TC DOCUMENT

I. Basic Information for TC

▪ Country/Region:	GUYANA/CCB - Caribbean Group
▪ TC Name:	Climate Resilience Support for the Adequate Housing and Urban Accessibility Program in Georgetown, Guyana
▪ TC Number:	GY-T1137
▪ Team Leader/Members:	Zambrano-Barragan, Patricio Xavier (CSD/HUD) team leader; Alleng, Gerard P. (CSD/CCS) alternate team leader; Van Doorn, Stephanie; Lemus Pablo, Edgar; Frugone, Maria del Rosario; Rajack, Robin Michael; Avila, Francy Dianela; Aguilar Blandon, Maria Alejandra; and Gonzalez Herrera, Beatriz (CSD/HUD); Williams, Derise Avione (CCB/CGY); Lieuw, Tanja (CGY/CCS); Chapuis, Emilie; and Louis-Grant Paula (VPC/FMP); Hennig, Betina (LEG/LEG); Barandiaran, Melissa; and Rojas, Julio (VPS/ESG).
▪ Taxonomy:	Operational Support
▪ Number and name of Operation Supported by the TC:	Adequate Housing and Urban Accessibility Program (GY-L1031).
▪ Date of TC Abstract authorization:	September 29, 2017
▪ Beneficiary:	The Cooperative Republic of Guyana
▪ Executing Agency:	Inter-American Development Bank (IDB)
▪ Source of funding:	Ordinary Capital Strategic Development Program for Sustainability (SUS)
▪ IDB Funding Requested:	US$500,000.00
▪ Local counterpart funding, if any:	No local counterpart
▪ Disbursement period:	48 months
▪ Required start date:	January 2018
▪ Types of consultants:	Individuals; Firms
▪ Prepared by Unit:	Housing and Urban Development Division
▪ Unit of Disbursement Responsibility:	Climate Change and Sustainable Development Sector
▪ TC included in Country Strategy (y/n):	No
▪ TC included in CPD (y/n):	No
▪ Alignment to the Update to the Institutional Strategy 2010-2020:	social inclusion and equality; (ii) climate change; and (iii) environmental sustainability

II. Description of the Associated Loan

2.1 This Technical Cooperation (TC) is associated to the loan “Adequate Housing and Urban Accessibility Program” (). which is reformulation of the "Road Network Upgrade and Expansion Program" (2741/BL-GY; GY-L1031).

2.2 **Adequate Housing and Urban Accessibility Program (2741/BL-GY; GY-L1031).** The objective of the reformulated operation is to improve the quality of life in urban and peri-urban Georgetown through better access to adequate housing and basic infrastructure for low-income populations, and through improved accessibility and mobility services. The reformulated program has two main components. Component 1 (C1), “Delivery of Housing and Basic Infrastructure Solutions,” will fund the delivery of subsidies to cover the costs of basic home improvements and new core home construction for low-income households, and will also fund the completion or rehabilitation of infrastructure and services of government-sponsored housing sites in the Georgetown area. Component 2 (C2), “Enhancement of Urban Road Network and

Road Safety," will finance the rehabilitation and expansion of Georgetown's main road axis, the Sheriff-Mandela road, as well as a National Road Safety Action Plan. In both cases, the Government of Guyana and the Bank are committed to identifying and implementing climate-ready designs, and exploring the potential for complementary sustainable infrastructure solutions, including green infrastructure. To achieve this, the Government of Guyana needs updated and granular information on the vulnerability profile of Georgetown's territory, and to develop locally-appropriate plans and design proposals based on this information.

III. Objectives and Justification of the TC

3.1 The purpose of this TC is to support the Government of Guyana with the integration of climate adaptation and resiliency aspects into the Adequate Housing and Urban Accessibility Program (proposed reformulation of 2741/BL-GY; GY-L1031). Specifically, this TC seeks to support the following activities: (i) carry out urban growth and risk assessment studies, part of the core baseline studies from the Bank's Emerging and Sustainable Cities Program (ESC); and (ii) develop planning proposals and associate technical studies for climate adaptation projects related to the reformulated operation, including technical specifications necessary to mobilize international assistance funds to finance or co-finance climate resilience activities. Overall, these activities can help improve the capacity of the operation's executing agency, the Central Housing and Planning Authority (CHPA), to manage and plan for urban resilience and climate adaptation.

3.2 **Housing, Urban Infrastructure and Mobility Challenges.** Guyana is home to ~750,000 people of which more than 90% lives on a semi-continuous urban coastal strip that represents only 5% of land area. Region 4, which includes the capital, Georgetown, and its low-density peri-urban areas, contains 311,000 people (40% of the population), but quality of life is affected by a variety of factors. First, due to elevated levels of poverty, there are qualitative housing deficits. Second, the city's settlements are located on lands below sea level, structured around inadequate drainage systems designed for agricultural land use, creating vulnerability to flooding. Third, even in government-sponsored residential estates, where an 'incremental' approach to construction was adopted, due to fiscal constraints, many internal roads and drains were never paved, sidewalks and street lighting not installed, and recreational facilities deemed to be important to the community at the time of planning, were never constructed. Finally, underinvestment in the construction and maintenance of transportation infrastructure, in both Georgetown and other Guyana regions, has created mobility challenges for the population, particularly with respect to congestion and road safety.

3.3 **Adequate Housing.** The operation's focus on adequate housing is justified given the critical role it plays in people's quality of life. The negative effects of poor housing and neighborhood conditions vulnerability to disasters, and the transmission of poverty have been well-documented.[1] Conversely, access to adequate housing can have a positive bearing on many dimensions of well-being, from health to education to jobs to improved social links. In addition, home ownership represents an important asset through which to build equity. Per a recent IDB study, programs that promote access to affordable housing and healthier neighborhoods for poor households can improve

[1] See Bouillon, C. et al. Room for Development. 2012, IDB, especially Chapter 1.

their quality of life and foster economic and social progress.[2] In Guyana, 27% of the population is estimated to be multi-dimensionally poor, higher than the regional average of 18.04%.[4] In addition to monetary deprivation, multi-dimensional measurements focus on overlapping deprivations suffered by poor families, including health, education, and standards of living, such as access to toilets, water, electricity, floor materials—conditions at the intersection of wellbeing and adequate housing. 29% of the population live in overcrowded housing (over two people per room), an issue exacerbated in low-income communities of Georgetown. Regarding construction materials, in the Georgetown area, 67% of the homes are built with timber; framing without masonry, concrete walls, or other structural reinforcements (typically located in low-incomes communities) that are situated below base flood elevation are more at risk. In addition, ~25% of households were still using pit latrines in 2012.

3.4 **Urban Infrastructure Services.** While Guyana has made efforts to improve access to services, challenges remain. Government-sponsored housing estates have in many cases not made the anticipated transition to becoming well-functioning settlements that foster, for example: proper road access to homes in all weather conditions (crucial given the amount of rainfall that Guyana receives); healthy surroundings that do not encourage the breeding of mosquitoes and pests in stagnant water; safety for women and children through lighting and separation of vehicular and pedestrian traffic; and social interaction and understanding through accessible and adequate recreational facilities. Regarding drainage, the city's main water control systems and irrigation canals, pumping stations, and sluices were historically designed for agriculture. With the consolidation of settlements along the coast, these systems struggle to keep up, especially given more intense and frequent rainfall events and high tides and inadequate maintenance. Prevalent problems in Georgetown include drain blockage, canal obstruction, and reduced impermeability; about a third of households experience regular low-distress flooding.[3] Vulnerability is prevalent among low-income populations, partly evident in the impacts from the 2005 Georgetown floods, among the most devastating in the country's history (100 return period). Damages were estimated at US$465 million, of which the majority affected the housing sector (US$276 million), twice the loss in the productive sector.[4]

3.5 In this context, the costs of maladaptation could be staggering for Guyana. By 2030, annual losses resulting from flooding could reach US$140 million; if hit by a single extreme event comparable to the floods that affected the capital in 2005, additional losses could amount to US$1 billion for the Georgetown area alone, by 2030 —more than a third of national Gross Domestic Product.[5]

3.6 Targeted investments in climate-ready infrastructure should be combined with improved land use and territorial planning, particularly for large urban areas along the coast. Though a combined 6% of the national budget between 2008-2011 was spent on sea/river defenses as well as on upgrades to drainage infrastructure, Guyana continues to play catch-up.[6] While the Government of Guyana is committed to

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2 Comparative Project Evaluation of IDB Support to Low-income Housing Programs in Four Caribbean Countries, IDB, 2017.

3 Collado, J. Stormwater Drainage Sector Plan for Guyana. 2017, IDB. (unpublished).

4 Disaster Assessment Portal. Data from ECLAC, 2005.

5 Cited in Mycoo, M., "Autonomous Household Responses and Urban Governance Capacity Building for Climate Change Adaptation: Georgetown, Guyana," 2014.

6 "At present, the cost of coastal protection in Guyana works out at US$2000 (D 1600) for a 100 m-long compacted earth dike, US$350,000 (D 280,000) for a 100 m-long rock armor dike, and US$5000–US$20,000 (D 4000–16,000) for a 100 m × 20 m swathe of replanted mangroves." Anthony and Gratiot,

including a climate perspective in all civil works and institutional capacity activities, additional support is required. Guyana does not yet have an integrated territorial/geospatial data management system in the urban development and transport sectors and has only partial capabilities to map its housing and infrastructure projects and their territorial context. Critically, there is no updated and granular information about climate risk, particularly flood risk for Georgetown and the urban coast. While the Reformulated Program's infrastructure designs, including drainage capacity, openly consider historic events such as the 2005 floods, the Government of Guyana and its implementation CHPA and the Work Services Group (WSG) require updated, granular information on risk, particularly for low-income communities that would benefit from the operation.

3.7 In addition, national and local level authorities lack the tools to monitor and evaluate risk, and currently do not actively incorporate climate considerations into long-term development planning. In the Georgetown area, once construction of sites and infrastructure is completed by national agencies, the responsibility for operations and maintenance is supposed to be transferred to the local Neighborhood Democratic Councils (NDC), the smallest local level administrative unit. This transfer is often delayed on the account of technical and regulatory gaps that do not fully qualify construction as complete. However, even when transfers do occur, the NDCs often lack sufficient institutional capacity and resources for long-term management.

3.8 This TC seeks to reaffirm the IDB's commitment to collaborate with partners to help translate the SDGs and the New Urban Agenda into meaningful country level targets, policies, and programs and support their effective implementation. The TC's support to governments aligns with commitments outlined in the IDB's Institutions for Growth and Social Welfare Sector Strategy (GN-2587-2). By benefitting vulnerable urban populations, the operation is aligned with: the GCI-9 sector priority "social policy for equity and productivity;" the cross-cutting themes "social exclusion and inequality pillar" and the "climate change and sustainable development" of the strategic policy objectives of the IDB's Institutional Strategy Update 2010-2020 (AB-3008); and the Gender and Diversity Sector Framework (GN-2800). Incorporating a focus on climate is in line with the cross-cutting themes included in the 2012-2016 IDB Country Strategy with the Cooperative Republic of Guyana (GN-2690). The TC's support for resilient neighborhood and road upgrading, and for the institutional capacity to maintain them, is in line with the strategic area "Establishing a Modern National Strategy and Planning Framework" included in the 2017-2021 IDB Country Strategy with the Cooperative Republic of Guyana (GN 2905-currently under approval process). Finally, the TC is also aligned with the program objectives of the Strategic Development Program for Sustainability (SUS) as it seeks to strengthen: the knowledge base on climate; institutional capacities including those aimed at environmental sustainability, disaster prevention and response; and technological innovation.

3.9 Two sector frameworks are relevant to the reformulated program, as well as to this TC. First, by contributing to the development of a more inclusive urban setting, it supports the Urban Development and Housing Sector Framework (GN-2732-6). The operation, and the climate-ready designs contemplated under this TC, contribute towards the improvement of infrastructure systems and the development of accessible, efficient, and safe urban transportation systems, thus aligning with the Transportation Sector Framework (GN-2740-7). The program also supports the

"Coastal Engineering and Large-Scale Mangrove Destruction in Guyana, South America: Averting an Environmental Catastrophe in the Making," 2012.

Strategy for Sustainable Infrastructure for Competitiveness and Inclusive Growth (GN-2710-5), as it seeks to support Guyanese authorities in their efforts to adapt to the effects of climate change.

IV. Description of Activities/Components and Budget

4.1 This TC seeks to support the following activities: (i) carry out urban growth and risk assessment studies, part of the core baseline studies from the Bank's ESC; and (ii) develop planning proposals and associate technical studies for climate adaptation projects related to the reformulated operation, including program funding proposals to mobilize international assistance funds to finance or co-finance climate resilience activities.

4.2 **Component I. Assessment of Climate Risk and Urban Growth.** The objective of this component is to develop up to date, high resolution baseline information on climate risk and historic urbanization in Georgetown. This information will be collected through the implementation of the core baseline studies from the Bank's ECS methodology. Specifically, these baselines studies include: (i) a greenhouse gas inventory including a roadmap for mitigation options; (ii) an assessment of disaster risk and vulnerability to the negative impacts of climate change, which will propose measures to reduce risk and vulnerability; and (iii) an analysis of the urban footprint that studies the historical growth of the city and models long term growth scenarios and will provide public policy recommendations for sustainable urban growth.

4.3 **Component II. Development of planning proposals for climate adaptation projects.** Building on the results from Component I, this component will support activities related to the preparation of planning proposals and associate technical studies for climate adaptation projects directly related to the reformulated operation GY-L1031. The component will finance: (i) a prioritization of the recommendations obtained from the urban and risk baseline studies and formulation of strategic solutions and climate-ready infrastructure interventions included in GY-L1031, particularly regarding infrastructure upgrading in low-income areas; (ii) an analysis of expected benefits to the users and beneficiaries within the projects' lifetime and the contribution of climate-ready infrastructure interventions to the economic and social development through economic studies (e.g. cost-benefit analysis); (iii) planning proposals, which synthesize the results from (i) and (ii) above, for the identified climate adaptation projects including broken-down project costs and specifications to mobilize international assistance funds to finance or co-finance climate resilience activities, and detailed activities and implementation schedules and terms of reference for technical (pre-) engineering designs of the interventions, as well as project-specific environmental and social impact assessments, as relevant.

4.4 The total funding for this TC will be US$500,000.00, which will be financed by the Ordinary Capital (OC) of the Strategic Development Program for Sustainability (SUS) fund.

Indicative Budget

Activity/Component	Description	IDB/Fund Funding	Counterpart Funding	Total Funding
Assessment of Climate Risk and Urban Growth	Develop up to date, high resolution baseline information on climate risk and historic urbanization in Georgetown.	US$300,000	$0.00	US$300,000

Activity/Component	Description	IDB/Fund Funding	Counterpart Funding	Total Funding
Development of planning proposals for climate adaptation projects	Preparation of planning proposals and associate technical studies for climate adaptation projects directly related to the reformulated operation.	US$200,000	$0.00	US$200,000

V. Executing Agency and Execution Structure

5.1 The Bank will execute the operation through the Housing and Urban Development Division (CSD/HUD), in coordination with the IDB Country Office in Guyana. CHPA will take the lead in coordination activities will all relevant stakeholders, an approach currently being used successfully for the implementation of technical assistance in the urban development sector (ATN/MG-15488-GY; GY-T1115 and ATN/OC-15974-GY; GY-T1136). The Government of Guyana requested that this TC be executed directly by the Bank. Bank execution is justified due to the Housing and Urban Development division's experience with the implementation of urban and climate adaptation studies in over 70 cities in the LAC region, and to ensure that the TC's outputs provide key inputs for the design and execution of the Adequate Housing and Urban Accessibility Program (2741/BL-GY; GY-L1031).

5.2 The activities to be executed are included in the Procurement Plan and will be contracted in accordance with Bank policies as follows: (a) AM-650 for Individual consultants; (b) GN-2765-1 and Guidelines OP-1155-4 for Consulting Firms for services of an intellectual nature and; (c) GN-2303-20 for logistics and other related services.

