Client before proceeding with the modelling and assessments.

Task 4: Phase 1 Training

In the *Inception Report,* the Consulting Firm shall specify opportunities for up to five persons at a time to receive hands-on training during Phase 1 data collection activities.

Upon submission of the *Report on Available Data and Strategy for Addressing Data Gaps and Constraints*, the Consulting Firm shall deliver a half-day workshop for at least 25 participants to summarize the overall approach, detailed methodologies, rationale for data needs, and approach for addressing data gaps and constraints.

Phase 2: Coastal Inundation, Erosion, Retreat, and Flood Modelling and Mapping

Task 1: Select Climate Change Scenarios and Sea Level Rise (SLR) Projections
Future rise in the global mean sea level strongly depends on which Representative Concentration Pathway (RCP) emission scenario is followed.[11] As such, the Consulting Firm shall select SLR projections under three RCPs as the basis for modelling up to 2050 and 2100, including (i) a stringent mitigation scenario (RCP 2.6) representative of a scenario that aims to keep global warming *likely* below 2°C above pre-industrial temperatures, (ii) an intermediate scenario (RCP 4.5 or RCP 6.0), and (iii) a very high GHG emissions (RCP 8.5) scenario.[12]

The three SLR projections selected may come from those generated by the IPCC, by other recent and reliable sources, or by a combination of these. The Client and regional jurisdictions and organizations (e.g., the Caribbean Institute for Meteorology and Hydrology, the Caribbean Community Climate Change Centre, and the PRECIS Caribbean initiative) must be consulted in selecting the most appropriate projections for informing modelling. In addition, the Consulting Firm shall consider the following sources of information, among others, in the selection of SLR projections:

- *Synthesis Report of the IPCC Fifth Assessment Report* (AR5);[13]
- Working Group 1's (WG1) report from the IPCC *Fifth Assessment Report* (AR5), which contains further information on regional climate change projections;[14]
- IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate* – Chapter 4: "Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities";[15]
- *Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of SLR in the Caribbean*;[16]
- *Saint Lucia: National Infrastructure Assessment* [17]
- other recent and reliable sources of SLR projections, as well as the regional downscaling of SLR projections based on observed SLR and available GCM/RCM data, produced for the Caribbean region through ParCA; and[18]
- SLR scenarios adopted by other jurisdictions for coastal vulnerability assessments and planning. The Consulting Firm will choose relevant guides carefully to find those that best compare to the situation in Saint Lucia.

A justification for the selection of each SLR projection shall be provided. If the Consulting Firm recommends using SLR projections outside of those provided in the IPCC Fifth Assessment Report, a justification for the same shall be provided.

Task 2: Determine Historic Shoreline Erosion Rates
The Consulting Firm will calculate historical rates of coastal erosion (or change in areas of progradation) using digitized shorelines generated based on decades of aerial imagery available for 1941, 1953, 1966, 1977, 1981, 1992, and 2009 or historical satellite imagery. The assessment of erosion impacts will focus on vulnerable ecological habitats, such as beaches and mangroves, tourism areas, and settlement areas. The results of this analysis will help to identify areas more vulnerable to accelerated future erosion with SLR and help to calculate the expected extent of such erosion.

Task 3: Model and Map SLR Inundation, Coastal Erosion, and Retreat
Inundation from SLR will become a permanent threat to socio-economic activity and ecosystems along the coast. SLR will also enhance rates of coastal erosion and may result in ecosystem retreat (inland shift of coastal ecosystems) in unconsolidated areas of shoreline. The Consulting Firm will conduct detailed modelling for each of the three SLR scenarios selected to determine the following:

[11] Oppenheimer et al., 2019.

[12] IPCC. (2014). *Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R. K. Pachauri, & L. A. Meyer (Eds.)]. https://www.ipcc.ch/report/ar5/syr/

[13] IPCC, 2014.

[14] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

[15] Oppenheimer et al., 2019.

[16] Simpson et al., 2010.

17 Adshead, D., Fuldauer, L.I., Thacker, S., Román García, O., Vital, S., Felix, F., Roberts, C., Wells, H., Edwin, G., Providence, A. and Hall, J.W. 2020. Saint Lucia: National Infrastructure Assessment. United Nations Office for Project Services, Copenhagen, Denmark

[18] The Partnership for Canadian Caribbean Climate Change Adaptation (ParCA) research program is currently being undertaken by CARIBSAVE in four countries across Canada and the Caribbean. Project duration: 2011–2016

i) the extent and depth of permanent inundation of coastal areas as a result of SLR to 2050 and 2100 under the daily operational nearshore wave environment; and

ii) the potential extent of coastal erosion and retreat in unconsolidated shoreline areas as a result of SLR to 2050 and 2100, considering historic shoreline erosion rates, accelerated erosion expected with SLR, and the potential permanent erosion impact from hurricane storm surge events that may be expected during the period based on return probabilities.

