RESILIENT L AND USE AND DEVELOPMENT PLANNING FOR DOMINICAN REPUBLIC MUNICIPALITIES

A Resource Notebook for Integrating Climate Change Considerations

USAID FROM THE AMERICAN PEOPLE

ICMA

ICF

FEDOMU
FEDERACIÓN DOMINICANA DE MUNICIPIOS

This publication is made possible by the generous support of the American people through the United States Agency for International Development (USAID) cooperative agreement number AID-517-A-15-00003. The contents are the responsibility of ICMA and ICF and do not necessarily reflect the views of USAID or the United States Government.

CONTENTS

CONTENTS

ACKNOWLEDGMENTS

This document is the culmination of three years of hard work by many different individuals and organizations as part of the USAID-funded Planning for Climate Adaptation Project implemented by ICMA in partnership with ICF, FEDOMU and INTEC. We are grateful to all who contributed their time, knowledge, expertise and love to this effort. Our hope is that this Notebook will provide comprehensive guidance to planners in the Dominican Republic, in order for them to facilitate climate adapted land-use planning processes as a mean to more sustainable and resilient development of Dominican municipalities.

Thanks to Joanne Potter, Molly Helmuth, Tara Hamilton, Angela Wong, and Charlotte Cherry of ICF for their initiative to put onto paper the incredible knowledge that they collectively possess on how to incorporate climate change into planning processes. And especially we thank the late Mike Savonis for his vision and initiative.

The ICF team complemented its knowledge with a great many trips to the Dominican Republic in support of the Project and the enthusiastic partnership of the four pilot cities (National District, San Pedro de Macorís, Santiago and Las Terrenas) which served as training ground for this initiative, as well as our partner the Dominican Federation of Municipalities, FEDOMU. The resulting document will enable Dominican planners, climate change/resilience experts, local government officials and staff, and committed individuals from all disciplines to lead, promote, or participate in resilient land use and development planning. The success of the overall Project, and the Notebook as one of its key legacies, would not have been possible without the leadership of the Project Director, Indhira De Jesus and the contributions of every member of the ICMA Dominican Republic Team – Susana Batista, Andrés Cepeda, Erick Dorrejo, Laura Mejía, Alejandro Herrera Moreno and Andrea Vogel. Special thanks go out to Alejandro Herrera Moreno for his dedication to and enthusiasm for the issue of climate resilience and land use planning and for tirelessly working to ensure that the Notebook becomes a relevant, easy to use guide and reference for anyone wanting to make their communities more resilient as they plan for growth and development.

Finally, credits go to Jenny Ortiz Paniagua and her team for the extraordinary effort to design and diagram this Notebook.

Isabelle Bully-Omictin
Director, Latin American/Caribbean Programs
ICMA

INTRODUCTION

Welcome to the *Climate Change Integration Notebook for Land Use Planning*! *This Notebook* is a companion resource to the *Methodological Guide for the Formulation of Municipal Land Use Plan* published by the Ministry of Economic Planning and Development (MEPyD) and the Ministry of Economy, Planning and Development (DGODT) in 2016. The *Notebook* and the accompanying tools and resources will help you organize and use climate information as you develop your land use plans so that you can identify the risks you should consider and address during the planning process. The *Notebook* can also help you to integrate climate change factors into other municipal planning and decision making, such as in your municipal development planning process.

WHO SHOULD USE THIS *NOTEBOOK*?

This *Notebook* is designed for professional staff or technical consultants who are leading or supporting a municipal land use planning process or the development of a municipal development plan. Information in the *Notebook* will also be useful to municipal staff and decision makers, policy makers, and stakeholders who want to better understand the relationship between climate change and municipal decisions. Some municipalities may have the staff capacity to use these tools and resources directly. Other municipalities may decide to obtain additional technical support.

WHAT DOES THE *NOTEBOOK* CONTAIN?

In this *Notebook* you will find:

- An overview of **Key Concepts** about climate change and the future of our cities
- **An Integration Roadmap** that shows the entry points for climate information into the land use planning process
- A **Process Timeline** that illustrates how a typical integrated land use planning process takes place over time
- **Stage-by-Stage Instructions** on how to integrate climate change into each stage of the land use planning process
- **Assessment and Planning Tools** to help you implement the steps in each Stage (Annex I)
- **Additional Resources** that may be useful (Annex II)

The printed version has page numbers for key references within the *Notebook* and color coding to help you navigate through the document. The web-based version contains embedded hyperlinks that allow you to search easily for the information you need.

WHERE DO I START?

Where you start depends on what stage of planning you are conducting. Your municipality may have already completed some of the activities discussed in this Notebook. Start with the section that is relevant to you now. You may find it useful to flip through all the instructions to provide context. You can return to earlier sections as needed.

HOW DO I USE THE STAGE-BY-STAGE INSTRUCTIONS?

This *Notebook* is designed in a modular, "cookbook" format that allows you to turn to the specific section that relates to the stage of planning in which you are involved. The Stage-by-Stage Instructions sections align with the seven stages and related steps of the *Guía Metodológica para la Formulación del Plan Municipal de Ordenamiento Territorial* (PMOT Guide). You will want to have the PMOT Guide handy and refer to it as you use this *Notebook*. The I**ntegration Roadmap** shows the land use planning stages and steps, and associated climate change integration guidance, covered in each section; the relevant section of this Roadmap is repeated at the start of each section.

- Begin with any section you choose, depending on what work you have already accomplished and what information you need to complete your land use plan. In each section you will find directions and information to help you complete that work.
- This icon will alert you to the tools in Annex I you can use to complete the activities described in that section, and this icon will indicate the resources you can find in Annex II.
- Each section closes with a simple checklist to help you confirm that you have accomplished the stage's objectives.

Stage 1: Institutional Organization
Step 1. Build political consensus
Step 2. Establish a technical team
Step 3. Design a work plan
Step 4. Conduct technical review of the work plan
Step 5. Design map of actors
Step 6. Disseminate, communicate, and motivate

Stage 2: Territorial Diagnosis
Step 1: Delimit the municipality
Step 2: Analyze the municipal context
Step 3: Analyze the municipal territory
Step 4: Identify critical themes and vulnerabilities

Stage 3: Territorial Prospective
Step 1. Develop municipal vision
Step 2. Construct municipal scenarios
Step 3. Formulate objectives and guidelines

Stage 4: Programming
Step 1. Zone preferred uses
Step 2. Develop policies, plans, programs, and projects
Step 3. Produce regulations

Stage 5: Design of Implementation Strategy
Step 1. Organize the implementation team
Step 2. Disclose results of plan with stakeholders and the public
Step 3. Install the municipal territorial information and management system

Stage 6: Design of Evaluation System
Step 1. Produce reports of the territorial management committee
Step 2. Produce progress reports of the inter-institutional coordination table
Step 3. Produce reports on PMOT implementation

Stage 7: Formalization
Step 1. Validate
Step 2. Certify
Step 3. Approve

KEY CONCEPTS ABOUT CLIMATE CHANGE AND THE FUTURE OF OUR CITIES

Many municipalities are paying more attention to how climate change is affecting their physical vulnerabilities and the health and safety of communities. Extreme weather events and longer-term impacts of climate change are taking an increasing toll in many areas of the world, including the Dominican Republic. In fact, island nations such as the Dominican Republic are often at higher risk for climate change impacts. Climate change may affect sea level height, storm activity, temperature, and precipitation patterns in your region, for example. Every community is unique—and climate change will have specific implications depending on your location, topography, and development patterns.

WHY CONSIDER CLIMATE RESILIENCY IN LAND USE PLANNING?

Considering climate change during your land use planning process helps your municipality understand how climate change may influence local land use patterns now and in the future. You can examine the connections between existing physical and social vulnerabilities and changes in climate. Assessing and accounting for these climate vulnerabilities when you design land use policies and practices—and addressing these risks as you decide how and where your community will grow—makes good sense to ensure a sustainable future.

WHY CONSIDER CLIMATE RESILIENCY IN MUNICIPAL DEVELOPMENT PLANS?

Climate change may affect not only the physical development of your municipality but your economic and social development as well. Municipal development plans document current conditions and project future demographic changes and development and economic trends to create a path forward that will meet the needs of your city as it grows. Your municipal development plan establishes a common vision for your community and documents the agreed-upon goals, objectives, and strategies for achieving this vision. By considering how climate change may affect specific development decisions in your community and integrating resilience concerns into your planning process, your municipality is more likely to achieve its vision for the future.

WHAT DO WE MEAN BY "INTEGRATION" OF CLIMATE CHANGE?

Assessing how climate change will affect the future of your city is not a separate process. Rather, understanding what climate conditions will be like in the future gives you important additional information that helps you ensure that the decisions you make are as strong as they can be to achieve a sustainable municipality. Thinking about climate risks up front can help you avoid making costly plans and investments that may not withstand future climate conditions. Further, smart land use and development decisions can help you reduce the risks of climate change impacts. By integrating climate change into the earliest stages of your planning process, you avoid duplicating effort and have the best opportunity to take proactive action.

WHY THINK ABOUT COMMUNITY PARTICIPATION?

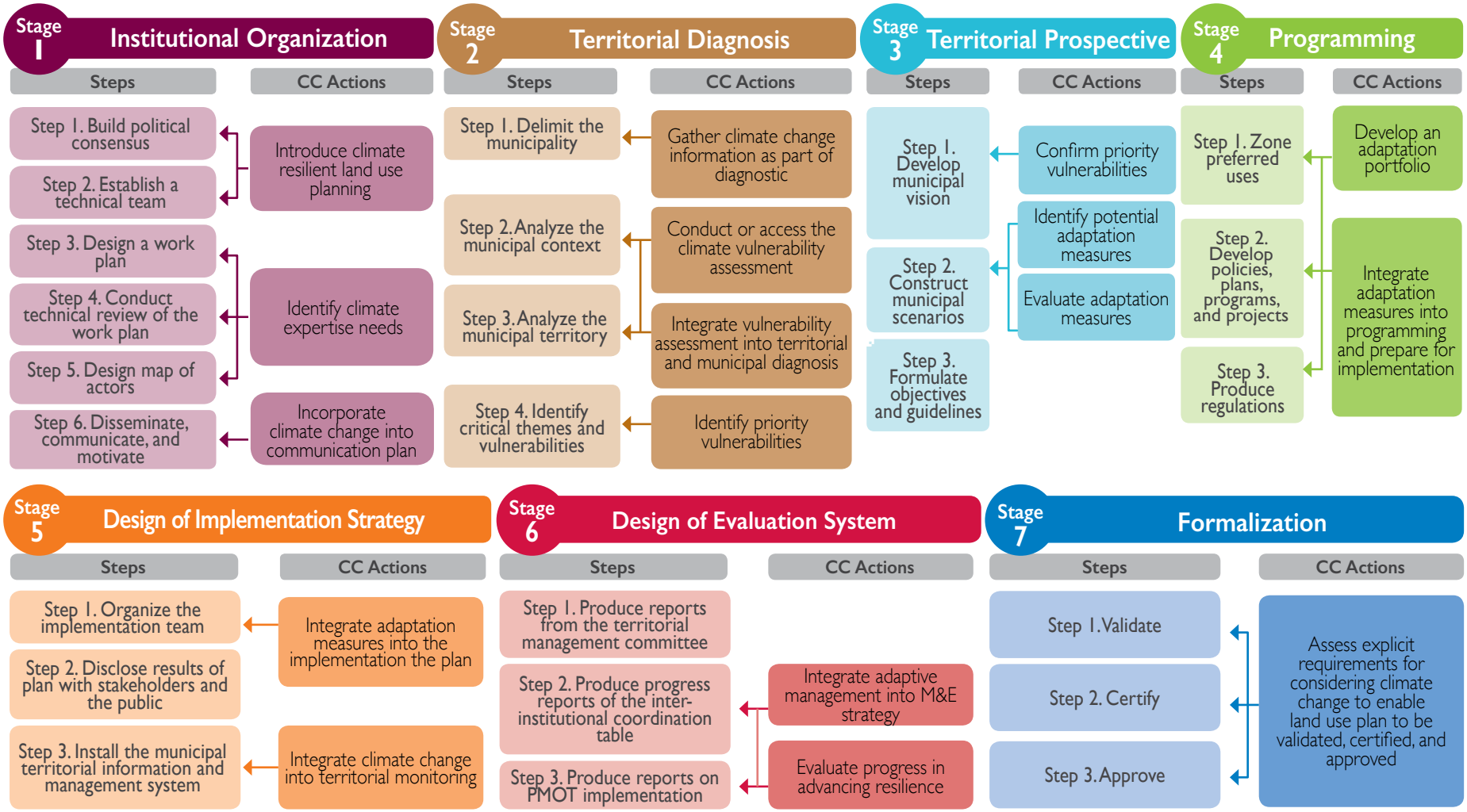
Every municipality includes a wide variety of communities, businesses, and stakeholders with different interests and experience. Planning includes analysis of the future needs of all of these constituencies. Encouraging all segments of your community to participate actively in the planning process will ensure a broad range of input on community needs. Further, community members bring a wealth of observations and local knowledge about specific on-the-ground vulnerabilities and impacts that can help you develop a more complete and accurate assessment of the issues facing your municipality. They have valuable ideas and insights about how these problems can be addressed. Community participation can help ensure your plan balances all stakeholder needs, taps the creativity and expertise of the entire community, and has broad support.

WHAT IS THE IMPORTANCE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN THE LAND USE PLANNING PROCESS?

Mapping is an essential part of land use planning. Municipalities must develop Geographic Information Systems (GIS) or establish alliances with institutions that have the capability to do so. During the process of preparing the Land Use Plan, GIS will allow a municipality to integrate, store, edit, analyze, share and display geo-referenced information. This will allow a municipality to create interactive queries, analyze spatial information, edit data, maps and present the results of any of the steps of the land use planning process in a way that will enable more effective decision-making.

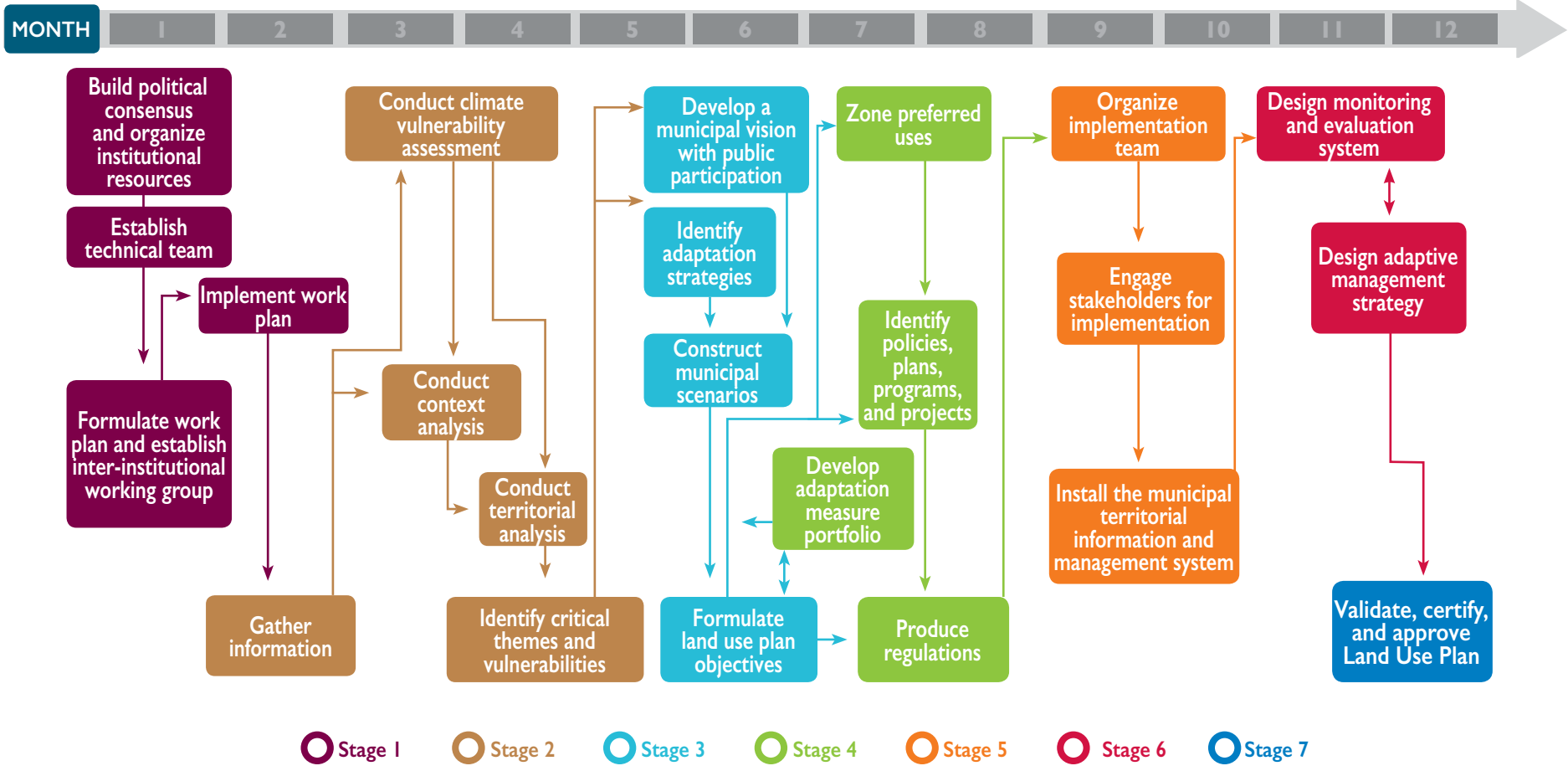
AN INTEGRATION ROADMAP: INTEGRATING CLIMATE CHANGE INTO YOUR MUNICIPAL LAND USE PLAN

This roadmap depicts the stages and steps of land use planning and shows the points where you can integrate climate change into each stage. You will see the relevant excerpt of this roadmap at the start of each section, along with a list of the tools and resources included in the annexes of the *Notebook* that you can use to integrate climate change adaptation considerations during each stage.



PROCESS TIMELINE

How long will your process take? This timeline provides the sequence of stages and steps covered in this *Notebook* and a general estimate of when steps will be completed over a 12-month span. The timeline also indicates strategic points throughout the process to schedule technical team and working group meetings. You can use this timeline as a starting point and adjust it to meet your municipality's needs and decision timeframe. Remember to incorporate the necessary time for training (on climate change, planning or other topics), when required.

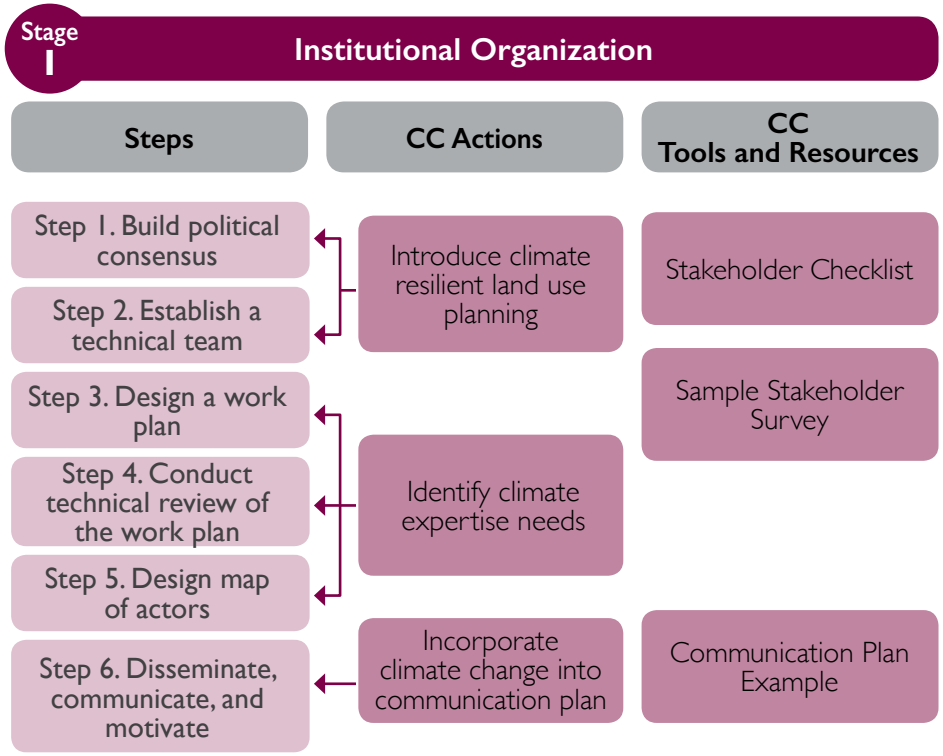


STAGE-BY-STAGE
INSTRUCTIONS

STAGE I

INSTITUTIONAL ORGANIZATION

Stage 1: Institutional Organization



Climate Change Integration Goal: Create a work plan and team that allows you to address climate change as part of land use planning.

In Stage 1, you lay the groundwork for a comprehensive, accurate, and implementable land use plan. You build a framework and design the processes to ensure that the ultimate land use plan is well thought out, that it reflects the input of community members and other stakeholders, and that it is complete. During this stage, you develop a work plan to guide you and the working groups through the process.

Why integrate climate change considerations? It is important to think about climate change capabilities at the earliest steps of the planning process to ensure you will have the skills you will need throughout your work. Including individuals who understand and have expertise in climate change and resilience in the formulation process, both in decision making and at the technical level, will help to ensure that climate change is integrated into the land use planning process.

STEPS TO INTEGRATE CLIMATE CHANGE INTO STAGE 1

Take the following steps to help you successfully integrate climate change into your land use planning process.

Introduce climate resilient land use planning

Climate-resilient land use planning is likely to be a new concept to many of the individuals engaged in the process. Therefore, it is necessary to discuss the value of considering climate change with your working group members and stakeholders, and gain buy-in to an integrated approach. Consider organizing a brief orientation to climate change concepts, and how they relate to land use planning, as part of an early working group meeting and outline the specific steps in the work plan where climate information will be important to take into account. You can begin introducing climate change into the land use planning process in Steps 1, 2, and 3 of Stage 1 as you build consensus, establish a technical team, and develop the work plan.

Identify climate expertise needs

To ensure that climate change and resilience is thoroughly considered in your planning process, you will want to think about the types of climate information you may need and recruit individuals with that knowledge to participate on the technical team you convene under Step 2. You may want to conduct a stakeholder mapping exercise to help you lay out key categories of stakeholders and their roles and responsibilities (Step 5), including participants with climate change expertise. This mapping can help you identify both the key players that will be engaged directly in the development of the land use plans (including the work plan development in Step 3), as well as the community members whose voices and local knowledge will lend the plan legitimacy and authenticity.

Stakeholders may include a diverse array of individuals and organizations, including from the private sector, government agencies, non-profit organizations, and neighborhood associations. To ensure that your group includes the expertise you will need to address climate resilience, consider engaging:

- Institutions with experience in climate risk management in the municipality (e.g., disaster prevention, mitigation and response committees, civil defense, Red Cross, or fire brigade)
- Technical advisors with sector-specific expertise (e.g., water, transportation, infrastructure and city planners, information and communications technology, and energy)
- Technical advisors with climate-related expertise (e.g., meteorologists, climate change adaptation experts, disaster risk managers, and greenhouse gas mitigation experts)

Technical advisory sub-committees can be developed to focus in on critical issues relevant to different infrastructure categories.

Consult the *Stakeholder Checklist (see page 191)* and *Sample Stakeholder Survey (see page 194)* in Annex II to help categorize the appropriate stakeholders in your planning process and identify climate expertise needs.

Engaging Critical Stakeholders in Las Terrenas

Tourism is the main driver for development in the municipality of Las Terrenas. Adaptation in this sector in particular requires engagement from a broad set of stakeholders, including the private sector, local citizens, utilities, and the national government. Las Terrenas worked to engage the full range of stakeholders in technical team and working group meetings to ensure their perspectives would be incorporated into adaptation planning. For example, a technical team meeting on findings from the territorial diagnosis and discussion of land use scenarios engaged representatives from DGODT and the Ministry of Tourism. The participation of this ministry is particularly important to help align the Ministry's land use plan, which regulates tourism development along the coast of Las Terrenas, with the plans of the municipality.

Incorporate climate change into communication plan

Communicating regularly with all stakeholders throughout the planning process promotes strong participation and helps generate support for the final plan. In Step 6, as you decide how you will communicate with your working groups, Advisory Council, and the broader public, decide how you will address climate change as part of this process. This may include:

- Developing a simple communication plan to help you effectively engage with the broader public and key stakeholders, including providing information about climate change
- Organizing a stakeholder working group that meets regularly, and designating a coordinator for this group; include presentations on climate change as part of working group meetings
- Engaging community members in surveys or "town hall" meetings to provide input on vulnerabilities to climate change and potential adaptation solutions

Consult the *Example Communication Plan (see page 199)* in the Stage I resources for ideas on developing an effective communication strategy, and incorporating climate change into that plan.

STAGE 1 RESOURCES

The climate change resources for Stage 1 that can be found in Annex II at the end of this *Notebook* are:

- **Stakeholder Checklist:** Use this list to help you develop and prioritize a list of stakeholders to engage during the land use planning process. Use in Stage 1, Steps 2, 3, and 5.
- **Sample Stakeholder Survey:** Use this to help collect information about stakeholders to gain an understanding of how they can best engage with the planning process. Use in Stage 1, Steps 2, 5, and 6.
- **Communication Plan Example:** This sample Public Participation Plan from Imagine Austin (Austin, Texas) shows how that community approached outreach and engagement throughout its planning process. Use in Stage 1, Step 6 and in Stage 5, Step 2.

STAGE 1 CHECKLIST

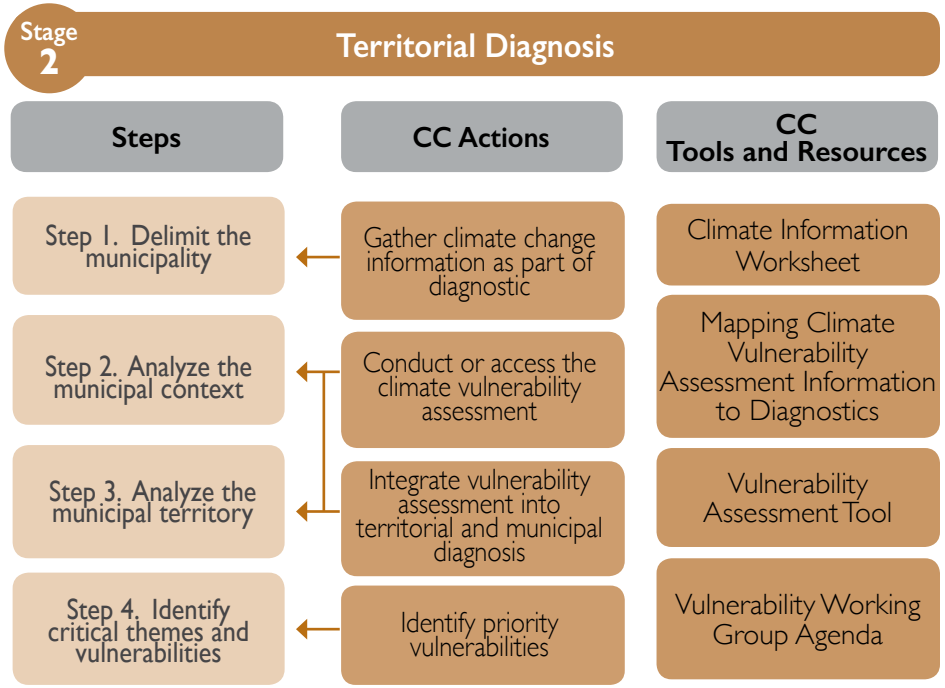
Have you conducted the following activities to incorporate climate change considerations into this stage of the land use planning process?

- ☐ Introduced the topic of climate change in the municipal arena to support building consensus.
- ☐ Designed a work plan that includes activities to consider climate change components.
- ☐ Included individuals with knowledge and expertise in climate and environmental issues on your technical team.
- ☐ Identified and mapped stakeholders/actors that represent a broad range of agencies, sectors, and community groups that have a stake in climate-related issues.
- ☐ Developed a communication plan for the development and implementation of the land use plan that includes how you will engage key stakeholders and the larger community on climate change issues.

Congratulations! Now that you have completed these activities, you are ready to move on to Stage 2.

STAGE 2
TERRITORIAL DIAGNOSIS

Stage 2: Territorial Diagnosis



Climate Change Integration Goal: Collect and analyze information to assess your municipality's climate change vulnerabilities.

In Stage 2, you "diagnose" your municipal territory to identify the overarching critical themes you want to address through the land use plan.

Why integrate climate change considerations? Thinking about climate change information as you conduct the territorial diagnosis is a more efficient use of the working group's time, and will result in a more complete picture of the challenges you face. During the diagnosis of the municipality and its broader geographic context you gather a range of information that you can also use to understand (or diagnose) how climate change may affect your area. These "diagnostics" include information about climate change stressors, drivers of change, important resources, economic activities, and municipal equipment and services. Understanding the environmental and development context of the territory is important because these factors will interact with, and may exacerbate, climate impacts. The information and data you collect provides the basis for an assessment of climate change vulnerabilities. You can use the *Climate Vulnerability Assessment Tool (see page 59)* in this *Notebook* to conduct this assessment, or use another approach. Once you have completed the vulnerability assessment, you directly integrate the results into the analysis of the municipal context, its territory, and critical themes.

What is a climate change vulnerability assessment? A climate change vulnerability assessment analyzes the extent to which municipal assets and people are susceptible to and/or unable to cope with the impacts of climate variability and climate change. A vulnerability assessment considers exposure to climate stress, sensitivity to that stress, and adaptive capacity. You can conduct a climate change vulnerability assessment to help inform the territorial diagnosis and your land use planning process.

Key Concepts in Climate Change Vulnerability Assessment

Exposure: Whether, how, and how much people, livelihoods, species, ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets experience climate variability and change.

Sensitivity: The extent to which a system, asset, or species is positively or negatively affected when/if exposed to a climate stressor. The effect may be direct (e.g., a change in crop water consumption in response to temperature change) or indirect (e.g., damage to roads as a result of erosion due to an increase in severe coastal flooding and sea level rise). The more sensitive the asset, resource, or population is to one or more climate stressors, the more vulnerable it tends to be.

Adaptive Capacity: The ability of a system to respond successfully to climate variability and change by minimizing exposure and sensitivity.

Taken together, exposure, sensitivity, and adaptive capacity of people, assets, and systems characterize climate change vulnerability.

For example, a vulnerability assessment can be used to answer questions like:

- How vulnerable is my municipality's water supply to intense or sustained drought?
- How vulnerable is the primary road network to severe flooding events?
- How vulnerable are our marine fisheries to warming temperatures, increased storm activity, freshwater flooding, and ocean acidification?
- What geographic locations are most vulnerable to increases in sea level or storm surge heights?

STEPS TO INTEGRATE CLIMATE CHANGE INTO STAGE 2

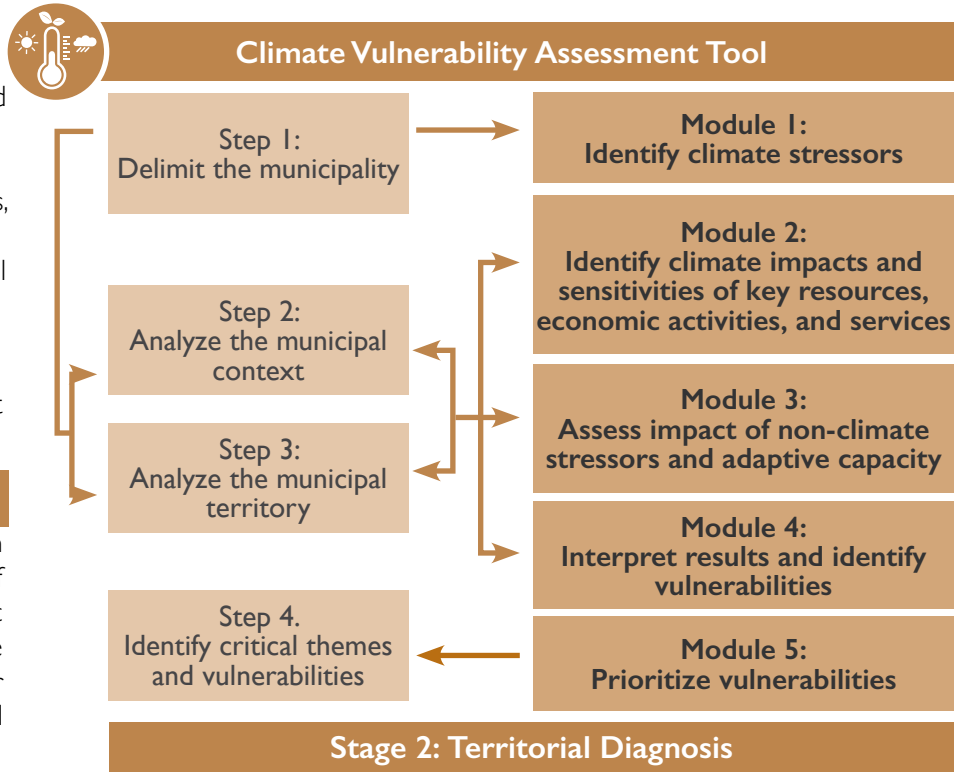
Take the following steps to collect and use climate change information as part of the territorial diagnosis.

Gather climate change information as part of the diagnostic

In Step 1 of the territorial diagnosis you collect relevant data, consult with stakeholders, and analyze a broad range of information and input. As part of this process, collect information on climate change, including both historic (observed) data and information about projected climate conditions. Use the *Climate Information Worksheet (see page 215)* in the Stage 2 resources for suggestions on the types of climate information you may want to collect, and where to find it.

Conduct or access the climate change vulnerability assessment

The *Climate Vulnerability Assessment Tool (see page 59)* provides a step-by-step approach to identifying how climate change may affect your municipality and region, and to identify priority vulnerabilities. Alternatively, you may have a vulnerability assessment that has already been conducted that you can use for the diagnostic process. The *Sample Vulnerability Working Group Agenda (see page 237)* in the Stage 2 resources may help you deciding how to conduct the climate change vulnerability assessment. You may also consult the *Mapping Climate Vulnerability Assessment Information to Diagnostics (see page 225)* to better understand how information gathered under Steps 2 and 3 for the diagnostics components can be applied to assess climate change vulnerabilities.



Integrate the vulnerability assessment into the municipal and territorial diagnosis

Next, you integrate the climate change vulnerability assessment information into the territorial and municipal diagnosis in Steps 2 and 3. In these two steps, you analyze three primary components of the municipality and the broader geographic area, using a set of diagnostics components that are specified in the PMOT Land Use Plan Guidance: environmental, social-economic, and spatial considerations. These diagnostics include information about the nature of economic activities, environmental characteristics and resources, and primary equipment and services. Consult the *Mapping Climate Vulnerability Assessment Information to Diagnostics (see page 225)* to better understand how climate change vulnerabilities can be integrated into the diagnostic components, and the municipal and territorial diagnosis.

Identify priority vulnerabilities

In Step 4, the final step of the diagnosis, you distill the information presented in the territorial and municipal diagnosis to identify the "critical themes and vulnerabilities" at municipal and territorial scales, by synthesizing the diagnostics to categorize key vulnerabilities and risks under each component. If you applied the *Climate Vulnerability Assessment Tool (see page 59),* take care to incorporate the identified priority vulnerabilities.

INCORPORATION OF GIS TO STAGE 2

In **Stage 2**, all existing maps need to be collected as part of the information gathering process, but it is really the subsequent steps of delimitation, municipal context analysis and municipal characterization which should result in a complete mapping of the environmental, socio-economic and spatial components of the municipality. All the services and sectors that are key to the functioning of the municipality must be identified and mapped during this stage. The factors that determine a municipality's vulnerability with respect to exposure (eg climate, topography and water resources), sensitivity (eg poverty) or adaptive capacity (eg community organization) should be integrated into the municipality's vulnerability map.

Building on Existing Work on Climate Risk and Adaptation Measures in Santiago de los Caballeros

Santiago de los Caballeros leveraged existing work on risk reports and sustainability action plans to look across the full range of climate risks and include future changes in climate. The climate change vulnerability assessment and adaptation planning built on the 2020 Strategic Plan developed by the municipality and the Council for the Development of Santiago (CDES), and on the Santiago Emerging and Sustainable Cities Action Plan developed by the Inter-American Development Bank, the municipality, and CDES. For instance, drought in recent years has resulted in water rationing in Santiago, particularly affecting domestic supply, hydropower availability, and crop irrigation, but water scarcity had not been evaluated and addressed in these plans. The vulnerability assessment evaluated recent and projected drought conditions and impacts and the working group identified additional adaptation measures to strengthen existing risk reduction measures. The working group identified adaptation measures to address drought by assessing future changes in precipitation patterns, land use adaptation interventions, adaptation measures for several sectors, and adaptation measures tailored for the municipal districts.

STAGE 2 TOOLS AND RESOURCES

The resources for Stage 2 provide guidance and training on how to assess both municipal and broader territorial climate change vulnerabilities and how to integrate these into your municipality's land use planning process.

These resources include the *Climate Vulnerability Assessment Tool* and other tools and worksheets to assist in the gathering of information and help carry out the vulnerability analysis.

The climate change tools and resources for Stage 2 that can be found in the annexes at the end of this *Notebook* are:

Annex I

- **Climate Vulnerability Assessment Tool:** A tool that takes municipal planners through a series of steps and checklists to identify climate change vulnerabilities of municipal and surrounding area populations, resources, economic activities, equipment and services. Use in Stage 2, Steps 2, 3, 4 and 5.

Annex II

- **Climate Information Worksheet:** A primer on how to gather information on climate change, including for a general or high-level assessment and a more detailed assessment. Use in Stage 2, Step 1.
- **Mapping Climate Vulnerability Assessment Information to Diagnostics:** A list of diagnostic information that can be used for a vulnerability assessment, as well as an indication of where climate change information and related climate impacts may be integrated into the municipal and surrounding area diagnosis. Use in Stage 2, Steps 1, 2, 3 and 4.
- **Sample Vulnerability Working Group Agenda:** This resource is a sample agenda for a working group meeting on vulnerability assessments. Use at any point during Stage 2.

STAGE 2 CHECKLIST

Have you conducted the following activities toward incorporating climate change considerations into this stage of the land use planning process?

- ☐ Gathered climate change-related data as part of the territorial and municipal diagnosis including consulting with stakeholders and analyzing a broad range of information and input.
- ☐ Introduced the concept of a climate change vulnerability assessment to the technical team and other stakeholders, and explained why it is important groundwork to complete prior to embarking on further land use planning activities.
- ☐ Conducted a climate change vulnerability assessment and integrated it into the territorial diagnosis.
- ☐ Identified and prioritized the vulnerabilities the municipality wants to focus on and address in the land use plan.

Congratulations! Now that you have completed these activities, you are ready to move on to Stage 3.

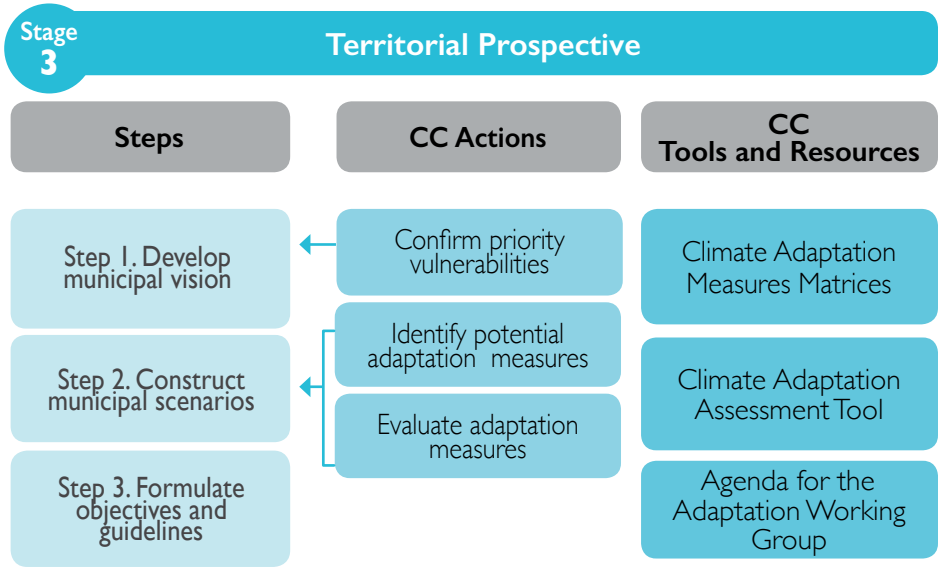
STAGE 3
TERRITORIAL PROSPECTIVE

Stage 3: Territorial Prospective

Climate Change Integration Goal: Identify a pool of adaptation measures to incorporate into scenario planning that addresses priority municipal vulnerabilities.

In Stage 3, you develop scenarios to better understand potential futures, so that you can define a collective future vision or pathway, and determine what actions are necessary in order to achieve this vision.

Why integrate climate change considerations? Climate adaptation can enhance your municipality's resilience by amplifying its capability to anticipate, prepare for, respond to, and recover from significant climate stressors with minimum damage. Adaptation planning helps to build your community's resilience by designing an organized path forward to develop and implement a portfolio of complementary adaptation strategies and measures.



STEPS TO INTEGRATE CLIMATE CHANGE INTO STAGE 3

Take the following steps to help you successfully integrate climate change considerations into your territorial prospective.

Confirm priority vulnerabilities

In order to identify adaptation measures, it is important that you have clearly articulated your vulnerabilities, and decided which of these vulnerabilities are most significant for your municipality (undertaken in Stage 2). If you have not identified these vulnerabilities, you may consult the *Climate Vulnerability Assessment Tool* in the Stage 2 tools *(see page 59)*, or the *Climate Adaptation Assessment Tool's* "Table 1: Priority Vulnerability Worksheet" in the Stage 3 tools in Annex I *(see page 92)*. These vulnerabilities can be used to inform the municipal development vision (Step 1).

