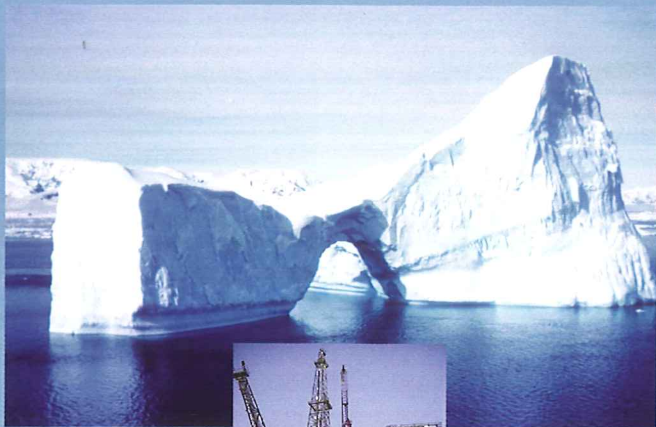
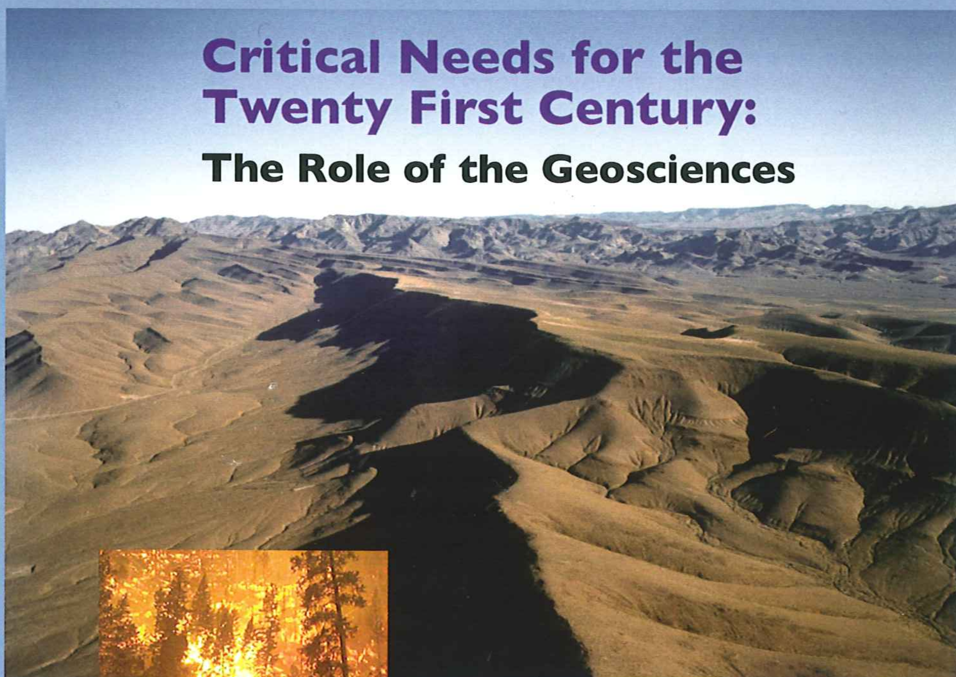
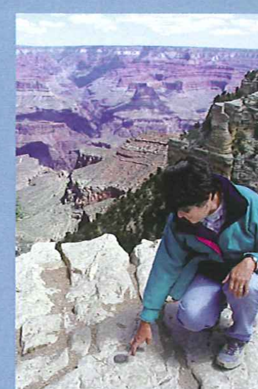





Critical Needs for the Twenty First Century:

The Role of the Geosciences

SERVING THE GEOSCIENCES WORLDWIDE

AGI

THE AMERICAN GEOLOGICAL INSTITUTE

Geoscience to Meet the Needs of the Twenty First Century: Natural Resources, Environmental Quality and Resiliency

The geoscience community provides the knowledge, experience and ingenuity to meet society's demands for natural resources, environmental quality and resilience from hazards. Here we outline the critical needs of the nation and the world at the outset of the twenty first century and provide policy guidance to grow the economy while sustaining the Earth system.

The Earth system includes complex linkages between the atmosphere, hydrosphere, biosphere and lithosphere. Natural resources we rely on are derived from the Earth system and include the following broad categories:

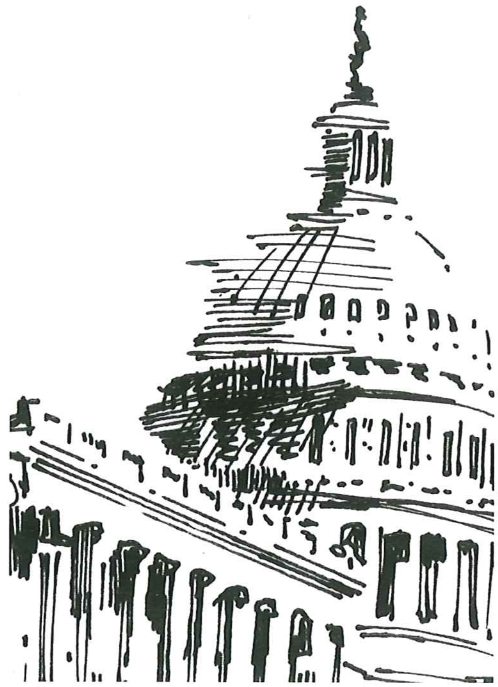
- Energy resources
- Water resources
- Soil resources
- Mineral, metal and building material resources
- Ecological resources, such as forests, wetlands, coastal systems and the oceans

With a burgeoning human population, rising demand for natural resources and a changing climate, it is critical to more fully integrate Earth observations and Earth system understanding into actions for a sustainable world. The geoscience community of more than 120,000 geoscientists represented by the 44 member societies of the American Geological Institute stands ready to help deal with the challenges of modern life in a delicately linked Earth system.

Critical Needs

1. **Energy and Climate Change: How do we secure stable energy supplies in an increasingly carbon-constrained world?**
2. **Water: Will there be enough fresh water and where will it come from?**
3. **Waste Treatment and Disposal: How will we reduce and handle waste and provide a healthy environment for all?**
4. **Natural Hazards: How will we mitigate risk and provide a safer environment?**
5. **Infrastructure Modernization: How will we develop and integrate new technology and modernize aging infrastructure?**
6. **Raw Materials: How will we ensure reliable supplies when they are needed and where will they come from?**
7. **Geoscience Workforce and Education: Who will do the work to understand Earth processes and meet demands for resources and resiliency? Who will educate the public and train the workforce?**

SERVING THE GEOSCIENCES WORLDWIDE
AGI
THE AMERICAN GEOLOGICAL INSTITUTE



Key Recommendations

- Establish a Natural Resource Advisor within the White House Office of Science and Technology Policy to advise the President on stewardship of natural resources based on scientific understanding and technological advances. The advisor will highlight connections between the different resources; improve integration between research, development, technology and demand of all resources; and advise the government on policy, management and risk reduction – all in a global context.