Modelling should be done using a physics-based, dynamic numerical model. The model selection must be justified and agreed to by the Client before proceeding. The model must be calibrated and validated. In conducting the modelling, any appreciable effect of tectonic movements on SLR should be factored in, as well as coral reef health, historic sand mining, and other factors that may affect erosion rates, together with development pressures that affect the ability of unconsolidated shorelines to retreat.

The daily operational nearshore wave environment shall be determined using an appropriate global ocean wave model, such as WW3, developed by the National Oceanic and Atmospheric Administration (NOAA), and a global tide model combined with local data on wind speed and direction, as well as wave height, wave period, and wave direction.

Expected erosion, retreat, or loss/inundation of shoreline should be quantified. In the case of coastal ecosystems, a distinction should be made between areas where there is room for retreat—and, as such, coastal ecosystems may migrate inland with rising sea levels—and where shoreline hardening or geologic features prevent retreat—and, as such, coastal ecosystems may be lost.

The modelling results will be used to develop a series of high-resolution cartographically correct GIS-compatible maps showing

(i) the geographic extent and depth of permanent inundation under each SLR scenario to 2050 and 2100;
(ii) the extent of coastal erosion or retreat in unconsolidated shoreline areas, including beach areas and other coastal ecosystems, under each SLR scenario to 2050 and 2100;
(iii) differential exposure of coastal areas under the SLR scenarios modelled; and
(iv) the coastal zone (including beach areas and other coastal ecosystems), categorized by high, medium, and low exposure to SLR hazards based on model results for each scenario.

A confidence analysis of modelling results must be performed. The limitations of the selected model, model validation, uncertainties of model results, and appropriate applications of mapping products must be discussed in full.

Task 4: Develop SLR Plus Tropical Cyclone-Induced Flood Modelling and Mapping
Some coastal communities experience fluvial flooding during heavy rainfall events, and the majority of Saint Lucia's coastline is susceptible to coastal flooding during tropical cyclones. The effects of fluvial flooding, coastal flooding, and erosion during tropical cyclones will be enhanced by SLR. To understand this combined effect, the Consulting Firm will model total flooding (coastal and fluvial) and erosion potential under two defined tropical cyclone events, enhanced by each SLR scenario to 2050 and 2100 as follows:

i. A tropical cyclone with a 50-year rainfall event and a 50-year storm surge as defined in the *Atlas of Probable Storm Effects in the Caribbean Sea*[19] or more current applicable storm surge return periods for the region, as agreed with the Client.

ii. A tropical cyclone with a 100-year rainfall event (or the maximum recorded rainfall event or calculable return period)[20] and a 100-year storm surge as defined in the *Atlas of Probable Storm Effects in the Caribbean Sea* or more current applicable storm surge return periods for the region as agreed with the Client. The storm surge heights and significant wave heights associated with the recent Category 5 hurricanes in the region (Hurricane Irma, Hurricane Maria, and Hurricane Dorian) should also be modelled if these exceed the wave height for the 100-year storm surge return period cited.

Appropriate numerical model(s) should be used to determine the extent and severity of coastal flooding and erosion associated with 50-year and 100-year storm surge events.

[19] Caribbean Disaster Mitigation Project. (2002). *Atlas of probable storm effects in the Caribbean Sea.* http://www.oas.org/CDMP/document/reglstrm/

[20] See the *CHaRIM Project Saint Lucia National flood hazard map methodology and validation report:* http://www.charim.net/sites/default/files/handbook/maps/SAINT_LUCIA/SLUFloodReport.pdf

For coastal communities prone to fluvial flooding (and where previous hydrologic modelling has been done), including Downtown Castries, Dennery, and Soufriere, the Consulting Firm will be expected to undertake hydraulic modelling analyses using storm surge, wave runup, wave setup, river flows, and other hydrologic inputs as boundary conditions to understand the combined effect of coastal and fluvial flooding enhanced by SLR. Important hydraulic structures will be included in the simulations.

For all scenarios, the model should reflect a combination of high tide, peak storm surge, and peak river discharge. The modelling results will be used to develop a series of high-resolution, cartographically correct, GIS-compatible maps showing

(i) for the entire coastline, the geographic extent of coastal flooding (from storm surge, wave runup, and wave setup) and associated wave heights, flood depths, and erosion estimates under each defined tropical cyclone event enhanced by each SLR scenario to 2050 and 2100;

(ii) the geographic extent of coastal flooding combined with fluvial flooding for Downtown Castries, Dennery, and Soufriere and associated wave heights, flood depths, and erosion estimates under each defined tropical cyclone event enhanced by each SLR scenario to 2050 and 2100;

(iii) differential exposure of coastal areas under the scenarios modelled in (i) and (ii) above; and

(iv) the coastal zone (including beach areas and other coastal ecosystems), categorized by high, medium, and low exposure to combined SLR and tropical cyclone hazards under each tropical cyclone event and SLR scenario to 2050 and 2100.

