



Sustainability Science 2.0

- a National Investment Roadmap

A Joint Initiative of Future Earth and the National Academies Sustainability Roundtable





Text: Edited by Judit Ungvari

Design and layout: Tzu-Hsun Anny Chang



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Executive Summary

From two dialogues with 60+ sustainability leaders from across the US, we produced a series of nine key areas of investment in the US sustainability research system that would collectively amplify the impact of sustainability science in the US and around the world.

1. Move at Scale:

Join, forge and support international partnerships with a focus on the development and strengthening of funding mechanisms and collaborations that cross sectors and geographies.

2. Engage with Big Data, ICT, AI, and Earth Observation:

Focus on market and pre-market partnerships pushing technological innovation to scale. Work on greater integration of these fields into research agendas, and include a focus on ethics, inclusion and environmental justice. Expand research, education and outreach focused on social-goods technology and innovation.

3. Develop and Champion Sustainability Leadership:

Celebrate, support and network engaged science leaders in the US and around the world. Build from, expand, and modernize current programs and champion leaders at all stages of their career—undergraduates, graduates, post-docs, mid-career professionals, with greater emphasis on integration and inclusion.

4. Organize and Integrate at a National Scale:

Work across sectors to develop integrated policies, innovative tools, more effective communication, and a stronger community focused on an integrated research agenda that is problem-defined, user-inspired and solution-driven, organized around the Sustainable Development Goals.

5. Build the Field of Transdisciplinary Research:

Use systems approaches to support academic institutions, emphasizing shifts in the funding for transdisciplinary solutions-oriented research; the development of a unified transdisciplinary research curriculum at multiple academic levels; and support for researchers, centers, and schools coming from many perspectives (law, business, economics, anthropology, engineering, health, natural sciences) focused on transdisciplinary sustainability work.

6. Support Science-Business Boundary Spanning:

Support centers of excellence focused on building the skills, behaviors, networks, and incentives needed for stronger solution-focused research, co-designed and transdisciplinary research, training, and outreach. Focus on alignment of sustainability and business agendas, and opportunities for academic actors to support policy-making at multiple scales. Take advantage of existing university structures - extension, professors of practice, boundary-spanning centers and institutes - and organize best practices to support transfer and scaling.

7. Make Inclusion and Diversity Core Principles in Sustainability Research:

The relevance of sustainability research will be defined by who it serves and who delivers the message. Expand both the audience for sustainability research and strengthen efforts to support individuals from under-represented groups to become a part of the next generation of sustainability research leaders - inside and outside of academia. Work along the full academic and professional career pipeline, and incorporate diverse values into the sustainability research curriculum.

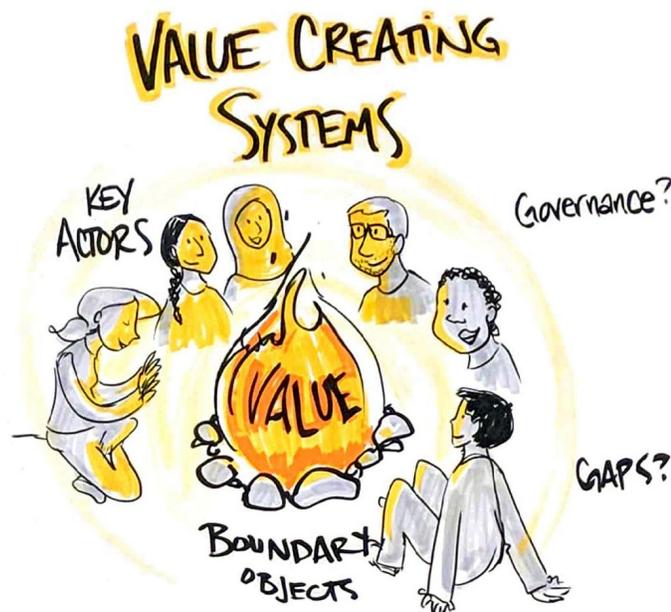
8. Build the Economic and Social Architecture into Sustainability Research:

Increase emphasis on understanding and communicating the costs and benefits of rapid policy and behavior shifts associated with the necessary sustainability transformations (e.g. food, energy, water, transport, infrastructure, medicine, etc.).

9. Make it Pop:

Harness and expand the scale, sophistication, and integration of media, communication and behavioral sciences within sustainability research. Build engagement for sustainability research sector by sector, engaging non-traditional allies and reaching back from constituent needs to drive agendas within sustainability research.

Future Earth is poised to establish a national structure in the US, and the community assembled through Sustainability 2.0, working closely with the National Academies Sustainability Roundtable, are ideally placed to guide the formation of this structure and to ensure that it provides essential connective services to the many efforts and organizations working to support sustainability in the United States.





Introduction and Background

Sustainability science, as a field of practice, aims to support societal actors with the evidence, strategies, tools, and capacities needed for decisive individual and collective actions in support of greater environmental sustainability and increased intergenerational wellbeing. It has been 20 years since the release of “Our Common Journey: A Transition Toward Sustainability” by the US National Research Council (1). In that time, science has matured rapidly, both in this country, and around the world (2–5). In the US, it is now time for a clear look at the elements of this field, and the system that supports it. Sustainability 2.0 is focused on taking that next step.

The relevance and impact of sustainability science in the US will depend, to a large extent, on the adoption and mainstreaming of research practices that are currently not well supported or consistently rewarded. These practices include collaborative, team-based approaches, a focus on systems-thinking and integration across disciplines, and knowledge co-creation with a wide range of societal partners (4–8). These research practices challenge many of our current incentive structures (5, 9, 10). The increasing demand for credibility, relevance, and salience (2) within evidence-informed solutions requires the field to expand in many ways at once – supporting new transdisciplinary research and implementation science focused on complex, multi-scale and often contentious research challenges (4, 5, 11), strengthening boundary-spanning capacities (12), training and supporting a diversity of sustainability leaders (13, 14), and establishing and disseminating the essential technical and domain-specific skill sets, resources, and toolkits to facilitate the informed use of the knowledge we already have (1).

