



May 2012
Volume 1, Spring

Science, Engineering, and Education for Sustainability (SEES) Newsletter

Mission Statement: *To advance science, engineering, and education to inform the societal actions needed for environmental and economic sustainability and sustainable human well-being.*

Welcome to the inaugural issue of the Science, Engineering, and Education for Sustainability (SEES) Newsletter. Our purpose is to provide information on SEES programs and highlight research undertaken by SEES investigators that may interest the NSF applicant community and the general public. The newsletter will be produced semiannually and feature different SEES program activities, research, investigators, and leadership. The features will showcase the broad range of interdisciplinary collaborations working together for a sustainable world.

Sincerely,

SEES Communications Team
 (A cross-Foundation Working Group)

Highlighting Research for Sustainability

The National Science Foundation (NSF) supports basic research at the frontiers of knowledge. Many of the discoveries and technological advances have been revolutionary. Through NSF support, scientists and engineers have discovered many of the fundamental particles of matter, decoded the genetics of viruses, and developed robots for search-and-rescue operations. They have analyzed sediment cores from the ocean floor to the polar ice caps to understand climate and environmental changes. They have developed educational programs, worked with museums, aquariums, and a host of organizations to broadly share their knowledge and discoveries. The Science, Engineering and Education for Sustainability (SEES) portfolio builds on this foundation of transformative and educational research in developing programs that address sustainability in a common framework to optimize investments and outcomes. NSF established the SEES investment area in Fiscal Year 2010 in order to use a systems-based approach to understanding, predicting, and reacting to change in the linked natural, social, and built environment and to address challenges in environmental and energy research and education.

NSF's work under SEES is a blend of activities -- formal solicitations and less formal announcements of interest (e.g.,

Dear Colleague Letters) that span multiple scientific disciplines and require input and oversight from multiple NSF directorates and offices. NSF also works with other federal and international agencies and stakeholder groups whose function and mission complement NSF's role to ensure that sustainability goals are carried forward.

A Sustainable World

A sustainable world is one in which human needs are met equitably without harm to the environment, and without sacrificing the ability of future generations to meet their needs. This goal is echoed throughout the SEES portfolio. But, where do we go? How do we start?

Fortunately, scientists are willing to go anywhere to explore the questions that will lead to a sustainable world. In this issue, learn how scientists are studying insects and fish to understand regions most affected by changing climates in *Meet a SEES Investigator* on page 3.

What do microbes on frogs have to do with a healthy planet? See *Did You Know?* on page 4.



Amphibian microbes.
 Jenifer Walke, Virginia Tech

In this issue:

Highlighting Research for Sustainability	1
A Sustainable World	1
Q&A with SEES Leadership	2
SEES Program Highlights	2
Meet a SEES Investigator	3
Building Partnerships	3
On the Horizon	4
Did You Know?	4
Additional Information	4

Q & A with SEES Leadership

Tim Killeen, Assistant Director for Geosciences



Above: Tim Killeen

SEES is a cross-Foundation effort and involves leadership across the Foundation. The Q&A section will feature different NSF leaders in the SEES effort from across the NSF Directorates and Offices.

The Q&A is excerpted in part from an interview with Dr. Tim Killeen, which appeared in International Innovation magazine and used here with permission. (Environment, Dec. 2011).

Question: Could you highlight some major areas of interest where [NSF] is currently focusing its efforts to ensure survival of our planet?

Killeen: *The National Science Foundation's Science, Engineering, and Education for Sustainability (SEES) portfolio consists of programs that spark innovations for tomorrow's clean energy solutions with a cross-disciplinary approach to sustainability science. SEES is designed to foster innovative insights about the environment-energy-economy nexus that will increase the effectiveness of our energy and management policies in adapting to and mitigating the impacts of climate change and improve our capabilities for rapid response to extreme events. SEES foci for the near future include mechanisms for both research and education in sustainability, including research on sustainable materials and chemistry, green computing, natural and technological disasters and societal resilience, and Arctic and coastal Systems. Education is critically important as well, for students at all levels and for the general public.*

Question: Many scientists and researchers consider this to be a crucial time to address problems such as climate change and availability of resources. How optimistic are you that we will be able to tackle these issues before it is too late?

