



## EDITORIAL

### How Many People Live in Coastal Areas?<sup>1</sup>

How many times have we read an academic paper, report, or book on some aspect of coastal hazards where somewhere within the first few paragraphs or pages it states that approximately 53% (or more) of the U.S. population lives within coastal counties, the coastal zone, or in coastal regions? Some of these publications focus on coastal water quality or other environmental issues; others center on geomorphological issues, such as sea-level rise, coastal erosion, or the potential impacts of hurricanes and nor'easters on the coastal population. Examples include:

- A paper in the *Journal of Coastal Research*, titled "A perspective on the Louisiana wetland loss and coastal erosion problem" (WILLIAMS, STONE, and BURRUSS, 1997 p. 593), where the authors note that "Coastal regions, including the Great Lakes, are now home to more than 138 million people (53 percent of the U.S. population. . .)."
- A workshop proceedings paper, "The coastal population explosion" (HINRICHSSEN, 1999 p. 28), which states that "In the United States, 55–60% of Americans now live in 772 counties adjacent to the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes." In the same workshop proceedings, a second paper entitled "Assessing the economic benefits of America's coastal regions" (MARLOWE, 1999 p. 77) notes that "In 1990, over 133 million Americans lived in the 673 counties along the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes."
- An academic paper titled, "Sea-level rise and shoreline retreat: Time to abandon the Bruun Rule" (COOPER and PILKEY, 2004 p. 158), citing HINRICHSSEN (1998), notes that "55–60% of the population live in the 772 coastal counties of the Atlantic and Pacific coastlines" (note that although this paper focuses on sea-level rise, Hinrichsen's population numbers actually include the Great Lakes).
- A report titled, "Sea level rise and global climate change" (NEUMANN *et al.*, 2000 p. 1) prepared for the Pew Center on Global Climate Change, states that "The land area of coastal counties. . . [accounted] for 53 percent of the U.S. population. . . in 1997."

The oft-cited "More than 53% of the U.S. population lives in the coastal zone" usually comes from one of two reports available online from the National Oceanic and Atmospheric Administration (NOAA): "Population: distribution, density

and growth," by THOMAS J. CULLITON (1998)<sup>2</sup> or "Population trends along the coastal United States: 1980–2008," by CROSSETT *et al.* (2004). Both reports paint a national picture of the burgeoning coastal population and examine trends in growth, population distribution, and other aspects of our crowding shorelines. CULLITON (1998) and CROSSETT *et al.* (2004) both note that there are 673 coastal counties in the United States, including 285 on the Atlantic, 142 on the Gulf of Mexico, 88 on the Pacific, and 158 surrounding the Great Lakes region. Given the frequent citations of the Culliton and Crossett *et al.* coastal population statistics in the scientific literature (the Hinrichsen papers appear to be cited less frequently), it is worthwhile to take a deeper look at what constitutes a "coastal county" as used by Culliton<sup>3</sup> and determine whether this usage is appropriate for certain types of coastal demographic analyses.

The term "coastal county" is defined in CULLITON (1998) as (1) a county with at least 15% of its total land area located within the nation's coastal watershed; or (2) a county with a portion of its land that accounts for at least 15% of a coastal catalogue unit.<sup>4</sup> Figure 1 displays a map of the United States showing "coastal counties" as defined by CULLITON (1998). Note that under Culliton's definition, San Bernardino County, California, a completely landlocked county of 1.7 million with a population center located about 50 miles (80 km) from the ocean, is considered a coastal county. Similarly, Sussex County, New Jersey, a county that is completely landlocked and located entirely within the highlands and piedmont of New Jersey, is also considered a coastal county. Appomattox County, Virginia, another completely landlocked county, the closest boundary for which lies more than 100 miles (161 km) from the Chesapeake Bay, is considered to be a coastal county. Further, 158 counties that lie within the Great Lakes watershed are considered coastal. In fact, 89% of Michigan's counties are considered coastal counties using the Culliton definition.

<sup>2</sup> An earlier NOAA publication authored by CULLITON *et al.* (1990), titled "50 years of population change along the nation's coasts 1960–2010" uses different, possibly inconsistent, criteria for identifying coastal counties. This publication lists 451 counties as "coastal counties" and notes that "almost one-half of our population now lives in coastal areas."

<sup>3</sup> CULLITON (1998) and CROSSETT *et al.* (2004) use the same definition of "coastal county" and appear to list the same counties. Hereinafter, "Culliton" generally refers to both CULLITON (1998) and CROSSETT *et al.* (2004).

<sup>4</sup> NOAA defines a coastal cataloging unit as "a drainage basin that falls entirely within or straddles an Estuarine Drainage Area or Coastal Drainage Area. Typically, most EDAs or CDAs are composed of several complete cataloging units (drainage basins)."

