National Science Foundation
WHERE DISCOVERIES BEGIN

**News Release 17-093**

# NSF awards $36.6 million in new food-energy-water system grants

**New research into how to provide food, energy and water security for Earth's increasing population**

Farmland has a role in meeting increasing food and bioenergy demands in sustainable ways.

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**September 19, 2017**

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Today, the number of humans alive on our planet is 7.5 billion. By 2087, projections show, 11 billion people will be living on Earth.

How will we continue to have a sustainable supply of food, energy and water, and protect the ecosystems that provide essential "services" for humans?

To help answer these questions, the National Science Foundation (NSF) has partnered with the U.S. Department of Agriculture's National Institute for Food and Agriculture (NIFA) to award $46.6 million in new grants through the joint NSF-NIFA program on Innovations at the

Nexus of Food, Energy and Water Systems (INFEWS).

NSF grants total $36.6 million; NIFA awards, $10 million. NSF directorates and offices supporting INFEWS are the Directorates for Geosciences; Engineering; Computer & Information Science & Engineering; Mathematical & Physical Sciences; Social, Behavioral & Economic Sciences; Office of International Science and Engineering; and Office of Integrative Activities.

"Food, energy and water have long been studied independently or in pairs, but not all three at once," says William Easterling, NSF assistant director for Geosciences. "Now, novel ways of examining all three together are yielding important new knowledge that will help us achieve food, water and energy security even with further population growth."

Adds Dawn Tilbury, NSF assistant director for Engineering, "Research at the food-energy-water nexus enables us to build more resilient and sustainable systems while maintaining the vitality of ecosystems. To create innovative solutions to food, energy and water-related challenges, we must understand the interconnections and interdependencies involved in the complex and highly coupled systems and processes that affect society and the environment."

Researchers have found that food-energy-water systems are intricately linked to each other and to the planet's ecosystems through complex interactions. With an increasing human population, there is a growing need for new approaches to understanding these interactions and how they will respond to population growth, land-use change, climate change and other factors.

Food, energy and water are, at times, in a three-way tug of war. Land-use decisions, climate change and increasing urbanization often pit one against the other. The goal of the INFEWS program is to minimize simultaneous risks to the security of food, energy and water supplies.

Hotter summers, for example, mean more power demand from air-conditioning use and, in drier climates, less water in rivers for hydropower production and for ecosystems.

Studying food, energy and water systems independently has shifted to looking at them as a linked system. The change was prompted by drought and the depletion of aquifers, shifts in farm production between food and fuel crops, concerns about food and livestock waste, and energy demand for food production, food processing and transportation.

How these systems interact, say scientists, has become an area of frontier research with results that are quickly transferable to government agencies and private companies.

INFEWS projects are designed to address such goals as:

- Significantly advancing the understanding of the food-energy-water system through quantitative, predictive and computational modeling, including support for relevant cyberinfrastructure.
- Developing real-time, cyber-enabled interfaces that improve understanding of the behavior of the food-energy-water system and increase decision support capability.
- Enabling research that will lead to innovative solutions to critical food-energy-water system problems.
- Growing a scientific workforce capable of studying and managing the food-energy-water system through education and other professional development opportunities.

Outcomes of the INFEWS awards aim to help decision-makers at every level better address human needs, and protect the natural world. Goals are for scientists and policymakers to gain a new understanding of the food-energy-water system, gather insights from innovative modeling, and develop new capabilities from cutting-edge technologies to reduce waste and increase efficiencies.

INFEWS investigators will incorporate physical, engineering, geological, biological, social and behavioral processes, as well as cyber elements, into their projects.

INFEWS awards will also prepare graduate students to understand the complex interactions of the food-energy-water system and to draw upon and integrate knowledge across disciplines.

To foster new discoveries, this year's INFEWS awardees will conduct research on such topics as linking current and future hydrologic change to hydropower, human nutrition and livelihoods; reducing the environmental impacts of the food-energy-water system in and around cities; and working toward a resilient food-energy-water system in response to droughts and socioeconomic shocks.

