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IMCAFS INTEGRATED MANAGEMENT OF COASTAL AND FRESHWATER SYSTEMS

Climate Change and the Risks of Settlement in the Low Elevation Coastal Zone

Gordon McGranahan, Deborah Balk and Bridget Anderson

This study involved the collaboration of the Center for Internationial Earth Science Information Network (CIESIN) at Columbia University in New York and the International Institute for Environment and Development (IIED) in London. Gordon McGranahan is at IIED; Deborah Balk at Baruch College, City University of New York; and Bridget Anderson at the New York City Department of Sanitation. Partial support for analysis of the GRUMP database was provided by National Aeronautics and Space Administration (Contract no. NAS5-03117) for the Continued Operation of the Socioeconomic Data and Applications Center (SEDAC) at CIESIN at Columbia University. Support was also provided by the Swedish International Development Cooperation Agency and Danish International Development Agency.

Coastal settlement is both environmentally damaging and environmentally vulnerable. Climate change, which will bring sea-level rise and greater storm intensity, amplifies the risks to coastal settlements. Yet coastal zones are densely settled and growing rapidly.

The low elevation coastal zone (LECZ) is defined as contiguous coastal land less than ten meters in altitude. It approximately accounts for only 2 percent of the world's land area, but contains 10 percent of the population, and 13 percent of the urban population.

As illustrated in Table 1, about two thirds of the population in this zone is in Asia. Yet even in Africa, which has only 1 percent of its land in the zone and has a comparatively high share of its population engaged in in-land agriculture, 7 percent of the total population and 12 percent of the urban population live in the zone.

While the Small Island States have by far the largest share of land in the zone, their population percentages are not exceptional. This is in part because some of the most populous small island states have comparatively little settlement in the low elevation areas. It is also because small island states do not have large rivers,

Table 1: Population and Land Area in Low Elevation Coastal Zone by Region - 2000

	Region's populations and land areas in LECZ				Shares of region's population and land in LECZ			
Region	Total Population	Urban population	Total Land	Urban Land	Total Population	Urban population	Total Land	Urban Land
	(10^6)	(10^6)	(10^3 km^2)	(10^3 km^2)	(%)	(%)	(%)	(%)
Africa	56	31	191	15	7%	12%	1%	7%
Asia	466	238	881	113	13%	18%	3%	12%
Europe	50	40	490	56	7%	8%	2%	7%
Latin America	29	23	397	33	6%	7%	2%	7%
Australia and New Zealand	3	3	131	6	13%	13%	2%	13%
North America	24	21	553	52	8%	8%	3%	6%
Small Island States	6	4	58	5	13%	13%	16%	13%
World	*634*	*360*	*2,700*	*279*	*10%*	*13%*	*2%*	*8%*

Source: McGranahan, G., D. Balk, and B. Anderson (2007), "The Rising Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones," *Environment and Urbanization*, Vol. 19, No. 1, pp. 17-37.

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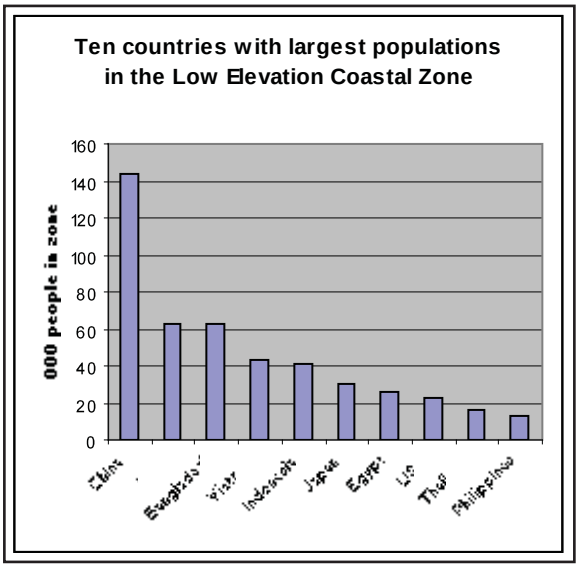

Figure 1. The countries with the highest population shares in the zone (excluding those with total populations of less than 100,000 or land areas less than 100 square kilometres) are shown in Figure 2. Three of these countries—Vietnam, Bangladesh and Egypt—are also among the countries with the largest overall populations in the zone. Only one is a small island state, although there would have been several more had the very small countries with populations below 100,000 been included in this figure.