Identify potential adaptation measures

Once you understand the priority climate vulnerabilities you face, the next step is to reduce those vulnerabilities by identifying a set of feasible adaptation measures that will address present and future climate risks. You can begin to identify these measures as you begin to formulate the municipal development vision under Step 1. When considering adaptation options it is best to think broadly—brainstorming a range of potential measures that can help increase your resilience. In addition, think about what actions you might take if a natural disaster occurs that results in significant destruction. How would you rebuild? Could there be opportunities associated with disasters to relocate people and assets to safer locations, and/or to build back better?

Use the *Climate Adaptation Assessment Tool's "Table 2: Adaptation Measure Description Worksheet" (see page 94)* in to help you with this process. You may also consult the *Climate Adaptation Measures Matrices (see page 104)* in the Stage 3 tools in Annex I, which includes lists of potential adaptation measures, to help you think about what options you may want to consider.

Evaluate adaptation measures

Once you have identified a broad range of adaptation measures, you then evaluate these possible adaptation options by considering how well they are likely to address the identified vulnerabilities, and fit with your municipal capabilities and objectives. Be sure to engage appropriate stakeholders to ensure that you have the right perspectives and expertise at the table when you conduct this evaluation. Use the *Climate Adaptation Assessment Tool's "Table 4: Evaluation Summary Worksheet"*—found in the Stage 3 tools in Annex I *(see page 97)*—to help you with this process.

Once you have identified potential adaptation measures deemed "appropriate to implement" in Table 4 in the *Climate Adaptation Assessment Tool,* you carry these measures into the construction of future ideal scenarios in Step 2 and develop objectives and guidelines applicable to these scenarios under Step 3.

You are likely to find that the selection of adaptation measures is an iterative process. As you move from developing the territorial prospective in Stage 3 and programming in Stage 4, you learn more about your municipality's needs and options, and have a better understanding of what actions are most feasible. As shown in the figure below, adaptation measures that involve land use will ultimately become part of your land use plan; measures that do not involve land use will be directed to the appropriate offices and staff within the municipality for them to integrate into their plans and programs (Stage 4 and 5). See the *Sample Adaptation Working Group Agenda (see page 241)* in Annex II for suggested discussion topics as you work with your team to integrate land use-related adaptation measures into scenarios.

Types of Adaptation Measures

There are a variety of ways to address climate change vulnerability and increase resilience.

- **Land use** measures can protect vulnerable locations, create buffer zones, and steer development to low-risk areas
- **Structural** measures involve engineered solutions to strengthen infrastructure, improve drainage, or create barriers to protect vulnerable areas and resources
- **Operations and maintenance** changes can help infrastructure stay in good condition and minimize damage and service disruption
- **Capacity building** helps municipal staff and communities to prepare for and manage severe climate events
- **Policies and programs** provide standards, regulations, and incentives to ensure climate-smart development and raise awareness about climate change.

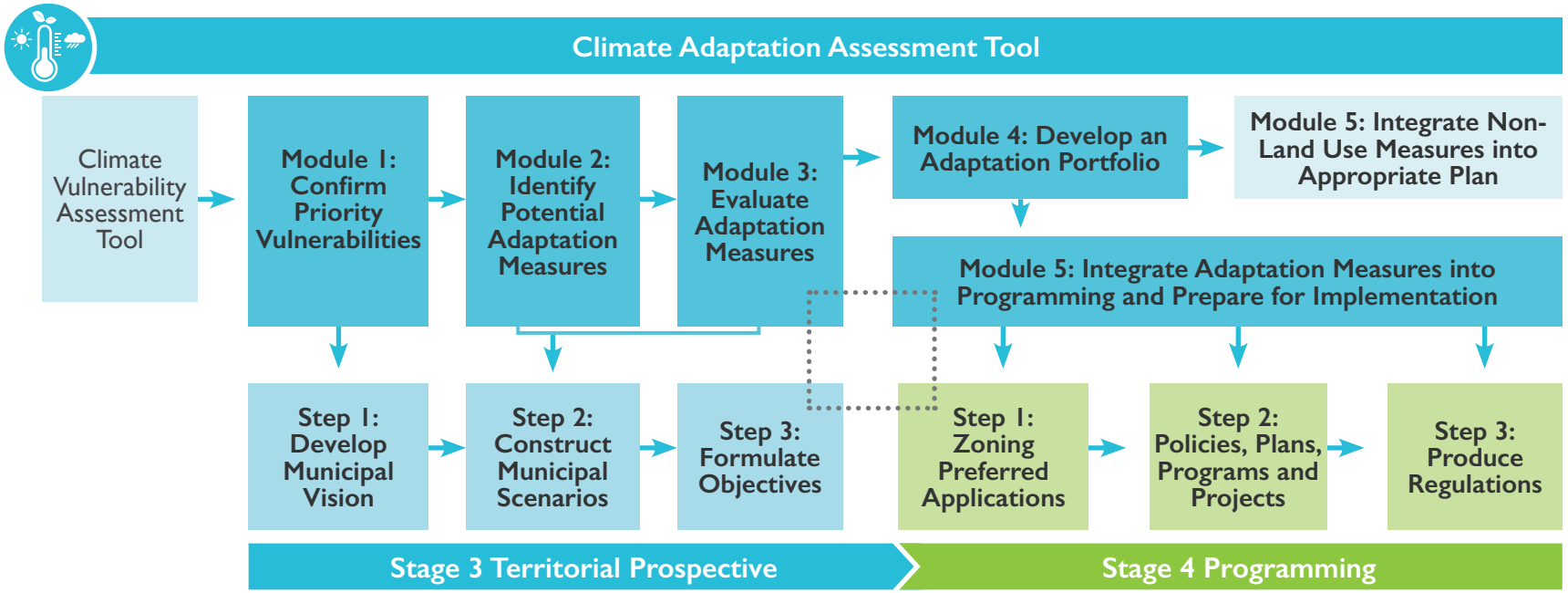


Figure 1. *Relationship of climate change adaptation assessment tool modules to the Stage 3: Territorial Prospective and Stage 4: Programming of the PMOT Land Use Planning Guidance. The development of the municipal vision (Step 1) can include an objective of addressing the priority vulnerabilities (an output either from the Climate Vulnerability Assessment Tool or the Adaptation Tool, Module 1: Confirm Priority Vulnerabilities); while the potential adaptation measures can be integrated into the scenario development process.*

INCORPORATION OF GIS INTO STAGE 3

In **Stage 3,** the GIS tools become relevant again when formulating the objectives and guidelines based on the vulnerabilities identified and as part of the adaptation strategies approach. In developing the portfolio of adaptation measures, each measure must be linked to a proposed land use planning instrument. Thus, all those measures that are going to be part of the zoning considerations must be accompanied by detailed geographic information that allow for the delimitation of each area, for example: vulnerable zones that should not be occupied.

STAGE 3 TOOLS AND RESOURCES

The resources for this stage will help you identify adaptation measures that fit your municipality's priorities and integrate the adaptation measures that relate to land use into your land use planning process.

These resources include the *Climate Adaptation Assessment Tool* and other tools and resources that may be useful as you work to engage stakeholders, set priorities for adaptation, and agree on next steps.

The climate change tools and resources for Stage 3 that can be found in the annexes at the end of this *Notebook* are:

Annex I

- **Climate Adaptation Assessment Tool (Modules 1, 2, and 3):** This tool provides guidance to help planners identify climate change adaptation measures to address vulnerabilities and promote climate-resilient land use planning at the municipal level. The tool contains several modules to 1) Identify priority climate change vulnerabilities, 2) Identify potential adaptation measures, 3) Evaluate adaptation measures, 4) Develop an adaptation portfolio, and 5) Integrate adaptation measures into planning and begin implementation. In Stage 3, you will focus on the first three modules. You will use Modules 4 and 5 as part of Stage 4. Use in Stage 3, Steps 2 and 3.
- **Climate Adaptation Measures Matrices:** This tool includes tables of potential adaptation measures and a worksheet for selecting priority adaptation measures and building your portfolio. You may find it helpful in both Stage 3 and Stage 4. Use in Stage 3, Steps 2 and 3.

Annex II

- **Adaptation Working Group Agenda:** This resource is an example agenda for a working group session focused on selecting adaptation options. Use in Stage 3, Step 2.

STAGE 3 CHECKLIST

Have you conducted the following activities toward incorporating climate change considerations into this stage of the land use planning process?

- ☐ Confirmed the priority vulnerabilities that you want to address.
- ☐ Engaged stakeholders in considering adaptation options.
- ☐ Identified, evaluated, and selected potential adaptation measures, using the Adaptation Assessment Tool and Climate Adaptation Measures Matrices included in Annex 1.
- ☐ Integrated the "appropriate to implement" measures into future ideal land use scenarios and develop objectives and guidelines applicable to these scenarios.

Congratulations! Now that you have completed these activities, you are ready to move on to Stage 4.

STAGE 4
PROGRAMMING

Stage 4: Programming

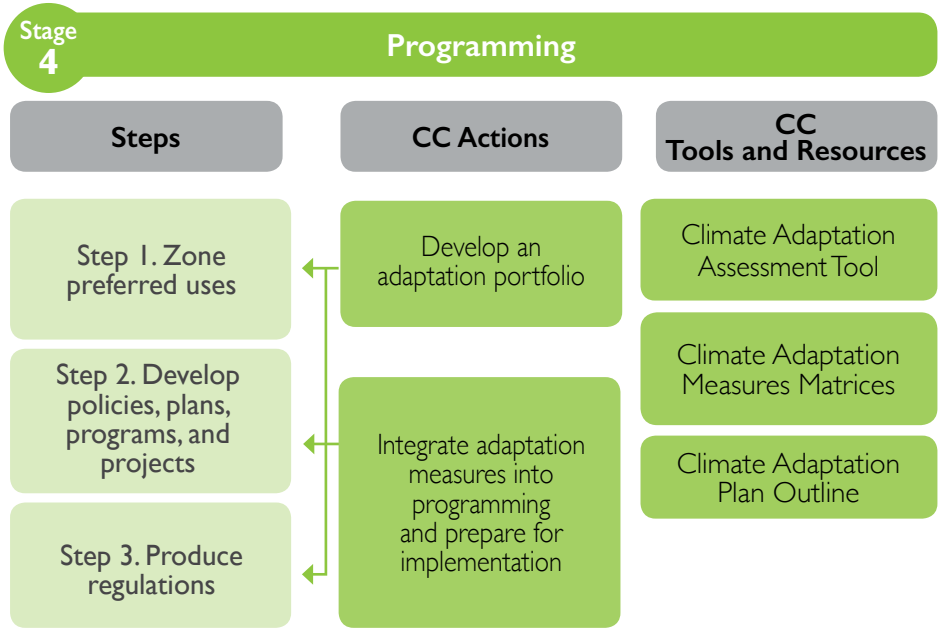
Climate Change Integration Goal: Integrate adaptation measures into the land use plan and develop programs and policies that enable you to successfully implement your adaptation measure portfolio.

In Stage 4, you focus on defining the specific programs and projects, land use zones, and regulations you want to pursue to achieve your municipality's goals and objectives. Importantly, you also want to determine the costs of these activities, and begin to identify resources to fund their implementation—preparing for Stage 5. Based on the overall strategies you developed in Stage 3, you define the specific actions your municipality needs to take to make these strategies a reality.

Why integrate climate change considerations? Thinking about climate change adaptation as you define your land use approach can save time and resources. In many cases, adaptation measures to address climate change will be actions that the municipality already wants to take to address other issues—achieving multiple objectives at once. For example, a program to improve solid waste collection will address climate-related flooding by keeping drains clear of garbage, and it will also help improve community health. Effective adaptation measures often result in other benefits as well.

STEPS TO INTEGRATE CLIMATE CHANGE CONSIDERATIONS INTO STAGE 4

The programs and projects, zoning decisions, and regulations you define in this stage will include climate adaptation measures to address climate change vulnerabilities. For example, adaptation measures to prevent development and occupation of vulnerable land (e.g., areas sensitive to floods and landslides) could be adjusted and incorporated into zoning (Step 1). To do this, you would use the information you developed during Stage 2 about climate vulnerable areas (current and future), and establish a zoning category of non-urban areas—locations that cannot be occupied or developed because they are at risk of climate-related impacts (drought, heat waves, floods and landslides).



Take the following steps to help you successfully integrate climate change into the programming process.

Develop an adaptation portfolio

In this stage you build on the work you conducted during Stage 3 to design a portfolio of different climate adaptation options that together will be most effective in addressing climate vulnerabilities and helping your municipality become more resilient. You take a closer look at the various adaptation measures you identified in Stage 3 and select a set of priority measures. When you conduct this assessment, you can continue to use the *Climate Adaptation Assessment Tool* introduced in Stage 3, beginning with Module 4 *(see page 98)*. In defining potential actions, include strategies you can implement now, and those you will implement over time.

Using this process, you build a portfolio of climate adaptation measures—a group of complementary adaptation actions that address one or multiple vulnerabilities—selecting measures you determine to be the most effective and feasible, and that will work well together. This portfolio of adaptation measures becomes an integral part of your land use plan. The adaptation measures you choose may include a range of strategies: land use and non-land use measures, engineered solutions and policy or operational strategies, different timeframes for implementation, varying costs, and other characteristics. Engaging a mix of stakeholders will help you identify strong measures and create a comprehensive climate resilience portfolio.

Ultimately, the adaptation measures you select should reduce the priority climate vulnerabilities you identified in Stage 2 and also help you achieve the municipal development vision you formulated in Stage 3.

Considering a Range of Adaptation Strategies in San Pedro de Macorís

San Pedro developed a **portfolio of adaptation measures** that spans a range of strategies: land use and non-land use measures, engineered solutions and policy or operational strategies, different timeframes for implementation, and varying costs. For instance, San Pedro plans to adapt to flooding through land use zoning of current and projected flood risk areas, structural measures including flood control technologies, and nonstructural measures such as early warning systems. The adaptation measures were identified through technical team discussions, a working group adaptation workshop, and contributions from their CityLinks partner. They were then evaluated by the technical team and validated by the city council.

Integrate adaptation measures into programming and prepare for implementation

Once you have developed your portfolio of climate adaptation measures, you need to determine how to incorporate the land use adaptation measures into the development of your municipal land use plan activities (Stage 4: Programming), and identify the other plans and strategies into which the non-land use adaptation measures will be integrated. You also need to think about how these measures will be implemented in Stage 5.

As you conduct this assessment, you can continue to use the Climate Adaptation Assessment Tool, which will walk you through considerations regarding how the adaptation measures will be "mainstreamed" into land use and other municipal programming. Some adaptation measures will be reflected in your municipal land use plan; others may be more appropriate to include in your development plan, or in other plans and activities, as shown in Figure 2, below.

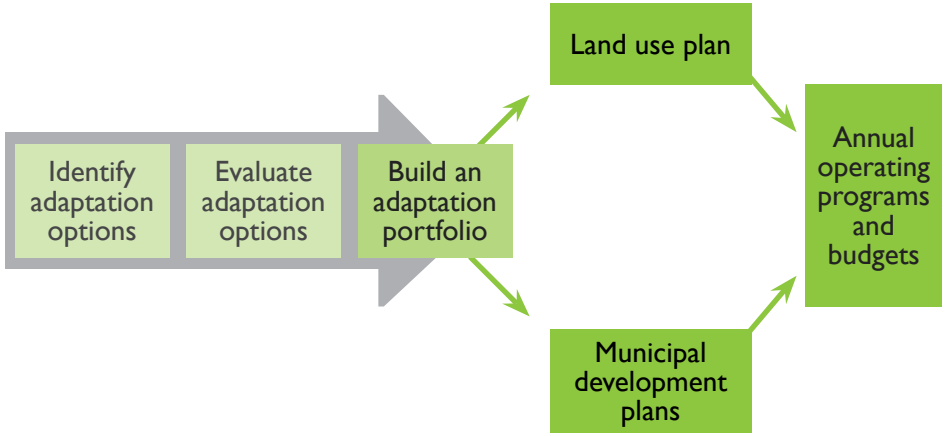


Figure 2. *Some adaptation measures will be integrated into the municipal land use plan; others will become part of the municipal development plan or other strategies.*

For those measures that belong in the land use plan, consider which types of actions are required and how the measure will be reflected in the plan:

- **Zoning actions (Step 1).** Many land-use related adaptation measures will require zoning changes. Some may be easily incorporated by updating existing land use measures to account for changes in climate vulnerabilities. For example, the width of an existing no-build zone in a coastal area that is subject to flooding may need to be expanded to allow for increases in projected sea level. Other adaptation measures may require new zoning.
- **Policies, plans, programs, and projects (Step 2).** Climate adaptation measures may require you to add new activities to your land use programming. In Step 2 of this stage, you define the policies and programs that will support implementation of these adaptation actions. For example, you may need to create or update policies regarding design standards for new construction to withstand higher projected wind speeds during severe storms, or you may need a new program to engage the public in emergency response programs. Changes in zoning may require new development projects in conjunction with these changes to support residents and businesses in relocating to less vulnerable locations that are suitable for development.
- **Regulations (Step 3).** To successfully implement your climate adaptation measures, you may also need to institute new or revised regulations as part of your land use plan programming. In Step 3, you devise regulations to ensure that your municipality is able to implement the adaptation plans, programs, and projects. For example, you may need to update regulations about deforestation to reduce erosion as part of your land use plan.

Some municipalities find it helpful to develop a separate adaptation plan that summarizes the full portfolio of adaptation measures—land use and non-land use—that the municipality plans to implement. The *Climate Adaptation Plan Outline* in Annex II *(see page 245)*, may be helpful if your municipality decides to develop an adaptation plan.

INCORPORATION OF GIS INTO STAGE 4

In **Stage 4,** the definition of preferential use zoning is a mapping exercise that will take advantage of the entire GIS database created in Stage 2 in order to create a preferential land use plan to include into the urban regulatory plan. In this plan information on vulnerable areas (current and future) is adjusted and incorporated. In addition, categories of zones that should not be occupied because they are areas of climate risk (floods, landslides) are established, as well as areas that need to stay as natural areas (eg areas with ecological, agricultural and forestry value) that can play a role in ecosystem-based adaptation.

STAGE 4 TOOLS AND RESOURCES

The resources for this stage will help you ensure that your land use plan programming includes the measures in your adaptation portfolio, and that the programs, projects, and regulations in the land use plan have incorporated future land use conditions. It will also help you review the overall program for any gaps in strategies that you might want to consider.

The climate change tools and resources for Stage 4 that can be found in the annexes at the end of this *Notebook* are:

Annex I

- **Climate Adaptation Assessment Tool (Modules 4 and 5):** This tool, found in Annex under Stage 3 tools, provides guidance to help planners identify climate change adaptation measures to address vulnerabilities and promote climate-resilient land use planning at the municipal level. The tool contains modules to 1) Identify priority climate change vulnerabilities, 2) Identify potential adaptation measures, 3) Evaluate adaptation measures, 4) Develop an adaptation portfolio, and 5) Integrate adaptation measures into planning and begin implementation. Modules 1, 2, and 3 can be used in Stage 3 to help you identify and select your pool of potential adaptation measures. In Stage 4, turn to Module 4 to develop your adaptation portfolio and Module 5 for guidance on integrating your adaptation measures into programming and prepare for implementation. Use in Stage 3, Steps 2 and 3 and Stage 4, Steps 1, 2, and 3.

- **Climate Adaptation Measures Matrices:** This tool, provided in the Stage 3 tools in Annex I, includes tables of potential adaptation measures and a worksheet for selecting priority adaptation measures and building your portfolio. You may find it helpful in both Stage 3 and Stage 4. Use in Stage 4, Steps 1, 2, and 3.

Annex II

- **Climate Adaptation Plan Outline:** This resource provides a sample outline for a municipal adaptation plan, based on plans that other municipalities in the Dominican Republic have developed. Use in Stage 4, after developing your adaptation portfolio.

STAGE 4 CHECKLIST

Have you conducted the following activities toward incorporating climate change considerations into this stage of the land use planning process?

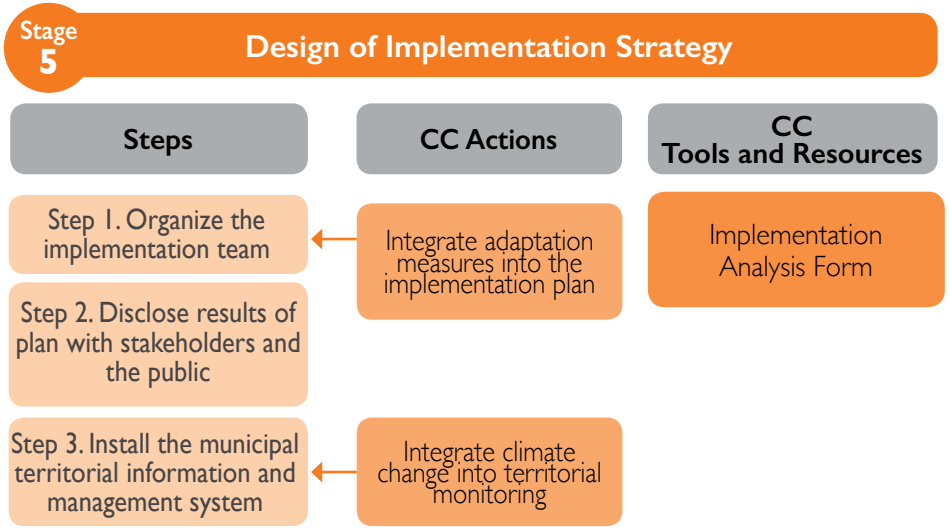
- ☐ Refined the adaptation measures initially identified in Stage 3 into a portfolio of adaptation measures that address key vulnerabilities, and take into consideration Stage 3 deliberations.
- ☐ Identified the policies, plans, programs, and projects that will provide the framework for implementing your adaptation actions.
- ☐ Identified the regulations you need that will ensure your municipality is able to successfully implement the policies, plans, programs, and projects.
- ☐ Ensured prioritized adaptation measures are reflected in your municipal land use plan, development plan, or other activities either by updating existing measures or by adding completely new activities to your programming if necessary.

Congratulations! Now that you have completed these activities, you are ready to move on to Stage 5.

STAGE 5

DESIGN OF IMPLEMENTATION STRATEGY

Stage 5: Design of Implementation Strategy



Climate Change Integration Goal: Ensure that you have a clear plan to implement your priority adaptation measures.

In Stage 5, you will develop and put into place an implementation strategy. The implementation process should be designed by your municipality, and include interactive engagement of key municipal stakeholders. During the implementation process, you will build capacity and strengthen your institutions, update rules and regulations, install or expand municipal land management information systems, and identify catalytic measures.

Why integrate climate change considerations?

Integrating the climate change adaptation measures you have selected into the implementation strategy will help ensure that these actions are implemented efficiently as part of the municipality's overall plan, and that the appropriate municipal managers and decision makers are engaged. Building municipal resilience will necessitate raising awareness about climate change both within municipal institutions and across the broader community. You can build understanding of the importance of climate change as part of the implementation planning process.

STEPS TO INTEGRATE CLIMATE CHANGE INTO STAGE 5

After organizing an implementation team (Step 1), you can continue to raise awareness (in Step 2) by discussing the results of your vulnerability assessment and your portfolio of adaptation measures with your stakeholders and the larger community via traditional media outlets, social media, and organized participatory presentations. Refer back to the communication plan you may have developed during Stage 1 (and see the *Example Communication Plan* in Stage 1, Annex II *on page 199*). Then, you can identify specific climate stressors to monitor and include in the municipal territorial information and management system (in Step 3).

Take the following steps to help you successfully integrate climate change into your implementation plan.

Integrate adaptation measures into the implementation plan

As discussed in Stage 4, a strong resilience strategy requires a diverse portfolio of adaptation measures. Many of these will become part of your municipality's land use plan and implemented through that mechanism. Other actions will need to be implemented through other municipal processes, such as the municipal development plan or the annual operating plans of individual municipal offices. Still others may require action by provincial governments, regional utilities, or national ministries. In many cases your municipality will need to work closely with local businesses, civic organizations, and research organizations. Understanding who needs to lead a particular activity, and what partners they need to involve, is essential to ensure that your adaptation plans become adaptation actions. The implementation team identified in Step 1 of this stage represent the critical actors necessary for the development of the implementation plan. Mainstreaming adaptation into the implementation plan will help ensure that climate resilience is an ongoing aspect of your municipality's sustainable development.

In Stage 4, you began the process of identifying implementation needs in applying *"Table 8: Adaptation Implementation Table"* in Module 5 of the *Climate Adaptation Assessment Tool* *(see page 103)*. You may build on this initial effort by engaging the implementation actors identified in Step 1, and applying the *Implementation Analysis Form* in the Stage 5 resources *(see page 253)* as you design your implementation strategy.

Understanding who needs to lead a particular activity, and what partners they need to involve, is essential to ensure that your adaptation plans become adaptation actions.

Navigating a Change in Administration in the National District

Changes in political leadership typically call for a fresh look at municipal plans under a new administration. After the 2016 election, work on adaptation planning in the National District was put on hold while the new administration assessed priorities and brought in new managers. Because technical staff within municipal departments had been closely involved in the vulnerability assessment and adaptation planning process, they were able to ensure continuity of efforts and provide the technical support needed for the new administration to effectively engage in resilience planning. Experienced technical staff, along with support from FEDOMU, helped build the capacity of new staff to understand climate change vulnerability and strategies to increase resilience to climate change.

In addition to identifying who will be responsible for leading adaptation actions, it is important to understand what resources it will take to implement the measures, what technical analysis will be required, what approval processes will be needed, and what timeframe should be expected to accomplish the measure. Understanding the critical path involved to implement different components of the adaptation portfolio can help you set priorities and balance near-term actions to improve resilience with longer-term strategies. Some municipalities find it useful to develop an action plan that lays out the key steps, the key actors involved, and what they are responsible for, and a target schedule.

Integrate adaptation measures into the implementation plan

To the extent that your municipality develops a territorial information and monitoring system (Step 3), and the relevant municipal capacity to manage the system, changes in climate and related impacts should be included. This information will allow the municipality to map climate impacts against populations, infrastructure, hospitals, and key municipal services with precise locations. For example, consider collecting the following information:

- Elevation data, in combination with hydro-meteorological data, are critical to understand potential flooding and to identify at-risk areas for potential land use control or remediation.
- Information on changes in sea level and coastal erosion, flooding and related flood extents, and documentation of highly vulnerable locations within the municipality can help you identify locations where land use changes and adaptation measures might be considered.

More information on the types of information on climate conditions and impacts that could be collected and monitored can be found in the *Adaptive Management Tool* *"Table 4: Identify Climate and Non-Climate Conditions to Monitor"* in Stage 6, Annex 1 *(please see page 183)*. You may also refer to the Climate Stressor Overview in the *Climate Information Worksheet* *(see page 213)* to identify climate information that could be monitored.

The information you collect can help you identify and prioritize adaptation needs. It can also be used to evaluate and monitor the effectiveness and progress of the implementation of the land use plan over time (Stage 6). Your municipality will need to work with the relevant institutions and with technical experts in order to collect, analyze, display, and distribute land use, infrastructure, and climate data in graphic, easily understood ways.

The end result of this stage as it relates to climate change is the successful implementation of adaptation projects and plans by your municipality and other stakeholders, the mainstreaming of climate change adaptation into your municipality's decision-making processes and operations, and the identification of specific climate stressors to monitor and about which to collect information.

STAGE 5 RESOURCES

The resource for this stage will help you design an implementation plan for the strategies and measures in your adaptation portfolio.

The climate change resource for Stage 5 that can be found in Annex II at the end of this Notebook is:

- **Implementation Analysis Form:** Use this simple checklist to identify core processes (e.g., land use plan, development plan, or operating budget) and other associated information, which are necessary to implement adaptation measures. Use in Stage 5, Steps 1, 2, and 3.

STAGE 5 CHECKLIST

Have you conducted the following activities toward incorporating climate change considerations into this stage of the land use planning process?

- ☐ Organized an implementation team and integrated adaptation actions into implementation plans, including identifying the key actors and responsibilities.
- ☐ Discussed the results of your vulnerability assessment and the portfolio of adaptation measures with your stakeholders and the larger community (using a communication plan you may have developed during Stage 1).
- ☐ Devised a plan to continue to raise awareness of the importance of including climate change in land use planning.
- ☐ Identified specific climate stressors to monitor and about which to collect information.
- ☐ Integrated climate change into territorial monitoring to mainstream adaptation implementation as an integral part of your municipality's work.

Congratulations! Now that you have completed these activities, you are well prepared to implement your climate change adaptation measures.

STAGE 6

DESIGN OF EVALUATION SYSTEM

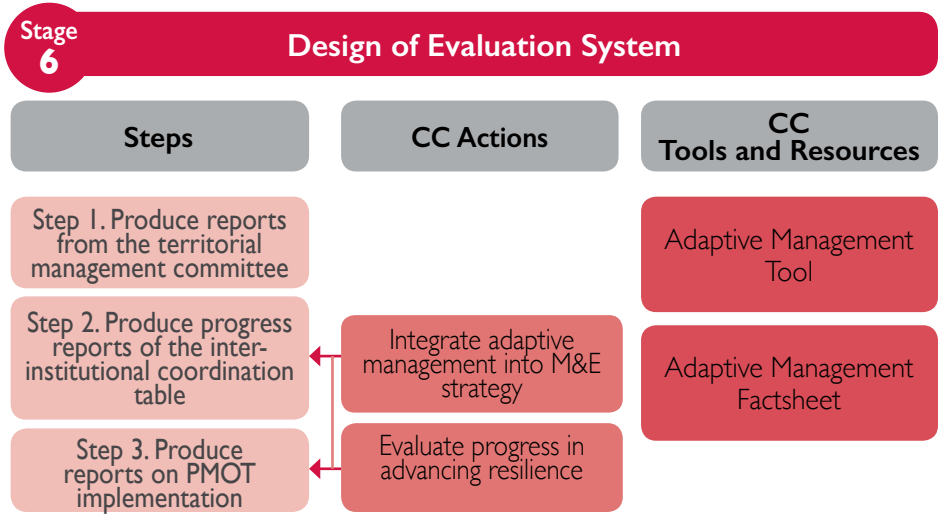
Stage 6: Design of Evaluation System

Climate Change Integration Goal: Support your municipality's ability to become increasingly resilient by tracking and evaluating the implementation and performance of adaptation measures.

In Stage 6, you establish a process that allows your municipality to track and evaluate implementation by measuring and assessing your progress. This stage presumes that one of the municipality's primary goals is to become more resilient over time.

What is adaptive management? Adaptive management is an iterative process for revisiting and improving adaptation practices. It utilizes flexible decision making to promote resilient systems and continuous learning by monitoring conditions and making changes based on new information, observations, and experience. This practice is particularly useful in adjusting adaptation measures to manage uncertainty in climate projections and future land use scenarios. For more information on adaptive management, refer to the *Adaptive Management Factsheet* in the Stage 6 resources *(see page 259)*.

Why integrate climate change considerations? Becoming a resilient municipality is an ongoing process. Climate conditions change over time. Likewise, municipalities are dynamic—growing and changing in ways that cannot be fully predicted. New challenges and opportunities continuously arise, technologies advance, and community priorities change over time. Further, implementation plans sometimes face challenges in execution, and adaptation measures that are implemented may not perform as expected. For all of these reasons, it is necessary to monitor conditions and the effectiveness of adaptation measures, and take additional action to adjust to these changes and increase resilience.
This stage helps to build resilience by incorporating the process of adaptive management into your municipality's monitoring and evaluation strategy. This strategy can guide your municipality in tracking changes in climate conditions, monitoring the effectiveness of climate adaptation measures, and adjusting plans and programs as indicated.



STEPS TO INTEGRATE CLIMATE CHANGE INTO STAGE 6

Take the following steps to help you successfully integrate climate change adaptive management into your monitoring and evaluation plan.

Integrate adaptive management into the monitoring and evaluation strategy

During this stage you first set up a monitoring and evaluation plan to track the progress and performance of the climate adaptation measures included in your adaptation portfolio. To do this, you need to identify the information you will need to collect, and what metrics—or indicators—you will use to gauge the effectiveness of your efforts. You can use the *Adaptive Management Tool* *(see page 175)*, which will guide you through a process of developing indicators relevant to monitoring and evaluating the progress of implementation and the performance of your adaptation measures. Follow the instructions in the *Adaptive*

Management Tool to fill out *"Table 3: Tracking Adaptation Measure Implementation Progress and Performance" (see page 182)*. This table can be integrated into your overall process of monitoring municipal programs and investments. Monitoring adaptation implementation allows you to assess:

- The **progress** you have made in implementing your implementation plan, and
- The **performance** of the adaptation measures you implemented in achieving greater resilience.

The second component of monitoring involves measuring changes in conditions and impacts. This monitoring will increase your municipality's knowledge and understanding of how climate risks are changing over time, and allow you to take advantage of the most recent climate information. Natural systems and non-climate conditions will continue to evolve as well and these changes in the broader context can affect the level of vulnerability and the effectiveness of adaptation options. Refer to *"Table 4: Identify Climate and Non-Climate Conditions to Monitor" (see page 183)* in the *Adaptive Management Tool* for more guidance on this process. (As noted above, this information can be included in the municipal territorial information and management system developed in Stage 5, Step 3).

Evaluate progress in advancing resilience

The information you collect from monitoring allows you to evaluate your municipality's progress in becoming more resilient. Through this evaluation you can identify the reasons the measures have been effective or ineffective—and begin the process of identifying techniques to change, supplement, or add to the measures in place. The *Adaptive Management Tool* provides guidance how to effectively evaluate the adaptation measures your municipality has begun to implement.

STAGE 6 TOOLS AND RESOURCES

The climate change tools and resources for this stage will help you collect information and evaluate the effectiveness of your municipality's adaptation efforts. They will also help you explain the value of monitoring and evaluation, and build the capacity of municipal staff to implement an adaptive management approach.

The climate change tool and resources for Stage 6 that can be found in the annexes at the end of this *Notebook* are:

Annex I

- **Adaptive Management Tool:** This resource provides practical guidance for monitoring and evaluating the effectiveness and implementation progress of the adaptation measures in your land use plan and a checklist of climate and non-climate conditions and impacts that should be monitored and tracked over time to improve understanding of vulnerabilities and effectiveness of adaptation measures. It also includes a checklist of questions to help you to assess and re-evaluate whether adaptation measures should be adjusted. Use in Stage 5, Steps 1 and 3, and Stage 6, Steps 2 and 3.

Annex II

- **Adaptive Management Factsheet:** This factsheet provides guidance on monitoring the effectiveness of climate adaptation measures, tracking changes in climate and non-climate conditions, and adjusting adaptation plans and programs as indicated. Use in Stage 6, Steps 2 and 3.

STAGE 6 CHECKLIST

Have you conducted the following activities toward incorporating climate change considerations into this stage of the land use planning process?

- ☐ Set up a monitoring and evaluation plan to track the progress and performance of the climate adaptation measures included in your adaptation portfolio.
- ☐ Implemented the plan to monitor/measure changes in conditions and impacts.
- ☐ Implemented a plan to evaluate progress in advancing resilience, according to the schedule you establish, using the information you collect from monitoring.
- ☐ Determined how actions will be taken to increase resilience based on the findings from the evaluation process.

Congratulations! Now that you have completed these activities, you have established a framework for ongoing progress in improving the resilience of your municipality.

STAGE 7
FORMALIZATION

Stage 7: Formalization

Climate Change Integration Goal: Approval and adoption of a municipal land use plan in which climate change adaptation planning is thoroughly integrated.

In Stage 7, the technical teams complete a set of required steps in order for your municipal land use plan to be officially adopted.

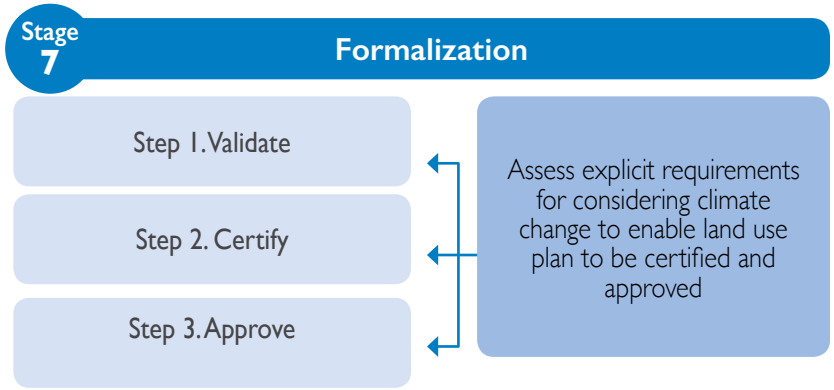
Why integrate climate change considerations? At this stage, you have integrated climate change into the land use plan you have developed. It is important to assess whether there are explicit requirements for consideration of climate change that must be met in order for your municipal land use plan to be certified and approved.and programs as indicated.

STEPS TO INTEGRATE CLIMATE CHANGE INTO STAGE 7

Take the following steps to help you successfully integrate climate change into the formalization process.

To integrate resilience into this stage, you will **assess whether there are explicit requirements for consideration of climate change that must be addressed in order for your municipal land use plan to be validated, certified, and approved.** If not, should these requirements be defined and recommended? Note that formalization can occur any time after Stage 4, however you must ensure that everything that relates to resiliency is included in the ordinance.

Your resilience plans may also contribute to regional or national goals for climate adaptation and resilience, such as the Dominican Republic's Nationally Determined Contribution under the United Nations Framework Convention on Climate Change Paris Agreement.



STAGE 7 CHECKLIST

Have you conducted the following activities toward incorporating climate change considerations into this stage of the land use planning process?

- Assessed whether there are explicit requirements in order to consider climate change that must be met in order for your municipal land use plan to be certified and approved.
- Considered whether changes to requirements should be defined and recommended.
- Validated, certified, and approved your land use plan that now incorporates climate change adaptation considerations.

Congratulations! You are well on your way to addressing the climate vulnerabilities that face your municipality, and to making ongoing progress toward your vision of a resilient and sustainable municipality.

Annex I
TOOLS

Annex I
TOOLS

STAGE 2 TOOL

- Climate Vulnerability Assessment Tool

STAGE 3 TOOLS

- Climate Adaptation Assessment Tool
- Climate Adaptation Measures Matrices

STAGE 6 TOOL

- Adaptive Management Tool

STAGE 2 TOOLS

- Climate Vulnerability Assessment Tool

Resource Title	CLIMATE VULNERABILITY ASSESSMENT TOOL
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☑ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	This Climate Vulnerability Assessment Tool supports municipal land use planners in identifying and assessing the vulnerability of municipal resources, services, and sectors to current and future climate impacts. The tool consists of five modules that start with identifying climate stressors and culminate with prioritizing vulnerabilities. Users integrate climate information and their knowledge and assumptions of potential impacts to identify and prioritize municipal vulnerabilities. The tool assesses the vulnerability to climate impacts of the resources, sectors, and services included in the land use planning diagnostics process.
Methodology	Vulnerability is a function of three factors: 1) the character, magnitude, and rate of climate variation to which a system is exposed; 2) its sensitivity; and 3) adaptive capacity (IPCC 2001). Exposure is defined as the degree of climate stress upon a particular unit analysis; it can be represented as either long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events (IPCC 2001). Sensitivity is defined as the degree to which a system will be affected by, or responsive to, climate stimuli (Smith et al. 2001). Adaptive capacity is defined as the potential or capability of a system to adjust to climate change, including climate variability and extremes, so as to moderate potential damages, to take advantage of opportunities, or to cope with consequences (Smit and Pilifosova 2001).
User(s)	Municipal staff involved in strategic and capital investment planning, in consultation with other municipal decision makers, stakeholders, and individuals with technical expertise.
Intended Use	To assess climate vulnerabilities of municipal resources, sectors, and services
Key Output(s)	A table that shows the vulnerability of different municipal resources, sectors, and services, and the relative priority of these vulnerabilities.
Limitations	The tool does not provide detailed engineering or design specifications of adaptation measures or address institutional roles or implementation mechanisms.
Ease of Use	Four- to eight-hour exercise. Users require a working knowledge of municipal resources, sectors, and services; and information about the historical sensitivity of assets to climate and non-climate stressors.

CLIMATE VULNERABILITY ASSESSMENT TOOL

CLIMATE VULNERABILITY AND LAND USE PLANNING

Some land use planning and development decisions are straightforward and require little analysis to implement. However, climate change adds a new dimension to land use plans, strategies, and projects. If climate change is not considered, degradation of development benefits may result over time. A careful assessment of climate change impacts on land use and municipal development initiatives can point to critical risks for planners to take into consideration. This document provides overarching guidance for municipal planners seeking to incorporate vulnerability assessments directly into the PMOT land use planning process.

WHAT IS A VULNERABILITY ASSESSMENT?

A climate vulnerability assessment can inform land use planning by analyzing the extent to which municipal assets and people are susceptible to and/or unable to cope with the impacts of climate variability and climate change.
It can be used to answer questions like:

- How vulnerable is my municipality's water supply to intense or sustained drought?
- How vulnerable is the primary road network to severe flooding events?
- How vulnerable are our marine fisheries to warming temperatures and ocean acidification?
- What geographic locations are most vulnerable to increases in sea level or storm surge heights?

HOW DOES THIS TOOL LINK TO THE PMOT STEPS?

This tool directly supports the integration of information on climate change and climate vulnerability assessment into PMOT Stage 2: Territorial Diagnosis, as outlined in Figure 1 (next page). The tool is not an exhaustive set of information or guidance to produce a detailed vulnerability assessment. Rather, it is designed to help land use planners think through, identify, and incorporate information on critical climate change risks and vulnerabilities.