VI. Major Issues

6.1 The main risk for this TC is that, while the joint IDB and CHPA teams can ensure that climate adaptation inputs be included in the design of housing and urban development operations in Guyana, long-term adaptation measures depend largely on national and subnational institutions and their capacity to follow planning recommendations and ensure enforcement overtime. To mitigate this risk, the Adequate Housing and Urban Accessibility Program has included an institutional strengthening component that should be closely coordinated with the activities in this TC, particularly to help CHPA in delivering outputs and related training to subnational institutional entities such as the NDCs.

VII. Exceptions to Bank policy

7.1 No exceptions to Bank policy have been identified.

VIII. Environmental and Social Strategy

8.1 The components financed by this TC will not have negative environmental or social impacts. According to the Environment and Safeguard Compliance Policy (OP-703) this operation is classified as category “B”. (See Safeguards Policy Filter Report and the Safeguard Screening Form).

Required Annexes:

- Annex I: Request from the client
- Annex II: Results Matrix
- Annex III: Terms of Reference
- Annex IV: Procurement Plan

IN REPLYING QUOTE DATE HEREOF AND No.....

MINISTRY OF FINANCE
49 Main & Urquhart Streets,
Georgetown,
Guyana.

July 1, 2016

Sophie Makonnen
Resident Representative
Inter-American Development Bank
47 High Street
Kingston
GEORGETOWN

Dear Ms. Makonnen,

Re: Emerging and Sustainable Cities Initiative

I write with reference to the subject at caption.

Please be advised that following meetings between the Bank and the Government of Guyana, the Government of Guyana is amenable to the Bank's suggestion of including the City of Georgetown as part of the Bank's Emerging and Sustainable Cities Initiatives. However, the Government is requesting that the Bank reconsiders the inclusion of Guyana's four new townships (Lethem, Mahdia, Mabaruma and Bartica) under the initiative.

If, all efforts are exhausted, and the possibility of applying the methodology of the Emerging and Sustainable Cities Initiative to the new townships is deemed as not viable, the Government of Guyana is seeking the Technical Assistance of the Inter- American Development Bank in executing similar studies within the new townships.

The Government of Guyana looks forward to the support of the IDB in this important national priority.

Sincerely,

Winston Jordan
Minister of Finance

Result Matrix

Outcomes

Outcome: 1 Improved capacity of the Central Housing and Planning Authority to

RF - Contribution

Outputs: Annual Physical and Financial Progress

1 Assessment of climate risk and urban growth

Outputs	Output Description	Unit of Measure	Baseline	Baseline Year	Means of Verification		Physical Progress 2018	Physical Progress 2019	Physical Progress EOP		Financial Progress 2018	Financial Progress 2019	Financial Progress EOP	Theme	Fund	Flags
1.1 Mitigation study completed	Greenhouse gas inventory including a roadmap for mitigation options	Studies (#)	0	2017	Final Consultant's Report, validated by CHPA	P	1		1	P	50000		50000	Sustainable Infrastructure	SUS	
						P(a)			0	P(a)			0			
						A				A						
1.2 Diagnostics and assessments completed	The assessment of disaster risk and vulnerability to the negative impacts of climate change and the analysis of the urban footprint that studies the historical growth of the	Diagnostics (#)	0	2017	Final Consultant's Report, validated by CHPA	P	1	1	2	P	250000		250000	Sustainable Cities	SUS	
						P(a)			0	P(a)			0			
						A				A						

2 Climate Adaptation Pre-investment Proposals

Outputs	Output Description	Unit of Measure	Baseline	Baseline Year	Means of Verification		Physical Progress 2018	Physical Progress 2019	Physical Progress EOP		Financial Progress 2018	Financial Progress 2019	Financial Progress EOP	Theme	Fund	Flags
2.1 Project proposal developed	Preparation of planning proposals and associate technical studies for climate adaptation projects directly related to the reformulated operation.	Proposals (#)	0	2017	Final Consultant's Report, validated by CHPA	P		2	2	P		200000	200000	Sustainable Cities	SUS	
						P(a)			0	P(a)			0			
						A				A						

Other Cost

Total Cost

	2018	2019	Total Cost
P	$300,000.00	$200,000.00	$500,000.00
P(a)			
A			

CRF Indicator Standard Output Indicator

TERMS OF REFERENCE

Urban Growth and Risk Assessment

Guyana

GY-L1031

GY-T1137

Climate Resilience Support for the Adequate Housing and Urban Accessibility Program

1. Background and Justification

1.1 Guyana is home to close to 750,000 people. The proportion of the population living in urban centers has hovered around 30% over the last four decades and currently sits at 26.4%. However, Guyana's actual urban population is much larger; as is the case in other Caribbean countries, alternative calculations that consider actual urban footprints and the 'overspill' of human settlements beyond administrative boundaries yield much higher rates. In Guyana, McHardy and Donovan (2016) note that the actual proportion of urban dwellers could be as high as 61%. This underestimation is consistent with one of the most salient features of Guyana's urbanization trends: more than 90% of the country's population lives on so-called 'towns' and 'villages' in a semi-continuous urban footprint, along coastal strip that represents only 5% of total land area. Region 4 alone, which includes the capital Georgetown and its low-density suburbs, contains over 311,000 people—over 40% of Guyana's population. The towns range in size from several hundred to several thousand inhabitants and often follow the pre-existing layout from drainage and irrigation systems of agricultural lands, both active and abandoned—in low-lying areas that are highly vulnerable to the potential impacts of climate change, particularly coastal flooding under higher estimates for sea-level rise.

1.2 This vulnerability, resulting from the population's spatial distribution, is compounded by large shelter deficits, particularly inadequate housing and supporting infrastructure such as paved roads and drains. In Georgetown, 29% of the population live in overcrowded housing (over two people per room). Basic infrastructure in new and established housing sites is developed 'incrementally' (enable housing construction through infrastructure upgrade and provision of formal title) by the Government of Guyana (GOG), an approach supported through two positively-evaluated IDB operations, the Low-Income Settlement Programs (LISP) I and II. However, despite the gains made, an estimated 249.5 km of roads and associated drainage—critical for flood management—still need to be completed to improve the living conditions of over 32,000 households, according to Guyana's main urban development authority, the Central Housing and Planning Authority (CHPA). Census data show that these deficits also occur in large non-CHPA Georgetown villages, such as Durban Area, Industrial State, and East La Penitence. Finally, the country has limited state capacity for adaptation, particularly at the local level. Maintenance of public infrastructure is the

responsibility of the local Neighborhood Democratic Councils (NDC), which lack sufficient institutional capacity for long-term site management.

1.3 The costs of maladaptation could be staggering for Guyana: a 2009 report, the Economics of Climate Adaptation Working Group noted that, by 2030, annual losses resulting from flooding could reach $140 million. If hit by a single extreme event comparable to the floods that affected the capital in 2005, by 2030 additional losses could amount to US$1billion for the Georgetown area alone—more than a third of national GDP. In this context, targeted investments in climate-ready infrastructure should be combined with improved land use and territorial planning, particularly for large urban areas along the coast. Though a combined 6% of the national budget between 2008-2011 was spent on sea/river defenses as well as on upgrades to drainage infrastructure, Guyana continues to play catch-up.

1.4 In order to tackle the housing and spatial challenges and to reduce the vulnerability of urban and peri-urban Georgetown, the GOG requested the IDB to support the country with the Adequate Housing and Urban Accessibility Program (GY-L1031). GY-L1031 is a proposed reformulation of the "Road Network, Upgrade and Expansion Program." [1] The objective of the reformulated operation is to improve the quality of life in urban and periurban Georgetown through better access to adequate housing and basic infrastructure for low-income populations, and through improved accessibility and mobility services. The reformulated program has two main components. Component 1 seeks to deliver quality housing and basic infrastructure solutions to low-income populations, through subsidies for upgrading and construction of climate-ready infrastructure and environmentally and socially vulnerable areas. Component 2 will finance the expansion and rehabilitation of Georgetown's main road axis, the Sheriff-Mandela road, with a special focus on sustainable mobility and accessibility. In both cases, the GOG and the Bank are committed to identifying and implementing climate-ready designs, and exploring the potential for complementary sustainable infrastructure solutions, including green infrastructure. To achieve this, the GOG needs updated and granular information on the vulnerability profile of Georgetown's territory, and to develop locally-appropriate plans and design proposals based on this information.

1.5 In this regard, the Bank requires a consulting firm to conduct the needed technical studies as support to the preparation and execution of the Adequate Housing and Urban Accessibility Program (GY-L1031). The consulting firm will address the issues described below, all of which have been incorporated into the planning processes finances by the Bank through the Emerging and Sustainable Cities Initiative:

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[1] GY-L1031 is a proposed reformulation of the Road Network, Upgrade and Expansion Program. The original operation was approved as a multiple works program in June 2012, for US$69.2M. In May 2017, Guyana's Minister of Finance officially requested the Bank to reformulate undisbursed resources and reallocate them to support its housing programs in the Georgetown area, while maintaining original activities focused on transport civil works with a revised scope that highlights sustainable and climate-ready mobility and accessibility challenges.

1.5.1 **Mitigation of greenhouse gas emissions.** From a global perspective, urban areas in LAC are not major GHG emitters. Given the rapid growth of cities, however, preserving this low-carbon footprint could prove difficult without careful planning. Mitigating emissions and thus helping to protect future generations from dangerous climate change is challenging in LAC as the present generation still lacks adequate access to food, housing, basic utilities, and social services. A culture of resource conservation, efficiency, and respect for the environment needs to be established while continuing to enhance the quality of life of the Region's citizens.

The Bank will provide its partner cities with a GHG inventory as a basis for analyzing its carbon footprint. It will also help developing a GHG roadmap, helping cities identify concrete options for reducing local emissions. Local governments can use these planning tools to develop a long-term vision and bring together different stakeholders to help decrease their community's carbon footprint.

1.5.2 **Disaster risk and climate change vulnerability reduction.** The impacts of climate change on cities are becoming clearer. The expected increase in the number and intensity of extreme climate events together with the lack of resilience and socio-economic fragility of urban centers in LAC aggravate the risk of flooding, landslides, droughts, and other natural hazards. The livelihoods of coastal communities, for instance, are highly vulnerable to sea level rise. Half of the Region's urbanized areas with a population of over 5 million people are located in low-lying coastal areas. According to Dasgupta et al. (2007), the damage caused by sea level rise in LAC would cost between 0.5% and 1.3% of the regional GDP.

An expected increase in the number and intensity of extreme hydrometeorological events—such as hurricanes, intensive precipitation, and droughts—is expected to have severe impacts on cities and their inhabitants. These hazards are projected to augment economic and human losses, reduce water availability and production capacity, aggravate erosion, threaten coastal areas, and generate significant negative social impacts.

LAC is also highly exposed to geophysical hazards. The economic losses from earthquakes in Haiti (USD 7.8 billion) and Chile (USD 30 billion) in 2010 came close to surpassing all economic losses in the region caused by natural disasters in the previous decade, a total of USD 34 billion between 2000 and 2009 (EM-DAT, Bureau of Labor Statistics, and Bank staff calculations).

The lack of adequate urban and rural planning further exacerbates the risk of disastrous events. The livelihoods of the poor are often located in areas with high exposure to natural hazards (i.e. river banks, wetlands, and areas with steep slopes). Disaster risk management in the Region's mid-sized cities is often insufficient. According to Vergara et al. (2013), the economic damages in LAC caused by some of the major physical impacts associated with a temperature rise of 2℃ are estimated to reach approximately $100 billion annually by 2050. This would correspond to more than 2 percent of the region's 2010 GDP.

For these reasons, the Bank seeks to provide each ESCI city with data and tools to assess key hydrometeorological and geophysical hazards as well as their vulnerability and options for risk reduction.

1.5.3 **Sustainable urban growth.** Sustainable urban growth requires adequate planning. The current urban footprint and its potential future growth are important factors that affect a city's ability to become sustainable and improve the quality of life of its citizens. The analysis of different growth scenarios (low density sprawl, medium to high density mixed-use communities) allows cities to estimate the future infrastructure costs and GHG emissions associated with each option. The Bank will provide such assessments through this consultancy in order to support planners and policy-makers in adapting territorial development plans, as well as priority IDB-financed housing and urban infrastructure programs accordingly. This exercise will contribute to low-cost and low-carbon growth while protecting key green infrastructure (like conservation areas and aquifer recharge areas) and avoiding the occupation of highly vulnerable areas.

2. Objectives

2.1. The overall goal of this consultancy is to promote sustainable development in Georgetown for city officials.

2.2. The studies that form part of this consultancy seek to achieve specifically the following:

a) The **climate change mitigation assessment** will provide the analysis and tools necessary to assess and reduce a city's carbon footprint.
b) The **disaster risk and climate change vulnerability assessment** will allow a better understanding of the risks a city faces from natural hazards, including increasing hazardous risk due to climate change, and facilitate adequate planning.
c) The **urban growth study** will assess the urban footprint of a city and its dynamics under past, current, and expected future trends to inform and facilitate successful infrastructure and environmental planning at the city and regional level.

3. Key Activities

3.1. **Consulting Engagement 1:** Develop a climate change mitigation assessment for Georgetown City.

a) **Develop at least one GHG inventory**. The consulting firm must create an inventory to reflect the current level of emissions (preferably for 2017). If data availability permits, an additional inventory for an earlier year (preferably 2015 or even earlier) is to be developed. Inventories shall follow national standards and take into account the most recent methodological approaches under the Global Protocol for Community-scale Greenhouse Gas Emissions (GPC) developed by

the World Resources Institute (WRI), C40 Cities Climate Leadership Group, and ICLEI. The emission sources to be covered shall be those included in GPC's BASIC+ methodology[2] unless the consulting firm can demonstrate to the Bank that certain sectors are not relevant in the city. National guidelines need to be taken into account if applicable. The inventory shall disaggregate emissions in a way that it becomes evident which emissions result from the operations of the local government.[3]

b) **Develop a GHG roadmap** through the following activities:

i. **Develop two GHG emission scenarios** for key economic sectors including water, transport, solid waste, energy (supply as well as residential, industrial, and commercial consumption), agriculture, and land use, land-use change, and forestry. The analysis shall provide an understanding of challenges and opportunities facing these sectors. Projections should generally be made for 2030 and 2050 (each for a current trends and a smart growth scenario as described under Consulting Engagement 3 which also needs to take the mitigation options described in the next paragraph into account) or in accordance to the time horizons of local development plans if applicable.

ii. **Determine mitigation targets and identify, assess, and prioritize mitigation options for relevant sectors**. 15 mitigation options shall be proposed. 3 to 5 of these shall help the city government to reduce emissions from its own operations as an organization to lead by example. For each option, an analysis of the following aspects shall be conducted:

1. Costs: The analysis shall calculate key financial variables as the upfront project costs, payback periods, internal rates of return, and the cost per tonne CO2e reduced.
2. Benefits: The assessment of GHG emission savings must draw on the calculation methods from the GPC methodology. If additional methodologies are needed, those from the national emissions inventory that the country reports to the UNFCCC, the Clean Development Mechanism (CDM), or Intergovernmental Panel on Climate Change (IPCC) shall be used. Co-benefits (social, health, environmental, etc.) must be identified and quantified based on calculations or experience from comparable projects. A special focus shall be on air quality co-benefits. An annex to the mitigation assessment report shall describe the current level of air pollution (Nitrogene Oxides, Carbon Monoxide, and Particulate Matter PM10 and PM2.5) in the city based on a review of existing literature and under consideration of the activity data collected for the GHG inventory. On this basis, the annex shall estimate the air quality improvements of the different GHG mitigation options.
3. Financial feasibility

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[2] Global Protocol for Community-scale Greenhouse Gas Emissions. Version 2.0, or newer versions if available.

[3] For stationary units, for example, the inventory could distinguish between residential buildings, commercial buildings, municipal buildings, and industrial facilities. For further guidance see: ICLEI 2009: International Local Government GHG Emissions Analysis Protocol (IEAP). Version 1.0.

