

2015–2016 ANNUAL REPORT



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Message from the Directors

Right now, researchers at the Stanford Woods Institute for the Environment are working across disciplines and with decision-makers around the world to solve some of our most pressing environmental challenges.

Stanford climate researchers have informed drought planning in California by showing the connection between the state's current historic drought and climate change. Woods has fostered new collaborations by bringing together computer scientists, earth scientists and economists to use satellite images to further our understanding of the connection between poverty and the environment. Woods-funded research teams have developed pioneering technology such as the resource recovery center on campus in which we can recover water, energy and nutrients at a scale beyond the lab bench. Others are currently using virtual reality to help people understand ocean acidification.

We are continuing to expand our work in educating the next generation of environmental leaders through our FUEL program, which helps undergraduates understand how they can influence environmental policy through their future careers.

Climate change, perhaps the most pressing environmental challenge of our time, is a core part and focus of all Woods centers and programs. So in that light it is only appropriate that the new Perry L. McCarty Director of the Stanford Woods Institute is Chris Field, a world-renowned climate scientist who has the ear of decision-makers at a global level as well as the esteem of every researcher working in the field.

Thank you to everyone who has supported and worked with the Stanford Woods Institute since its inception in 2003. Woods will continue to bring together faculty from different disciplines with private and public decision makers to actually solve those environment challenges that remain.

Sincerely,



Jeffrey Koseff and Barton "Buzz" Thompson
Perry L. McCarty Founding Directors



Jeffrey R. Koseff

Perry L. McCarty Founding Director and Senior Fellow
William Alden Campbell and Martha Campbell
Professor of Civil and Environmental Engineering

Barton H. "Buzz" Thompson, Jr.

Perry L. McCarty Founding Director and Senior Fellow
Robert E. Paradise Professor in Natural Resources Law

Meet New Director Chris Field



Photo: Nona Chiariello

World-renowned climate scientist Chris Field became the new Perry L. McCarty Director of the Stanford Woods Institute for the Environment in September 2016. Chris Field has exemplary scientific credentials and has been an energetic, effective leader both on campus and in the broader scientific community,” said Stanford Provost John Etchemendy. “He is remarkably well-positioned to lead the Woods Institute as it works to connect Stanford’s solutions-oriented environment research to action.”

Stanford Vice Provost and Dean of Research Ann Arvin said Field’s background is well-aligned with Woods’ mission and approach.

“Woods brings together researchers from across Stanford’s seven schools to pioneer the knowledge and solutions needed to solve the world’s major environmental challenges,” Arvin said. “Chris Field has convened

hundreds of scientists across disciplines and around the globe to advise world leaders on climate change. His accomplishments and approach embody the spirit of interdisciplinary collaboration that has been a hallmark of Woods since its inception. Field’s research ranges from finding prospects for renewable energy systems to helping community organizations minimize the risk of a climate-related tragedy of the commons. He has been deeply involved with national and international scale efforts to advance science and assessment related to global ecology and climate change. He served as co-chair of Working Group II of the Intergovernmental Panel on Climate Change from 2008 to 2015. Prior to his appointment as Woods director, Field served as director of the Carnegie Institution for Science’s Department of Global Ecology, which he founded in 2002. Learn more about Chris in our announcement of his appointment at: <http://stanford.io/28kCwso>.



CLIMATE

The drivers and effects of global climate change are interconnected. They cross physical, ecological, economic, political and ethical boundaries. Advancing solutions requires similar connectivity. The Stanford Woods Institute for the Environment supports research that cuts across disciplines and sectors to assess the impact of climate disruption on people and planet.

This work spans most Woods centers and programs. It focuses on water supplies, agricultural production, biodiversity, ecosystem health, built infrastructure and economies. Stanford researchers from all seven schools on campus are joining forces to analyze climate risks, reduce vulnerabilities and help people mitigate and adapt to the effects of global warming.

Highlights

Informing Climate Progress

Stanford scholars witnessed history being made in Paris last December when 195 countries forged an agreement to combat climate change by limiting the rise in global temperature to less than 2 degrees Celsius above pre-industrial levels. University leaders issued a formal statement ahead of the accord. For decades, Stanford researchers have informed global understanding of climate risk and adaptation, including major contributions to reports of the United Nations' Intergovernmental

Panel on Climate Change (IPCC). Stanford researchers at the event summarized the discussions in Paris and reflected on the challenges to come.

Investigating the 'Hiatus'

The purported hiatus of global warming—the idea that warming “stalled” or “paused” between 1998 and 2013—never occurred and was actually an misapprehension caused by faulty statistical methods, according to an investigation by scholars with the School of Earth, Energy and Environmental Sciences (Stanford Earth).

“In terms of the statistics of the long-term global temperature data, there never was a hiatus, a pause or a slowdown in global warming.”

—Stanford Professor Noah Diffenbaugh

CLIMATE

Tracking Carbon Emissions

The rapid increase in fossil fuel-related global carbon dioxide emissions has slowed over the past two years with China’s decreasing coal usage being largely responsible for the decline, according to a report from The Global Climate Project led by Michelle and Kevin Douglas Provostial Professor Robert Jackson (Stanford Earth). In the U.S., gas pipeline replacement programs—which address invisible gas leaks from aging or damaged pipelines—cut natural gas emissions by 90 percent as evidenced in another paper co-authored by Jackson, a Woods Senior Fellow.

Decoding California’s Climate


By examining atmospheric patterns that have occurred during California’s historical precipitation and temperature extremes, researchers discovered that atmospheric patterns associated with droughts in California have occurred more frequently in recent decades. A persistent blocking ridge, a region of high atmospheric pressure that disrupts typical wind patterns in the atmosphere, is diverting winter storms northward and preventing them from reaching California during the state’s drought, according to a study led by Woods Senior Fellow Noah Diffenbaugh (Stanford Earth). Members of the research team also predicted that despite an unusually strong El Nino this year, it would not be enough to end California’s worst drought on record.

