

Meeting the leadership challenges for interdisciplinary environmental research

A leadership forum could hasten understanding of complex problems, thanks to a historic meet-up of research pioneers.

The world's largest tides occur at the Bay of Fundy, between the provinces of New Brunswick and Nova Scotia in Eastern Canada, with height variations of 3.5 to 14.5 metres and an energy generation potential of 2,500 megawatts through the flow of billions of tonnes of water on a flood tide¹. When a group assessed how to sustainably harness this tidal energy potential, they had a great deal to learn. Industry, regulators and stakeholders had limited experience with sustainability science. The tidal-power developer did not have relationships with the local stakeholders or know how to build trust with communities; the public utility company had never linked renewable energy generated by tides to the grid; and local fishermen wondered how much the hulking generators would impede commercial fishing. For David Hart, an ecologist and biologist and director of the Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine, USA, it was an opportunity to study how a university as an institution could advance the transition to sustainability and document the project^{2,3}.

Over a decade after the Mitchell Center's involvement in that tidal energy project, Hart has found himself among a group of 20 leaders who seek to share their decades of success in leading interdisciplinary organizations, improve scholarship and formalize how they can learn from each other. Interdisciplinary research can be the most comprehensive approach to complex environmental problems^{4,5}. Research collaborations involving scientists from different fields have emerged as innovative. Yet leading this work to success is not well understood. With no clear avenue, no professional meetings and no organized mechanism to merge knowledge and best practices of interdisciplinary institutions, those new to interdisciplinarity cannot benefit from collective progress and start from scratch, duplicate what already exists, and endure steep learning curves⁶.

Now, a critical mass of work proliferating around the world could advance academic research approaches. An influential group of environmental research leaders from five



Credit: Margaret Palmer, SESYNC

continents that have each held positions for five or more years met for a week at the National Socio-Environmental Synthesis Center (SESYNC) in Maryland, USA, in March 2018. At the meet-up, frank discussions took place on how to combine core leadership knowledge and best practices, ranging from team formation to organizational and collaborative structures to proposal review, and to call for action in mainstreaming interdisciplinary research to solve global environmental sustainability challenges such as climate change and food and agriculture. These leverage points could help guide how leaders succeed, and help global research funders and practitioners of new interdisciplinary environmental activities work with multiple actors, set standards and prioritize actions.

"Society has changed expectations of academia," says Iain Gordon, the deputy vice-chancellor for Tropical Environments and Societies, James Cook University, Australia, who attended the meeting. Research agencies and thought leaders have long argued that solutions to inform better decisions on the urgent, potentially disruptive global environmental challenges surrounding a sustainable future require research at the boundaries of scientific disciplines, rather than individual disciplines. Yet most organizations

are poorly configured to deliver the transformations needed to shift to more collaborative interdisciplinary structures. Gordon says, "Academics have to play a role in terms of providing evidence and solutions to those challenges."

Similar to Gordon, Hart believes that a solutions-focused approach to academic research requires long-term, sustained emphasis on keeping research channels open for interdisciplinarity. His centre includes disciplines of mechanical engineering, physical oceanography, marine biology, sociology and political science, and approaches interdisciplinary research as experiments, gathering data about strategic interventions. The Mitchell Center works with 18 institutions of higher education across New England, accounting for 200 members of faculty from nearly every field of study, including the arts and the humanities, that would not otherwise work together. Hart suggests that leaders play many roles that go beyond helping research teams to look further than obvious research partners. "If they're missing expertise in their research, we help them find it. Or, if the teams crash into some conflict that arises when diverse teams try to work together, we help resolve it," he says.

Gordon and Hart acknowledge that a leadership group has already helped to

overcome barriers to interdisciplinary research, recognizing the need to work in partnership with scholars rather than to manage from the top-down, providing longer timescales and improving interdisciplinary peer review for research that involves a combination of disciplines and qualitative and quantitative academic approaches. According to Gordon and Hart, responding to structural differences of collaborative research processes and organizations themselves, and the structural differentiations of funding and promotion needed for interdisciplinarity, can herald a fresh wave of research that is urgently needed to solve complex problems and grand challenges.

