

University Corporation for Atmospheric Research
 Consortium for Ocean Leadership
 Incorporated Research Institutions for Seismology
 Lamont Doherty Earth Observatory
 Columbia University
 Woods Hole Oceanographic Institution
 Scripps Institution of Oceanography
 National Association of Marine Laboratories
 Association of Public and Land-grant Universities
 American Association of Petroleum Geologists
 SRI International
 University of California System
 Texas A&M University
 Oregon State University
 University of Colorado
 University of New Hampshire
 University of New Mexico
 University of Connecticut
 University of Wisconsin – Madison
 Florida State University
 University of Delaware
 University of Nebraska-Lincoln
 University of Massachusetts Dartmouth
 Michigan Technological University
 University of Hawaii at Manoa
 University of North Carolina at Wilmington
 University of Oklahoma
 University of Rhode Island
 University of Georgia
 The University of North Carolina at Chapel Hill,
 Institute of Marine Sciences
 Great Lakes WATER Institute, University of Wisconsin-Milwaukee School of Freshwater Sciences
 Humboldt Marine and Coastal Science Institute, Humboldt State University
 Moss Landing Marine Laboratories
 Grice Marine Laboratory, College of Charleston
 University of South Florida - College of Marine Science
 Center for Marine Sciences and Technology – North Carolina State University
 Louisiana Universities Marine Consortium
 American Anthropological Association
 Soil Science Society of America
 Bigelow Laboratory for Ocean Sciences, Maine
 Friday Harbor Laboratories, College of the Environment, University of Washington
 American Geosciences Institute
 National Association of Geoscience Teachers
 Seismological Society of America
 College of the Environment, University of Washington
 Penn State University
 Department of Geography and Meteorology, Valparaiso University
 The College of Arts and Sciences, Valparaiso University
 Metropolitan State University of Denver
 Saint Louis University
 Department of Earth & Planetary Sciences, The Johns Hopkins University
 Oregon Institute of Marine Biology
 University of Oregon
 Annis Water Resources Institute – Grand Valley State University
 The Institute of Earth, Ocean, and Atmospheric Sciences at Rutgers University
 Whitney Laboratory for Marine Bioscience, University of Florida
 Seahorse Key Marine Laboratory, University of Florida
 Marine Science Research Institute-Jacksonville University
 Galbraith Marine Lab, Eckerd College
 Western Washington University, Shannon Point Marine Center
 Belle Baruch Institute for Marine and Coastal Sciences, University of South Carolina
 University of California, Davis

Testimony Regarding Fiscal Year 2017 Funding for
 The National Science Foundation
 Submitted to the
 Subcommittee on Commerce, Justice, Science and Related
 Agencies
 Committee on Appropriations,
 United States Senate
 March 25, 2016

Dear Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to present testimony in support of strong and balanced funding for the National Science Foundation. This testimony is submitted on behalf of the organizations listed in the left margin on this and subsequent pages. They all support funding the National Science Foundation at \$8 billion in FY 2017 – including full funding for the geosciences portfolio of research and related national and user facilities within the NSF request.

We believe investing in NSF will support the kind of basic research and development investment that will prevent an innovation deficit and help ensure the United States maintains the world’s most innovative, dynamic and vibrant economy. Robust federal investment in basic research and development has long proven key to accelerating our economy’s productivity growth and much in the FY 2017 budget would help build on that progress. Increasing research investments in the earth, ocean, atmospheric and climate sciences – areas with incredible need and potential – are examples where this budget proposal seeks to address global problems with U.S.-led research that can also yield real economic benefits, national security, and public safety for our Nation.

Geosciences Research and National Security

On September 15, 2015, a distinguished group of former military and national security leaders said the following:

“...we urge you to protect funding for NASA Earth science and NSF Geoscience programs. These programs are essential parts of a broader whole of government and whole of society effort to provide essential data about and better scientific understanding of global, regional, and local Earth processes. That essential data about better scientific understanding of the underlying science are critical to many strategic planning, strategy, and

University of Maine
Michigan State University
Dauphin Island Sea Lab, Dauphin Island,
Alabama
Desert Research Institute, Nevada
The University of Kansas
University of Minnesota
The Institute at Brown for Environment and
Society, Brown University
The University of Texas at Austin
South Dakota State University
University of California at Irvine
American Association of Geographers
Hatfield Marine Science Center
Harbor Branch Oceanographic Institute-Florida
Atlantic University
Council on Undergraduate Research
The Weather Coalition
North Carolina A&T University
Sitka Sound Science Center, Sitka, Alaska
Romberg Tiburon Center for Environmental
Studies, San Francisco State University
Bermuda Institute of Ocean Sciences, New York
University of Maryland Center for
Environmental Science

investment decisions in both the private and public sectors, very much including national security. From better understanding weather, wind patterns and intensity, changing global land cover, snow, ice and glacier melting, and seismic activity, to capturing new insights about ocean-atmosphere dynamics and changing ocean circulation, these...programs represent one of the pillars of our nation's environmental information supply chain. This critical but fragile chain begins with science and data and evolves into decision support products and tools that inform and protect our citizens, property, businesses, and interests around the world. [These programs] directly link to food, water, energy, and economic security, all of which are inherently tied to our national security."

The national security implications are far reaching as they may exacerbate existing stressors, contributing to poverty, environmental degradation and political instability providing enabling environments for terrorist activity abroad. For example, the impacts of climate change on key economic sectors, such as agriculture and water, can have profound effects on food security, posing threats to overall stability.