The current US research system often falls short in supporting this work, and the growth of sustainability science in the US will depend on the ability of leaders in academia, civil society, public and private sectors to examine, repurpose, and restructure our traditional systems of knowledge generation and engagement. The rapidly growing field of sustainability science, when interpreted broadly to include the innovation communities, who are also deeply engaged in sustainability, is well-positioned to instigate change (3, 15, 16). Yet the structural support for sustainability science – professional societies, funding sources, academic incentives, curricula development – has not kept up with the explosive growth in the field.



The Sustainability 2.0 Dialogues

To assess the status and future of sustainability science in the US, the US National Academies of Sciences, Engineering and Medicine's Science and Technology for Sustainability Program, in collaboration with the US Global Hub of Future Earth, hosted two cross-sector dialogues engaging over 60 sustainability leaders in academia, civil society, business and the public sector (see Appendix 1). In a survey before the dialogues, all participants detailed the most important questions or challenges that must be addressed to build a sustainability science system in the US that optimizes the contribution of research to sustainability, both in the US and around the world. We used responses to these questions to develop key work areas, using a three-horizon model (17) to 1) highlight the key elements of the current research system that need reform, 2) co-construct the critical features of a high-impact future US sustainability research system, and 3) identify the transitional technologies and enabling programs that will get us from where we are now to where we need to go (Box 1). The first dialogue was hosted by Colorado State University, the second dialogue by George Mason University. Presidents of both universities attended.

We then used the ideas generated at both workshops, together with the survey results, to develop a set of nine key investment opportunities for strengthening the US Sustainability Science System.

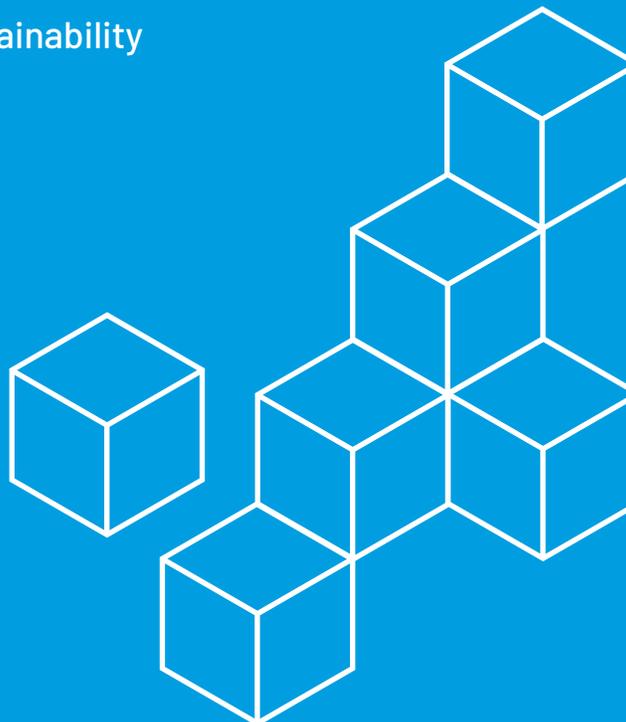
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Key Investments

Themes that emerge from the report:

- Strengthening coordination and collaboration
- Scaling: national and international level engagement and support for sustainability
- Developing linkages/synergies
- Innovation
- Digital technology and sustainability
- Communication



1. MOVE AT SCALE:

There is a strong need for the US sustainability research system to join, forge and support international partnerships. Our coordinated work will achieve the highest leverage if we focus on the development and strengthening of funding mechanisms and collaborations that cross sectors and geographies. Currently, mechanisms for this work exist, but efforts are not well coordinated. At the international level, a network of organizations are focused on building this connectivity. In particular, the following programs support integrated, international action across sectors:

- [Future Earth](#)
- [Globally Engaged Universities](#)
- [Sustainable Development Solutions Network \(SDSN\)](#)
- [International Network for Government Science Advice \(INGSA\)](#)
- [Global Forum for National SDG Advisory Bodies](#)
- [Belmont Forum](#)
- Global Funders Forum
- [Bridge Collaborative](#)
- [Global Sustainability Scholars Program](#)
- [Earth Leadership Program](#)

There are also focused networks and programs at the national level, such as The [National Academies Roundtable on Science and Technology for Sustainability](#) and the [US Global Change Research Program \(USGCRP\)](#). The programs are in a strong partnering position to support international engagement across this ecosystem, and structures to promote greater integration are in progress. For example, in 2020, Future Earth and the Belmont Forum launched [Sustainability Research and Innovation Congress \(SRI\)](#), an international annual cross-sector convening of experts and actors advancing sustainability.

Investments to Move at Scale:

Several near-term investments could allow the US sustainability research system to move at scale, but none is more important than investment in the connective tissue amongst existing organizations and initiatives. INGSA, Future Earth, the Globally Engaged Universities and SDSN all have national, regional, and global networks, and each network works in a different part of the sustainability ecosystem; but, these organizations do not currently pull together as they could. Connecting the government science advisory role of INGSA's North American Chapter, the higher education institutional relationships established through the Globally Engaged Universities and SDSN, and the rapidly growing individual-based networks being developed through Future Earth (through the establishment of a professional association and the 2020 launch of the Earth Leadership Program), all provide the potential connective tissue to allow the US sustainability ecosystem to move at scale. Investment in a core staff position devoted to integration, coupled with a modest investment in communication and convening, and predicated on these organizations and others coming together to deliver collaborative products, could have a powerful impact on the ecosystem.

Goals:

- Co-construction of a US national structure for Future Earth (which has such structures in 20 other countries)
 - Staffing
 - Convening
 - Conferences
- Support for a US sustainability science action agenda, led by The National Academy Sustainability Roundtable, Future Earth, INGSA, SDSN and Globally Engaged Universities, with deep engagement by key national and international global change, science and environment organizations (USGCRP, the [National Council for Science and the Environment](#) (NCSE), [American Geophysical Union](#) (AGU), [European Space Agency](#) (ESA), [Society for Conservation Biology](#) (SCB) etc.), university sustainability institutes and centers, international conservation and sustainability NGOs, and US sustainability funders.
- The establishment of stronger collaborative funders' networks.