A confidence analysis of modelling results must be performed. The limitations of the selected model, uncertainties of model results, and appropriate applications of mapping products must be discussed in full.

Task 5: Phase 2 Training
The Consulting Firm shall specify opportunities for up to five persons to receive hands-on exposure to the modelling conducted under Phase 2 as it is in progress.

After the completion of Task 4, the Consulting Firm shall deliver a full-day workshop for at least 25 participants to summarize the methodologies used and outcomes of Phase 2, including physical processes being modelled, driving equations, data inputs, model parameterization (sensitivity analysis), model calibration, model validation, limitations and uncertainties, and appropriate applications for results.

Phase 3: Vulnerability, Risk, and Economic Impact Assessment

Task 1: Climate Vulnerability and Risk Assessment
The Consulting Firm will use an intersectoral approach to examine vulnerability to and risk from SLR and combined SLR plus tropical cyclone coastal hazards in Saint Lucia, including permanent inundation, accelerated erosion, shoreline retreat, and temporary coastal and fluvial flooding. As a preliminary step, the Consulting Firm will overlay ecosystem, infrastructure, facility, asset, and population datasets on the results of the Phase 2 modelling and mapping to determine the degree to which populations and natural and built systems are exposed to SLR and SLR plus tropical cyclone hazards. To aid in evaluating potential consequences, the Consulting Firm will categorize exposed ecosystems, infrastructure, facilities, and assets (collectively termed natural and built assets) by function or sector and assign them a risk class according to the severity or magnitude of the impacts should they experience permanent inundation, flooding, or erosion. This process will be complemented by an analysis of gender and social factors that influence vulnerability and create barriers for vulnerable groups to participate in and benefit from adaptation action.

The results of the Climate Vulnerability and Risk Assessment are to be presented in a series of ***climate vulnerability and risk maps, vulnerability and risk inventories*** and ***vulnerability and risk profiles*** for each natural or built asset or asset class, as applicable, and supported by an overarching analysis that ties all of these together at the community, sector, and national scales and broadly discusses policy and planning implications to inform future adaptation planning.

The ***climate vulnerability and risk maps and inventories*** will complement each other and will be generated for **all** SLR scenarios to 2050 and 2100 and each SLR scenario combined with **one** tropical cyclone scenario, as agreed with the Client. The ***maps*** will show the location and distribution of exposed populations and natural and built assets (coded by categories and risk classes). The ***inventories*** will support the maps by providing vital details on exposed populations and natural and built assets; a quick view of vulnerability through summary indicators considering exposure, sensitivity, and adaptive capacity; and a risk rating considering potential impacts and consequences.

The ***climate vulnerability and risk profiles*** will provide a detailed analysis and in-depth understanding of vulnerability and risk for each exposed community and natural or built asset or asset class by assessing, quantifying, and rating exposure, sensitivity, adaptive capacity, impacts, and consequences. This process will include an explanation of how, why, and the extent to which a community, group, or natural or built asset/asset class is vulnerable and a description, quantification, and rating of potential impacts and consequences. The profiles will also include a brief discussion on policy and planning implications.

Asset vulnerability and risk profiles will be generated for a single combined SLR and tropical cyclone scenario to 2050 and 2100, which will be used as the basis for adaptation planning, as agreed with the Client.

The results of the climate vulnerability and risk assessment should be compared against the 2010 *Caribbean Study Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean*[21] and the recent assessment of infrastructure vulnerability to SLR by the National Integrated Planning and Programme Office with technical assistance from the United Nations Office for Project Services and Oxford University.

The climate vulnerability and risk assessment will include the following sub-components, which will be integrated into a high-level assessment of vulnerability and risk at the community, sector, and national levels:

a) Ecosystems Vulnerability and Risk Assessment

The Consulting Firm will produce ***maps and inventories*** that

(i) map and quantify the area of beaches, wetlands, coastal forests, other coastal ecosystems, and protected areas expected to be lost due to permanent inundation (where retreat is not possible or will not take place fast enough), including highlighting beach area lost in front of hotels/resorts. A detailed beach analysis (inclusive of beach profiles, grain size analysis, etc.) will be limited to a representative sample of up to 30 critical beaches (from ecological, tourism, cultural, or recreational perspectives), as agreed with the Client and key stakeholders;

(ii) map and quantify sea turtle nesting sites and iguana habitats expected to be lost due to permanent inundation or accelerated erosion;

(iii) identify and estimate populations of species that will experience habitat loss as a result of the impacts quantified above;

(iv) categorize the coastal zone (including beach areas and other coastal ecosystems) by high, medium, and low vulnerability to SLR under each required scenario to 2050 and 2100; and

(v) compare exposed natural assets, vulnerabilities, and risks under the various scenarios.