Forecasting Economic Costs

If climate change continues unchecked and unmitigated, the global economic situation may change significantly with even wealthy countries seeing an economic downturn by the year 2100 as shown in a study led by Woods Center Fellow Marshal Burke (Stanford Earth) published in the journal *Nature*. Even prosperous countries will see growth drop off sharply after temperatures pass a critical heat threshold.

Setting Presidential Priorities

The next U.S. President, regardless of political party, will need to address the impacts of climate change that are already happening to our environment and our economy according to panelists at the Setting the Climate Agenda for the Next U.S. President conference, organized by Stanford Distinguished Visiting Lecturer and Woods Consulting Professor David Hayes (Law) and attended by some of the most influential presidential advisors from both sides of the aisle. The summary explains that whomever wins the election should engage key stakeholders in energy, infrastructure, land use and other relevant sectors, as well as impacted state, local and international governments to advance a comprehensive agenda to tackle the impacts of a changing climate.



ECOSYSTEMS & CONSERVATION

Photo: Adriana Velasquez/Unsplash

Our well being is fundamentally linked to healthy ecosystems. To expand our knowledge of these connections, the Stanford Woods Institute for the Environment supports interdisciplinary work probing human impacts on nature and shapes new conservation paradigms. Woods convenes workshops and dialogues to expand awareness of nature's values and ways to sustain them. These events have laid the foundation for

partnerships such as the Natural Capital Project, a pioneering initiative transforming how governments and businesses factor nature's value into decision-making. Woods works to inform those decisions by sharing findings of Stanford's world-class biologists, ecologists, social scientists and others. Woods centers and affiliated scholars are provide cutting-edge research, support networks and practical tools to create solutions that benefit people and nature.

Highlights

Paul S. and Billie Achilles Professor of Environmental Biology, Emeritus, Harold Mooney and his former student, Erika Zavaleta, Pepper-Giberson Chair in Environmental Studies at UC Santa Cruz, co-edited *Ecosystems of California*, a thorough overview of the state's varied and rich ecosystems. The book's 149 contributors include a number of Stanford scholars. Woods facilitated briefings with key California policy and decision-makers in Sacramento and highlighted the value of the book as a resource for researchers, policy-makers, natural resource managers and students.

Tracking China's Progress

Though often noted for its environmental challenges, China has successfully implemented environmental policies and conservation science at a breathtaking scale. A decade-long report co-authored by Bing Professor of Environmental Science Gretchen Daily details the dramatic progress. InVEST, a software suite designed by the Natural Capital Project, found strong gains in carbon sequestration and soil retention attributed largely to reforestation. This allowed researchers to evaluate the economic and environmental tradeoffs of China's National Ecosystem Assessment efforts by analyzing data from satellites and other means.

“We need new approaches to environmental governance that regulate the impact of international actors.”

—Stanford Professor Eric Lambin

ECOSYSTEMS & CONSERVATION

Reducing Deforestation

Due to growing demand, agriculture is expanding into forest ecosystems. Because agricultural companies prefer areas where deforestation regulations are less restrictive, deforestation can shift between regions based on the regulatory environment, according to a study led by George and Setsuko Ishiyama Provostial Professor Eric Lambin (Stanford Earth). Understanding the motivations and market forces affecting companies can encourage collaboration with environmentalists to reduce deforestation according to another study by Lambin. Such efforts were found to be more than twice as effective as narrow programs developed by either group.

Integrating Nature and Business

Woods hosted the fourth in a series of Natural Capital Business Roundtables with NOAA and the U.S. Dept. of Commerce. The event brought together the private, public and academic sectors to discuss integrating natural capital into business models. Companies like HP and Google described incorporating natural capital into their operations and highlighted the need for the work of the Natural Capital Project which connects science, government and business communities with the tools and information needed to value natural capital.

Understanding Species Loss

An analysis of past large mammal extinctions by Stanford researchers showed that the disappearance of large land animals could have major and permanent impacts on associated plants and animals and even cause the loss of entire ecosystems. Species loss is also discussed in *The Annihilation of Nature*, co-authored by Bing Professor of Population Studies Paul Ehrlich (Biology). Proceeds from the book, which details the characteristics and likelihoods of extinction for various species, support research by young conservation biologists.

Conserving Biodiversity

Scientists found that by maintaining small patches of forest in and around farms, stakeholders can achieve most of their conservation goals while also providing benefits to agriculture and people. Climate change can also affect biodiversity, as noted in a study led by Woods Senior Fellow Eric Lambin that looks at the climate-induced die-off of Alaskan yellow cedar trees, and recommends a new model of conservation integrating social and ecological methods to forward climate adaptation.



By 2050, the world's population is estimated to reach 9 billion people. How can we produce enough food to sustain them without irreversibly depleting our lands and waters? To find answers, the Stanford Woods Institute for the Environment supports the Center on Food Security and the Environment (FSE). The center's interdisciplinary scholars are addressing critical

issues of hunger, poverty and environmental degradation. These experts focus on water resources, tropical oil crops, data science for food security, nutrition and health, aquaculture, climate and agriculture, crop and livestock systems and rural education. Their research generates vital knowledge and policy-relevant solutions to pressing food and environment challenges around the globe.

Highlights

Finding Climate Solutions

The research of David Lobell, William Wrigley Senior Fellow at Woods and the Freeman Spogli Institute for International Studies, focuses on climate adaptation solutions to increase and protect food security. Temperature increases, shifting rainfall patterns, extreme weather and other realities of climate change effect crops differently. Finding pathways to adaptation is paramount. Lobell, an associate professor at the School of Earth, Energy & Environmental Sciences (Stanford Earth),

joined other researchers in a call for a new field research network in the U.S. Midwest that could provide experimental facilities and access to farm settings needed to test adaptation and mitigation strategies.