Lead Actors:

- International organizations
- Universities
- NGOs
- Funding organizations

2. ENGAGE WITH BIG DATA, ICT, AI, AND EARTH OBSERVATION:

A new sustainability research agenda in the US must engage the information and communications technology (ICT) communities more effectively. This work will require market and pre-market partnerships; pushing technological innovation to scale; better integration of big data, artificial intelligence (AI), and earth observation into research agendas; stronger integration of these same subjects with considerations of ethics, inclusion and environmental justice; and expansion of connections focused on social-goods technology and related curricula and outreach activities.

Efforts to develop this ecosystem have been initiated, but they are not keeping up with the scale and speed of development within the tech industry. [Microsoft Research](#), [Amazon Sustainability](#) and AWS, and [Google Earth Engine](#) and Geo for Good all have strong sustainability-focused cloud-based platforms integrating big data, earth observation and sustainability. Earth observation providers, such as [Planet Labs](#) and [Digital Globe](#) are, at the same time, re-shaping the spatial and temporal scale of earth observation capacities. These changes, coupled with the exponential rise in connectivity and smart sensors (Internet of Things, IoT) and the increasing capacity of algorithms, artificial intelligence, and machine learning to make complex decisions, are likely to impact virtually all aspects of modern society. The exponential speed of these changes leave little time for reflection by the sustainability science community, but it will be critical that the community engage with these changes, both to take advantage of the opportunities afforded and to shape the future of the field.

Programs such as the World Economic Forum's [Center for the Fourth Industrial Revolution](#) are providing thought leadership and training through their Andre Hoffmann Fellows Program that focuses explicitly on the links between sustainability and the ICT community. In addition, an increasing number of R1¹ universities now have centers connecting environmental and global change issues with earth observation and data science (e.g. The University of Colorado's [Earth Lab](#), Michigan State's [Center for Global Change & Earth Observations](#)). Integrated efforts to connect artificial intelligence, big data, and sustainability, while less common in the US, are growing internationally. Organizations such as the [Group on Earth Observations](#) (GEO) are joined by UN efforts including the [Big Data Working Group](#), the Independent Expert Advisory Group on [Data Revolution for Sustainable Development](#), the [Global Pulse](#) project, and Future Earth's [Sustainability in the Digital Age](#) project.

Investments to Engage with Big Data, ICT, AI, and Earth Observation:

The US plays host to the largest ICT, AI, and IoT-focused companies in the world, and as in other sectors, demand for environmental and sustainability-focused professionals with strong quantitative skill-sets consistently outpaces supply. Data science centers and institutes now exist in most US research universities, but **the development of centers of excellence that link this work directly to sustainability science are still rare**. Investments in this area will have the largest impact if they are developed with **strong input from private sector partners, using principles of co-design**, providing the next generation of leaders in digital age sustainability full access to the key actors that are shaping the digital landscape.

1 It's a Carnegie Classification of Institutions of Higher Education term that means a university with very high research activity.

Goals:

- Develop direct linkages between the application of Big Data, ICT, and AI for Sustainability by actively convening and engaging researchers, think tanks, and the private sector.
- Establish/support centers and institutes of excellence that engage with Big Data, ICT, AI, and Earth Observation. For example, data centers at universities.
- Facilitate research and publications on the linkages of Big Data, ICT, AI, and Sustainability.
- Form direct partnership with [AmeriGEOSS](#), a community Platform and regional resource to promote collaboration and coordination among the GEO members in the Americas.

Lead Actors:

- Universities
- Think tanks
- Private sector

3. DEVELOP AND CHAMPION SUSTAINABILITY LEADERSHIP:

Sustainability research leadership must be better recognized and encouraged. We need to celebrate, support and network engaged science leaders in the US, and around the world. Our innovations and research are only as strong as our abilities to collaborate and support our teams in communicating across disciplines and geography. This type of leadership is built over a career, and is not typically a part of scientific training. This work is needed at all career stages - undergraduate, graduate, post-doc, mid-career, and within these programs, increasing emphasis on diversity and inclusion (7), engagement with the ICT community (2), and international connections (1) will increase their collective impact.

Parts of this scaffold are present at every level, and leading organizations in this area include [AAAS](#), [Sea Grant](#), the Society for Conservation Biology, and the Earth Leadership Program, but there is a need for much greater scaling.

Undergraduate Leadership Training: At the undergraduate level, programs such as the [Doris Duke Conservation Scholars Programs](#) (DDCSP) and the [Global Sustainability Scholars Program](#) (GSS) serve to support the next generation of conservation and sustainability leaders that reflect the diversity of our country.

Graduate Training: National level fellowship opportunities are fairly fragmented and often framed as science-policy fellowship programs. Exceptions to this framing include [SESYNC](#)'s Graduate Pursuits, and the Graduate Fellows Program offered by the Global Sustainability Scholars Fellows Program. University-led graduate programs in sustainability are becoming increasingly common, and many of these programs are sharing best practices and supporting greater scaling through [ANGLES](#), a network focused on graduate leadership in sustainability.

Post-doctoral Training: The best known US post-doctoral fellows program in conservation is the Smith Fellows program, hosted by the Society for Conservation Biology. The Smith program's core architecture, in which post-docs have both academic and practitioner mentors, has influenced the development of other international and national programs, including [The Nature Conservancy](#) (TNC) and university-supported [Nature Net Program](#) and the [Andre Hoffmann Fellows Program](#) at the World Economic Forum's Center for the Fourth Industrial Revolution,

Mid-Career: The strongest mid-career leadership training program in the US has been the Leopold Leadership Program, which has been hosted for most of its 20-year history by Stanford University. It was re-launched as the [Earth Leadership Program](#), a core activity of Future Earth, in collaboration with Stanford.

Long-standing sustainability-related leadership programs in the US, such as the Smith Fellows program for post-docs and the Leopold Leadership Program for mid-career academics, can claim impressive results--evaluations by program graduates point to large, career changing impacts, and graduates include many of the most influential academic conservation leaders in the country. These same programs, however, have done less to expand the diversity and inclusion within sustainability (7) or to strengthen links between sustainability and the ICT sector (2). Newer programs, such as GSS Fellows and the André Hoffmann Fellowships, are explicitly targeting these links.