- Invest in mapping, monitoring, assessments and state and federal surveys of natural resources. Ensure that data are integrated to provide the context for understanding climate change, supply and demand scenarios on global to local scales and risks from hazards.

- Invest in research and development to understand Earth processes because sustainable consumption and conservation of resources, enhancement of environmental quality and resilience from risk depend on living *with* our dynamic planet.

Energy and Climate Change:

How do we secure stable energy supplies in an increasingly carbon-constrained world?

Energy is essential for economic growth, national security, international relations, sustainable and adaptable communities and the overall quality of life. The energy must be cost-effective, reliable, efficient and flexible. Fossil fuels have filled this role for decades and will continue to be part of our energy portfolio for many more decades (Figure 1). Looking to the future, effective research and development of alternate energy resources should be balanced with continued research and development of cleaner and more efficient fossil fuels and newer carbon-based fuels. A key challenge is to sustain fossil fuel energy resources and increase other energy resources on commercial scales while dealing with climate change, pollution, water availability, and land use priorities.

The global climate is changing and this change will have negative effects on the environment (Figure 2). World leaders have agreed that unified global action is necessary to reduce carbon dioxide emissions as soon as possible to ameliorate the effects of climate change. Adaptation is also fundamental to ensuring quality of life and economic growth. Mitigation and adaptation will have costs – economic, social and cultural – but will also provide opportunities. Geoscientists are needed to collect and interpret observations and models in order to develop an effective mitigation and adaptation agenda. Together geoscientists, policymakers and the public can ensure the wisest use of natural resources now and in the future. Mitigation and adaptation will involve a global effort and will require strategic planning related to national security and international interests.

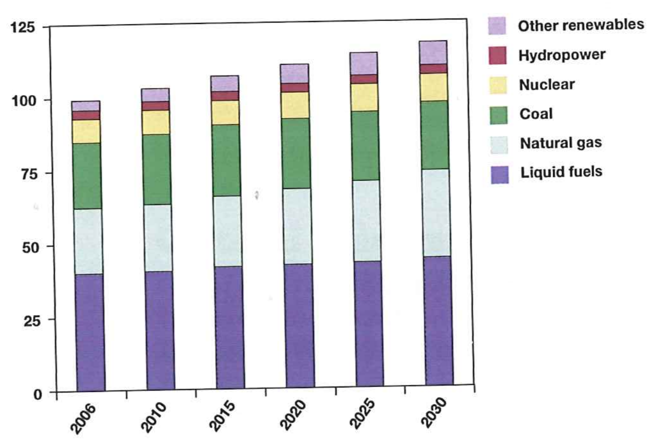


Figure 1: The U.S. Energy Information Administration predicts total primary energy consumption in the U.S. will grow by 0.7 percent per year and 55 percent of the increase will come from greater consumption of fossil fuels, while 45 percent will come from other energy resources. Figure is from the Energy Information Administration's Annual Energy Outlook 2008 and shows primary energy use in units of quadrillion British thermal units from 2006 to 2030.

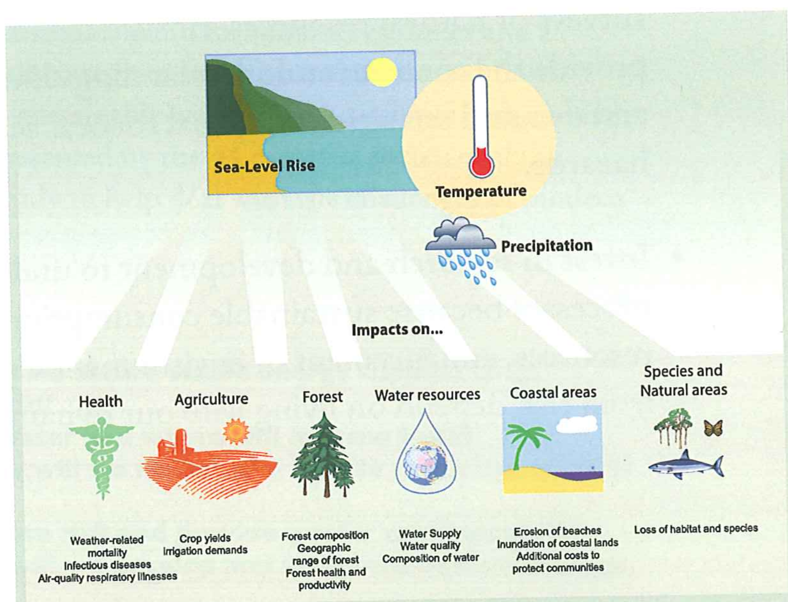


Figure 2: The U.S. Environmental Protection Agency notes that climate change effects temperature, sea level and precipitation on a local to global scale and such changes to key Earth system metrics will have impacts on human health, agriculture, forests, water resources, coastal areas and ecosystems. These effects and impacts could also increase the severity of hazardous weather events such as drought, heat waves, floods, hurricanes, tornadoes and snow storms. Figure is from the EPA and was published in "Understanding and Responding to Climate Change: Highlights of the National Academies Reports, 2008.

Given the need for secure and stable energy supplies in an increasingly carbon-constrained world, the geoscience community suggests the following national policy directions.

Energy and Climate Change

- Provide the President with continual and objective expertise on all natural resources, through strong and integrated leadership between the Secretary of Energy, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce and other leaders.
- Increase expertise in natural resources and environmental impacts among the staff and committees for Congress, the President's Office of Science and Technology Policy, the National Science and Technology Council and the Council of Environmental Quality. Ensure that development of energy resources are considered in terms of impacts on water, soil, mineral and ecological resources.
- Recognize that fossil fuels are the bridge to a more diverse and sustainable energy portfolio and as the transition to other energy sources occurs federal support for fossil fuel production and investment in fossil fuel research and development (R&D) must grow substantially to ensure full utilization of these vital resources.
- Increase investment in a more comprehensive energy R&D portfolio that includes all potential energy resources, their life cycles and their environmental footprints. Too often R&D support focuses on one resource for a short time while others are ignored. Strategic and steady long-term support is needed for solutions.
- Update and strengthen the goals of the U.S. Global Change Research Act of 1990 in light of current realities – in particular, the act should include research on regional and local effects related to climate change.
- Complete a global climate change assessment for Congress and the Administration on a regular basis.
- Ensure investment for climate change R&D across all agencies is sufficient to meet national and international needs and improve coordination of these efforts.
- Support land and space-based observations and monitoring networks, mapping and analysis across agencies.
    - Support the recommendations of the Decadal Study on Earth Observations from Space to develop the next generation of "tools" for climate change R&D and monitoring.
    - Support computer modeling, computational infrastructure and data archiving related to climate change R&D.
- Support ratification of the United Nations Law of the Sea Convention to enhance global cooperation related to the oceans, seafloor and Polar Regions.
- Proceed with the U.S. Ocean Action Plan of 2004 to ensure that the resources and health of the Great Lakes and oceans are sustained.
- Ensure that ocean policies are integrated with the rest of the nation's energy and climate change initiatives.