4. Feasibility of measuring, reporting, and verifying GHG emission reductions (MRV).

The prioritization of the mitigation options shall take the results from this analysis as well as the city's development priorities into account. Guidance shall be given to city officials on how to implement the prioritized mitigation options by providing international examples of successful application. Examples for potential mitigation options include commercial building efficiency improvements, introduction of emission standards, introduction of Park-and-Ride facilities, tree planting, capture and use of landfill biogas, and improvement of waste collection systems.

ii. **Develop a mitigation assessment manual to support the local capacity to understand and** update the products generated under this Consulting Engagement. The manual shall provide detailed instructions on how to update all elements of the climate change mitigation assessment and especially facilitate the use of the corresponding Excel calculation sheets.

3.2. **Consulting Engagement 2:** Develop a disaster risk and climate change vulnerability assessment for Georgetown City, Guyana.

The activities to be completed under this Consulting Engagement shall adhere to the following phases (Figure 1):

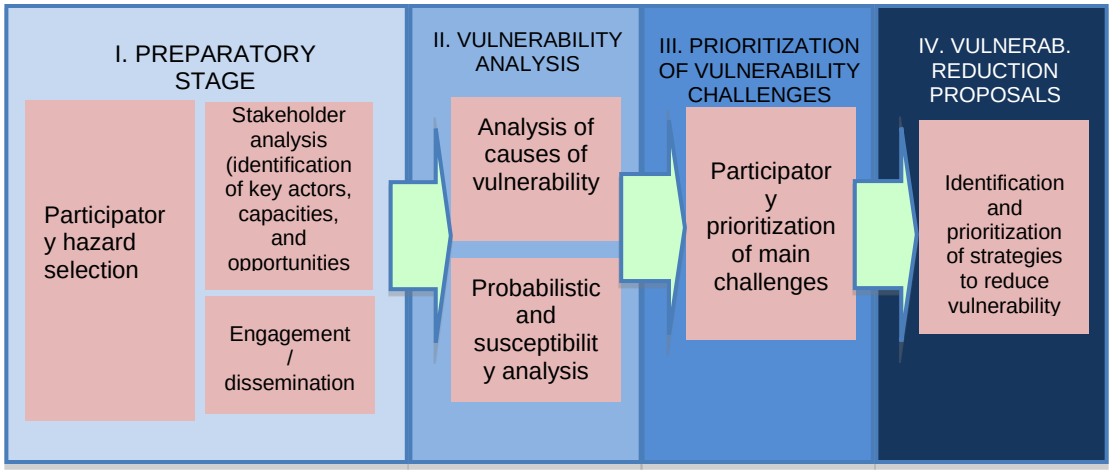


Figure 1: Elements of Consulting Engagement 2

a) Phase 1: Preparatory Stage

This phase includes three activities:

i. <u>Participatory hazard selection</u>

Three priority hazards affecting Guyana City must be assessed under this Consulting Engagement, at least one of these being a slow-onset hazard. Especially (but not only) the following hazards shall be considered:

Rapid-onset hazards:

1. Coastal flooding, storm surge, (under consideration of different levels of sea level rise as slow-onset hazard);
2. Inland flooding;
3. Hurricanes and tropical storm-strength winds;
4. Seismic activity and its effects (ground shaking, liquefaction, tsunamis, etc.);
5. Volcanic activity;
6. Landslides;
7. Wildfires;

   Slow-onset hazards:
8. Heat waves and Cold waves;
9. Coastal erosion (also taking into account sea-level rise)
10. Groundwater salinization
11. Drought.
12. (Further) Effects of changes in minimum or maximum temperatures, precipitation, insolation, and in seasonal climatic patterns (e.g. food and water shortages).

The hazard selection needs to be based on criteria to be agreed with national and local governments (and their implementing agencies responsible for urban planning and disaster risk reduction) and in consultation with Bank staff. Hazards shall be selected using a multi-criteria analysis for comparing and prioritizing them. Criteria should include, at a minimum, hazard frequency and recurrence, the area/population potentially affected, potential impact in key sectors (energy, transport, water, and economic activities, among others), and the pertinence of in-depth analysis for the hazard (e.g. based on local priorities, availability of necessary data, and existence of similar studies).[4] The final selection must be approved by the Bank.

ii. Stakeholder analysis

Identify public and private key actors on the local, state, and national level which need to be involved in the preparation of the study and in the application of its results. Institutional capacities and opportunities regarding risk reduction shall be assessed and current relevant initiatives identified (e.g. in the areas of urban planning, definition of land use regulations, development planning and institutional budgets).[5]

iii. Engagement and dissemination strategy

An engagement strategy considering different levels of participation shall be designed, including a list of potential focal points representing each stakeholder and of the activities to be undertaken to ensure an effective validation and dissemination of the study results. The strategy shall involve relevant public and private stakeholders from the national and sub-national

[4] Refer to the UK Climate Change Risk Assessment Methodology (HR Wallingford) for further information (p. 7-9): http://randd.defra.gov.uk/Document.aspx?Document=10065_CCRA_Method_Report_FINAL_R2.pdf .

[5] As a reference, the methodology for stakeholder analysis “Climate changing, changing communities” developed by ICLEI can be used (see Annex I.6 of these ToR and p.2-3 of the following document): http://www.lis.edu.es/uploads/7a9bad44_bf1f_4580_98ca_6a0885cc03c6.pdf .

level.

b) Phase 2: Vulnerability Analysis

i. Analysis of Causes of Vulnerability

This analysis shall identify infrastructure-related, institutional, social, and economic causes of vulnerability associated with the prioritized hazards. The analysis shall make use of site visits and stakeholder consultations in the form of interviews and focus group discussions.[6]

ii. Probabilistic and Susceptibility Analysis

The consulting firm will undertake the following activities for the selected hazards, taking into account the technical details provided in Annex I of these Terms of Reference:

a. **Identify and summarize available information**, including historical disaster data, risk information (hazard, exposure, and vulnerability), and regional climate change model outputs and studies.

b. **For inland flooding, coastal flooding, seismic activity and its effects, and hurricane-strength winds (if selected), develop a probabilistic disaster risk analysis** applying the methodology and tools from the Central American Probabilistic Risk Assessment (CAPRA; http://ecapra.org) or a similar platform (e.g. Hazus), with the following general steps:

1. Hazard analysis: Analyze past, current, and future hazard trends (under consideration of climate change if applicable to the hazard). The analytical data and modelling shall be complemented with field work (e.g. identification of historical inundation levels). The interplay of hazards has to be taken into account (multi-hazard; e.g. hurricanes in coastal areas can imply multiple risks like storm surge, strong winds, and inland flooding that interact with each other).
2. Exposure value calculation: Develop an inventory of critical infrastructure and residential and commercial areas that may be affected by those hazards. The data should include but not be limited to the best information available on health infrastructure, potable water supply, sanitation, drainage, electricity supply, solid waste collection, housing, and roads. In the case of residential areas, the firm will define in dialogue with relevant government authorities the construction area, value of assets, and exact location of construction. If cadastral information is not available at the residential level, the firm shall generate exposure maps at least at neighborhood level.
3. Description and identification of vulnerability functions: Define, with the appropriate technical justification and in dialogue with government authorities, the physical vulnerability function of each type of

[6] The methodology proposed by UNDP/BCPR (Proyecto Regional Capitales Andinas) and the DPAE (Municipality of Bogota) can be used as a reference. See Annex I.7 of these ToR and p. 24-28 of the following document: http://bvpad.indeci.gob.pe/doc/pdf/esp/doc1269/doc1269-contenido.pdf .

construction and infrastructure for the considered hazards. Existing vulnerability functions developed and/or deemed adequate by the Bank (e.g. CAPRA) may be applied.

4. Risk estimation: Based on the information of hazards, exposure values and vulnerability functions, develop a quantitative probabilistic risk analysis in terms of physical and human losses. This calculation includes the probable maximum loss and expected average annual loss from the prioritized hazards.
5. Develop maps that illustrate the results of the probabilistic disaster risk analysis.

c. **For all other hazards: Conduct a susceptibility and impact analysis**. This analysis needs to take into account climate change if climate change is expected to affect the hazard, and shall follow these steps:

1. Develop susceptibility maps that illustrate to which degree the different city areas are currently or expected to be affected by the hazards covered under this task, taking into account the different factors that influence these hazards. For details on the bivariate landslide methodology to be used, refer to Annex I.
2. Develop maps of the expected socio-economic impacts of the hazards covered under this task on the different city areas. A traffic light system shall illustrate the degree of the impact with red for critical impacts, yellow for moderate impacts, and green for low impacts. Different socio-economic impacts can be summarized in adequate categories depending on the share of the population and critical infrastructure affected and the degree of the expected impact.

d. **Climate Change** projections: It is expected that for slow-onset hazards two climate change projections, preferably for 2030 and 2050, and for each projection three climate change scenarios (optimistic, moderate, pessimistic) will be applied to the analyses. The time horizons of local development planning and the availability of climate change studies shall be taken into account if different from the projection periods and scenarios specified here). For rapid-onset hazards, other methodologies should be applied (for example, modelling of non-probabilistic scenarios), considering (if available) national guidelines.

e. **Calibration of risk and susceptibility maps and risk calculations**: The consultancy firm shall carry out and include in the report a calibration of the risk and susceptibility maps and risk calculations using information on historical losses in order to estimate the accuracy of the results.

f. **Application of the results to the urban growth scenarios**: The risk and susceptibility assessments shall also be conducted for the urban growth scenarios of Consulting Engagement 3 in order to determine how these will influence future vulnerability.

c) **Phase 3: Prioritization of vulnerability challenges**
A multi-criteria analysis in terms of magnitude, urgency, and probability of occurrence shall be used for prioritizing the vulnerability challenges. The risk and susceptibility identified in Phase 2 shall guide this analysis in a participatory process.[7]

d) **Phase 4: Identification and prioritization of solutions to risk challenges**
A set of proposals for dealing with the risk challenges previously identified shall be prepared, encompassing both engineering and socio-economic measures. From these proposals, five shall be prioritized and assessed in greater detail including a preliminary cost-benefit analysis to facilitate corresponding local planning. In order to account for uncertainty of climate and growth scenarios, these measures should have the following characteristics: (i) no/low regret, (ii) flexibility, (iii) safety margins, and (iv) appropriate timing making use of windows of opportunity.8 These proposals should be validated and prioritized through a participatory process involving the major stakeholders. The goal of the assessment is to provide an adequate overview of possible risk reduction activities to direct specific pre-feasibility studies.[9]

3.3. **Consulting Engagement 3:** Develop an urban growth study for Georgetown City, Guyana.

a) **Analyze the current and historic urban footprint** as follows:

i. Use multi-temporal satellite imagery and remote sensing technology to analyze past and current urban footprints and identify built-up area changes since 1984. This analysis must be done to the extent possible using high-resolution image data (1.5m or the best available) in intervals of approximately ten years.
ii. Classify land-covers using a highly accurate object-oriented supervised classification methodology, mapping the 23 classes of land-cover within the study area for each dataset as defined in Annex III.
iii. Urban areas shall have three separate built density (or intensity) categories based on their imperviousness: high density, medium density, and low density (20-50%; 50% to 80%; and 80% to 100%). Categories such as agriculture and pasture land will be separated with a dependable rule set that can be replicated in all data sets.
iv. Collect sample points or training data remotely to conduct classification through imagery and site surveys. Experts from the consulting team shall collect a local ground sample to calibrate training data that will be used to

[7] The UK Climate Change Risk Assessment methodology can be used as a reference. See p. 13-14 and 28-31 of the following document:
http://randd.defra.gov.uk/Document.aspx?Document=10065_CCRA_Method_Report_FINAL_R2.pdf
[8] For further details, see chapter three in "Urban Adaptation to Climate Change in Europe" (EEA 2012).
http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change
[9] The following two methodologies can be used as references: 1. the prioritization method used by the Bank's Climate Change Adaptation project in Santa Ana, El Salvador (forthcoming); 2. the methodology used by the UNDP/BCPR Andean Capital Cities Project for identifying disaster risk reduction proposals (p. 28-31of the following document: http://bvpad.indeci.gob.pe/doc/pdf/esp/doc1269/doc1269-contenido.pdf)

produce supervised classification. If existing ground samples or land cover data are available, the classification process must be able to incorporate those data in the sampling process.

v. Check final land cover classification for any quality assurance and quality control (QA/QC) issues. Land cover classes shall address any logical/illogical issue. For example, a speckle of urban categories in the middle of a lake or river will be an illogical classification.

vi. Develop a comprehensive geo-database with the GIS data produced and all relevant geo-referenced information available in the city. Include specific data on key green and gray infrastructure, produced through satellite imagery classifications, open street map databases, or other relevant sources. Gray infrastructure consists of human-built components which involve shared resources or networks. It comprises roads, water lines, water treatment plants, sewers, electric distribution systems, and various public facilities (schools, hospitals, etc.). Green infrastructure consists of specific components of the natural environment which produce identifiable ecological services. Examples are woodlands, wetlands, river corridors, parks, and other green spaces. These interconnected components generally provide a number of multi-functional uses, including provision of drinking water, soil slope stability, flood protection, various forms of biodiversity, and public recreation.

vii. Generate a geospatial metadata library for all land cover classification data following the ISO geospatial metadata standards.

b) **Develop urban growth scenarios** as follows:

i. Analyze census data and population projections to calculate current, past, and future population for the study area and for each administrative subdivision.

ii. Review all available information on planned gray or green infrastructure that may have an impact on future land use.

iii. Review existing urban development plans and identify areas where various kinds of development are currently allowed and determine the respective densities.

iv. Develop a set of constraining factors to future development, such as environmental masks that identify areas where various forms of development are impractical or not advisable and should be protected by urban growth policies. For example, general constraints should include environmental elements (such as aquifer recharge areas and forest reserves), areas that are highly vulnerable to natural disasters (such as flood plains and steep slopes, as resulting from the analysis from Consulting Engagement 2), areas where industrial uses or agriculture uses are specifically zoned, and cultural heritage and archeological areas.

v. Perform an analysis of recent historic land cover change and its associations with various potential non-spatial explanatory factors, such as aggregate population and employment growth. Project future land use demands (in hectares) for the projection horizon (e.g. demand for total urban residential land should be related to jobs, population growth rates, and built density).

vi. Analyze the spatial factors that can potentially explain the spatial patterns exhibited in recent historic change (attractiveness factors) which are expected to remain important across future scenarios (e.g. distance or travel time to various amenities).

vii. Develop a future-oriented “attractiveness” or “suitability” model that estimates the relative likelihood of each legally and practically buildable unit to be developed. Using the information gathered, determine land attractiveness for various uses across all potential development areas applying a 2050 projection of land cover, taking into account land use conflicts, vulnerable areas, economic changes, and existing planning rules and regulations. The objective of this calculation is to estimate the distribution of future populations over time, resolving land use conflicts using adjustable rules.

viii. Develop three different urban growth scenarios for each 2030 and 2050: “current trends” scenario, “smart growth” (ideal) scenario, and “feasible” scenario. The “current trends” scenario extrapolates current regional and urban growth trends based on existing policies and trends. “Smart growth” refers to an ideal growth pattern characterized by medium to high density, mixed-use development that seeks to improve quality of life and resource efficiency while at the same time reducing disaster risk, climate change vulnerability, and the city’s negative impact on the environment (ecological footprint), without taking into account financial or technological constraints. The feasible scenario reflects an intermediate growth pattern that differs from the current trends scenario by proposing strategic policies and interventions improving sustainability. Nevertheless, it is expected to be more feasible than the ideal of the smart growth scenario by taking financial, technological, and other constraints into account.

ix. Estimate the urban footprint extension and population density for each scenario in 2030 and 2050.

x. Analyze the investment costs for providing basic infrastructure (such as potable water supply, sanitation, drainage, electricity supply, urban mass transit, solid waste collection, roads, and works required to reduce natural disaster risk) to accommodate growth in the three different scenarios. Local costs for infrastructure should be considered.

xi. Analyze the impacts of each scenario on GHG emission levels.

xii. Develop a planning summary for policy makers expressing major findings of the analysis performed and detailed policy recommendations that can be used for planning and decision-making.

