

## MIT Environmental Solutions Initiative

The [MIT Environmental Solutions Initiative \(ESI\)](#) advances science, engineering, policy and social science, design, the humanities, and the arts toward a people-centric and planet-positive future.

AY2017 marks the first full year of leadership for ESI director John E. Fernández and executive director Amanda Graham. Activities in areas such as research, education, and resource development expanded significantly during the year, with notable accomplishments including formal Institute approval of a new undergraduate minor in environment and sustainability, the first publications from the inaugural round of ESI research seed grants, and the coordination of a diverse portfolio of public and private events.

Over the past year, there has been a significant shift in US federal policy on environment and climate. The promised withdrawal from the Paris Climate Agreement, looming budget cuts for environmental agencies and scientific enterprises, and the unraveling of US regulatory frameworks for environmental protection transformed the national government's trajectory on these issues from forward momentum to retreat. While many cities and business leaders continue forward progress on reducing carbon emissions, these and other subnational actors now operate without US federal government leadership. In this context, the importance and relevance of ESI's mission have only increased.

ESI's overarching goals for 2017–2018 are to (1) sustain and accelerate programs in research, education, and other areas; (2) secure substantial funds to support programmatic growth; and (3) complete the build-out of ESI's governing bodies.

ESI partnerships within and beyond MIT blossomed in 2016–2017. At the Institute, ESI works closely with diverse units focused on environment, climate, and sustainability (including the Abdul Latif Jameel World Water and Food Security Lab, the MIT Energy Initiative [MITEI], the Office of Sustainability, the Sloan Sustainability Initiative, the Joint Program on the Science and Policy of Global Change, the Center for Energy and Environmental Policy Research, the Climate CoLab, and Terrascope) as well as key units pursuing policy, education, and innovation agendas (including the International Policy Lab, the Teaching and Learning Laboratory, the Deshpande Center for Technological Innovation, the Legatum Center for Development and Entrepreneurship, the MIT Innovation Initiative, MIT.nano, the Office of Digital Learning, and the MIT Integrated Learning Initiative). ESI maintains clear and continuous communication with the three “core” departments of Civil and Environmental Engineering (CEE), Urban Studies and Planning (DUSP), and Earth, Atmospheric and Planetary Sciences (EAPS), as well as with the deans of all five schools.

ESI continues to work closely with numerous units in the Office of Resource Development, including the MIT Campaign for a Better World, Foundation Relations, Leadership Giving, and Alumni Relations, to attract the substantial resources required to enable ESI to meet its ambitious objectives.

## Research

### Seed Grant Program

The majority of ESI's research activity in 2016–2017 focused on continuing progress in the nine research seed grant projects selected under the leadership of founding ESI director Susan Solomon. These projects are notable for the multidisciplinary nature of their principal investigator teams, for their distribution across ESI's three priority research domains, and for their engagement in topics dispersed across the globe.

#### ***Research Domain 1: Climate Science and Earth Systems***

- Developing Solutions for Human and Environmental Health Risks Created by Exponentially Increasing Exposures to Lanthanide Metals: John Essigmann (Biological Engineering [BE], Chemistry), Bevin Engelward (BE), and Harry Hemond (CEE)
- Opportunities for Mitigating CH<sub>4</sub> and Other Non-CO<sub>2</sub> Energy-technology-related GHG Emissions: Jessika Trancik (Institute for Data, Systems, and Society [IDSS]) and Francis O'Sullivan (MITEI)
- Greenhouse Gas Emissions from Tropical Peatlands: Biogeochemical Processes and Mitigation Strategies: Charles Harvey (CEE), Benjamin Kocar (CEE), Martin Polz (CEE), Shuhei Ono (EAPS), and Roger Summons (EAPS)

#### ***Research Domain 2: Cities and Infrastructure***

- Fostering Sustainable Consumption in US Cities: Eran Ben-Joseph (DUSP)
- Clearer Skies in Beijing: Collecting and Interpreting Relevant Spatio-temporal Data for Air Quality Assessment: Marta Gonzalez (CEE) and Jinhua Zhao (DUSP)
- Improved Management of Common Pool Resources: Dennis McLaughlin (CEE) and Parag Pathak (Economics)

#### ***Research Domain 3: Sustainable Production and Consumption***

- Will New Limits on Coal Use in China Reduce Toxic Air Pollutants across Asia? Valerie Karplus (Sloan School of Management) and Noelle Selin (EAPS, IDSS)
- Digging Deep: An Integrated Approach for Assessing the Impacts of Deep-Sea Mining: Thomas Peacock (Mechanical Engineering [MechE]), Pierre Lermusiaux (MechE), and Glenn Flierl (EAPS)
- Metals and Minerals for the Environment: Antoine Allanore (Materials Science and Engineering [DMSE]) and T. Alan Hatton (Chemical Engineering)

Preliminary results from all projects were presented at an Earth Day mini-symposium in April 2016.