Investments to Develop and Champion Sustainability Leadership:

There are fundamental gaps in this scaffolding that need to be addressed. First, there are far too few post-graduate opportunities focused on sustainability science that also include a strong leadership component. A **robust national scale program focused on sustainability, building on the successes of the Smith Fellows example, would be a powerful addition to the system.** Within such a program, particular attention should be paid to diversity and inclusion and to connections with the ICT sector.

Second, **opportunities for scholars at all stages in their career to engage directly with multilateral organizations and the private sector (internationally or domestically) are too limited in scope and often come with significant limitations.** Investment in these types of programs is difficult—they require sustained, high-level funding, but the impact of these programs on the field are also very large. The Smith Fellows program, as an example, has an extensive and lasting network of engaged scholars who collectively define the direction of the field.

Finally, investments in programs that connect cross-sector leadership training with critical social issues (equity, diversity) and with rapidly growing private sector constituencies (the ICT sector) will increase the impact of current leadership investments.



Goals:

- Supporting the establishment of national level post-graduate programs focused on sustainability leadership, including a focus on diversity and inclusion.
- Ensuring that post-graduate programs establish linkages with Big Data, ICT, and AI for sustainability.
- Supporting the establishment of programs that connect scholars with multilateral organizations and the private sector.

Lead Actors:

- International organizations
- Private and public sectors
- Universities
- NGOs

4. ORGANIZE AND INTEGRATE AT A NATIONAL SCALE:

The sustainability research system needs to support the development of integrated policies, innovative tools, more effective communication, and a stronger community focused on a national research agenda. That agenda should be defined by the challenges we face nationally and internationally and elevate the role of research in supporting integrative solutions to these challenges. To ensure linkages with ongoing work around the world, this work should be organized around the [UN Sustainable Development Goals](#) and use the entry points and cross-cutting issues defined in the 2019 [“The Future is Now” UN Global Sustainable Development Report](#). To achieve the appropriate level of coordination and mobilization, this collaborative work should seek to unite sustainability researchers across the US and provide them with strong institutional support from across the sustainability ecosystem.

The strongest and most innovative work in sustainability research currently comes from university structures—departments, schools, colleges, institutes and centers. These centers of academic innovation are instrumental in supporting the growth and maturation of the US sustainability research system, and many are actively breaking down academic norms, rules and practices that enhance individual and institutional capacities to engage in transdisciplinary work on major sustainability challenges.

Equally important, civil society organizations (CSOs) focused on sustainability are also actively partnering with leading universities in the co-development of their research programs while also investing in substantive research programs of their own. This partnership extends beyond academia and civil society, with an increasing number of private sector coalitions and cross-sectoral partnerships forming to support a range of sustainability challenges, from the development of science-based targets ([Global Commons Alliance](#)), to the scaling of sustainability innovation (e.g. [MIT SOLVE](#), [Techstars](#)) and the establishment of sustainability business standards (e.g. [B-Corp](#)) and private sector executive leadership (e.g. the [We Mean Business Coalition](#)).

What is urgently needed at this point are linkage mechanisms - structures, platforms, venues, and umbrella organizations--that can effectively champion and connect this work, provide stronger opportunities for the exchange of best practices, and speed the pace of change that these university-based structures are working to support. Many organizations, from the [UN Sustainable Development Solutions Network](#) (SDSN), the National Council for Science and the Environment (NCSE, now GCSE, the [Global Council on Science and the Environment](#)), and [Globally Engaged Universities](#), [INGSA](#), the [National Academies](#), [AAAS](#) and [Future Earth](#), all have national or global programs in the US. Each of these organizations has different capacities, modalities, and missions, and this diversity provides exceptional, and under-utilized opportunities for collaboration.

[SDSN](#), a network of mostly academic structures, launched a US chapter in 2018 led by three universities. It could play a powerful role in engaging university leaders and their work could be significantly strengthened through direct collaboration with national scale partners, such as NCSE and other global consortia, such as the Globally Engaged Universities, supported both by [UNITAR](#) and [APLU](#). All three organizations have robust university leadership networks, but these efforts have few connections. Network organizations that focus on individuals could also play a critical role empowering engagement from scholars, NGOs, funders, public and

private sector actors. Future Earth is one such structure, and is already supporting national work in the 20 countries where National Committees are in place, but it will be hampered in this capacity in the US unless a national structure is established for this purpose. The National Academies Roundtable on Science and Technology for Sustainability is well-placed to support the establishment of such a national structure, as they already play an important cross-sectoral neutral broker role in the US.

Finally, cross-sector coalitions provide a collaborative capable of developing a more robust voice for science. An example of this work is the [Global Commons Alliance](#), which is bringing together academic leaders through the [Earth Commission](#) and connecting global research outputs directly to Issue Hubs led by action-focused organizations in civil society. It further supports the work through robust investment in broad communications.

Investments to Organize and Integrate at a National Scale:

A few key targeted investments could more thoroughly connect and support the sustainability ecosystem needed to meet our national goals. First, **investment that encourages collaboration among sustainability actors will benefit the system significantly.** Second, **the establishment and staffing of a US Future Earth NGO, if established as an inclusive, cross-sectoral platform for sustainability,** could help shape and complement the work of the National Academies Roundtable on Science and Technology for Sustainability.

Goals:

- Develop linkage mechanisms - structures, platforms, venues, and umbrella organizations that can effectively champion and connect sustainability at the national level.
 - Ex: Future Earth, SDSN
- Establish and staff the Future Earth NGO, which will serve as an inclusive, cross-sectoral platform for sustainability research and innovation.
- Encourage regular convening of sustainability researchers, professionals, and organizational leaders to strengthen coordination and collaboration at the highest levels.
 - Ex: Support for the Sustainability Research and Innovation Congress (SRI) as an annual convening of sustainability actors

Lead Actors:

- NGOs / CSOs
- International organizations
- Universities
- Private and public sectors

5. BUILD THE FIELD OF TRANSDISCIPLINARY RESEARCH:

Many of our most pressing sustainability challenges—climate adaptation, energy transformations, food insecurity, biodiversity protection—require stronger direct contributions by a wide range of integrated research disciplines (7), but these contributions will require much greater adoption of collaborative team-based science focused on problem solving, and these teams will need the capacity to work effectively with a wide range of societal partners (5, 7, 8, 18). Such scientific work is widely termed “transdisciplinary” (19, 20), and doing this work well necessitates a new set of tools, structures, best-practices and core values, as the current system of disciplinary research typically does not embrace transdisciplinary, solution-oriented research, and academic communities lack the curricular tools and integrated structures needed to train transdisciplinary sustainability leaders (4–8, 18, 21, 22).

