MIT Environmental Solutions Initiative

Agenda: 2018

Environmental Solutions Initiative

The ESI coordinates and develops interdisciplinary solutions to urgent challenges in environment and sustainability. ESI aims to harness the MIT community's ingenuity and the Institute's unique culture of collaboration through diverse activities in research, education, and convening.

UNLEASHING MIT SOLUTIONS

Humanity's past actions and current behaviors have already resulted in dramatic damage to people and to nature, and pose huge risks for our planet's future. From declining fisheries to acute urban pollution to record-breaking global temperatures, the evidence of human impact on the environment continues to mount (USGCRP, 2017). Across the MIT community, our scholars and students are working to understand, address, and reverse the negative effects of humanity's footprint on the Earth.

ESI aims to expand and accelerate progress toward environmental solutions in three vital domains:

Climate Science and Earth Systems

Cities and Infrastructure

Sustainable Production and Consumption

History has shown that effective solutions to challenging environmental problems nearly always depend on multiple disciplines; it is only through a broad perspective that truly effective improvements in our relationship with the environment may be achieved. Advancing our understanding of the drivers of and remedies to environmental issues requires contributions not only from science, engineering, and technology, but from the full range of fields represented at MIT: the humanities, arts, economics, history, architecture, urban planning, management, policy, and more. MIT's exceptional strength in all of these areas is matched by our proficiency, born of long experience, in bridging them.

Research

Investment in research is required to improve our understanding of how humans are disrupting the intricately interconnected systems and cycles on earth, as well as how to minimize this disruption and steer future global development towards a sustainable path. To date, ESI's Seed Grant Program has funded 15 multi-investigator projects across the institute. An undergraduate research program exposes students from all majors to the full spectrum of ESI research and partners.

Education

As emerging leaders, change agents, and innovators, MIT students have a profound interest in, and capacity to shape a more sustainable environment. Addressing complex environmental problems requires professionals, leaders, and scholars in all sectors of society who understand biological, geological, chemical, and physical processes; behavioral, organizational, governmental, and cultural dynamics; and how they interact. Highlights of ESI's educational activities include:

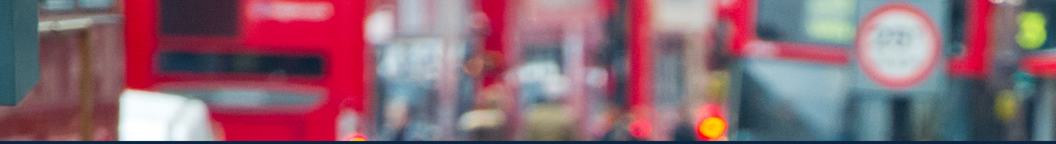
- An undergraduate minor in environment and sustainability
- Infusing foundational undergraduate classes with diverse environmental content
- Fostering hands-on, learning-while-doing experiences both on- and off-campus
- Building on the success of the Martin Family Society of Fellow for Sustainability by expanding graduate student support in environmental research

Convening

ESI fosters effective communication and engagement with the greater world through various forums connecting the MIT community with diverse experts and stakeholders. The ESI is working with lawmakers across the political spectrum – including former Congressman Bob Inglis (R-SC) and Senator Sheldon Whitehouse (D-RI) – to address the significant challenges that limit governmental climate action. Direct and sustained engagement with the world beyond MIT is critical to generate solutions that can be developed and deployed effectively where they are most needed.

ESI's convening efforts also bring together expertise, fields, tools, and approaches that have yet to be deployed in environmental research. A recent workshop on "Advancing conservation with artificial intelligence" assembled thought leaders in machine learning, robotics, and conservation science to exchange knowledge and establish long-term collaborations. ESI marshalls MIT's vast technical ability for solving the most pressing problems facing the natural world.

The remainder of this document introduces ESI's three domains of focus.



CLIMATE SCIENCE AND EARTH SYSTEMS

Rapidly progressing changes to our climate system have become a primary challenge to our species. These changes threaten entire regions and societies partly because we have become exquisitely attuned to the stability of the climate. Disturbances to that stability have already begun to result in great human suffering and ecosystem damage through increased severity and frequency of extreme weather events (such as flooding and droughts), water and food disruptions, ocean acidification, and more. It is increasingly clear that nature-based solutions – conservation, restoration, and improved land management practices – will play a central role in reducing atmospheric carbon dioxide concentrations (Griscom et al. 2017). Effectively leveraging such solutions will require an improved understanding of network ecology and human dynamics.

This domain seeks to improve both our understanding of global climate and earth systems generally, and the application of this knowledge to affect action, mitigate carbon emissions, and adapt to climate change. Research priorities in this area include:

- Fundamental physics of climate science
- Consequences of climate change
- Biodiversity and ecosystems
- Climate action: political, economic, and social challenges

CITIES AND INFRASTRUCTURE

Today, more than half of our species lives in cities, where 75% of energy is consumed and 75% of carbon emissions are produced. Urban populations are expected to double in the coming decades, and urban energy use and land areas will triple by 2050. At the same time, plans to mitigate climate change call for all cities to have decarbonization strategies in place by 2020 (Rockstrom et al. 2017). Reconciling such goals with the immense scale of projected urbanization will require rapid and continual innovation in environmentally-calibrated buildings, infrastructure, and transportation.