Water:

Will there be enough fresh water and where will it come from?

Clean, fresh water is essential for life and is our most precious commodity. Only about 2.5 percent of Earth's water is fresh water, the rest is salt water. Fresh water comes from lakes, rivers, streams and ground water. Maintaining healthy ecosystems that support these sources is crucial.

Besides providing drinking water, fresh water is harnessed for agriculture, energy, flood control and navigation (Figure 3). The U.S. population has grown from 5.3 million people in 1800 to over 300 million people in 2008 and our thirst for fresh water has grown significantly. The U.S. Climate Change Science Program detailed significant challenges for fresh water management because of climate change. Research and development from the federal government and states has allowed geoscientists and engineers to understand and discover fresh water sources, measure and protect quality and quantity within each source, and understand the effect of climate variability on fresh water resources. It is the state and tribal role to assess and manage their fresh water resources. Geoscientists working within communities, between municipalities and across the nation are needed to understand water quality and quantity within ecosystem boundaries rather than within management boundaries.

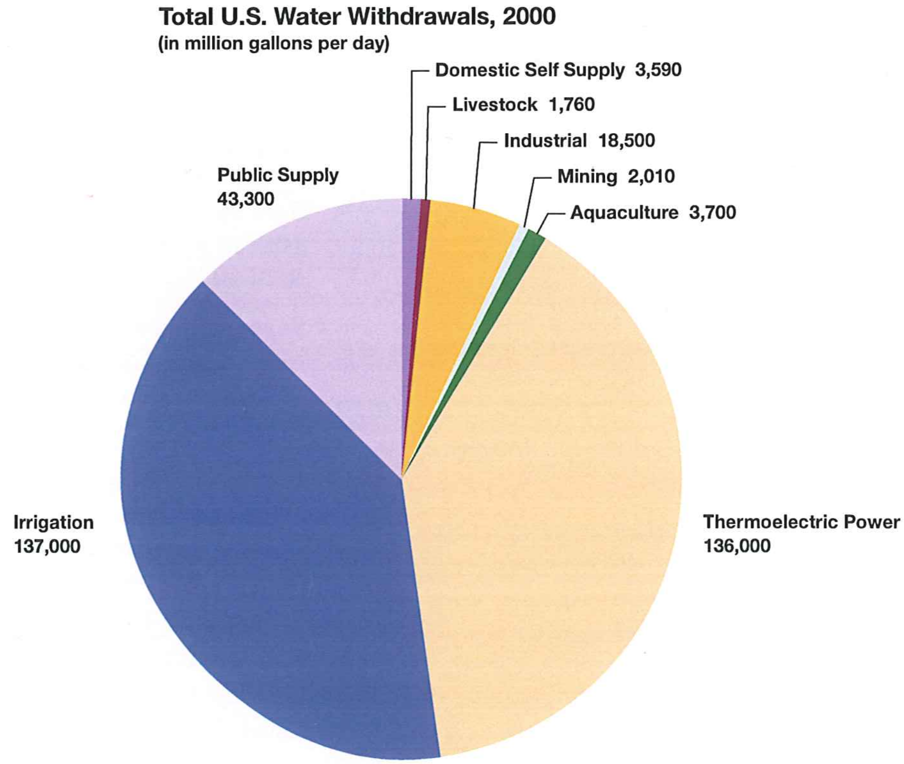


Figure 3: Surface water accounts for 79 percent of fresh water withdrawals and the rest comes from groundwater. On the basis of estimates from 1995, about 70 percent of withdrawals were returned to surface water bodies. Much less data is available about current water withdrawals and consumption, making water management far more challenging than is necessary. Figure is from "A Strategy for Federal Science and Technology to Support Water Availability and Quality in the United States", a 2007 report of the President's National Science and Technology Council.

SERVING THE GEOSCIENCES WORLDWIDE
AGI
THE AMERICAN GEOLOGICAL INSTITUTE

Given the critical need for fresh water for a growing population in a changing environment, the geoscience community suggests the following national policy directions.

Fresh Water

- Require a National Water Census to assess water availability, quality and human and environmental uses on a regular basis. Priorities of the census should include:
  - ❑ Surface and subsurface water assessments at local, regional and watershed levels.
  - ❑ Monitoring of surface and subsurface water quantity and quality. The national monitoring network should be enhanced.
  - ❑ Short-term and long-term water resources management and planning for multiple uses.
  - ❑ Modeling and assessment of point and non-point sources of contamination.
  - ❑ Modeling and assessment of the hydrologic effects of climate change.
- Establish the U.S. Geological Survey as the lead water science agency for the federal government, to:
  - ❑ Ensure integration of water R&D and monitoring for water planning across federal agencies.
  - ❑ Ensure that federal initiatives are integrated with regional, state, local and tribal entities that actually manage fresh water resources.
  - ❑ Ensure that federal initiatives are focused on the impact of land management on soil and water quality.
- Ensure that the U.S. Ocean Action Plan of 2004, which includes the Great Lakes, is integrated with other federal initiatives.
- Increase the use of recycled/reclaimed water through R&D and federal-level incentives for local, state, tribal and regional water managers.
- Develop a federal water policy that:
  - ❑ Emphasizes incentives to more effectively manage water resources;
  - ❑ Strengthens watershed-level management and cooperation;
  - ❑ Provides regular comprehensive assessments of all water resources.
- Significantly increase investment in basic research in the geosciences to gain a better understanding of the hydrologic cycle and water resources.

3

Waste Treatment and Disposal:

How will we reduce and handle waste and provide a healthy environment for all?