Understanding Food Security

William Wrigley Professor Rosamond Naylor (Stanford Earth) gave the opening plenary lecture at the Second International Conference on Global Food Security. She discussed the two most rapidly expanding sectors of the world food economy—aquaculture and tropical oil crops—and their effects on nutrition, the environment

“It’s time to make serious decisions about managing and protecting ocean fisheries, and China will play a pivotal role in this process.”

—Stanford Professor Rosamond Naylor

FOOD SECURITY

and global food security. Naylor’s research paper, “Oil crops, aquaculture, and the rising role of demand: A fresh perspective on food security,” was published in the journal *Global Food Security*.

Toward Sustainable Palm Oil

FSE work focuses on the large palm oil industry in Southeast Asia, and on the rapidly growing industry in West Africa. Stanford faculty, students and researchers are helping find solutions to the environmental, economic and social impacts of palm oil. FSE runs a major sustainable palm oil research project in Indonesia, Ghana and Cameroon in collaboration with the Stanford Graduate School of Business. Derek Byerlee, a visiting FSE scholar, Walter Falcon, the Helen C. Farnsworth Professor of International Agricultural Policy, Emeritus, and Woods Senior Fellow Rosamond Naylor co-authored a book providing a broad synthesis of the major supply and demand drivers of the rapid expansion of oil crops in the tropics; its economic, social, and environmental impacts; and the future outlook to 2050.

Ensuring Sustainable Seafood

FSE research scholar Ling Cao was named a member of the supervisory board of the Aquaculture Stewardship Council (ASC), a Netherlands-based nonprofit organization providing certification and labeling for responsibly farmed seafood. As a board member, Cao will promote more sustainable fish farming and responsible aquaculture practices to reduce negative social and environmental impacts. Cao plays a principal role in FSE research on aquaculture and fisheries management in China.

Tracking Crop Yields from Space

FSE Deputy Director David Lobell co-authored a study to estimate crop yields with more accuracy by using satellites to measure solar-induced fluorescence, a light emitted by growing plants. This result will help shape understanding of how crops react to a changing climate.

Farming Solar

Woods Senior Fellows and Stanford Earth professors Chris Field (Biology) and David Lobell co-authored an analysis that revealed that solar infrastructure can be located in agricultural areas in a way that maximizes land and water-use efficiency, while providing opportunities for rural electrification and economic growth.



Photo: Nicholas Hook/Wikimedia

FRESHWATER

Freshwater. It's essential to our survival. But challenges ranging from climate change to rising populations threaten water supplies around the globe. Stanford researchers are tackling those problems with novel approaches that cross academic disciplines. They range from a high-tech wastewater resource recovery center to decision-making tools illustrating major groundwater challenges and potential fixes. To advance innovative research in the field, the Stanford

Woods Institute for the Environment supports two programs. The Global Freshwater Initiative develops strategies to ensure the long-term viability of water supplies. The Water in the West Program creates and promotes strategies for more effective water management in the American West. Through these and other Woods initiatives, Stanford researchers are working to provide adequate supply and access to safe water for people.

Highlights

Improving Groundwater Management

Researchers with Stanford's Water in the West program are working to inform and support implementation of the historic Sustainable Groundwater Management Act. The program partnered with Stanford Law School's Martin Daniel Gould Center for Conflict Resolution on a survey of groundwater managers and stakeholders, which highlighted the need for consistent groundwater data across California. A team led by George L. Harrington Professor

Rosemary Knight (Stanford Earth) developed a computer algorithm that can "fill in" groundwater levels using satellite data to advance models of groundwater flow in regions with aquifer depletion.

Advancing Water Innovation

Newsha Ajami, Director of Urban Water Policy at Stanford's Water in the West program, was invited to attend the first-ever White House Water Summit, and on water sector innovation. Ajami also co-authored a series of briefs on Water Sector Innovation with Perry L.



FRESHWATER

McCarty Co-Director Barton “Buzz” Thompson, providing an overview of steps needed to update the nation’s aging water infrastructure with financing and management strategies.

Examining Desalination

Desalination may be critically important to specific coastal communities for freshwater supplies but it is unlikely to significantly alter the water equation in California due to its high cost, energy demands and other factors. That conclusion emerged from a report summarizing discussion at a Woods Uncommon Dialogue organized with the Center for Ocean Solutions and Water in the West, in collaboration with The Nature Conservancy and the Monterey Bay Aquarium. The two-day meeting was held to examine challenges and opportunities desalination presents for coastal communities in California.

Decoding Water Vulnerability

Institutional issues like corruption are the most common impediments to a stable water supply, and affect nearly 40 percent of 119 countries studied by Stanford Global Freshwater Initiative researchers including Steven Gorelick, the Cyrus Fisher

Tolman Professor in the School of Earth, Energy & Environmental Sciences.

Finding Fracking Impacts

Fracking operations near a small town in Wyoming have had clear impacts to underground sources of drinking water due to unsafe practices including the dumping of drilling fluids, unlined pits, and inadequate barriers to protect groundwater, according to a study co-authored by Michelle and Kevin Douglas Provostial Professor in Robert Jackson (Stanford Earth). Jackson, a Woods senior fellow, also presented evidence at the annual meeting of the American Association for the Advancement of Science that faulty wells can leak oil and natural gas and contaminate groundwater and drinking water supplies.

Water Financing

Water infrastructure requires significant investment—a challenge when traditional federal and state funding is limited. Using lessons learned from the energy and electricity sectors, researchers with Stanford’s Water in the West program produced a report on alternative ways to fund innovative water projects.



OCEANS

Photo: PD Pictures

Nearly three quarters of the earth is covered by ocean. Marine environments play an essential role in regulating climate and weather systems, as well as providing food, employment and transportation for people. The Stanford Woods Institute for the Environment seeks to manage and mitigate society's impact on the sea by developing new insights into issues ranging from

ocean acidification and sea level rise to overfishing and industrial pollution. Woods supports the Center for Ocean Solutions (COS), where science, engineering and policy experts develop solutions to address ocean threats and prepare leaders to take on those challenges. Woods-affiliated researchers are informing decisions that lead to healthy marine ecosystems and vibrant coastal communities.

