Geosciences Supporting a Thriving Society in a Changing World

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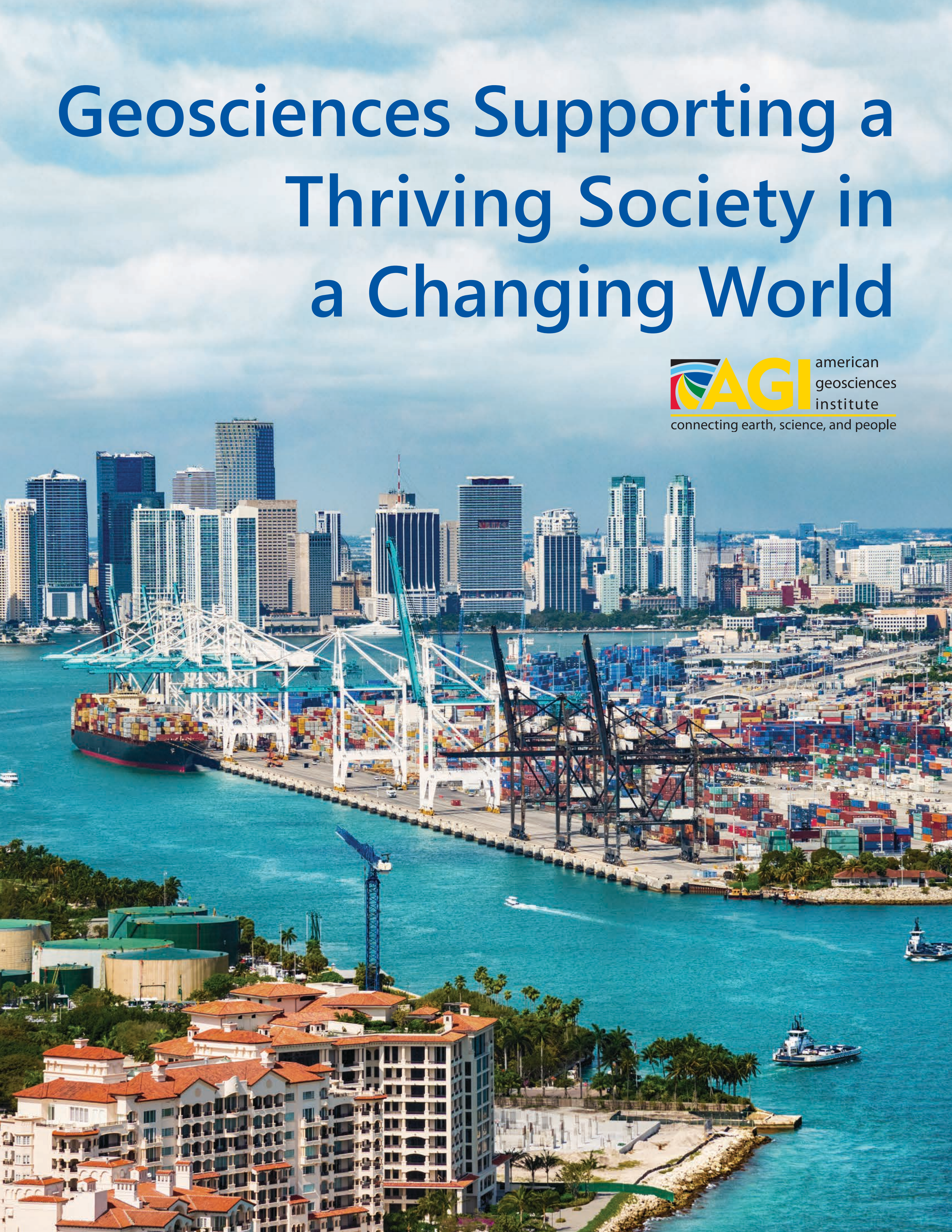

Geosciences Supporting a Thriving Society in a Changing World

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ISBN: 9798674418955

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Front cover photo of Miami, Florida:
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Letter from the Chair

Our modern society would not exist without the geosciences. The knowledge gained through the study of the earth, oceans, and atmosphere has improved our ability to get clean water, grow food, survive natural hazards, and power our economy. The future prosperity of our society will rely on the continued decision-making that incorporates geoscience expertise along with other forms of scientific evidence.

This report highlights areas of policymaking in which the geosciences play a significant role. Developed collaboratively by representatives of AGI Member Societies, it aims to represent the current priorities of the geoscience community. We focus on the many ways in which geoscience knowledge not only helps society but facilitates its ability to thrive. In addition, we emphasize the need to consider the whole earth system, which consists of many sub-systems that interact with one another, sometimes creating complex feedbacks. With this systems approach in mind, we have led with the climate change section as an exemplar of the interdisciplinary systems of our planet, which has effects that span across many sectors of the economy and throughout our lives.

This report will be distributed to science staff members within the presidential and congressional campaigns. It is also available for download on our website and we hope that it can serve as a resource for people nationwide. Whether you are crafting policies, speaking with your legislators, educating students or learning about the geosciences, we hope that you will find this report useful.

We urge decision-makers to draw on the expertise of the geoscience community when creating policy and educators to utilize the resources created by the geoscience community. Geoscientists are excited to share their research and continue the dialogue about how to build a thriving society.

Douglas Rambo
Secretary, National Association of State Boards of Geology (ASBOG)

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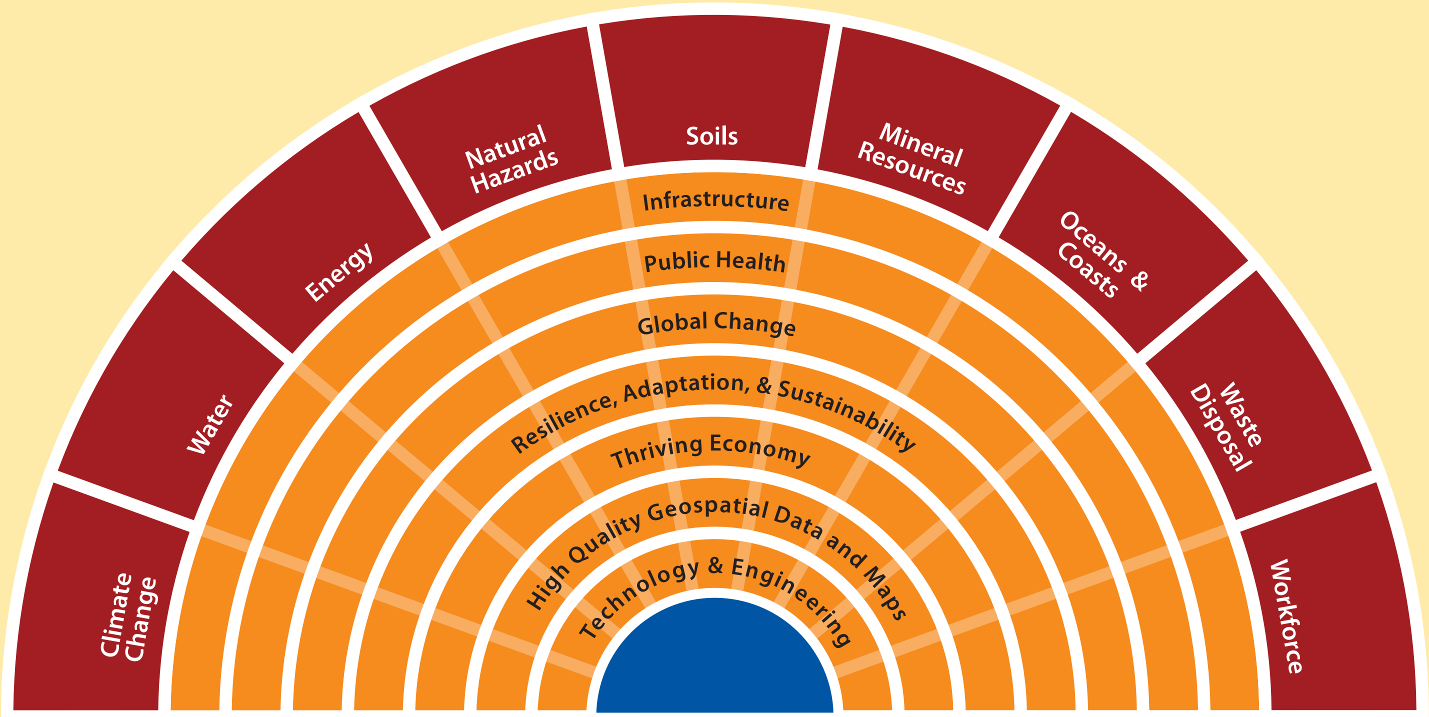
Critical Needs and the Geosciences



EXAMPLES

1. **Climate Change + Resilience, Adaptation, & Sustainability:** Climate change mitigation involves taking actions to reduce the amount of carbon dioxide in the atmosphere, thus reducing risks associated with a changing climate. Adaptation helps society and natural systems to deal with consequences of climate change. Managing risks from climate impacts protects communities and ecosystems and strengthens the resilience of the economy.

2. **Water + High Quality Geospatial Data and Maps:** Understanding the distribution of rock units and their geologic, chemical, and physical properties benefits the water resources community. Knowledge of which units have high, low, or no porosity; fracture vs. inter-granular porosity, etc., is essential in assessing groundwater hydrology.

3. **Energy + Technology & Engineering:** Innovative technology and engineering is essential to understanding alternative exploration scenarios for energy resources.

4. **Natural Hazards + Infrastructure:** Levee, floodwall and dam failures can be anticipated and avoided with proper assessments.
   - 2020: Edenville Dam
   - 2017: Oroville Dam
   - 2005: New Orleans Levees and Floodwalls
   - 1977: Laurel Run Dam

5. **Natural Hazards + High Quality Geospatial Data and Maps:** High quality mapping of bedrock and surficial materials is essential to understanding processes that involve the potential for natural hazards. Examples include mapping active faults or the relative stability of slope materials that could lead to landslide or produce slow mass-movement hazards.

6. **Soils + Global Change:** Global changes in temperature, precipitation, and nutrients will impact soils and agriculture in the United States.

7. **Mineral Resources + Technology & Engineering:** Mineral resources provide critical components for items that society relies on every day such as cell phones, batteries, and cars. Technology and engineering help geoscientists understand the extent and accessibility of the nation's mineral resources.

8. **Oceans & Coasts + Resilience, Adaptation, & Sustainability:** Coastal cities across the U.S. are becoming more sustainable and resilient to disasters such as coastal flooding and hurricanes through adaptation informed by geoscience research.
   - Miami
   - Boston
   - New York

9. **Oceans & Coasts + Infrastructure:** Ports are an important economic driver in coastal areas that create American jobs and help transfer goods to communities across the nation. Ports also serve as significant resources for national defense and emergency preparedness.
   - Norfolk
   - Los Angeles
   - Newark/New York

10. **Waste Disposal + Public Health:** Poor waste handling and disposal can lead to environmental pollution and cause diseases in animals and humans.
    - 2008: Kingston Coal Slurry Spill
    - 2005: Hurricane Katrina
    - 1970s: Agriculture Street Landfill

11. **Workforce + Thriving Economy:** A strong geoscience workforce can help create a thriving society by sharing their knowledge with the public and helping people to understand Earth's processes. A workforce made of people from diverse backgrounds is best positioned to respond to our Nation's needs, including ensuring a society safe from changing hazards.

Our Future: Geosciences Supporting a Thriving Society in a Changing World

The geosciences—earth, atmospheric, and ocean sciences—are critical to ensuring a thriving society and economy by providing the raw materials and expertise necessary for the production and resilience of food, water, energy, and infrastructure. Economic and population growth, climate change, and the creation of new technologies are continuing to increase the demand for these resources, requiring a corresponding advancement in geoscience capacity to meet these needs. By ensuring we understand how people and the planet interact, the geosciences inform solutions to growing environmental, health, and safety challenges.