Each year the nation requires more waste treatment and disposal. Wastewater, sewage, contaminated water, nuclear waste, landfills, brown fields, superfund sites, recyclable waste and non-biodegradable waste must be managed with great care. Long term planning is needed to prevent toxic build-ups, additional contamination, re-use as a biologic or nuclear weapons and leaks of hazardous materials (for example, either sudden risks, such as explosions or imperceptible, long-onset risks, such as disease-causing contaminants that build-up in the environment over decades).

The challenge is to efficiently and securely treat and dispose of the waste with a minimum impact on ecosystems and human health. Tracking mercury, originating from air pollutants to toxic methyl mercury in our food chain (Figure 4) is a good example of the data and understanding required to deal with the complexities of waste transport in the Earth system. All waste treatment and disposal solutions require geological, geochemical, geophysical, hydrological and biological expertise to determine the sources of waste, how the waste is transported, altered and/or concentrated in natural and man-made systems and what methods may be most effective in remediation or recycling waste for humans and the ecosystems we depend on. Waste can be a resource with some knowledge of the waste make up and a bit of ingenuity, waste products can be used efficiently. For example, coal ash could be mined for precious metals and there are many forms of waste-to-energy plants.

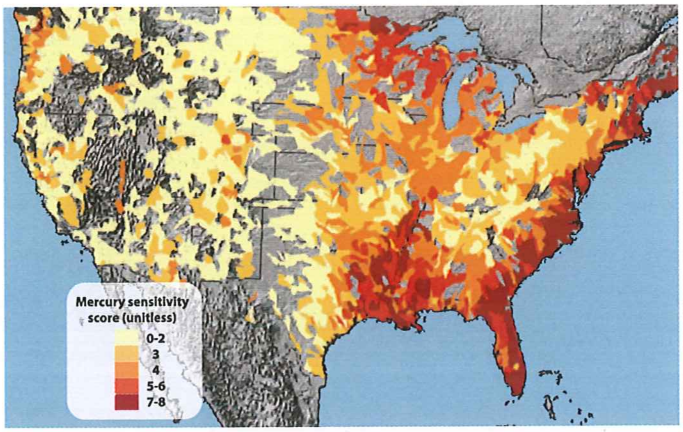


Figure 4: The U.S. Geological Survey is developing a mercury sensitivity map for the contiguous 48 states. The higher scores represent more sensitive ecosystems and the data are based on more than 55,000 water-quality sites and 2500 watershed measurements. Mercury pollution, primarily from power plants, accumulates in fish as methylmercury. Methylmercury is toxic for people and fish-eating wildlife. More details are available from infotrek.er.usgs.gov/mercury.

SERVING THE GEOSCIENCES WORLDWIDE
AGI
THE AMERICAN GEOLOGICAL INSTITUTE

Given the need to deal with waste of all kind and to recycle where feasible, the geoscience community suggests the following national policy directions.

Waste

- Provide incentives to support greater use of recycled materials, including reclaimed water, to reduce waste build-up and conserve resources.
- Build a database of "waste resources", places where economically valuable materials and services can be harnessed from waste streams.
- Invest in upgraded and advanced water/waste water treatment infrastructure.
- Invest more in wastewater R&D, which is often overlooked and is segmented among different federal agencies. Integrated and comprehensive support now will provide enormous economic and environmental benefits.
- Initiate a national re-assessment of nuclear waste and future plans. Consider in particular revisions to the Nuclear Waste Policy Act of 1982 based on current and future waste needs and advances in technologies.
- Invest in nuclear energy/nuclear waste R&D with an appropriate fraction of the resources directed toward training of skilled professionals for the nuclear industry and outreach/education for the public.
- Support clean-up of abandoned mines, brown fields and superfund sites as a high priority; set priorities for what should be cleaned up first given that there are not enough funds to initiate clean-up at all sites concurrently.

Natural Hazards:

How will we mitigate risks and provide a safer environment?

Natural hazards such as earthquakes, landslides, tornadoes, hurricanes, severe storms, floods, heat waves and drought, exact a significant toll on society. Our goal as a nation should be to develop resilient communities where losses are limited and recovery is rapid. While research and development have led to safer communities, improved forecasts to save lives and better planning and design to limit damage, there are ominous signs of increasing risks, especially to the built environment. Climate change and other alterations to the environment are increasing the risks from natural hazards. Increasing development in high risk areas, increasing population density in urban communities and aging infrastructure all contribute to increasing the threats from natural hazards.

The average costs of property damage from natural hazards in the U.S. has been increasing (Figure 5) because of population growth and greater development in risk-prone areas. Single catastrophic events, such as Hurricane Katrina in 2005 (which is estimated to have cost more than $140 billion in property damage alone) can greatly exceed the nation's ability to deal with direct damage costs and indirect economic, social and cultural losses. Geoscientists, working in cooperation with emergency managers, developers and others, are needed to understand the natural and human factors that may make Earth processes more hazardous and to help develop strategies to mitigate their risks. With cutting edge advances and steady use of observational, analytical and monitoring tools, geoscientists can help to educate the public about risks, in some cases forecast the timing, direction, intensity and targeted region for a natural hazard and help to develop strategies and technologies to reduce the risks. Research and development have served the nation well in saving lives and improving community resiliency and must be maintained to deal with the greater needs of a growing population and an expanding economy.