For all three consulting Engagements:

3.4. Each consulting engagement will serve both as an important input for the implementation of the ESCI methodology (see Methodological Guide at http://www.iadb.org/cities) and as a planning instrument for Georgetown City. In order to maximize synergies between the different engagements, the consulting firm is expected to link data, methodologies, and outputs wherever useful. For example, the GHG emission scenarios shall account for the growth patterns projected in the growth

scenarios, while the smart growth scenario on the other hand needs to consider both climate change mitigation and disaster risk reduction in the context of climate change.

3.5. In order to facilitate the implementation of the recommendations from the three Consulting Engagements, the consulting firm shall develop, in consultation with local and national stakeholders, a road map for Georgetown City. The road map must summarize the next steps to be taken, specifying responsibilities, timing, partners, and other relevant details.

3.6. The three Consulting Engagements feed into the ESCI methodology particularly through the Climate Change Filter as outlined in the Methodological Guide (pp. 37ff). This filter determines the potential to reduce GHG emissions in each topic and its vulnerability to climate change.[10] As part of this consultancy, the consulting firm shall facilitate this process by translating the results from its studies into the scoring system of the Climate Change Filter, following an approach currently being developed by the ESCI. This will allow the Bank and local stakeholders to prioritize the different themes based on climate change mitigation and adaptation considerations.

3.7. The study area for all three Consulting Engagements is in principle the metropolitan area of Georgetown City, plus the area that is expected to be relevant for the urban growth scenarios. The exact boundaries shall be derived under consideration of the city's physical, social, economic, ecological, infrastructure, and institutional subsystems as well as its political boundaries. It is not sufficient to only consider political boundaries. The boundaries shall be developed by the consulting firm early in the process and in dialogue with local stakeholders and the Bank. All maps must be developed at a scale of 1:10,000 (1:25,000 is sufficient if deemed adequate by the Bank).

3.8. In carrying out the aforementioned activities, the consulting firm will be responsible for all data collection and analysis. In addition to travelling to the city to gather information, it is highly recommended that the consulting firm employs local consultants to support data collection and the follow-up with local officials. The consulting firm shall not rely solely on the municipality as source of information but identify and use additional/alternative information sources to reach the desired results. These shall especially include the results of relevant studies conducted or commissioned by international, regional, national, and local organizations (IPCC, multi- and bilateral development agencies, academic institutions, etc.). After the first field visit, the consulting firm is expected to provide the Bank with a summary of what data is available and the implications for the three assignments.

3.9. For the development of each Consulting Engagement the consulting firm should engage the authorities at the national level such as the Ministry of Communities,

[10] A complete list of the 24 ESCI topics (e.g. water, sanitation and drainage, solid waste management) can be found in Annex 2 of the Methodological Guide.

Ministry of Public Infrastructure, Ministry of Environment, the Guyana Lands and Surveys Commission, and relevant disaster risk management agencies, among others. In agreement with the local government and the Bank team, representatives of these institutions could be invited to the presentations and capacity building activities.

3.10. In order to support the Bank in improving its activities related to this assignment, the consulting firm will implement a four-day workshop at IDB headquarters in Washington DC for Bank specialists after submission of the final draft products. The workshop will serve to discuss the methodologies used in each Consulting Engagement and the lessons learned from their application. Special emphasis shall be given to the incorporation of climate change into Consulting Engagement 2.

3.11. Throughout the assignment, the consulting firm is expected to maintain a close dialogue with national and local officials and the Bank (both ESCI coordination team and the Bank's country office). It is expected that key staff for each assignment will travel to Georgetown City at least three times in order to guarantee an adequate presence in the field for data collection, stakeholder consultations, results presentations, and capacity building activities. The minimum of three visits must cover the following aspects for each assignment:

a) Introduction of the consulting firm and its work program to all relevant stakeholders and first data collection on the ground.
b) Presentation of preliminary results in Georgetown City and participatory validation with all relevant stakeholders, ensuring that the products will meet their needs and expectations. This must be accomplished before submitting the advanced drafts for the three assignments to the Bank.
c) Presentation of final results and recommendations to all relevant stakeholders in targeted meetings, taking into account the different approaches needed to reach officials, technical staff, academia, citizens, etc. The final presentations will be held after the Bank's approval of the final reports and the road map.

4. Expected Outcome and Deliverables

4.1. All products must be presented to the Bank in an editable, electronic format. Reports and manuals shall be compatible with MS Word, inventories and comparable products with MS Excel, and the GIS database with ESRI ArcGIS. All maps produced shall be submitted in .mxd format. All spatial data should include metadata. A file summarizing the metadata of the layers (e.g. Excel file) should be submitted. All spatial layers shall additionally be submitted in Google Maps format (.kml). All data collected and used shall be submitted to the Bank, including a detailed listing of all input data used in each step of the Consulting Engagements with full references. Further specifications may apply. Reports, maps, and manuals shall also be submitted in print with five copies.

4.2. All products specified below must be provided in English.

4.3. **Consulting Engagement 1:** Develop a climate change mitigation assessment.
The consulting firm must produce the following products:

a) **Climate Change Mitigation Assessment Report** covering the GHG inventory and the GHG roadmap (Should include an executive summary no longer than 30 pages).
b) **Spreadsheets with calculations** for the GHG inventory and the GHG roadmap
c) **Mitigation Assessment Manual**

4.4. **Consulting Engagement 2:** Develop a disaster risk and climate change vulnerability assessment.

a) **Disaster Risk and Climate Change Vulnerability Report**: to document the methodologies used, their application, and the results for all activities undertaken in the four phases as described above. (Should include an executive summary no longer than 30 pages).
b) **Hazard, Exposure, Probabilistic Disaster Risk, Susceptibility, and Socio-economic Impact Maps** at appropriate scale (1:10,000, though 1:25,000 is sufficient if deemed adequate by the Bank), including the corresponding GIS data archive.
c) **GIS Database** including metadata with a description of the data and its format.
d) **Risk Calculation Data** (e.g. **.**ame format for CAPRA).

4.5. **Consulting Engagement 3:** Develop a study of urban growth.
The consulting firm must produce the following products:

a) **GIS Database - Development of Geospatial Data Infrastructure.** A geodatabase containing all the GIS data produced, including the land-cover classification as well as the density maps, key green and gray infrastructure and natural disaster-prone areas, in .shp format.
b) **Urban Growth Report** covering:

i. Current and Historic Urban Footprint: A historic analysis of the urban change since 1984 that presents the composition of the urban footprint in terms of land cover classes, and the identification of the areas of change since 1984, including a study of the historic densities associated with each urban footprint, and a study of the current densities for the city with documentation and imagery and photographic samples of each density category.
ii. Development of Urban Growth Scenarios: A simulation and its analysis for three different urban growth scenarios for 2030 and 2050: “current trends”, “smart growth” and “feasible” scenario., including: (i) a cost analysis of infrastructure for the three growth scenarios analyzed; (ii) analysis in terms of the impacts of each scenario (costs and GHG emission level implications); and (iii) a planning summary for policy makers expressing major findings of the analysis performed and policy recommendations.
iii. An executive summary no longer than 30 pages.

c) **Urban metrics data set** including:

i. Annual growth rate of the urban footprint (average for last decade).
ii. Urban population density (residents/km^2).

iii. Percentage of vacant lands within the urban footprint.
iv. Green area per 100,000 residents (hectares/100,000 residents).
v. Percentage of housing located in informal settlements.
vi. Percentage of households at risk due to inadequate construction or placement in areas of non-mitigable risk.
vii. Percentage of critical infrastructure at risk due to inadequate construction or placement in areas of non-mitigable risk.

4.6. **Cross-cutting products**:

a) **Work Plan**: All steps for completing the Consulting Engagements, the corresponding timelines, the composition of the task teams (with detailed CVs), and the methodologies to be used must be laid out in a work plan to be submitted as the first deliverable under these Terms of Reference. The Bank will approve the work plan or request changes within 5 business days.
b) **Digital Terrain Model** (DTM): In order to meet the quality requirements for the products outlined above, it will be necessary to base the corresponding analysis on a DTM. This DTM must meet the technical requirements specified in Annex II. If a DTM for the entire study area or parts of it is already available and its extent and quality approved by the Bank as being adequate for the purpose of this assignment, no DTM needs to be developed by the consulting firm.
c) **Minimum of three visits** to Georgetown City, Guyana by the key staff members of each assignment with corresponding reports.
d) **Capacity Building Activities** with each of the corresponding reports: To support the capacity of local and national officials to understand, make use of, and in the case of Consulting Engagement 1 replicate the activities this assignment. Capacity building activities must accompany the work of the consulting firm in Georgetown City. For each Consulting Engagement, a small group of technical personnel (3-5 persons) must be trained for at least 70 hours by the consulting firm throughout the contract duration to achieve these goals. To facilitate local learning, this training must accompany the activities continuously and shall not only be provided in workshops but (also) through regular mentoring that may take place remotely.
e) **Executive Summary Report** of the results from all three Consulting Engagements.
f) **Road Map** for using the results from the three studies.
g) **Power Point Presentation** summarizing the activities undertaken as well as the results.
h) **Climate Change Filter Report** with a description of the methodology used for topic prioritization, details on the relevance of each topic in the context of climate change, and the resulting list of scores per topic.
i) **Final workshop** with Bank specialists in Washington DC with corresponding report.

5. Project Schedule and Milestones

5.1. The activities under these terms of reference should be completed within **six months** from the starting date of the contract. The Bank may consider extensions of deadlines under extraordinary circumstances.

6. Proposal

6.1. Please note that proposals must not exceed 100 pages (excluding CVs). Proposals shall be submitted in English. Methodological details for all activities under this

assignment must be covered in the proposal. Special consideration must be given to the following aspects: In its proposal, the consulting firm must define a preliminary study area. Furthermore, it shall provide a preliminary list of hazards to be assessed as part of Consulting Engagement 2. A detailed technical justification for the hazard selection based on a rapid risk analysis that takes into account historical losses shall be included. The consulting firm shall describe in the proposal how they intend to link the probabilistic disaster risk analysis and the susceptibility and impact analysis with the impacts of climate change. The proposal shall elaborate on how the consulting firm will proceed if data from regional climate change models does not exist or has not been validated. For Consulting Engagement 3, the consulting firm shall specify and justify in its proposal the number of land cover classes that will be interpreted from satellite imagery. The modeling tools that it will use to estimate 'current' and 'smart' urban growth must be described and the choice justified. Also the type of infrastructure selected for the cost analysis must be specified and justified in the proposal. If data gaps are expected for any of the three Consulting Engagements, these should be addressed in the proposal together with suggestions for how the challenges resulting from these will be solved.

6.2. The estimated budget for this consultancy should consider the costs for a DTM. Prices shall be stated in USD. The consulting firm shall provide its prices for both cases outlined in Section **Error! Reference source not found.Error! Reference source not found.**b) - that is with and without developing a DTM.

6.3. Even though Consulting Engagements will not be contracted individually, the pricing shall be disaggregated by Consulting Engagement for informational purposes. For the DTM, also the price per km^2 shall be provided to allow cost comparisons despite potential changes in the study area.

7. Delivery and Payment Schedule

The delivery of the products and the corresponding payments will be scheduled as follows:

Milestone	Timing	Payment
Agreement on the work plan	within 2 weeks from the starting date of the contract	20%
Submission of the initial drafts	within 2 months from the starting date of the contract	20%
Submission of the final drafts	within 4 months from the starting date of the contract	20%
Submission of the final products	within 5 months from the starting date of the contract	40%

All payments are subject to the Bank's approval of the corresponding products.

8. Coordination and Supervision

8.1. The consulting firm's work and deliverables will be supervised by Patricio Zambrano-Barragan, Housing and Urban Development Specialist (CSD/HUD) and Gerard Alleng, Climate Change Senior Specialist (CSD/CCS).

Annex I: Additional information for the disaster risk and climate change vulnerability assessment

1. Drought

a) Rather than only looking at the impacts of droughts on agriculture, the ESCI focuses on the analysis of urban water availability under future urban growth and climate change scenarios.
b) For the analysis of water availability, the Bank proposes the following methodology:
    i. Water output: Analysis of the water balance of the main basins that supply water to the city including the following steps:
        a. Delineate the watershed and obtain the drainage area.
        b. Obtain the precipitation input data**, P, under current climate and future climate change conditions.**
        c. Generate Mean Areal Precipitation using either mean of gages or using the Thiessen polygon method.
        d. Obtain evaporation data or estimate using mean areal temperature data, **E, and considering climate change scenarios.**
        e. Obtain flow measurements at the outlet, **Q.**
        f. Obtain Water balance--- P-E-Q=delta storage.
    ii. Demand: Estimate the demand: Based on the future development scenarios estimate the potential demand for the different uses (agriculture, urban areas, industry, harbor, etc.).
    iii. Balance water output-demand. Calculate the hydrologic deficits (hydrological drought) for each future development scenario (smart, feasible, and business as usual) under current climate and future climate change conditions.

2. Coastal hazards

The consultant shall apply established methods for coastal hazard risk assessment.

3. Seismic Risk analysis

The return periods to be considered for the seismic risk analysis shall be 50, 100, 250, 500, y 1000 years.

4. Flood risk analysis

The probabilistic hazard analysis shall include the following:

a) Statistical analysis of precipitation data in the zone, with a justification for the selection of the data sets to be used for the analysis;
b) Application of a rainfall runoff model; and
c) Application of a one-dimensional hydraulic model for return periods of 20, 50, 100, and 500 years.

Once the flood hazard modeling is done, a probabilistic risk analysis shall be carried out as described in the ToR.

5. Landslide susceptibility

Introducción

Esta metodología ha sido adaptada a partir de la guía RECOMENDACIONES TECNICAS PARA LA ELABORACIÓN DE MAPAS DE AMENAZAS POR MOVIMIENTOS DE LADERAS de COSUDE-PNUD.

Paso 1. Recopilación y valoración de material existente

En el caso de muchos países de LAC, la información existente no es homogénea para todo el país, de manera que es muy importante conocer la información disponible en el área de estudio antes de definir la metodología a aplicar y la escala o precisión del trabajo a realizar.

Información necesaria para la elaboración del análisis de susceptibilidad a movimientos de ladera:

a) Fotos aéreas (posiblemente de diferente época), a colores y/o blanco/negro,
b) Imágenes Satelitales
c) Mapa topográfico según la escala disponible
d) Modelo digital del terreno con precisión vertical mínima de 10 metros.
e) Datos históricos de deslizamientos.
f) Datos históricos (prensa escrita, crónicas)
g) Bibliografía existente (geología, hidrogeología, estudios anteriores sobre movimientos de ladera, etc)
h) Mapas geológicos, litológicos, estructurales
i) Datos de alteración hidrotermal, meteorización, zonas de fracturación
j) Datos meteorológicos y climatológicos
k) Datos hidrológicos
l) Datos hidrogeológicos
m) Datos geotécnicos
n) Datos de monitoreo instrumental
o) Datos de propiedades y usos de los suelos
p) Otros

Estos, entre otros, son los insumos que se necesitan para una buena evaluación de la susceptibilidad a movimientos de laderas. En caso de que no se disponga de todos estos insumos, se tendrá que adaptar la metodología de trabajo a aplicar o bien estudiar la posibilidad de elaborar la información necesaria, opción, que generalmente resulta técnicamente y económicamente costosa.

<u>Escala de trabajo</u>

En la recopilación del material necesario para la evaluación de la susceptibilidad a movimientos de ladera es muy importante conocer la precisión y la escala original de los documentos que se van a utilizar, para así, poder determinar la escala y precisión de los documentos que se van a generar como resultado del estudio.
Por ejemplo, no se puede realizar un estudio a partir de mapas topográficos a escala 1:50.000 y fotos aéreas a escala 1:40.000 y decir que la escala de los mapas de susceptibilidad obtenidos es de 1:10.000.

Paso 2. Elaboración de un Inventario de Movimientos de ladera.