The geosciences help us thrive in a changing world by:

- Informing *climate change* mitigation and adaptation strategies that support continued economic and societal well-being
- Ensuring sufficient supplies of clean *water* for a growing population
- Developing sustainable *energy* to power the nation
- Building resiliency to *natural hazards* to reduce human and economic harm
- Managing healthy *soils* to meet the food security needs of humanity
- Providing raw *mineral resources* for modern society
- Expanding opportunities and mitigating threats in the *ocean and coasts*
- Managing *waste* for a healthy society
- Enabling these activities by increasing diversity, equity, and inclusion and meeting future geoscience *workforce and education* needs

Although we highlight nine critical issues, they are interwoven with the other physical, chemical, biological, and human components of the earth system, sometimes creating complex feedbacks. In our changing world it is crucial to understand when, where, and how the critical issues detailed in this document intersect with one another and with other policy areas. Considering these critical issues and their convergences in decision-making will lead to positive impacts on economic growth and a thriving society.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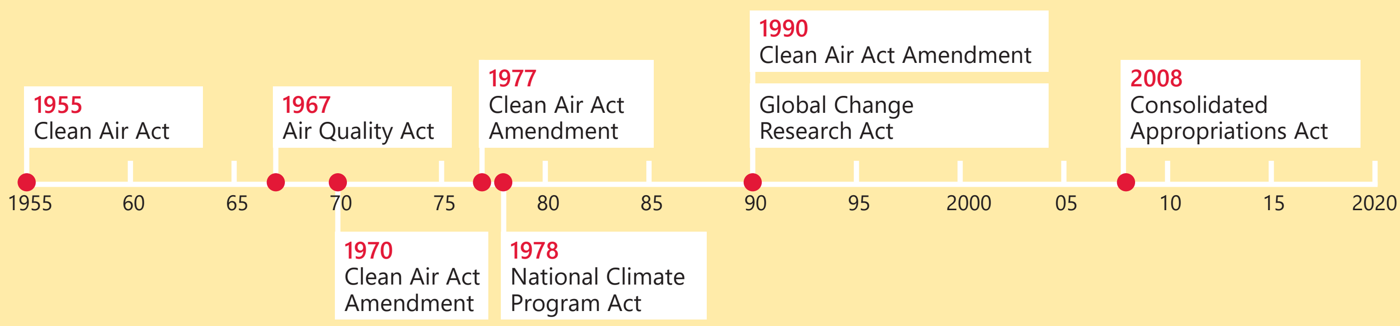
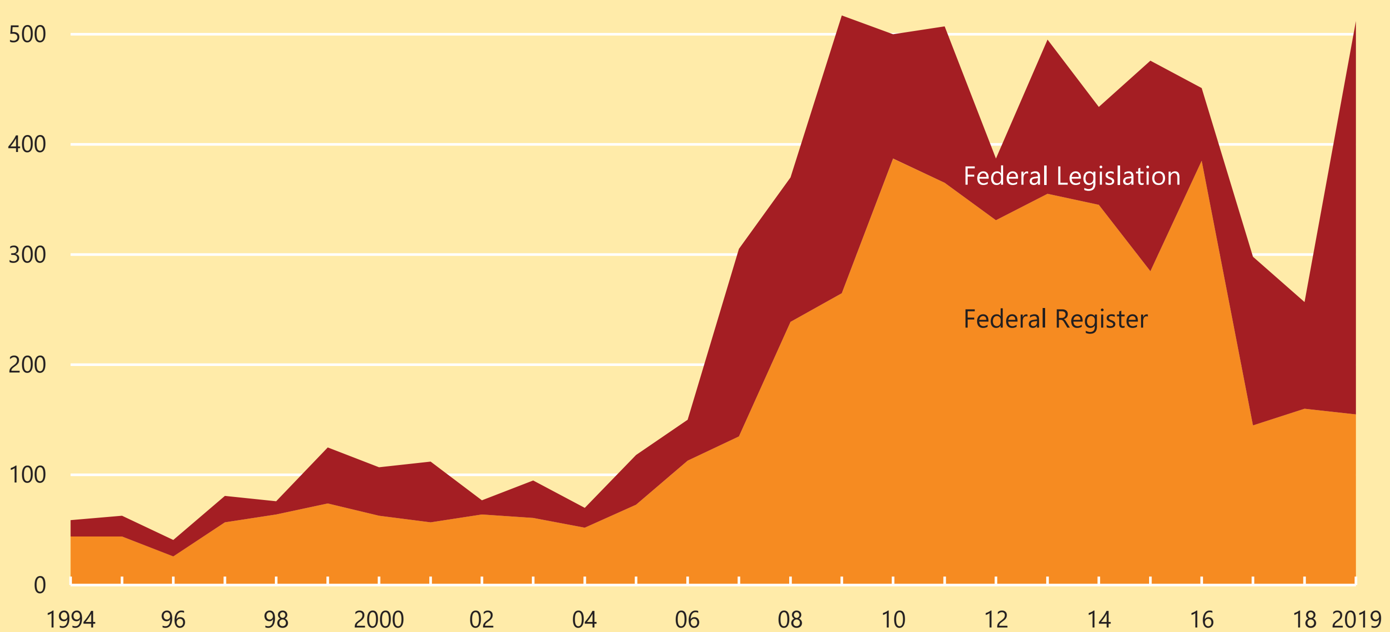
Measuring Our Progress: Climate Change

Timeline of Key Legislative Activities



Climate Change Policy

Number of documents that mention “climate change” and related terms



Sources: Federal Legislation: https://congress.gov/ — quantity of introduced legislation that reference the phrases “climate change,” “global warming,” and/or “global change”; Federal Register: https://www.federalregister.gov/ — number of documents using these phrases

Critical Needs 2020: Climate Change

Mitigating and Adapting to Climate Change

The coupling of the earth system with the welfare of the economy and society is no more evident than through the impacts of changes in climate. The critical tenets of a thriving society—stable food and water supplies and resilience to hazards—are acutely sensitive to changes in climate as a central expression of the earth system. Therefore, climate change poses serious risks to all nations and all people.

Scientists have determined that recent climate change, primarily driven by human-caused greenhouse gas emissions[1], has been:

- Changing the physical characteristics of the Earth: global temperature increase of about 1.8°F from 1901 to 2016, global sea level rise of 7–8 inches in the last 100 years, reductions in snow and ice coverage, and shifts in weather patterns including increases in the frequency and intensity of heavy precipitation events in most parts of the US[2]
- Changing Earth's biological systems: species locations, timing of life events, and occurrence and flow of goods and services from natural and managed systems[2]
- Changing the chemical characteristics of the Earth: increased carbon dioxide intake by the oceans has resulted in ocean acidification that can harm vulnerable marine ecosystems[2]

These changes impact society and every economic sector, including infrastructure, energy supply and demand, and fisheries and agricultural productivity and operations.[1] Future changes are dependent on atmospheric greenhouse gas levels and the responses of the other parts of the earth system.[1]

Options for managing risk associated with climate change fall into four broad categories: 1) mitigation—efforts to reduce greenhouse gas emissions or enhance sinks; 2) adaptation—increasing society's resilience to changes in climate; 3) geoengineering or Earth engineering—additional, deliberate manipulation of the earth system to counteract some of the impacts of greenhouse gas emissions; and 4) research and education—studying the impacts of climate change and mitigation, adaptation, and geoengineering strategies and communicating the findings. Geoscientists provide vital insight in all four areas.

Change Is

Scientists have determined, with high confidence that:

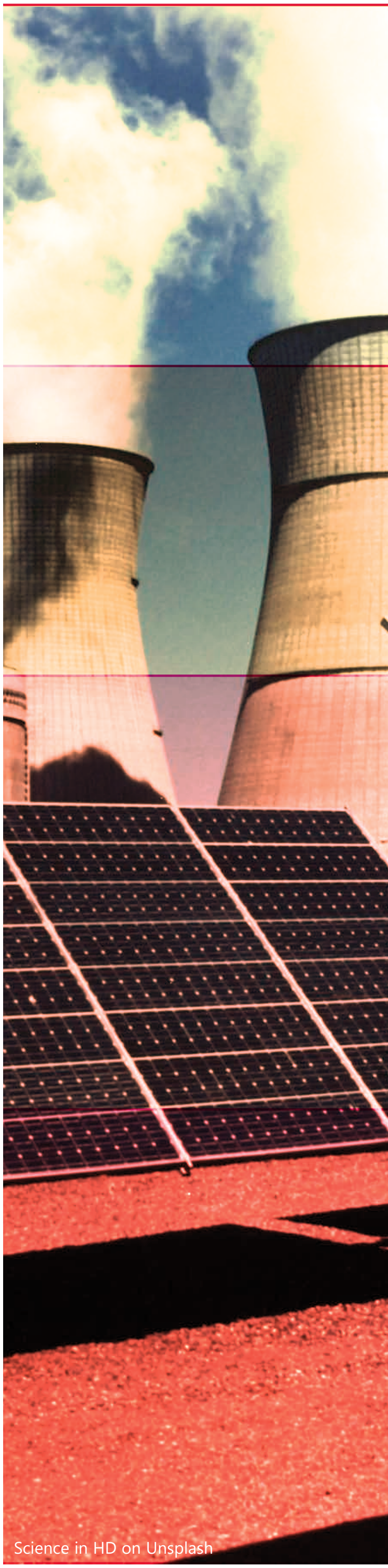
- People have caused a 45% increase in carbon dioxide concentrations in the atmosphere[1,2]
- Human-caused increases in greenhouse gases are primarily responsible for global warming of 1.9°F since 1880[3]
- The consequences to people from climate change are large and increasing[4,5]
- Warming is changing the physical characteristics of the Earth (where oceans and coasts meet; weather patterns; and the location of ice and snow)[6]
- Warming is changing biological systems: species locations; timing of life events; and occurrence and flow of goods and services from natural and managed systems[4]
- Warming is impacting society and every economic sector: infrastructure; energy supply and demand; agricultural productivity and operations[4]
- Warming will continue from our past emissions and future emissions will add to warming[6]

1 https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html
2 https://climate.nasa.gov/vital-signs/carbon-dioxide
3 https://climate.nasa.gov
4 IPCC WG II AR5 & US NCA 4: https://www.ipcc.ch/report/ar5/wg2/
5 https://nca2018.globalchange.gov
6 IPCC WGI AR5 https://www.ipcc.ch/report/ar5/wg1/

1 Climate Change 2014: Synthesis Report. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar5/syr/
2 Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II 2018. U.S. Global Change Research Program. https://nca2018.globalchange.gov

Rodrigo Lourenco on Unsplash

For a climate-resilient nation:



Science in HD on Unsplash

Evaluate and implement strategies to minimize the release of greenhouse gases and increase the removal of greenhouse gases already in the atmosphere (mitigate climate change)

Mitigating climate change is centrally driven by reducing the amount of carbon released into the atmosphere, especially through fossil fuel combustion. Geoscientists engage in various parts of this effort, such as providing the specialty mineral resources necessary for the energy transition to a low-carbon economy. Removal of carbon is another strategy, and geoscientists are working on carbon storage through both existing and innovative approaches including carbon sequestration in soils, enhanced weathering, and carbon capture and storage (CCS) in deep geologic formations.

Plan for the diverse and complex societal impacts of climate change (adapt to climate change impacts)

Climate impacts include shifts in the location, timing, and intensity of both single weather events, like heat waves and winter storms, and extended effects, such as drought, crop failures, vector-borne diseases, sea level rise, and damage to ecosystems[1], which carry the potential for long-term social and economic impact. Insight from geoscientists, who study the components of the earth system and their connections, strengthens climate-change adaptation plans.