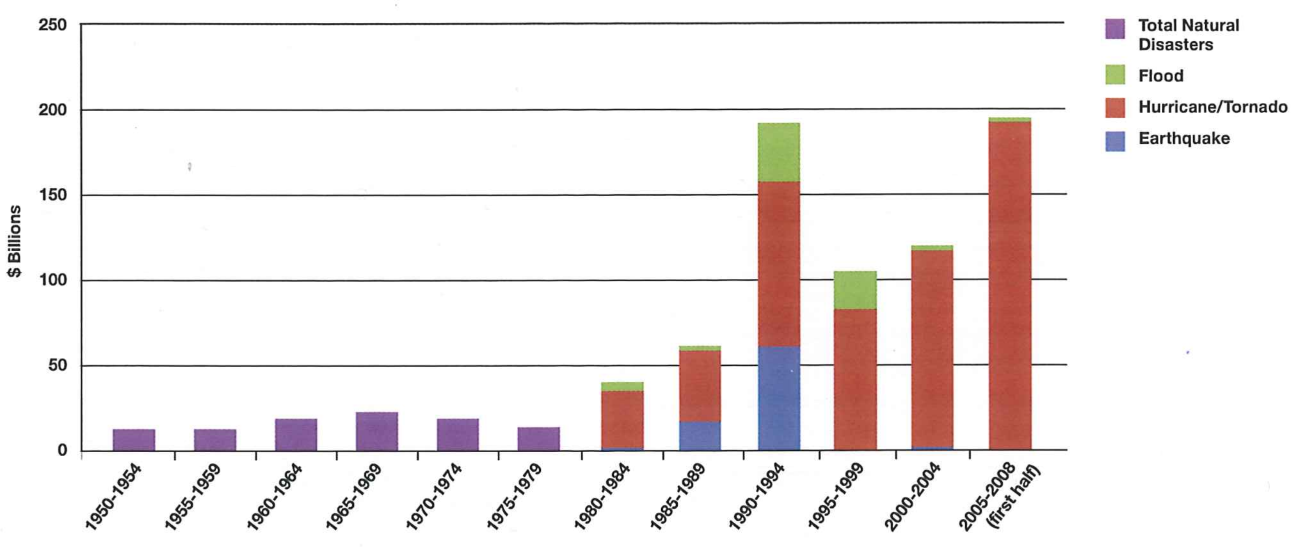


Figure 5: The cost of natural disasters in five year periods has increased over time because of greater development and greater wealth in more risk-prone regions. Data is from "Why the United States Is Becoming More Vulnerable to Natural Disasters" by G. van der Vink et al., EOS, November 3, 1998, p. 533 and Munich Reinsurance Company, NatCatService.

Given the need to make the nation less vulnerable to natural hazards, the geoscience community suggests the following national policy directions.

Natural Hazards

- Federal and state governments, businesses, academic institutions and communities should be effective partners in support and strengthening of:
  - ❑ Research into the links between natural hazards and Earth processes.
  - ❑ Real-time and long-term monitoring of Earth processes and the collection and management of data and models.
  - ❑ Modeling that combines geophysical, hydrological, ecological, societal and economic aspects of disaster scenarios.
  - ❑ Preparedness, education and mitigation efforts, focusing on the most-risk prone areas.
  - ❑ Incentives to reduce high-cost and/or high-density development in more risk prone areas.
- Federal agencies such as the U.S. Geological Survey, the National Science Foundation, the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the National Institutes of Standards and Technology, the Department of Agriculture, the Army Corps of Engineers and the Federal Emergency Management Agency (FEMA) should:
  - ❑ Coordinate natural hazards research, monitoring, training, education and public outreach efforts. The National Earthquake Hazards Reduction Program is an excellent example of such a well-coordinated and effective program across four agencies.
  - ❑ Work closely with other federal agencies, states, tribal and local governments.
  - ❑ Maintain a robust and effective external grants program for research, preparedness and mitigation to complement federal efforts.

Infrastructure Modernization:
How will we develop and modernize our infrastructure?

Infrastructure in the United States faces increasing demand by a growing, more mobile and more interconnected population. According to the Department of Transportation, since 1980, vehicle traffic has nearly doubled, air passenger-miles have increased by 150 percent and railroad freight traffic has increased by 80 percent. The nation's energy infrastructure, from pipelines to electrical grids, is having trouble keeping up with demand and the nation's burgeoning telecommunications infrastructure, from fiber optics to satellites, has become more central to economic growth and emergency management.

Much of the infrastructure that provides critical lifelines is aging and in need of repair while some is new technology that requires integration with existing systems. The American Society of Civil Engineers gave the nation's infrastructure an overall grade of "D" in 2005 and noted that an investment of $1.6 trillion by 2010 is needed to improve existing infrastructure. Infrastructure is also affected by climate change, weather, hazards, and chemical and mechanical erosion beyond the normal wear and tear of repeated use.

The largest and oldest levee systems in the U.S. along the Mississippi River (Figure 6) and the Central Valley of California are critical to the economic growth and resource management of the nation. These systems were primarily built to protect agriculture but now protect or put at risk billions of dollars of commercial trade, developed and populated communities and critical natural resources. The potential for additional catastrophic failures beyond the after effects of Hurricane Katrina (Figure 7) are significant because of the higher risk for earthquakes, floods and hurricanes in these regions, the aging infrastructure and the unknown effects of climate change. Much more work and funding is needed to understand the effects of natural hazards, problems with ground subsidence and soil conditions, the effects on ecosystems and the effects of water control on the health and maintenance of these systems. Geoscientists and geotechnical engineers play a critical role in the siting and design of infrastructure to increase its resilience to natural hazards and minimize its impact on the natural environment.

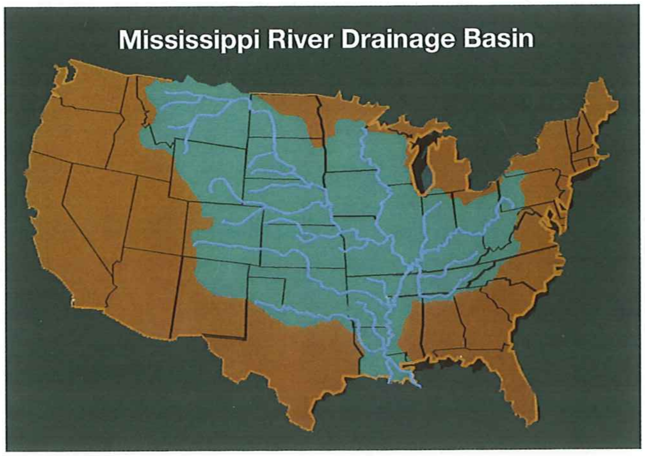


Figure 6: The Mississippi River has the third largest drainage basin in the world, exceeded in size only by the watersheds of the Amazon and Congo Rivers. It drains 41 percent of the 48 contiguous states. The basin covers more than 1,245,000 square miles, includes all or parts of 31 states and two Canadian provinces. The Flood Control Act of 1928 authorized the Mississippi River and Tributaries (MR&T) Project, the nation's first comprehensive flood control and navigation act. Figure and information from the U.S. Army Corps of Engineers web page – www.mvn.usace.army.mil/pao/bro/misstrib.htm

Given the critical need to modernize aging infrastructure and build new infrastructure, the geoscience community suggests the following national policy directions.

Infrastructure

- Assess infrastructure needs for the next 10, 50 and 100 years to provide a useful short-term and long-term outlook for planning purposes.
- Assess the interdependence of infrastructure and risks through research, monitoring, data collection, modeling and analysis.
- Support an independent review of large U.S. Army Corps of Engineers' projects as required by the Water Resources Development Act of 2007.

