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The engaged university: providing a platform for research that transforms society

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Despite a growing recognition that the solutions to current environmental problems will be developed through collaborations between scientists and stakeholders, substantial challenges stifle such cooperation and slow the transfer of knowledge. Challenges occur at several levels, including individual, disciplinary, and institutional. All of these have implications for scholars working at academic and research institutions. Fortunately, creative ideas and tested models exist that provide opportunities for conversation and serious consideration about how such institutions can facilitate the dialogue between scientists and society.

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Now more than ever, society requires academic research – with its creativity, diversity, and impartiality – to address environmental problems. No other sector is as well equipped as academia to gather information and determine the most effective ways to tackle today's complex problems. US academic institutions play a central role in basic scientific research, but they have played only a minor role in the translation of that effort to the public and to decision makers (Nisbet and Scheufele 2009) and have had little success in engaging the public in “the scientific process” (ie the “doing of science” – including formulating questions, collecting data, and communicating outcomes; Leshner 2007; Bonney *et al.* 2009).

In a nutshell:

- Academic institutions have enormous potential to transform the interface between science and society, but realizing this potential is hindered by institutional structures, review and reward systems, and funding mechanisms
- There is a strong need to develop modified review and reward systems that value work that contributes to both general knowledge and societal action
- Academic institutions should provide mentoring, leadership training, networking, technical support, and innovative curriculum development to foster successful engagement

In general, scientific research may be described as a continuum of categories, including “basic”, “applied”, “knowledge-to-action”, and “engaged”. Seeking to involve non-specialists as partners in conducting scientific investigations, “engaged research” is one crucial way in which scientists may interact with society (Bonney *et al.* 2009). Evidence strongly suggests that environmental knowledge created through engaged research is most likely to achieve social acceptance, become policy relevant, and influence outcomes having favorable environmental impacts (Overdevest *et al.* 2004). Interaction between scientists and members of local communities (ie community or societal engagement) is integral to engaged research but is not limited solely to communicating scientific findings. Rather, community engagement includes a diverse palette of techniques in (1) *education*, both formal and informal; (2) *consultation* in policy, practice, and planning; and (3) *training* the next generation of scientists, decision makers, and citizens (NRC 2009).

Here, we frame some of the issues involved in promoting dialogue between scientists and society, from a perspective within the US and concentrating on the role of academic research institutions in supporting engaged research. We also identify selected barriers that may impede engaged research and prevent its success – at the level of the individual, institution, and funding agency – as well as propose creative solutions based on recognized national and international efforts. Although this discussion of constraints and solutions is not exhaustive, our intention is to take the conversation about engaged science between academic colleagues/institutions and the public “to the next level”.

■ Transforming society through engaged research

Engaged research – typically involving academic scientists collaborating with other academic and/or societal partners, such as community organizations and decision makers – has the potential to transform our fundamental

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knowledge of human and natural systems and to develop solutions for the world's ongoing environmental challenges. There are many models and approaches to engaged research, which vary in the degree of collaboration. However, we recognize that not all research is amenable to collaborative settings and that not all researchers are prepared to work with societal partners.

Engaged research goes by many names, and has different histories of application and acceptance depending on the field of study. For instance, “community-based participatory research” (CBPR) is well established in public health and biomedical research disciplines. CBPR grew out of necessary collaborations among community-based health providers, their clients, and university researchers (Israel *et al.* 2005; Bonham *et al.* 2009). Similar engaged approaches have also been critical in the fields of environmental justice, psychology, and sociology, among others (eg Fawcett 1991; Williams 1999). Though different in certain respects, these types of collaborative research – for the most part – engage non-scientists at every stage of the research process, create partnerships that help make science socially relevant, and resist the unidirectional transfer of knowledge (ie “from science to society”). Indeed, societal partners are active throughout the process – from identifying problems to conducting research and developing strategies for applying outcomes.