Highlights

Finding Coral Solutions

Stanford scientists affiliated with COS were on an international team that surveyed more than 6,000 coral reefs across the globe, and discovered 15 places where coral health and fish populations were unexpectedly improving, thanks in part to human intervention. The study was published in the journal *Nature*. According to a study led by Rob Dunbar, the W.M. Keck Professor in the School of Earth, Energy & Environmental Sciences, blowing tiny

bubbles through seawater could help protect coral reefs and oyster farms from increasingly acidic oceans by transferring carbon dioxide from coastal marine environments and to the atmosphere.

Connecting Climate and Oceans

In the lead-up to the climate talks in Paris, COS experts explained why reducing greenhouse gas emissions is vital to protecting oceans and the critical resources these ecosystems provide to human society.



Photo: Roby Hudson/Wikimedia

OCEANS

Informing Tuna Conservation

Nearly 200 scientists and stakeholders gathered for the Bluefin Futures Symposium in Monterey to discuss the plight of the bluefin tuna, whose population has dropped nearly 97 percent from historic levels due to overfishing. Stanford scientists in collaboration with the Monterey Bay Aquarium and the National Oceanic and Atmospheric Administration devised a new methodology for measuring how and when ocean predators consume prey and identifying the Pacific bluefin tuna's preferred feeding locations to inform conservation strategies.

Guiding Deep-Sea Mining

Demand for valuable metals and rare-earth minerals has spiked interest in mining the deep-sea floor. In a study published in the journal *Science*, COS researchers and others proposed creating networks of Marine Protected Areas to balance commercial extraction of deep-sea resources with protection of diverse seabed

Awards

Charles and Elizabeth Prothro Professor in Marine Sciences Barbara Block received the Benchley Award for Excellence in Science for her groundbreaking research using satellite tagging data to track marine life. William Alden Campbell & Martha Campbell Professor in the School of Engineering Jeff Koseff received the 2015 Richard W. Lyman Award from the Stanford Alumni Association. Koseff has spoken at alumni events all around the world on pressing environmental issues such as marine ecosystem health.

habitats. This research informed the 21st Annual Session of the International Seabed Authority, which sets the groundwork for deep-sea environmental protection and mining regulations.

Combating Ocean Acidification

Clare Boothe Luce Associate Professor of Civil and Environmental Engineering Alexandria Boehm co-chaired the West Coast Ocean Acidification and Hypoxia Science Panel, which addresses oceans' absorption of increasing levels of atmospheric carbon dioxide, and subsequent loss of oxygen causing deleterious effects to marine life. The panel focuses on research, and recommends real-world policy solutions to combat this dire challenge.



PUBLIC HEALTH

Scientists increasingly are discovering new links between human health and our environment. The Stanford Woods Institute for the Environment brings world-class experts in medicine, environmental health and other disciplines together to solve complex challenges in resource-scarce areas. Woods' Water, Health and Development program works with global partners to deliver affordable, sustainable water supply and sanitation services. In Haiti, an initiative launched by Stanford graduate students is reducing water

contamination from human waste while creating jobs. In Bangladesh, a Stanford-led team is developing low-cost devices that treat water at the point of collection for thousands living in urban slums. In Senegal, researchers funded by Woods' Environmental Venture Projects program are pioneering natural approaches to curb the spread of a deadly parasitic disease. Through these and other projects, Stanford researchers are working to sustain the health and well being of people around the world.

Highlights

Informing Safer Groundwater

Groundwater in South and Southeast Asia often contains up to 100 times more arsenic than the World Health Organization's recommended limit, poisoning millions of people through toxic drinking water. The phenomenon was largely a mystery until The Terry Huffington Professor in the School of Earth, Energy & Environmental Sciences, Scott Fendorf and his team discovered how bacteria

living in shallow sediment layers of permanently flooded wetlands catalyzes arsenic release into groundwater.

Making Sanitation Sustainable

Lack of access to toilets and sustainable sanitation suffered by approximately one out of every four people globally has devastating effects on public health. Stanford researchers found that child growth improves when open defecation is reduced. Stanford's Water, Health and Development program hosted a webinar focused on container-based sanitation solutions as a

“Studying sanitation is not always the sexiest topic, but it certainly is rewarding when we are able to identify strategies to effectively improve quality of life and child health.”

—Stanford Environmental Health Engineer
Amy Pickering

PUBLIC HEALTH

way to address the need for sanitation. As evidence, nearly 75 percent of urban Haitians who participated in a trial using a portable dry toilet and a related service chose to pay to continue it according to a study co-authored by former Woods Rising Environmental Leaders Program fellows Kory Russell and Sebastian Tilmans.

Reaching for Water Goals

Stanford researchers launched a World Bank-funded study of the health impacts of access to chlorinated water in Bangladesh. This work became part of an interactive e-book for middle and high school students that illustrates how scientists and engineers solve problems. Higgins-Magid Senior Fellow Jenna Davis worked actively with the U.N. General Assembly to develop ambitious goals, targets and indicators for water supply and sanitation services including monitoring over the next 15 years.

Understanding Insect-Borne Disease

Stanford researchers are actively engaged in studying insect-borne illnesses such as Zika virus, which is transmitted through mosquitos and has reached epidemic levels in some parts of the world. Woods-affiliated Associate Professor of Pediatrics Desiree LaBeaud advised the public on how to avoid infection. In the San Francisco Bay Area, trail-lined open space holds surprisingly higher risks of tick-borne disease such as Lyme, according to a study by George and Setsuko Ishiyama. Provostial Professor Eric Lambin (Stanford Earth).

Finding Ecological Solutions

Emphasizing the connection between ecological and environmental factors and human disease, researchers launched the Program for Disease Ecology, Health and Environment at Stanford in collaboration with Woods and the Center for Innovation in Global Health. The program, led by Woods Senior Fellow Giulio De Leo (Biology) and Susanne Sokolow, research associate at Stanford's Hopkins Marine Station, will focus on finding sustainable ecological solutions to a range of diseases.