Se propone aplicar una metodología de trabajo basada en el ***Método Geomorfológico***, con los siguientes pasos a seguir:

Información a recopilar: Es importante identificar fuentes documentales para recabar testimonios personales sobre eventos pasados, signos indicadores de terreno, toponimia, crónicas de Indias o crónicas históricas, etc.

Identificación de las zonas de interés especial: se realizará partiendo de entrevistas a las autoridades municipales y a la población, con los cuales se puede realizar talleres participativos. La técnica del auto-mapeo se puede utilizar en este contexto.

Análisis de mapas topográficos y las fotos aéreas: En los ***mapas topográficos*** se identifican zonas con disturbios o discontinuidades en las curvas de nivel (curvas no paralelas o caóticas, lo que se relaciona con terrenos inestables), las cuales pueden preliminarmente marcarse como zonas de interés para comprobaciones. Para ayudar a visualizar estas discontinuidades pueden realizarse perfiles topográficos y geológicos, tanto en las áreas afectadas como en las áreas no afectadas; en mapas antiguos como en los más recientes, lo cual permite comparar la topografía y definir las áreas con movimientos de ladera. La densidad y tipo de drenaje es otro factor a considerar así como los cursos de ríos desviados y la definición o delimitación nítida de las líneas de los parte aguas de las unidades hidrológicas. Toda esta información debe ser verificada en el campo.

La *delimitación de los movimientos de ladera*, en algunos casos, también puede realizarse a través de la observación de las curvas de nivel y trazando las líneas limitantes en los puntos de inflexión de las curvas, lo cual debe ser verificado en el terreno.

Gráfico 1. Se aprecia que existe un cambio en las curvas de cóncavas a convexas. La propia toponimia del lugar (el nombre del derrumbo) es un buen indicador.

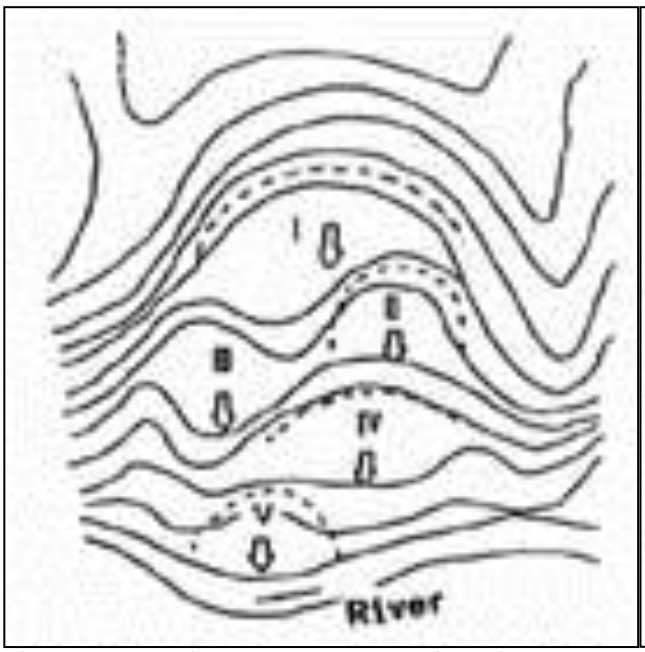


Gráfico 2. Curvas caóticas y cambio de dirección de río.

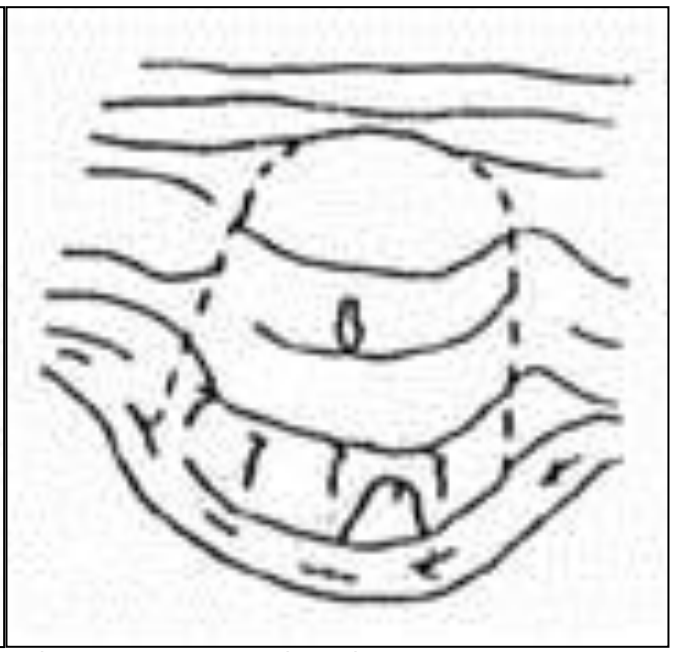


Gráfico 3. Cambio de dirección del río.

La identificación de los terrenos inestables en ***fotografías aéreas o en modelos tridimensionales del terreno***, es una herramienta importante para la evaluación de los movimientos y su delimitación espacial, además de que con la experiencia se ahorra al menos un 40% de tiempo en el recorrido de campo. Es posible identificar los terrenos inestables partiendo de la ubicación de depresiones de terreno, escarpes pronunciados, nichos de arranque, topografía ondulada, diferencias de coloración que sugiere cambios de litología o de dureza de las rocas, cambios de vegetación, zonas húmedas etc.

Compilación: si existen ortofotos, se digitaliza la fotointerpretación sobre las ortofotos para corregir la deformación de las fotos aéreas y así obtener un documento cartográfico. En caso de que no existan ortofotos se puede pasar a la interpretación sobre el mapa topográfico, proceso que genera más error que el anterior y por ende el documento resultante será menos preciso.

Trabajo de Campo**:** durante esta etapa se corrige sobre el terreno el documento obtenido en el paso anterior, y se completa la información que no aportan las fotos aéreas, es decir que solo se puede identificar en el campo. Los terrenos inestables pueden ser identificados en el campo partiendo de observaciones e interpretaciones generales de las cuencas, tanto de sus características geomorfológicas entre las que se destacan la presencia de un escarpe, un nicho de arranque, zona deprimida, topografía ondulada, zona de acumulación etc, como de sus características geológicas tales como fracturación, grado de alteración, tipo de roca, competencia de la roca, orientación de las estructuras, espesor de la capa de suelo, presencia de manantiales o zonas húmedas etc, comportamiento de la vegetación, entre otros. La observación sobre el terreno de los Indicadores Antecedentes es de gran ayuda para la identificación de movimientos de ladera sobre el terreno y por ende para la corrección del mapa preliminar.

Además se realizan una serie de observaciones en los puntos afectados por movimientos de ladera y se recopilan una serie de datos necesarios para el análisis, datos que se recopilan en una Ficha de Campo (ver propuesta de Ficha de Campo al final de esta sección “Landslide susceptibility”). En caso de que no se puedan visitar todos los puntos afectados por movimientos de ladera se puede hacer un muestreo sobre el mapa y seleccionar algunos puntos a visitar. Además de las observaciones de campo es importante recoger información testimonial de los habitantes de la zona mediante Encuestas a la Población.

Mapa de inventario de movimientos: La digitalización de las correcciones realizadas en el campo y de los datos recopilados permite obtener un Mapa de inventario de movimientos de ladera. El mapa debe identificar y distinguir las zonas donde se están produciendo los movimientos y sus diferentes tipologías, así como las zonas potencialmente afectadas por el alcance de los materiales movilizados, es decir las zonas afectadas por el trayecto y la acumulación de los materiales.

Paso 3. Evaluación y Mapeo de la Susceptibilidad

Una vez obtenido el Mapa de fenómenos, y como paso previo a la Evaluación del Nivel de Amenaza, es aconsejable la evaluación y la zonificación de la **Susceptibilidad a los Movimientos de ladera**.
Se entiende por Susceptibilidad la facilidad o propensión del terreno a generar Movimientos de Ladera. Tomando como premisa el Principio del Actualismo, si determinamos cuales son las características del terreno en las zonas afectadas por movimientos de ladera, podremos identificar las áreas con características similares como áreas Susceptibles a la formación de movimientos de ladera, o lo que es lo mismo, áreas con propensión de generar movimientos de ladera. Con el análisis de susceptibilidad se busca realizar una primera aproximación básicamente cartográfico-estadística, obviando la gran dificultad y coste de realizar una aproximación geotécnica al problema, que implicaría estudios concretos de movimientos, algo que está fuera del alcance de muchos de los estudios (Ayala Carcedo et al, 2002).
El Mapa de Susceptibilidad que se obtiene a partir de este análisis, representa la "amenaza potencial" por movimientos de ladera, documento que en caso de falta de datos para la realización de un análisis completo del Nivel de Amenaza, sirve para la confección de planes de ordenamiento territorial en base a una zonificación espacial de la amenaza potencial por movimientos de ladera, la cual no considera el aspecto temporal ni el de la intensidad del evento potencial.
Hay diferentes métodos de análisis de susceptibilidad:
Iguigaría y Chacón (2002) identifican ocho modelos de análisis como los más aplicados en el análisis de susceptibilidad de movimientos de ladera. Estos modelos son:

a) Modelos basados en el análisis de distribución de movimientos de ladera.
La forma más directa en la cartografía de susceptibilidad a los movimientos de ladera consiste en un mapa de inventario de movimientos basado en la interpretación de las fotografías aéreas, investigación sobre el campo y/o una base de datos de los registros históricos de una determinada zona. Este tipo de mapas se puede utilizar como una forma elemental de mapa de susceptibilidad, pues sólo permite identificar los movimientos que sucedieron poco antes de tomar la foto aérea y no posibilita conocer los cambios temporales en la distribución de movimientos, es decir, predecir nuevos movimientos.

b) Modelos basados en el análisis de actividad.
Estos modelos representan una mejora respecto a los mapas de distribución de movimientos. Consisten en la construcción de mapas de actividad, basados en la interpretación de varias series de fotografías aéreas a lo largo del tiempo.

c) Modelos basados en la densidad de movimientos.
La distribución de movimientos de ladera se puede mostrar mediante mapas de densidad, mapas de isopletas, donde se representa el porcentaje de una determinada unidad del terreno que aparece afectado por movimientos de ladera. Este método también se utiliza para comprender la influencia de cada parámetro individualmente en la estabilidad.

d) Modelos basados en el análisis geomorfológico.

En los métodos geomorfológicos, la cartografía de inventario de movimientos y su contexto geomorfológico constituyen el principal factor para la determinación de la susceptibilidad. En este método el grado de susceptibilidad se evalúa en cada punto sobre el terreno. Las reglas de decisión son, por tanto, difíciles de formular y varían de un sitio a otro. Dado que los criterios del análisis de susceptibilidad se han elaborado en la "mente del geomorfólogo", los métodos geomorfológicos se consideran como subjetivos. Este término subjetivo no es una descalificación, pues los análisis subjetivos pueden dar lugar a mapas muy fiables cuando se llevan a cabo por geomorfólogos con gran experiencia.

e) Modelos basados en análisis cualitativo.

Este método se basa en el conocimiento y experiencia que tengan los investigadores que son los que deciden qué parámetros son importantes en la generación de ladera y les dan un peso relativo. El inconveniente que genera la ponderación de los diferentes parámetros es que se hace en ocasiones con un conocimiento insuficiente del campo, lo que puede conducir a generalizaciones poco precisas. Los métodos cualitativos como el Bonham-Carter o el método de Mora-Vahrson son apropiados para análisis regionales pero muy subjetivos para análisis a nivel municipal.

f) Modelos basados en análisis estadístico bivariante.

Con el objetivo de conseguir un mayor grado de objetividad y que los mapas de susceptibilidad se puedan reproducir por investigadores diferentes (lo cual tiene gran importancia legal) se han aplicado técnicas de análisis estadístico en la evaluación de susceptibilidad. El fundamento del método de análisis bivariante se basa en el análisis cruzado de los mapas de variables y en el cálculo de densidad de movimientos en cada posible combinación de variables.

g) Modelos basados en análisis estadístico multivariante.

Este método se basa en el análisis estadístico multivariante para determinar la presencia o ausencia de fenómenos de movimientos de ladera dentro de una determinada unidad de terreno. Se ha propuesto la aplicación de diversas técnicas como el análisis discriminante y la regresión múltiple.

h) Modelos deterministas.

La aplicación de modelos deterministas se puede realizar cuando las condiciones de la zona de estudio son relativamente homogéneas en cuanto a tipo de movimientos y tipo de suelos. Tienen la ventaja de que poseen una base física. Usan métodos de estabilidad de taludes como el método del talud infinito.

Los pasos generales para elaborar un mapa de susceptibilidad son los siguientes: preparación del material, elaboración de mapas temáticos, análisis del peso de cada factor y elaboración del mapa de susceptibilidad.

a) Preparación del Material

Para la elaboración del mapa de suceptibilidad se necesita un mapa de inventario de movimientos de ladera en el cual se diferencien: (i) las diferentes tipologías de movimientos existentes en el área de estudio y (ii) las zonas afectadas por el trayecto y la acumulación de los materiales.

Hay que tener en cuenta que los factores que caracterizan el terreno pueden condicionar de manera diferente los diferentes tipos de movimientos de ladera, por esto es recomendable realizar un análisis de la susceptibilidad para cada tipo de movimiento de ladera.

b) Mapas Temáticos.

Una vez determinados cuales son los factores condicionantes de los movimientos de ladera que se van a estudiar, hay que recopilar o elaborar una serie de Mapas Temáticos donde se representen estos factores. Cuantos más Mapas temáticos podamos incorporar en el análisis mejor puede ser el resultado. No obstante, hay que tener en cuenta que la precisión y la escala original de estos mapas sea homogénea, para que este factor no distorsione la precisión de los resultados del estudio. Los factores son generalmente los factores condicionantes como pendiente, curvatura, tipo de geología, hidrología, distancia a fallas, distancia a contactos geológicos.

La metodología propuesta deberá ser adaptada según la disponibilidad de Mapas Temáticos en el área de estudio.

c) Cálculo de la susceptibilidad

Una vez preparado el material necesario se calcula el Grado de Influencia de cada uno de los factores del terreno a la formación de movimientos de ladera. Este Grado de Influencia permite calcular la susceptibilidad que por sus características presenta el terreno a la formación de movimientos de ladera.

Existen diferentes metodologías para realizar análisis de susceptibilidades, y la mayoría dependen de la disponibilidad de información y escala de la base topográfica disponible.

d) Zonificación de la Susceptibilidad

La clasificación de los valores de Susceptibilidad en diferentes intervalos permite zonificar el área de estudio según el grado de susceptibilidad a los movimientos de ladera. Se recomienda realizar el análisis de susceptibilidad para cada tipo de movimiento de ladera que se analice y en función del material o información disponible.

Como metodología para el análisis de susceptibilidad se propone usar al menos f) modelos basados en análisis estadístico bivariante. Modelos basados en análisis estadístico multivariante, (g) modelos deterministas (h) y modelos probabilistas también se consideran aceptables.

Los modelos basados en el análisis de distribución de movimientos de ladera a) modelos basados en el análisis de actividad b) modelos basados en la densidad de movimientos c) y modelos basados en el análisis geomorfológico d) pueden servir para generar insumos para el análisis bivariante pero el producto final no puede limitarse a la aplicación de estos modelos. Se descarta el uso de modelos basados en análisis cualitativo e).

En el siguiente link se puede encontrar un ejemplo de un Modelo de análisis estadístico bivariante:
http://www.adpc.net/casita/Case_studies/Landslide%20hazard%20assessment/Statistical%20landslide%20susceptibility%20assessmen%20landslide%20index%20method%20%20CS%20Chinchina%20%20Colombia/Statistical_landslide_susceptibility_analysis.pdf

FICHA DE DATOS DE MOVIMIENTOS DE LADERA

I. DATOS BASICOS

a) Datos de registro

Id o N° registro: fecha de colecta (dd-mes-año):

autor[11]:

institución:

b) Localización del movimiento:

Sitio[12]: _____

Localidad[13]: _____

Comarca: _____

Forma de acceso:_____

Municipio: _____

Departamento: _____

Longitud (geográfica): _____

Latitud (geográfica): _____

Este(m): _____Norte(m): _____ datum: _____

Nombre y cuadrante de la hoja topográfica: _____

Escala: _____

Observaciones:

_____

_____

_____

[11] Se pondrá el nombre de quien procesa los datos a partir de datos de campo o referencia bibliográfica
[12] Especificar el nombre del área (sector, km, etc.) donde ocurrió el evento (por ej. Km 17 carretera...)
[13] Especificar el nombre del volcán, cerro, montaña, comarca, barrio, etc.