On January 14, 2016, Robert Work, the Deputy Secretary of Defense issued DoD Directive 4715.21 that establishes departmental policy and responsibilities within DOD to assess and manage risks associated with the impacts of climate change. The policy statement in this directive says:

"...The DoD must be able to adapt current and future operations to address the military. Mission planning and execution must include: a) identification and assessment of the effects of climate change on the DoD mission; b) taking those effects into consideration when developing plans and implementing procedures; and c) anticipating and managing any risks that develop as a result of climate change to build resilience..."

DoD's ability to implement this new policy directive is dependent on the scientific information that comes out of the geosciences research supported by NSF and other agencies.

Geosciences and the Private Sector Commercial Weather Industry

On June 5, 2015, the Chairman and Executive Officer of the Weather Company said the following about the economic importance of the geosciences and related disciplines:

“...Research conducted through NSF’s geosciences program, NASA’s Earth Sciences program and NOAA’s weather and climate research programs have enabled us, in partnership with these agencies, to inform citizens and businesses of weather and climate events in a tailored manner that enables them to be weather-ready and climate-smart. Cutting these investments...will have negative consequences on our economy and quality of life in the coming years. They are vital investments to maintain our leadership in environmental information and services.”

Geosciences and the Insurance Industry

In a hearing before the Senate Environment and Public Works Committee in July of 2013 the President of the Reinsurance Association of America said the following about the importance of research in the geosciences to the economic viability of the insurance industry and those they insure:

“...Our industry [the reinsurance industry] is science based. Blending the actuarial sciences with the natural sciences is critical in order to provide the public with resources to recover from natural events...Developing an understanding about climate and its impact on droughts, heat waves, the frequency and intensity of tropical hurricanes, thunderstorms and convective events, rising sea levels and storm surge, more extreme precipitation events and flooding is critical to our role in translating the interdependencies of weather, climate risk assessment and pricing...”

Geosciences and the Private Sector Aquaculture Industry

On May 8, 2015 Diane Pleschner-Steele, Executive Director of California Wetfish Producers Association, a major industry aquaculture organization in California said:

“...NSF’s Geoscience Directorate funds data collecting buoys that provide a long-term signal of increased ocean acidification among other measurements. These forecasts will be critical to maintain for both open-ocean aquaculture and important shellfish fisheries, as these industries are hugely important economically on both west and east coasts. Proposed cuts to the Geoscience Directorate put the data on which the seafood industry depends, and the domestic seafood-producing economy as a whole, at risk...”

Research Underlying Fracking Technology Yields Economic Benefits

Investment in the geosciences provided the fundamental understanding of geologic structures and processes necessary to utilize hydraulic fracturing (fracking) processes to release oil and gas from shale formations. The ability of U.S. companies to develop these natural resources is built upon decades of fundamental research and technology development in the earth sciences. According to a 2013 report from U.S. Chamber of Commerce’s 21st Century Energy Institute, fracking has created a job boom even in states that don’t actually have shale deposits, with 1.7 million jobs already created and a total of 3.5 million projected by 2035.

Geoscience Graduates – Source of Technical Talent for Energy and Environment Industry

The geosciences research that NSF funds helps educate and train the next generation of geoscientists. According to the Bureau of Labor Statistics (BLS), there were a total of 296,963 geoscience jobs in 2012, and this number is expected to increase by 14% by 2022 to a total of 339,737 jobs. Approximately 143,000 geoscientists are expected to retire by 2022, but over the next decade, approximately 51,000 students will be graduating with their bachelor's, masters, or doctoral degrees in the geosciences. Therefore, according to the American Geosciences Institute's (AGI) *Status of the Geoscience Workforce Report 2014*, assuming minimal non-retirement attrition from the geoscience workforce, there is expected to be a deficit of approximately 135,000 geoscientists by 2022. Texas leads the nation in the number of geoscience undergraduates and graduate students enrolled within geoscience departments.

The AGI report, *Status of Recent Geoscience Graduates 2015*, shows a shift in hiring patterns for geoscience industries. For the first time in the report's history, an industry other than oil and gas hired the highest percentage of bachelor's graduates: environmental services. According to the report, approximately 40 percent of bachelor's graduates found a job in the environmental services industry, which includes fields such as environmental consulting and remediation of land assets such as water and soil. Sixteen percent of bachelor's graduates went on to find jobs in the oil and gas industry in 2015, down from 36 percent in 2014. Changing employment dynamics and record low oil prices have led the oil and gas industry to reduce employment opportunities. Nevertheless, 67 percent of master's graduates found jobs in the oil and gas industry, an increase from 59 percent in 2014. Other industries hiring geoscientists include: manufacturing or trade, construction, information technology services, and agriculture. NSF's support for the geosciences contributes significantly to the education and training of these individuals via NSF's programs in research, graduate student support, and undergraduate student support.

Conclusion

It is important to appreciate that the NSF's investments in all fields of science and engineering -- including the geosciences -- have addressed important national and global challenges, spurred new economic sectors, and led to the development and implementation of advanced technologies that save lives, protect property, and support our economy. We appreciate the difficult decisions Congress must make within the constraints of the budget environment. However, we believe the future of the nation is well served by a strong and sustained investment in the full scope of our research enterprise, which includes the geosciences. Thank you for the opportunity to present these views.