Renowned for its beauty and biological diversity, Costa Rica's Osa and Golfito region is an ecotourism paradise. But the area is poised for significant changes, including the proposed construction of an international airport and a hydro-electric dam. Rising demand for palm oil is driving conversion of diverse agricultural land to single-crop plantations. Through Woods' Osa and Golfito Initiative (known by its Spanish acronym INOGO),

Stanford researchers and students are working with local residents, government, the private sector and NGOs to pioneer a living process for sustainable development. The initiative is developing a strategy for the region that integrates economic well being, environmental health and social equity. It is empowering people to improve their economic outlook while stewarding the environment.

Highlights

Making Sustainability Pay

Through its Caminos de Liderazgo (Pathways to Leadership) program co-funded by the CRUSA Foundation of Costa Rica, INOGO provided connections to mentoring and a national tourism agency to improve a small family eco-tourism and café business and promote sustainable entrepreneurship. The business is now featured as part of Caminos de Osa, a newly created tour route modeled on the Inca Trail, and has more opportunity to expand. By listening to local business owners, community leaders, and scholars in Costa Rica, INOGO,

supports a thoughtful approach to conservation that considers the community's socio-economic needs.

Training Environmental Leaders

Building on two pilot efforts, INOGO launched the Stanford Environmental Leadership and Language Program (SELAL), an intensive program focused on engaging key community actors and training local high school students in environmental leadership, ecotourism and English. Led by Bing Professor in Human Biology, Emeritus, William Durham (Anthropology), SELAL addresses the challenge of sustainable development in the Osa and Golfito region.



Photo: Rob Jordan/Woods

SUSTAINABLE DEVELOPMENT

Innovating Agriculture

Past its pilot phase, the Experimental Sustainable Palm Laboratory run by Bing Professor in Environmental Science Rodolfo Dirzo (Biology) initiated the first stage of a study with the planting of eight paired test plots. The lab will evaluate innovations in crop diversification and increased sustainability in oil palm plantations by looking at the impact of epiphytes, plants that grow on other plants, on farmers' revenue streams and biodiversity, as well as intermingling banana, cocoa and high-value timber trees with oil palm trees to gauge effects on revenues and makes crop disease susceptibility.

Fostering Sustainable Development

Reciprocity and trust among institutions, organizations, and social networks at the local level is critical to furthering sustainable rural development and preserving

biodiversity in Costa Rica, according to a paper published in the journal Human Organization by Woods Senior Fellow William Durham and other INOGO researchers.

Honoring Sustainability Heroes

The annual Stanford Bright Award co-sponsored by Woods and the Stanford Law School recognizing significant contributions to global sustainability went to Polly Courtice, founding director of the University of Cambridge Institute for Sustainability Leadership, for her efforts in guiding thousands of business leaders to more sustainable business practices. Woods Senior Fellow Rodolfo Dirzo received the 2016 Miriam Aaron Roland Volunteer Service Prize for his efforts to inspire students from underserved communities to pursue environmental careers and conservation projects.

Research Centers & Programs

DISEASE ECOLOGY, HEALTH AND THE ENVIRONMENT



A joint initiative launched in 2015 with Stanford's Center for Innovation in Global Health, drawing on experts in public health, ecology, engineering, computer science, medicine and the social sciences to discover ecological solutions to humanity's health challenges and to develop the next generation of planetary health innovators.

Giulio De Leo, Faculty Director

Susanne Sokolow, Executive Director

CENTER FOR OCEAN SOLUTIONS



A collaboration among Stanford University (through the Stanford Woods Institute and the Hopkins Marine Station), the Monterey Bay Aquarium and the Monterey Bay Aquarium Research Institute, advancing knowledge and solutions to ocean challenges.

Larry Crowder, Science Director

CENTER ON FOOD SECURITY AND THE ENVIRONMENT



A joint effort with the Freeman Spogli Institute for International Studies that addresses the challenges of feeding the world's growing population without depleting the planet's natural resources.

Rosamond Naylor, Director

David Lobell, Deputy Director

GLOBAL FRESHWATER INITIATIVE



An interdisciplinary research effort that studies the long-term viability of freshwater supplies for people and the environment, factoring in threats from climate change, shifts in land use, increasing population and decaying infrastructure. The program focuses on developing and water-scarce regions throughout the world.

Steven Gorelick, Faculty Director

NATURAL CAPITAL PROJECT



A joint venture with The Nature Conservancy, the World Wildlife Fund and the University of Minnesota Institute on the Environment that uses open-source software and other tools to enable decision-makers to quantify nature's values, assess trade-offs associated with alternative land and water use choices, and integrate conservation and human development into land and water use and investment decisions.

Gretchen Daily, Co-Director

Mary Ruckelshaus, Managing Director

OSA & GOLFITO INITIATIVE (INOGO)



An initiative to support sustainable human development and environmental stewardship in Costa Rica's Osa and Golfito region through work with local communities, government, the private sector and nongovernmental organizations.

Rodolfo Dirzo, Faculty Director

William Durham, Faculty Director

Emily Arnold Mest, Associate Director

WATER, HEALTH & DEVELOPMENT



A program aimed at identifying ways to improve and increase the sustainability of water supply and sanitation service delivery, while also enhancing capacity for sustainable water and wastewater management in developing countries.

Jenna Davis, Faculty Director

WATER IN THE WEST



A joint program with Stanford's Bill Lane Center for the American West that develops and promotes solutions to key water management questions in the West, including better groundwater management, more sustainable urban water use, better use of markets and other mechanisms to help western states cope with water scarcity.