■ Existing constraints of, and suggested solutions for, engaged research

Societal engagement includes a diversity of activities, such as working with policy and decision makers; non-profits and advocacy groups; committees, panels, or as an expert witness (Figure 1); in primary and secondary education (K–12) and adult-learner education; or communicating through informal venues, such as news and popular science media, or via web arenas such as blogs. Scientists continue to explore new ways to “broaden the impact” of their research for society (Pace *et al.* 2010). (In the mid-1990s, the National Science Foundation [NSF] began requiring researchers to describe the “broader impacts” of their work as a component of their submitted grant proposals, and made this element subject to review.) Still, despite the history of success of such approaches, academic scientists continue to encounter constraints to integrating engaged research at several levels: (1) training opportunities for individual scholars, (2) disciplinary issues related to peer evaluation and review, and (3) institutional impediments (GUIRR 1999). We discuss some constraints and suggest potential solutions below, recognizing that these are overlapping issues.

Individual scholar issues

University and college teachers are well aware that students are increasingly approaching environmental sci-



Figure 1. Scott Doney from the Woods Hole Oceanographic Institution (Woods Hole, MA) and an Aldo Leopold Leadership Program Fellow testifying before the US Congress.

ence using interdisciplinary and collaborative frameworks. However, given that engaged research approaches are new to ecological science, a major obstacle for younger scholars is the relative lack of successful models to follow when charting an academic career in this area. Innovative mentoring and education programs (Panel 1; Figure 2) are becoming more common, although additional examples and success stories are needed.

Traditional science education does not prepare students to adequately communicate their work outside their field. Yet this skill is essential for research efforts that “bridge” to policy makers and other stakeholders. Although capacity remains limited, several entities – including Stanford University’s Aldo Leopold Leadership Program and

Panel 1. Georgetown University’s program on Science in the Public Interest (SPI)

The Science in the Public Interest (SPI) program (<http://spi.georgetown.edu>) at Georgetown University in Washington, DC, promotes direct dialogue with the government, industry, and the community on critical scientific issues and helps to develop the next generation of scientists engaged in policy. *Shaping National Science Policy* is an SPI seminar that introduces science majors to science advocacy and practical politics. Students begin with discussions of the political system and then transition into “hardball” politics, with guest lectures from congressional science staff, science journalists, lobbyists, and pollsters. The seminar concludes with an examination of five case studies in science advocacy. Students break into teams, identify a politically relevant science issue of their own choosing, develop an advocacy strategy, and then take their issue to the US Congress. In one such project, SPI students advocated for a “green campuses” initiative to support universities that build green buildings; their proposal became part of Senator Jeff Bingaman’s (D–NM) National Energy Efficiency Enhancement Act of 2010.

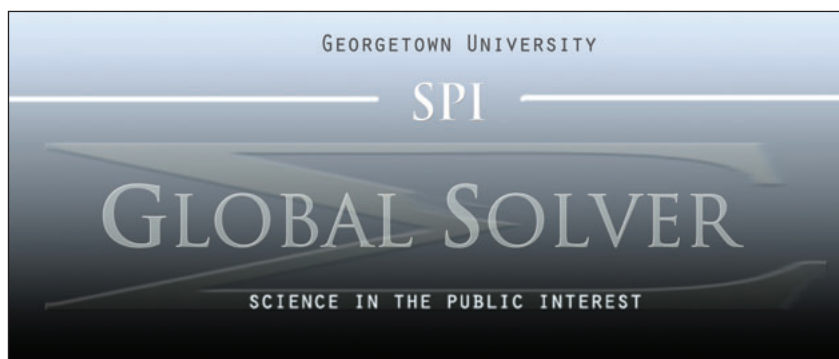


Figure 2. Signified by the uppercase Greek character Sigma (Σ), Global Solver is a science policy idea-building tool that brings together scientists and policy makers to engage students in the search for innovative solutions to the critical challenges of our time. Source: <https://digitalcommons.georgetown.edu/blogs/globalsolver/>.

Emmett Interdisciplinary Program in Environment and Resources, the American Association for the Advancement of Science, and the Society for Conservation Biology's Smith Fellows Program – now provide skills-based training in communication and leadership, as well as faculty and student mentorship. The Leopold Leadership Program illustrates how skills-based training and networking can advance “knowledge-to-action” approaches. Founded in 1998, the program is a competitive fellowship that provides intensive training in leadership and communication to mid-career academic environmental scientists. Many Fellows have gone on to mentor students about the importance of outreach. Fellows' success in conducting cutting-edge research that contributes to both general knowledge and practical environmental solutions has led over time to increased recognition by their respective universities.