The Consulting Firm will produce ***ecosystem vulnerability and risk profiles*** for beaches, wetlands, coastal forests, other coastal ecosystems, critical habitat types, and protected areas. In developing the profiles, the Consulting Firm shall consider linkages between ecosystems, livelihoods, and economic sectors (in particular, agriculture, fisheries, and tourism), surrounding land uses, future development pressures, and existing protection measures. The Consulting Firm should also consider and describe the natural and beneficial functions of the country's natural assets in protecting the coastline from the hazards being assessed.

b) Critical Infrastructure, Facilities and Assets Vulnerability and Risk Assessment

The Consulting Firm will produce ***maps and inventories*** that

(i) map and quantify all critical infrastructure, critical facilities, and critical assets expected to be permanently inundated, temporarily flooded, undermined by erosion, or otherwise impacted (e.g., impeded drainage) by SLR and SLR plus tropical cyclone coastal hazards. The map should distinguish the type of impact(s) expected for each; and

(ii) provide a comparison of exposed critical infrastructure, critical facilities, critical assets, and attendant vulnerabilities and risks under the various scenarios.

The Consulting Firm will produce ***climate vulnerability and risk profiles*** for all critical infrastructure, facilities, and asset classes, including details at the level of each major investment (e.g., each port) within each class. For tourism assets, the profiles will be built on information from a representative sample of tourism accommodation properties, as agreed with the Client.

The Consulting Firm is responsible for collecting all data and information on impact, sensitivity, adaptive capacity, and consequences required for the analysis through reports, field surveys, or consultations with managers of critical infrastructure and facilities. In the case of public infrastructure, facilities, and assets, the Consulting Firm shall

[21] Simpson et al., 2010.

review the ***Saint Lucia: National Infrastructure Assessment*** report[22], which will outline the findings of the National Infrastructure Systems Model (NISMOD)[23] applied to Saint Lucia. Among other things, the report includes a vulnerability assessment of Saint Lucia's infrastructure to a 1-metre SLR by 2100, combined with the impact of a 4-metre storm surge. A GIS model was used to determine the geographic extent of SLR and storm surge hazards.

Additionally, the Consulting Firm shall provide Saint Lucia's National Integrated Planning and Programme Office with the model output files of Phase 2 to facilitate generating updated NISMOD results for critical public infrastructure and facilities based on the refined modelling and mapping results from this assignment. The anticipated time required to incorporate new datasets to update the NISMOD is 6 weeks. The Consulting Firm shall use the results of the updated NISMOD together with any other required data from reports, field surveys, site visits, or consultations with managers of critical infrastructure and facilities to generate the required vulnerability and risk profiles.

Critical infrastructure, critical facilities, and critical assets to be assessed include but are not limited to:

Critical Infrastructure

- Transportation infrastructure, including roads, bridges, tunnels
- Ports, including airports and seaports
- Drainage infrastructure
- Energy infrastructure, including power plants, substations, and distribution lines
- Telecommunication systems, including communication towers and cables
- Water infrastructure, including water treatment plants, storage tanks, and distribution lines
- Sewage infrastructure, including sewage treatment plants and sewage collection systems
- Waste management infrastructure, including landfills and incinerator plants

Critical Facilities

- Health, emergency response, and education facilities, including hospitals, clinics, police stations, fire stations, churches designated as emergency shelters, human resource development centres, schools, and libraries
- Public facilities, including administrative buildings, banks, post offices, homes for the elderly, infant homes, burial grounds, and other critical community facilities

Critical Assets

- Tourism facilities, including hotels, resorts, villas, and built tourist attractions
- Fisheries landing and processing sites
- Agricultural processing facilities
- Other critical assets to support key economic activities
- Land categorized by major land uses, including urban/non-urban and residential, commercial, industrial, agricultural, recreational, and undeveloped
- Cultural assets, including national monuments, historic buildings, historic sites, and significant cultural sites

c) Community Vulnerability and Risk Assessment

The community vulnerability and risk assessment should be based on estimated population growth to 2050 and 2100, considering business-as-usual growth scenarios.