Encourage research to advance our understanding of the connection between Earth's systems, human activity, and climate change

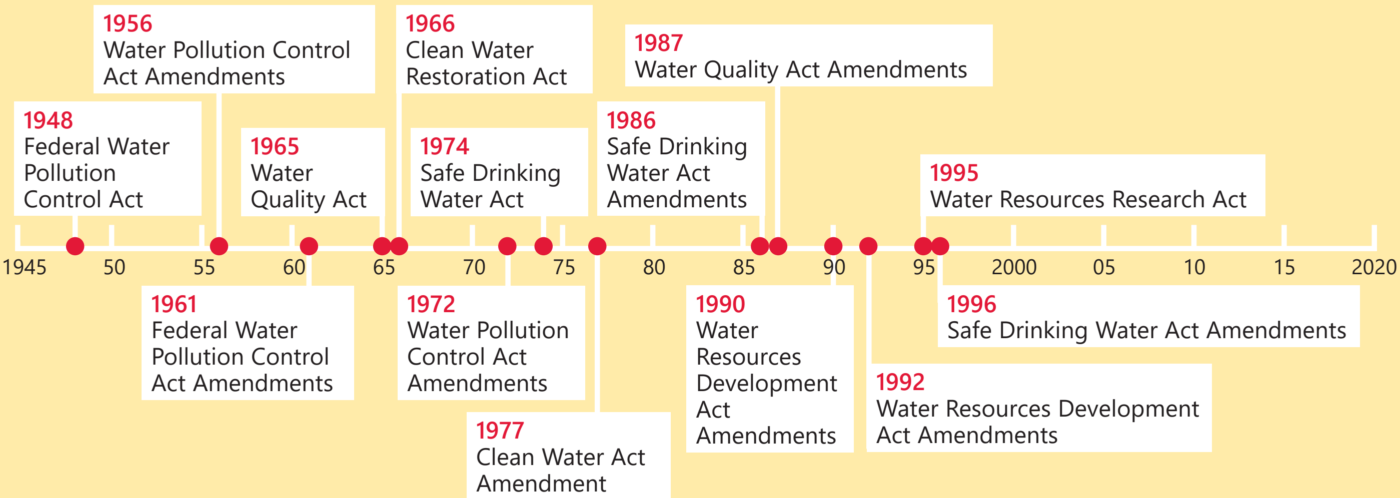
Earth's climate has shaped, and been shaped by, land, water, ice, and the ocean, for over four billion years. Geologic evidence helps us understand feedbacks within the earth system under past climates and improves our ability to predict how ecosystems will respond to continued climate change driven primarily by human-caused greenhouse gas emissions. Additional research into the potential for abrupt and irreversible climate changes and the impacts of mitigation, adaptation and geoengineering strategies is needed to inform climate-related decision-making. Advancing geoscience knowledge and understanding will empower and improve future responses to climate change.

Create policies using the best available evidence

Managing the risks of climate change depends on making the best possible use of the knowledge and understanding that we already possess. Scientists, decision-makers, members of the media, and the public must work together to have a common understanding of scientific evidence; appropriate expectations for the potential for scientific advancement; and a shared appreciation for the potential and limits of science to enhance decision-making.

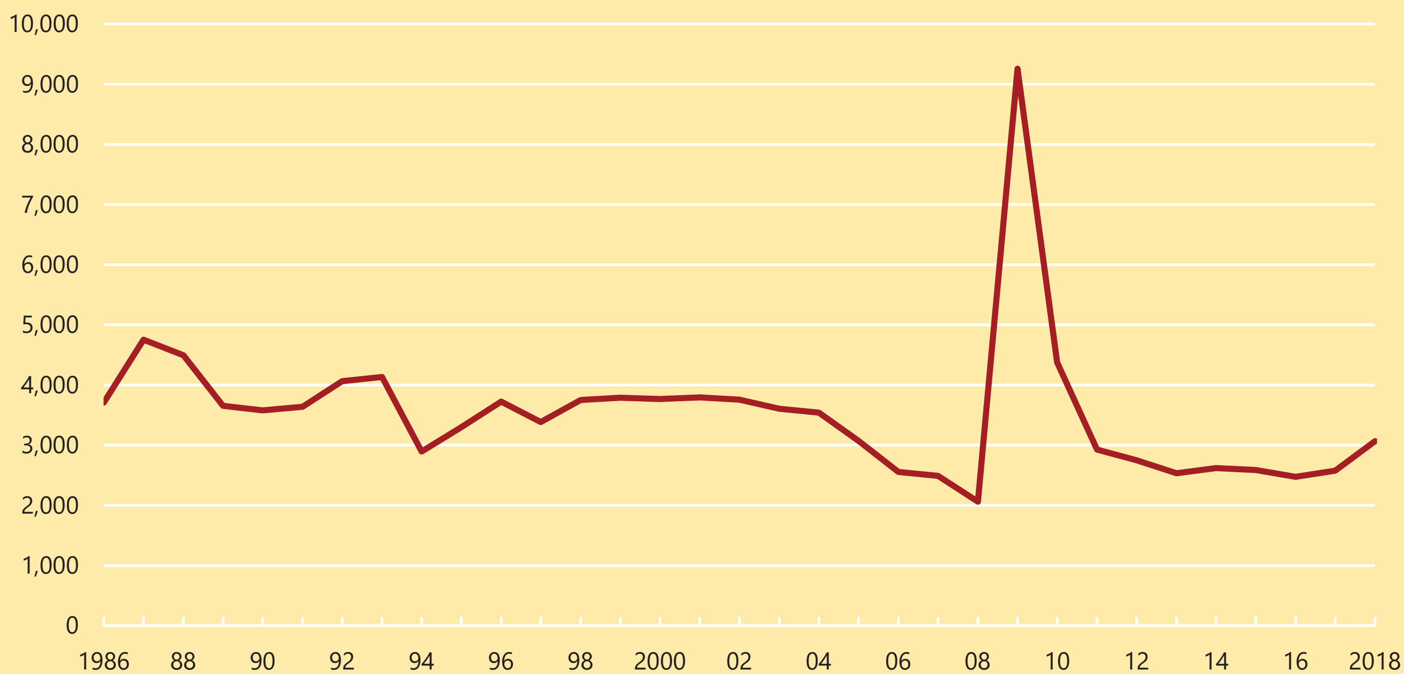
Measuring Our Progress: Water

Timeline of Key Legislative Activities



EPA Water Infrastructure Funding

Total appropriation in millions of 2020 dollars



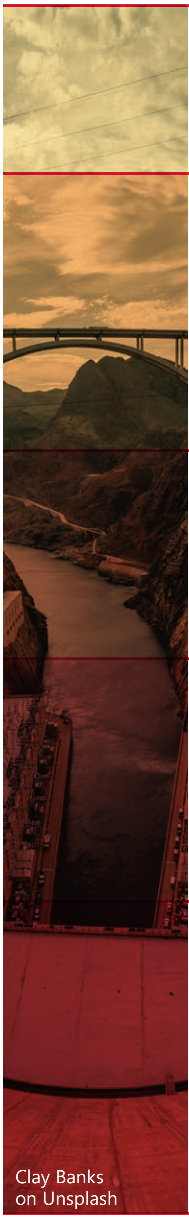
Source: CRS (https://fas.org/sgp/crs/misc/96-647.pdf)

Critical Needs 2020: Clean Water

Ensuring Sufficient Supplies of Clean Water

Clean water is necessary for life and is essential for a strong economy. Overdemand, water quality constraints, allocation issues, and climatic variability are some of the challenges affecting our Nation's water supplies. Effective planning and management strategies are critical for sustaining agriculture, electricity generation, fisheries, industry, transportation, recreation, drinking water supplies, and healthy ecosystems. Geoscientists provide expertise necessary for effective water resource planning, management, and sustainability, and they are conducting research to better understand and predict changes in the amount, quality, and location of water resources.

To optimize clean water availability:

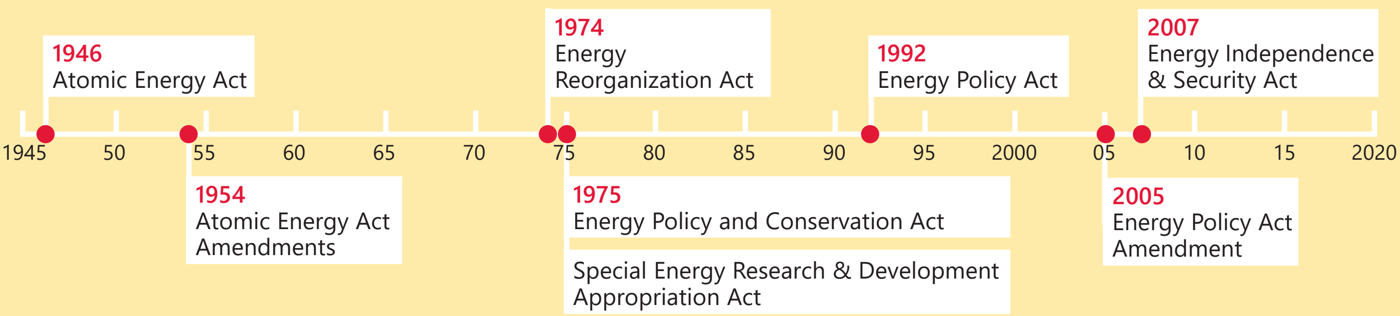

Clay Banks on Unsplash

Increase monitoring of both the quantity and quality of surface water and groundwater	Knowledge of the state of water resources and how they change both spatially and over time is critical for protecting, maintaining, and restoring the Nation's water quality and quantity. It is important to collect, manage, and widely share this information effectively.
Improve understanding of connections within the hydrologic cycle and between water resources and other critical issues	We need to better understand the interaction between surface water and groundwater and integrate that knowledge into water and land management practices. Implementation of practices such as managed aquifer recharge and aquifer storage and recovery (ASR) support sustainability of water supplies. Understanding links between water and other critical issues—including energy, agriculture, mining, natural hazards, transportation, and waste disposal—facilitates integrated planning and optimal decision making.
Balance smart water use and conservation practices with ecosystem needs in changing climatic conditions	Healthy ecosystems purify water and air, mitigate flooding, reduce erosion, and perform other key services, but ecosystem health depends on sufficient water availability. Seawater intrusion is impacting our coastal lowlands and aquifers thereby reducing essential habitat and sources of fresh drinking water.
Develop and maintain infrastructure to collect, treat, store, and deliver safe water to meet changing needs and conditions	About 6 billion gallons of clean drinking water are lost daily from failing infrastructure and leaking pipes in America[1]. The high costs of infrastructure development, maintenance, and replacement, such as lead service lines, and water sourcing decisions, such as in Flint, Michigan, impose growing financial burdens and require long-term planning based on geologic principles and innovative engineering.
Address new and persistent sources of contamination and identify threats to water quality in a timely manner	Water quality is threatened by long-recognized contaminants—such as trace elements, pesticides, industrial spills, excess salt from roadway deicing, and nutrients primarily from agricultural sources—as well as newer pervasive compounds such as pharmaceuticals, microplastics and per- and polyfluoroalkyls (PFAS), which are related to non-stick coatings and aqueous film forming firefighting foams, among many other uses. Expanding national lab capacity to test for emerging contaminants is key to defining the scope of contaminant issues in our water.

