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MAPPING THE EXPOSURE OF SOCIOECONOMIC AND NATURAL SYSTEMS OF WEST AFRICA TO COASTAL CLIMATE STRESSORS: GUIDE TO POSTER MAPS

OCTOBER 2014

This report is made possible by the support of the American people through the U.S. Agency for International Development (USAID). The contents are the sole responsibility of Tetra Tech ARD and do not necessarily reflect the views of USAID or the U.S. Government.

ARCC

African and Latin American
Resilience to Climate Change Project

This map guide was prepared by the Center for International Earth Science Information Network (CIESIN) at the Earth Institute of Columbia University through a subcontract to Tetra Tech ARD. Alex de Sherbinin led the team, which included Tricia Chai-Onn, Malanding Jaiteh, Linda Pistolesi, and Emilie Schnarr (Geographic Information Systems [GIS] analysts), as well as Valentina Mara (statistician).

All maps, spatial data inputs, and reports/documentation associated with this vulnerability mapping study can be found at http://ciesin.columbia.edu/data/wa-coastal.

This publication was produced for the United States Agency for International Development by Tetra Tech ARD, through a Task Order under the Prosperity, Livelihoods, and Conserving Ecosystems (PLACE) Indefinite Quantity Contract Core Task Order (USAID Contract No. AID-EPP-I-00-06-00008, Order Number AID-OAA-TO-11-00064).

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AFRICAN AND LATIN AMERICAN RESILIENCE TO CLIMATE CHANGE (ARCC)

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ACRONYMS

ACE2	Altimeter Corrected Elevations
CIESIN	Center for International Earth Science Information Network
GIS	Geographic Information Systems
LECZ	Low-elevation coastal zone
NOAA	National Oceanic and Atmospheric Administration
SVI	Social vulnerability index

1.0 INTRODUCTION

The Guinea Current countries of West Africa extend from Guinea Bissau in the northwest to Cameroon in the southeast, with a coastline of more than 3,600 kilometers. These countries have diverse ethnic, cultural, and historical backgrounds, and represent relatively disparate levels of economic development; however, they are united by a common pattern of high levels of economic activity and population concentrations in the coastal zone. We define the areas at risk of sea-level rise and storm surge as being in the low-elevation coastal zone (LECZ) of 0-20 meters above mean sea level, with lower elevations being at greater risk.[1] In 2010, some 15 million people resided in the LECZ of 0-5 meters elevation; by 2050, that number could grow to 57 million.[2]

Although global mean sea-level rise by the end of this century is predicted to range from 0.3-1.2 meters depending on the rate of warming and the response of ice sheets (Kopp et al., 2014), storm surge can greatly expand the area affected by seaward impacts. The breakdown in infrastructure and economic losses in the near-coastal zone would likely affect even areas outside those immediately exposed to storm surge. The Guinea Current countries already face storm surges with high winds and intense wave action resulting in coastal erosion (Niang, 2012; Appeaning Addo, 2013). This pattern is likely to increase and perhaps intensify as a result of higher sea-surface temperatures (Emanuel, 2005).

The purpose of this poster map guide report is to provide a short overview of data, methods, and results to accompany the poster-sized maps. The poster maps are derived from a larger study on the populations and natural systems that are exposed to combined seaward hazards. In that study, we identify patterns of exposure, sensitivity, and adaptive capacity that contribute to specific constellations of vulnerability (de Sherbinin, 2014). The Web site listed on the inside cover of this report provides PDF versions of the poster maps in French and English along with a summary and full report detailing assumptions, methods, and data.

As a general note, sea-level rise will not be uniform in the coastal zone. Some regions such as the Niger Delta, where land subsidence is occurring, will experience higher levels of relative sea-level rise (and therefore exposure) than regions that do not experience subsidence. Storm surge will also exhibit patterns of spatial differentiation depending on wind patterns. Because of differences in scale and spatial resolution in the original data sets, there are spatial mismatches within the maps between the LECZ, the land layer, the political boundaries, and some input layers such as population. As a result, in the poster maps, areas at the ocean's edge may appear to be outside the LECZ but are in fact within the LECZ, and political boundaries do not always match the coastline.

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[1] Data for the LECZ were derived from the Altimeter Corrected Elevations (ACE2) data set (Berry et al., 2008).