The diagnosis conducted in the PMOT Stage 2 is an intensive process that involves data collection, stakeholder consultations, and analysis geared toward identifying the "critical themes" of a municipality and its broader geographic context: What is the environmental, social, and economic status of the municipality and surrounding areas of influence? What are the key economic activities? Who are the people? Where are they located? How well is the municipality supporting the people and the economic activities? What are the key factors and enabling conditions that support municipal services and people? What are the key risks to the municipal assets and people? What are the interdependencies of the municipality and surrounding areas? What resources, infrastructure, and services from outside the municipality are critical to the development and livelihoods of the municipality?

The diagnosis of the municipality and its broader geographic context requires gathering a range of environmental, socio-economic, and spatial information to identify critical themes vulnerabilities, including climate change. As part of this territorial diagnosis and analysis, information should be gathered on climate change stressors; non-climate drivers of change; impacts to natural resources, populations, sectors, and services; and their capacity to adapt, recover, or avoid impacts.

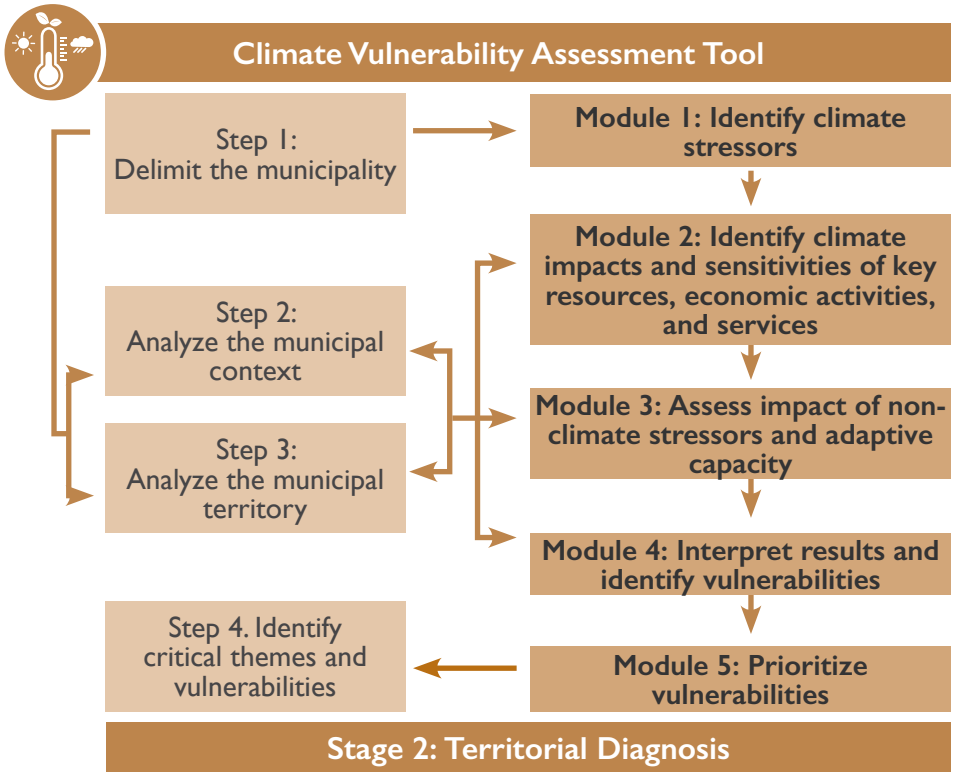


Figure 1. Relationship of climate change vulnerability assessment (brown boxes) to the Stage 2 diagnostics for the analysis of critical themes and vulnerabilities of the municipality and the surrounding territory of influence .

The climate vulnerability assessment integrates into the Stage 2: Territorial Diagnostics, as it is based on diagnostics used within the PMOT. Figure 1, above, highlights the key modules involved in this Climate Vulnerability Assessment Tool. Although the process is depicted as a linear progression, the underlying information and assumptions could be revised and revisited over time as part of the land use management process.

HOW TO USE THE CLIMATE VULNERABILITY ASSESSMENT TOOL

To use this tool, following the instructions for each of the five modules, beginning with Module 1. Each module starts with a brief explanation of the purpose of that module, followed by step-by-step directions. The five modules of this tool are:

- **Module 1. Identify climate stressors:** Identify climate stressors based on local expertise and information gathering.
- **Module 2. Identify climate impacts and sensitivities of key resources, economic activities, and services:** Analyze the extent to which exposed system assets are sensitive to climate stressors, and the degree to which they will be impacted by climate if no adaptation is undertaken.
- **Module 3. Assess impact of non-climate stressors and adaptive capacity:** Assess adaptive capacity by assessing the capacity of individuals, organizations, and/or ecosystems to adjust to potential climate impacts, to cope with consequences, or to take advantage of opportunities. This module does not require determination of specific adaptation actions.
- **Module 4. Interpret results and identify vulnerabilities:** Reach conclusions about the overall vulnerability of the development sector or service and communicate assessment results in meaningful ways to the target audience(s).
- **Module 5. Prioritize vulnerabilities:** Decide which of the vulnerabilities identified in Module 4 are most important to address, based on criticality, likelihood, and consequence.

MODULE 1: IDENTIFY CLIMATE STRESSORS

In this module, you compile information on climate stressors that are relevant to your municipality and the broader territorial context. You can gather this climate information by using the *Climate Information Worksheet* (included in this Notebook in Annex II under Stage 2 resources), or through consultation with climate experts. You (the planner) should conduct this module, and can engage a climate expert if one is available.

Under Stage 2: Territorial Diagnosis, of the PMOT Guide, a range of information is collected for several diagnostics components, including information on climate and climate-related extremes. To ensure that the climate information that is gathered is relevant to the assessment of climate change vulnerabilities, a compilation of the types of climate information to gather, and where to find it, is presented in the *Climate Information Worksheet.*

Categories of climate stressors are outlined in Table 1, below, along with a series of questions to help you to characterize the stressors for your location. Climate stressors can be useful for identifying exposed assets and locations, though you may need to further refine the level of detail of the information to assess specific resources, services, or economic activities.

The vulnerability assessment considers both current and future vulnerabilities. Therefore, you will need to identify:

- **Current and historical climate stressors –** These can be used to: (1) assess the extent to which exposure to climate variability and change has previously caused impacts, and (2) establish a baseline against which future exposure and impacts can be compared.
- **Future projections of climate change stressors –** These can be used to: explore possible changes in future climate stressors and conditions given different scenarios, at different points in the future.

INSTRUCTIONS FOR MODULE 1

In this module, take the following steps to identify climate stressors:

1. **Collect and review climate information:** You can either gather information using the Climate Information Worksheet and review this information, or work with a climate change expert to collect and review the information.
2. **Fill out Table 1, below:** Reflect on the questions in the second column of the table, and describe recent trends and projected changes for each climate stressor type that is relevant.

Table 1: Guiding Questions to Gather Information on Current Climate, Recent Trends, and Future Projected Climate Stressors

Climate Stressor Type	Prompting Questions
Rainfall Annual average Monthly average and distribution	• Has average annual rainfall amount or seasonal distribution changed in the recent past? • How are the annual average, seasonal distribution, projected to change?
Note recent trends and projected future changes in rainfall annual average and monthly average and distribution:	
Sea Level, Storm Surge, and Sea Temperature	• What are the current trends and projected future changes in coastal flooding extent and location, considering changes in storm surge height and sea level rise? • What are the current trends and projected future changes in sea temperature?
Note recent trends and projected future changes in sea level, storm surge, and sea temperature:	
Extreme Rainfall; Riverine/ Pluvial Flood Extent	• What are the current and projected future changes in extreme rainfall frequency and intensity? • What are the current and projected future changes of riverine/fluvial flooding extent? Maps with current and projected flooding are useful to consider these questions.
Note recent trends and projected future changes in extreme rainfall:	
Drought	• Has drought frequency and intensity changed in the recent past? How are drought and aridity projected to change in the future?
Note recent trends and projected future changes in drought:	

Climate Stressor Type	Prompting Questions
Temperature Monthly distribution Extremes	• Have monthly average, minimum, and maximum temperatures changed in the recent past? How are they projected to change in the future? • Have the frequency and magnitude of extreme heat (e.g., daily maxima, heatwaves) changed in the recent past? How are they projected to change in the future?

Note recent trends and projected future changes in temperature monthly distribution and extremes:

Tropical Storms, Cyclones	• Have the frequency and intensity of storms changed in the recent past? How are they projected to change in the future?

Note recent trends and projected future changes in tropical storms and cyclones:

Other: Landslides Fires Coastal erosion	• Have fire, landslides, or coastal erosion changed in the recent past? • How are they projected to change in the future?

Note recent trends and projected future changes in landslides, fires, and coastal erosion:

MODULE 2

IDENTIFYING CLIMATE IMPACTS AND SENSITIVITIES OF KEY RESOURCES, ECONOMIC ACTIVITIES, AND SERVICES

In this module, you consider whether these resources, services, and sectors are sensitive to climate stressors (e.g., drought, erosion, and/or flooding). You (the planner) should conduct this module, and engage experts who are highly familiar with the resources, services, and sectors to help you identify climate impacts and sensitivities.

The PMOT Stage 2: Territorial Diagnosis includes identifying and assessing important municipal resources and economic sectors and services, in order to evaluate their sustainability and vulnerabilities. This module also helps to directly integrate climate impacts into the territorial diagnosis. Based on the PMOT analysis, you can identify the most important sectors and services; including those that rely upon resources located outside of the municipal boundaries, such as water resources for the provision of drinking water supply, or hydro-electricity. The PMOT Stage 2 diagnostics are organized into environmental, socio-economic, and spatial components. Within these components, there are several resources, economic activities, and services that may be vulnerable to climate change impacts (see Figure 1, at the beginning of this tool), including:

- Population: Human Settlements
- Environmental and Natural Resources: Water Resources, Coastal and Marine Resources, Forests
- Municipal Services and Equipment: Solid Waste Management, Civil Protection and Health, Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage
- Infrastructure Services: Drinking Water, Sanitation, Wastewater Treatment, Urban Mobility, Stormwater Drainage, Power System, Telecommunications
- Commerce and Industry: Agriculture, Fisheries, Industry, Tourism

INSTRUCTIONS FOR MODULE 2

In this module, take the following steps to identify climate impacts and sensitivities. Using the checklist in Table 2: Assessment of Climate Sensitivity and Impacts of Key Sectors and Services to Current and Future Climate, below, as a guide, consider the degree to which resources and assets may be exposed and sensitive to the climate stressors you identified in Module 1 (see Table 1 on the previous page), and how that may change as a result of changes in future climate.

To complete the Table 2 checklist below:

1. In column 1, select the key economic sector and municipal service category diagnostics that are most important to your municipality.
2. In column 2, use the guiding questions as a starting point to consider sensitivities and note any past impacts. Write down a summary of these sensitivities under "Note key impacts" for each sector or service category. Note that the questions provided are illustrative; you can refer to the list of additional resources for a more comprehensive set of potential impacts and sectors.

To complete the table, you may want to refer to a map of the municipality that includes the location of key infrastructure and populations. The factors located in areas at risk of exposure can be marked directly on the map, and their sensitivity to impacts can be evaluated. Sensitivity is the extent to which something will be positively or negatively affected if it is exposed to a climate stressor. The more sensitive an asset, resource, or person is to one or more climate stressors, the more vulnerable it tends to be. For example, older adults tend to be more sensitive to extreme heat compared with the general population, and certain types or varieties of crops are more sensitive to drought.

Once you have completed Table 2, you are ready to move on to Module 3.

What's the bright idea?
Past climate-related impacts on your municipality provide the most useful window into understanding potential future impacts because they reflect your local context. The past is not a perfect mirror into the future, however. It is important to consider how the likelihood and consequences of future climate stressors may change (e.g., projected changes in intensity, frequency, and footprint of climate extremes), increasing the exposure and impacts of additional critical assets.

Table 2: Assessment of Climate Sensitivity and Impacts of Key Sectors and Services to Current and Future Climate

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Population, Environmental and Natural Resources	Human Settlements	▫ Are people in specific settlements currently exposed to inundation from riverine or coastal flooding, or landslides? Is climate change expected to increase the footprint of landslides or riverine or coastal flooding that would render additional assets and populations exposed to flooding or permanent inundation? Is housing and other infrastructure subject to damages from flooding or landslides? Is it designed to withstand projected changes in landslides, flooding, heavy rainfall, storm surge, or high temperatures? ▫ Is there critical infrastructure (e.g., hospitals, roads, emergency shelters) that provides services to one or more settlements that is or will be exposed to current and/or future riverine or coastal flooding? ▫ Are there any settlements that are particularly sensitive to physical damage from climate stressors due to their temporary or informal nature, poor construction, lack of regulation, higher density, low-income levels, and/or lack of services? Are there populations that are particularly sensitive to extreme heat due to a high concentration of young or elderly people and/or a lack of access to cooling centers?
	Note key impacts:	
	Water Resources, Coastal and Marine Resources, Forests	▫ Has average annual rainfall amount or seasonal distribution changed in the recent past, affecting the amount and quality of the water resources? How might changes in annual average and seasonal distribution of rainfall effect the water resource? ▫ Have aquifers nearby coastal areas experienced saltwater intrusion? How might an increase in sea level affect these areas? ▫ Are watersheds vegetated and able to slow runoff from heavy rains, attenuating flooding, erosion, and sedimentation downstream? How might changes in extreme rainfall effect water quality in the watershed? ▫ Are there marine species that are sensitive to temperature increases? Is there marine life that has calcium-based shells that might be adversely affected by ocean acidification? How might increasing temperatures and ocean acidification impact the productivity of marine fisheries with species sensitive to temperature increases and ocean acidification? ▫ Have coastal mangrove forests been removed, degrading the marine ecosystem, resulting in loss of habitat, and increasing coastal erosion? How might an increase in sea level and storm surge affect marine areas? ▫ Have terrestrial forests experienced stress from increasing temperatures or changing rainfall patterns? Has fire incidence as a result of drought and high temperatures increased? How might changes in temperature, rainfall amount and distribution effect forests?

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Municipal Services and Equipment	Solid Waste Management	▫ Have higher temperatures resulted in increased odor and pest activity putting workers or citizens at increased risk to infectious diseases? How might projected increases in temperature affect human health? ▫ Have collection, processing and disposal of solid waste been inundated by flood waters in the past? How might changes in rainfall intensity, sea level and storm surge, and flood footprints affect the location of solid waste management assets
		Note key impacts:
	Civil Protection and Health	▫ Have higher temperatures resulted in increased or changing patterns in water borne or infectious disease incidence (e.g., malaria)? How might projected increases in temperature affect human health? ▫ Have populations been impacted by flooding or drought in the past? ▫ Are there easily accessible designated shelters to accommodate populations at risk to injury or harm during flood, or storm events? Is the hospital easily accessible and located in an area that is not prone to flooding? ▫ How might changes in future intensity of rainfall and/or storms affect health and safety?
		Note key impacts:
	Housing, Sports Facilities, Cemeteries, Markets, Slaughterhouses, Cultural Heritage	▫ Are there municipal facilities (e.g., houses, sports facilities, cemeteries, markets, slaughterhouses, or cultural heritage sites) that have historically been subject to damage or flooding from landslides, storms, heavy rainfall, or storm surge? How might projected changes in climate impact damage to or flooding in these facilities? ▫ Is climate change expected to increase the footprint of landslides, riverine or coastal flooding that would render additional municipal facilities exposed to these stressors? ▫ Are there cultural heritage sites in areas where buildings have historically experienced fissures and cracking due to extreme temperatures? How might projected temperature increases impact these cultural heritage sites? ▫ Are there cultural heritage sites in areas that have historically experienced growth of organic materials such as insects, molds, and fungi? How might projected changes in precipitation and humidity impact these cultural heritage sites? ▫ Are there cultural heritage sites that have historically experienced structural damage, erosion, and moisture penetrating into porous materials due to strong winds? How might the projected increase frequency and intensity of storms impact the cultural heritage sites?
		Note key impacts::

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Infrastructure Services	Drinking Water	◘ Have water supply infrastructure and access roads experienced past damages from flooding? Is current water supply infrastructure designed to account for intense rainfall and flooding? Is flood frequency and intensity expected to change, and if so, would changes exacerbate flood impacts? ◘ Are there non-regulated river systems where extreme rainfall and increased sedimentation have already caused physical damage to intake infrastructure and impaired water quality? How might projected changes in extreme precipitation alter sedimentation and associated infrastructure and water quality impacts? ◘ Are there dams or other water reserves that have historically experienced water shortages due to drought? How might projected changes in drought frequency and intensity impact water supply? ◘ Have competing water demands increased as a result of higher temperatures, and supply decreased as a result of increased surface evaporation? How might projected increases in temperatures and potential evapotranspiration changes impact ability to meet drinking water demands? ◘ Is current ground water supply subject to salt water intrusion? How might increasing sea level affect municipal water supply? ◘ Is current surface water supply quality decreased by warmer temperatures (e.g., eutrophication)? How might projected increases in temperature affect water quality?
	Note key impacts:	
	Sanitation systems	◘ Have high water tables during intense rainfall events lead to groundwater contamination from latrines or septic systems? ◘ How might changes in rainfall frequency and intensity affect groundwater quality?
	Note key impacts:	

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Infrastructure Services	Wastewater Treatment	▫ Have past storms or extreme precipitation overwhelmed wastewater treatment facilities, inundated outfalls causing discharge to back up, or disrupted pumping or treatment due to power losses? How might projected changes in storms and extreme precipitation affect treatment, or combined sewage overflow systems? ▫ Have past extreme precipitation events or landslides impacted worker access to wastewater treatment plants, chemicals, fuel, or supplies? How might projected changes in extreme precipitation impact wastewater plant operations and worker safety? ▫ Have higher temperatures or prolonged drought reduced water quality and increased waste water treatment costs? Have drought conditions historically induced pipe blockage from reduced inflows, increased corrosion, reduced waste treatment effectiveness, or increased maintenance costs? How might projected temperature increases or changes in drought affect waste water treatment? ▫ Has extreme heat historically caused material degradation of electrical connections, treatment plant equipment, and access roads? Has pipe infrastructure or other equipment historically experienced significant corrosion? Have workers historically experienced heat stress? How might projected increases in average and extreme temperatures impact wastewater treatment plants?
		Note key impacts:
	Urban Mobility	▫ Is asphalt deterioration due to extreme temperatures currently affecting roads and/or runways? How might expected increases in temperature extremes result in new or more deterioration? ▫ Are ports and waterways adversely affected by silt deposition, low water levels, or scour? How might future changes in peak flows or low flows affect them? ▫ Are roads, railways, and airports currently affected by erosion or washout? How might changes in future rainfall intensity and flooding affect these assets? ▫ Is the density of roads sufficient to provide alternative routes in case of climate-related extreme events? Does dislocation of populations or reduced access to assets occur as a result of extremes?
		Note key impacts:

	1. Diagnostic	2. Checklist of key questions to assess sensitivity and impacts
Infrastructure Services	Stormwater Drainage	▪ Are natural drainage systems (e.g., creeks, streams, and tributaries) historically clogged with solid waste or impeded by informal settlements? Do these areas experience flooding? How might projected changes in extreme precipitation impact drainage and flooding? ▪ Are there areas that have historically experienced saturated soils and associated ponding? Are there boreholes in these areas that have historically been rendered inoperable due to damage from debris? How might projected changes in extreme precipitation impact drainage and aquifer contamination in these areas? ▪ How might an increase in intensity of storms impact the condition of stormwater drainage networks? How might these changes impact inundation and stormwater drainage?
	Note key impacts:	
	Power System	▪ Has energy infrastructure experienced past impacts due to high temperatures or intense storms? ▪ Are reductions in energy generation, transmission, and distribution efficiency and capacity currently experienced due to high temperatures? How might expected increases in temperature extremes result in new or greater reductions in efficiency of transmission and distribution, or thermal generation? ▪ Have past fluctuations in water availability reduced hydropower availability and generation, or caused conflict with competing water users? How might future projections in runoff result in increased or decreased generation potential and conflicts over water? ▪ Have increases in electricity demand for cooling occurred in the past during warmer days or seasons? How might future increases in temperatures result in higher electricity demand?
	Note key impacts:	

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Infrastructure Services	Telecommunications	▫ Is there telecommunications infrastructure within a floodplain, along the coast, or within another area that has historically experienced severe riverine or coastal flooding? Has historical flooding inundated electrical equipment, exposed cables due to erosion, or reduced access to low-lying coastal telecommunications buildings? How might projected changes in extreme precipitation impact telecommunications systems? ▫ Have extreme storms and winds historically downed cell towers or telephone poles? How might increasingly frequent and intense extreme events directly impact telecommunications infrastructure? How might changes in these events impact power outages and the telecommunications system? ▫ Has below-ground infrastructure historically experienced adverse effects from flooding, coastal saltwater intrusion, subsidence from drought or flooding, or damage from surface infrastructure (e.g., roads)? How might projected changes in extreme precipitation, sea level and storm surge, and drought impact below-ground infrastructure? ▫ Have data centers or other telecommunications stations historically experienced overheating? Have wireless signals historically been reduced in strength and quality due to increased temperatures? How might projected increases in average and extreme temperatures affect telecommunications systems? ▫ How might increasing temperatures and associated permafrost melt impact the physical stability of telecommunications towers?
	Note key impacts:	
Commerce and Industry	Agriculture	▫ Is current water supply or rainfall sufficient to meet agricultural needs? How might changing amount and distribution of rainfall effect production? ▫ Are crops currently affected during times of drought? Is drought frequency and intensity expected to change, and if so, would changes exacerbate drought impacts? ▫ Do crops, or water supply irrigation infrastructure, frequently incur damages as a result of intense rainfall and flooding, and associated erosion and sedimentation? Is flood frequency and intensity expected to change, and if so, would changes exacerbate flood-related impacts? ▫ Do agricultural areas experience salt water intrusion? How might increasing sea level affect agricultural production? ▫ Have past episodes of extreme temperatures or heatwaves stressed crops and increased pests, affecting agricultural productivity? How might projected increases in temperature affect agricultural productivity?
	Note key impacts:	

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Commerce and Industry	Fisheries	▫ Have past increases in sea surface temperatures affected coastal zone health, and fish habitat and breeding grounds? Have there been temperature-induced shifts in the ranges and populations of fish or changes in reproduction cycles? How would increasing sea surface temperature affect fish habitat and breeding areas? ▫ Have past storms damaged boats or fishing equipment? Has this increased production costs due to destruction of infrastructure and interruption of supply chains? How might increases in sea level, or changes in storm surge heights, and storm intensity affect fishing equipment? ▫ Have past storms resulted in destruction of fish habitat and ecosystem (e.g., coral reefs and mangroves)? Have past storms and flooding reduced fishery productivity due to increased sedimentation and runoff, and reduced water quality, degrading habitats and leaving fish unable to fertilize eggs or protect nests? How might changes in future storms affect habitat and productivity?
	Note key impacts:	
	Industry	▫ Has energy infrastructure experienced past impacts due to high temperatures or intense storms? ▫ Are reductions in energy generation, transmission, and distribution efficiency and capacity currently experienced due to high temperatures? How might expected increases in temperature extremes result in new or greater reductions in efficiency of transmission and distribution, or thermal generation? ▫ Have past fluctuations in water availability reduced hydropower availability and generation, or caused conflict with competing water users? How might future projections in runoff result in increased or decreased generation potential and conflicts over water? ▫ Have increases in electricity demand for cooling occurred in the past during warmer days or seasons? How might future increases in temperatures result in higher electricity demand?
	Note key impacts:	

1. Diagnostic		2. Checklist of key questions to assess sensitivity and impacts
Commerce and Industry	Tourism	◘ Are coastal areas vegetated and able to reduce wave impacts? Are dunes in place as natural barriers? ◘ Have historical storms led to direct damages to tourism infrastructure (e.g., beach resorts, roads, historical monuments and buildings)? How might projected changes in storms, sea level rise, storm surges and erosion directly affect tourism infrastructure? ◘ Have indirect impacts of extreme events (e.g., coastal erosion, coral bleaching) and short-term adverse perceptions of tourists after the occurrence of extreme events (e.g., flooding, tropical storms, storm surges) affected tourism? ◘ How might projected increases in temperature and heatwaves, and/or changes in storm frequency and intensity, affect tourism in the future?
	Note key impacts:	

MODULE 3

ASSESS IMPACT OF NON-CLIMATE STRESSORS AND ADAPTIVE CAPACITY

This module will help you determine how non-climate stressors might exacerbate climate impacts and, conversely, consider how the strengths or "adaptive capacities" of your municipality might moderate climate impacts. You (the planner) should complete this module and engage experts who are highly familiar with the conditions of the resources, services, and sectors, and who will be able to help you describe the condition of non-climate stressors and adaptive capacities that will influence the severity of climate impacts.

The social, economic, and political context of your municipality can influence the risk to your resources, sectors, and services from climate hazards. For example:

- Development along the coastline can increase pollution and exacerbate impacts from climate and other natural hazards on coastal environmental degradation.
- Lack of solid waste management can lead to blocked drainage, increasing flood extent and health exposure risks.
- Weak institutional capacity of the managing agencies can result in limited budget for operations and maintenance, reducing funds available for maintenance and repairs.

At the same time, municipalities, individuals, and institutions may have capacities in place that allow them to avoid, or better adapt or recover from climate-related impacts. For example:

- Legal regulations that include buffer zones for coastal or riparian development, in combination with strong legal enforcement, can reduce exposure of people and assets to coastal flooding.
- Good solid waste management can ensure that trash does not collect in drainage areas, providing more capacity to drain rainwater and reducing human contact with toxic waste materials.
- Hazard early warning systems and associated contingency plans can lessen the duration and severity of impacts and disruptions when hazards such as flooding or storms occur.

The PMOT Stage 2: Territorial Diagnosis includes gathering information on non-climate stressors and adaptive capacities as part of the diagnostics. Examples of non-climate stressors that may moderate or increase current and/or future impacts on the sectors or services relate to the following diagnostics:

Governance

- Governance and institutional capacity – Areas that have developed climate policies, plans and roadmaps, and have identified priority investment areas and begun to implement them are building capacity and awareness of climate-related risks.
- Regulations and enforcement capacity – Areas that have developed regulations to protect areas from development, pollution, and are able to enforce them are creating safer, more sustainable municipalities.
- Political instability – A more stable political environment allows for more government time and resources to be dedicated to helping communities adapt to climate change.
- Resource management – Considering projected climate change in resources management allows for more effective and resilient resource management planning.
- Human conflict – Less conflict allows for more resources to be dedicated to climate adaptation planning and implementation.

Land Use Planning and Rules

- Clear land ownership and enforcement – Clearly defined land ownership and management responsibilities increase the likelihood that adaptation actions will be undertaken.
- Urban planning – Planning settlements, as opposed to allowing them to arise in an unplanned fashion, allows for climate impacts and adaptation to be incorporated into the settlement, creating settlements that are more resilient to climate change.

Pollutants and Degradation

- Deforestation – A denuded landscape will be more susceptible to erosion and landslides, and sedimentation, as a result of intense rainfall events.
- Solid Waste Management – Poor solid waste management can increase pollution and increase the likelihood that climate impacts, such as increased flooding, will be exacerbated by a polluted environment.

- Natural territory protection – A high percentage of land under protected area status indicates a commitment to environmental preservation, which enhances adaptive capacity by reserving land that may buffer populations from climate impacts and provide species diversity that may help people adapt to climate change.

Demographics

- Population growth – A growing population can stress the ability of existing services to meet needs.
- Gender barriers – Gender barriers that limit access to information and resources and impose sociocultural constraints can inhibit women's participation and leadership in climate adaptation efforts, which presents a constraint to human capital in a community's adaptation efforts.

Poverty Rates

- Poverty rates – Higher levels of poverty indicate less ability to adapt to climate shocks and impacts, less ability to access savings.
- Strained financial resources – Strained financial resources reduce ability to invest in climate adaptation. Access to technology – Access to technology increases the ability to access information and communicate with others, thereby increasing resilience.

Education, Health and Employment

- Education – The percentage of population with primary, secondary, or tertiary education provides a measure of the education level of the population. Higher education levels indicate a more skilled labor force with higher income potential and more financial resources to adapt to adverse circumstances.
- Access to health care – Higher access to health care and lower levels of disease, indicate healthier populations which would be more mobile and less vulnerable to climate change.
- Employment – Higher employment levels, particularly skilled labor, indicate higher income potential and capacity to be more resilient to climate change impacts.

INSTRUCTIONS FOR MODULE 3

In this module, you identify the adaptive capacity (strengths) and non-climate stressors that will influence the impacts of climate change on your municipality. Adaptive capacity strengthens capacity to address climate impacts, while non-climate stressors weaken capacity to address climate impacts. Complete Table 3 by taking the following steps for each diagnostic factor. The diagnostic factors are listed in column 1. An example is provided in the first row. You may also want to refer to Table 5: Examples of Adaptive Capacity and Non-Climate Stressors Affecting Municipal Sectors and Services, at the end of this tool. Table 5 provides an illustrative list of adaptive capacities and non-climate stressors that may be useful to you.

1. In the first column, review the diagnostic factors and select those that are relevant to your municipality.
2. In the second column, enter the specific adaptive capacities/ strengths that are in place that may moderate current and/or future impacts.
3. In the third column, list specific non-climate stressors that may increase current and/or future impacts. Notice that some non-climate stressors and adaptive capacities may apply to several of the resources, sectors, and services.
4. In the last column, indicate whether there will be, on balance, an overall increase or reduction in vulnerability given the capacities and stressors you have identified. To what extent will the potential impacts you identified in Table 2 be exacerbated or reduced?

When you have completed Table 3, you will have compiled a complete picture of the adaptive capacity of your municipality and the non-climate stressors that will influence the degree of climate change impacts.

Table 3: Non-Climate Stressors and Drivers of Change That May Increase Current and/or Future Impacts, and Adaptive Capacity That May Moderate Climate Vulnerability

Diagnostic (Sector/ Service/Resource)	1. Adaptive Capacity (Strengths)	2. Non-Climate Stressors	3. Overall Increase or Reduction in Vulnerability?
E.g., Drinking Water	Well-developed contingency plans; large supply buffer	Highly polluted due to industrial effluent, increasing sedimentation as a result of deforestation (and intense rainfall events)	Increase
Human Settlements			
Water Resources, Coastal			
and Marine Resources,			
Forests			
Solid Waste Management			
Civil Protection and Health			
Housing, Sports Facilities,			
Cemeteries, Markets,			
Slaughterhouses, Cultural			
Heritage			
Drinking Water			
Sanitation Systems			
Wastewater Treatment			
Urban Mobility			
Stormwater Drainage			
Power System			
Telecommunications			
Agriculture			
Fisheries			
Industry			
Tourism			

MODULE 4

INTERPRET RESULTS AND IDENTIFY VULNERABILITIES

The outputs from the above exercises can help to provide a perspective on broad vulnerabilities to different resources, sectors, and services—through combined consideration of their level of exposure and sensitivity to climate stressors—and the influence of non-climate stressors, and adaptive capacity. In this module, you should interpret and synthesize the outcomes from Modules 2 and 3 to reach conclusions about the overall vulnerability of each resource, sector or service under consideration. The information you use to describe specific vulnerabilities should also include the scale, or granularity, of the risks you are considering. Climate change vulnerability can be considered at different scales, ranging from vulnerability of specific assets or facilities in particular locations to broader, community-wide vulnerability.

The vulnerabilities listed below can be synthesized and integrated into the PMOT territorial diagnosis to provide a clear indication of who and what activities are vulnerable (to what climate stressors), and where they are located. This information can be spatially represented, or documented in the land use plan. For example, maps delineating exposure of key populations and assets to different climate vulnerabilities can be prepared and included.

INSTRUCTIONS FOR MODULE 4

In Modules 4 and 5 you build on your findings in the previous modules to summarize and prioritize the climate vulnerabilities your municipality will face. In Module 4, start by completing the first two columns in Table 4 to identify the vulnerabilities you need to consider.

1. **Resource, Sector, Service:** In the first column, enter the resources, sectors and services where impacts were identified, referring to Table 2, column 1.
2. **Describe Vulnerability:** Using the information documented in Tables 2 and 3, write in column 2 a short description of the current and potential future impacts (from Table 2), and how these impacts may be affected by non-climate stressors and adaptive capacities (from Table 3) for each resource, sector, or service you noted in the first column. See the example in the first row.

You will rate the level of priority in the next module (Module 5).

Table 4: Priority Climate Vulnerabilities by Resource, Sector and Service

Resource, Sector, Service	Describe Climate Vulnerability	Priority
Ex. Drinking Water	Currently affected by periodic drought, climate change is projected to reduce rainfall and dry periods are projected to increase in frequency and duration. Population growth, and increasing competing water needs, and pollution, will exacerbate future ability to meet demands. Contingency planning and increased groundwater use may offer short-term resiliency to drought.	High

MODULE 5

PRIORITIZE VULNERABILITIES

Now that you have identified the climate vulnerabilities your municipality is facing, this module aims to help you prioritize these vulnerabilities. Understanding the relative importance of different vulnerabilities can help you make sound choices about what actions to take first and where to invest your resources.

To prioritize vulnerabilities, it is important to identify stakeholder priorities to ensure you consider different concerns and perspectives. This can be done as a participatory process by forming stakeholder working groups to establish criteria and incorporate input from an array of stakeholders (e.g., other government agencies, nonprofits or other groups focused on particular diagnostics, academics, etc.). For example, priority concerns can include the safety of residents, preservation of natural resources, socio-economic development, and other aspects important to the community.

To prioritize vulnerabilities, consider the criticality, likelihood, and consequence of the associated impacts:

a. **Criticality:** Are people at risk? How important are the asset(s) that would be impacted to achieving the economic and services objectives in your region?
b. **Likelihood:** What is the probability of the climate impact occurring and affecting the people and/or assets?
c. **Consequences:** What would be the severity of an impact if it does occur? Would the climate impact temporarily or permanently decommission the use of the asset? Will people be put into harm's way?

For instance, if socio-economic development is selected as a priority concern, higher priority vulnerabilities could include vulnerabilities to sectors/resources/services that are highly critical to socio-economic development, and address the vulnerability to other sectors and services would be a lower priority. The vulnerabilities of sectors/resources/services with low sensitivity or high adaptive capacity could also be considered lower priority.

INSTRUCTIONS FOR MODULE 5

In this module, you review the vulnerabilities you identified in Module 4 (Table 4) and decide their relative importance for action. Take the following steps:

1. In your working group, review the vulnerabilities in Table 4. Consider the criticality, likelihood, and consequence of each diagnostic vulnerability in the context of your municipality's development objectives and stakeholder priorities.
2. In the far right column of Table 4, indicate whether the priority of the vulnerability is high, medium, or low priority based on your assessment of the relative significance of each climate vulnerability impact.

When you have completed Module 5, you will have completed the Climate Vulnerability Assessment. You can use these findings to inform the Stage 2: Territorial Diagnosis in your land use planning process. The results of your assessment can also be shared with other decision makers.

Suggested resources for further information: Municipal vulnerability assessment, ONAMET, community or household hazard surveys, USAID Climate-Resilient Development resources: http://www.ccrdproject.com/.

Table 5: Examples of Adaptive Capacity and Non-Climate Stressors Affecting Municipal Sectors and Services

Adaptive Capacity That May Moderate Climate Vulnerability, and Non-Climate Stressors and Drivers of Change That May Increase Current and/or Future Climate Impacts		
Sector/Service	**Adaptive Capacity (Strengths)**	**Non-Climate Stressors (Weaknesses / Drivers)**
Human Settlements	Well-constructed communities	Dense, poorly constructed communities
Water Resources, Coastal and Marine Resources, Forests	Healthy and well-managed water/coastal/ marine resources and forests	Unhealthy and/or poorly managed water/ coastal/marine resources and forests
Solid Waste Management	Effective solid waste management system where very little waste pollutes the built and natural environment	Poor solid waste management system where the built and natural environments are highly polluted, and natural drainage is blocked by waste
Civil Protection and Health	Widespread civil protections, including early warning/ early action systems, and healthy population	Limited or inequitable civil protections and unhealthy population
Housing, Sports Facilities, Cemeteries, Markets, Slaughterhouses, Cultural Heritage	Well cared-for facilities that are in good condition	Degraded infrastructure, lack of proper waste treatment (slaughterhouse)
Drinking Water	Large supply to buffer seasonality, strong operational management systems	Insufficient drinking water supply and/or treatment, poor watershed management
Sanitation systems	Effective sanitation systems	Ineffective sanitation systems
Wastewater Treatment	Effective system that treats and disposes wastewater in a manner that does not adversely affect human or ecosystem health	Ineffective system, or lack thereof, that results in wastewater adversely affecting human or ecosystem health
Urban Mobility	Dense, redundant road networks, and connectivity	Limited road networks, connectivity

Adaptive Capacity That May Moderate Climate Vulnerability, and Non-Climate Stressors and Drivers of Change That May Increase Current and/or Future Climate Impacts		
Sector/Service	**Adaptive Capacity (Strengths)**	**Non-Climate Stressors (Weaknesses / Drivers)**
Stormwater Drainage	Effective stormwater drainage that prevents or reduces flooding during storms and extreme precipitation events	Ineffective stormwater drainage where flooding occurs during storms and extreme precipitation events
Power System	Reliable system that produces sufficient energy and distributes energy in an equitable manner	Unreliable system or system that produces insufficient energy, frequently blacks out, or distributes energy in an inequitable manner
Telecommunications	Reliable system that supports telecommunications in all populated areas	Unreliable system or system that does not support telecommunications in all populated areas
Agriculture	System that farms land in a sustainable manner, preserving soil and using water efficiently	System that farms land in an unsustainable manner, resulting in land and water degradation; such as slash and burn agriculture, or increased erosion due to poor farming practices
Fisheries	System that farms marine animals in a sustainable manner	System that farms marine animals in an unsustainable manner, damaging coral, or depleting resources
Industry	System that responsibly manages its emissions and waste	System that pollutes its community
Tourism	Well-managed tourism where community reaps the benefits and natural resources are not over-burdened	System where community does not reap benefits, natural resources are over-burdened (e.g., degradation of mangroves, construction close to beaches), and infrastructure is poorly planned

STAGE 3 TOOLS

- Climate Adaptation Assessment Tool
- Climate Adaptation Measures Matrices

Resource Title	CLIMATE ADAPTATION ASSESSMENT TOOL
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☑ Stage 3: Territorial Prospective ☑ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	This Adaptation Planning Tool supports municipal land use planners in identifying adaptation measures to address climate vulnerabilities and promote climate-resilient planning. It can be used to support municipal land use planning, as well as other municipal planning efforts. The tool consists of five modules: 1) confirm priority climate change vulnerabilities, 2) identify potential adaptation measures, 3) evaluate these measures, 4) develop an adaptation portfolio, and 5) integrate adaptation measures into land use programming. Users can start with the climate vulnerabilities that they identified in the *Climate Vulnerability Assessment Tool*, also in Annex I of this Notebook, and use this tool to prioritize and plan implementation of adaptation measures to address these vulnerabilities.
Methodology	First, the planner will identify vulnerabilities or bring in those identified through other stages of the Notebook. The vulnerabilities are prioritized based on the significance of the climate impacts on sectors, resources, or services that are important to the municipality. Then, potential adaptation measures are identified for each priority vulnerability and linked to PMOT diagnostic factors, vulnerability components, and land use elements. In the evaluation phase, the planner defines evaluation criteria and applies them to the list of possible adaptation measures generated in the previous module. Based on this evaluation, the user compiles a portfolio of adaptation measures that are ranked highly. Both land use and non-land use measures can be integrated into planning to help increase capacity and minimize vulnerability.
User(s)	Municipal staff involved in land use planning, other municipal decision makers, and a range of stakeholders representing community interests, and individuals with financial, technical, and institutional capacities. .
Intended Use	To identify and evaluate adaptation options for municipal planning

Resource Title	CLIMATE ADAPTATION ASSESSMENT TOOL
Key Output(s)	1. Priority Vulnerability Worksheet 2. Adaptation Measure Description Worksheet 3. Evaluation Summary Table 4. Land Use Adaptation Measure Integration Worksheet and Non-Land Use Adaptation Measure Integration Worksheet
Limitations	The tool does not provide detailed engineering or design specifications of adaptation measures or address institutional roles or implementation mechanisms.
Ease of Use	Four- to eight-hour exercise. Users require a working knowledge of municipal resources, sectors, and services; and understanding of the historical sensitivity of assets to climate and non-climate stressors.

CLIMATE ADAPTATION ASSESSMENT TOOL

INTRODUCTION

This tool provides guidance to help planners identify climate change adaptation measures to address vulnerabilities and promote climate-resilient planning at the municipal level. It can be used to support municipal land use planning, as well as other municipal planning efforts. The tool contains five modules. The first three inform Stage 3: Territorial Prospective, and the last two feed into Stage 4: Programming. There may also be some iteration of adaptation measures as you move from Stage 3 into Stage 4.

Stage 3: Territorial Prospective		Stage 4: Programming
Module 1: Confirm priority climate change vulnerabilities **Module 2:** Identify potential adaptation measures **Module 3:** Evaluate adaptation measures	Iteration of measures	**Module 4:** Develop an adaptation portfolio **Module 5:** Integrate adaptation measures into programming and prepare for implementation

This Climate Adaptation Assessment Tool features a series of checklists and worksheets to help guide your analysis and decision making. The tool is compatible with the Climate Vulnerability Assessment Tool; priority vulnerabilities to inform adaptation planning can be taken directly from Module 4 in the Climate Vulnerability Assessment Tool. Alternatively, users can identify vulnerabilities as outlined in Module 1, in this tool, below. You are encouraged to make copies of these checklists and worksheets for each vulnerability and/or adaptation measure you analyze.

HOW DOES THIS TOOL LINK TO THE PMOT STEPS?