Leon Szeptycki, Executive Director



ADVANCING DECISIONS

Photo: Casey Valentine/Cyperus

Woods magnifies the impact of Stanford's breakthrough environmental research by reaching beyond campus to inform and advance environmental decision-making. Through forums, workshops and briefings we convene diverse public and private sectors experts—from Stanford and beyond campus—who can collectively identify challenges along with the research and solutions needed to address them. These interactions

add new dimensions, in-field perspectives and currency to Stanford research. In turn, Woods staff and our affiliated scholars translate and disseminate new findings for those who make and implement decisions affecting the environment. Read on for highlights from our recent work to engage business leaders, policymakers, public servants and others in the process of developing, scaling up and implementing solutions.

Highlights

Clarifying Climate Priorities

Stanford Woods Institute Consulting Professor David Hayes, a Distinguished Visiting Lecturer in Law at Stanford, worked with Woods to organize a panel of climate change, energy and governance experts that included veterans of the Obama, Bush, Clinton and Reagan administrations to identify key climate and energy policies for the next U.S. president to push forward. The #ClimatePOTUS45 event was the first in the Climate Change Implementation Project Conference Series which culminated with a policy

forum at the National Press Club in Washington, D.C., on Sept. 15.

Connecting Climate to Security

Speaking at Stanford's Freeman Spogli Institute for International Studies, U.S. National Security Adviser Susan Rice noted research by Woods Center Fellow Marshall Burke (Stanford Earth) regarding the connection between worsening climate realities and armed conflict. Disputes over basic resources of food and water, refugees from climate impacted areas, and other issues are likely outcomes that could affect international relations.



Photo: Casey Valentine/Cyperus

ADVANCING DECISIONS

Informing Water Policy

Woods, the Public Policy Institute of California and the California Institute for Water Resources hosted a congressional discussion panel at the U.S. Capitol Visitors Center on California water policy and drought. The event featured a diverse group of speakers, including Perry L. McCarty Founding Co-Director Barton “Buzz” Thompson and Letty Belin, Senior Counselor to the Deputy Secretary of the U.S. Department of the Interior. The speakers focused on innovations in technology and ecosystem management. Separately, Thompson, Newsha Ajami, Director of Urban Water Policy at Stanford’s Water in the West program, and Woods Senior Fellow Noah Diffenbaugh (Stanford Earth) testified before the California Assembly Select Committee on Water Consumption and Alternative

Sources to discuss water solutions for California’s ongoing drought.

Collaborating on Solutions

Stanford’s Water in the West program and the Gould Center for Conflict Resolution, in conjunction with California State University Sacramento’s Center for Collaborative Policy, hosted a Groundwater Data Workshop Series. Groundwater managers, county and state representatives, and technical and water policy experts developed regulatory and policy solutions to data-related challenges of implementing the state’s Sustainable Groundwater Management Act.



CATALYZING RESEARCH

Photo: Frank Hadley Collins/Notre Dame

In the wake of the 2015 Paris climate talks, humanity is at a hopeful turning point. The need and momentum for real-world solutions to profound environmental challenges is perhaps greater than ever before. To tackle these challenges, Woods fosters cross-discipline collaboration and sponsors solutions-focused research around the world. At the heart of this effort is the Environmental Venture Projects (EVP) seed grant program, which helps innovative, often high-risk projects get off the ground. Since the EVP program began in

2004, Woods has awarded grants to 74 research teams working in more than 20 countries. These projects have garnered more than \$47 million in follow-on funding and have involved faculty from all of Stanford's seven schools. The Realizing Environmental Innovation Program (REIP), now in its second year, supports later-stage interdisciplinary research projects that have shown initial promise in identifying solutions. The program awards funding and offers external advising. Woods has awarded more than \$12 million in EVP and REIP grants.