The Consulting Firm will produce ***maps and inventories*** that

- map and quantify loss or significant impact on the housing stock in communities;
- map and quantify likely population displacement from communities;

[22] Adshead, D., Fuldauer, L.I., Thacker, S., Román García, O., Vital, S., Felix, F., Roberts, C., Wells, H., Edwin, G., Providence, A. and Hall, J.W. 2020. Saint Lucia: National Infrastructure Assessment. United Nations Office for Project Services, Copenhagen, Denmark.

[23] The National Infrastructure Systems Model (NISMOD), developed by the UK Infrastructure Transitions Research Consortium (ITRC), assesses a country's current and future infrastructure needs and provides recommendations on how those needs can best be met. The model is comprised of two separate yet complimentary components: Risk & Vulnerability and Long-Term Planning. Integral to the NISMOD is the incorporation of a wide range of spatial and economic datasets with country-specific engineering insights and on-the-ground assessments. NISMOD includes a visualization function that allows for the presentation of model outputs in the form of maps, time series, and other graphics. More information about NISMOD can be found at https://www.itrc.org.uk/nismod/.

- map and quantify likely job and livelihood displacements from communities and urban areas;
- provide a comparison of exposed communities, populations, housing stock, and jobs/livelihoods under the various scenarios; and
- map communities by their assessed levels of vulnerability and risk.

The Consulting Firm will produce community vulnerability and risk profiles for all communities with high exposure to SLR and combined SLR and tropical cyclone hazards. In developing the profiles, standard and locally appropriate social vulnerability considerations like age, gender, race, disability, income, education, housing type, and access to transportation must be assessed using a standard methodology. In the overarching analysis, the Consulting Firm will discuss which characteristics of communities and populations affect vulnerability and adaptive capacity and how, including analysis of gender and social norms, barriers to participation in governance and decision-making processes, and specific vulnerabilities experienced by particular groups (for example, people with disabilities or older persons who may have mobility issues that inhibit evacuation).

In developing the profiles, local knowledge should be harnessed through community surveys, focus groups, or other appropriate community engagement methods in each community to best understand the multi-scale socio-economic, governance, and environmental conditions that shape vulnerability and adaptive capacity.

Task 2: Perform an Economic Impact Assessment
Based on the results of the vulnerability and risk assessment, the Consulting Firm will determine the economic impact of the effect of SLR combined with tropical cyclone coastal hazards to 2050 and 2100 at the micro-, meso-, and macroeconomic levels under the select combined SLR and tropical cyclone scenario agreed with the Client.

At the *microeconomic level*, the Consulting Firm shall apply valuation methods (agreed upon in consultation with the Client) to determine the capital value of all natural and built assets lost or significantly impacted, as determined by the vulnerability and risk assessment. For natural assets that provide non-market values, such as ecosystem services, these non-market values shall be obtained from standard literature values appropriate to Saint Lucia's context, such as may be found in the *Guidelines for Measuring and Valuing the Coastal Protection Services of Mangroves and Coral Reefs* developed jointly by The Nature Conservancy and the World Bank or other literature available through Wealth Accounting and the Valuation of Ecosystem Services (WAVES). In valuing critical infrastructure and facilities, the rebuild or relocation cost should be used. In valuing land and housing stock, established market values for each land-use type and community and appreciation values should be considered.

The Consulting Firm shall also determine the annual/recurring cost of damage and loss, in particular, tourist expenditure loss from amenity damage/loss, such as beach erosion/loss, agricultural production loss, and industry loss, among others.

At the *mesoeconomic level*, the Consulting Firm shall aggregate findings to estimate the economic impact at the sector level for tourism, agriculture, fisheries, natural resources, infrastructure, and settlements, among other key sectors.

At the *macro level*, the Consulting Firm shall determine an estimate of total economic impact at the national level to 2050 and 2100, considering capital and annual costs and intersectoral linkages.

An appropriate discount rate must be selected and applied in determining future economic impact.

Task 3: Develop a Decision Support System for Coastal Development
Based on the model results and assessments, the Consulting Firm will develop a decision support system to guide coastal development in high-risk communities to 2100. The system will consist of

- an interactive GIS-based data viewer available as a web-based and mobile phone application that would allow the public to visualize exposure to SLR and combined SLR plus tropical cyclone coastal hazards;

- an interactive GIS-based map of the coastal zone categorized by high, medium, and low vulnerability to and risk of permanent inundation, erosion/retreat, and temporary flooding. High vulnerability and risk areas will become priorities for adaptation planning; and

- an interactive query interface allowing text-based searches of the vulnerability and risk maps, inventories, and profiles.

The technical requirements for the system shall also be developed by the Consulting Firm in consultation with the Client and agreed upon prior to the implementation of the system.