This tool supports the integration of climate adaptation strategies into PMOT Stage 3: Territorial Prospective and Stage 4: Programming, as shown in Figure 1 below. The output of Module 3, a list of potential adaptation strategies, will be incorporated into the development of scenarios in Stage 3. During Stage 4, these adaptation strategies may be revised or de-prioritized, based on how they align with other land use measures, to develop a portfolio of adaptation measures that will be included in the final land use plan or in other municipal plans. For those that are included in the final plan, this tool provides guidance to integrate them into Stage 4: Programming, where activities are developed. At each stage of land use planning, you evaluate the adaptation strategies to see if they are appropriate for the context and needs of the municipality.

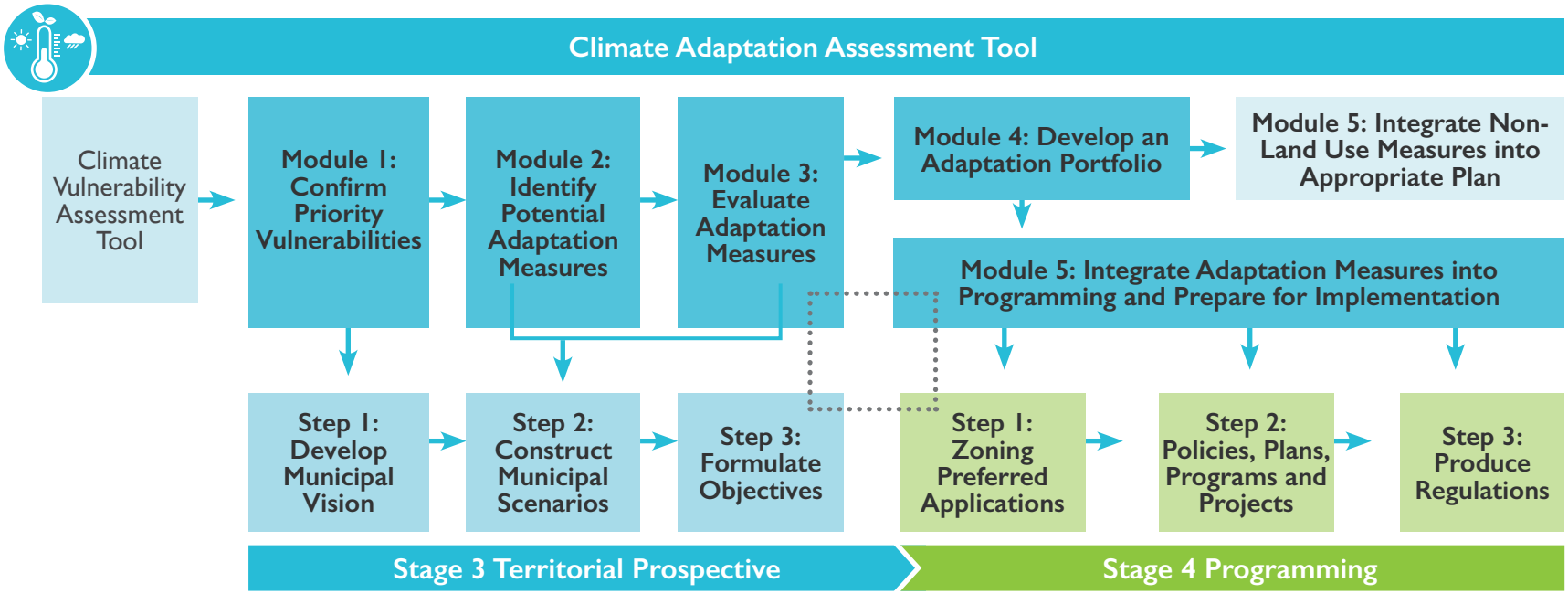


Figure 1. Relationship of climate change adaptation assessment to the Stage 3: Territorial Prospective and Stage 4: Programming of the PMOT Guide. Addressing the priority vulnerabilities (an output either from the Climate Vulnerability Assessment Tool or the Adaptation Tool, Module 1) can be integrated into the development of the municipal vision, and the potential adaptation measures can be integrated into the scenario development process. Ultimately a final portfolio of adaptation measures is included in the Stage 4 programming activities of zoning, policies, plans, and programs. The process of selecting adaptation measures is typically iterative as stakeholders formulate objectives and identify activities. Non-land use adaptation measures can be identified at the same time, and assigned to other municipal plans and policies for implementation.

WHO SHOULD BE CONSULTED?

Identifying strong adaptation measures and implementing these actions usually requires the involvement of several different stakeholders who can provide different community perspectives and offer financial, technical, and institutional capacities. Therefore, the process of brainstorming ideas and evaluating potential climate change adaptation measures should engage a range of stakeholders (e.g., the land use planning working group). This will help ensure that the final adaptation plan reflects the range of needs and opinions relevant to your municipality. Engaging stakeholders early in the process helps build consensus and support for the adaptation work ahead. For more guidance on identifying and engaging stakeholders, see Stage 1 of this Notebook.

HOW TO USE THE CLIMATE ADAPTATION ASSESSMENT TOOL

To use this tool, follow the instructions for each of the five modules, beginning with Module 1. Each module starts with a brief explanation of the purpose of that module, followed by step-by-step directions. The five modules of this tool are:

- **Module 1. Confirm priority climate change vulnerabilities:** Select the climate vulnerabilities that are most important to address through the adaptation planning process, drawing on the findings of the *Climate Change Vulnerability Assessment* or another analysis.
- **Module 2. Identify potential adaptation measures:** Identify a pool of measures that you could implement to address the priority climate vulnerabilities you identify in Module 1.
- **Module 3. Evaluate adaptation measures:** Assess the strengths and weaknesses of different potential measures, using criteria you define with stakeholders.
- **Module 4. Develop an adaptation portfolio:** Compile a set of adaptation measures that will work well together to address climate vulnerabilities, including both land use measures and other approaches.
- **Module 5. Integrate adaptation measures into programming and prepare for implementation:** Include adaptation measures in your land use programming and decide how these measures will be implemented.

Exposure: Whether, how, and how much people, livelihoods, species, ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets experience climate variability and change.

Sensitivity: The extent to which a system, asset, or species is positively or negatively affected when/if exposed to a climate stressor. The effect may be direct (e.g., a change in crop water consumption in response to temperature change) or indirect (e.g., damage to roads as a result of erosion due to an increase in severe coastal flooding and sea level rise). The more sensitive the asset, resource, or population is to one or more climate stressors, the more vulnerable it tends to be.

Adaptive Capacity: The ability of a system to respond successfully to climate variability and change by minimizing exposure and sensitivity.

Understanding whether an adaptation measure addresses exposure, sensitivity, or adaptive capacity provides useful information as to which component of the vulnerability is being addressed.

MODULE 1

CONFIRM PRIORITY CLIMATE CHANGE VULNERABILITIES

The purpose of this module is to confirm the priority vulnerabilities from climate change to your municipal resources, economic sectors, and services. Agreeing on these priority concerns will help you focus your assessment of adaptation measures on the vulnerabilities that are of greatest concern to the municipality.

INSTRUCTIONS FOR MODULE 1

In this module, you enter your priority climate change vulnerabilities into Table 1: Priority Vulnerability Worksheet, below. The way you accomplish this depends on what analysis you have already conducted and the information you have about climate change vulnerabilities that your municipality confronts.

Do you know your municipality's climate vulnerabilities? If so, use this information to complete Table 1, below.

- **If you have filled out the Climate Vulnerability Assessment Tool,** use your results from Table 4 in that tool. Enter the vulnerabilities listed as "high priority" in that Table 4 into Table 1 below.
- **If you have not filled out the Climate Vulnerability Assessment Tool but have results from another vulnerability analysis,** use those results to identify and confirm priority vulnerabilities. Enter the vulnerabilities identified as "high priority" in previous analyses into the Table 1: Priority Vulnerability Worksheet, below.

Do you need to identify your municipality's climate vulnerabilities? If you have not yet identified your municipality's climate vulnerabilities, follow these instructions.

- **If you have not used the Climate Vulnerability Assessment Tool** and do not have results from another vulnerability analysis, take the following steps:

1. Identify the priority resources, sectors, and services of the municipality

PMOT Stage 2: Territorial Diagnosis includes identifying and assessing important municipal and surrounding area resources, economic sectors, and services in order to evaluate their sustainability and vulnerabilities. This includes resources, sectors, and services located within your municipality; it also includes those resources located outside of the municipal boundaries that are important to the municipality, such as water resources for the provision of drinking water supply, or hydro-electricity. The PMOT Stage 2 diagnostics are organized into environmental, socio-economic, and spatial components. Within these components, there are several factors that may be vulnerable to climate change impacts, such as:

- Population: Human Settlements
- Environmental and Natural Resources: Water Resources, Coastal and Marine Resources, Forests
- Municipal Services and Equipment: Solid Waste Management, Civil Protection and Health, Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage
- Infrastructure Services: Drinking Water, Sanitation, Wastewater Treatment, Urban Mobility, Stormwater Drainage, Power System, Telecommunications
- Commerce and Industry: Agriculture, Fisheries, Industry, Tourism

Discuss the factors that are relevant to your municipality, and which are most important to the vision and development goals of your municipality. Once you have identified these priority diagnostic factors in PMOT Stage 2, enter these into the first column of the Table 1: Priority Vulnerability Worksheet, below.

2. Describe the climate change vulnerability of the priority diagnostic factors.

Drawing on the knowledge and expertise of your working group and other stakeholders, summarize the climate vulnerability of the factors you identified in step 1. This includes describing the three components of climate vulnerability: climate stressor exposure, sensitivity and potential impacts, and adaptive capacity and non-climate stressors. An example is provided in the first row.

a. Describe climate stressor exposure and impacts. For each priority diagnostic, consider which climate stressors it is exposed to, what negative impacts these stressors may induce, and how these stressors are projected to change. In the Dominican Republic, common climate stressors are flooding, landslides, tropical storms, coastal erosion, and drought. Other climate stressors that may be relevant to your municipality include rainfall (average and extreme), temperature (average, minimum, and maximum), sea level rise, sea temperature, and fires. Keep in mind that under a changing climate, stressors and their impacts will likely be different from what has been observed in the past. Enter the climate stressor impacts of concern and describe how the stressors and associated impacts are projected to change in column 2 of the Table 1: Priority Vulnerability Worksheet, below. Note that because each diagnostic factor is likely impacted by more than one climate stressor, three vulnerability rows are provided for each diagnostic factor, into which you can enter three separate climate impacts. Feel free to add additional rows if necessary. For more information on collecting climate information and identifying climate stressors, see the Climate Information Worksheet and Module 1 of the *Climate Vulnerability Assessment Tool*. For more information on identifying climate impacts and sensitivities, see *Module 2* of the *Climate Vulnerability Assessment Tool.*

b. Describe non-climate stressors and adaptive capacity. For each priority diagnostic climate impact, consider which non-climate stressors may exacerbate climate impacts, and which adaptive capacities may mitigate climate impacts. Describe these strengths and weaknesses. For example, a strong community education program can help build adaptive capacity to respond to severe weather events, thus helping to reduce the impact of climate stress. An increase in deforestation, a non-climate stressor, could exacerbate flooding during severe weather events, thus contributing to a climate vulnerability. Adaptive capacities and non-climate stressors can relate to a variety of characteristics of your municipality:

- **Governance:** *governance and institutional capacity, regulations and enforcement capacity, political instability, land ownership rules, urban planning, resource management, human conflict, urban mobility*
- **Pollutants and degradation:** *pollution, deforestation, solid waste management, natural territory protection*
- **Demographics:** *population growth, urbanization, gender barriers*
- **Poverty rates:** *poverty rates, strained financial resources, access to technology*
- **Education, health, and employment:** *education, access to health care, employment*

In column 2 of Table 1: Priority Vulnerability Worksheet, below, list the non-climate stressors and adaptive capacities that would most strongly exacerbate or moderate climate impacts, and what the effect would be. For more information on assessing the impact of non-climate stressors and adaptive capacities, see Module 3 of the Climate Vulnerability Assessment Tool.

3. **Determine whether the vulnerability is a priority.** For each diagnostic vulnerability, determine whether the vulnerability is a high priority by considering:

a. Criticality – Are people at risk? How important is the factor to supporting communities and achieving the socio-economic objectives of your municipality?
b. Likelihood – What is the probability of the climate impact occurring and affecting your municipality?
c. Consequences – How serious would the impact be? Would the climate impact temporarily or permanently disrupt important activities or services? Will people be in harm's way?

In general, the vulnerability will be a high priority if it would affect critical infrastructure or services, or if the consequences of impacts would be severe. In column 3, enter whether the vulnerability is or is not a high priority for your municipality. For more information on prioritizing vulnerabilities, see Module 5 of the Climate Vulnerability Assessment Tool.

Table 1: Priority Vulnerability Worksheet

1. Priority Resource, Sector, Service	2. Describe Vulnerability	3. Priority Vulnerability?
Ex. Drinking Water	**Vulnerability 1.** Water supply. **Exposure and sensitivity/impacts:** Currently affected by periodic drought. Climate change is projected to reduce rainfall and dry periods are projected to increase in frequency and duration. **Non-climate stressors:** Population growth and increasing competing water needs will exacerbate future ability to meet demands. **Adaptive capacity:** Existing contingency planning and increased groundwater offers some short-term resiliency to drought.	Yes
	Vulnerability 2.	
	Vulnerability 3.	
	Vulnerability 1.	
	Vulnerability 2.	
	Vulnerability 3.	
	Vulnerability 1.	
	Vulnerability 2.	
	Vulnerability 3.	
	Vulnerability 1.	
	Vulnerability 2.	
	Vulnerability 3.	

MODULE 2

IDENTIFY POTENTIAL ADAPTATION MEASURES

In this module, you identify and characterize a range of potential adaptation measures to address the priority vulnerabilities you identified in Module 1, using the Table 2: Adaptation Measure Description Worksheet, below. Use the compendium of example adaptation measures, the sector adaptation factsheets, and the worksheet below to brainstorm potential adaptation measures. While there are examples of many measures in the compendium and the sector adaptation factsheets, you are encouraged to come up with other land use and non-land use measures as well.

INSTRUCTIONS FOR MODULE 2

In this module, take the following steps to complete the Table 2: Adaptation Measure Description Worksheet. You will need one table for each vulnerability (or set of vulnerabilities) you decide to address.

1. **Vulnerability:** In the first row of the worksheet, list the priority vulnerability(ies) you want to address (from the Priority Vulnerability Worksheet in Module 1). Briefly describe who or what is vulnerable, the type(s) of climate stressor you are concerned about, and the non-climate stressors that exacerbate the vulnerability.
2. **Adaptation Measure:** Write down an adaptation measure that may address the vulnerability. Note that some adaptation measures may address multiple vulnerabilities; add these additional vulnerabilities if applicable.
3. **Resources, Economic Activities, and Services:** List the PMOT Stage 2 diagnostic factor that the adaptation measure addresses, which may include:

    - Population: Human Settlements
    - Environmental and Natural Resources: Water Resources, Coastal and Marine Resources, Forests
    - Municipal Services and Equipment: Solid Waste Management, Civil Protection and Health, Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage
    - Infrastructure Services: Drinking Water, Sanitation, Wastewater Treatment, Urban Mobility, Storm Water Drainage, Power System, Telecommunications
    - Commerce and Industry: Agriculture, Fisheries, Industry, Tourism

    Note that some adaptation measures may address multiple resources, economic activities, and services.

4. **Component(s) of Vulnerability Addressed:** In the next set of columns, identify which of the three components of vulnerability the potential adaptation measure would address for each relevant stressor. Would it reduce exposure or sensitivity to the climate change stressor(s)? Would it increase your capacity to adapt to these stressors, or to counteract the negative effect of a non-climate stressor? For the applicable climate stressor(s), enter:

    - E = Exposure
    - S = Sensitivity
    - AC = Adaptive Capacity

5. **Land Use Element:** The land use adaptation measures can be categorized by type, as outlined in PMOT Stage 4: Programming, which includes: 1) zoning; 2) project, plans, programs, and policies; and 3) regulations. In this set of columns, identify which of these elements would be necessary to implement the potential adaptation measures.

6. **Non-Land Use Strategies:** In this column, identify the adaptation measures that are not applicable to the land use plan by checking the box. For example, adaptation measures that may not be related to land use include structural (engineering) projects, capacity building, operations and maintenance measures, research activities, and different policy measures.

Repeat the directions above in each new row as you brainstorm additional adaptation measures to address the vulnerability. Repeat the process for additional vulnerabilities, making copies of the blank table as needed, and keep these worksheets available for the subsequent Modules 3 and 4 in this tool.

Table 2: Adaptation Measure Description Worksheet

1. Vulnerability:									
2. Adaptation Measuren	3. Resources, Economic Activities, and Services	4. Component(s) of Vulnerability Addressed (enter E, S, AC)				5. Land Use Element			6. Non-Land Use Strategy
		Tempera-ture increase	Heavy rainfall and floods	Reduced rainfall and drought	Sea level rise, storm surge, and coastal flooding	Zoning	Policies, plans, programs, and projects	Regulations	
#1									
#2									
#3									
#4									
#5									
#6									
#7									
#8									
#9									

*Create copies of this worksheet as needed for each vulnerability analyzed.

MODULE 3
EVALUATE ADAPTATION MEASURES

In this module, you evaluate the adaptation measures that you identified in Module 2 by considering how well they address the identified vulnerability and fit within the context of the municipality's capabilities and objectives. Be sure to engage appropriate stakeholders to ensure that you have the right perspectives and expertise at the table when you conduct this evaluation.

INSTRUCTIONS FOR MODULE 3

Take the following steps to evaluate the potential adaptation measures you have identified.

- **Choose Evaluation Criteria.** The first step is to agree on the criteria you will use to assess the relative strengths and weaknesses of different options. These evaluation criteria will help you assess how well the possible adaptation measures are likely to help reduce climate vulnerability, and how likely it is that you will be able to implement the measures. In this tool, start with the first three evaluation criteria in the box to the right: Effectiveness, Feasibility, and Affordability. You and your stakeholders may decide to use other criteria as well. Some additional optional considerations are listed in case they are important to your objectives. The Table 3: Evaluation Criteria and Example Considerations, provides illustrative questions you can use to evaluate adaptation measures for each of these criteria. With your working group, decide what criteria you will use. Mark the criteria you have selected on the Table 3: Evaluation Criteria and Example Considerations.
- **Complete Table 4: Evaluation Summary Worksheet**. To complete Table 4, use the example questions in Table 3 to discuss and evaluate each adaptation measure. Record your conclusions in Table 4, following these step-by-step directions:

  1. Enter into Table 4 the vulnerability, adaptation measures, and adaptation measure type from Module 2.
  2. For each identified adaptation measure from Module 2, consider the questions in the Table 3: Evaluation Criteria and Example Considerations, for each of the evaluation criteria you have selected.
  3. In the Table 4: Evaluation Summary Worksheet, record your overall assessment of how well the adaptation measure fits each criterion based on the municipal context. Rank the adaptation measure against each criterion on a scale of 1 to 5 (1 = Low and 5 = High).

Evaluation Criteria

- Effectiveness
- Feasibility
- Affordability
- Additional Considerations:
  - Additional Benefits
  - Robustness/Flexibility
  - Avoidance of Unintended Costs
- Timeframe

  4. Based on your evaluation of each potential adaptation measure, select the most appropriate adaptation measure(s) to integrate into your plan by checking the box in the column, "appropriate to implement," in Table 4. In general, the most appropriate measures will have moderate to high ratings for **effectiveness, feasibility, affordability, and additional considerations.**
  5. Some measures may be implemented quickly, while others may take many years to develop. Estimate the **timeframe** each measures will take to implement and enter that estimate into Table 4.
  6. Use the last column "Include in Portfolio" in the next module, Module 4.

- **Integrate land use-related adaptation measures into scenarios.** Once you have identified potential adaptation measures deemed "appropriate to implement" in Table 4: Evaluation Summary Worksheet (see Module 5, below), you will carry these measures into the construction of future ideal scenarios and develop objectives and guidelines applicable to these scenarios under the territorial prospective in Stage 3.

You will likely find that the selection of adaptation measures is an iterative process. As you move from developing the territorial prospective in Stage 3 and programming in Stage 4, you will learn more about your municipality's needs and options, and understand what measures will be most feasible.

Table 3: Evaluation Criteria and Example Considerations

Criteria	Considerations
Effectiveness: How well would the adaptation measure address the vulnerability?	◻ To what extent will the adaptation measure reduce the vulnerability? ◻ How robust is the adaptation measure? How would it perform under the range of possible outcomes from climate projections? ◻ Once the adaptation measure is implemented, how quickly can it become effective? Some measures, such as physical structures, can produce benefits immediately upon completion, while others, such as zoning or regulations, may take more time to produce results. ◻ For how long will the measure be effective in reducing climate vulnerability? ◻ Are there any characteristics of the adaptation measure that might weaken its ability to address the vulnerability?
Feasibility: How likely is it that you can implement this measure?	◻ Do you have the knowledge, information, and technical and institutional capacity to design the adaptation measure? ◻ Do you have the resources and materials to successfully implement the measure? ◻ Do the existing national, regional, and local capacities, institutions, and processes create an environment in which the adaptation approach could be appropriately implemented? ◻ Can you implement this independently, or is the support of other institutions required to move forward? ◻ Do you have the capacity and resources to enforce the measure?
Affordability: How costly is it to implement this measure and do you have the financial resources?	◻ Is the adaptation measure inexpensive relative to other adaptation measures you have identified? ◻ Is the cost of the measure in proportion to the increase in resilience it would achieve? ◻ Do you have the appropriate financial resources to fund the adaptation measure?
Additional Considerations (Optional)	◻ **Additional Benefits:** What other benefits might the adaptation measure provide? • Would the measure help accomplish other municipal objectives or mitigate non-climate stressors in addition to improving climate resilience (e.g., improving economic opportunities, socio-economic wellbeing, environmental quality, etc.)? • Would the measure help reduce greenhouse gas emissions? ◻ **Flexibility:** How easily can the adaptation measure be adapted to changing political, social, or environmental conditions? • Can the adaptation measure be reversed or changed if conditions change? • Would it be possible to strengthen the adaptation measure if needed, or implement complementary measures? ◻ **Avoidance of Unintended Costs:** Could there be additional costs? Have there been unexpected costs from actions similar to this adaptation measure in the past?
Timeframe: How much time will it take to implement?	◻ The rankings of the above criteria (effectiveness, feasibility, affordability, and other considerations) may impact how quickly you can implement your adaptation measure. Taking these into account, how much time will it take to implement the adaptation measure?

Table 4: Evaluation Summary Worksheet

Vulnerability: _____									
	Type		Effectiveness (1–5)	Feasibility (1–5)	Affordability (1–5)	Additional Considerations (1–5)	Timeframe	Appropriate to implement?	Include in portfolio?
	Land Use	Non-Land Use							
Adaptation Measure #1								☐	☐
Adaptation Measure #2								☐	☐
Adaptation Measure #3								☐	☐
Adaptation Measure #4								☐	☐
Adaptation Measure #5								☐	☐
Adaptation Measure #6								☐	☐
Adaptation Measure #7								☐	☐
Adaptation Measure #8								☐	☐

*Create a copy of this worksheet for each vulnerability analyzed.

MODULE 4

DEVELOP AN ADAPTATION PORTFOLIO

The results of the work that you have completed in Modules 1, 2, 3 of this tool will help you complete Stage 3 of the PMOT process. Moving forward, the work you conduct in Modules 4 and 5 of this tool will be used in Stage 4: Programming.

In this module you look again at the promising adaptation options you identified in Module 3, and consider how to develop a set of measures that will work best together to set the municipality on a strong path to resilience. Ultimately, you identify a portfolio of adaptation measures that you will integrate into the land use plan or into other non-land use planning strategies, drawing from the pool of strong measures that you identified in Module 3 and in the Stage 3: Territorial Prospective.

Resilience may not be achieved through a single adaptation measure; typically, a number of actions are required. An adaptation portfolio is a group of complementary adaptation measures that address one or multiple vulnerabilities. These adaptation measures may include a variety of land use and non-land use adaptation types, timeframes for implementation, costs, and other characteristics. They may also engage a mix of different stakeholders. Together, these measures create a comprehensive and robust climate resilience portfolio. In this module, you design this portfolio.

As in Module 3, the process of selecting climate change adaptation measures for the portfolio should involve a range of stakeholders (e.g., the land use planning working group, community representatives), especially those engaged in Stage 3: Territorial Prospective. This will help ensure that the results better reflect the outcomes of Stage 3, and the range of needs, capabilities, and opinions within your municipality, and generate support for the plan during implementation.
Once the portfolio is designed, the land use-related adaptation measures can be integrated into the PMOT Stage 4 Programming, and non-land use measures can be incorporated in other municipal plans and programs, as outlined in the next module.

INSTRUCTIONS FOR MODULE 3

Take the following steps to develop a portfolio of adaptation measures. Continue to use Table 4: Evaluation Summary Worksheet from Module 3 as you build your adaptation portfolio.

1. Review the list of adaptation measures you developed in Module 3, and consider the questions in Table 5: Guidance Questions for Developing Your Adaptation Portfolio, below.
2. Based on your answers to these questions and stakeholder input, identify the measures that you will include in the portfolio. Check "Include in Portfolio" in Table 4: Evaluation Summary Worksheet, if the adaptation measure is appropriate.
3. For each of the measures you include, identify if it as a land use measure or non-land use measure by checking the appropriate box.
4. Assess the completed portfolio of measures and make adjustments or additions as needed. In particular, consider what strategies may be missing that would help you achieve greater resilience.

Table 5: Guidance Questions for Developing Your Adaptation Portfolio

Of the adaptation measures that were marked as "appropriate to implement" in Table 4: Evaluation Summary Worksheet in Module 3, which ones work well together? Consider the following:	
Land Use Element	◘ Do the land use measures related to policies, plans, programs, projects, and regulations support the zoning scenarios?
Non-Land Use Synergy	◘ Does the portfolio include a variety of types of measures, including both land use and non-land use measures? ◘ Do the identified non-land use measures complement the land use measures, and provide additional important resilience benefits?
Timing	◘ Are there a variety of measures that can be implemented both in the near term and long term? ◘ Does the portfolio include "quick wins" that will improve resilience in the next year or two?
Feasibility	◘ Is the portfolio of measures manageable? Does the municipality have the capacity to implement the entire portfolio, over time? ◘ Are there any additional immediate adaptation measures that can make longer-term measures more feasible or effective? Are there adaptation measures that were not marked as "appropriate to implement" in the "Evaluation Summary Table," could be implemented following the completion of others? ◘ Are there ways to make difficult measures more feasible? Are there any long-term, complex adaptation measures that can be implemented in phases, split into multiple measures, or simplified, leading to incremental progress toward long-term adaptation?
Overall Effectiveness	◘ How well do the measures address frequent, moderate risks vs. infrequent, severe risks? ◘ Is the portfolio of measures sufficient to reduce current and future vulnerabilities?

MODULE 5

INTEGRATE ADAPTATION MEASURES INTO PROGRAMMING AND PREPARE FOR IMPLEMENTATION

This module will assist you in integrating your adaptation portfolio into your municipal land use planning and implementation process, and into other municipal plans, as part of Stage 4: Programming in the PMOT process. The module is broken down into two sections: (A) Determine how to integrate adaptation measures into land use planning, and (B) Begin implementation by assigning actors, specific responsibilities, and actions, and a developing a timeline for each adaptation portfolio measure.

MODULE 5A: DETERMINE HOW TO INTEGRATE ADAPTATION MEASURES INTO LAND USE AND OTHER PLANS

In this section of the module you determine how to incorporate each adaptation measure contained in your adaptation portfolio into the appropriate plan, so that all measures will move from plan to action. You will integrate the land use adaptation measures into the development of your municipal land use plan activities (PMOT Stage 4: Programming); the non-land use measures will be integrated into other appropriate plans and strategies.

INSTRUCTIONS FOR MODULE 5A:

Take the following steps to integrate your adaptation measures into land use and other plans.

1. Enter all adaptation portfolio measures that are related to land use into the first column of the Table 6: Land Use Adaptation Measure Integration Worksheet, below.
2. Identify opportunities to integrate each adaptation measure into the land use plan and enter these approaches in the second column of Table 6. Some land use adaptation measures may be easy to incorporate into the land use activities simply by updating land use measures that have already been identified to account for changes in climate or increased vulnerabilities. Others may require adding completely new land use activities into the land use plan, such as creating new regulations on climate adaptation. The integration of these measures into the land use plan in Stage 4: Programming is likely to be an iterative process as you develop a holistic plan that works well. To identify the necessary strategies, consider the following questions:

   - **Can you build on existing policies?** Do some of the adaptation measures in your portfolio directly relate to specific zoning; policies, plans, programs, projects; or to regulations already proposed for the land use plan?
   - **Can you augment activities already in process?** Are there opportunities to enhance the land use activities that have already been identified in order to address changes in climate?
   - **What measures are entirely new?** Would some adaptation measures represent unique or novel activities for the land use plan?
   - **Who should be involved?** Are there adaptation measures that engage the same stakeholders as the proposed activities for the land use plan? Are there opportunities to increase their awareness about climate change vulnerabilities and adaptation?
   - **Can you create synergies?** Are some adaptation measures expected to be implemented in the same area that some land use activities are currently implemented?
   - **Are there conflicts?** Are there proposed land use activities that would conflict with any of the adaptation measures? What steps need to be taken to resolve these conflicts?

3. Enter all adaptation portfolio non-land use measures into the first column of the Table 7: Non-Land Use Adaptation Measure Integration Worksheet, below.
4. In the second column of Table 6, describe how each non-land use adaptation measure will be integrated into the municipal development plan or other strategies. To identify the necessary strategies, consider the following questions:

- **What is the appropriate plan?** Some strategies may become part of the municipal development plan. Others may be appropriate for direct implementation by a municipal office. Still others may need to engage other jurisdictions, national government agencies, utilities, or the private sector.
- **Can you build on existing policies or programs?** Do some of the non-land use measures related to current programs or projects? Are there opportunities for synergies?
- **Are new institutional structures required?** What office or entity can take responsibility for moving the concept forward?
- **Who should be involved?** Are there stakeholders already engaged in similar work? Are there opportunities to increase their awareness about climate change vulnerabilities and adaptation?
- **Are there conflicts?** Would the proposed activities interfere with other programs or projects? What steps need to be taken to resolve these conflicts?

Table 6: Land Use Adaptation Measure Integration Worksheet

1. Land use adaptation measure	2. How will this adaptation measure be integrated into land use planning?

Table 7: Non-Land Use Adaptation Measure Integration Worksheet

3. Non-land use adaptation measure	4. How will this adaptation measure be integrated into a municipal plan or strategy?

MODULE 5B: ASSIGN ACTORS, RESPONSIBILITIES, AND TIMELINE FOR IMPLEMENTATION OF PORTFOLIO MEASURES

Once you understand how the adaptation measures fit into the land use plan and other municipal plans, and who needs to be involved, you consider the next steps needed to implement the adaptation measures. In this section of the module, you assign each adaptation measure in your portfolio to an actor with clear responsibilities for leading the implementation of the adaptation measure. You identify the specific actions that will be required and define a timeline for implementing the measure.

INSTRUCTIONS FOR MODULE 5B:

Take the following steps to identify the leader and critical next steps for implementation. For each land use and non-land use adaptation portfolio measure, enter the following information into Table 8: Adaptation Implementation Table. Create copies of the table as needed to address each adaptation measure.

1. **Enter the name of the adaptation measure** in the top row of Table 8: Adaptation Implementation Table, below.
2. **Identify a lead actor and supporting actors** within municipality departments or other stakeholders who are working on municipal land use and planning-related activities. The lead actor will be responsible for ensuring that the implementation of the adaptation measure moves forward. Be sure that the lead and supporting actors agree to this responsibility, and have the authority to take action.
3. **Assign clear responsibilities** to the lead actor and other key participants. This establishes ownership over activities and promotes accountability throughout the implementation process. If applicable, coordinate with other stakeholders, such as the national government, private stakeholders, community groups, and others to assign responsibility.
4. **Identify specific actions** to implement the adaptation measure. As you do so, identify any areas for incremental adaptation, particularly when you are implementing measures that will take a longer time. Are there near-term actions you can take that will help build resilience and make progress toward implementing a longer-term, more complex measure? Include these as steps in your action plan.
5. **Develop an estimated timeline** for implementing activities. Set intermediate checkpoints between now and the intended completion date to help ensure that progress continues to be made over the course of implementation. The timeline should align with the timeline of the municipal land use plan.

Table 8: Adaptation Implementation Table*

1. Adaptation measure:	
2. Actors	3. Responsibilities
Lead:	
Supporting actors:	
4. Specific Actions	5. Timeline

*Create a copy of this worksheet for each adaptation portfolio measure.

Resource Title	CLIMATE ADAPTATION MEASURES MATRICES		
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization	☑ Stage 4: Programming	☐ Stage 7: Formalization
	☐ Stage 2: Territorial Diagnosis	☐ Stage 5: Implementation	
	☑ Stage 3: Territorial Prospective	☐ Stage 6: Monitoring and Evaluation	
Description	This compendium lists examples of climate change adaptation measures applicable to land use planning, as well as to a range of other resources, sectors, and services. These resource, sector, and service categories map directly to the diagnostics categories used in the PMOT Land Use Planning Guide, to better enable their integration into the land use planning process. Each of the adaptation measures is characterized by adaptation type; resource, sector, and service; and the climate stressor and vulnerability component that it addresses. The sectors covered in this compendium are: 1. Human Settlements 2. Environment & Natural Resources 3. Solid Waste Management 4. Civil Protection & Health 5. Facilities: Housing, Sports Facilities, Cemeteries, Markets 6. Cultural Heritage 7. Drinking Water 8. Sanitation 9. Wastewater 10. Urban Mobility 11. Stormwater 12. Power 13. Telecommunications 14. Agriculture & Fisheries 15. Industry 16. Tourism		

Resource Title	CLIMATE ADAPTATION MEASURES MATRICES
Methodology	There are many ways to use the information in this spreadsheet: **Choose a Sector:** If you are primarily concerned about a particular sector (e.g., urban mobility, drinking water), you can select the relevant tab to review adaptation measures that particularly apply to that sector. The Land Use Adaptation Options tab highlights measures that use land use approaches to reduce climate risk and can be incorporated into the municipal land use plan. **Consider Strategies that Address Multiple Sectors:** The cross-cutting tab includes adaptation measures that may address risks to multiple sectors. In addition, adaptation measures listed in one sector-specific tab may address risks to other sectors as well. Some of these applications are noted in the final column of each table. **Choose a Climate Stressor:** If you are concerned about a particular climate stressor (e.g., increasing temperature or flooding) you can use the filter function in any of the tabs to see adaptation measures that address that stressor. Note that some adaptation measures can be used to address more than one stressor. The climate stressors addressed in this compendium are: • Temperature • Rainfall • Drought • Hurricane frequency and intensity • Extreme rainfall, riverine flooding, erosion, and landslide • Sea level rise, storm surge, and coastal erosion **Find Additional Information:** Use the References tab to find more information about some of the adaptation measures listed here.
User(s)	Municipal staff involved in land use planning, and a range of stakeholders representing financial, technical, and institutional capacities.
Intended Use	To serve as a resource to planners in identifying potential adaptation measures.
Key Output(s)	The compendium can be used to help municipal planners identify and select measures that will reduce climate risk and that could be integrated into the municipal land use plan. It is designed to be used with the *Climate Change Adaptation Planning Tool,* along with the PMOT Guide for Land Use Planning. The compendium can also be a useful resource for other municipal planning processes. Use this compendium to help brainstorm potential adaptation measures in Module 1 of the Adaptation Planning Tool. The filter functions in the spreadsheet can help you sort through adaptation measures based on your vulnerabilities and needs. The table can also be printed for easy reference while applying the tool.
Limitations	The list of potential measures is illustrative, and may not include the appropriate measure for a specific application. The measures are described in general terms, and will require further definition to be effective in a specific situation.
Ease of Use	Users require a working knowledge of municipal resources, sectors, and services; and the historical sensitivity of assets to climate and non-climate stressors.