Reflecting NSF's commitment to engaged research, NSF's Graduate Science, Technology, Engineering, and Mathematics Fellows in K–12 Education (GK–12) program creates mentoring and training opportunities among graduate students, K–12 teachers, and K–12 students. The GK–12 program's aims include improving graduate student communication and teaching skills by partnering graduate students with teachers in K–12 classrooms. Approximately 90% of respondents (participating graduate students and K–12 teachers who were surveyed) indicated that communication skills improved during GK–12 fellowships (Mitchell *et al.* 2003). A more recent program evaluation of the GK–12 program found that nearly three-quarters of the former GK–12 Fellows found employment within academia after graduation (Abt Associates 2010). The benefits of the GK–12 program extend beyond formal participants, given that one-third of the participating institutions reported that other graduate students benefited from the GK–12 program's teaching resources, training sessions, and other opportunities (Abt Associates 2010). This suggests that GK–12 and other programs targeted at encouraging graduate student professional development and engaged research not only help participating graduate students reach their

career goals but also have the power of “transforming” academic institutions, as former program participants become today's researchers, professors, and administrators.

Developing opportunities for undergraduate and graduate students to participate in internships at agencies, non-governmental organizations, K–12 schools, and so forth, allows both students and faculty members to engage with stakeholders (Figure 3). Adding an academic component makes these experiences even more powerful. For example, coupling a communication internship with reflective exercises (eg using electronic

or online portfolios) can change the internship from job training to experiential learning (eg Fenwick 2000; Brown 2009; Delany and Watkin 2009). Faculty members also continue their own learning experience (Getz 2009) and expand their interactions with stakeholders.

Hiring scientists and other professionals involved in environmental issues through “professors of practice” programs provides another way of mentoring students. Simply stated, professors of practice are non-tenured faculty positions that are held by highly qualified individuals from government and industry. Although common in business and engineering, these types of positions are much less prevalent in colleges of arts and sciences. Such appointments are sometimes controversial; academic institutions must balance their educational mission and the role of contingent faculty appointments (AAUP 2003). However, administrators in leading academic institutions are discussing the role of these types of appointments in a framework that respects the expertise of such professionals, addresses the role of tenure, and promotes fairness. Institutions should seriously consider whether and how innovative approaches to curriculum and faculty development might support efforts to connect institutions to societal stakeholders through faculty appointments that bridge this gap.

Disciplinary issues

Peer review – broadly defined here to include the process that occurs before the publication of scientific literature, as well as professional assessment of faculty for promotion within academia – is an important aspect of academic science. The peer-review system ensures that scientific work is well vetted, sometimes painfully so, but also both supports and hinders the transfer of academic knowledge to society. For example, early-career scholars conducting engaged research – which involves participating with policy makers and/or in transdisciplinary collaboration – face special challenges to succeeding in academia because their work often requires more time than traditional disciplinary work. Because tenure-granting committees require

justification for legitimately extending time to tenure review, such scholars seeking tenure may find themselves at a disadvantage. However, an acknowledged peer community can assist with resolving this problem by identifying scholarship that is promising and merits more time than that associated with a more traditional approach.

Products of transdisciplinary work, particularly that involving stakeholders, can be problematic in professional evaluation (CFIR and CSEPP 2004). Multi-author papers are common in engaged research, and promotion evaluators frequently question a researcher's "true" contribution to such papers. Scientific journals (notably *Nature*) have tried to resolve this by requiring footnotes that explain each author's contribution, but this practice is not yet widespread among research journals and does not address how different types of contributions should be rewarded. In addition, engaged research is often published in interdisciplinary and applied journals that are not as highly ranked as the "flagship" journals within ecological and environmental science disciplines. This challenges the tradition of using impact factors of journals – in which a scholar publishes his/her work – in tenure and promotion review. In response, the Interdisciplinary Tenure and Career Development Committee of the Council of Environmental Deans and Directors has recently developed *Interdisciplinary Hiring, Tenure and Promotion: Guidance for Individuals and Institutions* (Pfirman et al. 2010) as an online resource (<http://ncseonline.org/CEDD/cms.cfm?id=2042>).