[1] Report card for America's Infrastructure 2017. American Society of Civil Engineers. https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Drinking-Water-Final.pdf

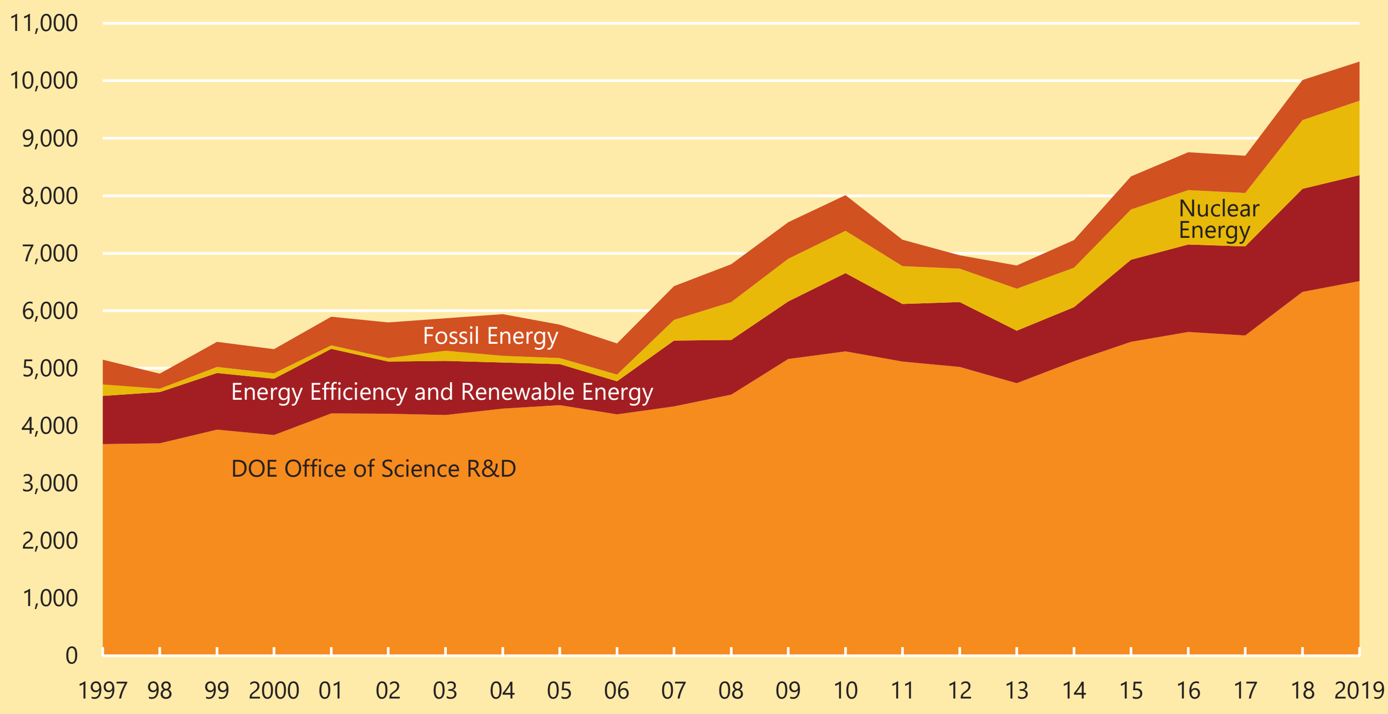
Measuring Our Progress: Energy

Timeline of Key Legislative Activities



Department of Energy Budget Authority

Millions of dollars



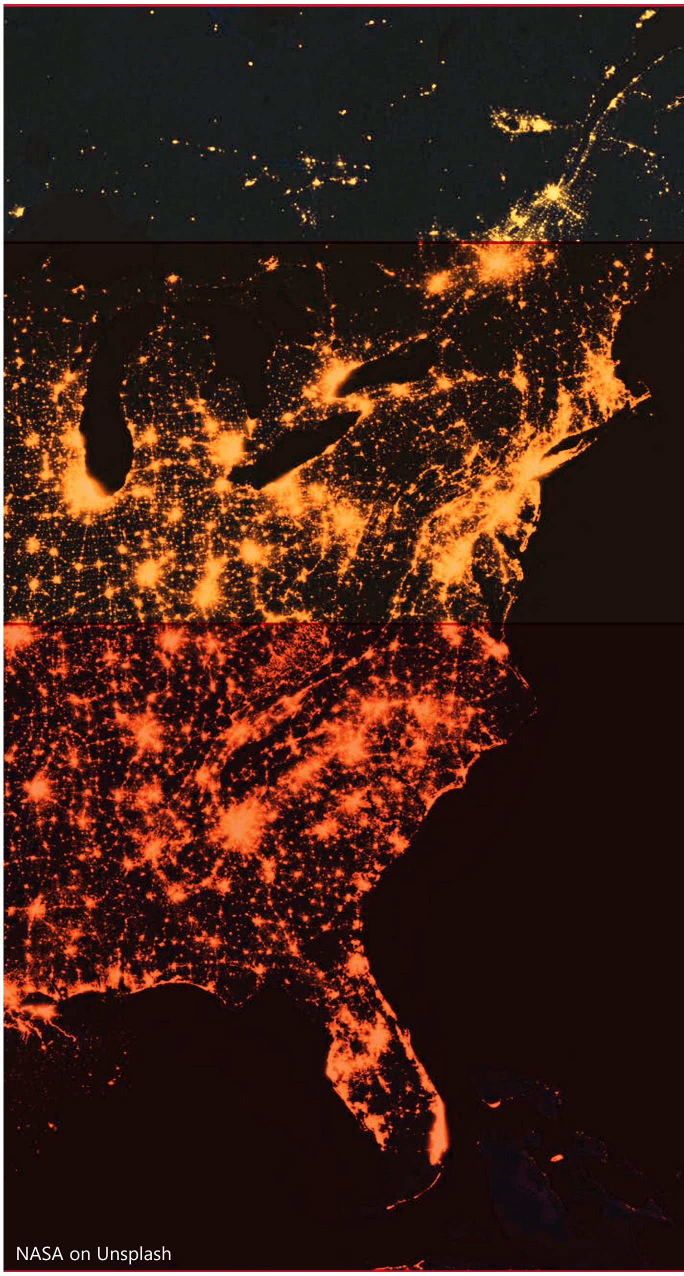
Source: AAAS (https://www.aaas.org/programs/r-d-budget-and-policy/historical-trends-federal-rd)
Note: Values adjusted for inflation.

Critical Needs 2020: Energy to Power the Nation

Developing Energy to Power the Nation

Energy supports economic growth and national security and is essential for all elements of daily life—food, water, transportation, communication, and entertainment. The United States' robust and secure energy systems enable our high quality of life. Geoscientists find and develop earth- and ocean-sourced energy resources, such as oil, natural gas, coal, uranium, and geothermal hotspots. They also find and develop the raw materials needed for renewable energy sources: concrete and metals for dams, critical metals for wind turbine generators and solar installations, and battery storage metals like lithium and cobalt. In addition, geoscientists help determine appropriate locations for energy infrastructure including refineries, transmission lines, dams, and wind farms.

For an energy-secure nation:

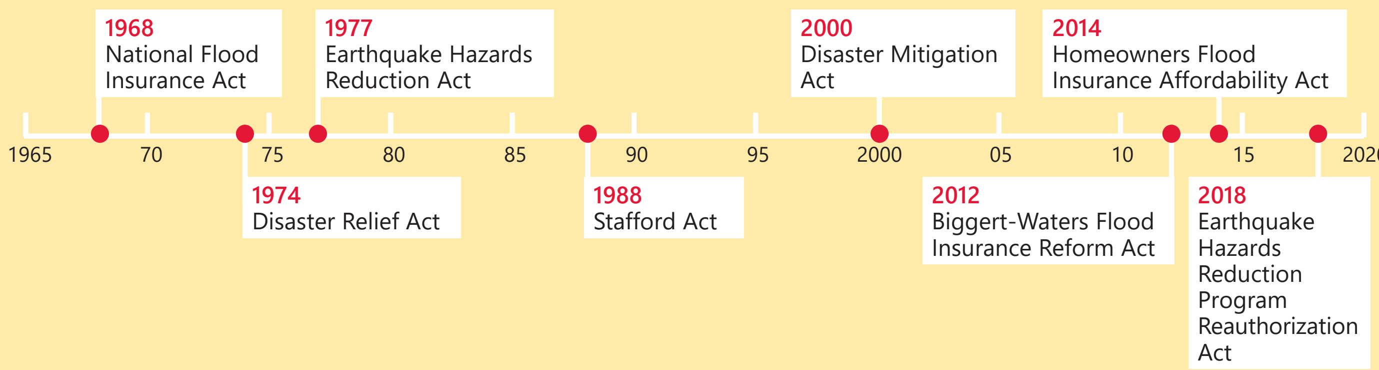


NASA on Unsplash

Assess the quantity, quality, and location of energy resources	Geoscientists improve understanding of energy resources, enabling decision makers to create robust energy policies and allowing energy producers to develop resources more efficiently.
Develop the Nation's diverse energy sources	The United States relies on a variety of energy sources including petroleum, natural gas, coal, nuclear, hydroelectric, geothermal, wind, and solar. The continued responsible exploration for and development of all energy sources, including emerging energy sources, is critical to ensure reliable energy supplies for the future.
Study and implement solutions that reduce the environmental impacts of energy extraction and generation	Geoscientists perform life-cycle analyses of the short- and long-term impacts of energy development, use, and waste disposal that inform energy policy decisions. Geoscientists are critical to finding and developing appropriate sites for waste products from the Nation's energy production, including nuclear waste repositories, underground injection sites, and landfills, as well as potential sites for carbon capture use and storage. They evaluate and develop renewable energy sources close to markets to reduce environmental impacts from long supply chains.

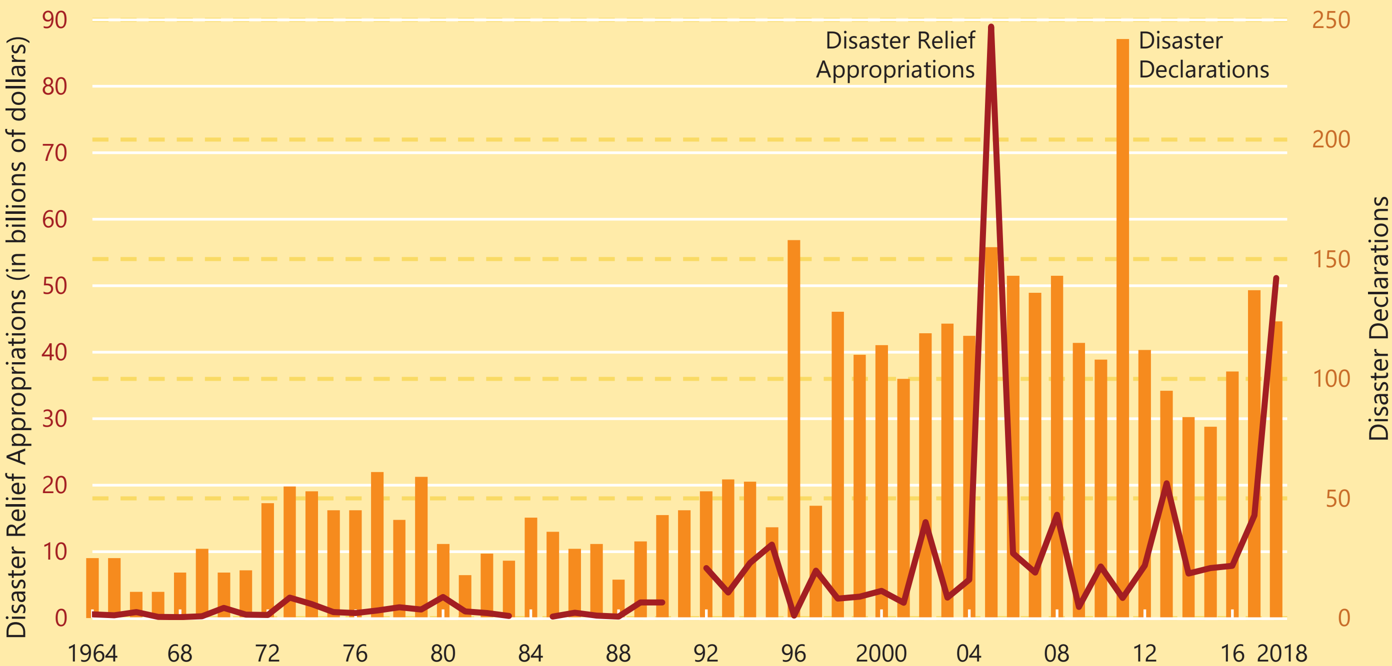
Measuring Our Progress: Natural Hazards

Timeline of Key Legislative Activities



FEMA Disaster Responses, Disaster Declarations and Relief Appropriations

Billions of dollars



Sources: FEMA (https://www.fema.gov/disasters/year) and CRS (https://crsreports.congress.gov/product/pdf/R/R45484)
Note: All types of declarations (major, emergency, fire management, fire suppression)

Critical Needs 2020: Resiliency to Natural Hazards

Building Resiliency to Natural Hazards

Natural hazards impact every state and territory in the United States. Hurricanes, floods, earthquakes, wildfires, tornadoes, volcanoes, landslides, sinkholes, extreme temperatures, and drought, among others, result in billions of dollars in annual losses to the United States.[1] These hazards threaten lives and property, disrupt services, damage infrastructure, and weaken the economy. At present, 39 percent of the U.S. population lives in counties directly on the coastline[2] and at risk to coastal flooding associated with sea-level rise. A thriving nation requires resilient communities so that citizens can endure economic and social disruptions related to natural hazards. Geoscientists help communities identify, avoid, mitigate, prepare for, respond to, and recover from natural disasters. In coordination with engineers, social scientists, public safety professionals, and emergency managers, geoscientists conduct natural hazards research, monitoring, training, education, and public outreach to help create resilient communities.