Killeen: *Sustainability science, engineering and education require a multifaceted consideration of the natural environment and human populations, energy use, the built environment and human behavior in order to meet the challenges brought on by large-scale environmental change, and the economic, technological, resource, agricultural and cultural demands of our modern world. NSF support of sustainability research represents a coupling of basic research with societal application, adaptation and improvement. NSF research can accelerate understanding of scientific problems which in turn can inform decision making for improvements to human and natural conditions.*

Our global community is at a critical juncture where scientifically-based choices need to be made and action has to be taken. Solutions to sustainability challenges require the robust, interdisciplinary approach that characterizes the emerging fields of sustainability natural and behavioral sciences, engineering and education. I remain optimistic that we will be able to address sustainability and resource security issues (food, water, finite materials, etc.), but not by conducting 'business as usual.' We need to re-double our efforts!

SEES Program Highlights

The most recent competitions held from the SEES portfolio were the Partnerships for International Research and Education (PIRE) program, Sustainability Research Networks (SRN) program and the SEES Fellows program.



The PIRE program supports international activities to advance research and education. The program has reviewed pre-proposals and full proposals are due May 15, 2012. The estimated number of awards is between 10-15, based on availability of funds, and award size is expected to be approximately \$4 million for each award over five years.

The SRN program challenges researchers to engage and explore fundamental issues in sustainability science, engineering, and education to increase understanding of the ultimate sustainability challenge - maintaining and improving the quality of life for the nation within a healthy Earth system. The SRN program has reviewed pre-proposals and full proposals were submitted by April 1, 2012. The estimated number of awards is between three to four awards, based on availability of funds, and award size expected to be approximately \$12 million for each award over four to five years.

Through the SEES Fellows program, NSF seeks to engage early career scientists and engineers in making discoveries needed to inform actions for environmental, energy and societal sustainability. The program's emphasis is to facilitate investigations that cross traditional disciplinary boundaries and address issues of sustainability through a systems approach, building bridges between academic inquiry, economic growth, and societal needs. Proposals have been reviewed and recommendations are now in process.

Meet A SEES Investigator

SEES is a cross-Foundation effort and covers a broad range of topics. The Meet the SEES Investigator section will feature different investigators who have received awards.

A Stream is a Stream is a Stream, Or Is It?

LeRoy Poff fords High-Mountain Waterways in North, South America to find out.

Scientists funded by NSF's Science, Engineering and Education for Sustainability (SEES) investment use everything from microscopes to submersibles in their research.

But how many need a machete?

That's exactly what LeRoy Poff, an aquatic ecologist and evolutionary biologist at Colorado State University, and a SEES-Dimensions of Biodiversity principal investigator, requires.

Poff and colleagues from Colorado State, Cornell University and the University of Nebraska are studying how temperature variation and extreme weather such as floods and droughts affect life in streams in temperate (Colorado) and tropical (Ecuador) climates.



LeRoy Poff collects insects from a stream in Ecuador.

They're comparing how aquatic insects and fish in small streams along the Colorado Front Range—which has a seasonally variable climate—and insects, fish and amphibians in streams in Ecuador, with its more stable climate, are faring at a time when Earth is heating up.

"To get to our Colorado research sites," says Poff, "there's relatively easy access along mostly paved roads." But to reach streams in the cloud forest headwaters of the Amazon, he says, it takes a machete to bushwhack through tangled vines that choke narrow waterways.

Poff and others will identify new species in both locales by barcoding these species' DNA, as well as track species movements based on their tolerance of warming water and declining oxygen levels.

The scientists plan to use the new understanding of species' sensitivity to climate change—and the ability of species to move with changing conditions—as a basis for developing maps for policy-makers and others. The maps will show where animals are most vulnerable to climate change in tropical and temperate streams.

To reach his goal, Poff is fording chutes from North to South America. His NSF SEES research takes not only microscopes and high-tech genetics labs.

It takes a machete.

Building Partnerships

NSF strives to work seamlessly across disciplinary, organizational, institutional, and national boundaries to promote global leadership in advancing research, education, and innovation.

As part of the *OneNSF* vision, SEES activities span the entire range of scientific domains at NSF. Among the goals of SEES is building partnerships across disciplinary, institutional, and national boundaries. The interdisciplinary nature of SEES programs fosters partnerships across NSF and several SEES programs also bridge federal and international boundaries.

The Dimensions of Biodiversity program involves partnerships with NSF-China, São Paulo State Research Foundation (FAPESP) of Brazil, and NASA, which adds its support to projects that incorporate substantive use of satellite remote sensing technologies.

The newly announced Arctic SEES (ArcSEES) program involves international partnerships with a consortium of French agencies, as well as several interagency partnerships at the national level: the Environmental Protection

Agency, Department of the Interior's Bureau of Ocean Energy Management and the U.S. Fish and Wildlife Service, as well as the U.S. Geological Survey.

