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 flood-specific implementation plan. See also **sdr.gov** for other hazard-specific implementation plans.

What is at Stake?

DEFINITION AND BACKGROUND. Floods are an overflow or inundation from a river or other body of water and causes or threatens damage. Floods occur in all regions of the United States, at all times of the year. One in three Federal disaster declarations is a result of flooding. An increase in population, more development in flood-prone areas, an increase in the frequency of heavy-rain events over the last fifty years, and impacts of wildland fire and land use changes have resulted in an increase in flood-related losses. Many of these losses are mainly caused by inundation but can also be the result of strong currents damaging structures and undermining foundations.

IMPACTS. In the last 100 years more than 9,000 people have died as result of inland flooding in the United States. In 2002 alone, 42 fatalities resulted from severe flooding, a majority of which could have been avoided if the victims had practiced risk-wise behavior.[1] Property damage from all types of flooding, from flash floods to large river floods, averages $2 billion a year.

The 1993 Mississippi Basin Flood was among the most severe disaster events in recent U.S. history, resulting in an estimated $12–$16 billion in damages.[2] More than 10,000 homes were destroyed during this event, and millions of crop acres were ruined by inundation.[3] Thousands of people had to be evacuated, and many of them were never able to return to their homes. The event also severely damaged forests and other

FLOOD

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wildlands and disrupted the local and national transportation infrastructure leaving major roads, rivers, bridges, and commercial airports out of service.

Flooding as a consequence of Hurricane Katrina caused the evacuation of New Orleans in August/September 2005 and, at this time, damages have been reported in excess of $100 billion,[4] with an estimated 1,464 deaths and 135 people still missing.[5]

Grand Challenges for Disaster Reduction: Priority Interagency Flood Implementation Actions

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

- ■ Strengthen hardware and improve placement for critical stream gages;
- ➤ Coordinate the use of existing Earth observation technologies and develop new Earth observation technologies and networks to collect more detailed flood-related data over larger areas (e.g., elevation data from LiDAR, existing soil moisture conditions, more detailed precipitation data, stream elevations from satellites, greater radar coverage in areas subject to flash flooding, and more multiparameter stream gages);
- ➤ Improve sensor network designs that couple *in situ* and Earth observations and operational capabilities to provide data needed for predicting and sensing hazards using physical process models;
- ◆ Improve instrumentation and densification of the stream gage network transmitting data in real time;
- ◆ Exploit digital elevation data to develop comprehensive mapping of inundation scenarios, referenced to the national stream gage network and river forecast points.

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

- ➤ Research the dynamic relationship between precipitation and its timing, land cover and land use, and patterns of erosion and sedimentation;
- ◆ Develop new or enhanced statistical and deterministic physical process and real-time models for rapid assessment of the likelihood of flooding for small and large basins; improve understanding of the interdependencies between floods and other hazards, such as landslides; and model the effects of climate and land use change;

- ◆ Develop improved data and models on impacts of wildland fire on flooding;
- ◆ Test and validate flood models and decision support systems with increased emphasis on exploitation of national geospatial data sets for soils, land cover, and elevation;
- ◆ Understand the impacts of climate change on flood risk by area.

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

- ■ Improve understanding of the consequences of unmitigated risk and develop strategies to foster pre-disaster mitigation;
- ➤ Evaluate the long- and short-term effects of alternate mitigation strategies, including hillslope and channel treatments;
- ➤ Conduct social science research into behavior related to risk and mitigation;
- ➤ Develop knowledge of the interdependencies necessary for cumulative impact analysis, collect the data necessary for valid cost benefit analysis of mitigation, and conduct research on the individual and community-level factors associated with local adoption of mitigation measures;
- ➤ Develop a tool kit of hydraulic, hydrologic, meteorologic, economic, and socioeconomic models for evaluation of structural and nonstructural mitigation measures and educational materials that improve communities' understanding of risk and the significance of mitigation alternatives;

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

- Develop new models and decision support systems for land use planning that relate land use change to flood risk by encouraging the use of rating systems that establish links between flood code and ordinance enforcement to serve as an incentive for flood insurance rate reduction (e.g., FEMA's Community Rating System Building Code Effectiveness Grading Schedule).