II. DATOS TÉCNICOS

a) Características del Movimiento de Laderas

- **Tipo de movimiento y Subtipo:**

	Deslizamiento		**Flujo**		**Desprendimiento**
	Rotacional		Detritos		Caída aislada
	Simple		Lodo		Caída de Bloques
	Múltiple		Lahar		Derrumbes de rocas
	Traslacional o Planar		No Determinado		Complejo
	No determindado				

	Otros Tipos:		
	Vuelco	Avalancha de Detritos	Desconocido
	Extrusión lateral	Reptación/superficial	
	Complejo[14]	Hundimientos	
OBSERVACIONES			

Movimiento localizado ☐ Área inestable ☐

Edad del movimiento:
Reciente ☐ Histórico ☐ Fósil ☐

Grado de Actividad: Activo ☐ Poco Activo ☐ Inactivo ☐
Grado de desarrollo: Nulo ☐Incipiente ☐ Avanzado ☐ Detenido ☐

b) Factores Desencadenantes

☐ Precipitaciones intensas (Máximas intensidades)

☐ Precipitaciones prolongadas (horas/días de lluvias y cantidad en mm)

☐ Erosión o socavamiento en la base de la ladera o del talud

☐ Fenómenos cársticos

☐ Movimientos sísmicos

☐ Actividad volcánica

☐ Tormenta/ huracanes[15] Nombre:

☐ Actividad biológica (vegetación y organismos subterráneos)

☐ Actividad antrópica (rellenos, cambios prácticas agrícolas, vertidos, minería, obra civil, ...)

☐ Cambios en la geometría original de la ladera

[14] Especificar los subtipos si se pueden reconocer, por eje. Rotacional y flujo de detritos.
< 100 años.
[15] Especificar entre paréntesis el nombre del huracán, por ejemplo Lluvia (huracán Michelle)

☐ Sobrecargas en la ladera

☐ Otros:

Observaciones:

c) Factores condicionantes:

☐ Materiales blandos, meteorizados o alterados

☐ Alternancia de materiales de distinta competencia

☐ Alternancia o contacto de materiales permeables e impermeables

☐ Estructura desfavorable

☐ Presencia de litologías plásticas (arcillas, margas, evaporitas, ...)

☐ Pendientes acusadas

☐ Otros:

d) Características morfológicas y geológicas del área inestable

Materiales afectados por el movimiento de ladera:

☐ Roca ☐ Suelo ☐ Relleno

Tipo: Espesor:

ESTRUCTURA:

Estratificación ☐ Dirección y Dirección y buzamiento:_____

Imbricación ☐ Otras discontinuidades☐

Condiciones de la roca o suelo:

Grado de fracturación: ☐ Alto ☐ Medio ☐ Bajo

Meteorización: ☐ Alta ☐ Media ☐ Baja

Humedad: ☐ Seco ☐ Semisaturado ☐ Saturado

Observaciones:

---

e) Estado de Conservación y Rasgos Presentes sobre el Depósito

Presencia de vegetación en la cicatriz:

Desnuda ☐ Semivegetada ☐ Herbácea ☐

Arbustiva ☐ Arbórea ☐

Cobertura:

>70% ☐ 70-40% ☐ < 40% ☐

Presencia de vegetación sobre el depósito:

Desnudo ☐ Semivegetada ☐ Herbácea ☐

Arbustiva ☐ Arbórea ☐ Agrícola ☐

Cobertura:

>70% ☐ 70-40% ☐ < 40% ☐

Cabecera/Corona
Conservada ☐ Erosionada ☐ Reforestada ☐

Depósito
Sin erosión perceptible ☐ Con erosión perceptible ☐
Estructura incoherente ☐

Rasgos observables:
☐Escarpes frescos ☐escarpes degradados
☐Escarpes múltiples ☐Escarpes sencillos
☐Diques laterales conservados ☐escalones visibles
☐Superficie del depósito irregular ☐Superficie del deposito plana
☐Grietas laterales abiertas ☐Grietas transversales abiertas
☐Signos de reptación ☐Coronas menores
☐Removilización antrópica ☐Afectado por otros movimientos

Observaciones:

f) Geometría y forma de la ladera
Forma de la ladera: cóncava ☐ convexa ☐ plana ☐

Natural ☐ inducida ☐
Altura (centro de la rotura): Cota cabecera: cota pie:

Desnivel máximo de la ladera Δ h:

Ángulo de la ladera previo a la rotura:

Angulo de la ladera con rotura:

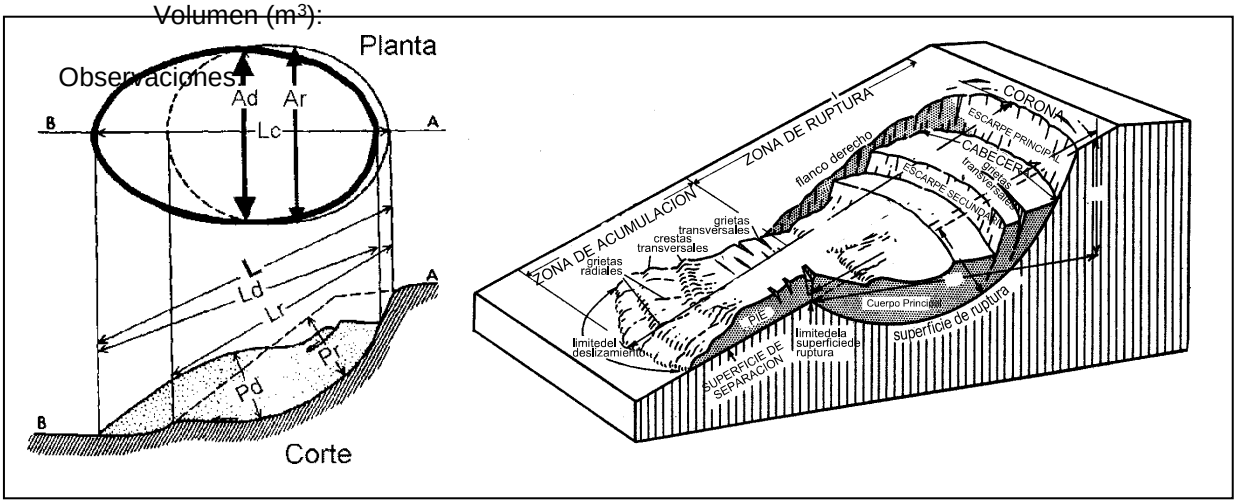
Pendiente media de la ladera:

Ubicación de la rotura en la ladera: cabecera ☐ parte intermedia ☐ pie ☐ desconocida ☐

Descripción y situación de grietas de tracción.
orientación: longitud:
apertura: profundidad:

Dimensiones:
-Superficie de ruptura
Longitud, Lr (m): Ancho, Ar (m): Profundidad, Pr (m):
-Masa desplazada
Longitud, Ld (m): Ancho, Ad (m): Profundidad, Pd (m):
-Longitud Total, L (m):
Longitud de la linea central, Lc (m):
Superficie (m²):
Volumen (m³):

Observaciones:



g) Condiciones hidrogeológicas

Fuentes o manantiales en la ladera: ☐ sí ☐ no situación:

Aparición de surgencias nuevas: ☐ sí ☐ no situación:

Desaparición manantiales o fuentes: ☐ si ☐ no

Existencia de pozos de agua próximos: ☐ si ☐ no

Coordenadas UTM:

Comportamiento hidrogeológico de los materiales:

☐ permeables ☐ semipermeables ☐ impermeables

Condiciones de drenaje:

☐ Existencia de arroyos o torrentes en la ladera

☐ Existencia de zonas encharcadas en la ladera. Ubicación(cabecera, pie...)

☐ Existencia de replanos, zonas llanas o endorreicas en la ladera

☐ Existencia de pantanos o lagunetas

☐ Otras circunstancias del drenaje:

h) Caracterización temporal del fenómeno

Edad del movimiento[16]:

Fecha del último movimiento (dd/mes/año):

Hora del movimiento:

Fecha de movimientos anteriores[17] (periodos de actividad) (dd/mes/año)::

i) Uso del suelo:

☐Urbano edificado ☐Urbano no edificado ☐forestal

☐Industria e infraestructura ☐Cultivos ☐malezas

☐Pastos natural ☐Pasto Mejorado ☐Natural

Confrontación de uso ☐ Adecuado ☐ Subutilizado ☐ Sobreutilizado

Descripción Breve*:

j) Velocidad del movimiento

☐Alta ☐Media ☐Baja ☐No determinada

k) Evaluación de daños

Nº de víctimas: N° de heridos No. de muertos

[16] Especificar si es histórico (anterior a 1990) o reciente (posterior a 1990)

[17] Esto es válido solamente para deslizamientos

* Describir además los usos que tiene la ladera y en el caso de la vegetación arbórea describir las especies con su nombre común (por la profundidad de las raíces y cobertura.

N° de viviendas afectadas:

Daños a infraestructuras transporte y comunicaciones: Carreteras ☐ Caminos

☐Trochas ☐ Líneas de comunicaciones ☐Antenas o Repetidoras ☐ Otros ☐

Daños a infraestructura de recursos hídricos: cauces y embalses ☐

☐Depósitos de agua ☐ estación de aforo ☐ redes de abastecimiento ☐ redes de saneamiento ☐ otros ☐

Daños a infraestructura energéticas: tendidos eléctricos ☐ otras ☐

Daños a elementos naturales: Cauces ☐ Elementos del Patrimonio Natural ☐ Otros ☐

Otras edificaciones afectadas: Educativos ☐ Administrativos ☐ Centros Operativos ☐ Hospitales ☐ Otros ☐

i) Tipos de Medidas adoptadas

Esquema o Grafico:

FICHA DE DATOS
PARA CAIDAS DE BLOQUES Y DERRUMBES

I. DATOS BASICOS

a) Datos de registro

ID o N° REGISTRO: FECHA DE COLECTA (dd-mes-año):

AUTOR[18]:

INSTITUCIÓN:

b) Localización del movimiento:

SITIO[19]: _____

LOCALIDAD[20]: _____

FORMA DE ACCESO: _____

MUNICIPIO:: _____

DEPARTAMENTO: _____

COORDENADAS(GEOGRÁFICA):_____

ESTE(m): _____ NORTE (m): _____ DATUM: _____

NOMBRE Y CUADRANTE DE LA HOJA TOPOGRÁFICA: _____

ESCALA: _____

OBSERVACIONES:

_____

_____

_____

[18] Se pondrá el nombre de quien procesa los datos a partir de datos de campo o referencia bibliográfica
[19] Especificar el nombre del área (sector, km, etc.) donde ocurrió el evento (por ej. Km 17 carretera...)
[20] Especificar el nombre del volcán, cerro, montaña, comarca, barrio, etc.

II. DATOS TECNICOS

a) Geometría y características de la ladera

COTAS DE CABECERA /PIE:

LITOLOGÍA:

FORMA DE LOS FRAGMENTOS:

TAMAÑO MÁXIMO DE BLOQUE DESPRENDIDO:

TAMAÑO MEDIO DE BLOQUE DESPRENDIDO:

ALCANCE MÁXIMO DE LOS BLOQUES DESPRENDIDOS (m):

DENSIDAD DE LA ROCA:

TIPO DE VEGETACION:

FORMA Y CARACTERÍSTICAS DE LA LADERA:

PENDIENTE:

RUGOSIDAD DE LA PENDIENTE:

VOLUMEN DEL DESPRENDIMIENTO (m^3):

DEPOSITO DE PIE DE TALUD. CARACTERISTICAS GENERALES:

DIMENSIONES DEL FRENTE O CARA DEL ESCARPE:

b) CONDICIONES DE LAS FRACTURAS:

	Espaciado		**Fracturación**		**Rugosidad**
	Extremadamente Junto (< 20mm)		Alta (espaciado entre 20 y 200 mm)		Escalonada
	Muy Junto (20-60 mm)		Media (espaciado entre 200 y 2000 mm)		Ondulada
	Junto (60-200mm)		Baja (espaciado mayor de 2000 mm)		Plana
	Moderadamente Junto (200-600 mm)		Desconocida		Desconocida
	Separado (600-2000 mm)				
	Muy Separado ((2000-6000 mm)				
	Extremadamente Separado (> 6000 mm)				
	Desconocido				

	Abertura		**Continuidad**
	< 0.1 mm		Muy alta (> de 20 m)
	0.1 mm – 0.25 mm (Cerrado)		Alta (entre 10 y 20 m)

	Abertura		Continuidad
	0.25 mm – 0.5 mm		Media (entre 3 y 10 m)
	0.5 mm – 2.5 mm (Abierto)		Baja (entre 3 y 1 m)
	2.5 mm – 10 mm		Muy baja (< de 1 m)
	> 10 mm (Ancho)		Desconocida
	1 cm – 10 cm		
	10 cm – 100 cm		
	> 1 m (Cavernosa)		
	Desconocido		

ORIENTACIÓN DE LAS DISCONTINUIDADES DEL MACIZO ROCOSO:

AZIMOT RUMBO:

DIRECCION BUZAMIENTO:

TIPO DE RELLENO:

CARACTERÍSTICAS DE LAS DISCONTINUIDADES:

c) Factores condicionantes(Geológicos-estructurales).

- ☐ Materiales blandos, meteorizados o alterados
- ☐ Materiales con estratificación masiva
- ☐ Alternancia de materiales de distinta competencia
- ☐ Alternancia o contacto de materiales permeables e impermeables
- ☐ Estructura desfavorable
- ☐ Presencia de litologías plásticas (arcillas, margas, evaporitas, ...)
- ☐ Pendientes acusadas
- ☐ Otros:_____

d)Factores desencadenantes

- ☐ Precipitaciones intensas y cortas
- ☐ Precipitaciones prolongadas
- ☐ Procesos de erosión o socavamiento en la base de los bloques
- ☐ Fenómenos cársticos
- ☐ Movimientos sísmicos regionales/locales
- ☐ Actividad volcánica
- ☐ Actividad biológica (vegetación y organismos subterráneos)
- ☐ Actividad antrópica (Defina brevemente):
- ☐ Tormenta/ huracanes[21] Nombre:
- ☐ Otros:_____

[21] Especificar entre paréntesis el nombre del huracán, por ejemplo Lluvia (huracán Michelle)

DATOS PARA FLUJOS

COTAS DE CABECERA /FRENTE:

MAXIMO ALCANCE:

ALCANCE DE LOS FLUJOS DE DETRITOS:

☐ Presencia de avenidas rápidas en la zona distal.

EXTENSION SUPERFICIAL AFECTADA:

VOLUMEN TOTAL SECO DEL MATERIAL MOVILIZADO:

OBSERVACIONES:

Factores condicionantes

- ☐ Presencia de intrusiones en el edificio volcánico
- ☐ Alternancia de materiales de distinta competencia
- ☐ Alternancia o contacto de materiales permeables e impermeables
- ☐ Elevada fracturación
- ☐ Elevada alteración hidrotermal
- ☐ Elevada pendiente
- ☐ Elevado desnivel de la ladera
- ☐ Elevada deforestación
- ☐ Importante erosión basal
- ☐ Otros:

Factores desencadenantes

- ☐ Movimientos de ladera
- ☐ Flujos piroclásticos
- ☐ Precipitaciones intensas
- ☐ Precipitaciones prolongadas
- ☐ Rotura de lagos o represamientos
- ☐ Movimientos sísmicos
- ☐ Actividad volcánica
- ☐ Tormenta/ huracanes[22] Nombre:
- ☐ Otros:

Condiciones climáticas y meteorológicas

ESTACIÓN PLUVIOMÉTRICA PRÓXIMA (especificar si es oficial o privada):

DATOS DE ACUMULADO 24 H:

[22] Especificar entre paréntesis el nombre del huracán, por ejemplo Lluvia (huracán Michelle)

INTENSIDAD MAX. HORARIA:

DIAS CONTINUOS DE LLUVIA Y CANTIDAD ACUMULADA (mm)

Comentario, croquis y fotografía del área movilizada. Indíquense los datos de interés. Si existe foto, especificar el código.