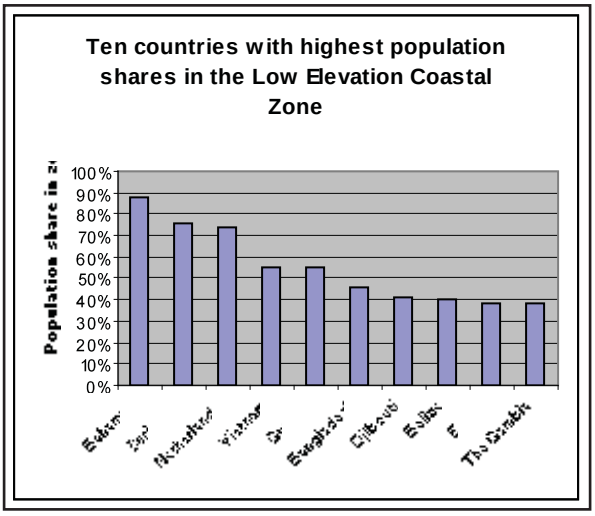

Figure 2. Of particular concern from a vulnerability perspective, is that all but two of the countries with the largest shares of their population in the LECZ (excluding the very small countries) are in the low or lower-middle income category. This is somewhat surprising, given that more coastal settlements are urban than are rural and more of those coastal urban settlements are in wealthy countries.

creating flat and fertile deltas where populations would otherwise locate.

Regional averages hide considerable national variation, and the 10 countries with the most people living in the LECZ (Figure 1) together account for about 463 million people, or about 73% of the people globally who live in the zone. Most of these 10 countries are both populous, and contain large and densely populated delta areas, many of which are also susceptible to subsidence, and already have large populations at risk from storm surges.

In the world as a whole, but most notably in Asia, not only are urban populations more likely to be in the LECZ than rural populations, but larger urban settlements are more likely to overlap with the LECZ than smaller urban settlements. While only 13 percent of urban settlements with populations under 100 thousand overlap with the LECZ, this rises to 65 percent among cities of five million or more. Of the 10 largest cities identified in 2005 by the United Nations, seven of these (Tokyo, New York, Bombay, Shanghai, Kolkata, Jakarta and Buenos Aires) extend into the zone. Indeed, more than 55 million people in these cities and their contiguous urban areas live in the LECZ. Perhaps even more striking, of the 183 countries with people living in the zone, 130 have their most populous urban area extending into the zone.

Continued urbanization is in danger of drawing still greater populations and population shares into the low elevation coastal zone. In China, where export-driven economic growth has been associated with very rapid coastal in-migration, national population growth between 1990 and 2000 was approximately 1 percent, while growth in the low elevation coastal zone was 1.9 percent, and urban populations in the zone grew by 3.4 percent. Even in Bangladesh, where urbanization is not so clearly a driver,