**2017 NSF INFEWS Awards**

Christina Bloebaum, Iowa State University: INFEWS/T2: Cyber-based Decision Support Strategies to Achieve Consensus for FEW System Sustainability Using Incentive and Policy Structures <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739551&HistoricalAwards=false>

Ximing Cai, University of Illinois at Urbana-Champaign: INFEWS/T1: Advancing FEW System Resilience in the Corn Belt by Integrated Technology-Environment-Economics Modeling of Nutrient Cycling <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739788&HistoricalAwards=false>

Michael Coe, Woods Hole Research Center: INFEWS/T1: Intensification in the World's Largest Agricultural Frontier: Integrating Food Production, Water Use, Energy Demand, and Environmental Integrity in a Changing Climate <https://nsf.gov/awardsearch/showAward?AWD_ID=1739724&HistoricalAwards=false>

Liping Di, George Mason University: INFEWS/T2: WaterSmart: A Cyberinfrastructure-based Integrated Agro-Geoinformatic Decision-Support Web Service System to Facilitate Informed Irrigation Decision-making <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739705&HistoricalAwards=false>

Hatim Geli, New Mexico State University: INFEWS/T1: Towards Resilient Food-Energy-Water Systems in Response to Drought Impacts and Socioeconomic Shocks: New Mexico <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739835&HistoricalAwards=false>

Lauren Greenlee, University of Arkansas: INFEWS/T3: Critical Nutrient Recovery and Reuse: N & P Recycling from Wastewaters as Struvite Fertilizer <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739473&HistoricalAwards=false>

Chad Higgins, Oregon State University: INFEWS/T1: Scarcity Amid Abundance: Understanding Trade-offs in the Food-Energy-Water Nexus in the Willamette River Basin <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1740082&HistoricalAwards=false>

Arpad Horvath, University of California, Berkeley: INFEWS/T1: Reducing the Environmental Impacts of FEW Systems in and Around Cities <https://nsf.gov/awardsearch/showAward?AWD_ID=1739676&HistoricalAwards=false>

Elena Irwin, Ohio State University: INFEWS/T1: Impacts of Deglobalization on the Sustainability of Regional Food, Energy, Water Systems <https://nsf.gov/awardsearch/showAward?AWD_ID=1739909&HistoricalAwards=false>

Neil Mattson, Cornell University: INFEWS/T3: Strategic FEW and Workforce Investments to Enhance Viability of Controlled Environment Agriculture in Metropolitan Areas <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739163&HistoricalAwards=false>

Bruce McCarl, Texas A&M University: INFEWS/T3I: Decision Support for Water Stressed FEW Nexus Decisions (DS-WSND) <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739977&HistoricalAwards=false>

Jeffrey Peterson, University of Minnesota-Twin Cities: INFEWS/T3: Innovations for Sustainable Food, Energy, And Water Supplies In Intensively Cultivated Regions: Integrating Technologies, Data, And Human Behavior <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739191&HistoricalAwards=false>

John Sabo, Arizona State University: INFEWS/T1: Linking Current and Future Hydrologic Change to Hydropower, Human Nutrition, and Livelihoods in the Lower Mekong <https://nsf.gov/awardsearch/showAward?AWD_ID=1740042&HistoricalAwards=false>

William Schnabel, University of Alaska Fairbanks: INFEWS/T3: Coupling Infrastructure Improvements to Food-Energy-Water System Dynamics in Small Cold Region Communities: MicroFEWs <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1740075&HistoricalAwards=false>

Yaunzhi Tang, Georgia Tech Research Group: INFEWS/T3: Collaborative Research: Closing the Loop: An Integrated, Tunable, and Sustainable Management System for Improved Energy, Nutrient, and Water Recovery from Biowastes <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739884&HistoricalAwards=false>

Xin Zhang, University of Maryland, College Park: INFEWS/T2: Sustainable Agriculture in the Nexus of Food, Energy, Water and Nutrient on National and Global scales <https://www.nsf.gov/awardsearch/showAward?AWD_ID=1739823&HistoricalAwards=false>

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Struvite produced by wastewater treatment is being studied as a replacement for fertilizers. Credit and Larger Version (/news/news_images.jsp?cntn_id=242998&org=NSF)

Wind farms are a renewable energy option for places with the right atmospheric conditions.
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A corn harvest and processing facility in Illinois produces some 350 million ga/yr of fuel ethanol.
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Fish harvesting provides food to meet large -- and increasing -- global demands.
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In-stream hydrokinetic generators could provide energy to rural arctic and subarctic communities.
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Hydroelectric dam construction requires planning for financial and environmental costs.
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**Related Websites**

NSF News: NSF invests $72 million in innovations at nexus of food, energy and water systems: https://www.nsf.gov/news/news_summ.jsp?cntn_id=189898 <https://www.nsf.gov/news/news_summ.jsp?cntn_id=189898>

NSF News: New grants foster research on food, energy and water: a linked system: https://www.nsf.gov/news/news_summ.jsp?cntn_id=135642 <https://www.nsf.gov/news/news_summ.jsp?cntn_id=135642>

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