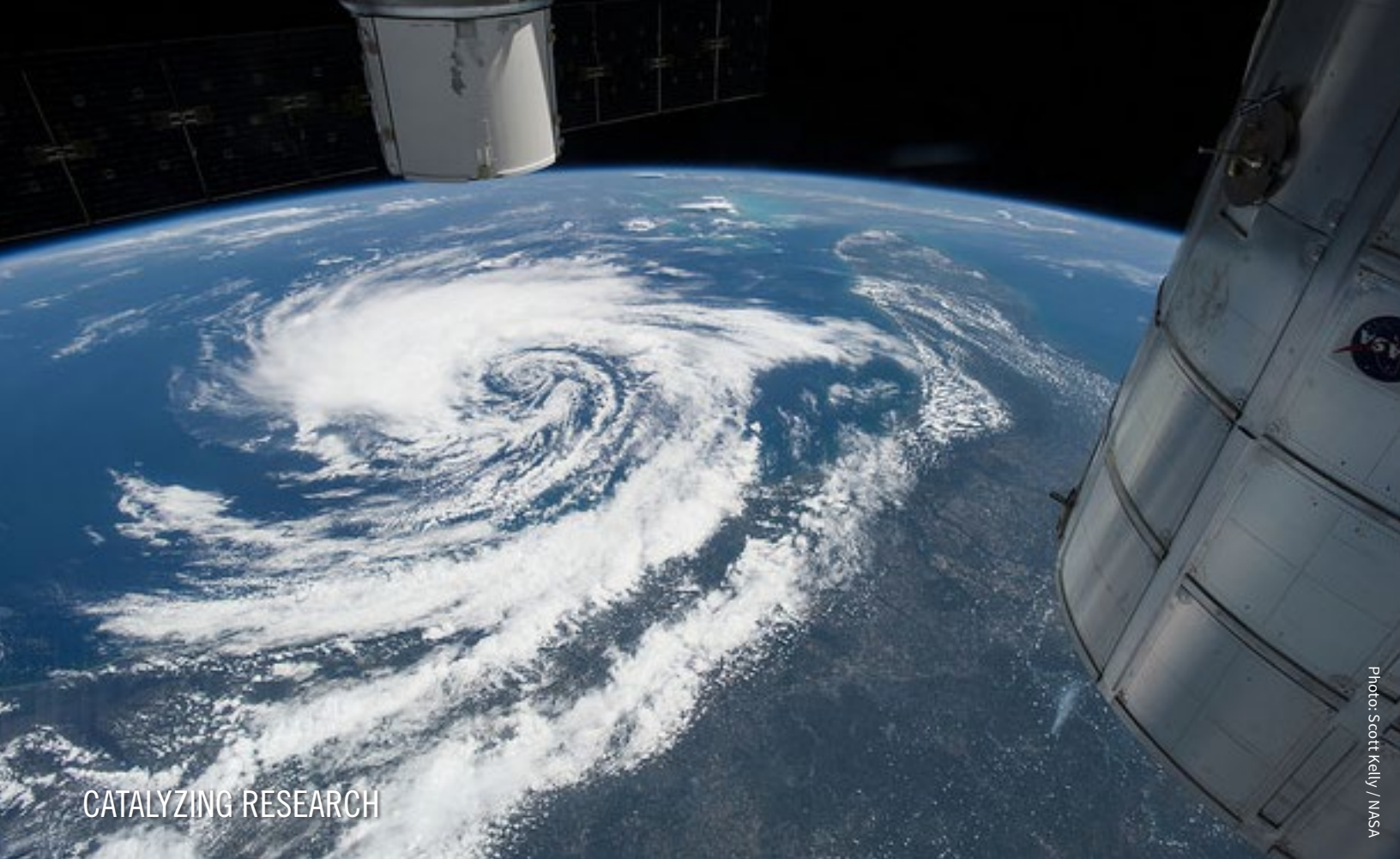
Highlights

Catalyzing Medical Innovation

Woods-affiliated Assistant Professor of Bioengineering Manu Prakash, the recipient of EVP funding for research on a low-cost technology for assessing mosquito-borne diseases, received more than \$2 million in follow-on funding to continue this work.

Preying on Parasites

Prawns are highly effective consumers of snails infected with a parasite that carries schistosomiasis, a potentially deadly disease that infects about 230 million people worldwide, according to study from a team of researchers that received EVP funding.



CATALYZING RESEARCH

Photo: Scott Kelly / NASA

Finding Water Sources

ReNUWit, a partnership of multiple universities and private industry co-directed by Palmer Professor of Civil and Environmental Engineering Richard Luthy, worked with local and federal agencies in drought-stricken California cities in an unprecedented effort to capture and reuse stormwater. ReNUWit, which grew out of seed funding from an EVP award, identifies new ways to supply urban water and treat wastewater efficiently and sustainably.

Sensing Environmental Solutions

Woods partnered with Stanford Energy 3.0 to create a funding program, Sensors and Big Data for Solving Environmental Challenges, which awarded four teams up to \$70,000 each to develop novel solutions and viable business models for sensors and data analytics tailored to environmental challenges.

Scaling Up Solutions

Through an EVP grant, a team of Stanford researchers formed Lotus Water, a project devoted to developing and testing intermediate-scale water disinfection technologies for urban slums around the world. The team is researching the demand for and impacts of a chlorine device deployed in Bangladesh. The project's researchers are working with MSR Global Health and the NGO PATH to maximize their knowledge and experience of scaling technologies and products for low-income settings.



Woods leadership and education programs are preparing students, researchers, professionals and decision-makers to forge new pathways to sustainability. A diverse portfolio of programs focuses on developing skills, knowledge and networks to move ideas into action and support informed decision-making. Our programmatic

offerings range from an intensive series of workshops and panels introducing emerging researchers to the inner workings of the nation's capital, to a community-based leadership program preparing local entrepreneurs to steward and benefit from biodiversity in Costa Rica's Osa and Golfito region.

Highlights

Preparing Indigenous Leaders

The Stanford-based First Nations' Futures Institute is a two-week program that prepares young indigenous leaders to tackle social, economic, environmental and cultural challenges in their communities. In Fall 2015 the program celebrated 10 years of providing participants with skills and strategies to address environmental, economic, social and cultural challenges in their communities.

Supporting Student Fieldwork

Woods and the Vice Provost for Undergraduate Education awarded nine undergraduate students grants

to do fieldwork around the through the Mentoring Undergraduates in Interdisciplinary Research (MUIR) program. MUIR supports interdisciplinary environmental research by Stanford faculty by providing summer stipends for undergraduate student researchers.

Inspiring Environmental Leaders

Woods launched a pilot program, the Forum for Undergraduate Environmental Leadership (FUEL), which allows Stanford students to investigate environmental careers. Participants visited Sacramento to meet with policymakers and professionals in the field to learn about environmental policymaking and opportunities in the legislative, agency and nongovernmental organization sectors.



Photo: Casey Valentine/Cyperus

EDUCATING LEADERS

Linking Science and Policy

Government policy decisions guide much of the scientific opportunities in the United States. The 20 graduate scholars who participated in Woods' Rising Environmental Leadership Program (RELP) underwent an intense week of 'D.C. Bootcamp' in the nation's capital to learn how science is linked to policy. RELP teaches scholars the value of building networks, communicating science effectively and informing policymakers. Participants attend campus workshops and networking events, and are introduced to federal agency and legislative professionals.