Internationally, growth in transdisciplinary research methods is growing rapidly, with the launch of the first international conference series for transdisciplinary sustainability research and innovation ([SRI2020](#)) by Future Earth and the Belmont Forum, the establishment of the [ITD Alliance](#) by a range of international transdisciplinary research and training organizations, and growing efforts to support university reform (e.g., [Beyond the Academy](#)). In the US, however, the scattering of centers and efforts focused on this work are not well coordinated, and the structures and processes needed for growth in the field—sharing best practices and establishing common goals, core curricula, and key resource needs—are largely missing. Further, the interactions between the research communities working to understand how to best support transdisciplinary research and the practical training communities working directly with scientists and stakeholders has been limited.

Investments to Build the Field of Transdisciplinary Research:

A strong coordinated effort to support academic institutions as they begin to embrace transdisciplinary research will be critical. This will require a systems approach, starting with increased coordination and emphasis on funding for transdisciplinary solutions-oriented research, the development of transdisciplinary research curricula at multiple academic levels, and a concerted effort to change academic incentive structures to support researchers focused on integrating across sectors and disciplines. A core part of this work is coordination of the many centers, institutes and schools in the US devoted to transdisciplinary sustainability research, outreach and training. This work should include the development of structures focused on future career opportunities for the growing number of transdisciplinary researchers in the US and support to develop and scale university department and institute incentives for transdisciplinary solutions-oriented research. To be successful, efforts must begin with an expansive and inclusive definition of STEM that gives a stronger voice to the social sciences, and these efforts must be designed to support centers, institutes, and initiatives coming from very different centers of gravity—law, business, economics, anthropology, engineering, global health—thus providing space for a broader mix of disciplinary and epistemological backgrounds than has traditionally been a part of the conversation.

Goals:

- Invest in academic institutions as they begin to embrace transdisciplinary research:
 - Collaborate with transdisciplinary centers and institutes. For example, George Mason University's [Institute for a Sustainable Earth](#)
 - Fund transdisciplinary research centers and institutes
- Increase funding for transdisciplinary solutions-oriented research.
- Develop a unified transdisciplinary research curricula at multiple academic levels.
- Advocate for a change in academic incentive structures (promotion, publications, and tenure) to support researchers focused on transdisciplinary research.

Lead Actors:

- Universities
- Think tanks
- International organizations
- NGOs/non-profits
- Private and public sectors
- Funding organizations

6. SUPPORT SCIENCE–BUSINESS BOUNDARY SPANNING:

Partnerships that cross research, policy, and business boundaries nourish the growth of action-oriented sustainability research. In the US sustainability science arena, boundary spanning work and transdisciplinary research efforts originating in academia have generally developed stronger links with public sector and civil society organizations (see (12) for examples) than they have with the private sector. While individual academic centers of excellence have made good progress linking with single corporate supporters (e.g. [University of Minnesota’s Institute on the Environment’s](#) relationships with [Cargill](#) and [General Mills](#)), or occasionally robust business coalitions (e.g. [ASU’s Sustainability Consortium](#) or [MIT’s SOLVE](#)), the most productive partnerships with business communities are often brokered by civil society organizations, businesses and industry collectives (e.g. [The Global Common’s Alliance](#)), or, occasionally, partnerships between civil society organizations, technologists, and universities (e.g. [The Natural Capital Project](#)).

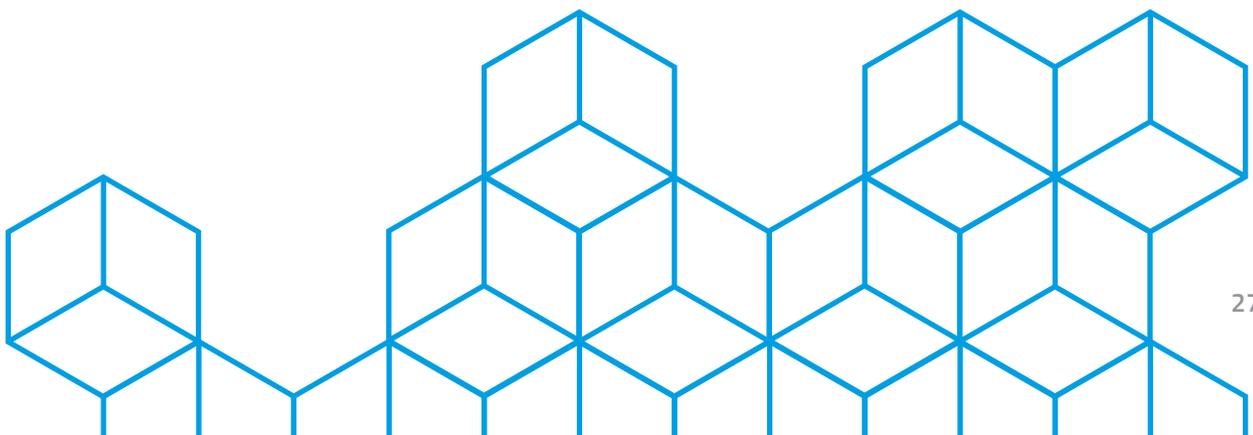
Academic centers and programs focused on private sector leadership have often come from business schools, but broader sustainability curricula blending business leadership and sustainability science have also emerged in programs such as [University of Pennsylvania’s Sustainability Program](#), the [School for Environment and Sustainability at the University of Michigan](#), and the [sustainability graduate program at Appalachian State University](#). Leadership training connecting sustainability science directly to business is often less common, but these programs are also emerging (e.g. [Stanford’s Change Leadership for Sustainability Program](#)).

