The CLIMATE VULNERABILITY AND LAND USE PLANNING TOOL was developed by the USAID/ICMA Planning for Climate Adaptation Program as part of the Toolbox for the Dominican Republic's Methodological Guide for Formulating Municipal Land-use Plans (DGODT/MEPyD, 2015).

CLIMATE VULNERABILITY AND LAND USE PLANNING TOOL

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 planners seeking to incorporate vulnerability assessments directly into land use planning.

HOW DOES THIS RESOURCE LINK TO THE PMODT STEPS?

This resource directly supports the integration of information on climate change and climate vulnerability assessment into the DGODT's Methodological Guide for Formulating Municipal Land-use Plans Step. 2: Territorial Diagnosis and Analysis, as outlined in Figure 1. This is not an exhaustive set of information, or guidance to vulnerability assessments, but is meant to help land use planners think through, identify, and incorporate information on critical climate change risks and vulnerabilities. The guidance is organized to help planners directly incorporate climate considerations into the three sub- steps of Step 2:

1. Gathering information
2. Delimitation and Analysis of Municipal Context
3. Preparation of territorial analysis of the municipality

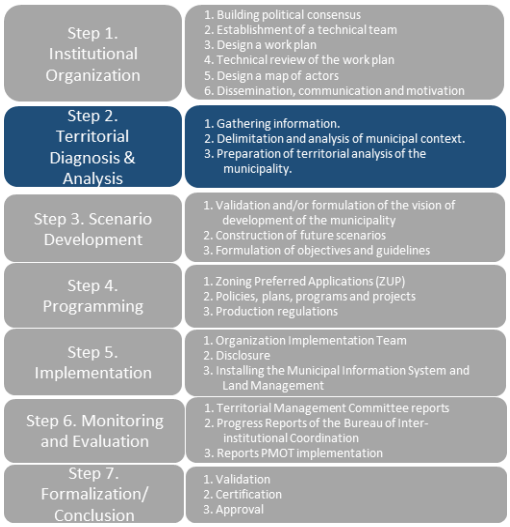

Figure 1. DGODT's land use planning steps.

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?

GATHERING CLIMATE INFORMATION

A first step in territorial diagnosis and analysis is to gather relevant information. Climate information is another important piece to include in the "compendium of information." The following is a checklist of information for planners to consider collecting as part of the diagnosis:

Type	What/ Why
□ Rainfall ▪ Monthly distribution ▪ Extremes	▪ Information surrounding current and future projected changes of the monthly amount and distribution of rainfall: provides an indication of how water availability may change ▪ Information surrounding current and projected future changes in frequency and magnitude of rainfall extremes: provides an indication of how flood risk may change
Notes:	
□ Coastal Flooding	▪ 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): provides an indication of land areas that may be subject to future inundation, may be overlaid on population and infrastructure to present a first level analysis of what is at risk
Notes:	
□ Riverine/Pluvial Flood Extent	▪ Maps indicating current and projected future changes of riverine/fluvial flooding extent: provides an indication of land areas that may be subject to future inundation, may be overlaid on population and infrastructure to provide a first level assessment of what is at risk, and where
Notes:	
□ Drought	▪ Information on current frequency and intensity, and future changes, in drought (e.g., Aridity Index, SPI): provides a comparative indication of whether future drought changes could worsen or positively affect water availability for productive development uses
Notes:	
□ Temperature ▪ Monthly distribution ▪ Extremes	▪ Information surrounding current and future projected changes of the monthly average, minimum, and maximum temperatures: provides an indication of how much temperatures may rise in your locality ▪ 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)
Notes:	

□ Tropical Storms, Cyclones	▪ 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)
Notes:	
□ Other: ▪ Landslides ▪ Fires ▪ Coastal erosion	▪ Information/maps surrounding current and future projected changes of frequency, location, and/or rate of climate related stressors such as fire, landslides, or coastal erosion: important considerations for land use planners in determining at-risk locations and assets, and for identifying potential adaptations that may be required to support and maintain infrastructure or other investments
Notes:	

*For guidance on choice of future climate change scenarios, timescales, and models, please see the "Scenarios Tool and Guidance."

DELIMITATION AND ANALYSIS OF MUNICIPAL CONTEXT

In this step guidance is provided on how to integrate climate impacts into the "delimitation and analysis of the municipal context." A checklist follows that municipal planners can use to consider how critical development sectors and land use planning objectives are affected by current climate, and how changes in future climate may exacerbate or reduce these impacts. When considering these impacts, keep in mind:

- Criticality – Are people at risk? How important are the asset(s) to achieving development objectives in a particular region?
- Likelihood – What is the probability of the climate impact occurring and affecting the people and/or assets?
- Consequences – Will the climate impact temporarily or permanently decommission the use of the asset? Will people be put into harm's way?

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 of additional critical assets.

Consider the key categories and questions, below, and note any key past impacts, and potential future impacts based on the information collected under "gathering information," above. Note that these questions and considerations are not exhaustive, please consider referring to the list of additional resources to consult for a more comprehensive set of potential impacts and sectors.

		Checklist of key questions:
Key municipal populations, assets, sectors	▪ Municipal population, and critical development sectors (see sectors listed in this table, below)	▪ Is the location of current infrastructure or populations currently subject to damage or inundation from flooding, heavy rainfall? How might the land use planning and location of development zones, assets, and populations be affected by projected future changes in flood footprints? ▪ Is climate change expected to increase the footprint of riverine or coastal flooding that would render additional assets and populations exposed or permanently inundated? ▪ Is there critical infrastructure (e.g., hospitals, roads) at risk to current and/or future flooding?
	Note key impacts:	
	▪ Water Supply	▪ Is current water supply sufficient during times of drought? Is drought frequency and intensity expected to change, and if so, would changes exacerbate drought impacts? ▪ 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:	
	▪ Transportation	▪ 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 affect these assets?
	Note key impacts:	
	▪ Energy Systems	▪ 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? ▪ 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:	
	▪ Coastal Tourism	▪ Have historical storms led to direct damages to tourism infrastructure (e.g., beach resorts, roads)? 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/or changes in storm frequency and intensity, affect tourism in the future?
	Note key impacts:	
	▪ Sanitation systems	▪ Has lower water quality as a result of higher temperatures or prolonged drought reduced water quality, increasing waste water treatment costs? How might projected temperature increases or changes in drought affect waste water treatment? ▪ 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? ▪ Have past storms overwhelmed waste water treatment facilities, inundated outfalls causing discharge to back up, disrupted pumping or treatment due to power losses? How might changes in future rainfall intensities or flooding affect treatment?
	Note key impacts:	
	▪ 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:	

PREPARATION OF TERRITORIAL ANALYSIS OF THE MUNICIPALITY

The information gathered in steps 1 and 2, above, should be synthesized and integrated into the territorial analysis. For example, maps delineating exposure, and information regarding current and future climate-related impacts should be directly integrated into the territorial analysis, where appropriate.

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

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