GRAND CHALLENGE #4: Reduce the vulnerability of infrastructure.

- Analyze the vulnerability of infrastructure systems to flood hazard, identify critical infrastructure vulnerable to flooding, and propose mitigation strategies;
- Conduct vulnerability analysis to reduce the risk of cascading failures and identify the potential impact of flooding on water supply and waste-water and fortify those structures and systems.

GRAND CHALLENGE #5: Assess disaster resilience.

- Develop effectiveness measures for land-use controls, zoning, insurance strategies, mitigation plan development, adoption, and enforcement for all major floodplains to create an index of resilience;
- Develop a methodology that enables assessment of resilience and conduct a comparison of actual losses to those that would have occurred using alternative mitigation strategies;
- Develop flood risk maps based upon ongoing and potential, future development of watersheds so that maps stay current and property owners understand how development does (ongoing) and can (potential) impact their vulnerability and risk;
- Facilitate immediate post-flood-event analyses to immediately capture lessons learned that can assist future recovery operations as well as provide measures to determine the most appropriate alternatives regarding the restoration, modification, or removal of impacted facilities;
- Continue oversight of the effects of land use change on flood and drought;
- Improve methodologies to analyze the effects of development alternatives.

GRAND CHALLENGE #6: Promote risk-wise behavior.

- Identify and develop effective methods to educate individuals and decision makers about flood threats so they can make more informed decisions when purchasing land and structures;
- Develop integrated, targeted, multi-media systems for issuing warnings on flash floods, flooding due to dam or levee failure, and more slowly developing flood events;
- Develop behavioral understanding and perform other research necessary to develop effective messaging and messaging technologies to permit targeted, rapid dissemination of flood threat information;
- Fully integrate flood hazard information and the impacts of large-scale disturbance and land cover and land use change on flooding into planning studies;
- Develop evacuation plans for all flood plains;
- Foster productive interaction between individuals, communities, and the development industry on strategies for resilient development;
- Develop more effective incentives for risk-wise development and building practices using revised codes, standards, and zoning regulations.

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 flood-specific implementation plan will create a more disaster-resilient America. Specifically:

Relevant hazards are recognized and understood. The dynamic relationship between precipitation and its timing, disturbance events, land cover and land use, and patterns of erosion and sedimentation will be better understood and mapped. Improved numerical models, inundation mapping, visualization, and decision-support tools will help each community identify their risk and vulnerability to flood hazards. The ongoing reevaluation of the 100-year recurrence interval will determine if that is an appropriate indicator of risk.

Communities at risk know when a hazard event is imminent. Improved instrumentation, more consistent data, better Digital Elevation Models (DEMs), improved behavioral understanding, and warning systems will be used to communicate risk and vulnerability more effectively prior to and during flood events of all types.

Individuals and property at risk are safe from hazards. Fewer vulnerable structures will be built in flood-prone areas thanks to improved understanding of inundation areas, risk, human behavior, and the benefits of zoning, enforcement, and mitigation.

Disaster-resilient communities experience minimum disruption to life and economy after a hazard event has passed. Losses will be reduced through improved coordination in prediction, modeling, and mitigation techniques for hurricanes, coastal and inland flooding, flooding and landslides, and other interrelated hazards.

Acronyms

FEMA Federal Emergency Management Agency
LIDAR Light Detection and Ranging

References

1. **http://www.nws.noaa.gov/oh/hic/flood_stats/recent_individual_deaths.html**
2. **http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.024-00.html**
3. **http://www.nwrfc.noaa.gov/floods/papers/oh_2/great.htm**
4. Louisiana Recovery Authority. 2007. Progress Report: December 2007. Available at **http://lra.louisiana.gov/assets/quarterlyreport/LRAQuarterlyReportDecember07.pdf**
5. Louisiana Family Assistance Center. 2007. Reuniting the Families of Katrina and Rita: Louisiana Family Assistance Center. Available at **http://www.dhh.louisiana.gov/offices/publications/pubs-303/Full%20Report.pdf**