Both the Water, Sustainability and Climate program and the Decadal and Regional Climate Prediction Using Earth System Models (EaSM) program involve an interagency partnership with the U.S. Department of Agriculture's National Institute of Food and Agriculture. The U.S. Department of Energy, Office of Biological and Environmental Research is also an interagency partner in EaSM.

Partnerships for International Research and Education (PIRE) is a long-standing NSF program that involves every directorate and office at NSF. Interagency partnerships include: Inter-American Institute for Global Change Research; U.S. Agency for International Development; U.S. Environmental Protection Agency; U.K. Economic and Social Research Council; U.K. Engineering and Physical Science Research Council; Ministry of Education and Science of the Russian Federation; and Japan Science and Technology Agency.



Jeffrey Kietzmann, NSF

On the Horizon

Arctic SEES and Future SEES Focus Areas

Recently joining the SEES portfolio of activities, is the Arctic SEES (ArcSEES) program. ArcSEES is an interagency, international, and interdisciplinary program designed to stimulate research and capacity building focused on the sustainability of the Arctic human-environmental system. The initial round of ArcSEES grants will focus on four themes: the natural and living environment; the built environment; natural-resource development, and governance.

As noted in *Building Partnerships* p.3, ArcSEES is partnering with several federal agencies (EPA, USGS, BOEM, USFWS, NSF) and a consortium of French agencies including: *Commissariat à l'énergie atomique et aux énergies alternatives* (CEA), *Centre National d'Etudes Spatiales* (CNES), *Centre National de la Recherche Scientifique* (CNRS), *Institut Français de Recherche pour l'Exploitation de la MER* (IFREMER), and *Météo-France*. French research interests in the Arctic, sustainability science, and international perspectives will contribute greatly to the science and engineering research conducted under the ArcSEES themes.

Through all of the partnering agency contributions involved in this joint solicitation,

the program expects to make 5-15 awards (pending availability of funds), with a maximum award size of up to \$2 million USD over 3-5 years. The program seeks to support research projects that contribute to our understanding of the resiliency, predictability, and sustainability of the Arctic. Integrated efforts that aid decision-making and/or provide structural, energy, cyberinfrastructure, and communications technology solutions that will inform community practices, management and policy for a more sustainable Arctic environment are also welcomed. Proposals for the FY12-FY13 ArcSEES competition will be due on September 14, 2012.

Also on the horizon, under the SEES portfolio of activities, focus areas for future SEES activities may involve chemistry/ materials/ engineering (renewable, non-toxic materials, process improvements), coastal regions (vulnerability, resilience, cultural impacts), hazards and disasters (science, engineering, risk assessment, decision-making), and information science and engineering (role in advancing sustainability science and reducing environmental impact of computing).

NSF Current SEES Portfolio

Arctic SEES
 Climate Change Education
 Coupled Natural & Human Systems
 Dimensions of Biodiversity
 Earth Systems Modeling
 Ocean Acidification
 Partnerships for International R&E
 Research Coordination Networks
 SEES Fellows
 Sustainability Research Networks
 Sustainable Energy Pathways
 Water Sustainability and Climate

Also on the horizon, under the SEES portfolio of activities, focus areas for future SEES activities may involve chemistry/ materials/ engineering (renewable, non-toxic materials, process improvements), coastal regions (vulnerability, resilience, cultural impacts), hazards and disasters (science, engineering, risk assessment, decision-making), and information science and engineering (role in advancing sustainability science and reducing environmental impact of computing).

Did You Know?

Did you know bacteria are important to the health of many creatures on the planet? While some bacteria are harmful, others have symbiotic relationships that are beneficial to the host. For example, humans have symbiotic relationships with billions of microbes in the gastrointestinal tract which aid our immune system in keeping us healthy. Recent studies suggest that frogs have symbiotic bacteria on their skin that may limit infections, including pathogens like the chytrid fungus that has decimated amphibian populations around the globe.



Brian Gratwicke, SCBI

Dimensions of Biodiversity award recipient, Dr. Lisa Beldon, of Virginia Polytechnic Institute, and colleagues will explore mi-

crobial diversity and their role in disease resistance. Their research will take them to the rainforests of Panama to study the diverse community of symbiotic microbes on the skin of the red-eyed tree frog and four other species.

How do microbial communities achieve beneficial functions? Can beneficial microbes in one species be helpful in another? The researchers may explore these questions and many more as they investigate the taxonomic diversity, genetic diversity, and functional diversity of microbes.

Additional Information

If you would like to learn more about SEES, visit our website www.nsf.gov/sees.

If you would like to subscribe to the SEES listserv, send an email to listserv@listserv.nsf.gov with the following text in the message: Subscribe SEES [Your Name].