



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 human and ecosystem health-specific implementation plan. See also sdr.gov for other hazard-specific implementation plans.

What is at Stake?

DEFINITION AND BACKGROUND. Human and ecosystem health hazards are conditions that predispose a person to adverse health outcomes (e.g., death, illness, injury, or disability), or result in the deterioration of ecosystem structure and functioning (e.g., acid rain, habitat degradation, animal or plant deaths, introduction of invasive species, community changes, loss of biodiversity).

IMPACTS. Recently, concern about an avian influenza pandemic and its potentially massive deleterious consequences on human and ecosystem health has mobilized the attention of the United States Government. This is one of many health hazards that our Nation and the world are facing.

The emergence of the West Nile virus in the United States in 1999 has caused annual outbreaks, leading to significant neuroinvasive disease in humans, infections in at least 58 mosquito species, and unprecedented mortality in birds. An estimated cost of the epidemic in Louisiana from June 2002 to February 2003 was \$20.1 million.¹

Similarly, in the environment, the increase in geographic distribution, frequency, and severity in the development of harmful algal blooms (HABs) has important ramifications on human and ecosystem health ranging from respiratory distress to death in both human and aquatic life.

HABs also have a large economic impact. In the past, the cost of HABs to our economy was estimated to be about \$50 million per year. Recently, the frequency and severity of major HABs outbreaks have increased, and costs can exceed \$50 million for one event alone.² Alien invasive species, including plants, animals, and microorganisms, cause up to \$120 billion in damage annually in the U.S.³ These affect agricultural and ecosystem productivity and the health of forests, rangelands, croplands, and land and aquatic ecosystems, in addition to resulting in human health impacts.



Human and ecosystem health disasters also can be consequences of other disasters such as earthquakes, floods, or volcanic eruptions. For example, in public health, major hurricanes such as Hurricanes Katrina and Rita in August–September 2005 led to extensive and significant short and long-term impacts on the health and well-being of affected communities in the Gulf Coast. Deaths from the events have exceeded 1,464 in states directly affected by the hurricanes and in those states housing displaced persons.⁴ Long-term and chronic effects have yet to be estimated. In the environment, the progressive destruction of marshes and wetlands along the Gulf Coast, especially in Louisiana and Mississippi, increased the impacts of these two hurricanes by reducing the protection of the coastal zones. As a result, the extensive flooding and accompanying widespread pollution of soils and waters dramatically increased the magnitude of the original disaster.



HUMAN AND ECOSYSTEM HEALTH

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Grand Challenges for Disaster Reduction: Priority Interagency Human and Ecosystem Health Hazards Implementation Actions

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

- Research the fundamental processes in human and ecosystem health that predispose adverse human health outcomes or result in ecosystem structure and function deterioration;
- Improve human and environmental health monitoring systems and protocols to identify, describe, collect, analyze, and interpret emerging infectious agents and other health hazards (e.g., organisms, toxic substances, etc.). These monitoring systems must be accurate and specific to allow for the correct identification of the threat;
- Develop and improve the timeliness and accuracy of human and ecological health forecasts;
- Assess the impacts of natural resource use on ecosystem health and the capacity of ecosystems to respond to hazards;
- Continue developing new technologies to detect agents that threaten human and ecosystem health;
- Using more comprehensive models, develop clear, actionable risk and vulnerability assessments based on data from monitoring systems and global observation networks (for diseases and environmental data);
- Develop searchable ecological and public health databases for early detection of emerging threats;
- ◆ Develop and improve remote, *in situ*, permanent, and mobile environmental and human health monitoring systems to collect and analyze data in real time;
- ◆ Facilitate and increase coordination between terrestrial, aquatic, and atmospheric monitoring systems.

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

- Use an interdisciplinary approach to expand and enhance the knowledge base of short-term, long-term, and cumulative risk factors and processes associated with hazard-related events to identify potential health and ecological adverse outcomes;
- Increase the workforce competence for human health care workers and ecosystem resource managers to address health and ecological threats by improving training;
- Assess the impacts of climate change and other global changes (e.g., increased input of nutrients in the environment, land-use changes, increased use of antibiotics in animal and food supplies) on human and ecosystem health;
- Understand the baseline and status of ecosystem health and human public health in order to track and monitor the impact of disease-causing agents and other health hazards;
- Research the evolution of health threats by using remote-sensing capabilities and tools, laboratory detection techniques and instrumentation, methods for ground-based assessments, and improved modeling capabilities;
- ◆ Understand the cumulative effects of stressors and hazards in human populations and ecosystems to better target causative agents and processes;
- ◆ Integrate biological, physical, chemical, and epidemiological models to provide accurate and timely forecasts of human and ecosystem health-related events and their impacts;
- ◆ Improve the use of surveillance networks, remote and *in situ* environmental monitoring systems, genomics, and cellular fingerprinting to better understand human and ecosystem health hazards;
- ◆ Develop models and scenarios to identify the impact of human intervention on human and ecosystem health and to evaluate programmatic, scientific, environmental, social, psychological, and economic consequences of specific decisions.