To minimize the potential impact of natural hazards:

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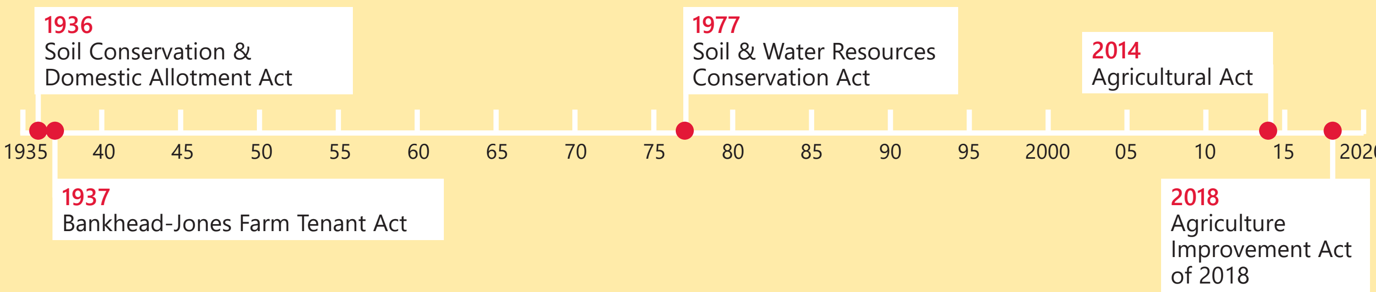
Encourage basic and applied research to strengthen community resilience by minimizing impacts on people and infrastructure	Geoscientists study the links between natural hazards and Earth processes and how natural hazards impact society. They identify hazard-prone areas through geologic mapping and LiDAR technology, and advise on transportation planning, land-use practices, and building codes, leading to more resilient communities.
Prioritize natural hazard monitoring	Geospatial tools such as satellites, LiDAR, seismometer networks, and tide and stream gauges help geoscientists collect data to assist in disaster assessment and response, and develop more accurate models, forecasts, and warnings. Monitoring networks need stable, long-term funding commitments to function properly.
Support communication of the risks and vulnerabilities associated with natural hazards to the public	Geoscientists translate technical data into actionable and accessible information, providing scientific advice for mitigation, preparedness, response, and recovery efforts.

1 U.S. Billion-Dollar Weather and Climate Disasters 2020. National Oceanic and Atmospheric Administration, National Centers for Environmental Information. https://www.ncdc.noaa.gov/billions/, DOI: 10.25921/stkw-7w73

2 National Coastal Population Report: Population Trends from 1970 to 2020. National Oceanic and Atmospheric Administration. http://stateofthecoast.noaa.gov/features/coastal-population-report.pdf

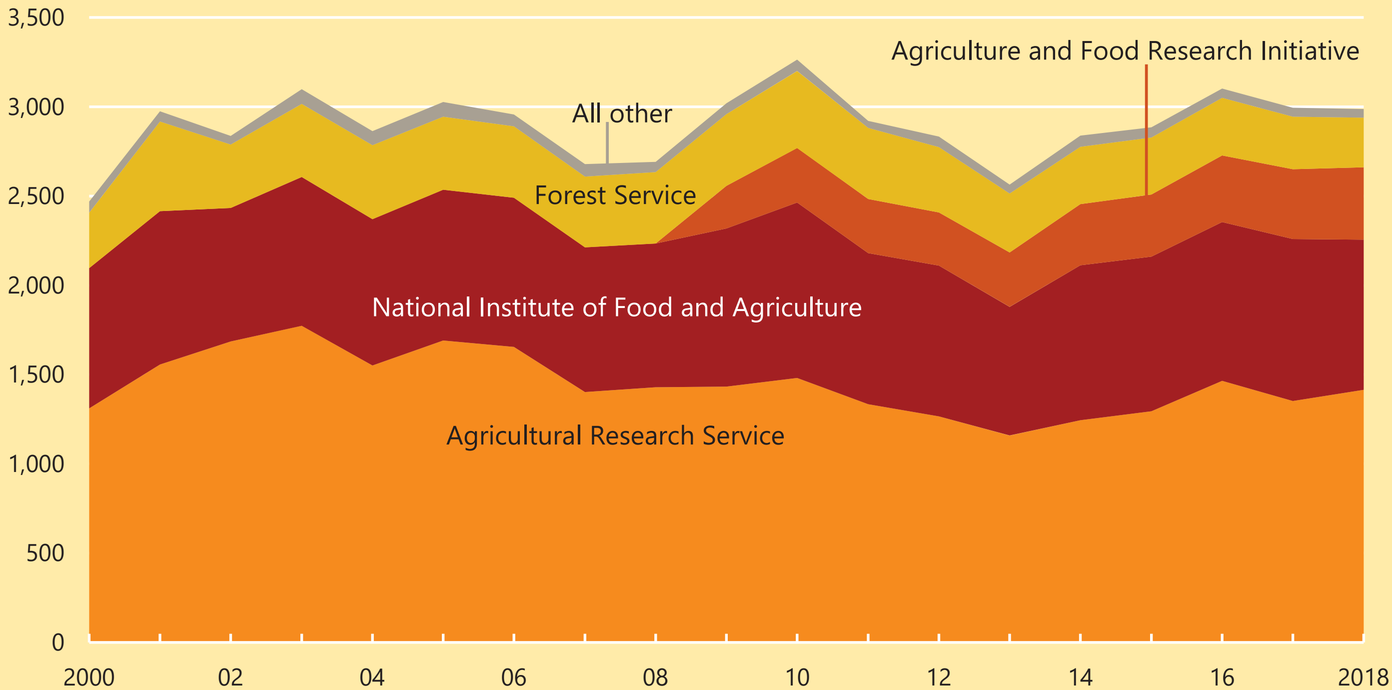
Measuring Our Progress: Soils

Timeline of Key Legislative Activities



Trends in Department of Agriculture R&D, FY 2000–2018

Budget authority in millions of constant 2019 dollars



Source: AAAS (https://www.aaas.org/programs/r-d-budget-and-policy/historical-trends-federal-rd)
Note: Values adjusted for inflation.

Critical Needs 2020: Healthy and Productive Soils

Managing for Healthy and Productive Soils

Soils are a complex combination of minerals from rocks, organic matter from plants and animals, micro- and macro-organisms, air, and water. The ability of soil to support plant life is vital to the production of the food we eat and the air we breathe. Geoscientists study the characteristics, development, and efficient management of soils to improve soil functioning. Functional soils improve agricultural yields, purify infiltrating water, reduce soil erosion, treat waste, improve foundation stability for infrastructure, provide carbon storage, and reduce the impact of natural disasters.

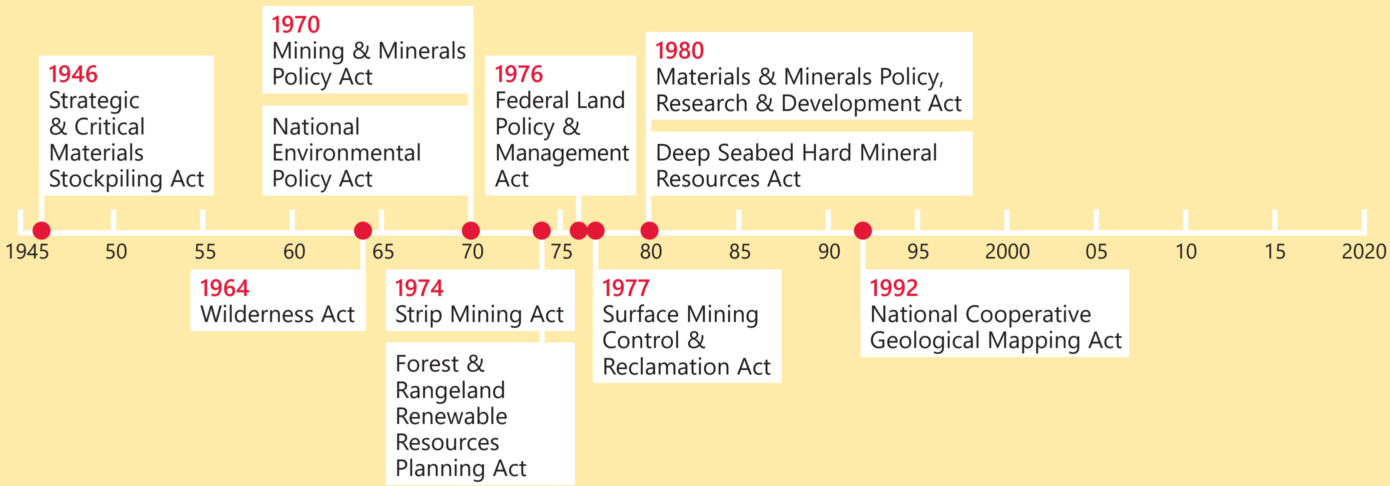
To manage the Nation's soils efficiently:


no one cares on Unsplash

Support monitoring of soil health and moisture, erosion, and deposition into waterways to allow for optimal operations and plant production	Managed soils improve fertility and crop yields, and potentially reduce offsite contamination. Soil health is based on understanding soil biodiversity and its relation to essential ecosystem functions. Healthy soil supports a wealth of biotic diversity. Geoscientists improve our understanding of the link between soil microorganisms and the functions they provide to support plant growth, remediate contaminants, and contribute to a drought- and flood-resilient ecosystem.
Incorporate knowledge of basic soil characteristics and properties into the planning, design, construction, and modification of critical infrastructure	Soil and rock provide the foundation for our Nation's buildings, roads, bridges, water systems, and pipelines. Understanding soil properties and how they relate to the underlying geology leads to more resilient infrastructure.
Expand the use of soil as a biological filter that removes and degrades pollutants from water	Environmental geoscientists use soil filtration as a natural and inexpensive means to mitigate pollution and improve water quality.
Improve soil characterization and geologic mapping to identify underlying hazards	Earthquakes, landslides, wildfires, droughts, and floods all affect soil stability, sometimes leading to loss of life and property. Identifying and mitigating potential weaknesses in soil layers benefits society by reducing the likelihood and impact of disasters.