CLIMATE ADAPTATION MEASURES MATRICES

Climate Change Adaptation Planning Tool Compendium: Example Land Use and Non-Land Use Adaptation Measures

Working Document; Version developed 8/21/2017

Developed by ICF under the USAID/DR Planning for Climate Adaptation Program

C EXAMPLE LAND USE ADAPTATION OPTIONS

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.1	Promote tree planting to increase shading and to absorb carbon dioxide and use urban shade strategies to improve visitor facilities and outdoor amenities	Policies, plans, programs, projects	Human Settlements	×						Sensitivity
0.2	Improve climatic comfort of key destinations through climate sensitive urban design	Policies, plans, programs, projects	Human Settlements	×	×	×	×	×	×	Adaptive Capacity
0.3	Relocate public buildings and critical infrastructure systems such as power plants, hospitals, water lines, or telephone lines to more protected areas under current and future conditions (e.g., on higher grounds)	Regulations	Human Settlements		×		×	×	×	Exposure

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.4	Relocate assets located adjacent to coasts that may be exposed to increased sea level and storm surge further inland	Policies, plans, programs, projects	Human Settlements					×	×	Exposure
0.5	Relocate communities out of drainage areas or flood-prone areas	Regulations	Human Settlements		×			×	×	Exposure
0.6	Restore natural areas, including green corridors and wetlands, to provide buffer zones, create shading and drainage, with the co-benefit of landscape improvement and increased biodiversity.	Policies, plans, programs, projects	Biodiversity and Protected Areas		×			×	×	Sensitivity
0.7	Limit new development in current and future high-risk areas through zoning and overlay controls	Zoning	Human Settlements	×	×	×	×	×	×	Exposure
0.8	Increase coastal setbacks and natural or 'soft' defense measures through land use overlays and planned retreat zones	Policies, plans, programs, projects	Human Settlements				×		×	Exposure

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.9	Incorporate a no-build buffer zones and setbacks along coastal and riparian areas that take into consideration increasing sea level and storm surge heights and/or changes in riverine flood risk	Zoning	Human Settlements		×		×	×	×	Exposure
0.10	Specify sea level/ natural hazard thresholds or indicators (informed by climate projections) as a basis for setting coastline building rules for the setback, elevation, or removal of buildings	Policies, plans, programs, projects	Human Settlements						×	Exposure
0.11	Move existing facilities or site new facilities on higher ground to account for flooding or sea water rise	Policies, plans, programs, projects	Human Settlements				×	×	×	Exposure
0.12	Adopt and enforce building design codes to meet increased hazards (e.g., wind, fire)	Regulations	Human Settlements	×	×	×	×	×	×	Sensitivity

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.13	Design infrastructure in new developments to accommodate potential changes in flood intensity and duration	Policies, plans, programs, projects	Human Settlements		×			×		Sensitivity
0.14	Retrofit infrastructure at lower elevations to accommodate higher flood levels	Policies, plans, programs, projects	Human Settlements				×	×	×	Sensitivity
0.15	Plan for rezoning of land following major disasters to prevent redevelopment/ repopulation	Policies, plans, programs, projects	Civil Protection	×	×	×	×	×	×	Exposure
0.16	Strategically locate critical infrastructure (e.g., hospitals, schools, emergency services, evacuation routes) away from flood sensitive areas	Policies, plans, programs, projects	Civil Protection	×	×	×	×	×	×	Sensitivity
0.17	Plan for secure landfill closure and/ or relocation away from areas with high water tables	Policies, plans, programs, projects	Solid Waste Management	×	×	×	×	×	×	Exposure

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.18	Properly site landfills away from floodplains, wetlands, or areas with high water tables	Policies, plans, programs, projects	Solid Waste Management		×				×	Exposure
0.19	Ensure land use zoning appropriate to hazards risk (e.g., sports fields on floodplains, critical buildings at higher elevations) más altas)	Regulations	Human Settlements	×	×	×	×	×	×	Sensitivity
0.20	Design and reconfigure settlements to reduce the need for trips and maximize viability for public transportation. Assess the transportation impacts of major new developments	Regulations	Urban Mobility	×	×	×	×	×	×	Adaptive Capacity
0.21	Ensure that new settlements are accessible by all-weather roads or alternative routes	Policies, plans, programs, projects	Urban Mobility	×	×	×	×	×	×	Adaptive Capacity
0.22	Construct protective structures such as seawalls and levees	Policies, plans, programs, projects	Civil Protection		×		×	×	×	Exposure

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.23	Incorporate land use and non-land use adaptation measures into community and/or municipality master plans, either in a dedicated section or embedded throughout the document	Policies, plans, programs, projects	Governance	×	×	×	×	×	×	Adaptive Capacity
0.24	Require maps of areas vulnerable to future flooding in applications for new development	Regulations	Human Settlements		×		×	×	×	Exposure
0.25	Conduct studies of urban topography and develop vulnerability maps (floods and landslides) that take climate change into account	Research and Monitoring	Civil Protection		×		×	×	×	Exposure
0.26	Establish policy framework for re-situating land uses that may become unsafe or unsuitable in the future due to climate change	Policies, plans, programs, projects	Human Settlements							Exposure
0.27	Maintain spaces for water retention and storage in regions where rainfall patterns are likely to become more extreme	Policies, plans, programs, projects	Civil Protection	×	×	×	×	×	×	Exposure

				Climate Stressor						
ID#	**Example Land Use Adaptation Measure**	**Land Use Programming Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
0.28	Require compensatory floodwater storage capacity for any development that reduces the existing floodwater storage capacity of a site in a 1-in-100 year flood zone	Regulations	Civil Protection		×		×	×	×	Exposure
0.29	Conduct trainings for municipal staff about climate-resilient land use	Policies, plans, programs, projects	Governance							Adaptive Capacity
0.30	Develop comprehensive education program at different levels (neighborhood, city, regional) on land use, climate change, and risk management		Capacity Building	×	×	×	×	×	×	Adaptive Capacity
0.31	Raise community awareness about climate-resilient land use	Policies, plans, programs, projects	Governance	×	×	×	×	×	×	Adaptive Capacity

EXAMPLE HUMAN SETTLEMENTS OPTIONS

				Climate Stressors							
ID#	**Example Human Settlements Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
1.1	Develop contingency plans to prepare for disruptions and impacts	Policy	Human Settlements	×	×		×	×	×	Adaptive Capacity	Tele-communications, Facilities, Human Settlements
1.2	Conduct a household census in coastal areas to assess risks	Research and Monitoring	Human Settlements								
1.3	Elevate sensitive electronic and mechanical systems (e.g., air conditioning) above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Human Settlements		×		×	×	×	Sensitivity	Tele-communications, Facilities, Human Settlements
1.4	Site new settlements in low-risk areas	Structural	Human Settlements		×		×	×	×	Sensitivity	Tele-communications, Facilities, Human Settlements

				Climate Stressors							
ID#	**Example Human Settlements Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
1.5	Help buildings withstand potentially greater exposure to climate stressors in the future by updating design standards to accommodate future climate scenarios	Policy	Human Settlements	×	×		×	×	×	Adaptive Capacity	Industry, Human Settlements
1.6	Reduce the chance of a building's foundation being undermined by erosion by laying deeper foundations	Structural	Human Settlements		×		×	×		Sensitivity	Facilities, Human Settlements
1.7	Improve drainage and reduced vulnerability of erosion through proper drainage systems for rooftops	Structural	Human Settlements		×			×		Sensitivity	Facilities, Human Settlements
1.8	Conduct capacity building and training to better prepare populations to cope with stressors or build longer-term resilience	Capacity Building	Human Settlements	×	×		×	×	×	Sensitivity & Adaptive Capacity	Facilities, Tele-communications, Civil Protection, ,

				Climate Stressors							
ID#	**Example Human Settlements Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
1.9	Use tire walls instead of concrete to reduce erosion on hillsides around informal settlements	Structural	Human Settlements		×		×	×	×	Exposure	
1.10	Cluster settlements at elevations above flood zone (i.e., on raised land) and with flood- and erosion-resistant construction materials	Structural	Human Settlements		×		×	×	×	Exposure & Sensitivity	
1.11	Implement buy-back/acquisition policy for properties in current or future high-risk areas	Regulations	Human Settlements	×	×	×	×	×	×	Adaptive Capacity	
1.12	Tailor urban and building design guidelines to local current and future climatic conditions	Regulations	Human Settlements	×	×	×	×	×	×	Sensitivity	

				Climate Stressors							
ID#	**Example Human Settlements Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
1.13	Develop a committee that identifies climate adaptation strategies as a priority and tracks the implementation of mitigation strategies that increase community resilience, including reporting on the status of projects	Capacity Building	Human Settlements							Adaptive Capacity	
1.14	Fortify embankments to counteract the effects of increased erosion	Structural	Human Settlements		×		×	×	×	Exposure & Sensitivity	
1.15	Reinforce dikes and drainage systems	Structural	Human Settlements		×		×	×	×	Sensitivity	

2 EXAMPLE ENVIRONMENT AND NATURAL RESOURCES OPTIONS: WATER RESOURCES, COASTAL AND MARINE RESOURCES, BIODIVERSITY AND PROTECTED AREAS

				Climate Stressor							
ID#	**Example Environment and Natural Resources Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
2.1	Monitor and maintain vegetation, trees, and forests in watershed to improve and maintain watershed infiltration capacity	Research and Monitoring	Water Resources		×		×	×		Exposure & Adaptive Capacity	
2.2	Develop a water source protection strategy	Estructural	Water Resources	×	×	×		×	×	Adaptive Capacity	Drinking water
2.3	Control erosion through structures such as gabions, channel armoring, or check dams	Estructural	Water Resources		×		×	×		Exposure	Storm water drainage
2.4	Implement Integrated Water Resource Management principles	Policy	Water Resources	×	×	×		×	×	Adaptive Capacity	Drinking water

				Climate Stressor							
ID#	**Example Environment and Natural Resources Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
2.5	Discontinue recreational use of protected areas if it becomes unsafe, infeasible, or undesirable because of changing environmental conditions	Operations and Maintenance	Biodiversity and Protected Areas	×			×	×	×	Adaptive Capacity	Tourism
2.6	Map, monitor, protect, and restore marine protected areas, marine reserves, networks of protected areas, etc.	Research and Monitoring	Biodiversity and Protected Areas	×			×		×	Sensitivity & Adaptive Capacity	
2.7	Conserve and regenerate mangroves	Operations and Maintenance	Biodiversity and Protected Areas	×			×		×	Sensitivity & Adaptive Capacity	
2.8	Protect low-lying and exposed areas, and reintroduce natural 'soft' defense measures	Structural	Biodiversity and Protected Areas				×	×	×	Exposure	
2.9	Prohibit development that threatens coastal processes or requires filling of wetlands or mangroves	Policy	Biodiversity and Protected Areas		×		×	×	×	Exposure	Land Use Planning

				Climate Stressor							
ID#	**Example Environment and Natural Resources Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
2.10	Introduce environmental assessment requirements for areas where existing information is insufficient to determine the impact of potential development scenarios without additional and costly research	Research and Monitoring	Biodiversity and Protected Areas, Human Settlements	×	×	×	×	×	×	Adaptive Capacity	
2.11	Institute payments for environmental services (flow regulation, reducing sedimentation, maintaining water quality, etc.)	Policy	Biodiversidad y áreas protegidas		×	×	×	×	×	Adaptive Capacity	
2.12	Implement ecological restoration plan near rivers and coastal areas to clean, restore, reforest, and monitor critical ecosystems	Policy	Biodiversity and Protected Areas	×	×	×	×	×	×	Sensitivity & Adaptive Capacity	
2.13	Develop an urban forest management plan to lay out a vision for maintaining urban ecosystems	Policy	Biodiversity and Protected Areas	×	×	×	×	×	×	Adaptive Capacity	

				Climate Stressor							
ID#	**Example Environment and Natural Resources Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
2.14	Develop a management plan for forest fire in hazardous areas	Policy	Biodiversity and Protected Areas	×		×				Sensitivity & Adaptive Capacity	
2.15	Install or protect reefs to reduce coastal erosion and storm surge damage	Structural	Biodiversity and Protected Areas						×	Sensitivity	
2.16	Provide educational program on land use, climate change, integrated risk management, and the role of ecosystems in adaptation	Capacity Building	Biodiversity and Protected Areas	×		×	×	×	×	Adaptive Capacity	
2.17	Promote land tenure and property rights reform to strengthen local natural resource management	Policy	Biodiversity and Protected Areas	×	×	×	×	×	×	Adaptive Capacity	

3 EXAMPLE SOLID WASTE MANAGEMENT OPTIONS

				Climate Stressors						
ID#	**Example Solid Waste Management Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
3.1	Properly site landfills away from floodplains, wetlands, or areas with high water tables	Structural	Solid Waste Management		×			×	×	Exposure
3.2	Regularly clear drains of solid waste that can clog drains during heavy precipitation events	Operations and Maintenance	Solid Waste Management		×		×	×		Sensitivity
3.3	Plan for secure landfill closure and/or relocation	Structural	Solid Waste Managements	×	×	×	×	×	×	Exposure, Sensitivity, & Adaptive Capacity
3.4	Cover loose sediment and materials to reduce carrying of sediment and waste downstream during extreme precipitation events	Structural	Solid Waste Managements		×		×	×	×	Sensitivity

				Climate Stressors						
ID#	**Example Solid Waste Management Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
3.5	Increase water removal capacity, such as increasing drainage capacity for low areas	Structural	Solid Waste Management		×		×	×	×	Sensitivity & Adaptive Capacity
3.6	Monitor and identify sites which are subject to chronic flooding and determine if they can be raised or relocated	Structural	Solid Waste Management		×			×	×	Exposure & Sensitivity
3.7	Develop sites large enough to accommodate projected population growth and corresponding waste generation	Structural	Solid Waste Management					×	×	Sensitivity
3.8	Prevent erosion of landfill slopes, covers, and access roads into and around landfills	Structural	Solid Waste Management		×			×	×	Sensitivity
3.9	Reduce volume of waste through instituting bans or fees on plastic bags	Policy	Solid Waste Management							Adaptive Capacity

				Climate Stressors						
ID#	**Example Solid Waste Management Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
3.10	Maintain collection vehicles to minimize disruptions due to mechanical failures	Operations and Maintenance	Solid Waste Management	×			×	×	×	Sensitivity
3.11	Implement an integrated management system ("zero waste") plan that addresses both environmental risks and adaptation options	Policy	Solid Waste Management							Adaptive Capacity
3.12	Educate the public on the environmental impact of solid waste management and its impact on worsening floods	Creación de capacidad	Solid Waste Management					×		Adaptive Capacity

4 EXAMPLE CIVIL PROTECTION AND HEALTH OPTIONS

				Climate Stressor							
ID#	**Example Civil Protection and Health Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
4.1	Incorporate considerations for changes in climate into early warning/ early action systems	Policy	Civil Protection	×	×	×	×	×	×	Adaptive Capacity	
4.2	Develop emergency protocols and conduct preparedness and contingency planning to respond to extreme events under a changing climate, including for rebuilding post disaster	Policy	Civil Protection	×		×	×	×	×	Adaptive Capacity	
4.3	Conduct capacity building and training to better understand implications of climate on infrastructure services and development	Capacity Building	Civil Protection	×		×	×	×	×	Adaptive Capacity	Facilities, Tele-communications, Human Settlements, Tourism

				Climate Stressor							
ID#	**Example Civil Protection and Health Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
4.4	Pre-identify emergency shelter locations for different types of disaster that are outside of the flood zone	Operations and Maintenance	Civil Protection				×	×	×	Adaptive Capacity	
4.5	Target community outreach about climate change impacts to at-risk individuals	Policy	Health	×		×	×	×	×	Adaptive Capacity	
4.6	Maintain a continuity of operations plan for the health sector, which directs staff on how to keep the Health Department running after a disaster or extreme weather	Policy	Health				×	×	×	Sensitivity	
4.7	Investigate and control disease-carrying insects, such as mosquitos, that can transmit diseases	Research and Monitoring	Health	×	×					Sensitivity	

				Climate Stressor							
ID#	**Example Civil Protection and Health Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
4.8	Invest in long-lasting insecticide-treated mosquito nets, or indoor residual insecticide spraying	Structural	Health	×	×					Sensitivity	
4.9	Invest in surveillance systems such as malaria early warning and detection systems	Operations and Maintenance	Health	×	×					Adaptive Capacity	
4.10	Consider impact of planning requirements on potential for spread of water borne and vector borne disease under future conditions	Policy	Health	×	×	×	×	×	×	Sensitivity	
4.11	Ensure access to flood insurance to manage risks in vulnerable areas	Policy	Civil Protection		×		×	×	×	Sensitivity	

				Climate Stressor							
ID#	**Example Civil Protection and Health Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
4.12	Reduce heat impacts by investing in green or painted white roofs, urban green spaces, cool pavements and shelters	Structural	Health	×						Sensitivity	
4.13	Ensure hospitals and critical facilities are located in less vulnerable areas and that multiple access routes are available	Operations and Maintenance	Health				×	×	×	Exposure	
4.14	Invest in cholera early warning, detection, and treatment centers	Operations and Maintenance	Health		×		×	×		Adaptive Capacity	

5 EXAMPLE HOUSING, SPORTS FACILITIES, CEMETERIES, AND MARKETS OPTIONS

				Climate Stressors						
ID#	**Example Housing, Sports Facilities, Cemeteries, and Markets Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
5.1	Implement green infrastructure solutions, including permeable pavement and rainwater harvesting	Structural	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage		×	×		×		Adaptive Capacity
5.2	Site or relocate projects to low-risk locations to reduce exposure to climate stressors and risk of damage	Operations and Maintenance	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×	×	×	×	×	Adaptive Capacity/ Sensitivity
5.3	Properly site facilities away from floodplains, wetlands, or areas with high water tables	Structural	Housing, Sports Facilities, Cemeteries, Markets, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications		×		×	×	×	Exposure

				Climate Stressors						
ID#	**Example Housing, Sports Facilities, Cemeteries, and Markets Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
5.4	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications		×		×	×	×	Sensibilidad
5.5	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Housing, Sports Facilities, Markets, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×		×	×	×	Adaptive Capacity
5.6	Lay deeper foundations to reduce the chance of a building's foundation being undermined by erosion	Structural	Housing, Sports Facilities, Markets		×		×	×	×	Sensitivity
5.7	Improve proper drainage systems for rooftops to reduce vulnerability of flooding and erosion at project and surrounding area sites	Structural	Vivienda, instalaciones deportivas, mercados, patrimonio cultural		×		×	×		Sensitivity

				Climate Stressors						
ID#	**Example Housing, Sports Facilities, Cemeteries, and Markets Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
5.8	Conduct capacity building and training to better understand implications of climate on infrastructure services and development, and help prepare for and cope with stressors or build longer-term resilience	Capacity Building	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications, Tourism	×		×	×	×	×	Sensitivity/ Adaptive Capacity
5.9	Cover loose sediment and materials that may be subject to erosion	Operations and Maintenance	Housing, Sports Facilities, Cemeteries, Markets		×		×	×		Sensitivity
5.10	Embed climate-related liabilities in property sector contracts to institutionalize protection of facilities	Policy	Housing, Sports Facilities, Cemeteries, Markets				×	×		Adaptive Capacity
5.11	Incorporate flexibility in building design to allow for future changes and construct buildings with resilient designs and materials	Structural	Housing, Sports Facilities, Markets	×		×		×		Adaptive Capacity

				Climate Stressors						
ID#	**Example Housing, Sports Facilities, Cemeteries, and Markets Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
5.12	Identify whether public areas can be designated as multi-purpose areas to provide flood retention services during heavy rainfall events	Policy	Sports Facilities		×		×	×	×	Exposure
5.13	Retrofit roofs to reflect heat (e.g., replace black roofs with green or brown roofs) and install white roofs to reduce building energy load	Structural	Housing, Sports Facilities, Markets, Cultural Heritage	×						Sensitivity
5.14	Improve the building envelope (e.g., fenestration, roofing materials, cladding material, vapor barriers, retarders, etc.)	Structural	Housing, Cultural Heritage	×	×					Sensitivity
5.15	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Research and Monitoring	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×	×	×	×	×	Adaptive Capacity

6 EXAMPLE CULTURAL HERITAGE OPTIONS

				Climate Stressors						
ID#	**Example Cultural Heritage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
6.1	Implement green infrastructure solutions, including permeable pavement and rainwater harvesting	Structural	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage		×	×		×		Adaptive Capacity
6.2	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage		×		×	×	×	Sensitivity
6.3	Improve proper drainage systems for rooftops to reduce vulnerability of flooding and erosion at project and surrounding area sites	Structural	Housing, Sports Facilities, Markets, Cultural Heritage		×		×	×		Sensitivity

				Climate Stressors						
ID#	**Example Cultural Heritage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
6.4	Use green infrastructure to reduce the impact of high temperatures and changing rainfall patterns on important sites. Promote drainage to protect from flooding	Structural	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage	×	×		×	×	×	Exposure & Sensitivity
6.5	Conduct capacity building and training to better understand implications of climate on infrastructure services and development, and help prepare for and cope with stressors or build longer-term resilience	Capacity Building	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage	×		×	×	×	×	Sensitivity & Adaptive Capacity
6.6	Retrofit roofs to reflect heat (e.g., replace black roofs with green or brown roofs) and install white roofs to reduce building energy load	Structural	Housing, Sports Facilities, Markets, Cultural Heritage	×						Sensitivity

				Climate Stressors						
ID#	**Example Cultural Heritage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
6.7	Improve the building envelope (e.g., fenestration, roofing materials, cladding material, vapor barriers, retarders, etc.)	Structural	Housing, Cultural Heritage	×	×					Sensitivity
6.8	Inventory, catalog, and update maps of heritage sites and built infrastructure	Research and Monitoring	Housing, Sports Facilities, Markets, Cultural Heritage	×			×	×	×	Adaptive Capacity
6.9	Apply rescue techniques, maintenance and preservation of heritage in selected areas of high vulnerability	Operations and Maintenance	Housing, Cultural Heritage	×			×	×	×	Sensitivity
6.10	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Research and Monitoring	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×	×	×	×	×	Adaptive Capacity
6.11	Install flood barriers to protect against inundation at flood-prone sites	Structural	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications		×		×	×	×	Sensitivity

				Climate Stressors						
ID#	**Example Cultural Heritage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
6.12	Monitor and identify buildings and sites which are subject to chronic flooding; determine if they can be raised or relocated	Structural	Housing, Cultural Heritage		×			×	×	Exposure & Sensitivity

7 EXAMPLE DRINKING WATER OPTIONS

				Climate Stressors						
ID#	**Example Drinking Water Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Componente de vulnerabilidad abordado**
7.1	Promote water conservation and end use efficiency	Capacity Building	Drinking Water		×	×				Sensitivity
7.2	Invest in new or improved water storage options	Structural	Drinking Water		×	×		×		Sensitivity & Adaptive Capacity

				Climate Stressors						
ID#	**Example Drinking Water Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Componente de vulnerabilidad abordado**
7.3	Evaluate new sources of groundwater supply and their resilience to climate change and other stressors	Research and Monitoring	Drinking Water	×		×		×	×	Sensitivity & Adaptive Capacity
7.4	Develop a water source protection strategy	Policy	Drinking Water	×	×	×	×	×	×	Exposure, Sensitivity, & Adaptive Capacity
7.5	Develop contingency plan for power outages, including backup power systems for water treatment and pumping facilities	Structural	Drinking Water	×			×	×	×	Adaptive Capacity
7.6	Monitor and maintain vegetation and trees in the watershed to protect water quality	Operations and Maintenance	Drinking Water			×	×	×		Sensitivity
7.7	Define or build protection around freshwater sources, such as marshes and lagoons	Structural	Drinking Water	×		×	×	×	×	Sensitivity

				Climate Stressors						
ID#	**Example Drinking Water Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Componente de vulnerabilidad abordado**
7.8	Promote rainwater harvesting, water re-use/ recycling	Structural	Drinking Water		×	×				Sensitivity & Adaptive Capacity
7.9	Modify reservoir operation rules to accommodate changing hydrology	Operations and Maintenance	Drinking Water	×	×	×	×		×	Adaptive Capacity
7.10	Reduce of non-revenue water losses (i.e., leakages) through improvements in distribution systems	Structural	Drinking Water	×	×	×		×		Sensitivity & Adaptive Capacity
7.11	Improve and maintain water quality through investment in additional treatment plants									
7.12	Adjust water tariffs	Operations and Maintenance	Drinking Water	×	×	×		×		Adaptive Capacity
7.13	Integrated water resource management	Policy	Drinking Water	×	×	×	×	×	×	Sensitivity & Adaptive Capacity
7.14	Promote artificial recharge	Structural	Drinking Water		×	×				Sensitivity & Adaptive Capacity

				Climate Stressors						
ID#	**Example Drinking Water Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Componente de vulnerabilidad abordado**
7.15	Invest in groundwater (e.g., boreholes, dug wells, hand pumps, and solar powered pumps)	Structural	Drinking Water							
7.16	Prioritize alternative sources of water supply options associated with minimal climate change impacts	Policies, plans, programs, projects	Drinking Water	×	×	×				Adaptive Capacity
7.17	Design water catchment systems that can store excess water if rainfall intensity increases	Structural	Drinking Water		×			×		Sensitivity
7.18	Implement water-use restrictions for non-essential activities during drought	Policies, plans, programs, projects	Drinking Water			×				Sensitivity

8 EXAMPLE SANITATION OPTIONS

				Climate Stressor							
ID#	**Example Sanitation Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
8.1	Regularly clearing drains to reduce solid waste that can clog drains during heavy precipitation events	Operations and Maintenance	Sanitation	×	×		×	×	×	Sensitivity	Solid waste management
8.3	Strengthen or relocate septic tank systems located in coastal or flood-prone areas. Site new facilities on higher ground or further inland	Structural	Sanitation		×	×	×	×	×	Sensitivity	
8.4	Increase maintenance of tanks and pipes, maintain backup systems	Operations and Maintenance	Sanitation		×		×	×	×	Sensitivity	

				Climate Stressor							
ID#	**Example Sanitation Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
8.5	Plan backup power systems for treatment and pumping facilities	Operations and Maintenance	Sanitation	×			×	×	×	Adaptive Capacity	
8.6	Develop plans for reclaimed water systems	Structural	Sanitation				×			Adaptive Capacity	
8.7	Separate storm water and sewage collection systems	Structural	Sanitation		×		×	×		Exposure/ Sensitivity	
8.8	Integrate information on climate change impacts into training and education about sanitation systems	Operations and Maintenance	Sanitation	×	×	×	×	×	×	Adaptive Capacity	
8.9	Clean latrine systems more regularly to prevent overflows	Operations and Maintenance	Sanitation		×		×	×		Sensitivity	

				Climate Stressor							
ID#	**Example Sanitation Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
8.10	Monitor water discharges for changes in effluent characteristics. Monitor water quality levels and evaluate need for new or modified source water protection plans	Research and Monitoring	Sanitation	×	×	×		×		Adaptive Capacity	
8.11	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Research and Monitoring	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-	×	×	×	×	×	×	Adaptive Capacity	
8.12	Site or relocate projects to low-risk locations to reduce exposure to climate stressors and risk of damage	Operations and Maintenance	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-		×		×	×	×	Adaptive Capacity/ Sensitivity	

				Climate Stressor							
ID#	**Example Sanitation Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temp**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**	**Cross-cutting**
8.13	Properly site facilities away from floodplains, wetlands, or areas with high water tables	Structural	Housing, Sports Facilities, Cemeteries, Markets, Sanitation, Wastewater, Urban Mobility, Power, Tele-		×		×	×	×	Exposure	
8.14	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-		×		×	×	×	Sensitivity	Tele-communications, Industry, Human Settlements
8.15	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Housing, Sports Facilities, Markets, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	X	×		×	×	×	Adaptive Capacity	Industry, Human Settlements

9 EXAMPLE WASTEWATER TREATMENT OPTIONS

				Climate Stressor						
ID#	**Example Wastewater Treatment Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
9.1	Plan backup power systems for water treatment and pumping facilities	Operations and Maintenance	Wastewater Treatment				×	×	×	Sensitivity & Adaptive Capacity
9.2	Flood proof the main WWTP electrical systems to ensure continuous operation during storm events	Estructural	Wastewater Treatment		×		×	×	×	Exposure
9.3	Protection of sewers from overflow	Operations and Maintenance	Wastewater Treatment		×			×	×	Exposure & Sensitivity
9.4	Adjustment of hydraulic systems to floods	Operations and Maintenance	Wastewater Treatment							Sensitivity

				Climate Stressor						
ID#	**Example Wastewater Treatment Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
9.5	Adjustment to operation below design capacity	Operations and Maintenance	Wastewater Treatment		×			×	×	Adaptive Capacity
9.6	Adjust treatment technology to new effluent composition efluentes	Structural	Wastewater Treatment	×		×		×		Adaptive Capacity
9.7	During routine maintenance and upgrades, integrate flood protection strategies at WWTP	Operations and Maintenance	Wastewater Treatment				×	×	×	Exposure & Sensitivity
9.8	Update existing operations, maintenance, and emergency response plans and procedures to address storm events	Policy	Wastewater Treatment		×		×	×	×	Adaptive Capacity
9.9	Reduce the vulnerability of the WWTP stormwater outfall through pumps or changing elevations	Structural	Wastewater Treatment		×			×	×	Sensitivity

				Climate Stressor						
ID#	**Example Wastewater Treatment Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
9.10	Repair cracked sewage pipes, increase capacity, and monitor total dissolved solids levels to ensure sufficient capacity at all times	Operations and Maintenance	Wastewater Treatment	×	×			×		Sensitivity
9.11	Expand the WWTP flood wall protection	Structural	Wastewater Treatment		×		×	×	×	Exposure
9.12	Utilize green Infrastructure, such as construction of wetlands for wastewater and stormwater management	Structural	Wastewater Treatment		×			×		Exposure
9.13	Develop point-of-use treatment	Structural	Wastewater Treatment	×	×	×		×	×	Sensitivity
9.14	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Investigación y Monitoreo	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Adaptive Capacity

				Climate Stressor						
ID#	**Example Wastewater Treatment Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
9.15	Site or relocate projects to low-risk locations to reduce exposure to climate stressors and risk of damage	Operations and Maintenance	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Sensitivity & Adaptive Capacitya
9.16	Properly site facilities away from floodplains, wetlands, or areas with high water tables	Structural	Housing, Sports Facilities, Cemeteries, Markets, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications		×		×	×	×	Exposure
9.17	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications		×		×	×	×	Sensitivity
9.18	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Housing, Sports Facilities, Markets, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×		×	×	×	Adaptive Capacity

10 EXAMPLE URBAN MOBILITY OPTIONS

				Climate Stressors						
ID#	**Example Urban Mobility Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
10.1	Elevate road section in areas that flood frequently	Structural	Urban Mobility		×		×	×	×	Sensitivity
10.2	Expand buffer zones (spaces between road and other development) to collect and absorb rainwater	Structural	Urban Mobility		×		×	×	×	Sensitivity
10.3	Develop or identify redundant services for critical routes	Structural	Urban Mobility	×	×	×	×	×	×	Adaptive Capacity
10.4	Use permeable pavement for roads to reduce runoff	Structural	Urban Mobility		×		×	×	×	Sensitivity
10.5	Design roads with drainage systems along roadways	Structural	Urban Mobility		×			×	×	Sensitivity

				Climate Stressors						
ID#	**Example Urban Mobility Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
10.6	Expand size of culverts in flood-prone areas	Structural	Urban Mobility							
10.7	Move road alignment away from vulnerable areas	Structural	Urban Mobility	×	×	×	×	×	×	Exposure
10.8	Schedule more frequent pavement inspections on very hot days	Operations and Maintenance	Urban Mobility	×						Adaptive Capacity
10.9	Install flood barriers to protect flood-prone areas	Structural	Urban Mobility		×		×	×	×	Exposición y sensibilidad
10.10	Increase water removal capacity, such as installing pumping systems or increasing drainage capacity for low areas	Structural	Urban Mobility				×	×		Sensitivity & Adaptive Capacity
10.11	Improve routine maintenance (and possibly making operational changes) for roads		Urban Mobility	×	×	×	×	×	×	Adaptive Capacity

				Climate Stressors						
ID#	**Example Urban Mobility Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
10.12	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Research and Monitoring	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Adaptive Capacity
10.13	Site or relocate projects to low-risk locations to reduce exposure to climate stressors and risk of damage	Operations and Maintenance	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Sensitivity & Adaptive Capacity
10.14	Properly site facilities away from floodplains, wetlands, or areas with high water tables	Structural	Housing, Sports Facilities, Cemeteries, Markets, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications		×		×	×	×	Exposure

				Climate Stressors						
ID#	**Example Urban Mobility Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
10.15	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications		×		×	×	×	Sensitivity
10.16	Establish parameters for new coastal roads and construction design and materials to ensure that it protects against erosion	Policy	Civil Protection, Transportation, Urban Mobility					×	×	Sensitivity
10.17	Encourage the use of public transportation over private vehicles, and regulate emissions of pollutants from existing systems	Policy	Transportation, Urban Mobility	×						Adaptive Capacity
10.18	Reduce mobility needs through urban planning, neighborhood design, and the construction of new public transportation systems	Structural	Civil Protection, Transportation, Urban Mobility	×				×	×	Sensitivity & Adaptive Capacity

				Climate Stressors						
ID#	**Example Urban Mobility Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
10.19	Encourage non-motorized modes of transport with infrastructure for cycling	Policy	Transportation, Urban Mobility, Health	×						Adaptive Capacity
10.20	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Housing, Sports Facilities, Markets, Sanitation, Wastewater, Urban Mobility, Power, Telecommuni-cations	×	×		×	×	×	Adaptive Capacity

EXAMPLE STORMWATER DRAINAGE OPTIONS

				Climate Stressor						
ID#	**Example Stormwater Drainage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
11.1	Regularly clear drains and canals to maintain designed drainage capacity	Operations and Maintenance	Stormwater Drainage		×		×	×		Exposure & Sensitivity
11.2	Install or improve drainage system to reduce strength of flow or excess water	Structural	Stormwater Drainage		×		×	×		Exposure
11.3	Implement terracing to intercept runoff and help infiltrate soil or be diverted elsewhere	Structural	Stormwater Drainage		×			×		Exposure
11.4	Implement green infrastructure solutions, such as rainwater harvesting and permeable pavement	Structural	Stormwater Drainage	×	×		×	×		Exposure

				Climate Stressor						
ID#	**Example Stormwater Drainage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
11.5	Implement vegetation planting and ecosystem-based adaptation to increase infiltration and keep soil in place	Operations and Maintenance	Stormwater Drainage	×	×		×	×		Exposure
11.6	Channel armoring in gullies to strengthen channel walls/floor to protect from erosion	Structural	Stormwater Drainage		×		×	×		Exposure
11.7	Design water catchment systems that can keep pace with projected rainfall patterns such as redirecting rainwater into reservoirs, dams, or other storage devices	Structural	Stormwater Drainage		×			×		Exposure & Sensitivity
11.8	Redirect rainwater toward less vulnerable storage areas and expand storage in reservoirs, dams, and other storage devices	Structural	Stormwater Drainage		×			×		Sensitivity

				Climate Stressor						
ID#	**Example Stormwater Drainage Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
11.9	Separate storm water and sewage collection systems	Policy	Stormwater Drainage	×	×		×	×		Sensitivity
11.10	Develop redundant structures or services that can be relied upon if structures fail	Structural	Stormwater Drainage		×		×	×	×	Sensitivity & Adaptive Capacity
11.11	Increase inspection frequency and maintenance schedule to ensure structures are enduring to climate change pressures	Operations and Maintenance	Stormwater Drainage	×	×		×	×	×	Sensitivity & Adaptive Capacity
11.12	Increase frequency of culvert maintenance, particularly in advance of forecasted heavy rain events	Operations and Maintenance	Stormwater Drainage		×		×	×		Exposure & Sensitivity
11.13	In new development, design stormwater infrastructure to drain into retention ponds rather than rivers or streams	Policies, plans, programs, projects	Stormwater Drainage		×		×	×	×	Exposure

I2 EXAMPLE POWER SYSTEM OPTIONS

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
I2.1	Develop system redundancies	Structural	Power System	×	×	×	×	×	×	Adaptive Capacity
I2.2	Relocate critical and high-value infrastructure with high vulnerability to lower risk areas	Structural	Power System	×	×	×	×	×	×	Exposure
I2.3	Install flood barriers to protect critical assets in flood-prone areas	Structural	Power System		×			×	×	Sensitivity
I2.4	Increase water removal capacity, such as installing pumping systems or increasing drainage capacity for low areas	Structural	Power System		×			×	×	Sensitivity & Adaptive Capacity

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
12.5	Maintain data on and monitor the status of restoration of downed trees, downed wires, road closure, power outages, and other system abnormalities	Research and Monitoring	Power System	×	×	×	×	×	×	Adaptive Capacity
12.6	Develop a list prioritizing buildings that require redundant power sources	Policy	Power System	×	×	×	×	×	×	Adaptive Capacity
12.7	Maintain portable Emergency Operations Center (EOC in a box)	Operations and Maintenance	Power System	×	×	×	×	×	×	Adaptive Capacity
12.8	Diversify power generation portfolio	Structural	Power System	×	×	×	×	×	×	Sensitivity & Adaptive Capacity
12.9	Reduce energy consumption in residential and commercial buildings	Policy	Power System	×		×	×	×		Sensitivity & Adaptive Capacity
12.10	Implement TOD (Time of Day) metering and differential pricing	Policy	Power System	×						Sensitivity & Adaptive Capacity
12.11	Toughen energy efficiency standards	Policy	Power System	×						Sensitivity & Adaptive Capacity

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
12.12	Utilize 'gray' water for thermal power plant cooling	Structural	Power System	×	×	×				Sensitivity & Adaptive Capacity
12.13	Require the incorporation of climate vulnerabilities into renewable resource assessments in the planning phase of investments	Policy	Power System	×	×	×	×	×	×	Adaptive Capacity
12.14	Create planning requirements for major new developments to utilize local sources of renewable energy	Regulations	Power System	×	×	×	×	×	×	Adaptive Capacity
12.15	Enforce building and urban design requirements that minimize energy requirements and maximize thermal comfort	Regulations	Power System	×						Sensitivity
12.16	Develop municipal regulations for installation of solar hot water and photovoltaic energy in residential buildings	Policy	Power System	×		×	×	×		Sensitivity & Adaptive Capacity

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
12.17	Promote clean energy when developing strategies to help reduce heat island effect and improve the natural environment	Policy	Power System	×						Sensitivity & Adaptive Capacity
12.18	Encourage no-regrets measures, such as energy efficiency and demand-side management strategies	Policy	Power System	×			×			Sensitivity & Adaptive Capacity
12.19	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Research and Monitoring	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Adaptive Capacity
12.20	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Investigación y Monitoreo	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Adaptive Capacity

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
12.21	Site or relocate projects to low-risk locations to reduce exposure to climate stressors and risk of damage	Operations and Maintenance	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×	×	×	×	×	×	Sensitivity & Adaptive Capacity
12.22	Properly site facilities away from floodplains, wetlands, or areas with high water tables	Structural	Vivienda, Instalaciones Deportivas, Cementerios, Mercados, Saneamiento, Aguas Residuales, Movilidad Urbana, Energía, Teleco-municaciones		×		×	×	×	Exposure
12.23	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications		×		×	×	×	Sensitivity
12.24	Acquire standby energy equipment and backup restoration supplies, particularly in critical facilities (hospitals)	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Telecommu-nications	×			×	×		Adaptive Capacity

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
12.25	Assess water risk to power generation and retrofit or equip plants with dry cooling technologies or water re-use technologies	Structural	Power System			×				Adaptive Capacity
12.26	Place transmission lines underground	Structural	Power System	×			×			Exposure
12.27	Use submersible equipment that can withstand corrosion from saltwater exposure	Structural	Power System				×	×	×	Sensitivity
12.28	Construct levees, berms, floodways, and storm surge barriers to protect exposed T&D infrastructure	Structural	Power System				×	×	×	Exposure
12.29	Use transmission line materials that can withstand higher temperatures and install heat-tolerant materials at substations	Structural	Power System	×						Sensitivity

				Climate Stressors						
ID#	**Example Power System Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Precipitaciones extremas, Inundaciones ribereñas, Erosión y Deslizamientos de tierra**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Vulnerability Component Addressed**
12.30	Create "green" buffers around T&D infrastructure to reduce tree contact with sagging lines due to extreme temperatures	Structural	Power System	×						Exposure
12.31	Prepare emergency contingency plans to ensure cooling water to cope with high temperatures.	Policy	Power System	×						Adaptive Capacity
12.32	Establish and expand education programs on energy efficiency and demand-response programs to encourage consumers to reduce power consumption voluntarily	Capacity Building	Power System	×						Sensitivity & Adaptive Capacity
12.33	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Vivienda, Instalaciones Deportivas, Mercados, Saneamiento, Aguas Residuales, Movilidad Urbana, Energía, Teleco-municaciones	×	×	×	×	×	×	Adaptive Capacity

I3 EXAMPLE TELECOMMUNICATIONS OPTIONS

				Climate Stressor						
ID#	**Example Tele-communications Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
13.1	Develop contingency plans to prepare for disruptions and plan ahead in case building assets are impacted by climate stressors	Capacity Building	Tele-communications	×			×	×	×	Adaptive Capacity
13.2	Develop redundant services to accommodate disruptions and plan ahead for extreme weather events	Operations and Maintenance	Tele-communications	×			×	×	×	Adaptive Capacity
13.3	Plan, site, relocate, and reroute critical infrastructure components inland or in low-risk areas	Structural	Tele-communications	×	×		×	×	×	Sensitivity

				Climate Stressor						
ID#	**Example Tele-communications Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
13.4	Capacity building and training to better understand implications of climate on infrastructure services and development; help prepare for and cope with stressors or build longer-term resilience	Capacity Building	Tele-communications	×		×	×	×	×	Sensitivity & Adaptive Capacity
13.5	Increase fuel supplies for backup power at antennas, cell towers, and central offices	Structural	Tele-communications	×		×	×	×	×	Adaptive Capacity
13.6	Trim trees near cables	Operations and Maintenance	Tele-communications				×			Sensitivity
13.7	Construct protective barriers around critical infrastructure and move cables below-ground	Structural	Tele-communications		×		×	×	×	Sensitivity
13.8	Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	Research and Monitoring	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×	×	×	×	×	Adaptive Capacity

				Climate Stressor						
ID#	**Example Tele-communications Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
13.9	Site or relocate projects to low-risk locations to reduce exposure to climate stressors and risk of damage	Operations and Maintenance	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×	×	×	×	×	Sensitivity & Adaptive Capacity
13.10	Properly site facilities away from floodplains, wetlands, or areas with high water tables	Structural	Housing, Sports Facilities, Cemeteries, Markets, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications		×		×	×	×	Exposure
13.11	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Housing, Sports Facilities, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications		×		×	×	×	Sensitivity
13.12	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Housing, Sports Facilities, Markets, Sanitation, Wastewater, Urban Mobility, Power, Tele-communications	×	×		×	×	×	Adaptive Capacity

14 EXAMPLE AGRICULTURE AND FISHERIES OPTIONS

				Climate Stressor						
ID#	**Example Agriculture and Fisheries Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
14.1	Expand rainwater storage for irrigation to redirect rainwater into reservoirs, dams, or other storage devices	Structural	Agriculture	×	×	×		×		Sensitivity
14.2	Distribute seasonal climate forecasts directly to farmers and conduct community training on the farm-level interpretation and use of such forecasts	Capacity Building	Agriculture	×	×	×		×		Adaptive Capacity
14.3	Invest in drought index insurance	Research and Monitoring	Agriculture	×	×	×				Adaptive Capacity
14.4	Invest in SMS and radio-based climate and weather services	Research and Monitoring	Agriculture	×	×	×		×		Adaptive Capacity

				Climate Stressor						
ID#	**Example Agriculture and Fisheries Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
14.5	Adapte y ajuste las prácticas de riego, para conservar agua	Operations and Maintenance	Agricultura	×	×	×				Capacidad de adaptación
14.6	Address point and non-point pollution of agricultural landscapes and freshwater and marine systems	Operations and Maintenance	Agriculture	×	×	×		×	×	Adaptive Capacity
14.7	Implement laws and policies to prevent overexploitation of fisheries and place further stress on marine populations	Policy	Fisheries	×	×	×		×		Adaptive Capacity
14.8	Restrict harmful agricultural practices such as slash and burn agriculture that increases erosion and reduces soil fertility	Policy	Agriculture	×	×	×				Adaptive Capacity
14.9	Encourage farmers, pastoralists, and fishers to manage natural regeneration of trees, grasslands, and fish stocks	Capacity Building	Agriculture	×	×	×		×	×	Adaptive Capacity

				Climate Stressor						
ID#	**Example Agriculture and Fisheries Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
14.10	Train farmers in basic techniques of sustainable agriculture, such as improving soil health, integrated pest management, and crop rotation	Capacity Building	Agriculture	×	×	×		×		Adaptive Capacity
14.11	Train farmers in use of drip and micro-irrigation techniques for more efficient irrigation	Capacity Building	Agriculture	×	×	×				Sensitivity & Adaptive Capacity
14.12	Provide farmers with new cultivars that are drought and heat-tolerant	Operations and Maintenance	Agriculture	×	×	×				Sensitivity
14.13	Encourage mixed crop-livestock systems and water, feed, and animal management to increase livestock productivity	Capacity Building	Agriculture	×	×	×				Sensitivity
14.14	Application of bio-digesters to cattle and pig farming/ management	Operations and Maintenance	Agriculture	×	×	×				Sensitivity & Adaptive Capacity
14.15	Promote adoption of breeds better adapted to the prevailing climate	Policy	Agriculture	×	×	×				Sensitivity

I5 EXAMPLE INDUSTRY OPTIONS

				Climate Stressor						
ID#	**Example Industry Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
15.1	Develop contingency plans to prepare for disruptions and plan ahead in case building assets are impacted by climate stressors	Capacity Building	Industry	×	×	×	×	×	×	Adaptive Capacity
15.2	Elevate sensitive materials above ground-level floors to help prevent excessive damage to building infrastructure	Structural	Industry		×		×	×	×	Sensitivity
15.3	Site new infrastructure in low-risk areas	Structural	Industry	×	×	×	×	×	×	Exposure

				Climate Stressor						
ID#	**Example Industry Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
15.4	Update design standards to accommodate future climate scenarios to help buildings withstand potentially greater exposure to climate stressors in the future	Policy	Industry	×	×	×	×	×	×	Adaptive Capacity
15.5	Lay deeper foundations to reduce the chance of a building's foundation being undermined by erosion	Structural	Industry		×		×	×	×	Sensitivity
15.6	Reconsider zoning and planning regulations to appropriately locate buildings in less vulnerable zones	Policy	Sector		×		×	×	×	Sensitivity
15.7	Ensure that temperature-sensitive rooms have air conditioning or that there is a backup energy supply to keep vital systems operational in particular instances/are not too sensitive to heat	Operations and Maintenance	Sector	×						Sensitivity

				Climate Stressor						
ID#	**Example Industry Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
15.8	Develop a maintenance and training program with employees to help them understand climate-related impacts and prepare appropriate plans	Structural	Industry	×		×	×	×	×	Adaptive Capacity

16 EXAMPLE TOURISM OPTIONS

				Climate Stressor						
ID#	**Example Tourism Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
16.1	Create boundaries and buffer zones to protect buildings and coastal infrastructure from sand encroachment, inundation, destruction, and other coastal hazardss costeros	Structural	Patrimonio Cultural, Turismo				×		×	Sensitivity

				Climate Stressor						
ID#	**Example Tourism Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
16.2	Conduct capacity building and training to better understand implications of climate on infrastructure services and development, and help prepare for and cope with stressors or build longer-term resilience	Capacity Building	Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage, Sanitation, Wastewater, Urban Mobility, Power,	×		×	×	×	×	Sensitivity & Adaptive Capacity
16.3	Protect reefs to reduce coastal erosion and storm surge damage	Structural	Cultural Heritage, Tourism				×		×	Adaptive Capacity
16.4	Remove, restrict and redesign aging coastal protection structures that have become less effective as they deteriorate with age or as their design elevations are exceeded	Structural	Cultural Heritage, Tourism			×	×	×	×	Exposure & Sensitivity
16.5	Regulate coastal lighting to reduce the vulnerability of sea turtles to climate change	Policy	Tourism, Natural Resources						×	Sensitivity

				Climate Stressor						
ID#	**Example Tourism Adaptation Measure**	**Adaptation Type**	**Resource, Sector, or Service**	**Temperature**	**Rainfall**	**Drought**	**Hurricane Frequency and Intensity**	**Extreme Rainfall, Riverine Flooding, Erosion, and Landslides**	**Sea Level Rise, Storm Surge, Coastal Erosion**	**Vulnerability Component Addressed**
16.6	Develop alternative transportation routes to access tourism spots through less exposed areas	Structural	Tourism	x			x	x	x	Adaptive Capacity

REFERENCES FOR CLIMATE ADAPTATION MEASURES

Reference	URL
Bajracharya, Childs, Hastings (2011). Climate change adaptation through land use planning and disaster management: Local government perspectives from Queensland.	http://www.prres.net/papers/Bajracharya_Childs_Hastings_Climate_change_disaster_management_and_land_use_planning.pdf
Birch Hill Geosolutions (2008). Climate Change Adaptations for Land Use Planners. Natural Resources Canada Project A1209.	http://www.cakex.org/sites/default/files/Birch_Hill_Geosolutions.pdf
City of Philadelphia (2016). Growing Stronger: Toward a Climate-Ready Philadelphia.	https://beta.phila.gov/media/20160504162056/Growing-Stronger-Toward-a-Climate-Ready-Philadelphia.pdf
FWS Pacific Region Adaptation Strategies. Internal resource.	
Hamin and Gurran (2009). Urban form and climate change: Balancing adaptation and mitigation in the U.S. and Australia. Habitat International. Volume 33 Issue 3.	http://www.sciencedirect.com/science/article/pii/S0197397508000659
Richardson and Otero (2012). Land use planning tools for local adaptation to climate change. Government of Canada.	http://publications.gc.ca/collections/collection_2013/rncan-nrcan/M4-106-2012-eng.pdf
USAID (2015). CCRD Rapid Vulnerability and Adaptation Screening Tool. Internal resource.	
USAID (2015). CCRD Adaptation Option Identification and Evaluation Tool. Internal resource.	