The roots of forming this leadership forum trace back to Gordon, who has long assembled teams of researchers for his applied research projects. In the 1980s, while working as a zoologist, Gordon studied the management of livestock in savannah rangeland in Africa and the conservation of wildlife species. “I couldn’t bring evidence to support decision making without bringing a whole range of disciplines together to understand the problem from all angles, including from the social and economic sciences,” he says. Years later, in 2008, while he acted as theme leader of sustainable ecosystems research at the Commonwealth Scientific and Industrial Research Organisation, the national government body for scientific research in Australia, Gordon removed researchers from disciplinary silos and organized work around “big, hairy audacious goals”, such as water for healthy communities. He proposed forming a leadership group to peers during that time, but nothing happened.

A few years later, as executive director of The James Hutton Institute, Aberdeen, Scotland, a research organization working in fundamental and applied science for sustainable use of land and natural resources, Gordon transformed a biophysical science organization to include social science. He built research programmes around integrating concepts, rather than disciplines. Gordon says, “I was lonely. As a leader of an organization, it’s a lonely existence because you’re responsible for large numbers of people, you’re responsible for big budgets and boards, and you’re trying to do something different like interdisciplinary science. If you want to share your experiences, you feel vulnerable.”

In conversations with Gabriele Bammer, a professor at Australian National University (ANU), Canberra, Australia, Gordon confided in the need for a leadership organization where he and other research pioneers could candidly discuss experiments

in leading interdisciplinarity, and with her the idea coalesced. Bammer had recognized the need for a leadership hub for some time. In the 1980s and 1990s, she saw interdisciplinary efforts increase but fail to sustain themselves. In one example, a cross-cutting environmental research programme from multiple disciplines at ANU turned down forming a department because they thought a structure would be too rigid and hamper innovation. When funding dropped and without a departmental bond, the university trimmed the programme.

Over the past two decades, Bammer has been arguing for the need of a new discipline of integration and implementation sciences (I2S) that seeks to improve research needed for complex problems and how that research can inform policy and actions. Since 2015, she has had a visiting appointment with SESYNC to build resources for complex, action-oriented team science. By 2016, a leadership forum became Bammer’s priority when the Global Research Council’s annual meeting identified a growing concern toward inadequate support for interdisciplinary research needed to address global challenges. The US National Science Foundation (NSF) reinforced that message in a meeting with her that same year.

Key funders told Bammer that they sought to support research on the grand challenges that the world faces. This, Bammer explained, requires research that brings together a range of disciplines, takes a problem-solving approach and can inform and support decision makers in governments, businesses and communities — research encapsulated by the term interdisciplinary.

“The research councils are fully aware that’s different from the bulk of research they currently support, and they are looking for advice on how their funding mechanisms can better encourage and support interdisciplinary research,” she says. “The leaders who met in Maryland now form the nucleus of an authoritative voice that can more reliably inform funders of what’s needed to better support research on the grand challenges. While this is clearly important for sustainability challenges, it’s also true for a wide range of other problems, in public health, security, education, and many more.”

Until now, no one could speak authoritatively for interdisciplinary researchers and research organizations. It has been difficult for funders to obtain accurate, generalizable information about what is needed to do interdisciplinary research well, and how they can better support it. Data and metrics of interdisciplinary research globally are missing^{5,7}. This stems in part from the lack

of agreement on the meaning of inter- and trans-disciplinarity. Furthermore, most countries collect data on disciplines rather than interdisciplinary work. If interdisciplinary leaders organize, they could exert a mechanism to engage funders of this research, says Bammer. If a government entity such as NASA wishes to place more funding into astronomy, they know the top research institutions to approach; but if a similar entity seeks to invest in interdisciplinary research on sustainability, the path is not so clear, she explains.

The bulk of research funding still largely favours disciplinary-based science, but this is changing. For example, the United Kingdom has created UK Research and Innovation (UKRI), an umbrella organization for seven disciplinary-based research councils, covering biological sciences, natural sciences, engineering and others, that were formerly all separate entities. UKRI has a research budget of £6 billion. The umbrella organization was developed after recognizing that more interdisciplinary science is needed. The UKRI’s Global Challenges Research Fund will begin supporting interdisciplinary research hubs from December 2018 through a five-year £1.5 billion fund for tackling global challenges.

Despite decades of work in interdisciplinary research, barriers have not gone away. Collaborative team research involving diverse specialties results in lower funding success⁸. Often, the projects are considered risky and proposal reviewers may lack knowledge from all angles. To rise above these obstacles, Margaret Palmer, a distinguished university professor at the University of Maryland, USA, and executive director of the NSF-funded SESYNC, transformed how her research centre works with principal investigators, beginning with the way its leadership and scientific review panel evaluates proposals.