Interdisciplinary Communication

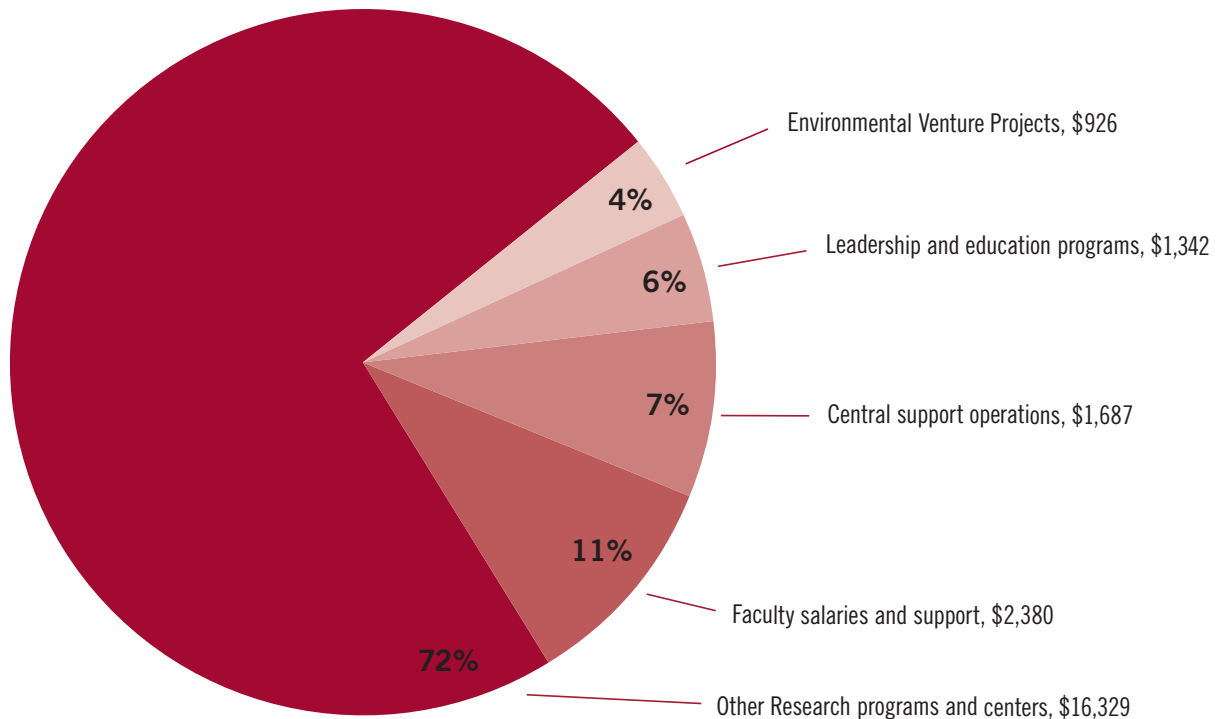
Finding ways for ocean scientists to communicate better with seafood industry workers was among the issues raised by insightful presentations at Woods' Young Environmental Scholars Conference. The annual event champions interdisciplinary dialogue between environmental researchers from all seven Stanford schools on environmental science, policy and behavior research. The conference, attended by 80 graduate students, is an opportunity for young scholars to present their research and foster collaborations across disciplines.



Fiscal Year 2014-2015 (Actual)

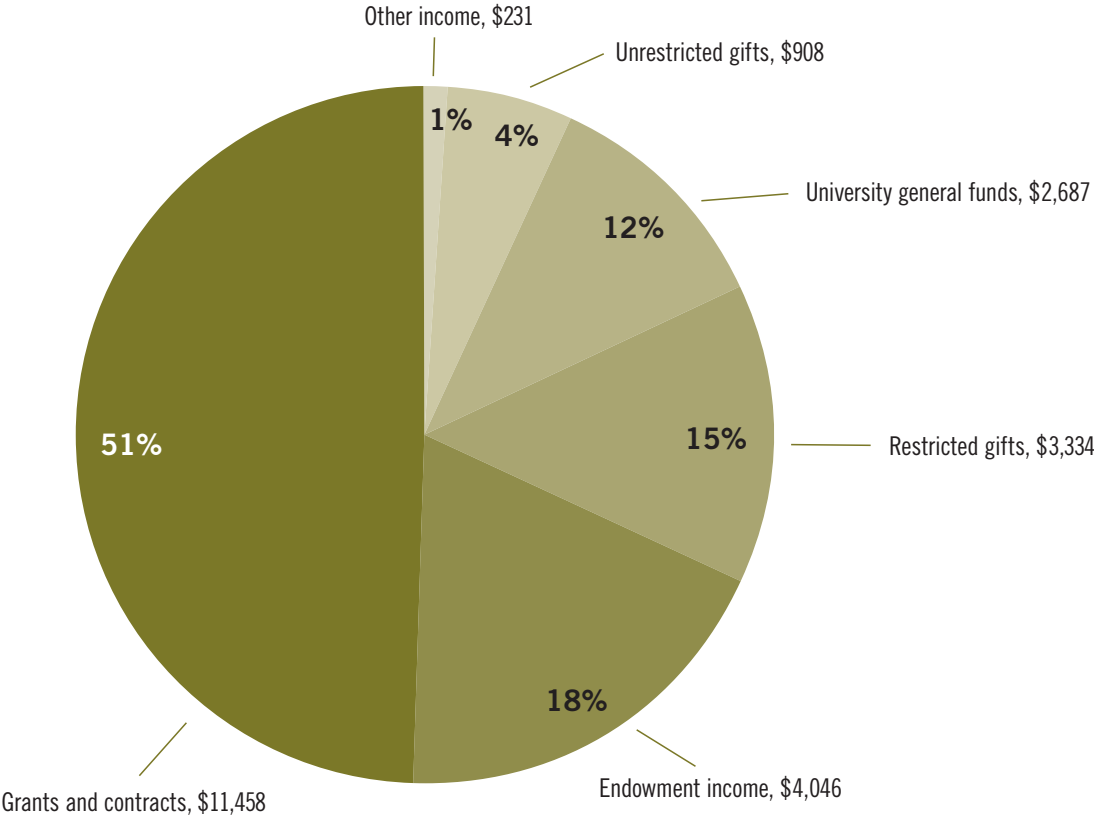
Sources of revenue which support the Stanford Woods Institute for the Environment in fiscal year 2014–2015 amounted to \$23.0 million, of which 12 percent originated from university general funds, 18 percent from endowment income, 19 percent from gifts, and 51 percent from grants and contracts. Expenses during the fiscal year 2014–2015 amounted to \$23.0 million. Woods largest expenditure includes Environmental Venture Projects and other research programs and centers, totaling \$17.3 million, or 76 percent of the institute’s annual budget.

Expenses (in thousands)



Total Expenses \$22,664

Sources of Revenue
(in thousands)



Total Sources of Revenue \$22,664



Photo: Daniel Karp/Stanford

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