Sea Level Rise in Liberia: A Risk and Vulnerability Analysis

Background and Project Objective

With the adoption and ratification of the Paris Climate Agreement in 2016—a landmark in the global efforts to tackle climate change—countries are focusing now in the implementation of their climate commitments under the agreement (NDCs). However, most developing countries—in particular the Least Developed Countries (LDCs)—lack the necessary capabilities to fully and adequately implement their commitments.

In this context, the recently established Climate Policy Lab (CPL) at The Fletcher School of Law and Diplomacy at Tufts University is partnering with the United Nations Development Programme to support these countries in the implementation of their NDCs, and Liberia is one of them. Liberia is an LDC highly vulnerable to the impacts of climate change, and more specifically, the country’s coastal areas are highly exposed to sea-level rise. This poses a serious threat to population, infrastructure and economic activities, which highly concentrate in the country’s coastal region, which hosts 58% of the population as well as most agricultural and fishing activities. If not properly addressed, sea level rise impacts can lead to loss of both lives and properties, displacement, and economic disruption.

This project aims to support the work of CPL and contribute to the Liberia project by answering the following questions: (1) what coastal areas will be inundated if sea level rises 0.3 meter (best-case scenario) and 2.5 meters (worst-case scenario); (2) what population will be affected under each scenario; (3) how many populated places in Liberia are within the inundation areas; (4) what area and type of land will be impacted under each scenario; and (5) which counties presently host the population most vulnerable to sea-level rise and which ones will potentially be most impacted under each scenario.

Methodology

In order to answer these questions, different methods have been used.

Inundation Zones: based on the latest assessment of the National Oceanic and Atmospheric Administration (NOAA) from January 2017, the global mean sea level rise projections for 2100 range from 0.2 meters to 2.5 meters conditional on future greenhouse gas emissions and associated ocean-atmosphere warming. Using the ASTER Digital Elevation Model (DEM) for Liberia, two sea level rise layers were created for each scenario by selecting and reclassifying the DEM values lower than 0.3m and 2.5m (blue and red raster layers respectively on the call-out maps). The Inundation Zone was calculated by overlaying both sea-level rise layers with the land cover raster for Liberia.

Population, Land and Populated Places Impact: the two sea-level rise layers were overlaid with the LandScan Global Population and the Modis GLCF land cover rasters, and a point dataset mapping Liberia’s populated places. By multiplying them estimated population, land cover and populated places impacted by 0.3m and 2.5m sea-level rise were calculated. This information is summarized and presented at the county level in tables. For the land impact, this project focuses exclusively on croplands, wetlands, forests, and urban areas because of their importance for Liberia’s development. Bar charts summarize the percentage of total land cover at the county that would be impacted by each sea-level rise scenario.

Vulnerability Assessment: each county was ranked from 0 to 3 (low to high vulnerability) for seven different variables (see vulnerability assessment map). These seven rankings for each county were summed up to create a total vulnerability score for each county ranging from 0 to 21 (low to high).

Coastal Inundation

Risk Assessment: the nine counties impacted by sea-level rise were ranked from 0 to 3 (low to high risk) based on the percentage of population and land, and the number of populated places potentially affected by 2.5m of sea-level rise.

These rankings are combined to assign a total risk score to each county ranging from 0 to 18 (low to high).

Impact Assessment

Interestingly, the vulnerability and risk assessment shows that many of the most vulnerable counties would not be the most highly impacted by sea-level rise. For instance Montserrado and Maryland, while potentially highly impacted, host a lower vulnerable population. However, while less vulnerable, Montserrado alone is home to most people at risk of sea-level rise (about 83% of the total potentially impacted population).

Sinoe and Grand Kru have relatively high vulnerable populations and will potentially suffer a higher impact. Therefore, when designing adaptation policies, these counties should be prioritized.

Potential County Risk

The analysis also reveals that the number of people affected is the same for the two sea-level rise scenarios. However, this might be the result of methodology limitations. There is no population data at the local level for Liberia, and the LandScan Global Population dataset was used. Thus, this data does not provide exact figures and should be used as rough estimations.

Furthermore, the population data is from 2015 and therefore the estimates do not reflect the actual population that would be affected by sea-level rise in the future. At a 2.4% growth rate of 2015, by 2100 the Liberian population impacted by sea-level rise would be considerably higher than these estimates suggest.

Looking at the land cover potentially impacted, the analysis reveals that for a 0.5m sea-level rise, the land mostly affected would be wetlands. However, it would still be a low percentage of total wetlands for each county (e.g. 0.2% of total wetlands in Grand Kru). Nonetheless, wetlands provide important resources such as fish, wood, fertile land, and agricultural products for Liberians. They also help to minimize the impacts of heavy rainfall, storms, flooding, and sea level rise. For 2.5m sea-level rise, the percentage of land affected increases dramatically, specially urban areas (e.g. 13% of total urban areas in Grand Bassa). Therefore, this area would be also highly impacted under this scenario, and they serve as sources of food, fodder, medicinal products, and heating, as well as being natural carbon sinks.

Thus, taking adaptation measures to mitigate the effects of sea-level rise and reducing Liberians’ vulnerability is critical.