STAGE 6 TOOLS

• Adaptive Management Tool

Resource Title	ADAPTIVE MANAGEMENT TOOL
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☑ Stage 5: Implementation ☑ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	Adaptive management is an iterative approach that allows planners and managers to revisit and improve climate resilience and adaptation measures. This resource provides practical guidance for monitoring program and project progress every six months and for evaluating land use plan implementation every two years. It provides a checklist of climate and non-climate conditions and impacts that should be monitored and tracked over time, and a checklist of questions to help you to assess and re-evaluate whether adaptation measures should be adjusted.
Methodology	• Tables 1 and 2 provide example indicators for measuring progress and performance. You can track the progress of implementation and effectiveness of each adaptation measure by comparing baseline (the current state) indicators to changes in these indicators over time. • Table 3 records the information you will use to monitor and evaluate the implementation of each adaptation measure. This information will be integrated into the monitor and evaluation system for your Municipal Land Use Plan. Note that new copies of Table 3 will be required for each periodic (6 months) update. • Use the questions in Table 4 to help evaluate whether the chosen adaptation measures are adequate or need updating.
User(s)	Municipal staff involved in land use planning; program managers; and stakeholders representing financial, technical, and institutional capacities.
Intended Use	To provide a framework and guidance for monitoring and evaluating implemented adaptation measures and changing climate conditions.
Key Output(s)	Monitoring and Evaluation indicators, targets, and timelines for integration into the land use monitoring and evaluation plan (Table 3)
Ease of Use	Users require a working knowledge of municipal resources, sectors, and services; and the historical sensitivity of assets to climate and non-climate stressors.

ADAPTIVE MANAGEMENT TOOL

This tool provides guidance to help planners integrate climate change into the PMOT Guide Stage 6 monitoring and evaluation activities and planning. Achieving climate resilience is an ongoing process. Adaptive management is an iterative approach that allows planners and managers to revisit and improve climate resilience and adaptation measures. This practice helps municipalities maintain and build resilience through the adjustment of adaptation strategies as they gain knowledge and understanding of changing climate and non-climate stressors, and the associated municipal impacts and vulnerabilities.

The PMOT Guide suggests the following monitoring and evaluation activities under Stage 6:

- Tracking land use permitting every three months,
- Monitoring program and project progress every six months, and
- Evaluating land use plan implementation every two years.

This tool provides practical guidance for the latter two activities, including for periodic (~6 months, Stage 6, Step 2) monitoring and evaluating the effectiveness and implementation progress of the adaptation measures in your land use plan. In addition, the tool supports the integration of climate change into the municipal territorial information and management system (Stage 5, Step 3) by providing a checklist of climate and non-climate conditions and impacts that should be monitored and tracked over time to improve understanding of vulnerabilities and effectiveness of adaptation measures (Module 2). Finally, a checklist of questions is provided in Module 3 to help you to assess and re-evaluate whether adaptation measures should be adjusted (~2 years, Stage 6, Step 3).

HOW CAN YOU MONITOR ADAPTATION IMPLEMENTATION PROGRESS AND PERFORMANCE OVER TIME?

Progress of implementation and the effectiveness of each adaptation measure can be tracked over time by comparing baseline (the current state) indicators to changes in the indicators over time. Evaluating progress focuses on how well your plans have been implemented; evaluating performance assesses how effective these actions have been in improving resilience. Table 1 provides example indicators for measuring progress and performance overall, while Table 2 provides example indicators for specific adaptation measures and strategies. Note that while each adaptation measure may have unique indicators for progress of implementation, indicators for performance of adaptation options may be cross-cutting.

Table 1: Example Monitoring and Evaluation Indicators for Progress and Performance

Progress of Implementation of Adaptation Options	Performance of Adaptation Options
• Number of permits, programs and projects that incorporate climate change adaptation • Amount of funding secured to finance the land use adaptation measure • Number of residents in areas zoned for climate risks • Percentage of coastal land protected as a buffer zone • Percentage of 'critical' municipal buildings (e.g., hospitals) that meet the building codes for extreme weather	• Number of days of disruption to businesses • Number of properties damaged by riverine or coastal flooding • Number of hospitalizations due to extreme heat • Number of days water supply curtailed due to drought • Number of hours per day power disrupted due to extreme weather • Number of roads damaged due to extreme weather • Maintenance and repair costs of municipal infrastructure due to storm events

Table 2: Climate Change Adaptation Strategies and Related Example Indicators

Example Adaptation Measure or Strategy	Example Progress and Performance Indicators
1. Incorporate a no-build buffer zone and/or setback along coastal and riparian areas that take into consideration increasing sea level and storm surge heights and/or changes in riverine flood risk.	PROGRESS Indicators: • Number of new regulations for adaptation in the Urban Regulatory Plan • Number of public and private projects outside vulnerable areas • Number of models of sea level rise and storm wave penetration PERFORMANCE Indicators: • Number of displaced or affected persons in extreme rainfall, coastal or riverine flooding events • Number of legal actions taken against invasions that violate Law 64-00 (water courses) or Law 305-68 (coastal fringe of 60 m) • Coverage (%) or extension (km^2) of vulnerable land or coastal area (declared as a non-developable area) that has not been occupied with respect to the baseline PMOT zoning map

Example Adaptation Measure or Strategy	Example Progress and Performance Indicators
2. Reduce or eliminate vulnerability in occupied sites vulnerable to floods and landslides, protecting the population and infrastructure through structural measures (including resettlement) and non-structural measures, in the medium and long term	PROGRESS Indicators: • Number of constructed works (e.g., walls or dykes) for the protection of the population in occupied vulnerable sites • Number of neighborhood design projects with flood mitigation solutions • Number of new engineering technologies implemented for flood management (e.g., biofiltration to permeable pavements) • Number of contingency plans for flood risk zones • Number of early warning systems created
	PERFORMANCE Indicators: • Coverage (%) or extension (km²) of occupied vulnerable soil recovered, with respect to the baseline PMOT zoning map • Number of people resettled with respect to the baseline of the population census in occupied vulnerable land • Coverage (%) or extension (km²) of vulnerable land reforested or incorporated into projects for public use • Number of people affected by flooding
3. Restore natural areas, including green corridors and wetlands, to provide buffer zones, create shading and drainage, improve the landscape, and increase biodiversity.	PROGRESS Indicators: • Total area (km²) of the Urban Green System relative to baseline • Number of Environmental Management Plans of the Urban Green System • Number of urban reforestation programs
	PERFORMANCE Indicators: • Coverage (%) or extension (km²) of urban green areas with respect to the baseline • Number of bird species • Qualitative and quantitative changes in the urban landscape • Indicators of the ITree Tool (e.g., Number and species of trees and their diameters, removal of pollutants (tons/year), storage (tons) and sequestration (tons/year) of carbon, runoff avoided (m3/year), energy saving of buildings ($) and avoided carbon emissions (tons/year)

Example Adaptation Measure or Strategy	Example Progress and Performance Indicators
4. Enhance climate resilience of services, (e.g., solid waste management, urban mobility, water supply, or power supply)	PROGRESS Indicators: • Number of improved plans for climate-resilient infrastructure services: water (e.g., number of new sources, number of people served, non-revenue water losses, and number of water quality monitoring sites); urban mobility (e.g., length (km) of improved public transport, area (km^2) of expanded buffer zones, number of redundant routes for critical facilities); or solid waste (e.g., number of landfills, number of solid waste management education courses); power (number of people served, number of backup systems, length of tree and vegetation maintenance corridor) PERFORMANCE Indicators: • Number of power failures • Number of people with water borne illness • Number of rivers, drainage systems blocked by solid waste
5. Strengthen inter-institutional and inter-sectoral coordination for adaptation, environmental improvement and the protection of natural resources.	PROGRESS Indicators: • Number of meetings including the Risk Management Units (UGR) and Environmental Management (UGAM) • Number of participatory meetings including the City Council, public and private organizations, vulnerable communities, and organizations competent in disaster prevention, mitigation and response • Number of trainings of municipal development councils on climate change PERFORMANCE Indicators: • Number of adaptation projects included in the participatory budget

Example Adaptation Measure or Strategy	Example Progress and Performance Indicators
6. Develop an asset management strategy and database to track the risks, costs, and impacts of a changing climate into decisions about resource allocation	PROGRESS Indicators: • Number of climate data management organizations (ONAMET and universities) contributing information to municipal decision makers • Number of municipal information centers with access to climate data • Number of research projects implemented to track municipal climate impacts • Number of municipal and coastal topographic surveys • Number of municipal hydro-meteorological, and tidal observation stations implemented PERFORMANCE Indicators: • Number of improved municipal decisions using climate and tidal data, research, and information (e.g., improved zoning with results from hydrological models and sea level rise)
7. Develop comprehensive education program at different levels (neighborhood, city, regional) on land use, climate change, and risk management	PROGRESS Indicators: • Number of climate change education and training projects • Number of community-level climate change trainings conducted • Number of people trained on climate change • Number of courses developed on climate change impacts and adaptation PERFORMANCE Indicators: • Number of trained individuals reporting an increase in their use of climate risk management and adaptation information and techniques

MODULE 1

TRACKING ADAPTATION MEASURE IMPLEMENTATION PROGRESS AND PERFORMANCE

The purpose of this module is to help you identify and select indicators to track your progress in implementation of adaptation options, and the performance of adaptation options once implemented. Identifying these indicators, and setting targets, clear objectives, and timing for implementation progress and performance will help you to better evaluate your resilience and identify where course corrections may be necessary.

INSTRUCTIONS FOR MODULE 1

In this module, answer the following questions, and record your answers in Table 3 of this tool, below. Note that new copies of Table 4 will be required for each periodic (6 months) update.

1. Identify the adaptation measure and type (zoning; policies, plans, programs, and projects; or regulations)

2. Identify and select indicators within the two indicator categories to track a) progress of implementation of adaptation options and b) performance of adaptation options once implemented. Refer to for example progress and performance indicators in Tables 1 and 2, above. Consider the following questions when selecting indicators:

- Does information gathered on the indicator help us understand the progress and performance of the adaptation measure?
- To what extent would data from the indicator help improve decision making?
- How burdensome is the process for collecting supporting data for the indicator?
- How feasible would it be to collect the data? Can you utilize existing monitoring systems or systems that will be set up to monitor land use?
- Does the indicator need to be quantitative or qualitative?
- Who will be updating and maintaining indicator data?

3. Record each indicator under the Progress Indicators (#2) or Performance Indicators (#5) sections in Table 3, as relevant.

4. Establish a baseline (#3 and #6) for each indicator in Table 3 for guidance.

5. Define targets and timing for each indicator. Targets should be specific, measurable, attainable, relevant, and time-bound.

- Given your indicators and their baselines, what outcome would indicate that you have succeeded?
- At the same time, what are realistic expectations for implementation, enforcement, and effectiveness of the adaptation measure?

6. Record the targets under the Target column (#4 and #7) of Table 3.

7. Identify a point of contact (#8) for managing the monitoring and evaluation process of the adaptation measure to make the process less burdensome for an organization. If the adaptation measure was identified using the Adaptation Planning Tool, then an appropriate point of contact could be a stakeholder associated with the measure identified in the tool's "Adaptation Measure Description Worksheet."

Table 3: Tracking Adaptation Measure Implementation Progress and Performance

1. Adaptation Measure and Type	2. Progress Indicators	3. Baseline	4. Target	5. Performance Indicators	6. Baseline	7. Target	8. Point of Contact
Example: 60m Coastal Buffer Zone, Zoning	Example: Percent of coastal buffer zone reclaimed	30%	100% within 6 years	Example: Number of coastal properties damaged by coastal flooding per year	180	Less than 10 per year within 5 years	DGODT
1	Indicator #1:			Indicator #1:			
	Indicator #2:			Indicator #2:			
	Indicator #3:			Indicator #3:			
2	Indicator #1:			Indicator #1:			
	Indicator #2:			Indicator #2:			
	Indicator #3:			Indicator #3:			
3	Indicator #1:			Indicator #1:			
	Indicator #2:			Indicator #2:			
	Indicator #3:			Indicator #3:			
4	Indicator #1:			Indicator #1:			
	Indicator #2:			Indicator #2:			
	Indicator #3:			Indicator #3:			

MODULE 2

IDENTIFY CONDITIONS AND IMPACTS TO MONITOR

The purpose of this module is to identify the climate and non-climate conditions that you will monitor. At local scales, the magnitude of future climate change and associated impacts are often uncertain, so gathering information on local climate and related impacts over time provides valuable information about local scale changes. You may also experience unexpected climate events and impacts that are important to document. Additionally, natural systems and non-climate conditions (e.g., land use, demographics, technology, etc.) will continue to evolve, affecting the level of vulnerability of people and assets, and the effectiveness of adaptation options.

INSTRUCTIONS FOR MODULE 2

In this module, consider the following questions and checklist, and record relevant information to monitor in the space provided. You may wish to also consult the priority vulnerabilities identified in Stage 2 and 3, to identify pertinent climate and non-climate stressors to your municipality. This section provides a checklist for identifying conditions and impacts to monitor.

Table 4: Identify Climate and Non-Climate Conditions to Monitor

Climate Conditions and Impacts	
What types of information should you collect?	☐ Trends in annual, monthly, seasonal, or extreme climate conditions relevant to your key vulnerabilities (e.g., seasonal rainfall and temperature) ☐ Changes in frequency, magnitude, and extent of climate impacts (e.g., riverine and coastal flood extent, coastal erosion) ☐ Note that information for some climate conditions may overlap with information on performance indicators. For example, if you are interested in reducing coastal flooding impacts, you may want to learn about the frequency of coastal flooding as well as the number of communities or properties impacted during those flooding events

Record pertinent climate conditions and impacts to monitor:

Climate Conditions and Impacts

Who should you engage with to collect information and monitor climate conditions?

- ☐ Climate and weather resources and experts (e.g., National Meteorological Office, local universities, local or regional weather stations)
  - Note that some met offices may only have raw climate data. When engaging with met staff, seek opportunities to synthesize information into averages and extremes (e.g., average monthly rainfall, average daily high temperature, maximum three-day rainfall, etc.)
- ☐ Emergency response agencies, to understand and/or quantify impacts following significant events

Non-Climate Conditions

What types of information should you collect?

- ☐ Changes in key non-climate stressors (e.g., demographics, pollution, water use consumption patterns)
- ☐ Changes in land use
- ☐ Staffing/labor availability and capacity
- ☐ New adaptation technologies and opportunities to improve adaptive capacity

Record pertinent non-climate climate conditions and drivers of change to monitor:

Who should you engage with to collect information and monitor non-climate conditions?

- ☐ Local government agencies related to land use planning, economic development, environmental protection, sanitation, housing, and other agencies involved in land use activities

MODULE 3

ADJUST EXISTING ADAPTATION MEASURES AND IDENTIFY NEW MEASURES

Evaluation of the land use plan occurs every two years. This process provides an opportunity to assess the progress and effectiveness of adaptation measures, based on the periodic monitoring of indicators recorded to date. Table 5 provides a checklist of questions to help evaluate whether adaptation measures are adequate or need updating.

INSTRUCTIONS FOR MODULE 3

In this module, consider the following set of questions, and record your answers in Table 5.

1. List adaptation measure and type (see Table 3)

2. Implementation Progress. For each adaptation measure recorded, determine:

- Given your established baseline and targets, how well has the implementation of the adaptation measure progressed to date?
- Is its implementation on track?
- What weaknesses of the measure have you observed during implementation?
- What strengths has the adaptation measure displayed?

3. Non-Climate Impacts. Consider changing climate and non-climate conditions, events, and impacts.

- Have changing conditions stressed the area and/or assets where you are implementing the adaptation measure?
- Alternatively, has stress on the area and assets been reduced due to changing conditions?

4. Adaptation Measure Performance. Are any of the adaptation measures significantly underperforming?

- If yes, do you want to consider a new adaptation measure? Please refer to the Adaptation Planning Tool for more comprehensive guidance on developing an adaptation measure that sufficiently addresses increased vulnerability identified in this tool.
- If yes, do you want to modify or adjust the measure? See point 5.

5. Modify Measure? (yes/no)

6. Recommended Adjustments. For adaptation measures that require modifications, consider the lack of implementation progress and effectiveness and potential impacts from changing climate and non-climate conditions:

- Is there a certain component of the adaptation measure that requires adjustment in order to meet its performance or progress targets? Why does it need to be adjusted?
- Are there particular barriers to implement the adaptation measure? For example, are you unable to bring necessary stakeholders onboard?
- How have vulnerabilities changed since the adaptation measure was selected during planning?
- What impacts does the adaptation measure need to adjust to?

1. Adaptation Measure and Type	2. Implementation progress	3. Non-climate impacts	4. Adaptation Measure Performance	5. Modify Measure (y/n)	6. Recommended Adjustments
Example: 60m Coastal Buffer Zone, Zoning	Some removal of existing structures	Continued encroachment due to new constructions within buffer zone	Inconsistent enforcement	y	Improve enforcement

ANNEX II
RESOURCES

ANNEX II
RESOURCES

STAGE 1 RESOURCES
- Stakeholder Checklist
- Sample Stakeholder Survey
- Communication Plan Example

STAGE 2 RESOURCES
- Climate Information Worksheet
- Mapping Climate Vulnerability Assessment Information to Diagnostics
- Vulnerability Working Group Agenda

STAGE 3 RESOURCES
- Adaptation Working Group Agenda

STAGE 4 RESOURCES
- Climate Adaptation Plan Outline

STAGE 5 RESOURCES
- Implementation Analysis Form
- Example Action Plan Worksheet

STAGE 6 RESOURCES
- Adaptive Management Factsheet

STAGE 1 RESOURCES

- STAKEHOLDER CHECKLIST
- SAMPLE STAKEHOLDER SURVEY
- COMMUNICATION PLAN EXAMPLE

Resource Title	STAKEHOLDER CHECKLIST		
Relevant Land Use Planning Stages	☑ Stage 1: Institutional Organization	☐ Stage 4: Programming	☐ Stage 7: Formalization
	☐ Stage 2: Territorial Diagnosis	☐ Stage 5: Implementation	
	☐ Stage 3: Territorial Prospective	☐ Stage 6: Monitoring and Evaluation	
Description	Use this list to help you develop and prioritize a list of stakeholders to engage during the land use planning process.		

STAKEHOLDER CHECKLIST

A range of stakeholders can play a key role in the planning process and, eventually, implementation. This list provides an overview of potential stakeholders to help the technical team consider and identify the stakeholders who are important to engage, given the needs and character of each individual municipality. Not all of these stakeholders will be appropriate for a specific municipality. To address the goal of integrate climate change resilience into land use planning efforts, it is important to include stakeholders with climate-related knowledge.

POTENTIAL STAKEHOLDERS

REPRESENTATIVES FROM GOVERNMENT AGENCIES

- Ministry of Economic Planning and Development (MEPyD)
- Ministry of Environment and Natural Resources
- Ministry of Public Works and Communications
- Ministry of Education (MINERD)
- Ministry of Public Health and Social Assistance (MISPAS)
- Ministry of Agriculture
- Ministry of Higher Education, Science and Technology (MESCyT)
- Ministry of Women
- Ministry of Tourism (MITUR)
- Ministry of Energy and Mines
- Ministry of Labor
- Ministry of Defense
- Ministry of Culture
- Council for Climate Change and Clean Development Mechanism (CNCCMDL)
- National Authority for Maritime Affairs (ANAMAR)
- National Institute of Hydraulic Resources (INDHRI)
- National Energy Commission (CNE)
- Directorate General for Special Programs of the Presidency (DIGEPEP)
- Commission for Municipal Affairs of the Chamber of Representatives
- Civil Defense/Emergency Operations Center (COE)
- Dominican League of Municipalities

MUNICIPAL ACTORS

- Mayor
- City Council
- Consejos de Desarrollo Municipales (e.g., Consejo de Desarrollo de Santiago CDES)
- Relevant offices in City Hall (e.g., Environmental Management Unit, Planning Department, Municipal Public Works, etc.)
- Municipal Prevention and Risk Mitigation Committee
- National Institute of Transit and Land Transportation (INTRANT)
- Land use planning representatives
- Other relevant city representatives

PUBLIC SERVICES AND UTILITIES

- National Meteorological Office (ONAMET)
- National Geological Service (SGN)
- National Energy Commission (CNE)
- National Statistics Office (ONE)
- National Geographic Institute "José Joaquin Hungria Morell"
- National Police
- National Institute of Potable Water and Sewerage (INAPA)
- Water and Sewage Corporation (of the relevant jurisdiction, e.g., CAASD in Santo Domingo or CORAAMOCA in Moca)
- Electricity distribution companies (EDESUR, EDENORTE, EDEESTE)

NON-GOVERNMENTAL

- Dominican Federation of Municipalities (FEDOMU)
- Dominican Red Cross
- Environmental organizations
- Development Associations/ Chambers of Commerce/ Producers Associations
- Climate Change Observatory – Instituto Tecnológico de Santo Domingo (INTEC)
- Center for Urban and Regional Studies (CEUR-PUCMM)
- Dominican Society of Geology (SODOGEO)
- Seismological Institute (UASD)
- Geographic Institute (UASD)

BUSINESS SECTOR

- Industries Association of the Dominican Republic (AIRD)
- Representatives from the tourism industry (e.g., hotels, taxi organizations)
- Trade organizations (e.g., Union of Builders, Confederation of Shepherds, Butchers Association, Retail Merchants Association)
- Telecommunications (e.g., cable, telephone, radio, TV)
- Dominican Association of Builders and Housing Developers (ACOPROVI)
- National Association of Young Entrepreneurs (ANJE)
- National Council of Private Enterprise (CONEP)
- Free Trade Zones Industry Association
- Dominican Association of Radio Broadcasters (ADORA)
- Public transit businesses

CIVIL SOCIETY

- Media
- Academy of Sciences
- Universities and research Centers
- Dominican Association of Professors
- Churches
- Citizen forums
- Neighborhood Associations and their Federations
- Chaplains Federation
- Mothers clubs
- Rotary Club
- Youth organizations
- Unions

INTERNATIONALES

Note: There may be institutions in the international development cooperation/financing community of interest to the process as potential sources of funding or information or both. Consider institutions such as the European Commission, the World Bank, the Inter-American Development Bank, United States Agency for International Development (USAID), Spanish Agency for Development (AECID), Japanese International Cooperation Agency (JICA), among others—as well as international NGOs such as OXFAM, ICMA, and The Nature Conservancy.

Resource Title	SAMPLE STAKEHOLDER SURVEY
Relevant Land Use Planning Stages	☑ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	This is an example of a stakeholder survey that can be used to help collect information about stakeholders' interests and to gain an understanding of how they can best engage with the planning process.

SAMPLE STAKEHOLDER SURVEY

Use to gather information on civil society organizations, including Community-Based Organizations (CBOs).

INTRODUCTION

Objective: Identify organizations´ weaknesses and work issues, and how many and which of them could we count on for developing the project and implementing future strategies and actions aimed at improving the vulnerability conditions of the communities where they operate. This survey will allow us to know, in addition to their location, work areas, relationships with key agents or institutions (governmental or private), the profile of their leaders and involvement availability (social commitment to climate adaptation).

1. Identification and location of the organization

Name_____Acronym _____
Foundation date _____
Address: Street_____
No._____
Sector_____Municipality _____
Office Tel_____ Mobile Phone_____
E-mail_____
Facebook_____

2. Type of organization

2.1. Select your organization type by objective and mission

☐Community ☐Cultural ☐Sports
☐Religious ☐Environmental ☐Business
☐Union of disabled ☐LGTBQ ☐Other.
Specify _____

- ☐ Neighbors Board
- ☐ Committee
- ☐ Housewife
- ☐ Associations

2.2 Is your organization recognized by one or more of the following mechanisms?

☐Law 122, on Non-profit Associations
☐Registration in the City Council
☐Registration in a public institution
☐None

2.3 To regulate its institutional life, the organization has:

☐ By-laws ☐Regulations ☐ Book of minutes ☐ Membership list
☐ Organization chart ☐Logo and stamp ☐ Letterhead paper and envelops

2.4 The organization works in:

☐ Own premises ☐ Rented premises ☐ Borrowed premises

2.5 It also has:

☐Computers ☐ Printer ☐Office equipment (furniture) ☐Telephone

3. Organization´s territorial character (geographical area of influence)

☐Sector ☐Neighborhood ☐Municipal ☐Provincial
☐Regional ☐National

4. About the membership

4.1 How many members does the organization have?

☐ 15-30 ☐31-45 ☐ 46-60 ☐ 60 and more

4.2 Men _____ Women _____

4.3 Ages

In which age group are most of the organization's members?

☐15-30 ☐30-45 ☐45 and more

4.4 Education level reached by most of the members

☐Literacy
☐Basic (first cycle, 1-4 grade)
☐Basic (second cycle, 5-8 grade)
☐Secondary
☐University
☐Specialty
☐Master

4.5 In your case, which category applies?
☐Literacy
☐Basic (first cycle, 1-4 grade)
☐Basic (second cycle, 5-8 grade)
☐Secondary
☐University
☐Specialty
☐Master

4.6 Which professionals or specialists are present in your organization?
_____
_____
_____

4.7 How many people work in your organization?
☐1-5
☐6-10
☐11-15
☐15 and more

4.8. Men _____ Women_____

4.9. Condition of those working in the organization
☐ Full time
☐ Part time
☐Temporary

4.10. Those who work in the organization are:
☐ Paid (have a salary)
☐ Volunteers

5. Communication
5.1 Communication means available in the organization. More than one option can be marked.
☐Computers ☐Telephone ☐Mobile phone ☐Fleet ☐Fax
☐Scanner ☐Internet ☐Web page ☐Social Networks
☐Others _____

5.2 How do you communicate within the organization? More than one option can be marked.
☐Meeting
☐Newspaper/Internal bulletin
☐Electronic mail
☐Printed correspondence
☐Others _____

6. Financing. How is the organization funded? More than one option can be marked.
☐Quota
☐Subsidy
☐Self-management/activities
☐Projects

7. Budget
7.1 Is there a budget?
☐ Yes
☐ No

7.2 Budget timeframe
☐Monthly
☐Biannually
☐Annually

7.3 What is the estimated amount of your organization budget?
_____

8. Organization´s work lines or axes:

☐Education ☐ Health ☐Gender ☐ Citizen rights ☐Pollution
☐ Solid waste ☐Sports ☐ Culture ☐ Research
☐ Local Development ☐ Housing and habitat

9. Social, environmental and climate problems of the territory

9.1 Could you prioritize the three first problems in your territory of influence? Only mark from 1 to 3, where 1 is the highest priority.

☐ Gender violence
☐ Citizen security
☐ Wastewater sewer
☐ Poor public services
☐ Unemployment
☐Other _____
☐ Intra-family violence
☐Contamination of water bodies
☐Contamination of creeks
☐ Solid waste management
☐Sexually transmitted illnesses

9.2 Which of the following event(s) occurs or has occurred in your territory?

☐Loss of beaches due to intrusion of the sea
☐Flooding
☐Landslides
☐Water shortage due to prolonged drought
☐Deforestation
☐Loss of rivers
☐Erosion and loss of soil
☐Heat waves
☐Changes in time, place and frequency of rainfall
☐Other(s) _____

9.3 Which of the following events have been or continue to be of greatest concern?

☐Loss of beach due to intrusion of the sea
☐ Flooding
☐ Landslides
☐ Water shortage due to prolonged drought
☐ Deforestation
☐ Loss of rivers
☐ Erosion and loss of soil
☐ Heat waves
☐ Changes in time, place and frequency of rainfall
☐ Other(s) _____

9.4 Impacts, in your territory, by the selected events _____
_____
_____
_____
_____
_____
_____

9.5 Which actions has your organization implemented in response to the selected events? _____
_____
_____
_____

10. Articulation/coordination

10.1 Is your organization part of any coordination space?

☐ Yes
☐ No

If your answer is yes, please go to the next question.

10.2 The type of coordination is:

☐ Union
☐ Association
☐ Federation
☐ Confederation
☐ Front
☐ Other _____

10.3 The coordination character is:
☐Local (neighborhood)
☐Municipal
☐Provincial
☐Regional
☐Nacional

10.4 Your organization has had work agreement or coordination of actions with:
☐ Sector (Ministries)
☐ Autonomous Public Organisms
☐ City Council
☐ International Cooperation

11. General data of the person who offers the institutional information

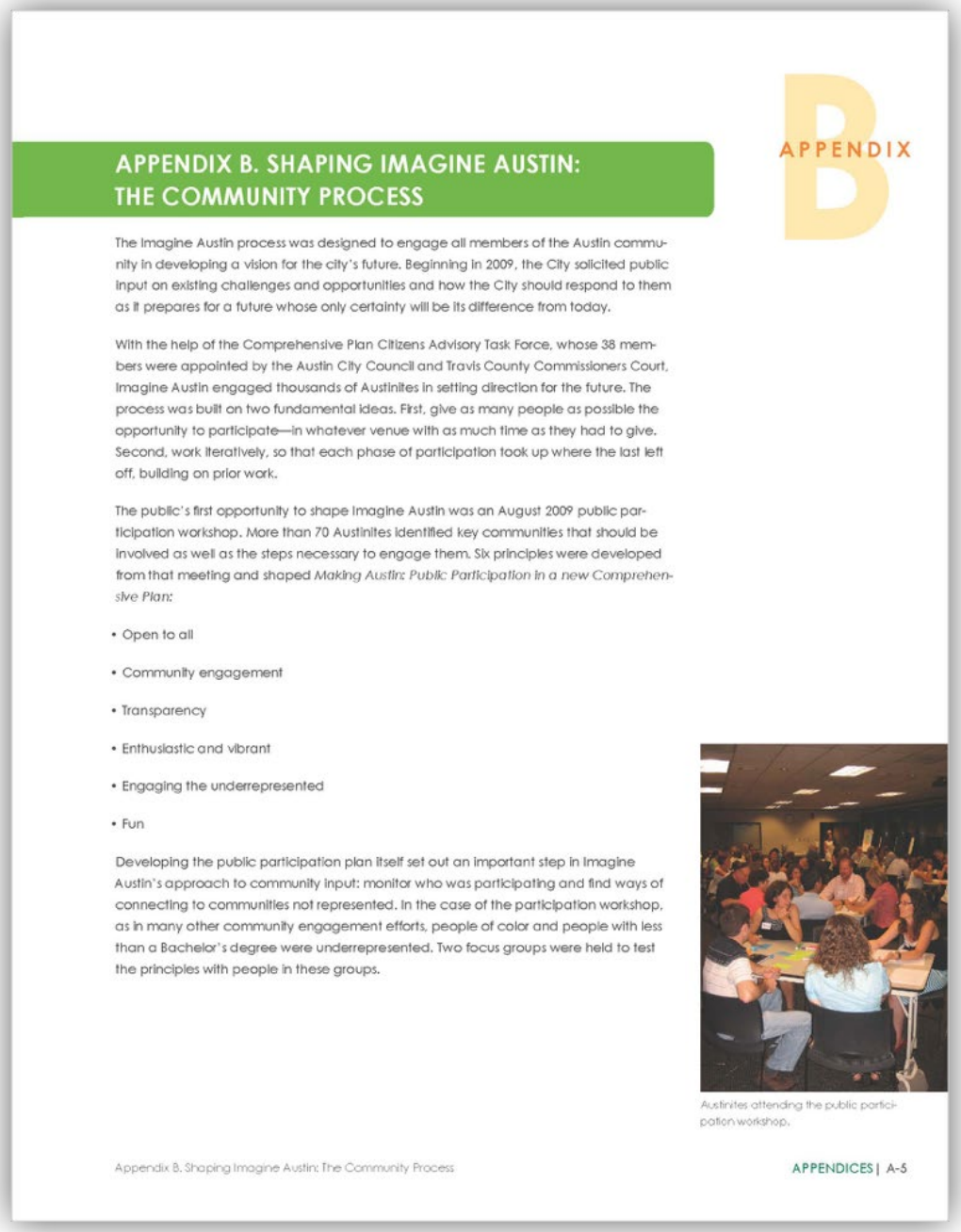
Name _____
Address _____
Telephone _____ e-mail _____
Current post within the organization _____
Time in the organization _____

12. Do you have any comment or suggestion? Please, share with us by using this space or by e-mail to [contact e-mail]

On behalf of *[organization name]*, thank you for your time.

Resource Title	COMMUNICATION PLAN EXAMPLE
Relevant Land Use Planning Stages	☑ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	This sample Public Participation Plan from Imagine Austin (Austin, Texas, USA) shows how that particular community approached outreach and engagement throughout its planning process.

COMMUNICATION PLAN EXAMPLE



APPENDIX B

APPENDIX B. SHAPING IMAGINE AUSTIN: THE COMMUNITY PROCESS

The Imagine Austin process was designed to engage all members of the Austin community in developing a vision for the city's future. Beginning in 2009, the City solicited public input on existing challenges and opportunities and how the City should respond to them as it prepares for a future whose only certainty will be its difference from today.

With the help of the Comprehensive Plan Citizens Advisory Task Force, whose 38 members were appointed by the Austin City Council and Travis County Commissioners Court, Imagine Austin engaged thousands of Austinites in setting direction for the future. The process was built on two fundamental ideas. First, give as many people as possible the opportunity to participate—in whatever venue with as much time as they had to give. Second, work iteratively, so that each phase of participation took up where the last left off, building on prior work.

The public's first opportunity to shape Imagine Austin was an August 2009 public participation workshop. More than 70 Austinites identified key communities that should be involved as well as the steps necessary to engage them. Six principles were developed from that meeting and shaped *Making Austin: Public Participation in a new Comprehensive Plan:*

- Open to all
- Community engagement
- Transparency
- Enthusiastic and vibrant
- Engaging the underrepresented
- Fun

Developing the public participation plan itself set out an important step in Imagine Austin's approach to community input: monitor who was participating and find ways of connecting to communities not represented. In the case of the participation workshop, as in many other community engagement efforts, people of color and people with less than a Bachelor's degree were underrepresented. Two focus groups were held to test the principles with people in these groups.

Austinites attending the public participation workshop.

Appendix B. Shaping Imagine Austin: The Community Process

APPENDICES | A-5

The Citizens Advisory Task Force was appointed by the City Council to provide guidance and help City of Austin staff and the consultant team engage the community. The task force met over 100 times and provided important recommendations that lead to the adoption of Imagine Austin.

SHAPING THE PLAN

Telling people about the plan is only the beginning. Actually engaging Austinites in shaping the plan is the ultimate goal of public participation. Mindful of the many competing demands on the public's time, the Imagine Austin team sought to provide as many ways in to the process as possible, while always striving to balance input from our most engaged citizens, able to provide countless hours and detailed comments, with the briefer contacts from the rest of the community.

Public input was organized into five steps, interspersed with major plan milestones that were reviewed by the Citizens Advisory Task Force, Planning Commission, and City Council.

Four of these steps were structured as Community Forum Series, with each series consisting of multiple public meetings, surveys, and other tools. The other step consisted of a several-months-long Working Groups process. Each of these steps and milestones are recounted below.

Participants at the Asian American Cultural Center conduct a meeting-in-a-box exercise as part of Community Forum Series #1.

TOOLS FOR ENGAGEMENT

A number of tools were used at different times throughout the process. The questions asked of the public were tailored in each step to match the tool being used.

- **Public meetings** were held in different parts of the city and different times of day throughout the process. Meetings were structured to encourage or require participants to engage with one another directly by working in small groups or indirectly by posting responses during the course of the meeting.
- **Online and paper surveys** accompanied every step in the process, allowing Austinites to participate at their convenience. While most survey respondents completed surveys online, paper surveys were distributed through a number of mechanisms: at libraries and public events and, in some cases, inclusion in the Austin-American Statesman or Austin Chronicle.
- **Online forums and comments** offered a less structured way for Austinites to communicate with staff and with one another.
- **Traveling teams** visited high-traffic areas such as football games, farmers markets, and festivals to promote the process, distribute surveys, and directly engage passersby.
- **Meetings-in-a-Box** allowed community groups, businesses, and individuals to host their own meetings at their convenience.
- A **Speakers Bureau** that allowed community groups to host a presentation from City staff and provide comments.

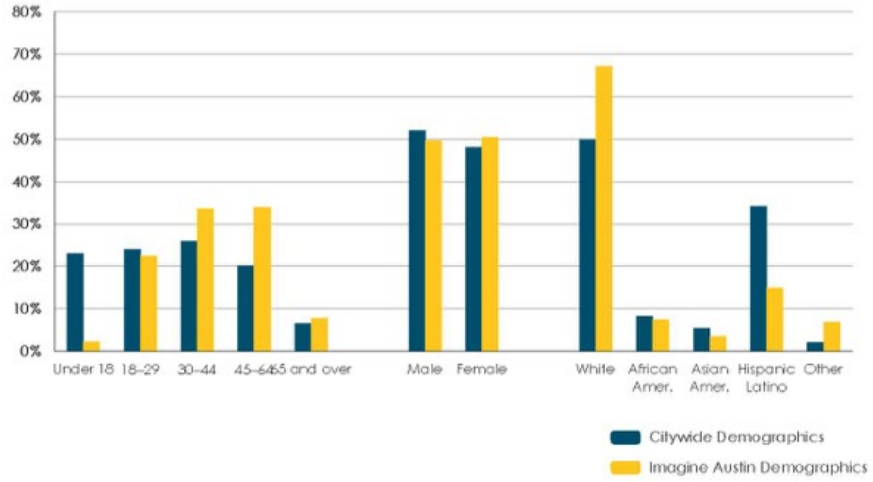
Imagine Austin was overseen monthly by a Citizens Advisory Task Force and a committee of Planning Commission, and less frequently by a committee of the City Council. As public meetings, each of these allowed for citizen communication, as well as direct public engagement with staff, Task Force members, Planning Commissioners, and Council members.

DEMOGRAPHICS

The demographics of participants were monitored throughout the process. As gaps were identified, additional outreach was developed to overcome them.

The results below show the total demographics from the first three Community Forum Series. While some gaps remain, being aware of them allowed planners and Task Force members to understand who the public input represented and to rely on other avenues to complement public input. This could take the form of formal and informal communication with community leaders or reliance on previous planning efforts, such as the Hispanic Quality of Life Study and its community oversight team.

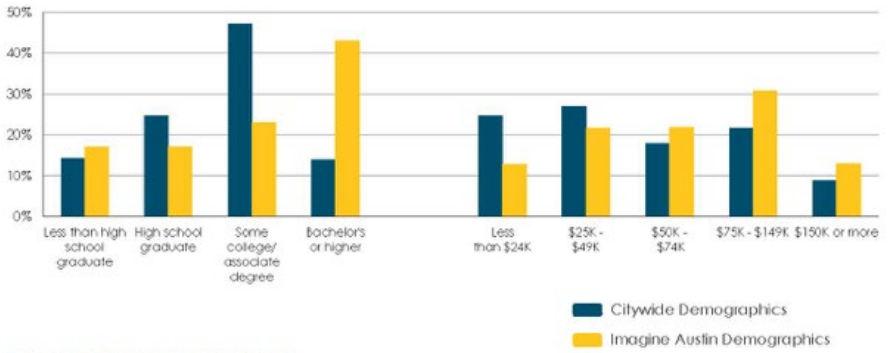
Demographics of Community Forum Participants



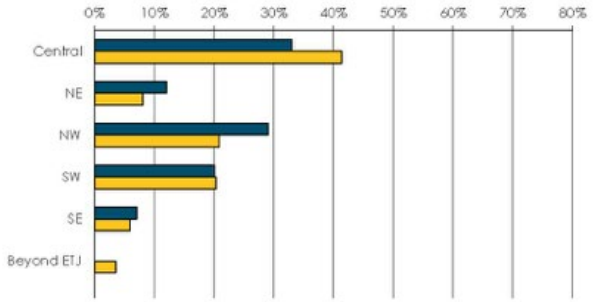
Appendix B. Shaping Imagine Austin: The Community Process

APPENDICES | A-7

Education and Income Levels of Community Forum Participants



Geography of Community Forum Participants



A-8 | IMAGINE AUSTIN COMPREHENSIVE PLAN

PHASES & MILESTONES

The Imagine Austin process was structured around two principles: repeat public engagement, with each round building on the previous round, and repeated check-ins with Planning Commission and City Council.