SESYNC convenes 700 interdisciplinary researchers annually as members of science teams. The centre’s leadership provides input on research proposals that is informed by discussions during scientific review. While roughly half of the proposals are rejected outright from the review panel, the majority of the rest that are recommended by the panel for potential funding require iteration with the leadership, which occurs over a two- to three-month time period. “We identify a good question and a good problem, and then provide constructive comments to improve the project,” says Palmer. “This does not mean that everything gets funded; it’s recognizing that reviewers can help the research community build capacity for interdisciplinary work.”

In June 2018, Palmer led a three-day international symposium for 250 researchers about boundary spanning, designed to catalyse and inspire new collaborative and interdisciplinary communities of environmental research and practice. To offer attractive opportunities and a pipeline for innovation for young scholars, the centre supports 15 to 20 postdoctoral fellows in an interdisciplinary immersion programme, and leads workshops on interdisciplinary skill building, the science of collaborations, and proposal writing for graduate students.

Decision makers are calling for a solutions-based approach to inform better decisions, and through SESYNC Palmer wants the research enterprise to respond to and influence the societal demand, she explained, adding that improving opportunities for dialogue and a common language among interdisciplinary researchers is important to leading success⁸. “People in a group can talk right past one another not even realizing it, and there are very different aspects of a problem that individuals with different [disciplinary] expertise and interests focus on. Illuminating and discussing these different aspects as a group can result in much more impactful research,” she says. With the right tools, “you can get people in a research team talking in a substantive way”.

Those new to interdisciplinarity often underestimate the hurdles, such as the assumptions that are made about other disciplines, Palmer explained. “We need disciplines and grounding but also need a way to bind [disciplines] that naturally don’t combine well given traditional academic boundaries,” she says. “I do not think we need to necessarily have departments of interdisciplinary sustainability. I actually don’t think that’s advisable, but I do think we need mechanisms that centres can bring to promote and support interdisciplinarity. Those are very different things so people still have their disciplinary home but having space to congregate, that is so important... Some have said facilitation is most important, but it is way more than that. It is creating the right culture, having knowledge of other disciplines... and the will to take a risk and do the work”.

At The James Hutton Institute, building capacity for interdisciplinary research has also meant changing physical barriers. The institute employs 350 scientific staff and 35 of those are social scientists from a diverse range of disciplines, and 80% of the research is interdisciplinary. By investing capital in new physical infrastructure and integrating the offices of social scientists within the same hallways as natural scientists, disciplines interact on a day-to-day basis.

“The world’s problems are bigger and the science teams doing the research need to be bigger and bigger, and so putting them in a physical space where they have time to do this work is one of the myriad ways that will help connect people to each other and build science that can inform better decisions,” says Colin Campbell, chief executive of The James Hutton Institute. “This can mean co-locating offices, or leaving space and time to put diverse people, experts from around the world, to meet in one location to tackle a particular problem. Getting face to face contact and making space and time to do that is still absolutely essential, whether they’re in the same institutions or from many, many different types.” Beyond a physical space, other scholars are being organized by building programmes and networks to bring people together; for example, the Institute of the Environment at the University of Arizona, USA, and the York Environmental Sustainability Institute at the University of York, UK.

Campbell believes that all levels of academic institutions must make changes. “We need to be training new types of scientists, and maybe trying to create functional ways of getting together which are not happening on their own,” he says. “Universities are still predominantly training disciplinary-based scientists. We find it difficult to recruit people who have already been exposed to interdisciplinary work and can understand the problems. We are very often starting from scratch with disciplinary-trained scientists and trying to convert them into interdisciplinary scientists.” Campbell’s institute trains research scientists to facilitate workshops and provides tactics, methods and skills for scientists to lead interdisciplinary working groups, which have been important tools for advancing the science, he says.

Campbell plans to provide research teams with longer timescales for accomplishing work, and to adjust measures of success. Advisory boards without interdisciplinary backgrounds might expect major papers, research results and grant funding to come off the assembly line much more quickly than possible or even appropriate, he explained. Over time, boards have adjusted measures of success to “see some things that were more subtle and soft”.

The Institute on the Environment (IonE) has become the University of Minnesota’s source for interdisciplinary research in the US state. Director Jessica Hellmann has been working to understand how integrating structural approaches of her mission-oriented organization within a university could help others to overcome constraints in academia. For Hellmann, the biggest

constraints are budgetary. “We have to constantly articulate our value, because often that value doesn’t conform to the standard metrics of accounting performance,” she says. “Innovation and opportunity comes from being outside the mold, but from an operational point of view and budgeting and human resources, it can be tiring.”

