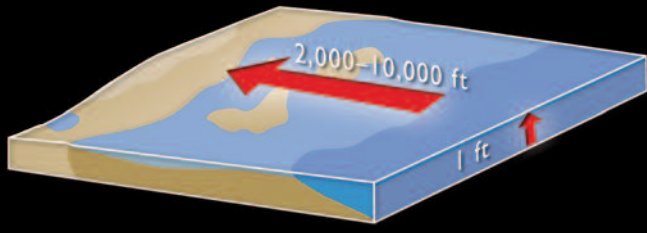
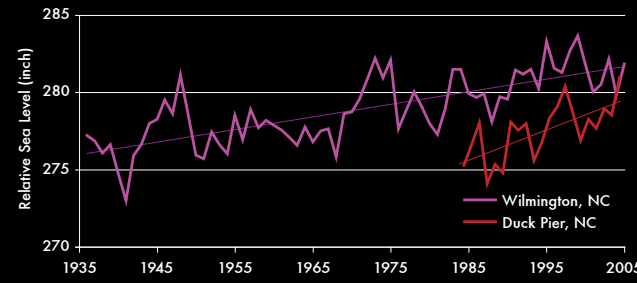


Sea-level Rise and Coastal Inundation

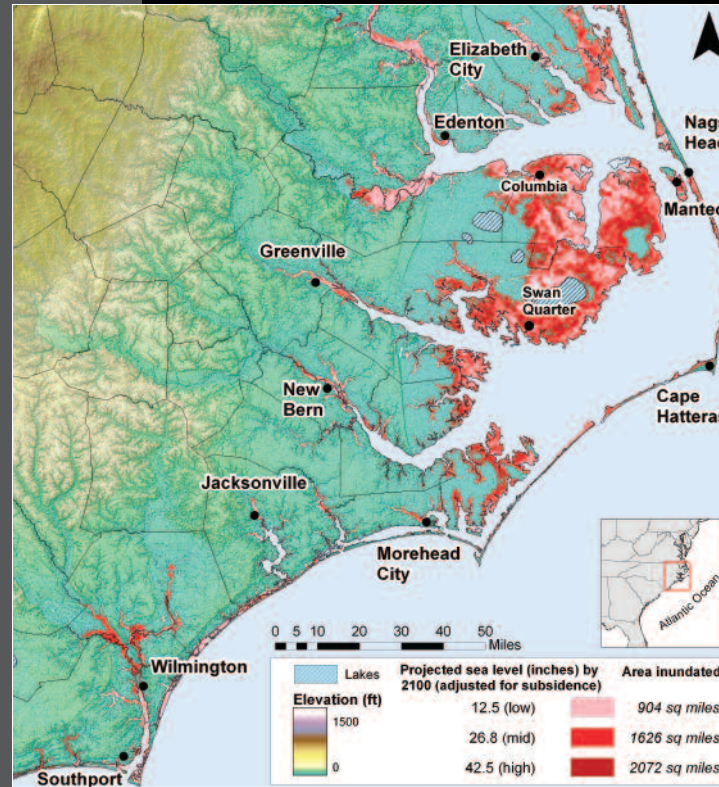


A one-foot rise in sea level can cause the inland movement of the shoreline by 2,000 to 10,000 feet when the land is as flat as the North Carolina coast.

Observed Rates of Sea-level Rise along the North Carolina Coast



Land in Red is at Risk of Loss Due to Sea-level Rise by 2100



The sea-level rise projections for this area range from about one to three feet within this century, with additional increases later.

The North Carolina coast is particularly vulnerable to sea-level rise for several reasons: the land has very little slope, meaning that even small increases in sea level result in a wide expanse of coastal land being inundated and lost. In addition, while sea level is rising globally due to warming, the coastal land in this area is slowly sinking due to tectonic forces, so the relative sea-level rise is larger here than in places where the coastline is stable or rising. Thus the current rate of sea-level rise in this area is about twice the global average.

Global warming causes sea level to rise for several reasons. First, as water warms it expands, taking up more space. Second, as mountain glaciers around the world melt, this water flows to the oceans. And third, the two large polar ice sheets on Greenland and Antarctica are now melting, although how much and how fast they will melt is not well known. Thus current projections of future sea-level rise don't fully account for changes in the large ice sheets, and future sea-level rise could be greater than the assumptions used in this study.

