Caribbean Disaster Mitigation Project
Implemented by the Organization of American States
Unit of Sustainable Development and Environment
for the USAID Office of Foreign Disaster Assistance and the Caribbean Regional Program

Use of Storm Hazard Mapping in Development Planning

Development planning attempts to guide future growth and change by outlining a process of change and describing a vision of the intended end result. It requires a careful balancing of often competing goals, within the context of existing opportunities and constraints presented by the political, social, economic and physical realities of the land and society. Caribbean states are blessed with a wide variety of natural resources, desirable landscapes and temperate setting. The Caribbean, however, is also a highly hazard-prone region, with hurricanes, earthquakes, landslides, flooding and other natural hazards regularly causing damage and injury in the region. The small size of many of the states in the region, the concentration of high-value lands in low-lying coastal areas or unstable slopes only serve to complicate the effects of these hazards and limit the options for response. Consequently, the prevalent hazards in the region must be included as one of the major constraints on all development planning programs—whether for economic, physical, social or infrastructure development—in the region. Not doing so has the potential to undo all other parts the development planning program due to the damage and interruption caused by a major hazard event.

Addressing Coastal Storm Surge Hazard in Physical Development Plans

Storm surge is a localized increase in the height of the sea due to a combination of forces associated with tropical cyclones, including decreased atmospheric pressure and wind and wave effects. Storm surges can cause significant coastal flooding and allow wave effects to reach further inland than would be possible with normal sea levels. The forces exerted by the surge and waves can cause significant coastal erosion, flatten buildings and severely scour foundations of walls and structures located in the areas of impact. The saltwater that moves inland with storm surges can damage plant life, surface aquifers and infrastructure in the coastal zone.

The effects of natural hazards on infrastructure and society can be reduced by avoiding hazardous areas, building to standards sufficient to withstand the effects of the hazards, or a combination of these two approaches. In the Caribbean, the same lands that are at highest risk to storm surges—coastal areas—are also highly valued for the port, harbor and tourist facilities that are central to the economy of many states in the region. Complete avoidance of these hazardous areas, therefore, is not an option. Nonetheless, it is possible with a coastal project to remove many structures from the hazard zone by either setting them back a sufficient distance from the shoreline or raising their ground level above the height of the expected surge. For those facilities that must be built in the impact zone, different design standards must be employed to ensure that they can withstand the surge and wave effects or that only non-critical components are lost to such hazards.

To address surge hazards within the development planning context, it is necessary to:

- understand the characteristics of the hazard in a given area,
- determine what lands and facilities are at risk to this hazard, and

- develop vulnerability reduction and mitigation measures to address the identified risks.

The first two steps, analyzing the hazard and assessing the vulnerability, are primarily technical exercises. The third step, developing responses, however, falls in the realm of development planning and public policy. With information on hazard risk and vulnerability in hand, a society (through its government) or individual must decide what level of risk is acceptable in respect to the hazard. The answer may vary, depending upon the importance of the structure. For instance, avoiding surge risks would most likely be a higher priority for critical facilities such as hospitals and power plants than for offices or shops. The surge hazard varies along the coastline, with localized bathymetry and topography, coastline shape and existing development determining the amount of land that falls within the areas determined to have acceptable risk.

CIMH Storm Surge Atlases

The Caribbean Institute for Meteorology and Hydrology (CIMH), with the support of the USAID/OAS Caribbean Disaster Mitigation Project (CDMP), is producing national-level storm hazard maps for selected territories in the eastern Caribbean, using the TAOS/L storm hazard model. These maps show the maximum expected storm surge height for various combinations of hurricane category, forward speed and storm track. Surge heights are estimated at approximately 1-km intervals across the map. The surge information presented in this atlas of maps can be used to determine the characteristics of the surge hazard in the territory—and how that hazard varies with storm intensity and direction along the coastline. The maps produced by CIMH show surge heights at the coastline. Using more detailed topographic information, these surge heights can be extended inland to determine what lands and existing facilities are vulnerable to surge effects for those selected storms. Since the surge information on which these maps were based is available in a geographic information system-compatible form, this vulnerability assessment can be undertaken in a GIS, if detailed digital elevation information is available.

Using the results of the vulnerability assessment, it is possible to set building standards and land use guidelines along the coast. For instance, upon analysis of the maps, it is possible to determine that development above the 2-meter contour line will be safe from inundation from storms up to category 4, except in one particularly vulnerable cove, where 2.5 meters is a safer elevation. Appropriate guidelines and standards can then be developed for areas above and below the target contour. This type of analysis is not solely the domain of governments. Individual landowners and risk underwriters should undertake a similar analysis for any potentially vulnerable properties under consideration for development, to determine what level of risk is acceptable for the development—and if higher than required standards will be incorporated into the project's design.

The 1-km grid scale of the surge information presented in these maps provides a solid context to guide policy decisions. Approximate surge levels and localized effects, such as sections of the coastline which receive concentrated effects when compared to neighboring areas, can be determined from these maps. While these maps are not sufficiently detailed to support parcel-level analysis, they do support the development of standards and guidelines for larger sections of coastline, which is the scale at which existing coastal development regulations are likely to be set. A more detailed, higher resolution analysis will be required for on-shore locations where coastal lifeline facilities, such as harbors, are planned or where high-value residential investments are considered.

More information on the storm hazard modeling and the TAOS/L storm hazard model is available on the CDMP web site at http://www.oas.org/en/cdmp/taos.htm.

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