Investments to Support Science-Policy-Business Boundary Spanning:

Investments in this boundary spanning work should take multiple forms. The development of next generation research-business boundary spanners will require greater investment in **programs that place graduate students and postdoctoral associates within industry partnerships, where they can learn the business culture while continuing their research training.** Opportunities for sustained, direct cross-fertilization are often limited to professional master's programs, but a broader emphasis on group and individual internships and co-designed solution-focused work is urgently needed.

Strengthening working partnerships between industry leaders and sustainability science is also critical. This requires investment in broad, evidence-based initiatives that connect these domains through products and platforms that help leading private sector actors measure their progress across a wide range of well recognized sustainability goals. **Equally important, there is a need for greater investment in programs that measure impact, assessing the links between metrics, behavior change, and system change.**

All of this work should take advantage of existing university structures—extension, professors of practice, boundary-spanning centers and institutes—and it should build collaborations between academic and non-academic sectors and institutions.



Goals:

- Increase paid internships and fellowship opportunities for students to engage with the private sector.
- Foster and strengthen robust partnerships between industry and sustainability science. For example, ensure that sustainability scientists serve as sustainability officers in the private sector.
- Fund the development of frameworks, methodologies, and metrics that measure sustainability impact.

Lead Actors:

- Universities
- Private sector
- Funding organizations
- Public sector
- Think tanks
- NGOs / CSOs

7. MAKE INCLUSION AND DIVERSITY CORE

PRINCIPLES IN SUSTAINABILITY RESEARCH:

The relevance of sustainability research will be defined by who is conducting the research, who the research serves, and how it is conducted and communicated. There is an urgent need to rapidly expand both the targets of sustainability research and dramatically increase inclusion and participation of under-represented communities within the next generation of sustainability research leaders—inside and outside of academia. This effort will require supporting and scaling programs that focus on diversity and inclusion in the field and that recruit and train sustainability professionals from under-served groups. It will also require the sustainability field to value and integrate diverse perspectives into sustainability research. This commitment to inclusivity is also relevant to #5 “Build the Field of Transdisciplinary Research,” which seeks to empower the voices and perspectives of societal partners / stakeholders into the research endeavor. At its core, sustainability initiatives and research must include diverse groups with perspectives that better reflect US society.

The level of innovation and the capacity for sustainability to contribute productively to socially significant and relevant innovations is directly related to diversity. As such, broader engagement and increased participation and retention of persons historically excluded from sustainability sciences will benefit problem-solving capacity and the efficacy of future sustainability solutions. In the US, underrepresented groups made up less than 10% of doctorates in non-medical biological and earth sciences between 2001 and 2012, and the number of women from underrepresented groups earning doctorates in environmental sciences has not increased significantly since 2000. This has undoubtedly affected the research questions pursued, the interpretation of results, how it is communicated to society and the receptivity and audience of the findings. This trend is mirrored in faculty and leadership positions in the US. Millions of dollars have been spent on programs focused on providing skills, contacts, and experiences for underrepresented groups in STEM disciplines, but many of these programs implicitly consider the lack of diversity and equity as a problem of access to resources and training, focusing more on perceived underrepresented groups' deficits. While many of these "deficit model" programs have assisted individuals, they can also undermine their agency, and they have not produced the system-level change that is needed to encourage broad and diverse participation in STEM. For example, while the higher education graduation rate of women in STEM fields has increased, we have seen almost no change in senior executive level hiring numbers.

Investments to Make Inclusion and Diversity Core Principles in Sustainability Research:

Programs that specifically address equity, diversity, and inclusion in their mission and programming: [Ray Fellowship](#), [TNC internships](#), [DDCSP](#), [GSS](#)

Goals:

- Emphasize inclusion and diversity as core principles in sustainability research.
- Support scalability of programs that focus on diversity and inclusion.
- Invest in recruitment, training, and promotion programs to increase representation and retention of underserved groups.
- Integrate diverse perspectives into the co-creation and co-implementation of sustainability research to maximize societal impact.

Lead Actors:

- Universities
- Funding organizations
- Public sector
- Private sector
- Think tanks
- NGOs / CSOs

8. BUILD THE ECONOMIC AND SOCIAL ARCHITECTURE INTO SUSTAINABILITY RESEARCH:

Sustainability research has strong roots in the natural sciences, and yet many of the most important societal transformations, and pathways to greater sustainability involve significant changes in economic and social systems. An emphasis on understanding and communicating the costs and consequences of the rapid policy and behavior shifts associated with the necessary sustainability transformations (in agriculture, energy, water, transport, infrastructure, medicine, etc.) will be essential for rapid progress in sustainability research.

The dominance of natural and physical science within sustainability research communities, however, comes in large part from the separation between academic communities associated with sustainability science and leaders in the field of sustainable development, which is dominated by leaders in social sciences. This gap is largest in academic circles but it persists in the federal government, where connections between foreign aid (administered by [USAID](#)) and research (led by [NSF](#) and [NIH](#)) are weak and largely ineffective. Work to close this gap is ongoing, coming both from social science communities (e.g. the [University of Michigan's Sustainability and Development Initiative](#)) and natural science communities (e.g. the expansion of the Leopold Leadership Program to include social scientists), but there are fewer national efforts focusing on the economic costs and benefits associated with major sustainability transitions in the US. The US Global Change Research Program has taken on some of this work through its National Climate Assessment, but this focuses primarily on projecting potential costs of climate change, rather than assessing full costs and benefits of alternative policy choices.



Investments to Build the Economic and Social Architecture into Sustainability Research:

Continuous, robust integration of the rapidly changing economic and social consequences of sustainability transitions (e.g., in energy sources, food systems, transport systems, building materials) will require greater investment in centers and institutions integrating big data analytics, public policy, economics and sustainability. The rapid growth in the use of large, heterogeneous datasets in assessing social outcomes of complex policy environments (e.g. [Opportunity Insights](#)), provides a model for this work. Supporting connections between these approaches and the growing work on environmental justice and the distribution of differential health and wellbeing outcomes that come from policy choices (23) would strengthen integration and impact.