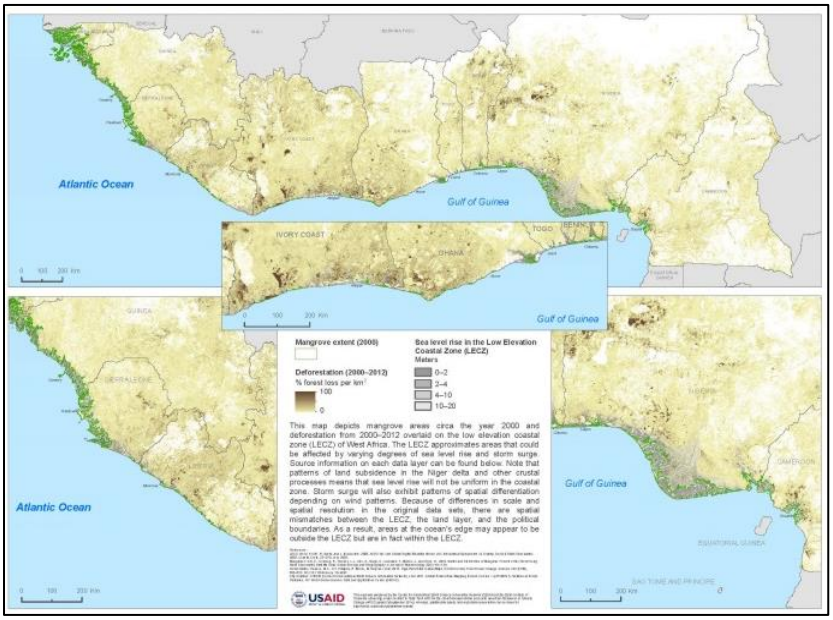
[2] See full report for the population projections methodology.

2.0 MAPS, METHODS, AND RESULTS

Three types of poster maps were developed, representing a sub-set of the indicators and data layers produced in the larger study. In the first set, we represent mangroves in relation to the low-elevation coastal zone and deforestation from 2000 to 2012. In the second set, we represent a social vulnerability index for the 200 kilometers adjacent to the coastline in relation to the low-elevation coastal zone. In the third set, we focus on a subset of cities that have large populations and extensive infrastructure that are exposed to sea-level rise and storm surge. These are described in greater detail below.

2.1 LOW-ELEVATION COASTAL ZONE, MANGROVES, AND DEFORESTATION

FIGURE 1. WEST AFRICA COASTAL VULNERABILITY: THE LOW-ELEVATION COASTAL ZONE, MANGROVES, AND DEFORESTATION



This regional map and associated country maps represent the extent of mangroves circa the year 2000 in relation to two potential threats: sea-level rise, as represented by the LECZ, and deforestation. The data for mangroves extent come from Giri et al. (2010), and the data on deforestation summarize the percent of each one square kilometer pixel that has been deforested between 2000 and 2012. The deforestation layer is derived from Hansen et al. (2013), who used Landsat Thematic Mapper 30m data to measure forest loss between the two years.

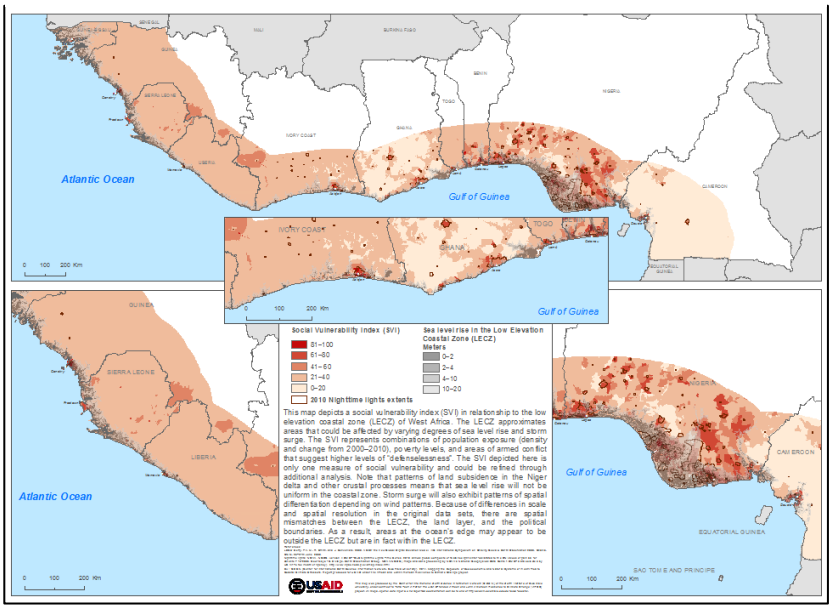
Sea-level rise will have clear impacts on mangroves in West Africa. Mangroves are sensitive to water depth and salinity. Thus, many mangrove areas will need to migrate inland with rising seas, and their ability to do so will depend on land uses and infrastructure that abut the mangrove areas. Deforestation may also be a threat, though it is less clear that this threat is having an immediate impact on wetlands. Visual inspection of the Hansen et al. data in mangrove areas, and discussions with Giri (*personal communication*), suggest that mangrove areas may in fact be expanding in parts of coastal West Africa. However, Twusami and Merem (2006) found mangrove loss in portions of the Niger Delta.

