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

What is at Stake?

DEFINITION AND BACKGROUND. Drought is a persistent and abnormal moisture deficiency that has adverse effects on vegetation, animals, or people. Drought is a unique natural hazard because it is slow-onset, has nonstructural impacts, and can be defined in meteorological, hydrological, agricultural, natural resource, and/or socioeconomic terms.

IMPACTS. Societal, environmental, and economic impacts of drought are enormous. Annual direct losses to the United States due to drought are estimated at $6-8 billion, making it on average the most costly of natural disasters affecting our nation.[1] During the spring and summer of 2002, moderate to extreme drought over much of the United States resulted in an estimated $10 billion in damages. The 2002 drought also contributed to major wildfires in 11 western states. Over 2.8 million hectares (7 million acres) were burned, resulting in 21 deaths and the loss of $2 billion in damages. Droughts with over $1 billion in damages also occurred in 1996, 1999, 2000, and 2005.[2]

The agriculture industry is the largest consumer of water in the United States and very sensitive to droughts. This was particularly evident during the 1988 drought that affected 35 states. Rainfall totals over the Midwest, Northern Plains, and the Rockies were 50–85 percent below normal, causing severe soil damage and a decrease in productivity of both crops and livestock. Total agricultural losses from this event are estimated at $40 billion.[3] Drought causes steep increases in agricultural production costs due to reductions in

DROUGHT

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

An element of the National Science and Technology Council

soil productivity, increased plant and animal susceptibility to disease and insects, and the need to purchase and import supplemental water sources.[4] Often these effects will continue to be felt long after the drought has subsided. Impacts of drought on natural resources include decreased forage on rangelands, increased mortality in forests and shrublands (from both direct drought effects and indirect effects of increased susceptibility to insects and disease), and increases in severity and breadth of wildfires.

Grand Challenges for Disaster Reduction: Priority Interagency Drought Implementation Actions

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

- ■ Implement and expand the National Integrated Drought Information System (NIDIS), including development of the NIDIS web portal;
- ■ Develop, expand, and link information systems tracking impact and losses related to hydro-meteorological events and seasonal fluctuations and associated drought effects, including water supply, hydropower, crops, rangeland, wildland fire, carbon sequestration and invasive species;
- ➤ Leverage activities with international partners, such as World Meteorological Organization (WMO) and bilateral collaborators, to deliver improved drought information;
- ➤ Develop interagency protocols, coordinated and integrated drought observations, analysis, and predictions;
- ➤ Assess science and technology needs for improved drought planning, mitigation, and response, including decision support tools, community involvement, drought response triggers, insurance and financial strategies, and demand efficiencies;
- ➤ Develop and improve drought-monitoring capabilities at the state and local level, including improved impact assessment technology.

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

- ■ Monitor and analyze key physical, environmental, and societal variables associated with drought and related planning triggers. Key variables include: land use, climate data, soil moisture, stream flow, ground-water levels, reservoir and lake levels, snow-covered area, snow water storage, canopy water, and chlorophyll content of vegetation (e.g., for agriculture, forest and rangeland health, and fire risks);
- ➤ Design drought research efforts to be multi-disciplinary and well-coordinated among relevant state and federal agencies, universities and the private sector to improve predictive capability of seasonal/multi-decadal droughts;
- ◆ Improve understanding of major climate processes related to drought through satellite and meteorological data and model development.

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.**

- ➤ Develop technologies that enable more efficient water use and conservation;
- ➤ Support research and development of more drought-resilient crops;
- ➤ Focus on planning strategies, collaborative decision support tools, and assessment science to create comprehensive mitigation strategies;
- ◆ Develop improved capabilities at the state and local level for drought preparedness planning;
- ◆ Develop sophisticated decision-support tools, available through the NIDIS web portal, so drought monitoring and prediction products can be effectively incorporated into decisions to mitigate impacts on public health, critical infrastructure, and provision of public utilities and services.

GRAND CHALLENGE #4: **Reduce the vulnerability of infrastructure.**

- ➤ Investigate drought predictions and indicators to improve operational decision making for water supply, transportation, hydropower, and irrigation;
- ➤ Incorporate social science research into effective public communications calling for demand reduction during drought and improving demand-side efficiencies;
- ➤ Develop improved information for water supply operation, transportation, hydropower, irrigation augmentation systems, and for the development of new supplies and estimation of demand-side efficiencies.

GRAND CHALLENGE #5: **Assess disaster resilience.**

- ■ Assess societal, economic, and ecosystem/environmental vulnerability, impacts, and response capacity to drought;
- ■ Research economic impacts of drought and quantify the monetary benefits of improved drought prediction and mitigation;
- ■ Improve coordination of Federal, state, local, and international activities for drought planning and emergency response;
- ■ Develop meaningful socio-economic and ecosystem/environmental impact drought indices for use by decision makers and the general public including research into human actions that increase drought severity;
- ➤ Identify and track the metrics of observable drought impacts at county and sub-county scales by blending *in situ* and satellite observations.

GRAND CHALLENGE #6: **Promote risk-wise behavior.**

- ■ Strengthen the capacity of states, Native American Tribal Governments, and watershed communities to manage and respond to drought risks;
- ➤ Develop Federal-state-local partnerships to identify actionable strategies and incorporate scientific and technological advances to inform practices that reduce drought vulnerability;
- ➤ Develop evaluation and feedback mechanisms for drought information system refinements;
- ➤ Improve systems for communicating drought information and essential public actions.

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

Relevant hazards are recognized and understood. Because of its slow onset over space and time, drought can only be identified through the continuous collection of climate and hydrologic data. Modernizing legacy observing systems, increasing the spatial density of key variables, integrating synoptic satellite views, and leveraging newly established state and local observing networks will greatly enhance drought monitoring. Enhanced understanding of natural climate cycles will improve forecasts of droughts associated with such cycles.

Communities at risk know when a hazard event is imminent. To enhance decisions and minimize costs, drought warning systems will provide credible and timely drought risk information and forecasts. Targeted advances in scientific research and forecast model development will provide decision makers with credible information that can be used in planning and preparation for future changes in drought expanse and severity. Advancements in areas such as warm-season precipitation forecasting will enhance drought forecasting, which will benefit drought planning and preparedness activities.

Individuals at risk are safe from hazards. More centralized and direct access to available drought information will enable users to fully capitalize on existing and newly developed drought models. Education of decision makers will enhance the understanding and application of drought indicators for identifying drought severity thresholds.

Disaster-resilient communities experience minimum disruption to life and economy after a hazard event has passed. A shift from crisis management to risk management will enable a more drought-resilient society. Better understanding of drought-related impacts such as increased wildland fire risk, interruptions to business activity, and impacts on major population centers will enhance drought planning, mitigation, and response activities.

References

1. FEMA, 1995
2. Billion Dollar U.S. Weather Disasters, NOAA National Climatic Data Center, **http://www.ncdc.noaa.gov/oa/reports/billionz.html**
3. "What is Drought?," the National Weather Service Forecast Office, **http://www.wrh.noaa.gov/fgz/science/drought.php?wfo=fgz**
4. "Economic Impacts of Drought and the Benefits of NOAA's Drought Forecasting Services," NOAA Magazine Online, September 17, 2002, **http://www.magazine.noaa.gov/stories/mag51.htm**