Goals:

- Strengthen centers and institutions integrating the natural and social sciences to improve sustainability outcomes.
- Apply large heterogeneous datasets for the development of informed policy making that leads to positive societal outcomes.
- Recognize, support, and integrate the work being conducted in the areas of environmental justice, health inequities and wellbeing disparities (distribution of differential health, and wellbeing outcomes).
- Engage communities most adversely impacted as equal stakeholders.

Lead Actors:

- Universities
- Funding organizations
- Public sector
- Private sector
- International organizations
- Think tanks
- NGOs / CSOs

9. MAKE IT POP:

It is essential that we harness and expand the scale, sophistication, and integration of media, communication and behavioral sciences within sustainability research. Related to this, we need to build engagement for sustainability research sector by sector, engaging non-traditional allies and reaching back from constituent needs to drive agendas within sustainability research. Strong, evidence-based, solution-focused narrative communication, ranging from independent journalism (e.g. [Anthropocene Magazine](#) and [Yale360](#)) to coordinated communications products (e.g. the [Our Future on Earth Report](#), by Future Earth), are also critical to this work.

Investments to Make It Pop:

Supporting connections between established, existing approaches and growing the staffing resources for a strong communication team trained in multiple media formats and communication strategies are essential for delivering the message.

Goals:

- Scale-up information sharing mechanisms, including newsletters, op-eds, articles, journals, social media platforms, etc.
- Strengthen evidence-based, solution-focused narrative communication.
- Consider science communication as a legitimate and just as important as the science itself.

Lead Actors:

- Universities
- NGOs / CSOs
- International organizations
- Public sector
- Private sector
- Think tanks
- Funding organizations

V.
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Next Steps

Future Earth has over 20 National Structures supporting sustainability research and innovation in countries around the world. The organization is poised to activate and empower these structures. Future Earth has established a US 501(c)(3) to support the growth of the sustainability research and innovation community in the US, but we have yet to launch a US organizing hub to do this work. The community who gathered at the two Sustainability 2.0 dialogue events, coupled with the deep expertise existing in the National Academies Sustainability Roundtable, are exceptionally well-placed to guide the formation of this national structure, which would have the express purpose to act as a boundary organization, providing connective tissue between the many efforts ongoing in the US.

The establishment of this structure and initial investment in the core staff needed to support its growth would constitute an initial step in the development of a more cohesive, robust, globally connected sustainability research and innovation system in the US.



VI.

Appendix 1

Participants in the two workshops

Participants:

Karen Bailey: University of Colorado Boulder.
Expertise: Social-Ecological Systems.
Perspective: Early Career Academic, STEM
Under-represented minority.

Edward Barbier: Colorado State University.
Expertise: Natural Resource, Development Economics.
Perspective: Senior Academic

Peter Backlund: Associate Director, School of Global
Environmental Sustainability, Colorado State University
Expertise: Sustainability, Policy
Perspective: Senior Academic

Roger N. Beachy: Washington University,
National Science Board
Expertise: Plant Biology, Agricultural Biotechnology
Perspective: Senior Academic, Science Advisor

Angela Bednarek: Program Officer, The Pew Charitable Trusts
Expertise: Marine Science Policy, Boundary organizations
Perspective: Funder

Melody Brown Burkins: Associate Director, Dartmouth College
Expertise: Science Policy & Diplomacy, Earth & Environmental
Systems, Women's Leadership, Arctic Science & Diplomacy
Perspective: Senior Academic

Angel Cabrera: President, George Mason University, President
Expertise: Business educator
Perspective: University President

Franklin Carrero-Martinez: Director, Science and Technology
for Sustainability Roundtable, National Academy of Sciences
Expertise: Cell and Dev. Biology, Business, Science Diplomacy
Perspective: Researcher and Educator,
Science Administrator and Diplomat

William Clark: Professor, Harvard University
Expertise: Sustainability Science
Perspective: Senior Academic

William Colglazier: American Association
for the Advancement of Science
Expertise: Science Diplomacy
Perspective: Civil Society, Science - Policy

Monica Contestabile, Editor in Chief, Nature Sustainability
Expertise: Sustainability
Perspective: Media

Sharon Collinge: Professor, University of
Colorado Boulder, NEON Chief Scientist
Expertise: Ecology, Conservation Biology, Big Science
Perspective: Senior Academic, Science Infrastructure

Aurali Dade: Associate Vice President Research
Development, George Mason University
Expertise: Higher Education
Perspective: Academic Administrator

Ariane DeBremond, Executive Officer,
Global Land Programme
Expertise: Land Systems
Perspective: Science Network Leader

David Dzombak: Professor, Carnegie Mellon
Expertise: Water, Engineering
Perspective: Senior Academic

Christopher Filardi: NiaTero
Expertise: Indigenous Conservation
Perspective: Indigenous peoples, Civil Society Leader.

Tony Frank: President, Colorado State University
Expertise: Veterinary Medicine, Biology,
Public University Institutional Change
Perspective: University President

Kathleen Galvin: Professor, Colorado State University
 Expertise: Anthropology, cultures, sustainability
 Perspective: Senior Academic

Marilu Hastings: VP for Sustainability Programs, Cynthia and George Mitchell Foundation
 Expertise: Sustainability
 Perspective: Funder

James Leape: Co-Director, Center for Ocean Solutions, Stanford Woods Institute for the Environment, Director General, WWF
 Expertise: Law, Ocean, Policy
 Perspective: NGO leaders

Victoria Lee: Project Lead, Environmental Initiatives – 4IR for the Earth, World Economic Forum
 Expertise: Technology, Environment, Governance
 Perspective: Civil Society

Andrew Light: Professor, George Mason University
 Expertise: Climate Diplomacy and International Environmental Policy
 Perspective: Senior Academic

Tom Lovejoy: Director, Institute for a Sustainable Earth, George Mason University
 Expertise: Biodiversity
 Perspective: Senior Academic

Amy Luers: Future Earth Executive Director,
 Expertise: Sustainability Research
 Perspective: Civil Society Leader, Innovation Leader

Neil Hawkins: Fred A. and Barbara M. Erb Family Foundation
 Expertise: Former private sector
 Perspective: Private sector, NGO

Jessica Helmann: Professor and Director, University of Minnesota
 Expertise: Environmental Science
 Perspective: Academic Sustainability Institute Director