2.2 LOW-ELEVATION COASTAL ZONE AND SOCIAL VULNERABILITY

This map depicts a social vulnerability index (SVI) in relationship to the LECZ of West Africa. The SVI represents a combination of the following spatial indicators in an overall index:

- Population density, 2010
- Population growth, 2000–2010
- Subnational poverty and extreme poverty
- Conflict data for political violence
- Maternal education levels
- Market accessibility (travel time to markets)

FIGURE 2. WEST AFRICA COASTAL VULNERABILITY: THE LOW-ELEVATION COASTAL ZONE AND SOCIAL VULNERABILITY

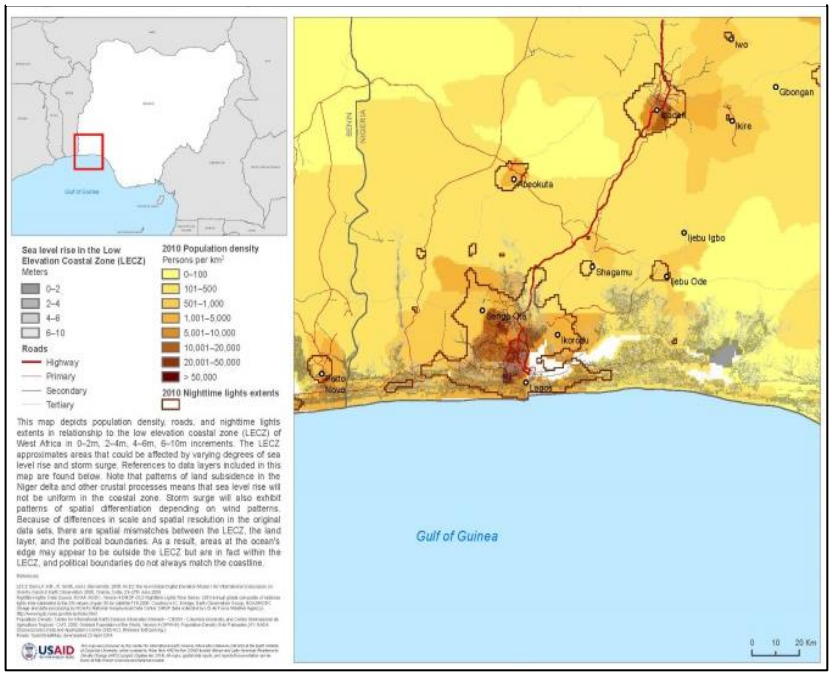


These layers are meant to represent aspects of sensitivity (population density, population growth, poverty, and conflict) and adaptive capacity (maternal education and market accessibility), which together with exposure (the LECZ) combine to produce vulnerability. Higher values on the SVI suggest higher levels of "defenselessness" against coastal sea-level rise and storm surge. The SVI depicted here is only one measure of social vulnerability and could be refined through additional analysis and better data. The maps also include 2010 night-time lights from the Defense Meteorological Satellite Program (courtesy Christopher Elvidge of the National Oceanic and Atmospheric Administration [NOAA] National Geophysical Data Center, n.d.), which represent a proxy for urban built-up areas and areas that have extensive infrastructure, such as oil-drilling sites. The country versions of these poster maps include settlements with populations greater than 100,000.

Results show very high social vulnerability and high exposure in the Niger Delta and around Lagos and Cotonou. There is high social vulnerability, largely due to high population densities and growth, but slightly less exposure in the coastal cities of Lomé, Abidjan, and Accra.

2.3 LOW-ELEVATION COASTAL ZONE, POPULATION, AND INFRASTRUCTURE

FIGURE 3. WEST AFRICA COASTAL VULNERABILITY: THE LOW-ELEVATION COASTAL ZONE, POPULATION, AND INFRASTRUCTURE



City maps for Abidjan, Accra, Conakry, Douala, and Lagos depict population density, road infrastructure, and night-time lights extent in the LECZ. The purpose is to show the degree of exposure of urban built-up areas and associated infrastructure to potential sea-level rise and storm-surge impacts. The roads data are from OpenStreetMap, a best available public domain roads data set. The population data are from CIESIN's Gridded Population of the World, v4 (alpha) (2014). The night-time lights extent data are the same as described above.

Although each of the cities has areas within the LECZ, Lagos is the most exposed, followed by Douala. Accra and Abidjan have fewer exposed areas, and Conakry is the least exposed.

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