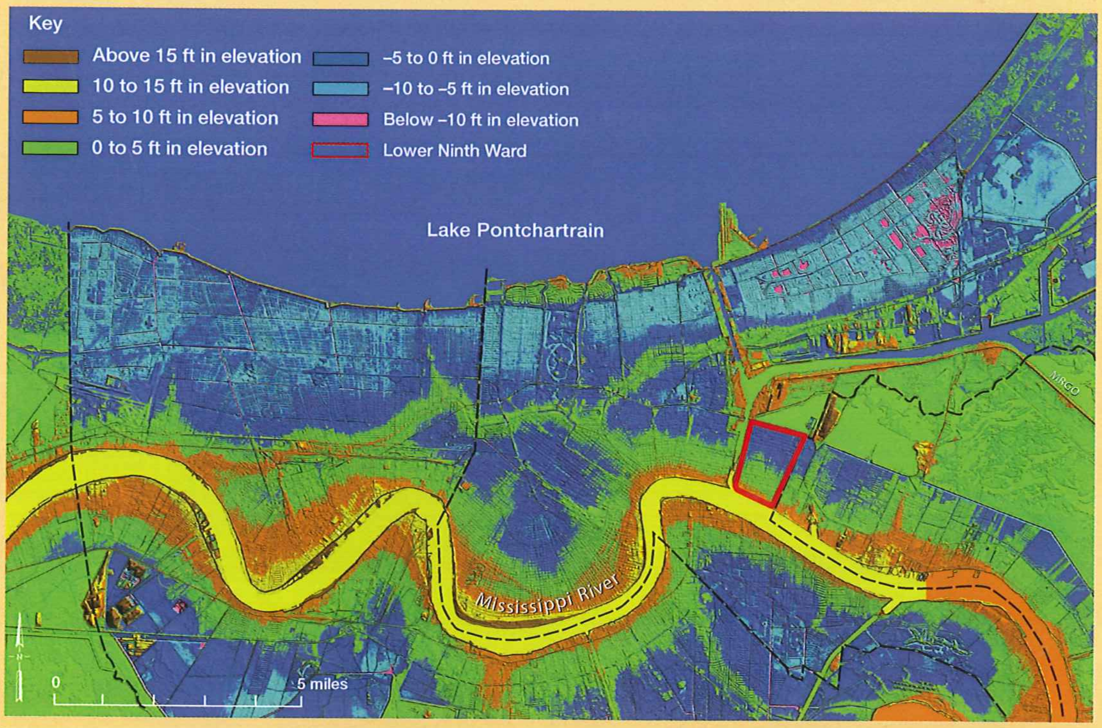


Figure 7: Relief map of New Orleans metropolitan area indicating the extensive flooding as a result of Hurricane Katrina. In general, areas colored light and dark blue as well as magenta were flooded. Significant investments must be made to rebuild and strengthen the infrastructure of particularly vulnerable regions. The figure is courtesy of the Louisiana Geological Survey and is from "Geology and Hurricane-Protection Strategies in the Greater New Orleans Area, 2006."

6

Raw Materials:

How will we ensure reliable supplies when they are needed and where will they come from?

Minerals help to sustain life as natural or added supplements in food and drink. Minerals are also essential in just about any product used in daily life from calcite in toothpaste to silicon from silicate minerals in computers, DVDs and solar panels. The global demand for metals, such as aluminum, copper, gold and platinum, has led to a steep rise in their prices. Aggregate, including sand, gravel, crushed stone, slag, or recycled crushed concrete, is an essential building material as well as an essential ingredient in paint, paper, plastics, glass, other household products and in medicines. Aggregates account for more than one-half of the volume of all mining, and more than one-half of all the aggregate produced in the U.S. in the 20th century was mined in the last 25 years of the century (Figure 8).

The foundation of agriculture and healthy ecosystems rests upon the soil. The soil is a critical biozone that must be understood and sustained in order to maintain a robust agricultural system and a healthy ecosystem while dealing with other uses such as biofuel production. Soil filters and stores water and ensures our fresh water resources. There is an immediate need for greater understanding of the effect of multi-uses on soil sustainability.

All of these raw materials must be wisely managed and efficiently prepared for their final use. Geoscientists are needed to locate these materials, assess their quantity and quality, cleanly and efficiently manage their extraction, reduce byproducts or excessive waste and assess strategic needs for low-supply critical materials that are in high demand or relate to national security.

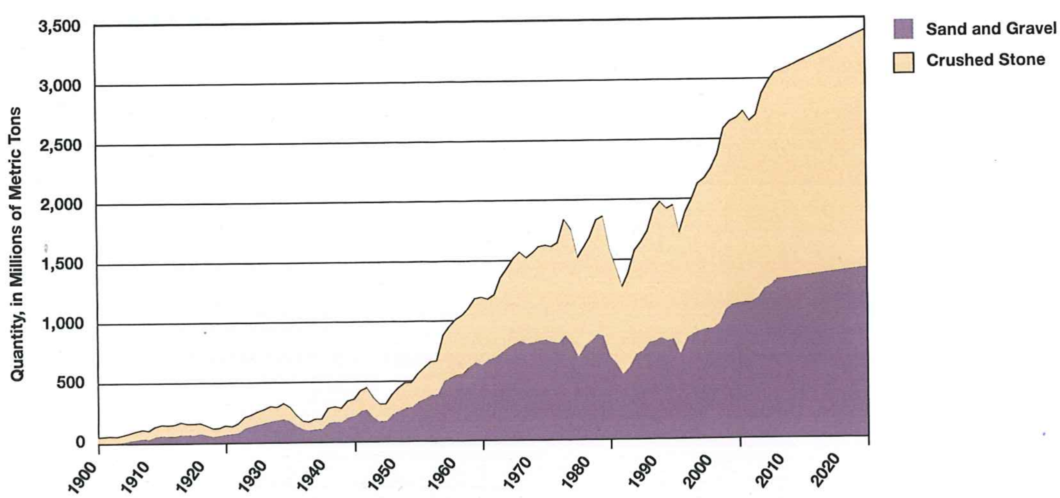


Figure 8: The U.S. Geological Survey tracks supply and demand for natural raw materials, including non-fuel minerals such as aggregate. Graph shows aggregate production in the United States with projections to 2020, based on a growth rate of 1 percent for stone and 0.5 percent for sand and gravel. Data from the U.S. Geological Survey.

Given the increasing need for raw materials in our daily lives, the geoscience community suggests the following national policy directions.

Raw Materials

- Significantly increase support for mineral assessments of the nation and the rest of the world conducted by the U.S. Geological Survey, state geological surveys and other geoscientists.
- Support the completion of soil survey and ecological site descriptions on the more than 195 million acres of public lands managed by the Bureau of Land Management, Forest Service, National Park Service, Bureau of Indian Affairs/ Natural Resources Conservation Service and others.
- Significantly increase investments in geologic mapping and data preservation in support of assessments, exploration, and production of raw materials, led by the U.S. Geological Survey in cooperation with state geological surveys and other geoscientists.