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

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

- Improve guidelines for use by state and local government officials to prepare for and respond to human and ecological health threats;
- Develop and pre-deploy stockpiles, tools, and supplies that can be used at the onset of human and ecological health events requiring resources for response;
- Improve coordinated, geographically focused human and ecosystem health mitigation plans to enhance region-specific and local emergency preparedness and response;
- Recommend actions that can prevent or reduce adverse effects of hazards on human and ecosystem health;
- Integrate new information about known and emerging human and ecosystem health hazards;
- Use interdisciplinary knowledge from recurring and emerging human and ecological health threats to provide the foundation for national and local preparedness and mitigation strategies;
- Implement a comprehensive prevention and mitigation strategy for known and emerging human and ecosystem health threats;
- Develop and improve human and environmental decontamination gears, capabilities, plans, and protocols for chemical, biological, radiological, and other hazardous substances;
- Accurately model the outcomes of natural and technological hazards in specific geographic areas and the outcomes of various management decisions, scenarios, and land-use strategies on the environment;
- ◆ Reduce human and ecosystem susceptibility to future hazards by restoring human and ecosystem health following a hazard;
- ◆ Integrate new research about the potential human and ecosystem health impacts of climate change into mitigation strategies;
- ◆ Sustain local capabilities to effectively mitigate the adverse impacts of human and ecosystem health hazards.

GRAND CHALLENGE #4: Reduce the vulnerability of infrastructure.

- Assure that access to critical care facilities, emergency response, and emergency management services is maintained following disasters;
- Note which infrastructures are at risk during any detrimental event. Assess the risks of a subsequent human or ecological disaster;
- Properly repair critical infrastructure immediately following a disaster.

GRAND CHALLENGE #5: Assess disaster resilience.

- Strengthen programs for community training in emergency medicine and environmental preventive and corrective actions;
- Assess availability of rapid response capabilities to quickly detect, diagnose, and treat human and ecosystem injuries, disease, and detrimental conditions (e.g., invasive species, climate change);
- Assess the capabilities available to prevent and control chronic human and ecosystem health conditions and other long-term adverse effects;
- Restore human and ecosystem health from post-disaster conditions to pre-disaster states by instituting recovery programs such as injury rehabilitation, mental recovery, suicide and domestic violence prevention, water system integrity evaluation, food water safety, vector control (monitoring and surveillance), and ecosystem and natural population restoration;
- Develop pilot projects for recovery and restoration techniques (e.g., replanting of multiple species in areas decimated by diseases or parasitic invasion, restoration of coastal marshes, diagnostic tools for mental health);
- Evaluate the effectiveness, appropriateness, and timeliness of responses to a hazard-related event;
- Provide risk assessments to determine the likelihood and potential impacts of hazard-related events and to identify at-risk communities or areas;
- ◆ Develop a database of lessons learned from past disaster events with human and ecological health impacts.

GRAND CHALLENGE #6: Promote risk-wise behavior.

- Create educational products to effectively communicate recommendations for protective action and preventive behavior;
- Develop protocols to evaluate the scientific basis and reach interagency agreement on best practices for individual actions before, during, and after an event;
- Communicate clear messages that can be understood by all in harm's way about the risks associated with an impending hazard;
- ◆ Develop early warning systems that: (1) incorporate research findings from the social sciences; (2) leverage the latest innovations in dissemination technologies; and (3) provide actionable information in real time, based on solid scientific information and on state-of-the-art models to protect critical facilities, infrastructure, and vulnerable populations and ecosystems.

Expected Benefits: Creating a More Disaster-Resilient America

Fulfilling this human and ecosystem health-specific implementation plan will create a more disaster-resilient America. Specifically:



Relevant hazards are recognized and understood. New and improved tools or methods (such as portable kits for rapid identification of bacteria, viruses, or toxins, genetic analysis, field assessment methods, or diagnostic models) will significantly increase public health officials' and resources managers' ability to identify, collect, monitor, analyze, and interpret health and environmental threats in real time. The potential for cascading health and ecosystem health hazards will be understood following all hazard events.

Communities at risk know when a hazard event is imminent. New and improved risk assessments, near real-time forecasts, early warning systems, and new approaches to identify specific ecosystem and human health threats in near real-time will alert decision makers to the initiation, timing, path, potential spread, and severity of human or ecosystem health conditions, thus reducing the adverse impacts of the hazards.

Individuals at risk are safe from hazards. Improved personal and collective protective behavior will prevent, reduce, or control human and ecosystem health deterioration. Pre-deployment of diagnostic equipment and material (e.g., medicine or diagnostic kits), public and ecological health services, and trained personnel will lead to more effective response.

Disaster-resilient communities experience minimum disruption to life and economy after a hazard event has passed. Coordinated, geographically focused human and ecosystem health mitigation plans will enhance region-specific and local emergency preparedness and response. Human and ecosystem health will be restored from post-disaster to pre-disaster conditions after all events.

References

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