ESI's second call for research seed grant proposals closed in February 2017, with funding selections finalized in summer 2017. This second round of two-year grants supports six projects across ESI's three research domains.

### **Research Domain 1: Climate Science and Earth Systems**

- Genetically Engineered Solutions to Environmental Nitrogen Paradoxes: Andrew Babbitt (EAPS)
- Improved Climate Modeling through Machine-Learning and Data-Driven Approaches: Paul O’Gorman (EAPS)

### **Research Domain 2: Cities and Infrastructure**

- Sustainability of Autonomy-Enabled Transportation Systems: Steven Barrett and Sertac Karaman (Aeronautics and Astronautics)
- Decarbonized Energy Systems for the New Volpe Center: Leslie Norford (Architecture), Christoph Reinhart (Architecture), and David Hsu (DUSP)
- Achieving Water Affordability in America’s Shrinking Cities: Solutions for Financial Sustainability and Social Equity: Lawrence Susskind and Gabriella Carolini (DUSP)

### **Research Domain 3: Sustainable Production and Consumption**

- Beneficial Use of Industrial Wastes in the Built Environment: Elsa Olivetti (DMSE)

### **Air Conditioning in India Project**

A gift from David Vogel ’95 and the VoLo Foundation enabled the launch of a project to pursue decarbonization of air conditioning in India. The project is organizing a workshop in India in February 2018 with the intent to mobilize a domestic industry for low-carbon cooling.

### **SHASS Fellowship**

One strategy deployed this year to foster the involvement of the School of Humanities, Arts, and Social Sciences (SHASS) in research on the environment was to provide a summer fellowship for a student in the doctoral program in History, Anthropology, and Science, Technology, and Society (HASTS). Ashawari Chaudhuri received the fellowship in summer 2017 for her research on agricultural biotechnology. We anticipate continuing and potentially expanding the program in future years, contingent on adequate funding.

### **Martin Fellowships for Sustainability**

Eleven doctoral students from eight departments were selected as Martin Fellows for Sustainability in 2017–2018. Also, a new Martin Fellow website was launched. Faculty oversight for the Martin Society rests with the governance committee, which includes Professors Jennifer Light (Program in Science, Technology, and Society [STS], DUSP), Les Norford (Architecture), J. Taylor Perron (EAPS), John Sterman (Sloan), and Heidi Nepf (CEE). ESI director John Fernández is an ex officio member of the committee and was the featured speaker at the annual induction dinner in October 2016. The annual weekend retreat also took place in October, with fellows and alumni traveling to Thompson Island for a program focused on salt marsh ecology and the impact of climate. A celebration of the 20th anniversary of the establishment of the Martin Fellowships is planned for spring 2018.

## Education

The main educational priorities in 2016–2017 were to fully develop and secure approval of a formal proposal for an environment and sustainability minor, to fund an initial round of curriculum grants, and to begin integration of environment topics into the General Institute Requirements (GIRs).

### Environment and Sustainability Minor

ESI conducted five community meetings in 2016 to gather faculty insight into the design of a minor in environment and sustainability. A total of 47 faculty and lecturers from all five schools and 17 departments or units participated in these meetings. A formal proposal for a new multidisciplinary minor was submitted in December 2016 and approved by the Committee on Curricula and the Committee on the Undergraduate Program in March 2017.

The minor, which will launch in September 2017, will include two required, multidisciplinary subjects along with a sequence of three electives. The minor’s curriculum integrates the four content “pillars” described below. Students can pursue electives within one of the four pillars or create their own elective sequence in consultation with their minor advisor.

Pillar 1, Earth Systems and Climate Science, encompasses distinct disciplines such as ecology, geology, meteorology, and more to provide students with an understanding of the physics, chemistry, and biology of the Earth and its climate.

Pillar 2, Environmental Governance, includes political science, environmental law and justice, environmental management, and other fields so that students can gain an understanding of the distribution of power and decision making in society and, in particular, the strategies and tools directed toward consciously guiding our relation to the environment.

Pillar 3, Environmental Histories and Cultures, enlists historical, anthropological, cultural, and humanities studies as well as urban studies and planning to provide students with an understanding of the anthropogenic transformation of the environment through our economies, cities and other human settlements, and institutions.

Pillar 4, Engineering for Sustainability, comprises a vast panoply of engineering and design disciplines directed toward innovation and including expertise in construction and manufacturing processes and operation, use, reuse, and disposition of materials, devices, and systems for sustainable and humane development.