Eve-Lyn S. Hinckley: Assistant Professor, CU Boulder
 Expertise: Biogeochemistry
 Perspective: Early-Career Academic

Elena Irwin: Professor, Ohio State University
 Expertise: Urban-rural systems, Environmental economics
 Perspective: Senior Academic

Rob Jackson: Stanford University
 Expertise: Earth Systems Science
 Perspective: Senior Academic

Kiki Jenkins: Associate Professor, Arizona State University
 Expertise: Sustainability
 Perspective: Academic, under-represented groups

Sally Jewell: CEO REI, Interior Secretary, CEO Nature Conservancy
 Expertise: Entrepreneur, Engineer, CEO, Land Management
 Perspective: Policy, Funder, Senior Academic

Emi Kameyama: National Academy of Sciences
 Expertise: International Affairs
 Perspective: Science, Administrator

Michael Kuperberg: Director, US Global Change Research Program
 Expertise: Environmental toxicology, ecology and carbon cycling
 Perspective: Environmental Science Policy

Ed Maibach: Director, Center For Climate Change Communication George Mason University
 Expertise: Climate change communication
 Perspective: Senior Academic

Michael Mascia: Chief Scientist, Conservation International
 Expertise: Governance and Biodiversity Conservation
 Perspective: NGO science Leadership

Pam Matson: Professor, Director and Dean Stanford University
 Expertise: Sustainability Science
 Perspective: Senior Academic, NGO advisor

Michael Anthony Mendez: Yale University
 Expertise: Sustainability Studies, Climate Change, Policy, Communities of Color
 Perspective: Mid-Career Academic, STEM Under-represented minority.

Jason Neff: Director Sustainability Innovation Lab, CU Boulder
 Expertise: Biogeochemistry, Sustainability Technology
 Perspective: Senior Academic, Academic Institute Director

Carol O'Donnell: Director, Smithsonian Science Education Center
 Expertise: Geosciences, Education
 Perspective: Senior Academic

Lumari Pardo-Rodriguez: CU Boulder, GSS Instructor
 Expertise: Geography, educator, diversity, sustainability
 Perspective: Early Career Academic, STEM Under-represented minority.

Dusan Pejakovic: Program, Officer, Gordon and Betty Moore Foundation
 Expertise: Physics, Astronomy, Sustainability Science
 Perspective: Funder

Patty Romero Lankao: Senior Researcher,
National Renewable Energy Laboratory
Expertise: Sociology, urban systems, global environment
Perspective: Senior Academic, STEM
Under-represented minority.

Mark Rosegrant: Research Fellow, CGIAR
Expertise: Food
Perspective: Civil Society Research

Kirsten Rowell: Global Sustainability
Scholars Director, CU Boulder
Expertise: Geosciences, Diversity, Sustainability
Perspective: Senior academic, international program leader

Alan Rudolph: Colorado State University,
Vice-president for Research
Expertise: Interdisciplinary Life Sciences
Perspective: Senior Academic, University
Research Coordination

Rebecca Shaw: Director of Science, WWF
Expertise: Sustainability Science
Perspective: Civil Society

Heather Tallis: Vice President, The Nature Conservancy
Expertise: Human well-being and conservation
Perspective: Civil Society

Meghna Tare: Professor, University of Texas at Arlington
Expertise: Sustainability
Perspective: Senior Academic

Josh Tewksbury: Director, Colorado Hub of Future
Earth, Executive Editor, Anthropocene Magazine
Expertise: Ecology, conservation
biology, sustainability science
Perspective: Senior Academic, Network
Leader, Communications Leader

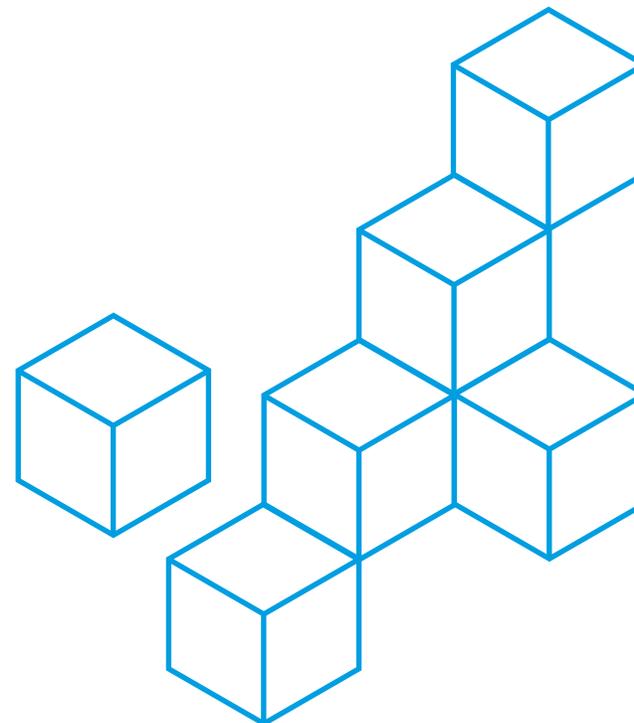
Maria Uhle: Program Director for International
Activities, National Science Foundation
Expertise: Environmental Science, Geology
Perspective: Funder

Judit Ungvari: AAAS Science & Technology
Policy Fellow, National Science Foundation
Expertise: Ecology, Tropical Conservation & Development
Perspective: Early Career Academic

Casey Verbeck: Partner, Veris Wealth Management
Expertise: Impact Investment
Perspective: Private Sector, Investment Sector

Cyrus Wadia: Former Nike Chief Sustainability Officer
Expertise: Business
Perspective: Private Sector

Diana Wall: Director, School of Global Environmental
Sustainability, Colorado State University
Expertise: Soils, Sustainability
Perspective: Senior Academic, Academic Administrator



VII.

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**FUTURE EARTH
USA GLOBAL HUB**

Boulder

Sustainability, Energy and
Environment Complex (SEEC)
MacAllister Building Suite N292
4001 Discovery Drive
Boulder, Colorado 80303

usa@futureearth.org

Fairfax

Institute for a Sustainable Earth
George Mason University
4400 University Drive, MSN 6D5
Fairfax, Virginia 22030

MISE@gmu.edu