Geoscience Workforce and Education:

Who will do the work to understand Earth processes and meet demands for resources and resiliency? Who will educate the public and train the workforce?

More people are needed for a geoscience-based workforce now and in the future (Figure 9). A geoscience-based workforce includes technicians, professional geoscientists, professional engineers, research and development managers, exploration managers, data managers, applied researchers, basic researchers and educators at all levels. Such a workforce needs a knowledge and understanding of the Earth system and Earth processes, computational and analytical skills, a sense of discovery and adventure and strong problem-solving traits. In addition, this workforce is critical for teaching the next generation of workers, based on their sound understanding of geoscientific concepts and their work experience.

The growth of a U.S.-based geoscience workforce and an educated public begins with the formal and informal education of the nation's children. According to State Indicators of Science and Mathematics Education 2001, published by the Council of Chief State School Officers (CCSSO), less than 7 percent (about 860,000) of 13 million high school students took a high-school Earth science course in 2000. That percentage has declined since then as high school students take even fewer science courses in general and more high schools have eliminated Earth science classes. In addition the tens of thousands of Earth science teachers in K-12 grade levels have received little to no training in the geosciences during their formal education careers and must try to pick up some expertise through summer workshops and other opportunities. Renewed emphasis on student and teacher education in the Earth sciences would help to provide the U.S. geoscience workforce of the future and help the nation deal with the critical issues outlined above.

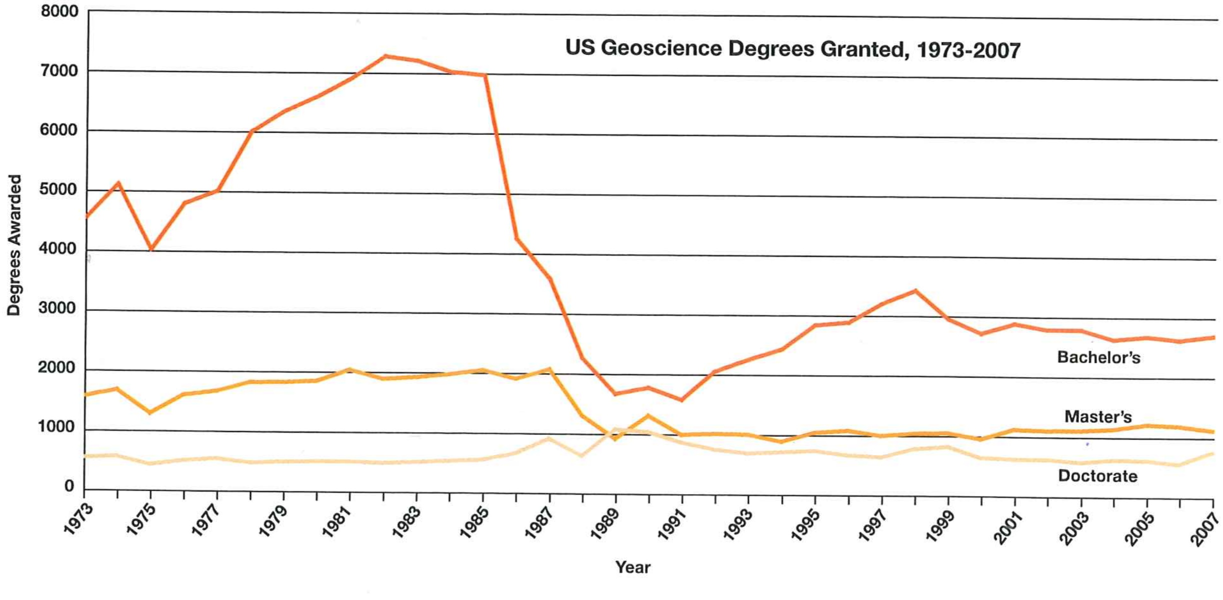
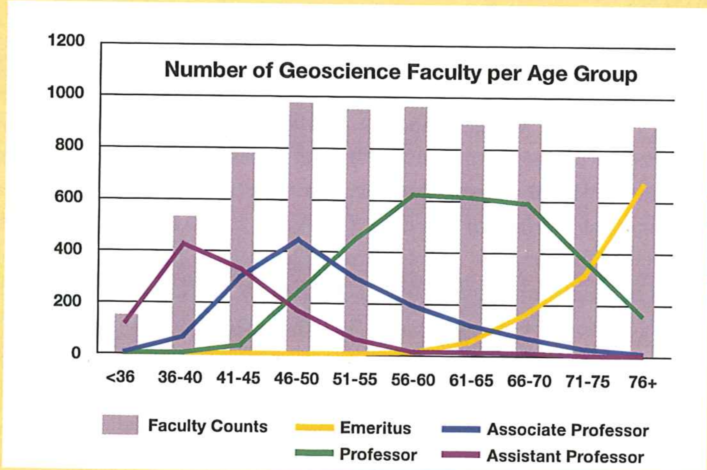


Figure 9: Data collected and collated by the American Geological Institute shows the decline in geoscience degrees granted (top) and the associated smaller pool of new geoscience faculty at U.S. institutions as of 2006 (opposite). The public and private sectors face the same dilemma of an aging workforce and a limited number of skilled new workers educated in the U.S. to fill the growing gaps.

Given the critical need for a skilled geoscience workforce and more robust geoscience education, the geoscience community suggests the following national policy directions.

Geoscience Workforce and Education

- Support inquiry-based education in geoscience for K-12 grade levels.
  - ❑ Include geoscience as a core course in middle school and high school.
  - ❑ Increase the rigor of geoscience courses and establish an Earth Science Advanced Placement class.
- Support public outreach and informal education through specifically funded programs in geoscience at national parks, museums and other public venues.
- Support geoscientists teaching in schools and encourage the Department of Education to recognize and support the importance of learning geoscience at the K-12 grade levels.
- Conduct an assessment of the geoscience workforce to determine specific needs and concerns.
- Provide greater support for scholarships, grants and fellowships for students majoring in geoscience at undergraduate and graduate levels (e.g. re-instate geological sciences in the Department of Education's graduate assistantship grants for the program "Graduate Assistance in Areas of National Need").
- Provide more scholarships, grants and fellowships for students majoring in education with an emphasis on science teaching.
- Increase incentives for student-teachers in their formal training to take geoscience courses as a requirement for teaching degrees.
- Provide incentives for teachers to gain additional geoscience training as a requirement for certification and advancement during their teaching careers.