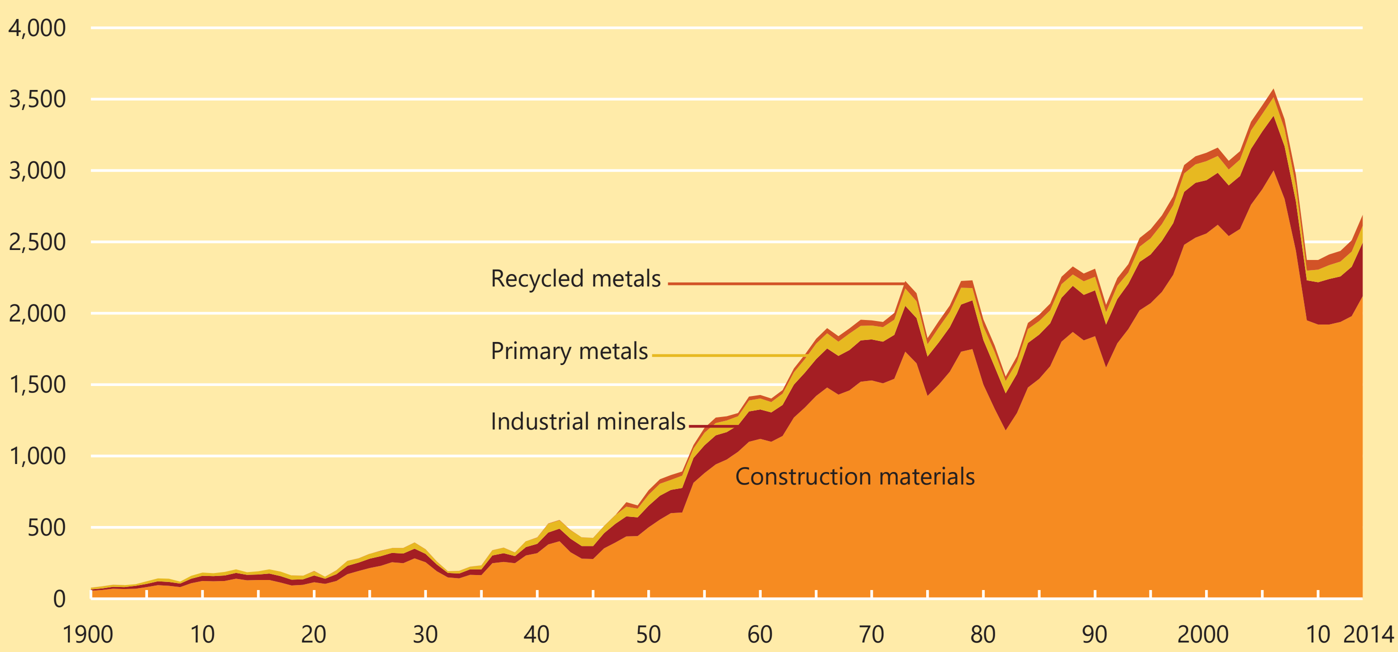
Measuring Our Progress: Mineral Resources

Timeline of Key Legislative Activities



Raw Materials Put Into Use in the U.S., 1900–2014

Millions of metric tons



U.S. raw materials put into use annually from 1900 through 2014, by category. Materials embedded in imported goods are not included. Data source: https://pubs.usgs.gov/fs/2017/3062/fs20173062.pdf

Critical Needs 2020:
Mineral Resources for the Future Economy

Minerals for Modern Society

Modern life, national security, and the wider economy all depend on an abundant supply of minerals—indium for touch screens, phosphates and potassium for crop fertilizers, rare earth elements for missile guidance systems, lasers, and high power magnets, lithium for batteries and energy storage, copper for electricity transmission, and crushed stone in concrete for buildings and roads, among many others. Although minerals are vital for modern life, the pervasiveness of mineral use is not common knowledge and the full extent and accessibility of the Nation's mineral resources is not currently known. A significant proportion of U.S. industry—as well as the defense and energy sectors—are reliant on supplies of minerals from overseas, including critical minerals that are vital for defense, energy, medical, and advanced technology industries.

Minerals also underpin local, regional, and national infrastructure developments. In addition, mining, refining, and processing of minerals provides jobs, and contributes to the health of our economy. The move towards a green technological future is reliant on mineral resources; these raw materials are essential for lower or constrained carbon emissions and for supporting increased demand for hybrid and electric vehicles and renewable energy generation and storage.

The United States relies on imports for more than half of its consumption[1] of 49 mineral commodities[2], including base metals such as zinc and nickel as well as 31 of the 35 critical minerals[3]. The domestic supply of 14 of these critical minerals is completely reliant on imports. There is an urgent need to understand the mineral resource potential of the U.S. and the feasibility of increasing domestic production across a wide range of mineral commodities.[4]

Natanael Melchor on Unsplash

1 Apparent consumption is usually defined as (production + imports) – exports.

2 Mineral Commodity Summaries 2019. U.S. Geological Survey. https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs2019_all.pdf

3 As defined in Executive Order 13817, 82 Fed. Reg. 60835, 2017. https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals

4 A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals 2020. U.S. Department of Commerce. https://www.commerce.gov/sites/default/files/2020-01/Critical_Minerals_Strategy_Final.pdf

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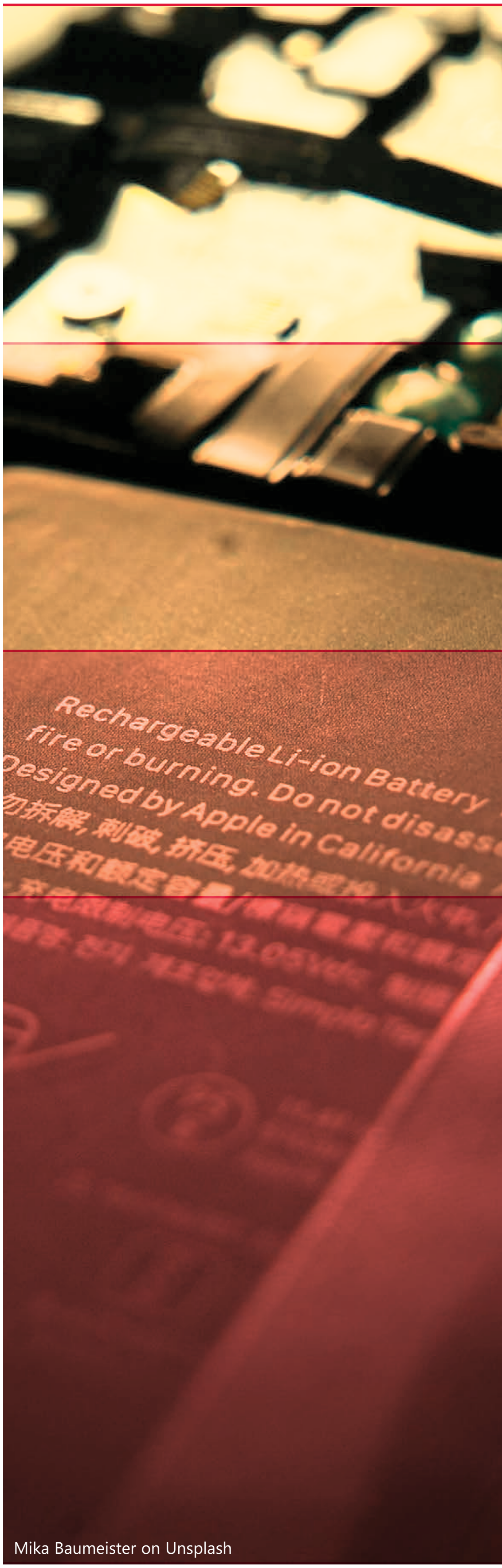
To support a secure supply of minerals the U.S. needs to:

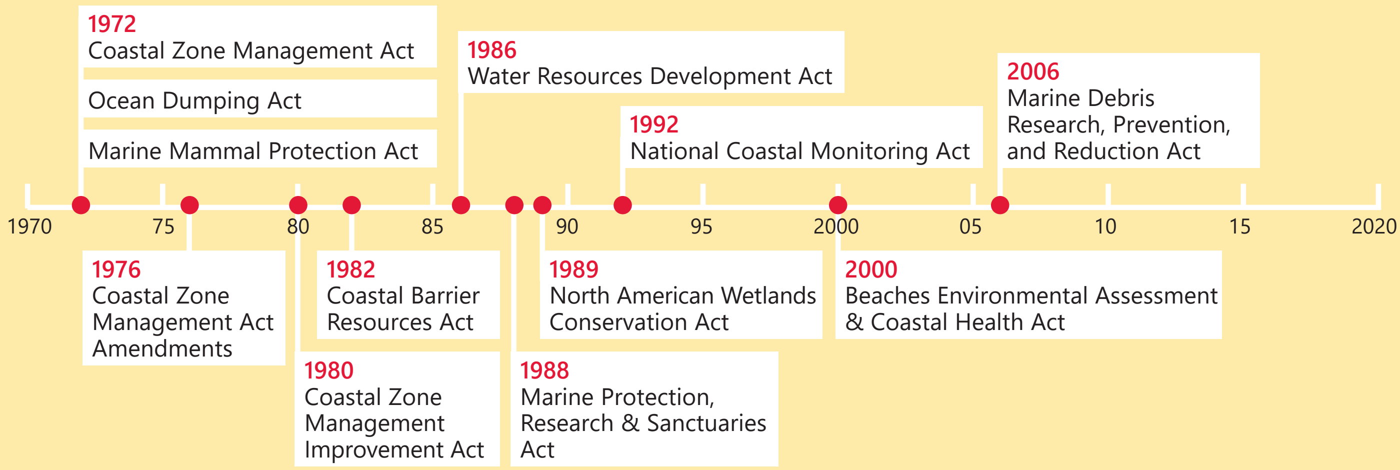


Mika Baumeister on Unsplash

Assess the nature and distribution of domestic mineral resources, especially critical minerals, and improve the topographic, geological, and geophysical mapping of the United States to ensure this information is available for both industry and government	Fundamental information on the Nation's mineral resources is essential for government, industry, energy, defense, environmental, financial, and community decision making, including technology and trade policies.
Quantify domestic and global supply of, demand for, and flow of minerals	Global and domestic industries rely on a stable supply of raw materials. Understanding the global distribution of mineral resources and projecting market trends that impact mineral supply is essential to anticipate and avoid supply disruptions and to make well-informed financial and policy decisions.
Support socially, economically, and environmentally responsible domestic mineral production	Develop responsible approaches to production, including access to public lands for mineral extraction and increasing the potential for secondary mineral production from material previously considered waste.
Develop innovative solutions to lessen the environmental impact of mining and mineral use	Recycling and substitution are increasing, but mining is, and will continue to be, the primary source for most materials. Innovative approaches to mining, mineral use, reclamation, and product disposal can mitigate the impacts of mineral production and consumption.