Task 4: Phase 3 Training
After the completion of Task 3, the Consulting Firm shall deliver a full-day workshop for at least 25 participants to summarize the methodologies used and outcomes of Phase 3 and train persons in the use of the decision support system.

5. Payment Schedule

Payments will be made in instalments based on the fixed contract price, as follows:

#	Deliverable	Due by	% Contract value (est.)
PHASE 1: DATA COLLECTION AND ANALYSIS			***30%***
1	Inception report, including participant lists disaggregated by gender (with a target of 50% women participating)	month 3	
2	Completed inventory report, including details of databases with descriptions of available data (delivered)	month 3	
3	Completed report and communications products detailing analysis of available data and a strategy for addressing data gaps and constraints posted to the Saint Lucia climate change website	month 5	
4	a. Completed full-day training workshop for at least 25 participants, Phase 1 b. Summary training report for one full-day Phase 1 training workshop, including pre- and post-workshop evaluation forms, training materials, and a participant list disaggregated by gender	month 5	
PHASE 2: COASTAL INUNDATION, EROSION, AND FLOOD			***40%***
5	Final modelling report summarizing files for selected climate change scenarios and SLR projections	month 7	
6	Final assessment report of erosion impacts	month 8	
7	Final report on coastal inundation, erosion, and flood modelling and mapping, including detailed modelling for each SLR projection; a series of high-resolution, cartographically correct GIS-compatible maps; and a confidence analysis of the modelling results	month 12	
8	Final model report containing the total flooding (coastal and fluvial) and erosion potential under two defined tropical cyclone events with a series of high-resolution cartographically correct GIS-compatible maps	month 12	
9	a. Completed full-day training workshop for at least 25 participants, Phase 2 b. Summary training report for Phase 2, including pre- and post-evaluation forms, training materials, and a participant list of 25 stakeholders disaggregated by gender (with a target of 50% women participating)	month 13	
PHASE 3: VULNERABILITY, RISK, AND ECONOMIC IMPACT ASSESSMENTS			***30%***
10	Final vulnerability and risk assessment report, including vulnerability and risk maps, vulnerability and risk inventories, and vulnerability and risk profiles for each natural or built asset or asset class. Sub-components of the vulnerability and risk assessment are an ecosystem vulnerability and risk assessment; a critical infrastructure, facilities, and assets vulnerability and risk assessment; and a community vulnerability and risk assessment	month 17	
11	Approved economic impact assessment report for SLR combined with tropical cyclone coastal hazards	month 18	
12	a. Report on technical requirements for a decision support system for coastal development b. Fully functional decision support system to guide coastal development in high-risk communities to 2100 based on coastal	month 19	

	mapping and modelling, including an interactive GIS-based data viewer; an interactive GIS-based map of the coastal zone categorized by vulnerability; a comprehensive database of all data and information used for the conduct of the assignment; and an interactive query interface allowing text-based search of vulnerability and risk maps, inventories, and profiles.		
13	a. Completed full-day training workshop for at least 25 participants, Phase 3 b. Final summary training report for Phase 3 and pre- and post-evaluation forms, including training materials and a participant list disaggregated by gender (with a target of 50% women participating).	month 20	

6. Location and Duration of the Assignment

The assignment will be delivered over a period of 20 months between March 2024 and October 2025. It is expected that the Consulting Firm will be required to deliver the work through a combination of remote and in-person work in Saint Lucia during this period.

7. Reporting

All reports shall be submitted electronically in English in Microsoft Word and PDF format. The first submission of each deliverable is considered a draft. Client comments on each deliverable must be submitted to the Consulting Firm within the stated timelines. The final version of each deliverable addressing Client comments must be submitted within two weeks of receipt of Client comments.

All reports, documents, maps, and data collected relevant to the Consulting Firm's services shall become the property of the GoSL.

As such, all data collected and generated during the assignment will be submitted to the GoSL in the format required for its transfer to relevant country databases by secure electronic means. All spatial data must be submitted in a well-organized metadata format and should comply with international and local standards required by the relevant national agencies. The submission shall include an inventory naming and describing each file.

8. Working Arrangements

IISD and the Department of Sustainable Development will establish a **Technical Working Group (TWG),** which will supervise the execution of the project. The TWG will provide comments on deliverables submitted by the Consulting Firm through IISD.

IISD and the Department of Sustainable Development will

a) ensure ongoing communication with the Consulting Firm and timely feedback on any issues raised;
b) ensure timely review of the reports submitted by the Consulting Firm and within the stipulated duration stated in the TOR;
c) initiate consultation and cooperation with other agencies required to provide support to the Consulting Firm for the realization of the relevant aspects of the assignment;
d) negotiate permission to use and facilitate access to available data required for the assignment through outreach to agencies and establishment of Memoranda of Understanding, etc.;
e) facilitate the organization of community/stakeholder engagements/consultations, as agreed with the Consulting Firm;
f) facilitate the provision of spaces required to conduct workshops and training sessions and provide any refreshments/meals; and
g) provide one office space (desk, chair, and internet connection) at the Department of Sustainable Development to facilitate the work of the Consulting Firm.