Sea-level Rise

Impacts of Global Warming on North Carolina's Coastal Economy

This study was conducted by:

Okmyung Bin, Department of Economics, East Carolina University, Greenville, NC

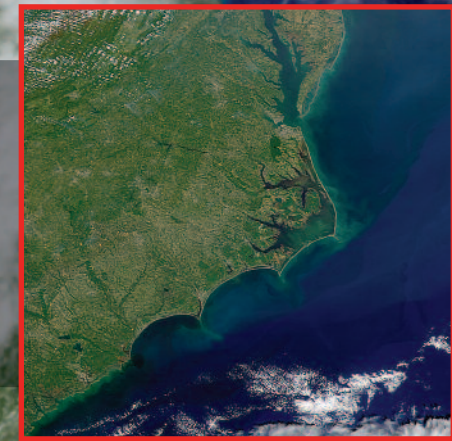
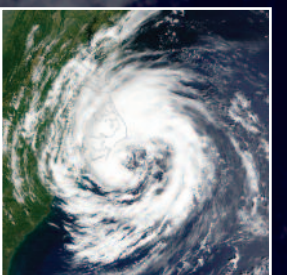
Chris Dumas, Department of Economics and Finance, University of North Carolina at Wilmington

Ben Poulter, Duke University, Nicholas School of the Environment and Department of Global Change and Natural Systems, Potsdam Institute for Climate Impact Research, Germany

John Whitehead, Department of Economics, Appalachian State University, Boone, NC

For further information about the research, contact **John Whitehead** <whiteheadjc@appstate.edu> or **Ben Poulter** <ben.poulter@pik-potsdam.de>

This research was supported by a grant from the National Commission on Energy Policy.



Key Findings

Global warming is projected to have significant impacts on North Carolina coastal resources as sea level rises and hurricanes become more intense. Extensive development in the coastal zone in recent decades has put more people and property at risk for these impacts.

In this context, a scientific study was undertaken by researchers at four North Carolina universities to consider three important aspects of the coastal economy and their vulnerability to a changing climate: the impacts of sea-level rise on the coastal real estate market, the impacts of sea-level rise on coastal recreation and tourism, and the impacts of stronger tropical storms and hurricanes on business activity.

The study used a range of moderate assumptions, not best- or worst-case scenarios. Its focus was only the specific economic impacts mentioned above, and as such, it does not attempt to provide a comprehensive analysis of all potential impacts, such as the possible loss of species or the natural ecosystems in which they live. This brief summary brochure is designed to present the main findings of the study in plain language for the benefit of the public and policy makers. The full technical report can be obtained at: <http://econ.appstate.edu/climate/>

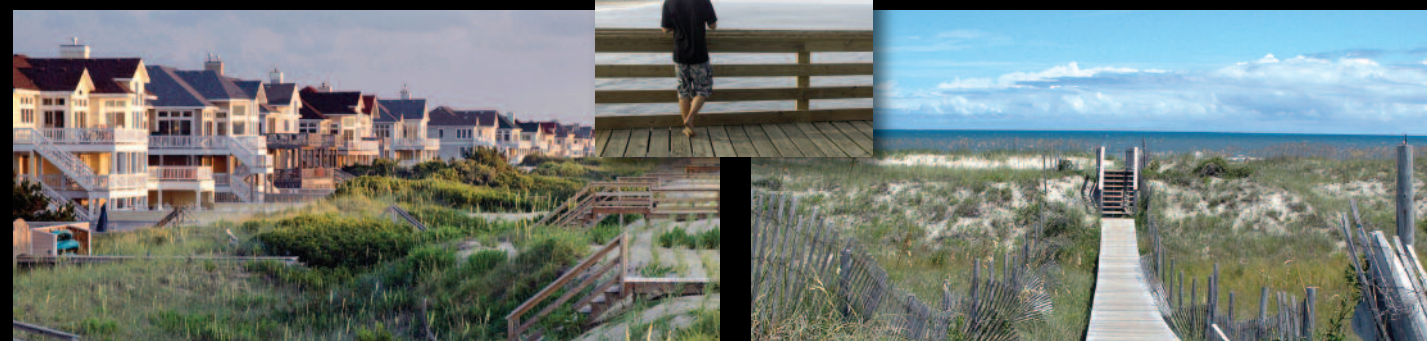
Global warming will result in

Sea-level rise

- Billions in lost property values
- Large losses in recreational benefits
- Complete loss of many beaches

Hurricane intensity increases

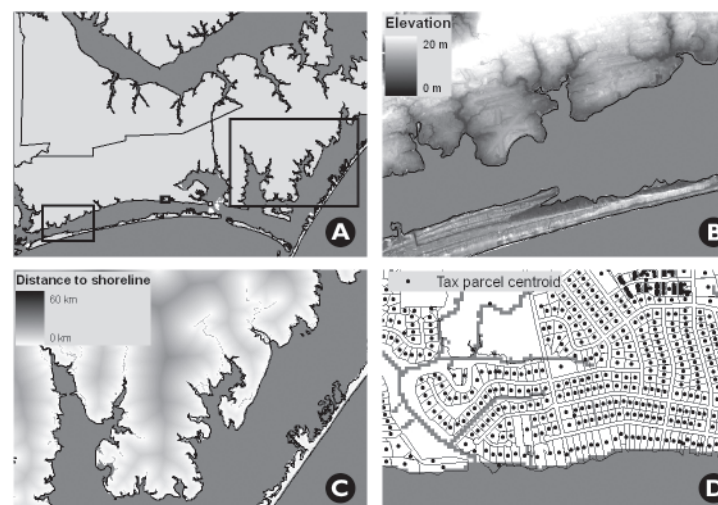
- Losses due to business interruptions
- Increasing agricultural losses
- Greater damage to forests
- Increasing commercial fishing losses



