Global Warming and Sea-Level Rise

Human activities, such as the combustion of fossil fuels, have caused a substantial increase in atmospheric greenhouse gases since the Industrial Revolution. The Intergovernmental Panel on Climate Change estimates that greenhouse gas emissions could increase globally averaged surface air temperatures by 1.4 to 5.8°C by 2100.

Warmer temperatures cause thermal expansion in the oceans and encourage glacial melt. The United States Global Change Research Program projects an increase in sea level of about 48 cm over the next century. Because subsidence in the Mid-Atlantic Region exacerbates sea-level rise, a 60-cm sea-level rise scenario was chosen for this analysis.

Hampton Roads, Virginia

The Hampton Roads metropolitan region consists of ten cities and six counties, and is just over 7500 km². It is the second largest port in the East Coast of the United States. Hampton Roads is home to 1.5 million people and the largest naval base in the world.

The city of Chesapeake is used below in an illustrative example of the analysis.

Hurricane Isabel

The aftermath of storm surge flooding, September 2003

Vulnerability to storm-surge flooding has been determined using the SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model from the National Hurricane Center. The SLOSH model shows maximum surge heights for each hurricane category after a series of model runs. The at-risk area can be mapped by calculating where surge heights are higher than elevation.

Flood-risk scores range from 1 (low risk) to 6 (at risk from all hurricanes). Overall vulnerability to storm-surge flooding can be depicted by multiplying flood-risk scores by social vulnerability scores. Overall vulnerability increases under the 60-cm sea-level rise scenario.

Determining Risk to Critical Facilities

Some facilities—such as hospitals, schools, police departments, and utility companies—provide services that are crucial to the health and safety of a population as well as to the daily functioning of a community. Exposure of critical facilities to storm-surge flood risk will be calculated at present and after sea-level rise.

Addressing Uncertainty

Sea-level rise in the Mid-Atlantic Region over the next century may be more or less than 60 cm. The analysis has also been completed using 30-cm and 90-cm sea-level rise scenarios.

Also, the level and distribution of development will not remain static in Hampton Roads over the next century. Various population growth and population distribution scenarios will be devised for the region. High-risk scenarios will assume that most growth will occur in high flood-risk areas, and vice versa. The population growth and distribution scenarios will be combined to produce three future-impact scenarios; future population estimates will be given for each scenario and flood-risk zone.

Further Research

This project is funded by the Consortium for Atlantic Regional Assessment. Support for CARA is provided by the Global Change Research Program, Office of Research and Development, U.S. Environmental Protection Agency (Cooperative Agreement R-835333-01).