The Consulting Firm is expected to take full responsibility for the assignment and implementation of the tasks and supervision of its team.

The Consulting Firm will

a) be responsible for the collection of all data and information required for the timely completion of the assignment;
b) be mindful of recent and parallel work being undertaken in Saint Lucia, which has the potential to support this project, as there may be opportunities for synergies, such as sharing collected data;
c) engage the appropriate qualified and experienced technical and administrative staff and other resources necessary to undertake the services;
d) be responsible for the supervision of its technical staff, including providing any additional office space, equipment, materials, travel, accommodation, and transportation required; and
e) execute the services in accordance with the laws, customs, and practices of Saint Lucia and use appropriate international standards for the preparation of technical information.

9. Qualification and Skill Requirements of the Consulting Firm

The Consulting Firm is expected to possess skills and at least 10 years of experience in the following areas:

- Coastal engineering
- Coastal geomorphology
- Numerical modelling of coastal dynamics and simulation of SLR, tides, storm surges, wave runup, and wave setup
- Experience with high-resolution modelling of urban flooding
- Coastal vulnerability and risk assessments
- Economic impact assessments

Additional minimum qualifications of the Consulting Firm include

- scientific and technical background in coastal disaster risk modelling, disaster risk management, and climate change projections and coastal impacts;
- proven ability to develop vulnerability and risk profiles in a short time frame by leveraging available datasets (the Consulting Firm is expected to leverage in-house data available from its partners);
- work experience in the Caribbean region or small tropical islands; and
- excellent written and oral communication abilities in English.

With regard to the **team composition and qualifications**, the following are required:

i. The Consulting Firm shall have sufficient qualified personnel and resources to provide all necessary professional, technical, and expert services, as required, to accomplish all the services described above within the prescribed time. The assignment will require a Team Leader supported by specialists who possess the relevant technical expertise detailed in the following subsection.
ii. The team should include local experts to ensure that the local context and experiences are fully considered, providing the specific aspects and lessons learned in relation to the national context.
iii. Brief CVs for all team members should be included in tenders.
iv. All proposed team members must be independent and free of conflicts of interest in the responsibilities accorded to them.

Other required attributes are:

- Strong project management skills
- Strong technical report writing skills
- Excellent, clear, and concise communication skills, including presentation skills

The minimum qualifications and experience of key experts are summarized below; however, the Consulting Firm may propose an effective team considered to be the most suitable for carrying out the assignment. The technical proposal must outline why the proposed composition of the team is considered capable and most suitable, as well as the estimated number of persons required and the estimated number of person-months for each professional.

Key Experts' Minimum Qualifications

Team Leader

- Overall responsibility for the implementation of the tasks outlined in this TOR.
- At least a master's degree in a field related to integrated coastal zone management, such as coastal engineering, coastal ecosystems management or coastal management policy, with a minimum of 15 years of demonstrated work experience in the respective field.

- Substantive experience and certification in project management and planning, including experience managing a similar project in scope and magnitude.

Coastal Engineer

- Lead all activities under Phase 1 and Phase 2 of the assignment, supported by the other key experts, in particular the Coastal Morphology and Ecosystems Expert.
- Hold at least a master's degree in coastal engineering with at least 15 years of experience in the field. At least 10 years of work experience in dynamic numeric coastal modelling is required, as well as prior experience conducting SLR, coastal flooding, and hydraulic modelling.
- Work experience in the Caribbean region or small tropical islands is required.

Coastal Morphology and Ecosystems Expert

- Provide key inputs into Phase 1 and Phase 2, including leading the activities related to the inventory and characterization of coastal ecosystems and the determination of historical shoreline erosion rates. This task will include conducting interviews with relevant organizations and stakeholders to assess the geo-ecological conditions of existing coastal habitats and their potential to provide coastal protection ecosystem services and evaluate existing and planned proposals and investment programs in those areas or adjacent areas. The Expert will assess where and how healthy and restored ecosystems can address current and growing risks from natural hazards and climate change, as well as the vulnerability of and risk to coastal ecosystems, and provide implications for policy and planning as it relates to protecting coastal ecosystems. They will also support the Economist in the valuation of natural assets.
- Hold at least a master's degree in a relevant discipline such as coastal morphology, physical geography, or coastal engineering, with at least 15 years of experience in the field and at least 10 years of experience in the characterization of coastal ecosystems, the determination of historical shoreline erosion rates, and experience in ecosystem valuation. At least 5 years of work experience in the area of climate change adaptation is also required, along with previous experience carrying out a similar assignment.
- Work experience in the Caribbean region or small tropical islands is required.