Property Losses

- The value of property at risk to sea-level rise in just four counties over the next 75 years is \$6.9 billion.
- Projected losses in residential property values vary by county, with the northern counties comparatively more vulnerable than the southern. The property at risk in Dare County ranges from 2% to 12% of the total property value.

Property Value Data for Carteret County



Carteret County (a), lidar elevation surface (b), distance to shoreline (c), and tax parcel centroids (d).

New Hanover, Dare, Carteret, and Bertie Counties were chosen for this analysis because they represent a cross-section of the NC coast geographically and in terms of development. Three of these are also the three most populous counties on the NC coast.

Recreation and Tourism

- The lost recreation value of climate change-induced sea-level rise to local beachgoers is projected to be \$93 million a year by 2030 and \$223 million a year by 2080 for the southern North Carolina beaches.
- Spending by non-local North Carolina residents on beach trips would fall significantly with warming-induced sea-level rise, dropping by 16% per year by 2030 and by 48% per year by 2080.
- Reduced opportunities for beach trips and fishing trips are projected to result in lost recreational benefits totaling \$3.9 billion for the southern North Carolina beaches over the next 75 years.

Only the southern NC counties of Brunswick, New Hanover, Pender, Onslow, and Carteret were considered in the beach recreation analysis, due to data limitations.

Projected Changes in Beach Width for the Southern NC Beaches

By 2080, 14 of the 17 recreational swimming beaches in southern NC are projected to have eroded all the way to the road, making beach recreation no longer possible.

Beach	Average width (in feet) in each year		
	2004	2030	2080
Fort Macon	90	40	0
Atlantic Beach	135	85	0
Pine Knoll Shores	110	60	0
Indian Beach/Salter Path	90	40	0
Emerald Isle	130	80	0
North Topsail Beach	82	32	0
Surf City	90	40	0
Topsail Beach	110	60	0
Wrightsville Beach	160	110	3
Carolina Beach	185	135	28
Kure Beach	130	80	0
Fort Fisher	400	350	243
Caswell Beach	80	30	0
Oak Island	120	70	0
Holden Beach	90	40	0
Ocean Isle Beach	85	35	0
Sunset Beach	115	65	0

Business, Agriculture, and Forests

- Increased hurricane intensity will interrupt businesses, reducing economic output to varying degrees, depending on location and the severity of warming. Business interruption losses in just four NC counties due to increases in category 3 hurricane severity (excluding increases in all other categories) are projected to rise by \$34 million per storm in 2030, and by \$157 million per storm in 2080. Assuming no increase in hurricane frequency, the projected cumulative losses from 2004 to 2080 due to increased category 3 severity in these four counties amount to \$1.44 billion.
- Increasing storm intensity is expected to have serious impacts on agriculture. A category 1 hurricane now causes about \$50 million in agricultural damage, a category 2, about \$200 million, and a category 3, about \$800 million, illustrating how significant an increase in hurricane intensity would be for this sector.
- Increased forest damage associated with an increase in storm severity from category 2 to category 3 is about 150% per storm event, or about \$900 million more in damages.

The four counties (New Hanover, Dare, Carteret, and Bertie Counties) selected for the hurricane intensity analysis represent a range of geographic location and urbanization intensity. Changes among low-intensity hurricane categories were identified as the most likely impacts of climate change on storm intensity. Although low-intensity storms cause less physical damage than do high-intensity storms, low-intensity storms occur with much greater frequency, especially in North Carolina; thus, their cumulative economic impacts can be very large.

Impacts of Increased Storm Severity on NC Timber Damage (2004 dollars)

Hurricane Category	NC Statewide Forest Acres Damaged	NC Statewide Timber Damage Losses
2	0.8 million acres	\$0.6 billion
3	8.3 million acres	\$1.5 billion

Impacts of Increased Storm Severity on Agricultural Damages Per Hurricane, 1996–2006

Storm Category	NC Statewide Totals (2004 dollars)
Tropical Storm	\$53,695,368
Category 1	\$32,878,317
Category 2	\$208,558,508
Category 3	\$837,822,329

As hurricanes increase in intensity, average damages rise.