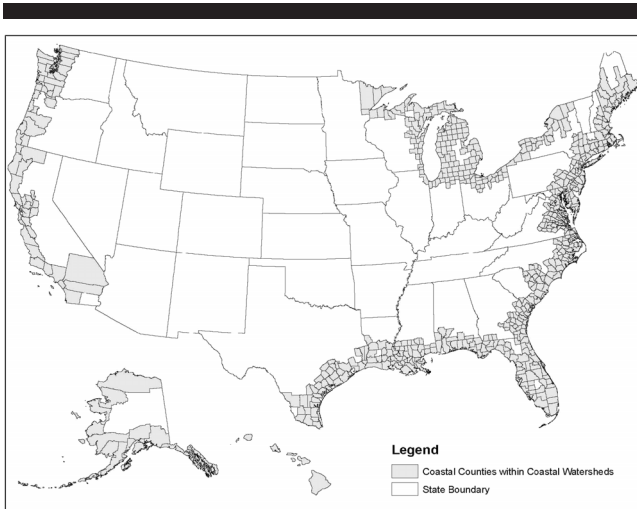


Figure 1. Coastal counties as defined by CULLITON (1998) using the watershed-based criteria.

#### WHAT HAPPENS WHEN OTHER CRITERIA ARE USED TO DEFINE “COASTAL COUNTY”?

The Federal Emergency Management Agency (FEMA) has recently compiled U.S. census population, housing, and other demographic data in order to provide guidance on mapping and funding priorities for revising and modernizing FEMA’s Flood Insurance Rate Maps. As an exercise, the authors used more restrictive criteria to define “coastal county” and conducted geographic information system (GIS) analyses using 2000 census data. “Coastal county” was defined in this exercise using criteria similar to that employed by FEMA in the late 1980s for use in sea-level rise and, in particular, coastal erosion studies. That is, a “coastal county” was defined as any county that (1) has a coastline bordering the open ocean or Great Lakes coasts (or associated sheltered water bodies), or (2) contains velocity zones, or “V zones.” V zones are a special type of flood zone that are defined by FEMA and the National Flood Insurance Program as having a one-percent annual chance of (100 y) flood caused by coastal storms and impacted by wave action (CROWELL, HIRSCH, and HAYES, 2007). “Coastal counties” defined by tidal-influenced waters were considered but not used in this exercise.

For this exercise, coastlines were delineated based on census block groups. Using a GIS, census block group polygons were converted to polylines and cleaned up so that only the polylines that touched open water or inlets were delineated as coastlines. We estimate that the U.S. ocean coastlines (including the Great Lakes) delineated by census block groups are approximately 65,000 miles (105,000 km) in length. This estimate includes coastlines associated with bays, inlets, deltas, mangrove islands, and the back sides of barrier islands. Because of the simplification of census block group boundaries (as compared to the natural morphology of the land-sea margin), the derived coastline for many inlets, bays, and estuaries is truncated a certain distance inland where census



Figure 2. Coastal counties defined as any county that (1) has a coastline bordering the open ocean or Great Lakes coasts (or associated sheltered water bodies), or (2) contains velocity zones, or “V zones.”

block groups join together across open-water areas. As such, these mileage estimates are smaller than estimates that could be obtained from other sources, such as navigation charts. However, since this coastline corresponds directly to census block group units, it provides a good spatial delineation for analyzing census demographic data.

Based on these criteria, 281 counties can be considered to be “coastal counties.” When the counties bordering the Great Lakes are included in the data set, 364 counties can be considered “coastal counties” (Figure 2). Population numbers based on 2000 census data are as follows: coastal population excluding the Great Lakes counties is 85,640,000, or 30% of the total U.S. population; coastal population including the Great Lakes is 104,990,000, or 37% of the total U.S. population.

These population numbers, while based on a “coastal county” definition less inclusive than that used by Culliton, are still substantial. However, the fraction of the U.S. population estimated to live in coastal counties drops from about one-half to about one-third.

The coastal statistics discussed up to this point are associated with coastal county land units. We also compiled data for the approximately 209,000 census block groups in the nation (excluding block groups associated with U.S. Territories and those composed of water areas without any population). The use of the smaller census block group unit, compared to the larger coastal county designation, is intended to provide alternate statistics associated with flood hazards in the coastal zone. Similar to the “coastal county” definition, in this exercise “coastal census block groups” are defined as any census block group that has a coastline bordering the open ocean or Great Lakes coast (or associated sheltered water bodies) or that contains V zones. Given this definition, preliminary results of a nationwide GIS analysis indicate that there are 9,790,000 people living in coastal census block groups. This is ~9% of the estimated 104,990,000 people living in coastal

counties (using the open ocean coast and V zone definition) and 3% of the total U.S. population. Finally, coastal statistics were also compiled within FEMA's designated V zones, which provide yet a smaller spatial scale of assessment. V zones are typically smaller spatial units located entirely within coastal census block groups. Note that V zone areas are generally not mapped in the Great Lakes and in some other coastal areas. Preliminary estimates indicate that less than one million people live within FEMA's coastal V zones.