Civil Engineer/Infrastructure Specialist

- Lead activities related to the inventory, characterization, and assessment of physical/built coastal assets under the vulnerability and risk assessment.
- Conduct interviews with relevant organizations and stakeholders and undertake site visits to determine the conditions of existing coastal infrastructure, facilities, and other built assets and existing and planned proposals and investment programs; interpret the results of the updated NISMOD; integrate the findings into the vulnerability and risk assessment; and provide implications for policy and planning as they relate to protecting physical coastal assets.
- Hold at least a master's degree in civil engineering and be a registered/licensed professional engineer in their country of practice with at least 15 years of experience in the field. At least 5 years of work experience in the area of climate change adaptation is required.
- Work experience in the Caribbean region is required.

Community Planner

- Lead the activities related to the inventory, characterization, and assessment of communities under the community vulnerability and risk assessment and support the Economist in the economic impact assessment. Among other tasks, the Community Planner will conduct interviews with relevant organizations and community stakeholders, undertake site visits and collect data otherwise as necessary to determine the conditions of the existing housing stock (in collaboration with the Civil Engineer) and understand the socio-economic conditions and growth projections in exposed communities. The Community Planner will also provide implications for policy and planning as it relates to protecting populations, housing stock, and livelihoods.
- Hold a master's degree in urban and regional planning, disaster risk management, or a related field with at least 10 years of experience in community or disaster planning.
- At least 7 years of work experience in vulnerability and risk assessments is required, including experience leading participatory planning exercises in the Caribbean region. The Consulting Firm is expected to have a good understanding of the physical, social, and economic aspects of vulnerability.
- Experience in undertaking vulnerability and risk assessments to SLR and tropical cyclone hazards is required, with knowledge of small island developing states or developing countries desired. Prior knowledge and understanding of the socio-economic context of Saint Lucia would be an asset.

Economist

- Among other tasks, conduct interviews with relevant organizations and stakeholders and undertake analyses to inform the economic impact assessment, which they will lead.
- Hold at least a master's degree in economics or a related area and have 10 years of experience in the field.
- Have a good understanding of the social and economic aspects of vulnerability, risk, and intersectoral linkages in small-island tourism-based economies.
- Experience in undertaking asset valuation, including natural assets, and conducting complex economic impact assessments at community, sector, and national scales is required. Prior experience conducting economic impact assessments related to SLR and tropical cyclone hazards is preferred.

Geographical Information Systems (GIS) Specialist

- Provide technical expertise, knowledge and understanding of the application of GIS models in the delivery of specific deliverables under outcome 3.2, all outputs.
- At least 10 years of experience and a master's degree in environmental science, information technology, or a related field. A good understanding of GIS models for application in coastal resilience assessments/SLR modelling.
- Scientific and technical background in coastal disaster risk modelling, disaster risk management, and climate change projections and coastal impacts.
- Numerical modelling of coastal dynamics and simulation of SLR, tides, storm surges, wave runup, and wave setup.
- Experience with high-resolution modelling of urban flooding.

Decision Support System Specialist

- Lead the design and development of the Decision Support System under Phase 3.
- At least 5–10 years of experience and a master's degree in environmental science, technology, or a related field.
- A good understanding of systems thinking.

Social and Environmental Specialist

- Provide specific technical expertise and guidance throughout the delivery of Phases 2 and 3.
- At least 10 years of experience and a master's degree in social science, environmental science, climate change, or a related field.
- Expected to have a good understanding of the social, environmental, and economic aspects of vulnerability and risk and intersectoral linkages in small-island tourism-based economies.

10. Application Process

Suitably qualified organizations/firms are invited to submit their Expression of Interest (EOI), including the following documents:

- **Motivational letter detailing how your organization/firm's experience, qualifications and professional networks align with the requirements for this consultancy.**
- **Curriculum Vitae of team lead and relevant key experts.**
- **Contact details of two (2) professional references.**

Shortlisted applicants from the EOI stage will be invited to submit a comprehensive application package, including Technical and Financial Proposal**.**

All submissions must be in English. Applications will only be accepted through **Bamboo HR** which can be accessed via **Employment & Consulting at IISD.**

Companies/firms have the option to collaborate with other organizations to enhance their qualifications. It is important to clearly state whether the collaboration is in the form of a partnership or sub-consultancy.

The deadline for submission of EOIs is **December 20, 2023, at or before 2:00 p.m. EST**.