Peer review of submitted publications is a time-consuming process and therefore can itself substantially slow the transmission of ideas beyond academic institutions. Sense About Science's Peer Review Survey 2009 found that 57% of respondents who submitted papers for consideration waited more than 3 months from submission to final "acceptance" (SAS 2009; Figure 4), and further time delays occur if papers prepared in the accepted language of scholarly journals must be "translated" into something more accessible for decision mak-



Figure 3. Mackenzie Zippay (left) works with high-school student Veronica Pessino on a marine science field project as part of a mentoring program.

ers and other end users (Norton 1998). Online publishing of research has shortened the time before research findings are made available, and we encourage these and other efforts.

Modifying the current peer-review system will help to meet the needs of both scientists and decision makers. Success lies in building a peer community that understands the value of work that contributes to both general knowledge and societal action (Panel 2). This community would then be called on to articulate standards of excellence for engaged, collaborative research approaches. This is not the first call for revamping tenure and promotion processes; Trower (2009) notes that existing tenure and promotion guidelines were developed in the 1930s and 1940s and that a redesigned set of guidelines by current faculty members might include ideas such as "a tenure track for faculty members focused on teaching;...interdisciplinary centers with authority to be the locus of tenure; broader definitions of scholarship and acceptable outlets and media to 'publish' research...". Trower and Chait (2002) called for a "constitutional convention" to rethink tenure policy for the positive effects it could have, particularly on issues of diversity; we reiter-

Panel 2. Developing a peer community: an early success story

Research begun in 1992 by Pamela Matson and Rosamond Naylor on dimensions of agriculture and variability in the Yaqui Valley of Sonora, Mexico, demonstrates how a peer community may be gathered to advise and evaluate "knowledge-to-action" research. Initially, the peer community for the Yaqui Valley work consisted of segments of the Ecological Society of America's Sustainable Biosphere Initiative (SBI) group, the International Geosphere–Biosphere Programme (IGBP) of the Swedish Academy of Sciences, and the UN University's International Human Dimensions Programme (IHDP). The SBI contingent's interest lay in the ecological underpinnings of the work, whereas the IGBP and IHDP contingents were primarily interested in its interdisciplinary nature. None of these groups were especially attuned to the "linking knowledge-to-action" dimension of the work. However, leading scientists understood and encouraged this aspect of the Yaqui researchers' approach; they appreciated both that it was different from the "same old science" and that it was important. Today, this sustainability science community is growing and almost always exhibits an interest in solutions-oriented research. The bottom line is that there are strong links among all these communities – SBI, IGBP, IHDP, and sustainability science – and parts of them have coalesced into the kind of peer community that is needed to support knowledge-to-action work.

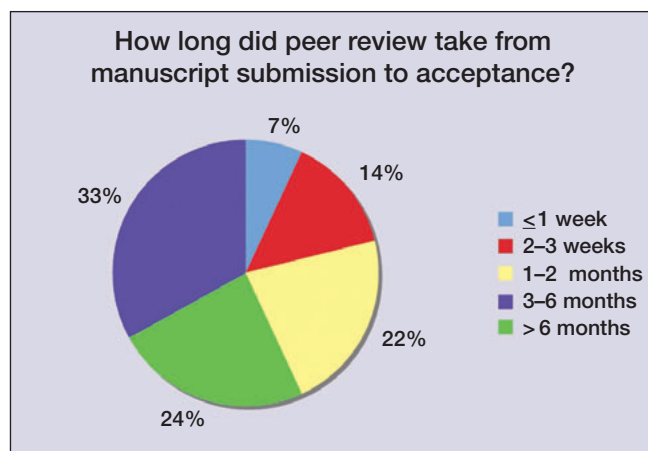


Figure 4. Survey responses regarding length of time respondents experienced from submission of a manuscript to acceptance by a peer-reviewed journal. The survey included responses from 4037 researchers. Modified from the 2009 Peer Review Survey conducted by Sense About Science (www.senseaboutscience.org).

ate their opinion that “...the idea merits philanthropic support and deserves to be tested”.

Non-academic research institutes can have an important role to play in moving engaged research forward. Because these institutes can bypass the tenure practices of academic institutions, they can take a leadership role in creating a peer community that will make the work possible in academic institutions. Non-academic research institutes can promote discussion on how they evaluate engaged research and community engagement to provide models for tenure and promotion. The Board of Mathematical Sciences has argued that professional societies are key to rethinking tenure and promotion, given that they can identify important case studies and data on engagement techniques and research (BMS 1997). Professional societies can and should assist academic institutions in evaluating new approaches to research and research collaborations.