## DISCUSSION

“Coastal county” or “coastal zone” are terms that can represent a wide range of coastal areas depending on the processes and spatial criteria used to define the terms. On the one hand, the watershed-based, coastal county definition represents an extreme broad swath; on the other hand, the open ocean coast and V zone census block group definition represents a minimal swath. In between, there is a gray zone in which other defining criteria can present different pictures of what constitutes a coastal county or coastal zone (with associated coastal demographics). So what defining criteria should be used to describe coastal counties or coastal zones? Obviously, that depends on the natural or manmade processes being investigated. Besides the watershed-based criterion, tidal-, coastal storm-, and elevation-based criteria are three others that readily come to mind. (In fact FEMA, besides using the open ocean coast and V zone criteria for past coastal erosion studies, also uses tidal-based criteria for identifying coastal communities in the National Flood Insurance Program (NFIP) Community Information System database.)

Nonetheless, it is clear that the use of Culliton's watershed-based definition of “coastal county,” which emphasizes land areas within which water flows into the ocean or Great Lakes, is in fact appropriate to use in situations where coastal ecosystems or water quality is of major concern (particularly where jurisdictional matters are being considered), for example, papers or research concerned with the environmental health of our coastal waters. It is equally obvious that studies concerned with the impacts of hurricanes, nor'easters, coastal erosion, and especially sea-level rise, require a different spatial definition for what constitutes a coastal county. In particular, as far as sea-level rise is concerned, Great Lakes water levels are not directly impacted by rising sea levels, and, certainly, population data from these counties should not be emphasized in reports focusing on the impact of sea-level rise.

## FUTURE INVESTIGATIONS

The use of velocity zones provides a low-end initial estimate of the population impacted by coastal storms and flooding; however, FEMA also identifies and maps land areas where coastal flooding can occur but that do not have the wave action and/or high-velocity water associated with velocity zones. These zones, known as A zones, are also used to designate riverine flood hazards; however, current NFIP regulations do not distinguish between coastal and riverine A zones. There is therefore a need to identify A zones associated with coastal flooding, rather than riverine flooding, and in-

clude these areas in spatial analyses to provide better estimates of the population at risk from coastal flooding. We intend to refine this approach over the next year to account for these additional hazard areas.

## SUMMARY AND CONCLUSIONS

Our preliminary analyses of coastal population distributions at the county level yielded the following conclusions:

- Coastal population statistics derived from a specifically defined coastal-based spatial unit are not necessarily applicable to all categories of coastal hazards or other coastal concerns.
- Papers and reports that reference coastal population statistics need to clearly state how the coastal spatial unit (*e.g.*, coastal county, coastal zone, *etc.*) was defined.
- Papers that focus on the impacts of sea-level rise on coastal populations should not in any way base their conclusions on the coastal population statistics contained in CULLITON (1998), CROSSETT *et al.* (2004), or HINRICHSSEN (1998), unless there is further parsing of the data (in particular, removal of the Great Lakes coastal population data from the aggregate population numbers), or a clarifying discussion.
- Smaller coastal units, such as census block groups, and specific definitions of what makes a unit “coastal,” lead to more refined estimates of populations at risk from various coastal processes.
- When “coastal county” is defined as any county that has a coastline bordering the open ocean or associated sheltered water bodies, or a county that contains V zones, then 281 counties can be considered to be “coastal counties.” When the counties bordering the Great Lakes are included in the data set, 364 counties can be considered to be “coastal counties” under this definition. Population numbers are as follows: coastal population excluding the Great Lakes counties is 85,640,000, or 30% of the total U.S. population; coastal population including the Great Lakes is 104,990,000, or 37% of the total U.S. population.

Finally, it is important to emphasize that it is not our intent to minimize the potential threat of coastal-related hazards on the coastal population. A significant portion of the population does indeed live in coastal areas where the threat from hurricanes, coastal storms, sea-level rise, erosion, tsunamis, *etc.*, is ever present. It is also not our intent to denigrate the Culliton data set. Coastal watershed-based criteria certainly have a place in defining coastal zones or counties, particularly in situations where coastal ecosystems are concerned. Our purpose is to point out that most published data on coastal demographics are limited and represent the upper bounds of a wide range of possible coastal population statistics. Perhaps because of this limitation, numerous published papers and reports on a variety of coastal matters inappropriately reference the CULLITON (1998), CROSSETT *et al.* (2004), and HINRICHSSEN (1998) coastal population data.

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Mark Crowell  
Federal Emergency Management Agency  
500 C Street, S.W.  
Washington, DC 20472  
U.S.A.

Scott Edelman  
Watershed Concepts  
4905 Koger Blvd., Alamance Building, Suite 270  
Greensboro, NC 27407  
U.S.A.

Kevin Coulton  
Watershed Concepts  
5933 NE Win Sivers Dr., Suite 201  
Portland, OR 97220  
U.S.A.

Scott McAfee  
Federal Emergency Management Agency  
500 C Street, S.W.  
Washington, DC 20472  
U.S.A.