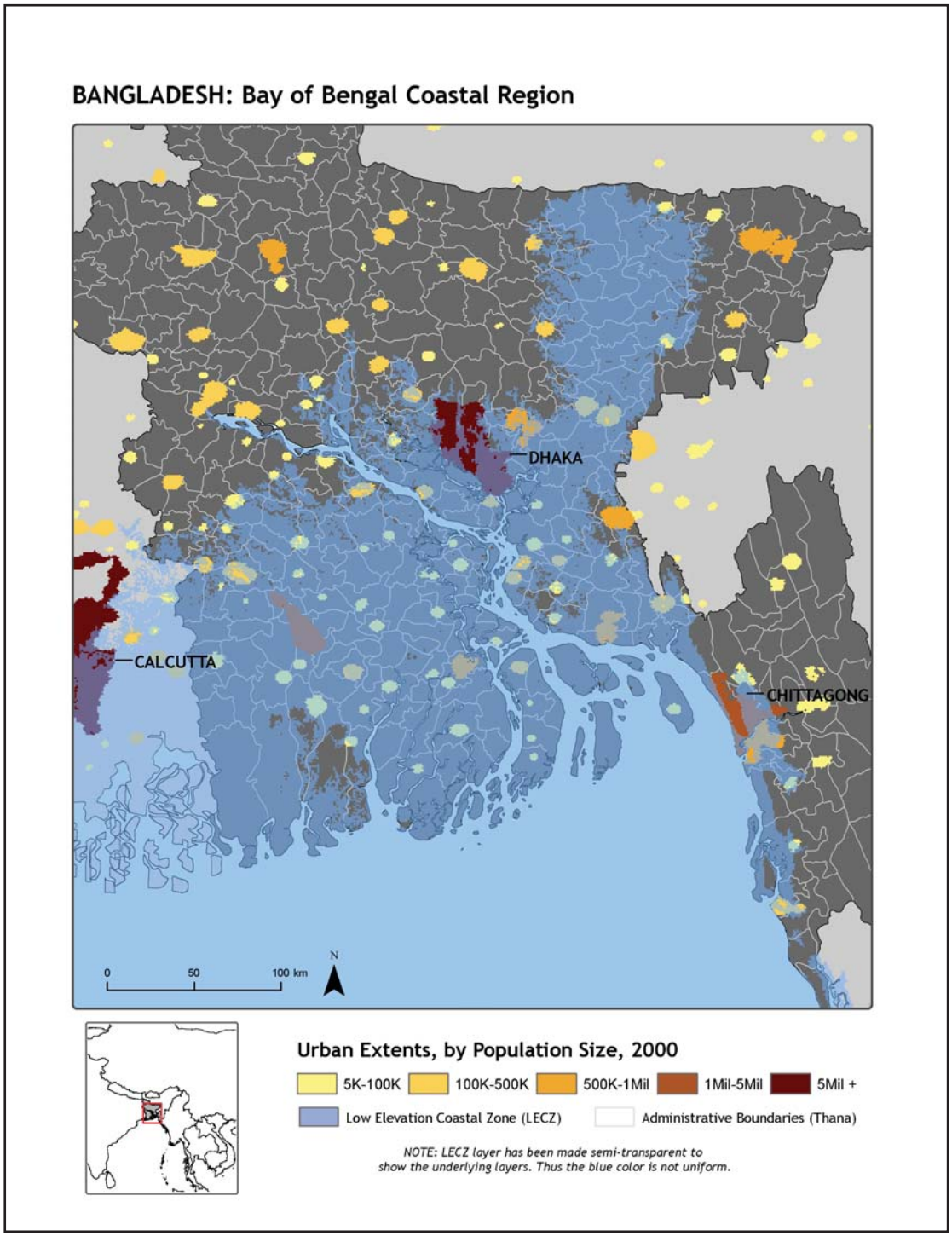

Figure 3: Map of Bangladesh identifying low elevation coastal zone and urban extents

movements towards the coastal zone are evident. For example, the country's total population growth rate is 1.2 percent, while the growth rate in its LECZ is 2.1 percent and growth in the urban population living within that LECZ is 2.8 percent.

Looking to the future, the responses to the growing risks in coastal settlements brought on by climate change will need to include each of the three Ms—mitigation, migration and modification—all of which have a long lead-time. It is low-income groups, who often settle along the flood plains, who are most at risk, at the same time, it is these same groups who are most at risk from hastily constructed government policies. This points to the need for timely action—starting now.

This study integrated recently-developed spatial databases of finely resolved global population distribution, urban extents, and elevation data to produce country-level estimates of urban land area and population in LECZs (low elevation coastal zones). By overlaying geographic data layers, the population and land area within the LECZ were calculated and summarized by country, region, and economic grouping. Shuttle Radar Topography Mission (SRTM) data was used to delineate a low elevation coastal zone including land area contiguous with the coast up to 10 meters in elevation. Urban extents were taken from Columbia University's Center for International Earth Science Information Network's Global Rural Urban Mapping Project (GRUMP). These urban extents were primarily delineated using NOAA's night-time lights satellite data (city lights 1994-95) verified with additional settlement information, and represent urban agglomerations including surrounding suburban areas. Population and land area were also taken from GRUMP, which provides these data as gridded surfaces globally based on geo-referenced census data with population allocated between urban and rural areas as delineated by the urban extents. All data are expressed at 1 km resolution. Figure 3 illustrates for the Bay of Bengal region of Bangladesh the data layers with which the calculations were made.

For access to the data and related publications, see: http://sedac.ciesin.org/gpw/lecz.jsp

This summarizes material presented in McGranahan, G., D. Balk, and B. Anderson (2007), "The Rising Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones," *Environment and Urbanization*, Vol. 19, No. 1, pp. 17-37. This summary has also appeared in "The Edge" (Autumn, 2007), a publication of CoastNet (http://www.coastnet.org.uk/).

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