### Curriculum Development Grants

With the generous support of the Dirk (‘75) and Charlene (‘79) Kabcenell Foundation, ESI issued curriculum development grants for two core subjects, seven new and three adapted elective classes in the minor, and one interactive teaching resource.

***New Core Subjects***

- 12.387J/15.874J/IDS.063J People and the Planet: Environmental Governance and Science: Noelle Selin (EAPS, IDSS), Susan Solomon (EAPS), and John Sterman (Sloan)
- 11.004J/STS.-33J People and the Planet: Environmental Histories and Engineering: Janelle Knox-Hayes (DUSP), Robin Scheffler (STS), Thomas Consi (Sea Grant College Program), and Brian Anthony (MechE)

***New Electives***

- 12.174 Biogeochemistry of Natural and Perturbed Systems: Andrew Babbin (EAPS)
- City on a Hill: Understanding Environmental Change and Health in the City of Boston: Robin Scheffler (STS)
- 11.148 Environmental Justice: Law and Policy: Justin Steil (DUSP)
- History of Earth's Environment: Kristin Bergmann (EAPS)
- 2.S975 Sensing for Resilience and Sustainability (Independent Activities Period [IAP]): Michael Triantafyllou (MechE) and Thomas Consi (Sea Grant College Program)
- 11.S938/2.S999 Solving for Carbon Neutrality at MIT: Timothy Gutowski (MechE) and Julie Newman (DUSP)
- Urban and Environmental Technology Implementation Lab: David Hsu (DUSP)

***Adapted Electives***

- 1.061 Design for Complex Environmental Issues: Building Solutions and Communicating Ideas: David McGee (EAPS)
- 21H.185J/12.386J Environment and History: Harriet Ritvo (History) and Susan Solomon (EAPS)
- 12.003 Introduction to Atmospheres, Oceans, and Climate: Timothy Cronin (EAPS)

***Adapted Teaching Resources***

- EsGlobe: an interactive educational resource for environmental data: Lodovica Illari (EAPS)

**Environment General Institute Requirement**

During 2016–2017, Professor Peter Dourmashkin and his team developed and tested environmentally focused problem sets in physics GIR subjects. This pilot effort had positive results, and ESI continues to work with an array of instructors to further advance inclusion of environment, climate, and sustainability topics in the service of teaching diverse GIRs. It is anticipated that problem sets and other learning materials will be developed for several GIR subjects in the AY2018 fall and spring terms.

## Science Communication

In collaboration with the International Policy Lab and the nonprofit organization COMPASS, ESI organized a full-day IAP workshop on science communication for graduate students working in climate and environment.

## First-Year Student Activities

ESI hosted an open house during Campus Preview Weekend to begin informing incoming students of opportunities for interdisciplinary environmental study at MIT, particularly the environment and sustainability minor. ESI director Fernández led a freshman advising seminar.

## Convening

ESI's convening activities in 2016–2017 followed three strands: pursuing promising partnerships with external entities, establishing regular forums for engaging the MIT community in lively discussions on critical topics in environment and sustainability, and sustaining and expanding ESI annual events and student-led initiatives.

## Major Collaboration with Conservation International

ESI and MIT's Office of the Vice President for Research have secured a partnership with one of the world's leading conservation organizations, Conservation International (CI). A joint workshop involving CI scientists and MIT faculty was held in July 2016, and the two organizations signed a memorandum of understanding in January 2017 with the intent to pursue a robust agenda of research and education. Several CI scientists participated in ESI's second annual Hackathon for Climate during the 2017 IAP, and in September 2017 ESI and CI will co-host a two-day workshop at MIT with the Computer Science and Artificial Intelligence Laboratory and the Media Laboratory on opportunities for deploying artificial intelligence, machine learning, and robotics to advance conservation and environmental priorities.

## Additional Partnerships

ESI is partnering with the McCormack Graduate School of Policy and Global Studies at the University of Massachusetts Boston to plan and co-host the 2018 Boston Forum on Science for Environmental Solutions under the auspices of UN Environment. ESI is also working with the X Company (formerly Google X); Argentina's major water corporation, Agua y Saneamientos Argentinos S.A.; and Morocco's Office Chérifien des Phosphates.

## People and the Planet Lecture Series

ESI launched its campus community lecture series in September and hosted four lectures throughout the academic year. Each speaker also joined a salon-style dinner with faculty and local thought leaders, and a student roundtable was added to the speaker visit program during the final spring 2017 event. AY2017 speakers included Nathaniel Stinnett, founder and CEO of the Environmental Voter Project; Conservation International scientists Sandy Andelman and Will Turner; ESI visiting scholar and award-winning science writer Deborah Cramer; and former US congressman Bob Inglis, founder of the climate change group republicEn.org. We anticipate holding four lectures during 2017–2018.