Referencias Bibliográficas

Autor: Fecha (dd/mes/año):

Titulo/Observaciones:

Institución/Editor

Tabla para estimación de frecuencia de deslizamientos

Periodo de Observacion:

Nº de Hoja topográfica y Nombre:

Nº de foto aerea y Línea de Vuelo - Año	Cantidad de deslizamientos	nº de nuevos deslizamientos observados o reactivados	Area de deslizamiento	Código de deslizamiento (nº de foto + nº consecutivo + letra del fenómeno	Coordenadas al centro del deslizamiento		Reactivaciones observadas en fotografias aereas Años vuelo					Memoria histórica	Frecuencia
					N	E	1954	1970	1988	1996	2000		1 en 50 años

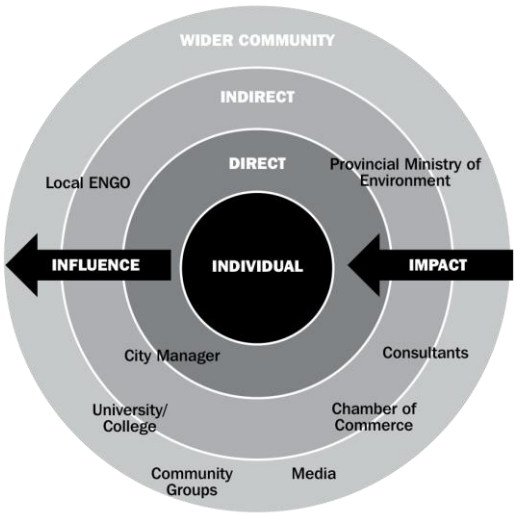
6. Stakeholder Analysis and Engagement Strategy

As a reference, the stakeholder analysis used by the following initiatives can be revised and adapted:

- ICLEI: Climate changing, changing communities (pp. 2-3)

Breve reseña de la metodología:

- Método para la identificación de actores clave (stakeholders analysis): A partir del nivel de influencia que el/los promotores del proceso pueden tener, así como del nivel de impacto que puede tener sus acciones en los acciones. Propone también la definición por parte de los propios actores del nivel de participación que desean tener: sólo en toma de decisiones ampliadas, o en el proceso de recojo de información, debate y toma de decisiones.



- A partir de la identificación de actores clave, se procede a conformar un grupo central (o grupo promotor) y un grupo externo. En el grupo central se identifica el mandato del grupo, y se define un actor líder (al interior del grupo, y con ascendencia para lograr la integración de los participantes) y un CAMPEÓN (quien tendrá la función de ser el vocero del grupo ante la prensa y la opinión pública).

- IADB: Metodología de identificación de iniciativas de ACC en ciudades emergentes

Breve reseña de la metodología:

- A partir del mapeo de actores, se organiza la participación de las instituciones en tres grupos: equipo implementador externo, grupo de apoyo local y el grupo de consulta ciudadana. Cada uno de ellos con diferente nivel de involucramiento en el proceso.

The complete documents regarding these initiatives are attached to this TORs.

7. Risk Configuration Process Analysis

As a reference, the methodology used by the UNDP/BCPR and DPAE (Municipality of Bogota) can be revised and adapted:

Breve reseña de la metodología:

Esta metodología permite complementar la información de un análisis probabilista y profundizar en el análisis de los procesos de configuración de condiciones de riesgo, identificando las causas que influyen y determinan su generación (amenaza y vulnerabilidad) y en el tipo de efectos (sociales, económicos, institucionales, ambientales) que tendría la ocurrencia de desastres.

El esquema a continuación resume el enfoque de análisis:

En el que cada una de las partes analiza los siguientes aspectos:

Estado	Frecuencia, magnitud y cobertura del área potencialmente afectada	Ej. Sector inundable y las características de su población, su infraestructura, act. económicas
Núcleo	Acciones, actores y su ubicación que influye en la generación de condiciones de riesgo	Ej. Urbanizadores formales e informales que promueven la ocupación + Municipalidad que brinda los permisos + Empresas de servicios que extienden sus redes.
Entorno	Factores que condicionan, facilitan o permiten que se desarrollen esas acciones	Ej. Desarticulación entre inst. de nivel central y local + conflicto entre municipios + toma de decisiones reactivas.
Efectos	Consecuencias físicas, económicas, ambientales, político-institucionales, culturales-organizativas, que define al desastre	Ej. Daños en vidas humanas, en pérdidas económicas, en funcionamiento de las instituciones

A partir de este análisis se puede priorizar de manera participativa los principales condicionantes y desencadenantes en la configuración de condiciones de riesgo.

Annex II: DTM Specifications

Three outputs shall be developed for the study area, all of which are necessary to produce high resolution topographic information:

a) A Digital Terrain Model (DTM). The model includes detailed information about the elevations of a terrain. DTMs represent a key input for geospatial applications, including the creation of accurate floodplain maps, terrain models, transportation infrastructure planning and design base maps, and land use management.

b) One or more pairs of high resolution satellite imagery. Stereo imagery consists of a pair of images of a single target site viewed from different angles and acquired simultaneously from state-of-the-art satellites. One or more pairs of stereo imagery are needed as a critical input for the production of DTMs and are thus a central part of the assignment. The firm may provide the most cost-effective option from either 1) one or more pairs of stereo images or 2) a condensed, single set of monoscopic satellite images of the target area.

c) High resolution topographic maps for the study area. Topographic maps are essential for infrastructure planning and resource management, as they provide information on a region's contour lines, spot elevations, hydro-enforced breaklines, and other elevation data.

The consulting firm will gather all the data necessary to produce a DTM using best available, cost-effective technological tools, according to the following technical specifications:

a) DTM resolution of at least 2 meters;
b) Contour lines at a minimum of 2 meters;
c) Horizontal accuracy of at least 2.5 meters;
d) Vertical accuracy of at least 1.25 meters.

Production of DTMs at this level of technical detail is achieved by processing elevation information from two sets of data: i) one or more pairs of high resolution stereo satellite imagery from the target site and ii) manually-collected elevation information such as breaklines and mass points, referred to as Ground Control Points (GCPs), which are necessary to extract precise topographic information from the target site.

Annex III: Land Cover Classification

USO PRINCIPAL	USO DEL SUELO	DENSIDAD POTENCIAL	CONSOLIDACIÓN	CLASES DE ANÁLISIS PARA EL CRECIMIENTO URBANO	SIMBOLO
Urbano	Residencial o mixto con predominancia residencial	Muy baja densidad en unifamiliar (clase media-alta y alta)	Consolidado Consolidación media No consolidado	• Colonia residencial de clase media-alta y alta (o mixta con predominancia residencial) de muy baja densidad en unifamiliar consolidado, algunas de ellas en circuito cerrado. • Colonia residencial de clase media-alta y alta (o mixta con predominancia residencial) de muy baja densidad en unifamiliar no consolidado, algunas de ellas en circuito cerrado.	
		Baja densidad en unifamiliar loteamientos mínimos de 360 m2 (clase media y media-baja) a partir de lotes urbanos básicos con características rurales		• Lotificación residencial o mixto con predominancia residencial de baja densidad en unifamiliar de clase media-media y/o baja con lotes mínimos de 360 m2 consolidado. • Lotificación residencial o mixto con predominancia residencial de baja densidad en unifamiliar de clase media-media y/o baja con lotes mínimos de 360 m2, de media consolidación a partir de lotes urbanos básicos con características rurales. • Lotificación residencial o mixto con predominancia residencial de baja densidad en unifamiliar de clase media-media y/o baja, no consolidada, con lotes mínimos de 360 m2, a partir de lotes urbanos básicos con características rurales.	
		Alta densidad en multifamiliar (mixto)		• Áreas urbanas residenciales de alta densidad donde se mezclan edificios en altura multifamiliares y viviendas unifamiliares. • Áreas urbanas mixtas residenciales y comerciales, donde se mezclan edificios en altura multifamiliares, viviendas unifamiliares, comercios e industrias.	
		Crecimientos mixtos	Crecimientos mixtos Crecimientos lineales mixtos	• Mixto con predominancia de vivienda unifamiliar • Mixto: Urbano residencial, comercial, industrial y otros usos vinculado a las vías (en el suelo urbano) • Mixto: Crecimientos lineales con predominancia de viviendas, comercios e industrias en las vías (en el área rural)	
	Centros rurales			• Centros urbanos en municipios rurales	
	Suelo vacante			• Suelo vacante.	
	Asentamientos marginales o informales			• Asentamientos desordenados con viviendas marginales o precarias.	
	No residencial			• Urbano no residencial de actividades económicas con predominancia comercial • Urbano no residencial de actividades económicas con predominancia industrial • Urbano no residencial con usos especiales (aeropuertos, cementerios, institucionales, etc.) • Urbano no residencial verde: áreas verdes urbanas y otros espacios verdes (campos de golf, jardín botánico, etc)	
Rural	Productivo			• Mosaico con vivienda dispersa (>30%) cultivos y otros. • Mosaico con vivienda dispersa (entre 10 y 30%) cultivos y otros. • Agrícola: agrícola, pasturas y frutihorticola.	
	Conservación			• Areas boscosas y pequeños bosquetes aislados, algunos en taludes y cerros. • Humedales y bañados • Cuerpos de agua y sus bosques de protección	

Additional sections (to be included in corresponding sections of the IDB Request for Proposals):

Firm Background/Expertise

For all the consulting engagements described in the Terms of Reference, it is important that the Offeror has the ability to produce high quality written and visual communication products. The following specific skills and experience are required for the consulting engagements:

i. Consulting Engagement 1: Strong analytical skills and ability to develop local climate change mitigation assessments, including the ability to estimate current GHG emissions, to project future GHG emissions, and to develop mitigation actions and strategies.

ii. Consulting Engagement 2: Strong analytical skills and ability to develop probabilistic disaster risk assessments as well as susceptibility and impact analysis; ability to incorporate climate change scenarios into such assessments and analysis; demonstrated working experience in the creation, processing and analysis of spatial data sets in the context of disaster risk management; ability to identify and analyze causes and consequences of vulnerability; ability to develop risk reduction actions and strategies including both engineering and socio-economic aspects.

iii. Consulting Engagement 3: Strong analytical skills; ability to analyze urban growth from satellite imagery; ability to develop sustainable urban growth strategies; experience in advanced mapping and urban growth projection software required.

Personnel

Offeror is to identify the Project Manager for this effort, and must provide the composition of the proposed team, including the resumes of the staff that would be assigned to this project if the Offeror is selected for contract award. Such resumes should describe the experience with other companies and institutions that directly relates to this project.

Qualifications: Offeror with interest in responding to this RFP should demonstrate the following qualifications:

i. **Consulting Engagement 1:** The proposed subproject manager must have a Master's degree in applied sciences, environment, engineering, or related areas, and should have at least 8 years of professional experience in developing GHG emission inventories, emission scenarios, and GHG mitigation actions and strategies. Documented work experience at city level is considered an asset. The members of the team should have a minimum combined experience of 20 years in the subject area.

ii. **Consulting Engagement 2:** The proposed subproject manager must hold a Master's degree in applied sciences, engineering, or related areas, and should have at least 8 years of professional experience in probabilistic disaster risk assessments and climate

change adaptation in an urban context. Key personnel must have expertise in hazard and risk assessment and related disciplines including hydrology, coastal engineering, geology, and experience in GIS applications. The members of the team should have a minimum combined experience of 20 years in the subject area.

iii. **Consulting Engagement 3:** The proposed subproject manager must be a professional in city planning and urban information systems with at least 10 years of professional experience. The members of the team should have a minimum combined experience of 20 years in sustainable urban development and planning and developing related information systems (including GIS), preferably with a focus on incorporating climate change mitigation and adaptation as well as disaster risk management.

iv. A local consultant with expertise relevant to this assignment and based in Georgetown City must be hired to serve as a focal point for data collection and stakeholder consultations. An alliance with a local research institution is highly recommended.

TERMS OF REFERENCE

Development of planning proposals for climate adaptation projects

Guyana

GY-L1031

GY-T1137

Climate Resilience Support for the Adequate Housing and Urban Accessibility Program

1. Background and Justification

1.1. Guyana is home to close to 750,000 people. The proportion of the population living in urban centers has hovered around 30% over the last four decades and currently sits at 26.4%.[1] However, Guyana's actual urban population is much larger; as is the case in other Caribbean countries, alternative calculations that consider actual urban footprints and the 'overspill' of human settlements beyond administrative boundaries yield much higher rates. In Guyana, McHardy and Donovan (2016) note that the actual proportion of urban dwellers could be as high as 61%. This underestimation is consistent with one of the most salient features of Guyana's urbanization trends: more than 90% of the country's population lives on so-called 'towns' and 'villages' in a semi-continuous urban footprint, along coastal strip that represents only 5% of total land area. Region 4 alone, which includes the capital Georgetown and its low-density suburbs, contains over 311,000 people—over 40% of Guyana's population. The towns range in size from several hundred to several thousand inhabitants and often follow the pre-existing layout from drainage and irrigation systems of agricultural lands, both active and abandoned—in low-lying areas that are highly vulnerable to the potential impacts of climate change, particularly coastal flooding under higher estimates for sea-level rise.

1.2. This vulnerability, resulting from the population's spatial distribution, is compounded by large shelter deficits, particularly inadequate housing and supporting infrastructure such as paved roads and drains. In Georgetown, 29% of the population live in overcrowded housing (over two people per room).[2] Basic infrastructure in new and established housing sites is developed 'incrementally' (enable housing construction through infrastructure upgrade and provision of formal title) by the Government of Guyana (GOG), an approach supported through two positively-evaluated IDB operations, the Low-Income Settlement Programs (LISP) I and II. However, despite the gains made, an estimated 249.5 km of roads and associated drainage—critical for flood management—still need to be completed to improve the living conditions of over 32,000 households, according to Guyana's main urban development authority, the Central Housing and Planning Authority (CHPA). Census data show that these deficits also occur in large non-CHPA Georgetown

1 Guyana Bureau of Statistics. 2012 Census Data.
2 2012 Census.

villages, such as Durban Area, Industrial State, and East La Penitence. Finally, the country has limited state capacity for adaptation, particularly at the local level. Maintenance of public infrastructure is the responsibility of the local Neighborhood Democratic Councils (NDC), which lack sufficient institutional capacity for long-term site management.[3]

1.3. The costs of maladaptation could be staggering for Guyana: in a 2009 report, the Economics of Climate Adaptation Working Group noted that, by 2030, annual losses resulting from flooding could reach $140 million. If hit by a single extreme event comparable to the floods that affected the capital in 2005, by 2030 additional losses could amount to US$1billion for the Georgetown area alone—more than a third of national GDP.[4] In this context, targeted investments in climate-ready infrastructure should be combined with improved land use and territorial planning, particularly for large urban areas along the coast.

1.4. In order to tackle the housing and spatial challenges and to reduce the vulnerability of urban and peri-urban Georgetown, the GOG requested the IDB to support the country with the Adequate Housing and Urban Accessibility Program (GY-L1031). GY-L1031 is a proposed reformulation of the "Road Network, Upgrade and Expansion Program." The objective of the reformulated operation is to improve the quality of life in urban and periurban Georgetown through better access to adequate housing and basic infrastructure for low-income populations, and through improved accessibility and mobility services. The reformulated program has two main components. Component 1 seeks to deliver quality housing and basic infrastructure solutions to low-income populations, through subsidies for upgrading and construction of climate-ready infrastructure and environmentally and socially vulnerable areas. Component 2 will finance the expansion and rehabilitation of Georgetown's main road axis, the Sheriff-Mandela road, with a special focus on sustainable mobility and accessibility. In both cases, the GOG and the Bank are committed to identifying and implementing climate-ready designs, and exploring the potential for complementary sustainable infrastructure solutions, including green infrastructure. To achieve this, the GOG needs updated and granular information on the vulnerability profile of Georgetown's territory, and to develop locally-appropriate plans and design proposals based on this information.

