The *Grand Challenges for Disaster Reduction* outlines a ten-year strategy crafted by the National Science and Technology Council's Subcommittee on Disaster Reduction (SDR). It sets forth six Grand Challenges that, when addressed, will enhance community resilience to disasters and thus create a more disaster-resilient Nation. These Grand Challenges require sustained Federal investment as well as collaborations with state and local governments, professional societies and trade associations, the private sector, academia, and the international community to successfully transfer disaster reduction science and technology into common use.

To meet these Challenges, the SDR has identified priority science and technology interagency implementation actions by hazard that build upon ongoing efforts. Addressing these implementation actions will improve America's capacity to prevent and recover from disasters, thus fulfilling our Nation's commitment to reducing the impacts of all hazards and enhancing the safety and economic well-being of every individual and community. This is the coastal inundation-specific implementation plan. See also **sdr.gov** for other hazard-specific implementation plans.

What is at Stake?

DEFINITION AND BACKGROUND. Coastal inundation is the flooding of coastal lands, including wave action, usually resulting from riverine flooding, spring tides, severe storms, or seismic activity (tsunami). With over 50 percent of the United States population living in the coastal zone[1] and as the source of more than half of the nation's economic productivity,[2] the impacts of coastal inundation can be severe. Long-term vulnerability and future impacts are exacerbated by sea-level variability and land subsidence as well as long- and short-term climate change affecting wave heights and coastal and riverine water levels. As a result of Hurricanes Katrina and Rita in 2005, coastal inundation throughout Louisiana, Mississippi, and Alabama left millions without power and tens of thousands in temporary housing,[3] and severely impacted critical coastal and riverine ecosystems. In addition, our nation's energy supply, ability to ship goods, and overall commerce were significantly affected.

IMPACTS. Coastal inundation is a major cause of natural disaster deaths in the United States. The largest natural disaster death toll from a single event was the Galveston hurricane in 1900 wherein at least 6,000 people died, the vast majority as a result of the surge associated with the storm.[4] One need only look at the devastation from Hurricane Katrina in 2005 including levee failures and subsequent flooding to see how much coastal inundation can impact a population.

Tsunami inundation has also impacted the United States and the Caribbean, causing more than 3,000 fatalities over the past 150 years. Inundation can also permanently alter or damage coastal and riverine ecosystems, which provide an important buffer for communities and significant habitat for migratory birds, and are critical for sustaining fisheries.

Insurance losses related to coastal inundation can be catastrophic as well. Repetitive flood loss, of which coastal inundation is a significant part, is the largest expense for public

COASTAL INUNDATION

A report of the Subcommittee on Disaster Reduction
www.sdr.gov

An element of the National Science and Technology Council

insurance claims.[5] National Flood Insurance Program claims are expected to top $22 billion from Hurricane Katrina alone, $7 billion more than all combined claims in the 30-year history of the program.[6] In Louisiana, an estimated 118 square miles of critical wetlands were lost due to Hurricane Katrina,[7] and the revenue losses from forestry, wildlife, fisheries, and other natural resource benefits have been estimated at over $1 billion.[8]

Grand Challenges for Disaster Reduction: Priority Interagency Coastal Inundation Implementation Actions

GRAND CHALLENGE #1: Provide hazard and disaster information where and when it is needed.

- ■ Ensure the operability of *in situ* tide and water-quality monitoring stations so that real-time flooding information is available to decision makers throughout the storm;
- ■ Inventory existing observations and models, improve critical observational and information delivery components, and develop observation-based decision-support systems;
- ■ Inventory existing or planned wave-hindcast models, sea-level models, and storm-surge and inundation models and assess their strengths and weaknesses, required developmental and operational data inputs and costs, and enhance linkages with climate model projections;
- ■ Seek interagency agreements on developing and sharing data and information to support the generation of high-resolution coastal Digital Elevation Models (DEMs);
- ■ Build critical framework databases, including but not limited to, high-resolution coastal topographic, shallow bathymetric, and water level data;
- ➤ Develop, maintain, and enhance robust and open data archives and retrieval systems;
- ➤ Establish and maintain a national geographic information database of inundation hazard, vulnerability, and risk;
- ➤ Develop sophisticated, flexible, and adaptable decision-support tools so existing and new data and products can be effectively incorporated and utilized;
- ➤ Further develop probabilistic inundation hazards prediction and methods to effectively quantify and communicate risk.

GRAND CHALLENGE #2: Understand the natural processes that produce hazards.

- ■ Establish common interfaces, standards, and goals for inundation modeling;
- ■ Evaluate capabilities of High Frequency Radar (HFR)/Synthetic Aperture Radar (SAR) for swell/wave and deformation measurements;
- ■ Select output from climate model simulations that can be used to generate future scenarios of climate for input into inundation models;
- ■ Develop coastal wind/wave climate maps and shoreline process models to better understand and predict the seasonal and long-term aspects of coastal erosion and inundation in populated coastal environments;
- ■ Assess the impacts of climate change on coastal inundation, especially in relation to wave heights, riverine and coastal water levels, and storm surge;
- ➤ Observe and assess interactions of coastal inundation with critical coastal and riverine resources and ecosystems;
- ➤ Conduct atmospheric re-analysis for input to wave-model, sea level, and storm surge and inundation models;
- ◆ Use high-resolution coastal topographic and shallow bathymetric databases to establish and

Key: ■ Short Term Action (1-2 years) ➤ Medium Term Action (2-5 years) ◆ Long Term Effort (5+ years)

maintain a national coastal DEM, which will improve inundation models. Incorporate the vertical datum transformation software tool to more effectively characterize relative elevation and vulnerability;

- ◆ Determine the climate scale factors at the global, regional, and local levels that relate to sea level variability and rise;
- ◆ Continuously improve inundation source modeling technology and data sources.