Community Forum Series #1

(5,892 participants)

The first Community Forum Series was organized around three questions:

- What are Austin's strengths?
- What are our challenges?
- How can the city be improved on its 200th anniversary, 2039?

Starting with an October 2009 Open House at the Austin Convention Center, Community Forum Series #1 ran for seven months, with six public meetings and an online and paper survey. The Meeting-in-a-Box was also introduced at this time.

Community Forum Series #2

(4,211 participants)

The second Community Forum Series consisted of two parts. The first part developed and tested Components of a vision statement. The second part was an interactive chip exercise, where participants worked together to allocate Austin's future growth across the city and in different forms. Four public meetings featuring the chip exercises were followed by eight community-sponsored and hosted chip exercises, to produce 63 total maps. Community Forum Series #2 included a second round of surveys and Meetings-in-a-Box focusing on the Components of the vision statement, as well as Speak Week, in which traveling teams visited 42 events and 31 locations throughout the city. This round of input also included a statistically valid survey of 1,100 Austinites to develop the vision components.

Community Forum Series #1

Appendix B. Shaping Imagine Austin: The Community Process

APPENDICES | A-9

Community Forum Series #3 (4,761 participants)

Using the chip exercise maps and current trends, five alternate future scenarios were created, each illustrating a different way that Austin could grow in the future. The future scenarios were assessed on a range of sustainability indicators. In the third Community Forum Series, the public reviewed and rated these scenarios at nine open house meetings, in community conversation kits, at traveling team booths, and by paper and online surveys.

Planning Framework & Preferred Scenario

The Plan Framework and Preferred Scenario set out key strategic directions for the City to take to achieve the vision. The Plan Framework contains policy guidance, while the Preferred Scenario shows the spatial patterns of growth that support the vision. They were developed with the Citizens Advisory Task Force and reviewed by 19 City Boards and Commissions, Planning Commission, and City Council. In March 2011, City Council forwarded the Plan Framework and Preferred Scenario to the Working Groups for more detailed work. The strategic directions are incorporated into this plan as Building Block Policies; the Preferred Growth Scenario was the basis for the Growth Concept Map.

Working Groups

Hundreds of Austin residents and leaders joined seven Building Block Working Groups to develop actions to implement the directions included in the Plan Framework. These seven Working Groups met on 22 occasions throughout spring and summer 2011 and took two surveys. The actions and priorities they developed are included in Chapter 5.

Community Forum Series #4 (2,979 participants)

The last round of public input was structured around review of the initial draft comprehensive plan. Beginning at the Release Party in October 2011, Austinites weighed in on the plan's priorities, as well as on the draft plan itself. The plan was also presented to 19 Boards and Commissions. Staff, consultants, and members of the Citizens Advisory Task Force and Planning Commission reviewed all public comments on the plan for inclusion in the adoption draft.

The distinctive benefit of a comprehensive plan is that it confronts big issues in a big-picture way. Other city plans are more focused – and deal with topics such as parks, solid waste, transportation, water, or smaller geographic areas. But only a comprehensive plan fully considers how the whole community's values, needs, people, and places are interrelated and interdependent. In creating this plan, we identified the defining issues that are central to Austin's future success.

Today, Austin tops numerous state, national, and international "Best Of" lists. This visibility is accelerating our attractiveness and population growth. As we grow and evolve, how can we preserve and amplify the special things we value about Austin? How can we face our more difficult problems, improve the city, and meet our challenges head-on?

Appendix B. Shaping Imagine Austin: The Community Process

APPENDICES | A-11

OUTREACH AND EDUCATION

Throughout its two years, Imagine Austin used a number of different venues for spreading the word and engaging the public: coverage by local media, advertising, booths and tables as public events, speaking engagements, and direct outreach by email, social media, and utility bills. Businesses, community groups, churches, and neighborhood associations were also directly engaged and encouraged to spread the word to their members and employees. Through this process, Imagine Austin built a contact list of thousands of individuals and hundreds of organizations. Neighborhood and community listservs amplified these messaging, spreading the word about Imagine Austin to many more stakeholders.

Stakeholder Interviews

Annual Austin Economic Forecast Event
Asian American Cultural Center
Austin Board of Realtors
Austin Chamber of Commerce
Austin City Council & Planning Commission
Austin Community College
Austin Convention and Visitor's Bureau
Austin Independent Business Alliance
Austin Independent School District
Austin Neighborhood Council
Austin Urban Coalition
Capital Area Council of Governments
Capital Area Metropolitan Planning Organization
Capital Metro Transportation Authority (CapMetro)
Concordia University
Downtown Austin Alliance
Del Valle Independent School District
Hill Country Conservancy
Immigrant Services Network
Leadership Austin
Lower Colorado River Authority
Meals on Wheels and More
Real Estate Council of Austin
St David's Community Health Foundation
Texas Nature Conservancy
Travis County Health and Human Services
UT Sustainability Center

Public Meetings

Participation Workshop

Community Forum Series #1
- 6 meetings plus the Kick-Off Open House

Community Forum Series #2
- 4 public meetings, plus 8 follow-on meetings

Community Forum Series #3
- 9 public meetings

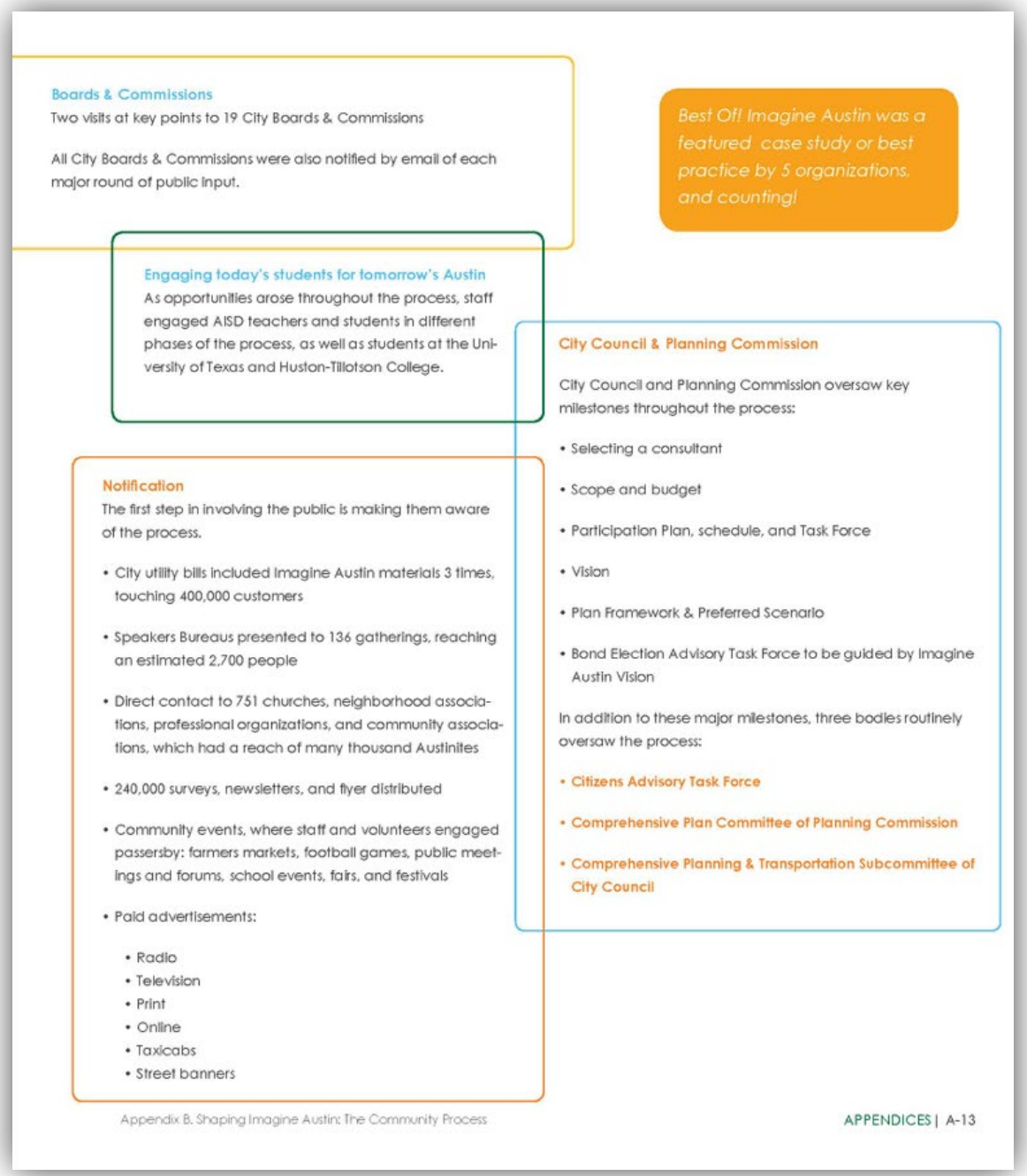
Working Groups
- 22 public meetings

Community Forum Series #4
- 2 public meetings

Neighborhoods engagement
- 5 meetings throughout the process related to Neighborhood Plans or Contact Teams

Business engagement
- 19 briefings for Community Forum Series #4

Live Music! 7 Meetings featured one or more Austin acts!



Boards & Commissions

Two visits at key points to 19 City Boards & Commissions

All City Boards & Commissions were also notified by email of each major round of public input.

Best Of! Imagine Austin was a featured case study or best practice by 5 organizations, and counting!

Engaging today's students for tomorrow's Austin

As opportunities arose throughout the process, staff engaged AISD teachers and students in different phases of the process, as well as students at the University of Texas and Huston-Tillotson College.

City Council & Planning Commission

City Council and Planning Commission oversaw key milestones throughout the process:

- Selecting a consultant
- Scope and budget
- Participation Plan, schedule, and Task Force
- Vision
- Plan Framework & Preferred Scenario
- Bond Election Advisory Task Force to be guided by Imagine Austin Vision

In addition to these major milestones, three bodies routinely oversaw the process:

- **Citizens Advisory Task Force**
- **Comprehensive Plan Committee of Planning Commission**
- **Comprehensive Planning & Transportation Subcommittee of City Council**

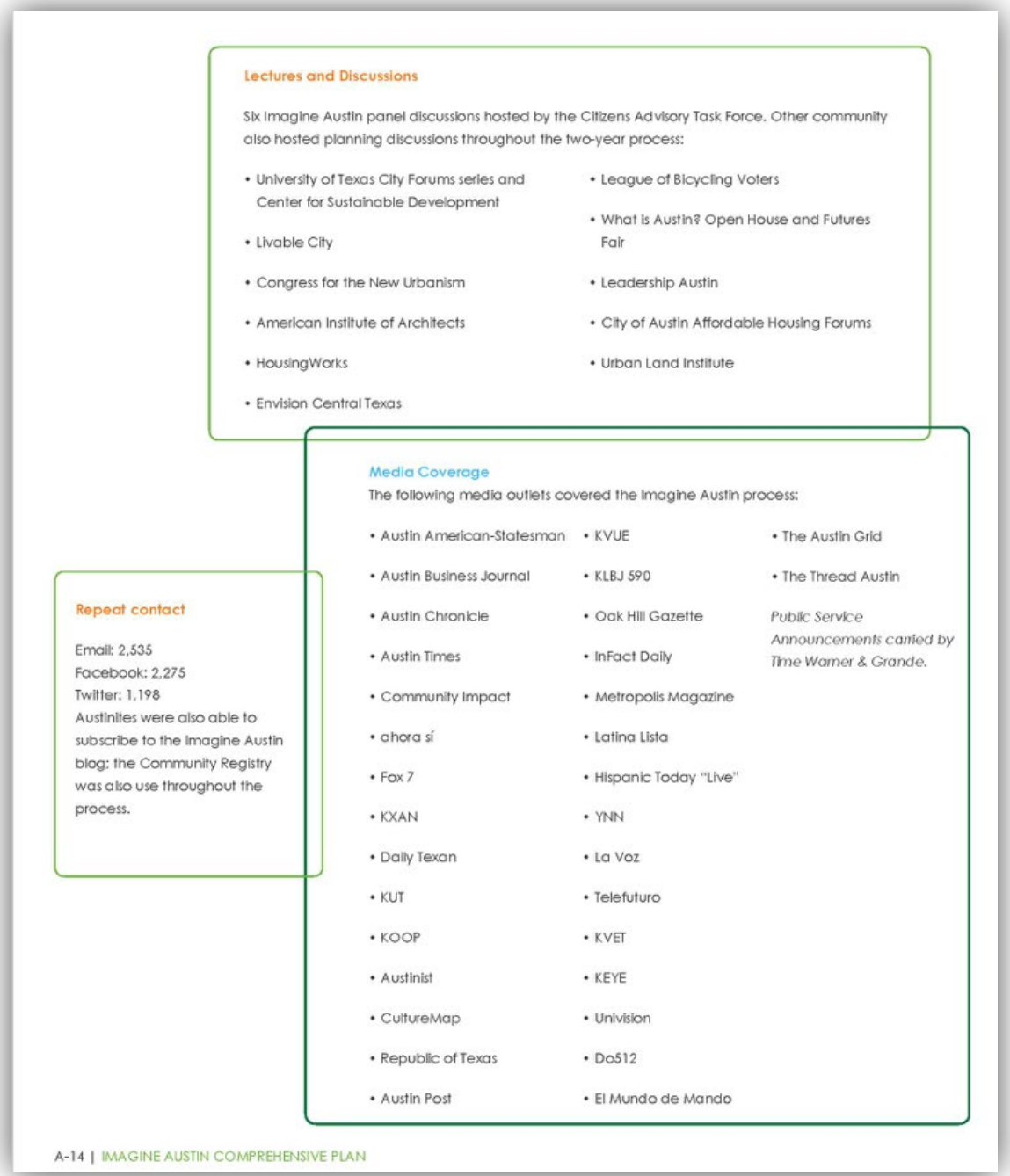
Notification

The first step in involving the public is making them aware of the process.

- City utility bills included Imagine Austin materials 3 times, touching 400,000 customers
- Speakers Bureaus presented to 136 gatherings, reaching an estimated 2,700 people
- Direct contact to 751 churches, neighborhood associations, professional organizations, and community associations, which had a reach of many thousand Austinites
- 240,000 surveys, newsletters, and flyer distributed
- Community events, where staff and volunteers engaged passersby: farmers markets, football games, public meetings and forums, school events, fairs, and festivals
- Paid advertisements:
  - Radio
  - Television
  - Print
  - Online
  - Taxicabs
  - Street banners

Appendix B. Shaping Imagine Austin: The Community Process

APPENDICES | A-13



Lectures and Discussions

Six Imagine Austin panel discussions hosted by the Citizens Advisory Task Force. Other community also hosted planning discussions throughout the two-year process:

- University of Texas City Forums series and Center for Sustainable Development
- Livable City
- Congress for the New Urbanism
- American Institute of Architects
- HousingWorks
- Envision Central Texas
- League of Bicycling Voters
- What is Austin? Open House and Futures Fair
- Leadership Austin
- City of Austin Affordable Housing Forums
- Urban Land Institute

Media Coverage

The following media outlets covered the Imagine Austin process:

- Austin American-Statesman
- Austin Business Journal
- Austin Chronicle
- Austin Times
- Community Impact
- ahora sí
- Fox 7
- KXAN
- Daily Texan
- KUT
- KOOP
- Austinist
- CultureMap
- Republic of Texas
- Austin Post
- KVUE
- KLBJ 590
- Oak Hill Gazette
- InFact Daily
- Metropolis Magazine
- Latina Lista
- Hispanic Today "Live"
- YNN
- La Voz
- Telefuturo
- KVET
- KEYE
- Univision
- Do512
- El Mundo de Mando
- The Austin Grid
- The Thread Austin

Public Service Announcements carried by Time Warner & Grande.

Repeat contact

Email: 2,535
Facebook: 2,275
Twitter: 1,198
Austinites were also able to subscribe to the Imagine Austin blog; the Community Registry was also use throughout the process.

A-14 | IMAGINE AUSTIN COMPREHENSIVE PLAN

STAGE 2 RESOURCES

- CLIMATE INFORMATION WORKSHEET
- MAPPING CLIMATE VULNERABILITY ASSESSMENT INFORMATION TO DIAGNOSTICS
- SAMPLE VULNERABILITY WORKING GROUP AGENDA

Resource Title	CLIMATE INFORMATION WORKSHEET
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☑ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	Climate information can be useful for identifying exposed assets and locations during the vulnerability assessment, which will consider current and future vulnerabilities and requires gathering current and historical climate information and future climate change projections. This worksheet can assist you as you collect information about current and projected impacts of climate variability and change.
Methodology	The worksheet is divided into three sections, which you can consult to help you find information you need to conduct a Climate Vulnerability Assessment: 1. **Climate Stressor Overview:** Lists climate variables, what questions to answer in collecting climate information, and how the information will be useful. 2. **Tier 1 – Climate Snapshot:** Lists resources that provide basic climate information. This section should be used by those who have limited time and resources to spend collecting climate information. 3. **Tier 2 – Detailed Climate Information:** Lists resources that provide more detailed climate information and datasets. This section should be used by those who have more time to collect climate information and a stronger background in data analysis.
User(s)	Municipal staff involved in land use planning, and a range of stakeholders representing financial, technical, and institutional capacities.
Intended Use	To provide resources you can use to find information about a range of climate variables, which can use in the *Climate Vulnerability Assessment Tool.*
Key Output(s)	Collected climate information and datasets
Ease of Use	Users require a working knowledge of municipal resources, sectors, and services; and the historical sensitivity of assets to climate and non-climate stressors.

CLIMATE INFORMATION WORKSHEET

This worksheet aims to help you collect information about current and projected impacts of climate variability and change. The worksheet is divided into three sections, including:

1. **Climate Stressor Overview.** This section lists climate variables, what questions to answer in collecting climate information, and how the information will be useful.
2. **Tier 1 – Climate Snapshot:** Lists resources that provide basic climate information. This section should be used by those who have limited time and resources to spend collecting climate information.
3. **Tier 2 – Detailed Climate Information:** Lists resources that provide more detailed climate information and datasets. This section should be used by those who have more time to collect climate information and a stronger background in data analysis.

Climate information can be useful for identifying exposed assets and locations during the vulnerability assessment, though the information that is initially gathered may need to be further refined given the specific municipal service or sector being assessed. The vulnerability assessment will consider current and future vulnerabilities, which requires gathering:

- Current and historical climate information that can be used to: (1) assess the extent to which exposure to climate variability and change has previously caused impacts, and (2) establish a baseline against which future exposure and impacts can be compared.
- Future climate change projections that can be used to: (1) explore possible future climatic conditions given different scenarios of change, at different points in the future.

Gathering and using climate change projections requires some knowledge and understanding of the types of information, scenarios available, and uncertainty, but generally for planning one should use:

- Information from multiple climate models (GCMs) to obtain a more complete understanding of the potential range of change and to account for uncertainty.
- Multiple emissions scenarios (e.g., high, medium, low) to account for uncertainty associated with the world's future development path, such as CMIPs RCP4.5 and 8.5.
- Decadal spans of years to help account for year-to-year variability so that if planners are interested in examining exposure for a particular year in the future (e.g., 2050), use data from the surrounding decade (e.g., 2040–2059) relative to a more recent reference time period (e.g., 1986–2015).

Gathering information on climate stressors includes direct changes in meteorological conditions such as temperature, rainfall, and wind, or indirect changes in sea level, landslides, flooding, or drought. Climatic extremes (and projected changes in extremes) are important to consider, because they generally pose more of a threat to development than do changes in average climate conditions (IPCC, 2012). A good starting point for gathering information is to think about which climate stressors have affected the municipality in the past. Planners can create a list of these stressors and document in detail the nature of the past stressors and the resulting impacts.

CLIMATE STRESSOR OVERVIEW

AVERAGE ANNUAL AND MONTHLY RAINFALL

- Has the total amount or seasonal distribution of rainfall changed?
- How are annual rainfall totals, and seasonal distributions, projected to change?
- Useful for understanding potential impacts on water resources, and water-dependent services.

EXTREME RAINFALL

- What are the historic trends in extreme rainfall?
- How might the frequency and magnitude of rainfall extremes change?
- Useful for understanding how flood and landslide risk may change.

DROUGHT

- What areas have experienced drought regularly in the past?
- How might the frequency, severity, location, or timing of drought change?
- Useful for determining if future drought changes could worsen or positively affect water availability for water resources and water-dependent sectors.

TEMPERATURE

- How has temperature changed, both seasonally and annually?
- How might temperature change, both seasonally and annually?
- Useful for understanding potential risks to all sectors, particularly those involving outdoor activity and agriculture.
- Information surrounding current annual average and monthly average temperatures, and future projected changes provides an indication of how much temperatures may rise in your locality.

MINIMUM TEMPERATURE

- Has the minimum temperature changed?
- How might the minimum temperature change?
- Useful for anticipating changes in minimum temperatures that might exceed or fall below thresholds and require particular efforts to prepare.

MAXIMUM TEMPERATURE

- Has the maximum temperature changed?
- How might maximum temperature change?
- Useful for anticipating exceedances of maximum temperature thresholds and preparing for heat waves.
- Information surrounding current frequency and magnitude, and future projected changes in temperature extremes (e.g., daily maxima, heatwaves) provides an indication of future extreme temperature, and whether hotter temperatures or extremes could exacerbate current temperature related impacts (e.g., heatwaves and health, extreme temperatures and infrastructure damages).

TROPICAL STORMS

- How susceptible has the region been to tropical storms?
- How might the frequency and intensity of tropical storms change?
- Useful for disaster preparedness and planning for future extreme events.
- Information surrounding current and future projected changes of frequency and intensity of storms provides an indication of how the future compares to present, and whether planners should anticipate more frequent and intense storms, and associated impacts (e.g., flooding, damages, deaths)

SEA LEVEL

- Has sea level changed in the region? How much has it changed?
- How might sea level change in a particular locality?
- Useful for anticipating future inundation and planning construction in low-risk zones.
- Maps indicating current and projected future changes of coastal flooding extent and location (requiring information regarding changes in storm surge height and sea level rise) provide an indication of land areas that may be subject to future inundation.

SEA TEMPERATURE

- Has sea temperature changed in the region? How much has it changed?
- How might sea temperature change?
- Useful for understanding temperature impacts on marine resources with temperature thresholds, such as coral reefs; or sectors, such as tourism and fisheries.

FLOODING

- How susceptible is a particular locality to flooding?
- How might the location or height of inundation change?
- Useful for planning for future construction and disaster risk reduction.

LANDSLIDES

- How susceptible is a particular locality to landslides?
- How might the location or frequency of landslides change?
- Useful for planning for future construction and disaster risk reduction.

FIRES

- How susceptible is a particular locality to fires?
- How might the location or frequency of fires change?
- Useful for planning for future construction and disaster risk reduction.

COASTAL EROSION

- How susceptible is a particular locality to coastal erosion?
- How might the location or frequency of coastal erosion change?
- Useful for planning for future construction and disaster risk reduction.

Tier 1 – Climate Snapshot

VARIABLE	TIME FRAME	WHAT	RESOURCES/APPROACH
AVERAGE ANNUAL AND MONTHLY RAINFALL	HISTORICAL	Graph of average monthly rainfall at a specific location, and data can be downloaded at country scale	**World Bank Group Climate Change Knowledge Portal** – Country and municipal scale historical climate information, available for the period 1901–2015 *http://sdwebx.worldbank.org/climateportal/*
		Graph of daily or monthly rainfall based on station observations, data can be downloaded	**CLIMARED (Climate Network)** – Available for select municipalities near data stations, 1981–present *http://climared.com/consulta-de-datos/*
		Map with animation of monthly climatological precipitation throughout the year, available for Caribbean region	**International Research Institute for Climate and Society, Columbia University** –IRI Climate Monitoring Animation based on CAMS-OPI data using the 1981–2010 base period (from IRI Climate Modeling) *https://goo.gl/exbHCJ*
	PROJECTED	Map layer of rainfall and graph of mean projected rainfall at a specific location; municipality level	**World Bank Group Climate Change Knowledge Portal** – Available for future time periods (2030, 2050, and 2090) and for four representative concentration pathways (RCP) scenarios *https://goo.gl/1rncsP* [To use: select variable, time period, statistic, and scenario in menu bar; set location by clicking on the map]
EXTREME RAINFALL, RIVERINE FLOODING	HISTORICAL	Map of Caribbean showing extreme precipitation trends over the region (Figure 6)	**Stephenson, T.S., et al. 2014. Changes in Extreme Temperature and Precipitation in the Caribbean Region, 1961-2010. International Journal of Climatology** – Changes in extreme temperature and precipitation in the Caribbean region, 1961–2010 *http://onlinelibrary.wiley.com/doi/10.1002/joc.3889/full*
		Map of hazard level by locality, available at municipal level (very coarse granularity)	ThinkHazard! – River flood risk levels available for analysis *http://thinkhazard.org/report/72-dominican-republic/FL*

VARIABLE	TIME FRAME	WHAT	RESOURCES/APPROACH
EXTREME RAINFALL, RIVERINE FLOODING	PROJECTED	Graph of projected extreme rainfall changes at a specific location; data to download at a country scale that provides information on the mean or change in days with extreme rain by mid-century	**World Bank Group Climate Change Knowledge Portal** – Available at a specific location (indicating 25th, 50th, and 75th percentile changes for a range of models); Country-scale data to download in Excel, available through 2040–2059 *https://goo.gl/zjfStX* [To use: select Future GCM, type: CMIP3. Under variables, select days with extreme rain, the desired time period in the future, country, mean or anomaly, and RCP scenario]
		Country-level hydrological statistics, including changes in high flows	**World Bank Group Climate Change Knowledge Portal** – Country-level hydrological statistics for three emissions scenarios, 23 Global Circulation models and two future time periods (2030–2039 and 2050–2059) *https://goo.gl/UGgdvm*
DROUGHT	HISTORICAL	Animated or still map, and associated data plots, of derived drought index over particular localities, available yearly, monthly, and daily	**Latin American Flood and Drought Monitor** –Data can be viewed as a time series plot or map *http://stream.princeton.edu/LAFDM/WEBPAGE/interface.php?locale=en*
	PROJECTED	Graph of projected change in the number of dry days at a specific location; data to download that provides information on the mean or change in days without rainfall by mid-century	**Portal de Conocimiento de Cambio Climático del Grupo del Banco Mundial** – 25th, 50th, and 75th percentile changes for a range of models); Country-level data to download in Excel *https://goo.gl/zjfStX* [To use: select Future GCM, type CMIP3. Under variables, select days without rain, the desired time period in the future, country, mean or anomaly, and RCP scenario]

VARIABLE	TIME FRAME	WHAT	RESOURCES/APPROACH
TEMPERATURE	HISTORICAL	Graph of monthly average temperature at a specific location. Data can also be visualized as a map layer over the country, and downloaded	**World Bank Group Climate Change Knowledge Portal** – Available for future time periods (2040–2099) and for four RCP scenarios *https://goo.gl/v8dd87* [To use: select variable, time period, statistic, and scenario in menu bar]
	PROJECTED	Graph of mean projected temperature for future time periods at a specific location Map layer of temperature averages and change by mid-century and end of century	**World Bank Group Climate Change Knowledge Portal** – Available for future time periods (2040–2099) and for four RCP scenarios *https://goo.gl/v8dd87* [To use: select variable, time period, statistic, and scenario in menu bar]
MINIMUM TEMPERATURE	HISTORICAL	Graph of daily or monthly minimum temperature averages based on station observations, data can be downloaded	**CLIMARED (Climate Network)** – Available for select locations near data stations, from 1981–present *http://climared.com/consulta-de-datos/*
	PROJECTED	Graph of minimum temperature (mean and change) for future time periods at a specific location	**World Bank Group Climate Change Knowledge Portal** – Available for future time periods (2040-2099) and for 4 RCP scenarios *https://goo.gl/v8dd87* [To use: select variable, time period, statistic, and scenario in menu bar]

VARIABLE	TIME FRAME	WHAT	RESOURCES/APPROACH
MAXIMUM TEMPERATURE	HISTORICAL	Graph of daily or monthly maximum temperature averages based on station observations, data can be downloaded	**CLIMARED (Climate Network)** – Available for select locations near data stations, from 1981–present *http://climared.com/consulta-de-datos/*
	PROJECTED	Graph of maximum temperature (mean and change) for future time periods at a specific location	**World Bank Group Climate Change Knowledge Portal** – Available for future time periods (2040–2099) and for four RCP scenarios *https://goo.gl/v8dd87* [To use: select variable, time period, statistic, and scenario in menu bar]
TROPICAL STORMS	HISTORICAL	Map of historical hurricane tracks over particular localities	**National Oceanic and Atmospheric Administration (NOAA)** – Identify historical hurricanes and tropical storms by location and find details about storms *https://coast.noaa.gov/hurricanes/*
	PROJECTED	Summary for Atlantic hurricanes and global warming	**National Oceanic and Atmospheric Administration (NOAA)** – An overview of current research results related to climate change and hurricane patterns, as of 2017 *https://www.gfdl.noaa.gov/global-warming-and-hurricanes/*
SEA LEVEL, STORM SURGE, AND COASTAL FLOODING	HISTORICAL	Historical trend and time series data of sea level based on long-term gauge observations, available for regional locations Graph of annual and monthly sea level rise from tidal gauges across the region	**National Oceanic and Atmospheric Administration (NOAA) Tides & Currents** – Map of sea level trends around the United States and Caribbean *https://tidesandcurrents.noaa.gov/sltrends/sltrends.html* **Permanent Service for Mean Sea Level (PSMSL)** – Tide gauge data available at Barahona (1954–1969) and Puerto Plata (1949 –1969) *http://www.psmsl.org/data/obtaining/*

VARIABLE	TIME FRAME	WHAT	RESOURCES/APPROACH
SEA LEVEL, STORM SURGE, AND COASTAL FLOODING	PROJECTED	Map of global sea level rise projections under different climate scenarios Interactive map where you can enter different levels of sea level rise and see what localities would be flooded	**Intergovernmental Panel on Climate Change** – IPCC fifth assessment Report, Chapter 13 on sea level change – Figure 13.20 shows projected changes by the end of the century for RCP scenarios *https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter13_FINAL.pdf*
SEA TEMPERATURE	HISTORICAL	Global map of sea surface temperature SST Contour Chart Map with animation of monthly climatological sea surface temperature through the year, based on Reynolds and Smith OISST Version 2 data	**National Aeronautics and Space Administration (NASA) Earth Observatory** – Animated map from 2002–2017 *https://earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MYD28M* **National Oceanic and Atmospheric Administration (NOAA) Office of Satellite and Produce Operations** *http://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html* **International Research Institute for Climate and Society, Columbia University** *https://iridl.ldeo.columbia.edu/maproom/Global/Forecasts/SST.html*
	PROJECTED	Map of forecasted ocean sea surface temperature	**National Oceanic and Atmospheric Administration (NOAA) Ocean Prediction Center** *http://www.opc.ncep.noaa.gov/SST_fcasts.shtml*
LANDSLIDES	HISTORICAL	Map with points representing locations of landslides with the data (cause, size, storm name, and fatalities) included	**National Aeronautics and Space Administration (NASA) Open Data Portal** – Global Landslide Catalog *https://data.nasa.gov/Earth-Science/Global-Landslide-Catalog/h9d8-neg4/data*

Tier 2 – Detailed Climate

VARIABLE	TIME FRAME	WHAT	PUBLIC SOURCES
AVERAGE ANNUAL AND MONTHLY RAINFALL	HISTORICAL	Time series of average monthly rainfall (mm) 1901–2016, for specific user-defined locations	**KNMI Climate Explorer** – Available for specific geographic areas *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly observations> Precipitation CRU TS 4.01 (1901–2016), upload a custom mask]
	PROJECTED	Time series of projected monthly rainfall for the mean model ensemble of "low" and "high" climate change scenarios	**KNMI Climate Explorer** – Raw data available for download [To use: select a field>monthly CMIP5 scenario runs> precipitation (pr) variable under CMIP5 mean (RCP 4.5 and 8.5); apply custom boundary (basin area); select average, and "convert to mm/day." Upload a custom mask for specific geographic areas]
EXTREME RAINFALL, FLOODING	HISTORICAL	Time series of extremely wet days, and maximum one- and five-day rainfall events, available 1951–2017	**CLIMDEX, Climate Change Research Centre** *http://www.climdex.org/gewocs.html* [To use: select region, and 1-, 5-, or extremely wet day (R99pTOT) time series]
	PROJECTED	Time series of projected wet days and maximum one- and five-day rainfall events for the mean model ensemble of "low" and "high" climate change scenarios	**KNMI Climate Explorer** – Available for specific geographic areas [To use: select a field>annual CMIP5 extremes>CMIP5 mean RCP 4.5 and 8.5 for precipitation extremes, upload a custom mask]

VARIABLE	TIME FRAME	WHAT	PUBLIC SOURCES
DROUGHT	HISTORICAL	Time Series of the Palmer Drought Severity Index (PDSI)	**KNMI Climate Explorer** – Palmer Drought Severity Index (PDSI) average and trend available for specific geographic areas, 1960–2016 *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly observations>Drought Index for CRU self-calibrated PDSI 1901-2016, upload a custom mask]
		Time series of maximum number of consecutive days per year with less than 1 mm of precipitation	**CLIMDEX, Climate Change Research Centre** – Time series of consecutive dry days (CDD) by geographic location *http://www.climdex.org/gewocs.html*
	PROJECTED	Time series data of average annual consecutive dry days (CDD), which are days where there was less than 1 mm of precipitation	**KNMI Climate Explorer** – Projected changes for the mean model ensemble RCP 4.5 and 8.5 (for mid-century 2040–2059; compared to mean model ensemble simulated 1985–2015) [To use: select a field>annual CMIP5 extremes>CMIP5 mean RCP 4.5 and 8.5 for altcdd, upload a custom mask for specific geographic areas]
TEMPERATURE	HISTORICAL	Time series of monthly average temperature data for specific user-defined locations, available 1901–2016	**KNMI Climate Explorer** – Available for specific geographic areas *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly observations>Temperature 1901-2016: CRUTS 4.01, upload a custom mask for specific geographic areas]
	PROJECTED	Time series of monthly temperature projections for the mean model ensemble high and low scenarios (in degrees Celsius)	**KNMI Climate Explorer** – Time series of monthly temperature projections for the mean model ensemble high and low scenarios (in degrees Celsius). Data available for download. [To use: select a field>monthly CMIP5 scenario runs> temperature (tas) variable under CMIP 5 mean (RCP 4.5 and 8.5); for user-defined location; select average, and "convert to Celsius". For specific geographic areas (select CMIP 5 mean RCP 4.5 and 8.5 for Tave) upload a custom mask]

VARIABLE	TIME FRAME	WHAT	PUBLIC SOURCES
MINIMUM TEMPURATURE	HISTORICAL	Time series of monthly average minimum temperature data for specific user-defined locations, available from 1901–2016	**KNMI Climate Explorer** *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly observations>Tmin 1901–2016: CRU TS 4.01, upload a custom mask for specific geographic areas]
	PROJECTED	Time series of monthly minimum temperature projections for the mean model ensemble high and low scenarios (in degrees Celsius) Number of cold days (tn90p) can be used to assess changes for mid-century	KNMI Climate Explorer *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly CMIP5 scenario runs> temperature minimum (tas min) variable under CMIP5 mean (RCP 4.5 and 8.5); apply country map; select average, and "convert to Celsius"; once generated, can download raw data set; upload a custom mask for specific geographic areas]
MAXIMUM TEMPERATURE	HISTORICAL	Time series of monthly average maximum temperature data for specific user-defined locations	KNMI Climate Explorer *https://climexp.knmi.nl/start.cgi* [To use: select field>monthly observations>Tmax 1901–2016: CRU TS 4.01, upload a custom mask for specific geographic areas]
	PROJECTED	Time series of monthly maximum temperature projections for the mean model ensemble high and low scenarios (in degrees Celsius)	KNMI Climate Explorer *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly CMIP5 scenario runs; for specific geographic areas select CMIP5 mean RCP 4.5 and 8.5 for Tas max, upload a custom mask]

VARIABLE	TIME FRAME	WHAT	PUBLIC SOURCES
MAXIMUM TEMPURATURE	PROJECTED	Time series data for the number of hot days (tx90p)	**KNMI Climate Explorer** *https://climexp.knmi.nl/start.cgi* To use: select a field>monthly CMIP5 scenario runs; for specific geographic areas select CMIP5 mean RCP 4.5 and 8.5 for tx90p, upload a custom mask]
TROPICAL STORMS	HISTORICAL	Map of historical hurricane tracks over particular user-defined areas and locations	**National Oceanic and Atmospheric Administration (NOAA)** – Identify historical hurricanes and tropical storms by location and find details about storm *https://coast.noaa.gov/hurricanes/*
	PROJECTED	There is no data on projected hurricane tracks; Current research and understanding of the relationship of climate change and future hurricane frequency and intensity is summarized in this short resource	**National Oceanic and Atmospheric Administration (NOAA)** – Research on future hurricane changes in frequency and intensity in the Atlantic *https://www.gfdl.noaa.gov/global-warming-and-hurricanes/*
SEA LEVEL, STORM SURGE, AND COASTAL FLOODING	HISTORICAL	Historical trend over time of sea level based on quality long-term observations	**National Oceanic and Atmospheric Administration (NOAA) Tides & Currents** – Historical sea level data for available stations https://tidesandcurrents.noaa.gov/sltrends/sltrends.html
		Datasets and graphs for download that provide information on historical Global Mean Sea Level (GMSL)	**CSIRO Marine and Atmospheric Research** – Reconstructed GMSL from 1880 to 2013 *http://www.cmar.csiro.au/sealevel/sl_data_cmar.html*
	PROJECTED	Global map of sea level rise projections under different scenarios Interactive map where you can enter different levels of sea level rise and see what localities would be flooded	**Intergovernmental Panel on Climate Change** – IPCC fifth assessment report, Chapter 13 on sea level change – Figure 13.20 (page 1196; sea panels b and d for projected changes under RCP 4.5 and 8.5 at centuries end) https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter13_FINAL.pdf – IPCC Chapter 29 – small islands Table 29.1, Page 1628

VARIABLE	TIME FRAME	WHAT	PUBLIC SOURCES
SEA TEMPERATURE	HISTORICAL	Time series of monthly mean global sea surface temperatures. Available for user-defined areas, including Hadley Centre SST data set HadISST1, with reconstructed monthly data available from 1870 to 2017 in degrees Celsius	**KNMI Climate Explorer** – Several options are available from KNMI for downloading SST. *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly observations>SST, select desired model]
	PROJECTED	Time series of projected sea surface temperature for low and high emissions scenarios, for user-defined area	**KNMI Climate Explorer** – KNMI sea surface temperature data *https://climexp.knmi.nl/start.cgi* [To use: select a field>monthly CMIP5 scenario runs> select variable TOS, and input custom mask]
LANDSLIDES	HISTORICAL	Table and map with points representing locations of landslides with the landslide type, trigger, size, storm name, and fatalities included	**National Aeronautics and Space Administration (NASA) Open Data Portal** – Global Landslide Catalog *https://data.nasa.gov/dataset/Global-Landslide-Catalog-Export/dd9e-wu2v*
FIRES	HISTORICAL	Map or data download for locations of past fires	**National Aeronautics and Space Administration (NASA) EARTHDATA** – MODIS and VIIRS information from Fire Archive Download Tool, available as Shapefile or text file with fire/hotspot archive observations, since 2000 *https://firms.modaps.eosdis.nasa.gov/download/*

Resource Title	MAPPING THE CLIMATE VULNERABILITY ASSESSMENT INFORMATION TO STAGE 2 DIAGNOSTICS
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☑ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	This is a list of diagnostic information ("diagnostics") that can be used to indicate where climate change information and impacts may be integrated into the municipal and surrounding area diagnosis. The resource helps planners use these diagnostics to identify and assess the climate-related vulnerabilities of the municipality and surrounding territory. These diagnostics will be used in the *Climate Vulnerability Assessment Tool (see page 59)* and can increase the efficiency of data gathering and collection for the climate vulnerability and make it easier to integrate the climate vulnerability assessment into the PMOT Stage 2 assessment reports by directly mapping how planners can gather additional information relevant to the diagnostics that can be used to assess climate vulnerabilities.
Methodology	Use Table 1 in this resource to assess how diagnostics will inform the Stage 2 results. Use Table 2 in this resource to categorize the diagnostics by the module that they will be used within the *Climate Vulnerability Assessment Tool* including climate stressors (Module 1), impacts (Module 2), and non-climate stressors and adaptive capacities (Module 3). For each diagnostic, this table lists the types of information that should be collected to inform the climate vulnerability assessment and Stage 2 analysis.
User(s)	Municipal staff involved in land use planning, and a range of stakeholders representing financial, technical, and institutional capacities.
Intended Use	To collect and organize information that will be used in the *Climate Vulnerability Assessment Tool.*
Key Output(s)	Diagnostics to input into the *Climate Vulnerability Assessment Tool*
Ease of Use	Users require a working knowledge of municipal resources, sectors, and services; and the historical sensitivity of assets to climate and non-climate stressors.