In one cross-cutting project for understanding natural capital to evaluate the value of clean water in Minnesota, researchers combined the approaches of identifying the biophysical threats to drinking water quality and socioeconomic factors that impact the capacity for communities to protect drinking water, and brought that knowledge into a decision-making process. Researchers merged knowledge of mapping, modelling of economic factors, and conversations with water experts around the state of Minnesota to develop a more complete understanding. “This was not just a GIS problem or an economics problem or an ecology problem, it was an intersection of all those things,” says Hellmann.

Building bridges across historic divides often takes the gravitas of a senior researcher with a published track record to do the work, she says. But Hellmann’s latest efforts to cultivate and sustain what she calls a “wider range of assets” — IonE associates that provide a service to other researchers and academics beyond tenure track — are paying off. Young scholars can help develop a collaborative structure, according to Hellmann. “We need to do interdisciplinary research better to serve the common good,” she adds. “Interdisciplinary research is the guts that can push an ancient institution, The Academy, in a modern direction.”

Lessons such as these — of leading interdisciplinary organizations to tackle global environmental challenges — are not easily shared, reports Gabriele Wendorf, scientific director at the Center for Technology and Society (ZTG), Berlin, Germany. For Wendorf, the experience of spending a week working on developing a leadership forum in Maryland was “cathartic”. Leading stronger interdisciplinary institutions will require this group of research pioneers to band together to accomplish their work on the world’s most complex problems, she says, adding, “Who, if not the leaders of such institutions, could have an impact on changing the system? People here are willing to change the system, and this for me was the most important thing, to really build a group that is able to influence somehow decision-makers, not because we would like to have more funding to something. It’s not that we would like to

have another kind of competition with the other institutions, but we, all together, we feel somehow responsible for the future of the science system, and because we know that the problems we're having on earth, they are so urgent, this is why we see that something fundamentally needs to be changed."

While universities and science-funding agencies have been committed to supporting collaborative research, critics argue that it is a threat to disciplines. But interdisciplinary leaders say this critique is misguided, and thus need to think of interdisciplinarity as similar to statistics in research design: it is part of a necessary process⁹.

The goals of the leadership group are to support each other at the leadership level and build stronger guidance for international research institutions. "It is

critical that the interdisciplinarians set their own standards, just as immunologists set their own standards of review and physicists set their own standards. Every man and his dog thinks they can tell us what an interdisciplinarian needs to do, and those who have experience doing [interdisciplinary research] don't have a greater voice than those who have never done it in their lives but are just pontificating," says Bammer.

By creating an interdisciplinary leadership hub that can integrate collective progress, leaders say they could share knowledge more effectively, generate chain reactions, transcend misguided administrative practices and fundamentally advance the science. Their next meeting is at the University of Michigan in autumn 2018. □

Lisa Palmer

National Socio-Environmental Synthesis Center in Annapolis, Annapolis, MD, USA.

e-mail: lpalmer@sesync.org

Published online: 16 July 2018

<https://doi.org/10.1038/s41893-018-0103-3>

References

1. *Tidal Energy Project in the Bay of Fundy* (Natural Resources Canada); <https://www.nrcan.gc.ca/energy/funding/current-funding-programs/cef/4955>
2. Hart, D. D. et al. *Ecol. Soc.* **20**, 4 (2015).
3. Hart, D. D. et al. *Elem. Sci. Anth.* **4**, 90 (2016).
4. Ledford, H. *Nature* **525**, 308–311 (2015).
5. Bromham, L., Dinnage, R. & Hua, X. *Nature* **534**, 684–687 (2016).
6. Bammer, G. *Palgrave Commun.* **3**, 30 (2017).
7. Reckling, F. J. & Fischer, C. *Soc. Sci. Res.* <http://doi.org/10.1016/j.socres.2010.03.001> (2010).
8. Palmer, M., Kramer, J., Boyd, J. & Hawthorne, D. *Curr. Opin. Environ. Sustain.* **19**, 111–122 (2016).
9. Szostak, R. Why we should not ignore interdisciplinarity's critics. *Integration and Implementation Insights* <https://i2insights.org/2017/11/07/interdisciplinarity-and-critics/#more-9798> (2017).