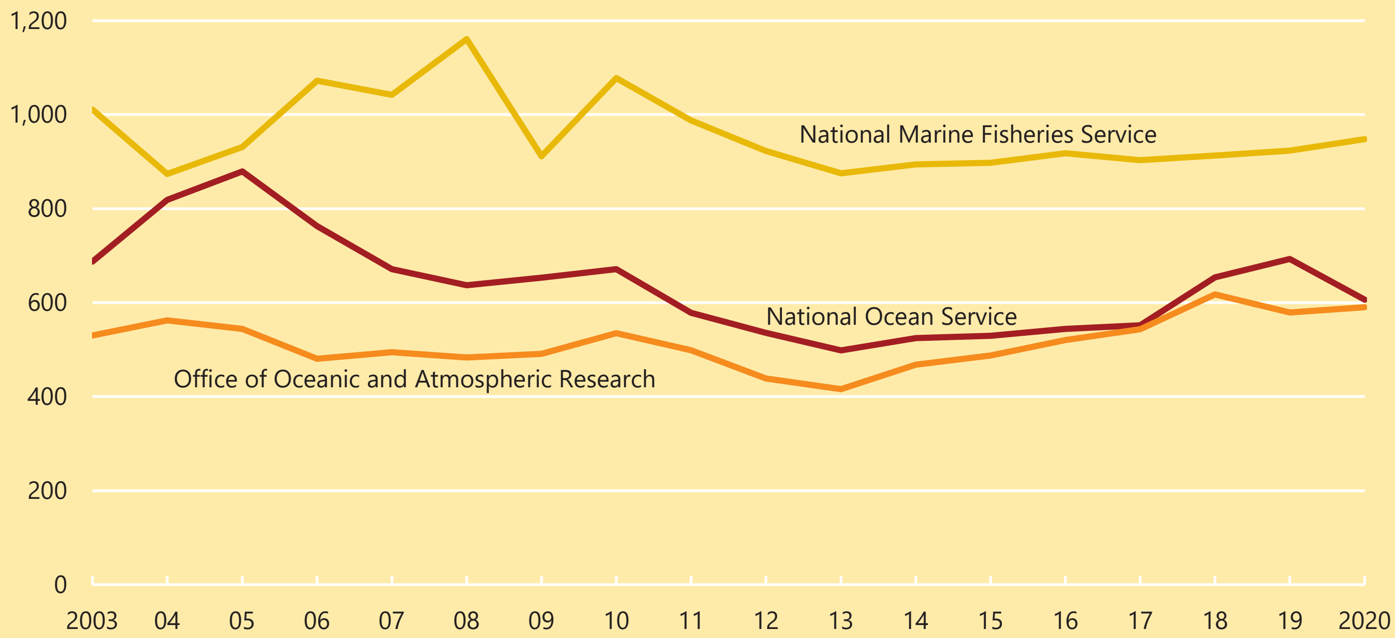
Measuring Our Progress: Oceans & Coasts

Timeline of Key Legislative Activities



NOAA Budget Authority

Millions of 2020 dollars



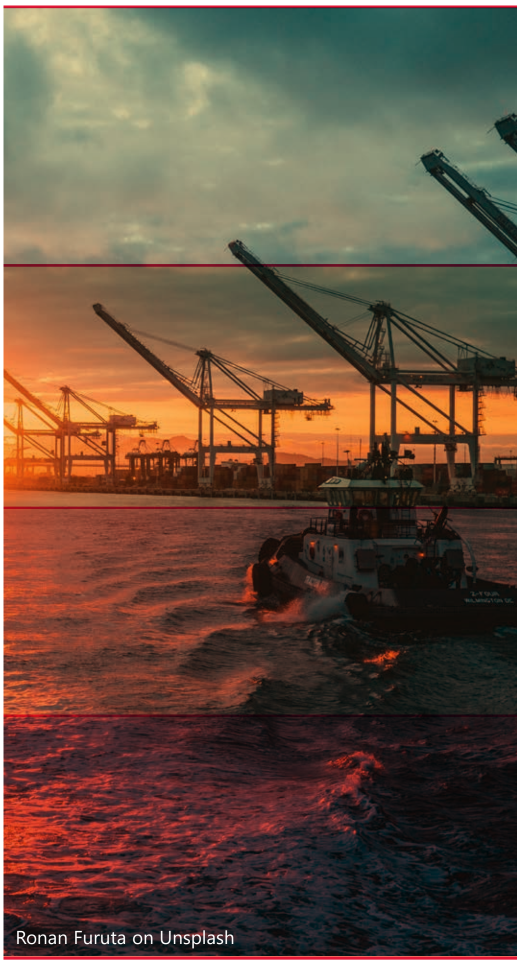
Source: AAAS Reports and agency budget data. Constant dollar conversions based on OMB's GDP deflators from the FY 2020 budget.

Critical Needs 2020: Oceans & Coastal Opportunities

Expanding Opportunities and Mitigating Threats

The United States depends on the oceans and the Great Lakes for food, national security, energy resources, transportation, recreation, and other important needs. More than half of the United States population lives in coastal watershed counties that generate 58 percent of the Nation's gross domestic product.[1] Geoscientists provide information about how our planet's coasts, oceans, and seafloor behave now and how they have functioned in the past. Geoscientists also conduct research on marine energy and mineral resources, natural hazards, sea level rise, and ocean acidification. The United States has jurisdiction over 3.4 million square miles of ocean[2], almost as big as the land area of all 50 states combined. This vast marine area offers environmental resources and economic opportunities; however, coastal communities are threatened by sea-level rise, tsunamis, hurricanes, industrial accidents, and water-borne pathogens, which are already being exacerbated by climate change. A better understanding of our ocean and coastal areas will strengthen our economy and save lives.

To ensure the long-term sustainable use of our oceans, coastal resources, and polar regions:

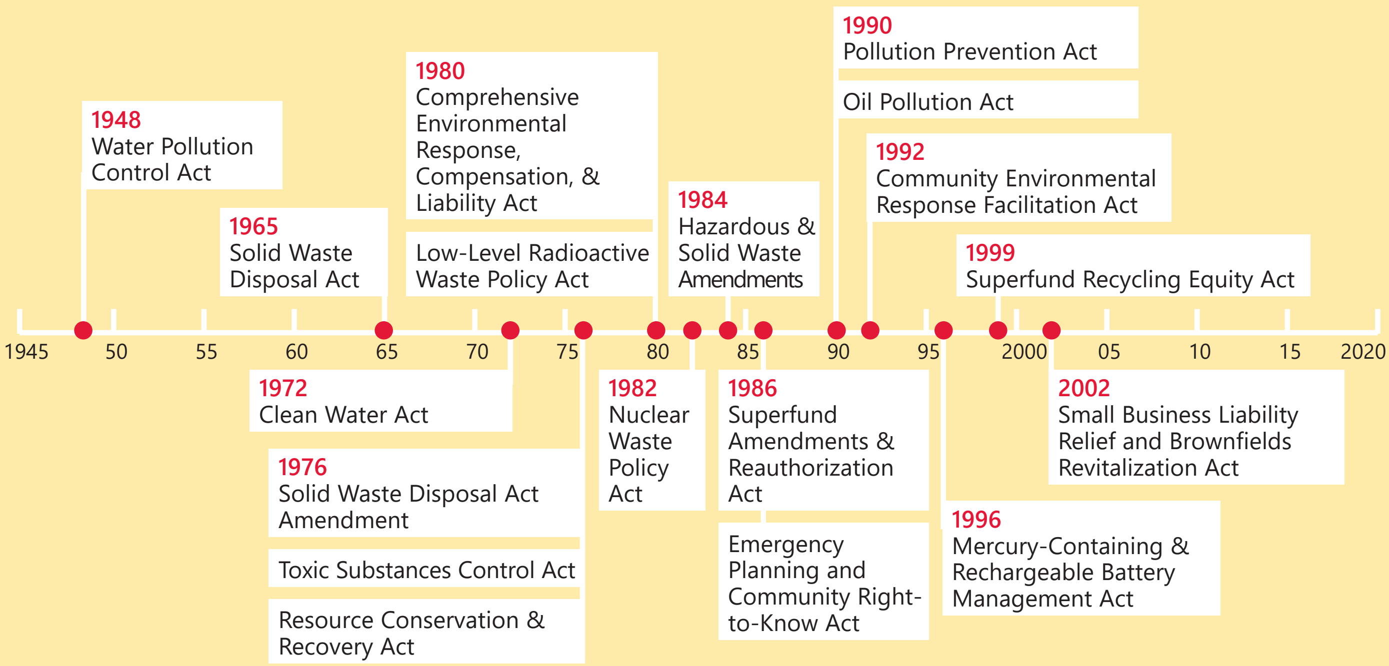

Ronan Furuta on Unsplash

Conduct basic and applied research on ocean and coastal issues	An improved understanding of ocean and coastal processes will help protect the oceans and marine life, increase resilience of coastal communities, and promote economic growth by constructing accurate scenarios for the ocean's behavior in the future.
Enhance ocean observations	The oceans drive global water and weather systems by absorbing, storing, and moving vast amounts of the Earth's heat, water, and CO_2. A resilient nation needs sustained ocean observations from space, from the ocean surface, and at depth.
Monitor, research, and respond to sea-level rise	Sea levels are rising, and the rate is projected to accelerate under warmer conditions, changing coastal ecosystems and making vital coastal communities vulnerable to erosion and flooding associated with storm surges and high tides.
Assess marine energy and mineral resources, including their environmental context	The ocean is not only a source for mineral resources, including metal-bearing seabed minerals and deep-water forms of frozen natural gas, but is an energy source itself in the form of tidal and wave motions that can be used to generate electric power.

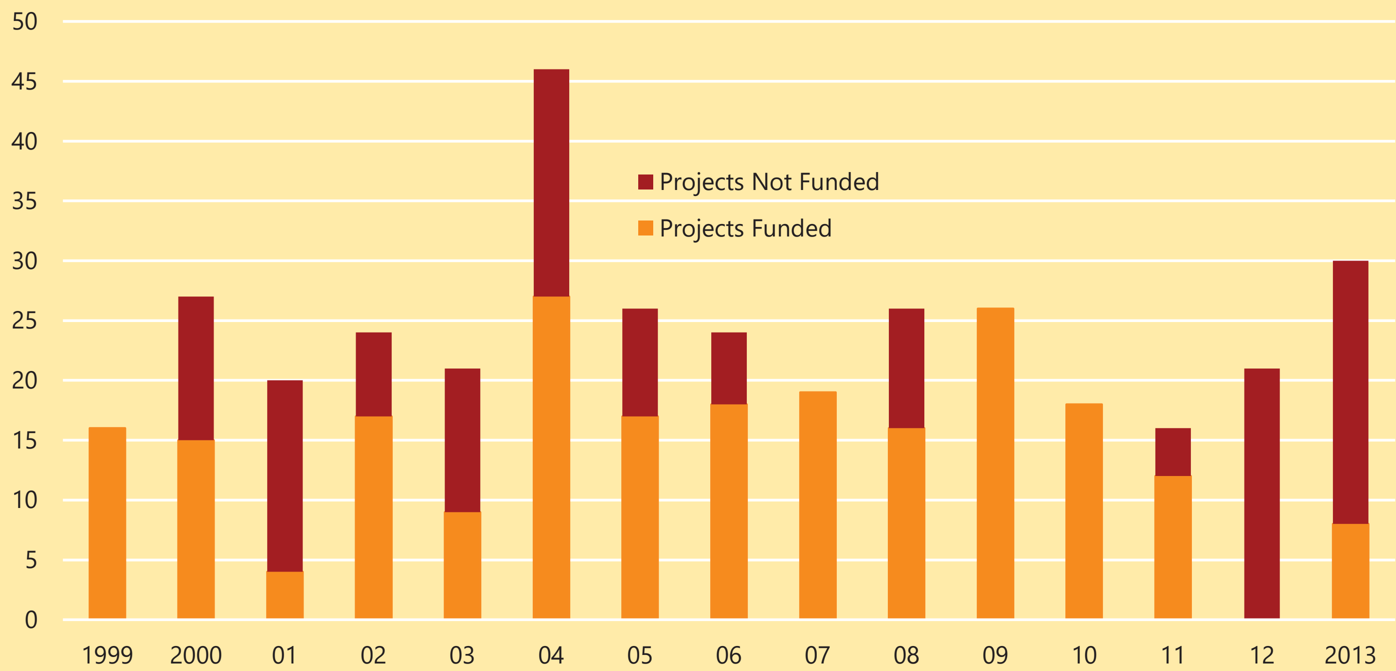
1 National Coastal Population Report: Population Trends from 1970 to 2020. National Oceanic and Atmospheric Administration. http://stateofthecoast.noaa.gov/features/coastal-population-report.pdf
2 USEEZ: Boundaries of the Exclusive Economic Zones of the United States and territories. National Oceanic and Atmospheric Administration, Special Projects Office. https://coastalmap.marine.usgs.gov/GISdata/basemaps/boundaries/eez/NOAA/useez_noaa.htm