MAPPING CLIMATE VULNERABILITY ASSESSMENT INFORMATION TO STAGE 2 DIAGNOSTICS INFORMATION

Assessing climate vulnerability fits within the PMOT Guide Stage 2: Territorial Diagnosis. The primary purpose of Stage 2 is to assess and identify the critical themes and vulnerabilities of the municipality and of the surrounding territory, which is summarized in two separate reports (Territorial and Municipal Assessment Reports and Analyses). Table 1, below, shows the structure of these reports, which are each organized into an Introduction, and three components that describe the Environment, Socio-Economy, and Services and Equipment. Each of these sections are informed by a standard set of "diagnostics" as shown in the table.

These diagnostics can also be used to identify and assess the climate-related vulnerabilities of the municipality and surrounding territory. The use of a common set of diagnostics for the climate vulnerability assessment and the Stage 2 analysis increases the:

1. Efficiency of data gathering and collection for the climate vulnerability and Stage 2 assessments, and
2. Ease of integrating the climate vulnerability assessment into the Stage 2 assessment reports, by directly mapping how planners can gather additional information relevant to the diagnostics that can be used to assess climate vulnerabilities.

Table 2. Mapping the Integration of the Vulnerability Assessment into the Land Use Plan's Territorial and Municipal Assessment, categorizes the diagnostics by the module that they will be used within the *Climate Vulnerability Assessment Tool,* including Climate Stressors (Module 1), Impacts (Module 2), and Non-Climate Stressors and Adaptive Capacities (Module 3). For each diagnostic, Table 2 lists the types of information that should be collected to inform the climate vulnerability assessment and Stage 2 analysis, and the rationale for gathering the information.

Table 1: Diagnostics for Territorial and Municipal Assessment Report and Analysis

INTRODUCTION	COMPONENT 1. ENVIRONMENT	COMPONENT 2. SOCIO-ECONOMY	COMPONENT 3. SERVICES AND EQUIPMENT
Governance and Land Use Regulations: • Municipal governance/ institutions • Land use laws and regulations • Civil Society and Community Participation • Civil Protection **Administrative Boundaries:** • Urban Structure • Human Settlements	• Terrain and Soil • Climate • Natural Hazards • Pollutants and Degradation • Water Resources • Mineral Resources • Biodiversity and Protected Areas • Coastal and Marine Resources	**Social Development:** • Demographics • Poverty rates • Education • Health • Employment • Culture and Identity **Economic and Commercial Activities:** • Industry • Tourism • Agriculture • Other	**Municipal Services and Equipment:** • Solid Waste Management • Markets • Cemeteries and funeral services • Sports facilities • Slaughterhouse • Public space • Architectural heritage **Infrastructure Services:** • Drinking water • Stormwater drainage • Sanitation • Power System • Housing • Telecommunications • Urban mobility

Table 2: Mapping the Integration of the Vulnerability Assessment into the Land Use Plan's Territorial and Municipal Assessment

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Introduction		
Governance and Land Use Regulations		
Municipal governance/ institutions	Adaptive Capacity and Non-Climate Stressors	• **Existing climate policies, plans and roadmaps:** Areas that have developed plans, identified priority investment areas and begun to implement them are building capacity and awareness of climate-related risks. • **Level and access to financial resources** enables more rapid recovery in the aftermath of events.
Land use laws and regulations	Adaptive Capacity and Non-Climate Stressors	• **Existing regulations and ability to enforce them:** Areas that have developed regulations to protect certain areas from development, pollution, etc. and are able to enforce them are creating safer, more sustainable municipalities. • **Land ownership:** Clearly defined land ownership and management responsibilities increase the likelihood that adaptation actions will be undertaken. • **Urban planning:** Planning settlements, as opposed to allowing them to arise in an unplanned fashion, allows for potential areas at risk to climate impacts and adaptation measures to be incorporated into the settlement design and location, creating settlements that are more resilient to climate change.
Civil protection	Adaptive Capacity	• **Existing early warning/early action systems** can reduce climate impacts to livelihoods and the economy. • **Access to insurance** can act as a safety net at the municipal and national scale when extreme events occur. • **Population security:** Healthy and secure populations will be more mobile and less vulnerable to climate variability and extreme events.
Civil society and community participation	Adaptive Capacity and Non-Climate Stressors	• **Strength of local and community participation** improves capacity to identify and address climate risks.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Administrative Boundaries		
Human settlements	Climate Impacts	• **Location of high density settlements in at-risk areas:** Densely populated informal settlements are particularly at risk to climate impacts from flooding and landslides, particularly those located on steep hillsides or in areas at risk to coastal or riverine flooding. • **Poor construction:** Informal settlements and lack of construction standards, particularly on steep hillsides or in areas at risk to coastal or riverine flooding, are particularly vulnerable. • **Past climate-related damage:** Noting past climate-related impacts can help municipalities identify which settlements are at risk, and to what types of hazards.
Component 1. Environment		
Terrain and soil	Adaptive Capacity and Non-Climate Stressors	• **Topography and slope:** Mapping the topography and slope of the municipal terrain can help identify areas at risk from flooding, landslides, and other hazards. • **Soil type and land cover:** In combination with slope, understanding the soil type can also help to identify areas at risk to rainfall induced landslides (e.g., steep, denuded landscapes)
Climate	Climate Stressors	• **Historical trends and future projections in rainfall distribution and amount:** See Climate Information Worksheet for more details. • **Historical trends and future projections in temperature distribution and mean:** See Climate Information Worksheet for more details.
Natural hazards	Climate Stressors	• **Historical and projected changes in sea level and storm surge heights; and frequency and intensity of coastal and riverine flooding, intense rainfall events, cyclones or tropical storms, drought, heatwaves or coastal erosion, landslides, and fires:** See Climate Information Worksheet. • **Historical information about the impacts of natural hazards on economic and social stability:** Information about how natural hazards have impacted the economy, society, and the environment in the past will provide a baseline for understanding vulnerability to future events. This will help with planning response and recovery, as well as mitigating risk through resilience-building.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Water resources	Climate Impacts	• **Historical changes in quantity and quality of water resources, both groundwater and surface water**: Understanding the sensitivity of water resources to climate variations provides a useful benchmark to understanding how future projected climate changes may affect water quality and quantity. Identifying root causes of changes to the watershed integrity (e.g., non-climate stressors such as deforestation) that have affected water availability and quality.
Pollutants and degradation	Non-climate Stressors	• **Pollutants:** Identify sources of contamination, which may be exacerbated as a result of increases in temperature, changes in water resources availability, and increases in rainfall intensity; for example, industrial effluent or outflow from slaughterhouses may pollute and degrade already stressed water resources. • **Land degradation due to deforestation:** A denuded landscape will be more susceptible to erosion and landslides, and sedimentation, as a result of intense rainfall events.
Biodiversity and protected areas	Climate Impacts, Adaptive Capacity	• **Habitat thresholds:** Some species might have climate-related thresholds beyond which their behavior or food sources will change or no longer exist. • **Protected natural territories (percent land area):** A high percentage of land under protected area status indicates a commitment to environmental preservation, which enhances adaptive capacity by reserving land that may buffer populations from climate impacts and provide species diversity that may help people adapt to climate change. • **Past climate impacts on biodiversity and protected areas:** Understanding how species, ecosystems, and protected areas have been impacted by, and responded to, climate stressors and shocks provides insight into future risks and informs planning efforts to reduce risk.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Coastal and marine resources	Climate Impacts	• **Past climate impacts on the health of coastal and marine resources:** Identify past impacts of high temperatures on marine and coral life. Identify how sea level or storm surge affected beaches. • **Sand mining:** Removal of sand from beaches negatively impacts water quality and water resources, reduces natural protections from flooding, and increases erosion and impacts habitats that support diverse ecosystems. In turn, this can have a significant impact on human health, tourism, and the livelihoods of those who depend on these ecosystems and their services. Also, it can cause instability for structures built in areas where sand is mined. • **Mangrove destruction:** Mangroves provide a wide range of ecosystem services that will be lost if mangroves are removed or degraded. These services include protecting soils, storing carbon, protecting water quality, providing fish habitats, and attracting visitors for ecotourism. Removal of mangroves also makes coastal areas more vulnerable to storm surge and extreme events.
Component 2. Socio-economy		
Social Development/Characteristics		
Demographics	Adaptive Capacity and Non-Climate Stressors	• **Population growth and density:** High population growth and density can stress the ability of existing services to meet needs. • **Sensitive population cohorts** Identify populations that may be more vulnerable to climate impacts, including disabled, elderly populations.
Poverty rates	Adaptive Capacity and Non-Climate Stressors	• **Poverty index and distribution:** Areas with high poverty levels are particularly vulnerable to climate impacts. Higher levels of poverty indicate less ability and fewer resources to adapt to climate shocks and impacts. • **Access to savings:** Personal and business savings are used to respond to extreme events in absence of or in addition to insurance.
Education	Adaptive Capacity and Non-Climate Stressors	• **Education level (percentage of population with primary, secondary, or tertiary education):** Higher education levels indicate a more skilled labor force with higher income potential and with the capability of being trained for alternative livelihood opportunities; conversely, lower levels of education indicate potentially fewer opportunities and lower capacity to be resilient and adapt to climate change impacts.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Health	Adaptive Capacity and Non-Climate Stressors	• **Incidence and distribution of disease:** Some populations may be more at-risk of disease, due to lack of access to quality services and poor living conditions. • **Types of disease, particularly waterborne and vector borne:** The risk of some diseases may increase as a result of rising temperatures and changing seasonality of rainfall that influences the distribution of vectors (e.g., mosquitos carrying malaria). • **Number of healthcare facilities:** If hospitals are accessible, they will increase the ability of community to respond to acute impacts of climate change or extreme events. Healthcare facilities that are sited in less vulnerable locations or that implement adaptation plans will be less exposed and more prepared for climate Early warning systems can reduce impacts of climate and non-climate-related health outbreaks.
Employment	Adaptive Capacity and Non-Climate Stressors	• **Unemployment rate:** Higher employment rates, particularly skilled labor, indicate higher income potential and capacity for resiliency. • **Types of employment:** Identify major employers operating in industries that might face rising challenges due to climate variability and change. • **Diversification:** A population with a diversity of employment opportunities will have a greater ability to adapt to shocks and transition to other industries.
Culture and identity	Adaptive Capacity and Non-Climate Stressors	• **Strength of social network:** Strong social networks and relationships.The more communities and households exhibit connectedness, social participation, equality, and inclusivity, the more likely they will be able to respond effectively to both climate and non-climate stressors.
Economic and Commercial Activities		
Industry	Climate Impacts, Adaptive Capacity and Non-Climate Stressors	• **Backup Power Supply:** Frequent power outages disrupt business continuity, operations and reduce profitability. Backup power supply increases adaptive capacity to climate-related power shortages. • **Past climate impacts:** Critical infrastructure and assets that are located in potentially exposed areas are at higher risk to impacts.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Tourism	Climate Impacts	• **Reliance on natural resources:** Tourism that is dependent on natural resources such as coastal areas may be greatly impacted as a result of climate change. • **Past direct damages to tourism infrastructure from flooding and storms (e.g., beach resorts, roads, historical monuments and buildings):** Storm surges and erosion, sea level rise, storms, and flooding present threats to natural resources and tourism infrastructure.
Agriculture	Climate Impacts	• **Percentage of irrigated and rain-fed agriculture:** Rain-fed agriculture is particularly vulnerable to changes in rainfall amount and distribution, and changes in temperature. Irrigated agriculture increases competition across water users, and can further stress the water balance. • **Past climate impacts:** Noting past and current impacts is helpful for identifying potential future impacts; including impacts on agricultural productivity due to salinity, drought, high temperatures, and flooding.
Component 3. Spatial		
Municipal Services and Equipment		
Solid waste management	Climate Impacts	• **Solid waste management service capacity:** Lack of solid waste management can lead to blocked drainage, increasing flood extent and health exposure risk. • **Past climate impacts:** Noting the past and current climate impacts is useful for understanding potential impacts of climate variability and change. Higher temperatures increase odor and pest activity, which increases the risk of infectious disease. Changes in rainfall intensity, sea level and storm surge, and flood affect the location of solid waste management assets.
Markets	Climate Impacts	• **Location:** Markets sited in floodplains or coastal areas may be vulnerable to flooding, sea level rise, and storm surge. • **Past climate impacts:** Noting the past and current climate impacts is useful for understanding potential impacts that may result from climate variability and change. Changes in rainfall intensity, sea level and storm surge, and floods may cause damage to or disrupt markets.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Cemeteries and funeral services	Climate Impacts	• **Past impacts to flood-related damages (riverine or coastal):** Identify past impacts such as inundation and infrastructure damages at that location.
Sports facilities	Climate Impacts	• **Location and siting:** Important to assess risk prior to construction of major facilities. It could be more prone to damage if it is located in a flood-prone area, land that might be at risk due to rising sea level, or in the footprint of potential landslides. • **Past climate impacts:** Identify how the site or facility has responded to flood-related events, landslides, storms, heavy rainfall, and storm surge in the past.
Slaughterhouse	Climate Impacts/ Non-Climate Stressor	• **Past climate impacts:** Identify how the site or facility has responded to flooding, storms, and heavy rainfall, in the past. • **Proximity to water sources:** If sited near a key water source, flooding or runoff from heavy rainfall may cause contamination to surrounding areas.
Public space	Climate Impacts	• **Past climate impacts:** Identify how public spaces have been impacted by floods, heavy rainfall, and extreme temperatures in the past as a way of understanding potential vulnerability to future climate changes. • **Accessibility of public spaces:** Designated shelters should be easily accessible to accommodate population at risk during an extreme event.
Architectural heritage	Climate Impacts	• **Past climate impacts:** Understand the vulnerabilities of the sites to fissures and cracking due to extreme temperatures, growth of organic materials, or structural damage due to flooding, or strong winds.
Infrastructure Services		
Drinking water	Climate Impacts	• **Past climate impacts:** Understanding how water supply and quality have been impacted by past variations in amount and seasonality in rainfall, including droughts and flooding, can help municipalities understand potential future resource sensitivities to climate variability and change. • **Water supply sufficient during times of drought:** Document how water supply is impacted by drought and the implications for meeting drinking water needs. • **Ability of water supply to meet water demand:** Assess the ability of the municipality to meet demand, especially if it generally increases due to higher temperatures or higher evaporation. • **Susceptibility of the groundwater supply to saltwater intrusion:** Sea level rise affects municipal water supply.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Drinking water	Climate Impacts	• **Quality of surface water supply:** Understand how temperature changes and drought can impact water quality (i.e., greater levels of contamination from bacteria or algae growth, runoff of contaminants with heavy rainfall, higher concentrations of contaminants when water levels drop). • **Water supply infrastructure:** Document how water supply infrastructure has been impacted by past intense rainfall and flooding events. Flood frequency change could exacerbate flood impacts.
Stormwater drainage	Climate Impacts	• **Past climate impacts on drainage systems:** Determining how well the drainage system withstands pressure from extreme rainfall events and inundation will help municipalities plan infrastructure that can handle potential increases in rainfall. This information can inform standards for designing drainage components that will meet the capacity demands. • **Capacity of drainage systems:** Comparing stormwater drainage capacity to historical and projected rainfall amounts will help municipalities assess whether their systems will withstand changes in rainfall. This might involve meeting infrastructure standards or changing designs to ensure sufficient drainage capacity that will reduce the risk of flooding. • **Capacity of natural drainage systems:** Clear and well-managed streams, creeks, and tributaries can protect settlements from flooding.
Sanitation	Climate Impacts	• **Water table:** High water tables during intense rainfall events lead to groundwater contamination from latrines or septic systems. • **Past climate impacts:** Based on past events, determine the capacity of sanitation systems and processes to withstand changes in temperature, precipitation, extreme events, etc.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Power system	Climate Impacts	• **Past climate impacts on energy infrastructure:** Higher temperatures may reduce generation, transmission and distribution efficiency and capacity. • **Reliability/backup energy sources:** Resilience depends on redundancy and backup capacity that can be used to prevent extended blackouts. • **Diversification:** Diversified energy portfolios will be more resilient. Some types of energy are more vulnerable to particular impacts (i.e., hydropower reliability depends on water availability and particular times) • **Demand:** Increased temperatures could increase electricity demand for cooling, which may strain the power system.
Housing	Climate Impacts	• **Past climate impacts on housing:** Higher temperatures, extreme rainfall, sea level and storm surge changes put stress on housing infrastructure. Understanding how housing has responded to past changes will help municipalities determine potential impacts of climate variability and change. • **Density of housing stock:** High housing density can stress the ability of existing services and, when combined with poor construction, may be extremely vulnerable to climate and non-climate-related events. • **Location of housing stock:** Settlements in in areas where flooding and heavy rainfall are common may expect higher levels of vulnerability to heavy rainfall and landslides, or be more susceptible to riverine or coastal flooding. • **Poor construction:** Vulnerability to flooding, heavy rainfall, or high temperatures due to lack of construction codes for housing or poor construction.
Tele-communications	Climate Impacts	• **Past climate impacts on telecommunications:** Higher temperatures, flooding, extreme events, and intense rainfall all pose risks to telecommunications infrastructure. Understanding what impact these types of events have had on the system will help municipalities determine potential impacts of climate variability and change. • **Access to telecommunications:** Communities will be more resilient if they have access to information and communication that allows them to respond quickly and effectively. In an emergency, being able to access telecommunications is vital for effective response by public services to minimize mortality. • **Redundancy:** Layers of redundancy ensure that systems will still be operable even when some components are damaged, which prevents extended outages. • **Location of critical sites:** Understanding where telecommunications infrastructure is located can help municipalities identify where there might be risks from extreme temperatures, precipitation, sea level rise, flooding, etc. Critical infrastructure built in flood-prone areas should be strengthened or moved.

Territorial and Municipal Assessment Diagnostic	Climate Vulnerability Assessment Tool Module(s)	Climate Vulnerability Assessment: Specific Information to Gather and Why It Is Helpful
Urban mobility	Climate Impacts; Adaptive Capacity	• **Past climate impacts on urban mobility:** Higher temperatures, flooding, extreme events, and sea level rise all pose risks to transportation infrastructure, including roads, railways, ports, and airports. Understanding what impact these types of events have had on transportation assets and infrastructure in the past will help municipalities determine potential changes in future vulnerability. • **Density of road network:** Higher density of road networks indicates higher connectivity of populations to an array of services, increasing adaptive capacity to varied stressors. • **Access to public transportation systems:** Some communities may rely on public transportation, particularly with increasing stress on other assets. • **Repair and maintenance schedules:** Regular operations and maintenance helps to maintain key infrastructure, increasing resilience to climate impacts. • **Exposure of ports and navigable waterways** to increased sea level, and silt deposition, which could disrupt service and damage equipment. • **Exposure of roads, railways, and airports** to erosion, flooding, washout, and other impacts that could be exacerbated by climate variability and change. • **Adaptation plans:** Ensure that transportation design and maintenance departments incorporate climate impacts into planning.

Resource Title	SAMPLE VULNERABILITY WORKING GROUP AGENDA		
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization	☐ Stage 4: Programming	☐ Stage 7: Formalization
	☑ Stage 2: Territorial Diagnosis	☐ Stage 5: Implementation	
	☐ Stage 3: Territorial Prospective	☐ Stage 6: Monitoring and Evaluation	
Description	This resource is a sample agenda for a working group meeting on vulnerability assessments.		

SAMPLE VULNERABILITY WORKING GROUP AGENDA

Planning for Climate Adaptation Program

Presentation of the Climate Vulnerability Analysis of San Pedro de Macorís Municipality

AGENDA

Place:	San Pedro de Macorís City Council
Date:	Thursday, April 21, 2016, at 9:00 AM Introduction and Objectives, ICMA/ICF
9:15 am	Presentation of the Municipal Climate Vulnerability Analysis (Dr. Molly Hellmuth and Dr. Alejandro Herrera-Moreno)
10:00 am	Discussion of results (plenary session) Objective: validate results, identify missing information (if any), prioritize vulnerabilities
10:30 am	Coffee Break
10:45 am	How can we face our priority vulnerabilities? Relevance of vulnerability results for land use planning, territorial planning and adaptation plans (Dr. Joanne Potter) Discussion and next steps.
12:00 pm	Closure

STAGE 3 RESOURCES

• ADAPTATION WORKING GROUP AGENDA

Resource Title	SAMPLE ADAPTATION WORKING GROUP AGENDA
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☑ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	This resource is an example agenda for a working group session focused on selecting adaptation options.

SAMPLE ADAPTATION WORKING GROUP AGENDA

Planning for Climate Adaptation Program

AGENDA

TYPE OF ACTIVITY	Session of Work Group WG3
GENERAL OBJECTIVE	Formulation of municipal territorial perspective
ESPECIFIC OBJECTIVES	Presentation of municipal critical factors Presentation of sceneries Definition of guidelines and goals
PLACE	Meeting room – San Pedro de Macorís City Council
DATE AND TIME	February 9, 2017 – 9:30AM to 1:00 PM

TIME	ACTIVITY	DESCRIPTION
08:45	Registration	Verify that each participant institution is part of the Work Group.
09:15	Presentation of critical factors of the municipality	Summary of the elements that served as the basis for the definition of the scenarios. This is presented in plenary session and is physically hand in.
09:45	Presentation of sceneries	Presentation of the scenarios (map and written description) in the plenary session to get to know the trend and the ideal proposal. Then, in two groups, the scenarios are reviewed and complemented starting from the critical factors.
10:30	**Coffee break**	
10:45	Presentation of territorial development vision	Presentation in the plenary session of the process exhausted to date to defining the territorial development vision, its inputs and the final product.
11:00	Definition of objectives and goals	Training on the concept of territorial planning objectives and goals. This will allow the participants to be divided into groups according to the identified scenarios, so that each group constructs the objectives and identifies the goals. At the end, each group is asked to present their progress.
13:00	Closure.	Next steps … in the elaboration of the Municipal Land Use Plan.
13:15	**Lunch**	

STAGE 4 RESOURCES

- CLIMATE ADAPTATION PLAN OUTLINE

Resource Title	CLIMATE ADAPTATION PLAN OUTLINE
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☑ Stage 4: Programming ☐ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	Some municipalities find it helpful to develop a separate adaptation plan that outlines the full portfolio of adaptation measures—land use and non-land use—that the municipality plans to implement. This resource provides a sample outline for a municipal adaptation plan, based on plans that other municipalities in the Dominican Republic have developed.
Methodology	Use this outline as a guide to develop your own adaptation plan. Use this outline as a template to get started, or as a guide to develop your own.
User(s)	Municipal staff involved in land use planning, and a range of stakeholders representing financial, technical, and institutional capacities.
Intended Use	To illustrate one approach to developing an adaptation plan and provide suggestions on key elements to include to ensure the adaptation plan is effective.
Key Output(s)	Climate Adaptation Plan
Ease of Use	Users require a working knowledge of municipal resources, sectors, and services; and the historical sensitivity of assets to climate and non-climate stressors.
Computer Requirements	This outline is in Microsoft Word format and can be used on a desk-top computer or hard copy.

CLIMATE ADAPTATION PLAN OUTLINE

I. INTRODUCTION: CLIMATE RISK MANAGEMENT IN THE MUNICIPALITY

[This chapter provides background information on climate risks to the municipality, the purpose of the adaptation plan, and how it will be used.]

- **Overview of municipality and climate risks**
  - o High-level summary of municipal climate change risks and vulnerabilities
  - o The importance to the municipality of managing climate risk and developing an adaptation plan

- **Overview of adaptation portfolio approach to addressing risks**
  - o This plan uses a portfolio approach of various types of measures (hard, soft, land use, non-land use) to address multiple sectors, stressors, and implementation timeframes

- **Overview of pathways for adaptation implementation**
  - o Municipal land use plan
    - Incorporate land use adaptation measures into territorial perspective phase of municipal land use planning
  - o Municipal development plan
    - Incorporate non-land use adaptation measures into plan as a program or project
  - o Annual operating budget (pathway is through the municipal development plan)
    - Incorporate non-land use adaptation measures into annual operating budget. Projects in the municipal development plan inform development of the annual operating plan

- **Overview of organization of adaptation plan**

II. OVERVIEW OF MUNICIPAL CLIMATE CHANGE VULNERABILITIES

[This chapter provides an overview of how livelihoods and the natural resources, infrastructure, and municipal services that people depend on in the municipality are vulnerable to multiple climate change stressors (e.g., extreme temperatures, variable precipitation patterns, and storm surge).]

- **Overview of municipal climate change vulnerabilities by PMOT Stage 2 diagnostic categories** [select those categories relevant to the municipality]
  - o Population: Human Settlements
  - o Environmental and Natural Resources: Water Resources, Coastal and Marine Resources, Forests
  - o Municipal Services and Equipment: Solid Waste Management, Civil Protection and Health, Housing, Sports Facilities, Cemeteries, Markets, Cultural Heritage
  - o Infrastructure Services: Drinking Water, Sanitation, Wastewater Treatment, Urban Mobility, Storm Water Drainage, Power System, Telecommunications
  - o Commerce and Industry: Agriculture, Fisheries, Industry, Tourism
  - o Institutional Coordination, Education, And Ongoing Research

- **Municipality's priority vulnerabilities addressed in the adaptation plan**

III. ADDRESSING PRIORITY CLIMATE VULNERABILITIES

[This chapter provides an overview of how the municipality plans to address its priority vulnerabilities. The municipality has worked to identify and prioritize adaptation strategies and measures that the municipality will take to reduce or manage those risks. These adaptation strategies are developed only for each priority vulnerability, by diagnostic category. Within each selected diagnostic category, the adaptation measures, responsible parties, timeframe for implementation, and type of action are identified. The strategies presented should have been validated by the municipal city council. This chapter may also include additional adaptation measures that have been identified but are not considered priorities at this time.]

[Municipality] has identified and prioritized adaptation strategies and measures it will undertake to reduce or manage risks and vulnerabilities. These adaptation strategies were developed only for each priority vulnerability, and are organized by diagnostic category. Within each diagnostic category, the adaptation measures, responsible parties, timeframe for implementation, and type of action are identified. The strategies presented in this adaptation plan have been validated by the municipal city council.

A. HUMAN SETTLEMENTS

[Each diagnostic category section contains a table of identified priority adaptation measures for the municipality to implement (see Table A-1)]

Table A-1: Priority Adaptation Measures for Human Settlements

Adaptation Measure	**Responsible Party**	**Timeframe for Implementation** (Near-, mid-, long-term)	**Type of Action** (land use, municipal development project, operations/ management, training, other)

[In addition to the above priority adaptation measures, the municipality could consider additional measures to adapt to the full range of impacts to the sector. Additional illustrative adaptation measures are identified below (see Table A-2)]

Table A-2: Additional Adaptation Measures for Human Settlements for Consideration

Adaptation Measure	**Vulnerabilities Addressed**

B. ENVIRONMENTAL AND NATURAL RESOURCES

[Each diagnostic category section contains a table of identified priority adaptation measures and a table of additional illustrative adaptation measures]

1. WATER RESOURCES
2. COASTAL AND MARINE RESOURCES
3. FORESTS

C. MUNICIPAL SERVICES AND EQUIPMENT

[Each diagnostic category section contains a table of identified priority adaptation measures and a table of additional illustrative adaptation measures]

1. SOLID WASTE MANAGEMENT
2. CULTURAL HERITAGE
3. CIVIL PROTECTION AND HEALTH
4. HOUSING, SPORTS FACILITIES, CEMETERIES, MARKETS

D. INFRASTRUCTURE SERVICES

[Each diagnostic category section contains a table of identified priority adaptation measures and a table of additional illustrative adaptation measures]

1. DRINKING WATER
2. SANITATION
3. WASTEWATER TREATMENT
4. URBAN MOBILITY
5. STORM WATER DRAINAGE
6. POWER SYSTEM
7. TELECOMMUNICATIONS

E. COMMERCE AND INDUSTRY

[Each diagnostic category section contains a table of identified priority adaptation measures and a table of additional illustrative adaptation measures]

1. AGRICULTURE AND FISHERIES
2. INDUSTRY
3. TOURISM

F. INSTITUTIONAL COORDINATION, EDUCATION, AND ONGOING RESEARCH

Actions led by individuals, communities, and institutions play an important role in responding to climate risks. Adaptation strategies to increase adaptive capacity, through increased institutional coordination, education, and ongoing research will enhance the resilience of the municipality to future changes in climate.

[Each diagnostic category section contains a table of identified priority adaptation measures and a table of additional illustrative adaptation measures]

IV. TOWARD A MORE CLIMATE-RESILIENT [MUNICIPALITY]: IMPLEMENTING PRIORITY ADAPTATION MEASURES

[This section provides an overview of how the municipality will implement the adaptation measures it has prioritized, including: incorporation into municipal plans, specific implementation actions, and an ongoing process to manage resilience through adaptive management]

V. OVERVIEW OF IMPLEMENTATION PLAN

- How: Overview of pathways for adaptation implementation in [municipality] (municipal land use plan, development plan, annual operating budget)

VI. IMPLEMENTATION ACTIONS FOR ADAPTATION MEASURES

- Overview of actions [municipality] will take to implement adaptation measures

Detailed Actions to Implement Adaptation in [Municipality]

Adaptation measure #1: [insert]		
Actions	**Timeline**	**Lead Actor**

Adaptation measure #2: [insert]		
Actions	**Timeline**	**Lead Actor**

Adaptation measure #32: [insert]		
Actions	**Timeline**	**Lead Actorl**

VII. ADAPTIVE MANAGEMENT

- Discussion of the importance of monitoring progress of adaptation implementation, tracking changes in climate and non-climate conditions, and evaluating changes to resilience

- Overview of the concept of continually adjusting and refining adaptation strategies as needed to improve the municipality's resilience to climate change

STAGE 5 RESOURCES

- IMPLEMENTATION ANALYSIS FORM

Resource Title	IMPLEMENTATION ANALYSIS FORM
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization ☐ Stage 2: Territorial Diagnosis ☐ Stage 3: Territorial Prospective ☐ Stage 4: Programming ☑ Stage 5: Implementation ☐ Stage 6: Monitoring and Evaluation ☐ Stage 7: Formalization
Description	Use this simple form to organize the critical information surrounding the implementation of adaptation measures, including details on key stakeholder roles and responsibilities, timelines, costs, required approvals, and other information. By gathering this information for each measure, you will be able to better integrate the information into an implementation or action planning process.
Methodology	This Implementation Analysis Form supports municipal land use planners in understanding what resources are needed to implement the adaptation measures, what technical analysis and actions be required, what approval processes will be needed, and what timeframe should be expected to accomplish each measure.
User(s)	Municipal planners and technical working groups
Intended Use	Municipal staff involved in strategic and capital investment planning
Key Output(s)	To help planners organize and document all of the key components required to successfully implement prioritized adaptation measures.
Limitations	Integration into an action or implementation plan will require engagement of all key actors in order to identify the critical actions and timelines.
Ease of Use	Moderate

IMPLEMENTATION ANALYSIS FORM

This form helps you identify core processes and other details necessary for implementation of adaptation measures.The table builds on **Table 6: Adaptation Implementation in the Climate Adaptation Assessment Tool, Module 5,** where you may have already assigned each adaptation measure in your portfolio to a municipal planning process, assigned key actor roles and responsibilities, identified specific actions, and defined a timeline for implementing the measure. Here we expand that table to include information on key approvals/regulatory requirements, estimated cost of implementation, and sources of information.

To complete this form, for each land use and non-land use adaptation portfolio measure take the following steps:

1. **Enter the name of the adaptation measure** in the top row of the sample "Adaptation Implementation Table," below. Include a brief description of the measure, and identify the primary implementation process.

2. **Identify a lead actor and supporting actors** within municipality departments or other stakeholders who are working on municipal land use and planning-related activities.

3. **Assign clear responsibilities** to the lead and supporting actors. This establishes ownership over activities and promotes accountability throughout the implementation process. If applicable, coordinate with other stakeholders, such as the national government, private stakeholders, **community groups, and others to assign responsibility.**

4. **Identify specific actions** to implement the adaptation measure. This can be a series of numbered steps to follow in order to implement the adaptation measure.

5. **Develop a timeline** for implementing activities. Set intermediate checkpoints between now and the intended completion date to help ensure that progress continues to be made over the course of implementation. The timeline should align with the timeline of the municipal land use plan.

6. **Key approvals/regulatory requirements** for implementation and project construction (if needed) should be identified. For example, given the sensitive nature of coastal, littoral and riparian areas, most activities that can impact these areas or have a potential effect on the aquatic environment will require approvals before work is undertaken.

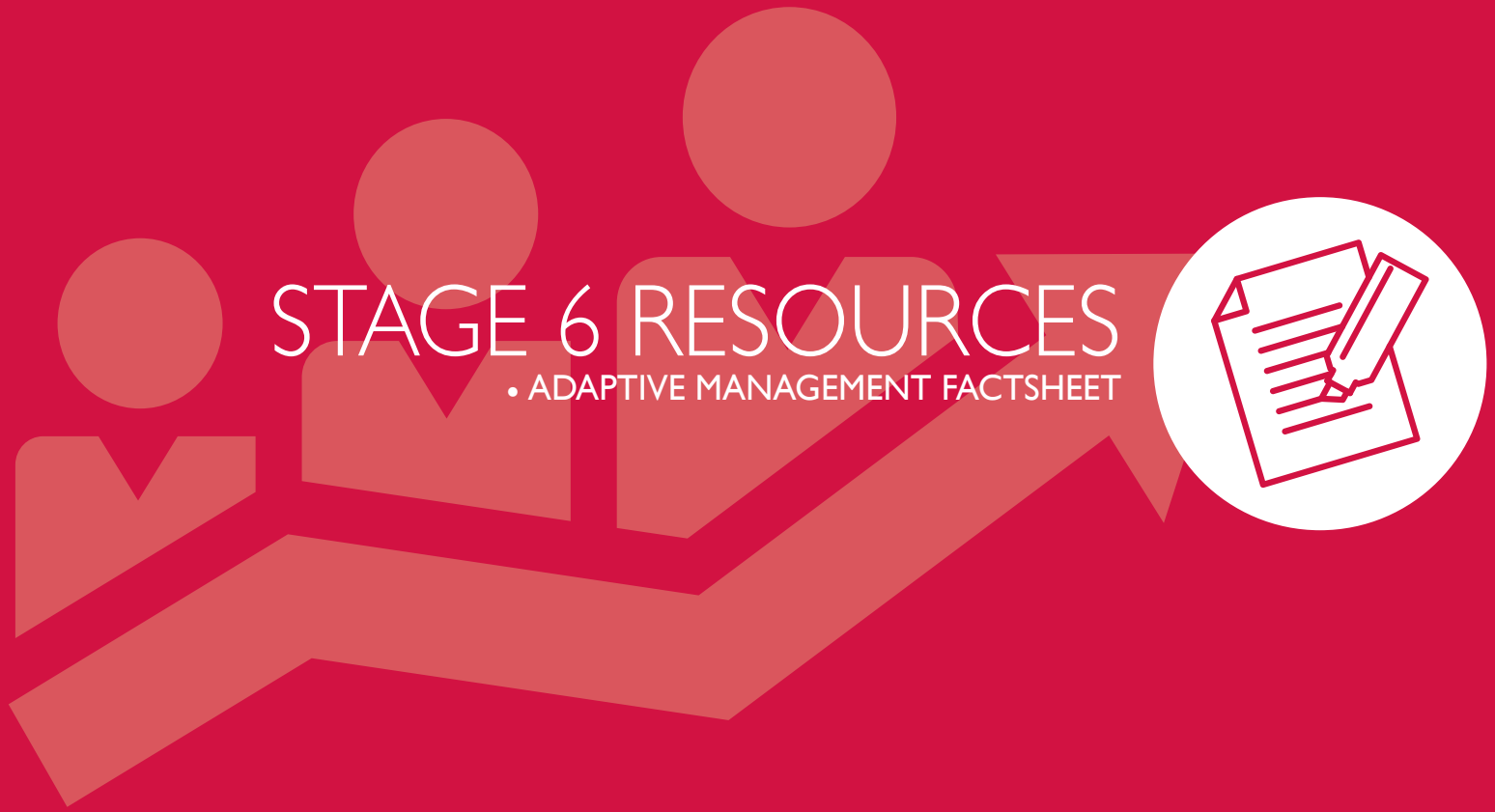
7. **Estimate cost** of implementing the specific measure(s). Identify and estimate all capital and maintenance costs of implementing the adaptation measure.You may be able to get existing cost data from similar projects in your municipality or from other communities. You can develop estimates for the capital costs, maintenance costs, and timing of each maintenance cost for each adaptation strategy using existing data, or by consulting experts. Some capital costs will be incurred in the near future and others will not be incurred until later in the planning horizon. Try to get specification details and information about the useful life of each measure.

8. **Source(s) of information** that are presented in the table should be documented.

1. Adaptation measure: Primary implementation process (land use plan, development plan, operating budget, other)	
2. Actors	**3. Responsibilities**
Lead:	
Supporting actors:	
4. Specific Actions	**5. Timeline**
1.	1.
2.	2.
3.	3.
4.	4.
6. Key approvals/regulatory requirements:	
7. Estimated cost:	
8. Source(s) of information:	

STAGE 6 RESOURCES

• ADAPTIVE MANAGEMENT FACTSHEET

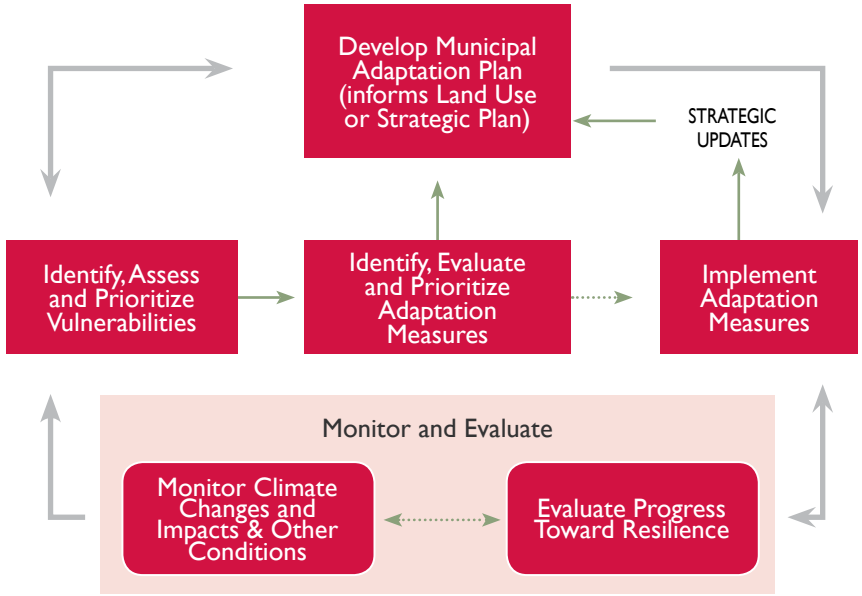


Resource Title	ADAPTIVE MANAGEMENT FACTSHEET		
Relevant Land Use Planning Stages	☐ Stage 1: Institutional Organization	☐ Stage 4: Programming	☐ Stage 7: Formalization
	☐ Stage 2: Territorial Diagnosis	☐ Stage 5: Implementation	
	☐ Stage 3: Territorial Prospective	☑ Stage 6: Monitoring and Evaluation	
Description	This factsheet provides guidance on monitoring the effectiveness of climate adaptation measures, tracking changes in climate and non-climate conditions, and adjusting adaptation plans and programs as indicated.		

ADAPTIVE MANAGEMENT FACTSHEET

Achieving climate resilience in land use is an ongoing process. **Adaptive management** is an iterative approach that allows planners and managers to revisit and improve climate resilience and adaptation measures. This practice helps municipalities maintain and build resilience through the adjustment of adaptation strategies as they gain knowledge and understanding of changing climate and non-climate stressors, and the associated municipal impacts and vulnerabilities.

As an iterative approach, adaptive management builds on the monitoring and evaluation process to conduct periodic monitoring of changes in climate and related impacts, and evaluation of the progress toward resilience (see figure). The information gained from monitoring and evaluation can be used to update and reprioritize vulnerabilities, to refine or identify new adaptation measures, and to regularly incorporate new information into adaptation planning.



Adaptive management involves iteration.

Integrating adaptive management into land use planning

Adaptive management is an integral part of the PMOT Guide Stage 6: Design Monitoring and Evaluation system. The system tracks land use permitting every three months, monitors program and project progress every six months, and evaluates land use plan implementation every two years. As shown in the figure, above, specific considerations for adaptive management include evaluating progress toward resilience and monitoring climate change, impacts, and other conditions. The municipal land use plan includes implementation of climate change adaptation measures for zoning, regulation, polices and projects. Evaluating the effectiveness, or performance, of these adaptation measures requires assessing the degree to which progress has been made in building resilience. The progress and performance of the adaptation measures can be tracked over time through the application of indicators. Indicators are measurable or tangible signs that indicate whether and how resilience has changed.

In addition to monitoring and evaluating progress and performance, adaptive management involves monitoring changes in conditions and impacts. This data improves the knowledge base about changes to specific stressors, setting the context for determining the effectiveness of adaptation measures. Projected climate change should already be factored into your adaptation measures, but your detailed understanding of future climate within your specific municipal setting will be strengthened by monitoring of local climate and impacts. Additionally, natural systems and non-climate conditions will continue to evolve as well; these changes in the broader municipal context can affect the level of vulnerability and the effectiveness of adaptation options.

Please refer to the *Adaptive Management Tool* (Stage 6 Tools, Annex 1) for practical guidance on how to identify adaptive management considerations unique to climate resilience that can be incorporated into municipal and land use planning.

USAID
FROM THE AMERICAN PEOPLE

ICMA

ICF

FEDOMU
FEDERACIÓN DOMINICANA DE MUNICIPIOS