1.5. In this regard, the Bank requires a consulting firm to develop two planning proposals of climate adaptation projects and conduct the needed technical studies that strengthen these proposals as support to the preparation and execution of the Adequate Housing and Urban Accessibility Program (GY-L1031). The consulting firm will (i) prioritize and formulate climate-ready infrastructure interventions; (ii) analyze the expected benefits of these interventions; (iii) prepare detailed planning proposals; and (iv) prepare funding

[3] Guyana is divided into 10 regions, each of which is composed of local Neighborhood Democratic Councils—the smallest local-level administrative unit.

[4] Cited in Mycoo, M., "Autonomous Household Responses and Urban Governance Capacity Building for Climate Change Adaptation: Georgetown, Guyana," 2014.

proposals for international assistance funds to implement the planning proposals interventions.

1.6. The Bank will provide the consulting firm the baseline information on climate risk and historic urbanization in Georgetown, which is developed within the same Program. This baseline information is needed to start this consultancy and includes (i) a greenhouse gas inventory including a roadmap for mitigation options; (ii) an assessment of disaster risk and vulnerability to the negative impacts of climate change, which will propose measures to reduce risk and vulnerability; and (iii) an analysis of the urban footprint that studies the historical growth of the city and models long term growth scenarios and will provide public policy recommendations for sustainable urban growth.

2. Objectives

2.1. The overall objective of this consultancy is to develop planning proposals of climate adaptation projects with the aim to promote the sustainable and resilient development in Georgetown, Guyana. The specific objectives of this consultancy are to:

a) Formulate strategic solutions and climate-ready infrastructure interventions based on the baseline information, in line and in direct coordination with the proposed infrastructure works included in GY-L1031.
b) Analyze expected benefits to the users and beneficiaries within the projects' lifetime and the contribution of climate-ready infrastructure interventions to the economic and social development of Georgetown through economic studies (e.g. cost-benefit analysis).
c) Formulate planning proposals for the adaptations including broken-down project costs, detailed activities and implementation schedules and terms of reference for technical (pre-)engineering designs of the interventions, as well as project-specific environmental and social impact assessments, as relevant.
d) Prepare funding proposals for international assistance funds to finance or co-finance (part of the) climate resilient interventions previously identified for Georgetown city with the aim to promote the sustainable and resilient development.

3. Key Activities

3.1. All activities described herein shall be performed in close cooperation with the IDB. The consulting firm shall keep in mind that the activities and tasks described herein cannot be considered as the complete and comprehensive description of the firm's services and duties. It is rather the firm's responsibility to critically verify the scope of the services indicated herein, and to propose modifications in the proposal wherever the firm deems it necessary according to the professional judgment and the knowledge that the firm will acquire during the preparation of the proposal. It is understood that the firm shall perform all the activities as necessary to fulfill the objective of the Consultancy Contract.
The firm shall carry out the next activities:

A. Prioritization of the baseline information recommendations

a) **Compile and Review Available Information.** The Bank will share with the firm the baseline information that was prepared for this Program, which includes hazard, vulnerability and risk maps for inland and coastal flooding for 25, 50 and 100 year-return periods. Compile and review information available from private and public sources, to the extent feasible, which will provide an understanding of the physical conditions and flood risks of the project area, including topography, geologic and geotechnical characteristics, surface and groundwater hydrology, and drainage conditions.

b) **Collect and Develop Site-Specific Data.**
   i. Information on the characteristics and values of exposed assets (physical, economic, and social).
   ii. Land use information.
   iii. Geological and geotechnical data.
   iv. Relevant biodiversity information.
   v. Sediment particle sampling (20 samples).

c) **Analyze Information, Conduct Site-Specific Risk Analysis and Write Pre-Design Report.** Analyze the information gathered and the data generated in the above tasks (3 a) and 3 b)) and conduct a risk analysis for the project area. This includes the following:

   i. **Estimate the probabilistic occurrence of hazards**. Prepare a 2D hydraulic analysis of the flood risk in the study area for a 25, 50 and 100 year-return period, using historical flood events to calibrate and adjust results. This step will include de-archive FLOD-2D, SWAT or better, updating the system with new information, conducting tests and validating results. The consulting firm will also need to establish HEC-RAS or better for drainage canal, interface with FLO-2D, SWAT or better.
   ii. **Climate change impact assessment on local hydrology with an emphasis on major floods**. Taking as a reference the standard hydrological study and the probabilistic study on hazards occurrence mentioned above, the consultant will undertake additional analytical work to assess the impacts of climate change on local hydrology throughout:

      a. The revision and update of existing IDF curves (intensity-duration-frequency) for use by the city of Georgetown. To this aim, the consultant will use a non-parametric K-nearest Neighbor weather generator algorithm operating on a daily time step to synthetically create long time series of weather data. For the analysis, two climate scenarios could be used; the first is the historic climate change scenario used to reshuffle and perturb observed data. The second could be a wet scenario used to modify observed record according to regionalized climate model simulation outputs. Results of this analysis include tabular and graphical representation of updated IDF curves for Georgetown.

(results will be generated for return periods of 5 ,10, 25, 50, 100 and 250 years).

b. The generation of average hydrographs for downscaled regional climate model´s projections for the 2020s, 2050s and 2080s time horizons and the baseline for Georgetown. The document generated should contain a discussion of results and recommendations to the use of data generated in the design phase of infrastructure for the protection of the city of Georgetown. It is highly recommended to use different (at least 3) regional climate models (e.g. HadCM3, CCSM3.0, ECHAM5, CSIRO, CCCMA, among others).

iii. **Assess the probable damages to assets and estimate risk.** Assess the damages to assets within the project area based on the probabilistic occurrence of flood-related hazards, annual risk exposure (vulnerability), and asset values. Estimate the net present value of future annual-risk exposure values to understand the total risk the project area faces. The consulting firm will clarify which vulnerability function will be used for the probabilistic risk assessment.

iv. **Risk maps.** Develop site-specific risk maps for inland and coastal flooding. Write a report that includes an analysis on site-specific risks, and an engineering analysis, complete with identification of design issues and needs for adaptation measures

B. **Prepare a quantitative cost-benefit analysis to compare adaptation measures options**

a) Elaborate conceptual designs and assess parametric costs of adaptation measures.
b) Conduct a cost-benefit analysis for the adaptation measures based on the feasibility studies.
c) Develop Alternative Conceptual Designs. Based on the previous activities, develop three conceptual design alternatives for Georgetown adaptation measures - green infrastructure, and drainage system - based on the probabilistic risk scenario for the return periods of 25, 50 and 100 years of the current hazard and 2050 CC scenario. Examine and quantify green alternatives to supplement “hard” adoption measures (e.g. local scour, erosion). It is critical that conceptual designs maximize biodiversity benefits and minimize potential impacts on local vegetation.

   Furthermore, assess the impact of the different design options on reducing flood risk exposure of communities and business. Determine potential beneficiaries and clearly identify project outputs and outcomes.

   Provide parametric cost estimates for each alternative and conduct a cost-benefit analysis (CBA) to compare options under each probabilistic risk scenario for the return periods of 25, 50 and 100 years of the current hazard and 2050 CC scenario.
d) Identify biodiversity measures to be implemented as green infrastructure, and assess direct and indirect benefits.
e) Prepare a quantitative cost-benefit analysis to compare adaptation measures options.

C. **Prepare at least two planning proposals for the identified climate adaptation projects**

a) Provide detailed project descriptions including the activities or components, implementation schedules, costs estimate of each adaptation project,
b) Prepare bidding documents for final engineering designs for the adaptation measures.
c) Building on the Environmental and Social Analysis undertaken the context of GY-L1031, undertake project specific impact environmental and social impact assessments for the identified projects (green infrastructure and drainage system) based on the pre-engineering designs, and prepare project specific measures to be addressed in the final engineering designs and an Environmental and Social Management Plan.
d) Conduct a gap analysis of national standards and regulations (e.g. Environmental impact assessment legislation, coastal management regulations, building codes, etc.) in case of absence of a regulatory framework and make relevant recommendations.

D. **Prepare funding proposals for international assistance funds to finance or co-finance (part of the) climate resilient interventions**

a) Evaluate the availability of relevant international sources of climate-related financing, such as the Green Technology Fund and the Green Climate Fund, and determine alignment.
b) Verify eligibility and other criteria applied to Guyana.
c) As relevant, prepare a draft proposal for each of the proposals, in order to advance with the application to the selected fund(s), to be submitted by the IDB as accredited agency.

4. Expected Outcome and Deliverables

The consulting firm must submit the following products:

a) A detailed Work Plan with timeframe, the organizational structure of the working team, and methodologies that will be applied;
b) First Report (pre-design reports) including the results of Activity A;
c) Second Report including the results of Activities B and C;
d) Final Report (overall synthesis), including at least one funding proposal for international assistance funds to finance or co-finance climate resilient interventions.

The firm must submit all the relevant raw calculation data (excel sheets, shape files, etc.) associated with the study. Every report must be submitted to the Bank in an electronic file and editable format. The report should include cover, main document, and all annexes. Zip files will not be accepted as final reports, due to Records Management Section regulations.

5. Reporting Requirements and Supervision

The contract includes the preparation of the following:

a) Work Plan, within the first week of the contract, containing the time frame, organizational structure of the team, and methodologies that will be applied;
b) First Report, within the first two months of the contract, including the prioritization of the baseline information recommendations;
c) Second Report, within the first four months of the contract, including the results of a quantitative cost-benefit analysis and comparison and selection of several adaptation measures options;
d) Final report, at the end of the contract.

Supervision of the contract will be the responsibility of the Bank, through the coordination team of the Housing and Urban Development Division.
Division Leader or Coordinator: Patricio Xavier Zambrano Barragán pzambrano@iadb.org (CSD/HUD)

6. Other Requirements

The consulting firm must have at least 15 years of experience. Team members must have strong analytical skills and ability to develop probabilistic disaster risk assessments as well as susceptibility and impact analysis; ability to incorporate climate change scenarios into such assessments and analysis; demonstrated working experience in the creation, processing and analysis of spatial data sets in the context of disaster risk management; ability to identify and analyze causes and consequences of vulnerability; ability to develop risk reduction actions and strategies including both engineering and socioeconomic aspects.
The project manager must hold a Master's degree in applied sciences, engineering, or related areas, and should have at least 10 years of professional experience in probabilistic disaster risk assessments and climate change adaptation in an urban context. Key personnel must have expertise in biodiversity; public engagement and participatory design; and hazard and risk assessment and related disciplines including hydrology, coastal engineering, geology, and experience in GIS applications.
In addition, the project team should include an international engineer with at least 10 years of experience in developing risk-reduction and/or climate change adaptation projects, and must be familiar with international best practices. The members of the team should have a minimum combined experience of 20 years in the subject area.

7. Characteristics of the Consultancy

a) Consultancy category and modality: Lump Sum
b) Contract duration: 8 months
c) Place(s) of work: External consultancy, with at least three field visits to Georgetown, Guyana are required.
d) Division Leader or Coordinator: Zambrano Barragán, Patricio Xavier (CSD/HUD).

8. Schedule of Payments

8.1. The IDB Official Exchange Rate indicated in the RFP will be applied for necessary conversions of local currency payments.

8.2. Payment will be made according to the following schedule, provided the prior approval and total satisfaction of the IDB of the following products:

Payment Schedule	
Deliverable	**%**
1. Upon signature of contract and approval of the work plan	15 %
2. Upon submission, the First Report	25 %
3. Upon submission of the Second Report	30 %
4. Upon submission of the third and final Report.	30 %
TOTAL	100%

Inter-American Development Bank
ORP/GCM

PROCUREMENT PLAN FOR BANK EXECUTED OPERATIONS

Country: Guyana | **Executing Agency: IDB** | **UDR: CSD**

Project number: GY-T1137 | **Title of Project: Climate Resilience Support for the Adequate Housing and Urban Accessibility Program in Georgetown, Guyana**

Period covered by the Plan: 48 months | **Total Project Amount:** $ 500,000

Component	Procurement Type (1) (2)	Service type (1) (2)	Description	Estimated contract cost (US$)	Selection Method (2)	Type of Contract	Source of Financing and Percentage				Estimated date of the procurement notice	Estimated contract start date	Estimated contract length	Comments
							IDB/MIF		Other External Donor					
							Amount	%	Amount	%				
Component 1	A. Consulting services	Consulting Firm (GN-2765)	Consultant 1: Assessment of Climate Risk and Urban Growth	$ 300,000	FCS	Lump Sum	$ 300,000	100%	$ -	0%	1-Feb-18	1-May-18	6 months	
Component 2	A. Consulting services	Consulting Firm (GN-2765)	Consultant 2: Development of planning proposals for climate adaptation projects	$ 200,000	SCS	Lump Sum	$ 200,000	100%	$ -	0%	1-Aug-18	1-Feb-19	10 months	
Prepared by:			**TOTALS**	**$ 500,000**			**$ 500,000**	**100%**	**$ -**	**0%**				

(1) Grouping together of similar procurement is recommended, such as publications, travel, etc. If there are a number of similar individual contracts to be executed at different times, they can be grouped together under a single heading with an explanation in the comments column indicating the average individual amount and the period during which the contract would be executed. For example: an export promotion project that includes travel to participate in fairs would have an item called "airfare for fairs", an estimated total value od US$5,000, and an explanation in the Comments column: "This is for approximately four different airfares to participate in fairs in the region in years X and X1".

(2) (i) **Individual consultants:** ICQ: Individual Consultant Selection Based on Qualifications; SSS: Single Source Selection. Selection process to be done in accordance with AM-650.

(2) (ii) Consulting firms: Per GN-2765-1, Consulting Firm selection methods for Bank-executed Operations are: Single Source Selection (SSS); Simplified Competitive Selection (<=250K) (SCS); Fully Competitive (>250K) (FCS); and Framework Agreement Task Order (TO). All Consulting Firm selection processes under this policy must use the electronic module in Convergence.

(2) (iii) Goods: Per GN-2765-1, par. A.2.2.c: "The procurement of goods and related services, except when such goods and related services are necessary to achieve the objectives of the Bank-executed Operational Work and are included in the consulting services contract and represent less than ten percent (10%) of the consulting services contract value."

CLIMATE RESILIENCE SUPPORT FOR THE ADEQUATE HOUSING AND URBAN ACCESSIBILITY PROGRAM IN GEORGETOWN, GUYANA

GY-T1137

CERTIFICATION

I hereby certify that this operation was approved for financing under **Ordinary Capital Strategic Development Program for Sustainability (SUS)** through a communication dated September 29, 2017 and signed by Jane Silva (ORP/GCM). Also, I certify that resources from said fund are available for up to **US$500,000** in order to finance the activities described and budgeted in this document. This certification reserves resource for the referenced project until December 13th, 2017. If the project is not approved by the IDB within that period, the reserve of resources will be cancelled, except in the case a new certification is granted. The commitment and disbursement of these resources shall be made only by the Bank in US dollars. The same currency shall be used to stipulate the remuneration and payments to consultants, except in the case of local consultants working in their own borrowing member country who shall have their remuneration defined and paid in the currency of such country. No resources of the Fund shall be made available to cover amounts greater than the amount certified herein above for the implementation of this operation. Amounts greater than the certified amount may arise from commitments on contracts denominated in a currency other than the Fund currency, resulting in currency exchange rate differences, represent a risk that will not be absorbed by the Fund.

CERTIFIED BY: *Original Signed* — *11/28/2017*

Sonia M. Rivera
Division Chief
Grants and Co-Financing Management Unit
ORP/GCM

Date

APPROVED BY: *Original Signed* — *11/29/2017*

Tatiana Gallego Lizon
Division Chief
Housing and Urban Development Division
CSD/HUD

Date