GRAND CHALLENGE #3: Develop hazard mitigation strategies and technologies.

- ■ Develop an understanding of the social, cultural, and economic factors that promote or inhibit adoption and enforcement of promising mitigation strategies or technologies;
- ■ Develop outreach and training programs to enhance state and local government capacity to adopt improved mitigation strategies and policies;
- ➤ Develop strategies for mitigating negative impacts on coastal zone ecosystems;
- ➤ Develop improved and more accessible mitigation strategy models (e.g., HURREVAC computer software, risk and vulnerability tools, improved DEMs and maps) and other technical assistance to state and local governments that are adopting new mitigation strategies and policies;
- ➤ Develop a coastal inundation GIS system using information on historical and projected probabilities of various categories of sea level incursion to help identify socio-economic impacts of vulnerable regions/areas/populations.

GRAND CHALLENGE #4: Reduce the vulnerability of infrastructure.

- ■ Model the impacts of events affecting the infrastructure, including the effects of seismic activity, waves, and coastal change (i.e., erosion, inlet formation);
- ■ Examine the interaction between wind and inundation to determine the impact on building foundations and critical infrastructure;
- ➤ Focus research on new mitigation technologies for purpose of avoidance, resistance, rapid repair and restoration of critical infrastructure and other essential facilities;
- ➤ Model the impacts of changes in coastal zone ecosystems on infrastructure vulnerability;

- ◆ Provide the technical basis for revised codes and standards for critical infrastructure and essential facilities by using risk and vulnerability assessment tools.

GRAND CHALLENGE #5: Assess disaster resilience.

- ■ Develop an interagency program for provision of coastal high-resolution maps, including elevation, land use and land cover, to improve coastal assessments;
- ■ Facilitate coordinated, inter-agency post-event assessment of infrastructure and ecosystem damages, injuries, and deaths for all coastal hazards;
- ■ Assess and improve every community's ability to respond to coastal inundation, including assessing vulnerability, evacuation capability, and public knowledge of appropriate preventative actions;
- ➤ Develop and distribute community assessment tools.

GRAND CHALLENGE #6: Promote risk-wise behavior.

- ➤ Strengthen the capacity of local communities, states, and regional associations to reduce vulnerability to prepare for and manage coastal inundation and wave action risks by identifying and implementing actionable strategies that incorporate scientific and technological advances to inform practices that enhance community resilience to coastal hazards;
- ➤ Facilitate expanded networks of communication and education to produce "hazards literacy;"
- ➤ Develop timely and focused data, information, and GIS decision-support tools to provide information to individuals as well as outreach training efforts on understanding and using the information.

Key: ■ Short Term Action (1-2 years) ➤ Medium Term Action (2-5 years) ◆ Long Term Effort (5+ years)

Expected Benefits: Creating a More Disaster-Resilient America

Fulfilling this coastal inundation-specific implementation plan will create a more disaster-resilient America. Specifically:

Relevant hazards are recognized and understood. Improved and more readily available outreach and education programs disseminated through diverse media in partnership with local and state governments will enable users to fully capitalize on existing and newly developed inundation products and information. Better understanding of coastal inundation processes combined with outreach to individuals and government decision makers will enhance their understanding of the risks of coastal inundation and the benefits of strategies to mitigate impacts and improve resilience.

Communities at risk know when a hazard event is imminent. Through improved observation technologies and new and improved modeling capabilities, forecasters will have the necessary information to improve warning accuracy and lead time. An integrated "all-hazards" approach improves the effectiveness of warnings, modeling, communication, planning, and building techniques by integrating the many aspects that contribute to coastal inundation.

Individuals at risk are safe from hazards. Through improved observations, modeling, and decision support tools, communities will have the necessary information to identify areas of the community at risk, where inundation vulnerabilities lie, and what can be done to mitigate damage and improve resilience.

Disaster-resilient communities experience minimum disruption to life and economy after a hazard event has passed. Repetitive flood loss, of which coastal inundation is a significant part, is the largest expense for public insurance claims. By having improved inundation models and decision support tools to better inform citizens and decision makers, steps can be taken to protect vulnerable areas, reduce the number of vulnerable structures being rebuilt in flood-susceptible areas, and increase infrastructure resilience to the effects of coastal inundation damage. Through improved risk and vulnerability assessment tools and appropriate planning and mitigation strategies, critical infrastructure and ecosystems at risk from coastal inundation can be identified. As a result, preparations can be made to mitigate damage to natural resources and to protect new and existing infrastructure through retrofit, effective backup mechanisms, and alternative options.

References

1. Pew Ocean Commission, Coastal Sprawl: The Effects of Urban Design on Aquatic Ecosystems in the United States; 2002
2. The Changing Ocean and Coastal Economy of the United States, NOEP; 2003
3. **http://www.washingtonpost.com/wp-dyn/content/article/2005/09/14/AR2005091402654.html; http://www.cnn.com/2005/WEATHER/09/26/rita/**
4. **http://geography.about.com/library/misc/blcenturyworst.htm**
5. **http://www.fema.gov/pdf/press/katrina_after/repetitive_loss_faqs.pdf, http://www.fema.gov/nfip/sign1000.shtm**
6. Seminar: Impact of Hurricane Katrina on Development in the Louisiana and Mississippi Coastal Zones; Mike Buckley, FEMA, 9-30-2005, Washington, DC
7. USGS Reports Latest Land-Water Changes for Southeastern Louisiana, February 2006: **http://www.lacoast.gov/latest%20hurricane%20land%20change/Land%20Water%20Changes%20for%20SE%20LA.pdf**
8. Hurricanes prove the urgency of rebuilding wetlands, WaterMarks, Number 30, March 2006: pp. 3-4. **www.lacoast.gov**