Concluding Remarks

Strategic and prudent investments in the geosciences are essential to integrate scientific understanding into effective national policies. This synopsis and the short, non-comprehensive list of references on the opposite page provide only a summary of national needs.

The geoscience community, as represented by the American Geological Institute's 44 member societies and the over 120,000 geoscientists that make up these societies, provides the information, ingenuity, innovation and education to meet demand for natural resources, environmental quality and enhanced resiliency against natural and man-made hazards.

The geoscience community can provide objective scientific advice about the critical issues in this synopsis. Please contact Dr. P. Patrick Leahy, Executive Director of the American Geological Institute at pleahy@agiweb.org or 703-379-2480 for additional information.

Member Societies of the American Geological Institute

American Association of Petroleum Geologists (AAPG) ■ American Association of Stratigraphic Palynologists (AASP) ■ American Geophysical Union (AGU) ■ American Institute of Hydrology (AIH) ■ American Institute of Professional Geologists (AIPG) ■ American Rock Mechanics Association (ARMA) ■ American Society of Limnology and Oceanography (ASLO) ■ Association for Women Geoscientists (AWG) ■ Association of American State Geologists (AASG) ■ Association of Earth Science Editors (AESE) ■ Association of Environmental & Engineering Geologists (AEG) ■ Clay Minerals Society (CMS) ■ Council on Undergraduate Research, Geosciences Division (CUR) ■ Environmental and Engineering Geophysical Society (EEGS) ■ Friends of Mineralogy (FOM) ■ Geo-Institute of the American Society of Civil Engineers (GI) ■ Geological Society of America (GSA) ■ The Geological Society of London (GSL) ■ Geoscience Information Society (GSIS) ■ History of Earth Sciences Society (HESS) ■ International Association of Hydrogeologists/U.S. National Chapter (IAH) ■ International Basement Tectonics Association (IBTA) ■ Mineralogical Society of America (MSA) ■ National Association of Black Geologists and Geophysicists (NABGG) ■ National Association of Geoscience Teachers (NAGT) ■ National Association of State Boards of Geology (ASBOG) ■ National Earth Science Teachers Association (NESTA) ■ National Speleological Society (NSS) ■ North American Commission of Stratigraphic Nomenclature (NACSN) ■ Paleobotanical Section of the Botanical Society of America (PSBSA) ■ Paleontological Research Institution (PRI) ■ Paleontological Society (PS) ■ Petroleum History Institute (PHI) ■ Seismological Society of America (SSA) ■ SEPM (Society for Sedimentary Geology) (SEPM) ■ Society for Mining, Metallurgy, and Exploration, Inc. (SME) ■ The Society for Organic Petrology (TSOP) ■ Society of Economic Geologists (SEG) ■ Society of Exploration Geophysicists (SEG) ■ Society of Independent Professional Earth Scientists (SIPES) ■ Society of Mineral Museum Professionals (SMMP) ■ Society of Vertebrate Paleontology (SVP) ■ Soil Science Society of America (SSSA) ■ United States Permafrost Association (USPA)

References

Energy and Climate Change

Annual Energy Outlook, Energy Information Administration, 2008.
Visit www.eia.doe.gov/oiaf/aeo/

Understanding and Responding to Climate Change: Highlights of the National Academies Reports, National Academy of Sciences, 2008. Visit dels.nas.edu/basc/climate-change/

Scientific Assessment of the Effects of Global Change on the United States, National Science and Technology Council, 2008. Visit www.ostp.gov/cs/nstc/documents_reports

Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond, National Research Council, 2007. Visit www.nap.edu

From Sea to Shining Sea, Priorities for Ocean Policy Reform, Joint Ocean Commission Initiative, 2006. Visit www.jointoceancommission.org

Water

A Strategy for Federal Science and Technology to Support Water Availability and Quality in the United States, National Science and Technology Council, 2007. Visit www.ostp.gov/cs/nstc/documents_reports

Confronting the Nation's Water Problems: The Role of Research, National Research Council, 2004. Visit www.nap.edu

Natural Hazards

Draft Strategic Plan for the National Earthquake Hazards Reduction Program Fiscal Years 2008-2012. Visit www.nehrp.gov/pdf/NEHRP_StrategicPlan_Draft.pdf

Grand Challenges for Disaster Reduction Implementation Plans, National Science and Technology Council, 2008. Visit www.sdr.gov

Improved Seismic Monitoring, Improved Decision-Making: Assessing the Value of Reduced Uncertainty, National Research Council, 2006. Visit www.nap.edu

Grand Challenges for Disaster Reduction, National Science and Technology Council, 2005.
Visit www.sdr.gov

Raw Materials

Minerals, Critical Minerals and the U.S. Economy, National Research Council, 2008.
Visit www.nap.edu

Infrastructure

Economic Report of the President, U.S. Government Printing Office, 2008.
Visit www.gpoaccess.gov/eop/

Report Card for America's Infrastructure, American Society of Civil Engineers, 2005.
Visit www.asce.org/reportcard

Workforce

Science and Engineering Indicators, 2008, National Science Board, 2008.
http://www.nsf.gov/statistics/seind08/

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future, National Academy of Sciences, 2007. Visit www.nap.edu

Image Credits

Antarctic Iceberg (Courtesy of: NOAA; Image source: NOAA Photo Library)

Offshore Oil Platform (Courtesy of: Chad Teer, Creative Commons Attribution; Image source: Wikimedia Commons)

Small Wind Farm (Courtesy of: Olivier Tétard, Creative Commons Attribution ShareAlike; Image source: Wikimedia Commons)

Braided River in Southern Alaska (Copyright © Marli Miller, University of Oregon; Image source: Earth Science World Image Bank, http://www.earthscienceworld.org/images/)

Yucca Mountain Ridgeline (Courtesy of: Department of Energy; Image source: DOE OCRWM-Favorite Photos)

Bitterroot National Forest Wildfire (John McColgan, BLM Alaska Fire Service; Image source: Earth Science World Image Bank)

Hoover Dam and Lake Powell (Copyright © Lynn Betts, NRCS; Image source: Earth Science World Image Bank)

Aerial view of Kennecott Bingham Copper Mine (Copyright © Michael Collier; Image source: Earth Science World Image Bank)

Geologist pointing at a benchmark in the Grand Canyon (Copyright © Thomas McGuire; Image source: Earth Science World Image Bank)

World Globes on Cover and Page 1: IStockPhoto International

Illustration on page 3: Bill Firestone