Measuring Our Progress: Waste Disposal

Timeline of Key Legislative Activities



New EPA Non-Federal Remedial Action Project Funding Decisions



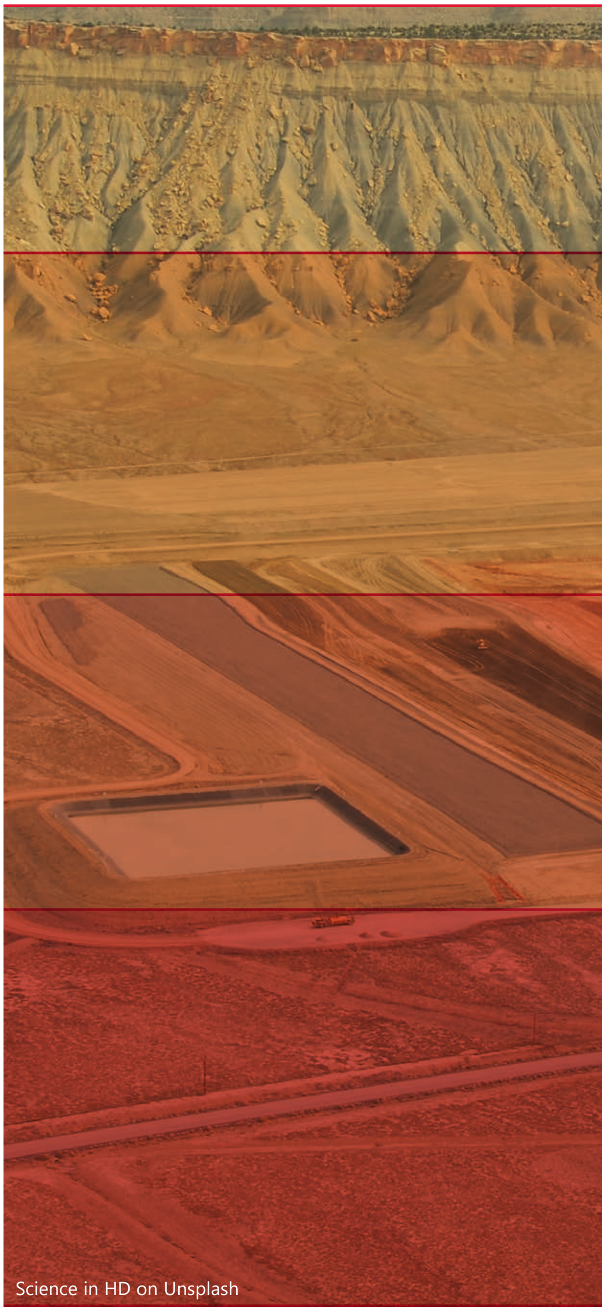
Source: https://www.gao.gov/assets/680/672734.pdf

Critical Needs 2020: Managing Waste Disposal

Managing Waste to Maintain a Healthy Environment

Waste is an inevitable byproduct of society. The composition, volume, and toxicity of waste varies over space and time through different human activities. As a result, historic assessment of waste provides opportunities for reuse and helps us understand environmental impacts. Protection of human health and the environment relies on geoscience knowledge to isolate waste materials from people and ecosystems. Geoscientists translate their understanding of complex Earth systems into meaningful approaches for isolating waste streams and remediating waste sites to be productive land again.

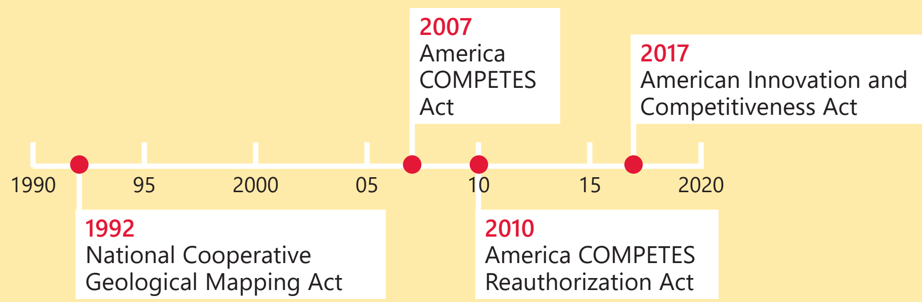
To optimize the balance between resource use and a healthy society:


Science in HD on Unsplash

Assess the safety of disposing of liquid waste in deep wells	This method of disposal is commonly used to dispose of treated wastewater, chemicals, and oil field brines, but it can potentially induce earthquakes or contaminate groundwater. Geoscience investigations can help make this type of disposal safer.
Understand and minimize impacts of energy production and usage	Energy production byproducts include solid wastes such as fly ash, thermal pollution of water from power plant cooling, liquid wastes, and gaseous byproducts like CO_2. Geoscientists have a key role in ensuring this waste is safely disposed of and stored, and they will be at the forefront of a circular economy where re-use and recycled materials formerly considered waste become a resource.
Mitigate the risks associated with nuclear waste	Large volumes of spent nuclear fuel are stored at multiple temporary sites in the United States, and more such waste continues to be generated. A long-term disposal option is still needed for this toxic radioactive waste, and a geologic repository may provide a long-term solution. Geoscientists provide information to help assess site suitability and selection.
Support cleanup of abandoned mines, brownfields, and Superfund sites	Landfills, dumps, and spills can introduce a variety of toxic chemicals into the environment. Geoscience provides a basis for evaluating risks, setting priorities for remediation, and assuring that expenditures yield substantial benefits. Geoscientists also work to understand ocean systems in order to assess the movement and impacts of plastic waste in marine environments.

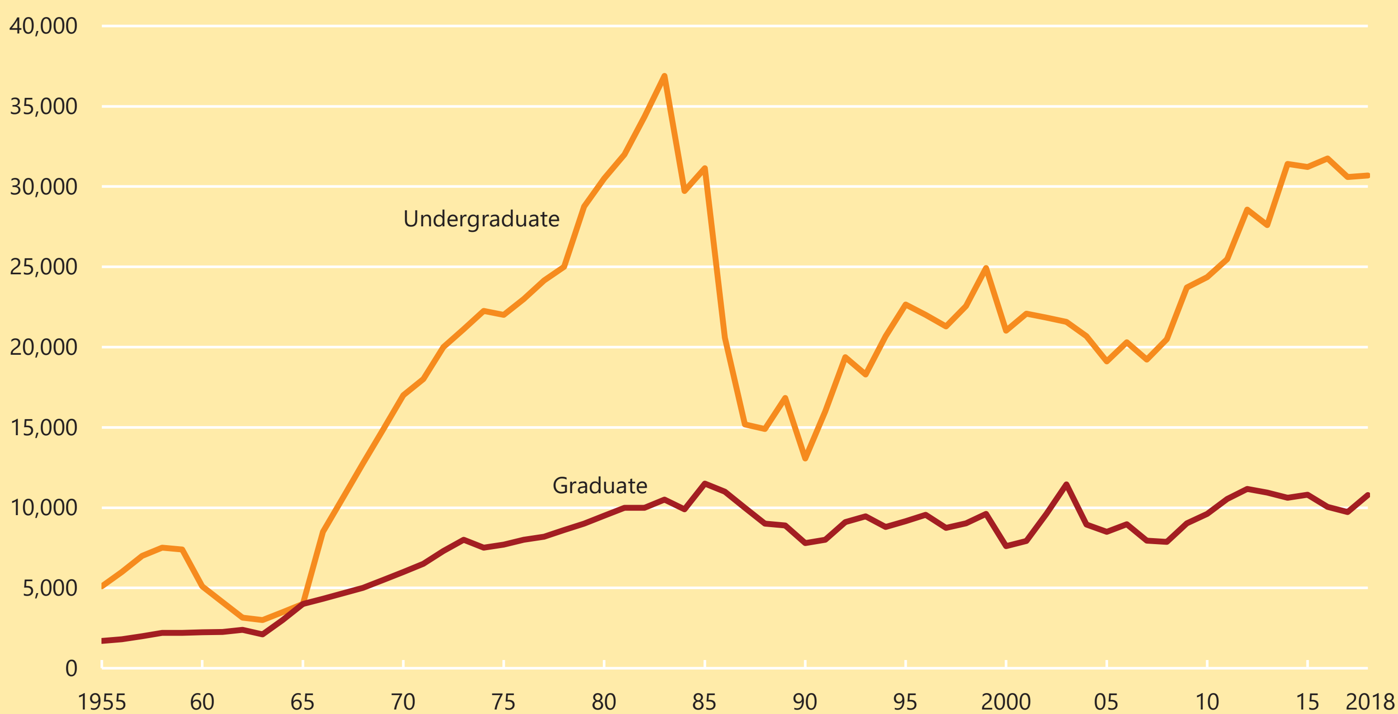
Measuring Our Progress: Workforce

Timeline of Key Legislative Activities



Geoscience Student Enrollment 1956–2018

United States colleges and universities



AGI Geoscience Workforce Program; Data derived from AGI's Directory of Geoscience Departments database

Critical Needs 2020: A Diverse and Robust Workforce

Training and Retaining a Diverse and Robust Workforce

The need for trained geoscientists in the workforce increases along with the expansion of the population and economy as society occupies a wider footprint of our planet. Geoscientists help society understand Earth's processes and recognize resources, hazards, and environmental issues so that communities can respond to these needs and events. Geoscientists have vital roles in identifying and characterizing mineral and energy deposits and providing essential information for efficient resource extraction and sustainable development of resources and effective environmental stewardship. Demand for geoscientists continues to grow within the United States and worldwide, yet increasing numbers of U.S. geoscientists are retiring from the workforce. AGI estimates a shortage of 90,000 geoscientists within the U.S. in the next decade[1]. All of this indicates a need to grow the American geoscience workforce to foster a robust domestic economy.

Resources need to be invested to educate geoscientists in a variety of societally relevant specializations. The Nation's schools, colleges, and universities must be ready to educate and train the next generation of geoscientists by fostering inclusive and accessible learning environments able to prepare students from all backgrounds. For America to maintain a competent and diverse workforce, companies and professional organizations require resources to develop and educate existing and future geoscientists.

NOAA on Unsplash

[1] Wilson, C.E., The Status of the Geoscience Workforce 2018. Alexandria, VA: American Geosciences Institute, 2019.

ThisisEngineering RAEng on Unsplash

To develop a knowledgeable, experienced, and innovative geoscience workforce, we need to:

Improve the resiliency and flexibility of the geoscience workforce by increasing representation of diverse viewpoints and fostering a safe and inclusive work culture	Like most sciences, the geosciences have been historically represented by white, male, and non-disabled persons and the geosciences remain one of the least diverse areas of science[1]. By encouraging people from traditionally underrepresented backgrounds to pursue geoscience and fostering a culture and operational approaches that removes barriers to inclusion and success, the geoscience workforce is able to tap the best and brightest by becoming more diverse and thus better able to solve the increasingly complex problems facing society.
Sustain and grow programs to educate a diverse group of students in science, technology, engineering, and math (STEM)	Geoscience educators at all levels ensure that students across the U.S. have opportunities to learn about the Earth and its processes. They recruit, teach, and mentor talented students—especially those from backgrounds traditionally underrepresented in the geosciences—and encourage them to pursue careers in the field.
Support federal investments in basic and applied geoscience research	Federally-funded research is critical to scientific discovery and provides essential educational and training opportunities for students pursuing geoscience careers.
Increase community engagement and participation in the geosciences	Applied and basic research, monitoring, and citizen-science projects enhance opportunities for public education and improve engagement in geoscience for people of all ages and backgrounds. Engaging the public early and often improves recruitment and retention of diverse professionals in geoscience fields.
Encourage partnerships between industry, government, and academia	Private-sector research and development is essential to maintaining America's globally competitive, knowledge-driven economy. Institutionalized partnerships between government, industry, and higher education, such as the USGS' EDMAP program[2], are necessary to foster innovation and facilitate the research, development, and implementation of best management practices and new technologies. These partnerships strengthen the U.S. economy while providing extensive opportunities for students entering the workforce and professional development opportunities for the existing workforce.

1 Bernard, R.E., Cooperdock, E.H.G. No progress on diversity in 40 years. *Nature Geosci* 11, 292–295 (2018). https://doi.org/10.1038/s41561-018-0116-6
2 EDMAP. U.S. Geological Survey. https://www.usgs.gov/core-science-systems/national-cooperative-geologic-mapping-program/science/edmap?qt-science_center_objects=0#qt-science_center_objects

AGI's Vision

A world that understands and trusts the role of the geosciences in fostering creative solutions for the Earth and humanity.

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www.americangeosciences.org/policy/critical-needs

american geosciences institute

connecting earth, science, and people