## Lunch Seminar Series

ESI held eight faculty seminars throughout the academic year. These informal seminars were held on the central campus over lunch and featured faculty from seven departments describing current research and education initiatives. Conversations were lively and highly cross disciplinary. We are expanding the seminar series to include postdocs and graduate students as both presenters and participants in AY2018.

## Other Events and Initiatives

Additional ESI events in AY2017 included a “welcome back” party for students, faculty, and staff in the first week of September; the second IAP Hackathon for Climate; an open house for prospective students during Campus Preview Weekend; an Earth Day celebration on the Kresge Oval that included numerous student groups and members of both the MIT and Cambridge communities; and an April mini-symposium at which preliminary results of ESI research seed grant projects were presented.

ESI sponsored student-led events including a daylong materials reuse event, the Sloan Sustainability Summit, and the UA Committee on Sustainability’s Dorm Electricity Competition and Trashion Show. Also, ESI supported the attendance of two graduate students at the annual conference of the Association for the Advancement of Sustainability in Higher Education (AASHE).

ESI also provided support to two longer-term student initiatives. First, together with the School of Architecture and Planning, ESI is supporting “Climate Changed,” an effort led by graduate students to bridge the climate modeling, civil engineering, and architecture/design communities. The initiative includes a major symposium, a design competition, and a public exhibit, all to take place during 2017–2018. Modest external support has been secured. Second, several Sloan graduate students joined forces to create “Before It’s Too Late,” a new, not-for-profit organization aiming to leverage virtual reality technology as a means of introducing the realities of climate change to citizens and business leaders across the political spectrum. ESI provided support for one undergraduate and one graduate student to participate in the multi-university development process and continues to advise the group’s leaders.

## Governance

ESI formed a student advisory council in 2016 with nearly 20 inaugural members from the undergraduate, graduate, and postdoc communities. The council provides a critical, coordinated voice to ESI leadership on our priorities and portfolio. In addition, members take part in projects to help build ESI capacity, such as featuring environmentally relevant companies and positions at the Career Fair and creating short videos to highlight MIT students and faculty active in sustainability research and education. This year ESI also began reconfiguring its Faculty Advisory Committee and forming its External Advisory Board, in consultation with MIT senior leadership.

## Resource Development

Efforts to secure funding for ESI expanded significantly in 2016–2017. Director Fernández introduced ESI to several alumni groups, including groups from Hong Kong,

San Francisco, and Boston, and met with a number of potential private, public, and corporate sponsors throughout the year. Resource development activities will continue to increase in 2017–2018, aided by the hiring of a 50% director of corporate engagement to start in August 2017.

### **Administration and Other Activities**

In January, ESI hired its first two Northeastern University “co-op” students as full-time six-month interns. The students have expanded ESI’s administrative capacity significantly, and this intern program will continue into AY2018. With the assistance of the interns, ESI has launched two communication vehicles: a Facebook page (to increase our visibility to students and prospective students and to publicize events) and an e-newsletter (to provide information and share ESI updates with the MIT community, alumni, and external partners and contacts).

Director Fernández joined the advisory committee of the Sloan Sustainability Initiative and continues to serve as a member of MIT’s Climate Action Advisory Committee, the Campus Sustainability Task Force, and the Institute Planning Committee. This year, he became closely involved with the Institute’s plans to build a new undergraduate dorm and has provided substantial guidance with respect to optimizing the new building’s energy and resource sustainability. Fernández made a presentation at a conference of the Northeastern Governors/Eastern Canadian Premiers in August, spoke at the opening session of the 2016 Cambridge Climate Congress in October, served on a panel at MIT’s “Day of Action” in April, and served as an advisor throughout the year for the “fuel” pillar of the Solve initiative.

ESI executive director Amanda Graham joined the advisory council of the Association for the Advancement of Sustainability in Higher Education. She presented with MindHandHeart co-director Maryanne Kirkbride at the World Summit on Sustainable Development, hosted at MIT in September; presented on a panel at the annual AASHE meeting in October; moderated the student-organized “Worn Wear” panel in March; and collaborated with the Office of Sustainability on its annual SustainabilityConnect event in May.

ESI visiting scholar Deborah Cramer’s book *The Narrow Edge: A Tiny Bird, an Ancient Crab, and an Epic Journey* received numerous awards during 2016–2017, including Best Book from the National Academy of Sciences and the Rachel Carson Book Award.

**John E. Fernández**  
**Director**  
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