The degree to which future waste streams, including carbon dioxide emissions, increase with population growth will be greatly determined by the technologies and engineering solutions deployed to serve urban needs. Research priorities in this area include:

- Cities and nature
- The “Future City”
- Continued urbanization: political, economic, and social dynamics

SUSTAINABLE PRODUCTION AND CONSUMPTION

Adverse environmental consequences on humans and many other species – ranging from anthropogenic climate change to the Flint water crisis – result directly from energy and material extraction/generation and refinement, processing and production, and transportation and consumption. Transitioning these processes towards a more sustainable society and will require building in new capacities to anticipate and minimize environmental and cultural harm. Solely adopting low carbon energy will be insufficient in mitigating climate change; truly creative solutions are needed to convert our industrial system to one with a reduced demand for material production (Allwood et al. 2017).

This domain aims to improve our understanding of the interaction of technical, political, and cultural dynamics in energy and material demand. Close engagement with a wide range of industrial partners will be critical to developing alternative modes for supplying society's needs. Research priorities in this area include:

- Production of materials and services
- Societal consumption
- Pollutants: source, transport and health impact

TIMING IS EVERYTHING

The world is at a technological and societal crossroads in its relationship with the environment. Decarbonization must be pursued immediately if we are to meet the Paris target of limiting warming to 1.5°C (Figueres et al. 2017). Though we face significant known and unknown challenges, possibilities for regional and global solutions are emerging. Industry, government, and civil society must work together to have any real prospect of forging a promising future.

ESI is dedicated to leveraging MIT's unique culture and enormous capacity toward this end.

CLIMATE SCIENCE AND EARTH SYSTEMS

Fundamental physics of climate science
- aerosols and clouds
- ocean and atmosphere dynamics
- biogeochemical cycles and stability

Consequences of climate change
- population displacement and conflict
- ocean acidification
- sea level rise and coastal resilience
- changes in extreme weather
- disruption of water, food, and materials

Biodiversity and ecosystems
- network ecology and predictive modeling
- quantifying the value of ecosystem services
- fostering ecological resilience and advancing conservation
- formulating nature based solutions
- management practices and governance
- novel applications of machine learning, robotics and environmental sensing

Climate action: political, economic and social challenges
- climate discourse and the role of communication and behavioural sciences [e.g. addressing the politicization of the climate debate]
- international environmental governance
- informing key climate science documentation [e.g. IPCC report, climate negotiation briefs]
- engage diverse communities in knowledge building, decision making, and action [e.g. interactive climate scenarios for stakeholder engagement]

CITIES AND INFRASTRUCTURE

Cities and nature
- urban metabolism
- ecosystem services and urban ecology
- mind-body-culture-environment relationships
- urban air pollution

The “Future City”
- sustainable building design
- sustainable neighborhood design and leveraging urban density
- blue-green infrastructure
- climate change mitigation and adaptation
- urban mobility [e.g. electrification, optimization, and automation]
- waste management and leveraging co-benefits
- smart cities and the role of machine learning, big data, and robotics
- interurban mobility [e.g. high speed rail, airport connectivity]
- energy [e.g. renewables and distributed generation and storage] (MITei)
- food and water security (J-WAFS)

Continued urbanization: political, economic and social dynamics
- demographic flows and big data analytics

- urban governance, decision making, and civic engagement
- jobs and employment [e.g. cleantech opportunities, job losses from automation and robotics]
- urban-rural and intracity equity issues [e.g. wealth concentration in cities, education inequality between districts, pollution sites being collocated with low income sites]
- sub-national sustainability leadership

SUSTAINABLE PRODUCTION AND CONSUMPTION

Production of materials and services

- resource extraction, processing, and supply chains
- life cycle assessment and systems orientation
- the impact of resource extraction on communities, cultures and economies
- design for reuse, disassembly, material recovery and other extensions of material and product lifetimes
- carbon offsetting with negative emissions [e.g. carbon capture and sequestration, direct air capture]

Societal consumption

- understanding patterns, organization, and coordination of human action [e.g. utilizing big data and machine learning]
- levers of cultural change towards reducing consumption [e.g. changing preferences and habits, moral economies]
- political and economic methods of accounting for externalities [e.g. carbon tax, environmental regulation]
- addressing environmental and climate justice

Pollutants: source, transport, and health impacts

- health relevant analysis based on quantified transport and exposure [e.g. climate models, enhanced sensing]
- impact on biodiversity and ecosystems
- toxicity and carcinogenesis of novel materials [e.g. microplastics and nanomaterial]

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