Institutional and structural issues

Although numerous researchers and funding agencies encourage collaborative approaches, mechanisms for recognizing the value of public engagement efforts are limited (CFIR and CSEPP 2004). Many of these engagement activities are included in the “service” category, which is commonly the least valued of the three “pillars” (ie research, teaching, and service) of the traditional evaluation matrix. Faculty members must figure out how to connect these activities to evaluation metrics, particularly with regard to research and teaching, yet many report that they are advised against participating in activities with societal stakeholders until after obtaining tenure. Although this might be an appropriate suggestion for untenured faculty members given the particular circumstances of their department and/or evaluation criteria, the lack of discussion about how and when these activi-

ties may play a role in career development suggests they are unimportant.

Clearly, many of the activities (including stakeholder interactions) that scholars use to engage society do not complement the current guidelines for tenure and promotion in academia. Some solutions may occur through shifts in the culture of science to be more encouraging and accepting of this work (for which scientists themselves are responsible). However, institutions can play a role. In 2005, the Carnegie Foundation for the Advancement of Teaching (CFAT) announced a new classification “schema” for institutions’ mission and practices to include community engagement (Driscoll 2009). In the program’s first year, 76 academic institutions received this new classification, though applicants’ approaches to community engagement varied considerably (Driscoll 2009).

The data suggest a disconnect between what institutions say they want (ie engaged faculty) and institutionalized practices of faculty reward (Driscoll 2009). Overcoming this disconnect requires revising tenure and promotion criteria so that engagement is included as part of the faculty member’s teaching and research roles where appropriate. The service role might then revert to a more traditional definition and include activities such as administrative tasks and committee membership. The difficulties for revising tenure and promotion criteria are numerous, including developing reward policies and practices for documenting engagement products (Calleson *et al.* 2005). Most universities that have earned CFAT classification for community engagement are only in the process of revising their respective tenure and promotion guidelines (Saltmarsh *et al.* 2009). Exemplifying this trend, Michigan State University’s Office of University Outreach and Engagement developed a definition of “outreach as scholarship” as well as indicators for “evaluating its quality” (Doberneck and Fitzgerald 2008). *Imagining America: Artists and Scholars in Public Life* (www.imaginingamerica.org/), a consortium of over 80 colleges and universities originally based at the University of Michigan, has established a “tenure team” to develop policies and processes that appropriately value public scholarship and engagement (Cantor and Lavine 2006). Although individual institutions will need to carefully consider how outreach and engagement are evaluated, high-quality and valuable efforts must no longer go unrecognized.

At least one model that may be used as a basis for rethinking evaluation metrics exists outside the US. Nearly 10 years ago, the UK’s Natural Environment Research Council (NERC) realized that many of their criteria used to evaluate investigator-driven science were inappropriate for judging solutions-oriented work; although both require peer review, they rely on somewhat different criteria. Solutions-oriented research requires an evaluation of utility (eg Will it solve or has it solved the problem? Did practitioners take it up? Was it financially successful?), as well as of excellence. It can be irrelevant

that the work was “only patented”, not published in a peer-reviewed journal, and so on. The particular metrics used required time to be refined but are now part of NERC’s normal operating processes, accepted by both the “pure” and the “applied” communities.

Reviews of the CFAT program, as well as a similar effort supported by the WK Kellogg Foundation, found that overcoming institutional barriers requires that universities incorporate community engagement into their core missions and strategic-planning efforts (Calleson *et al.* 2005; Driscoll 2009). Institutional structure often, and perhaps unintentionally, constrains faculty members from collaborating. At many universities, there are extensive barriers to cross-departmental teaching that inhibit faculty participation. Of even greater impact may be the administrative constraints on how funds flow to administrative units based on teaching credits and collaborative research grants. Increasingly, institutions rely on indirect cost funds from grants to cover operational costs. Multi-institutional/departmental grants, even if large, may represent only small resources for individual grantees. As such, this system implicitly discourages researchers from seeking such collaborative funding. The importance of this issue varies among institutions and review processes, but in general, researchers are rewarded for the funding they bring to their institution.

Establishing topic-oriented research centers on a university or college campus often represents a reliable method for supporting interdisciplinary environmental research and engaged science (Panel 3), particularly when a percentage of indirect funds from grants is allocated toward such centers. Support beyond basic administrative assistance, such as science writers and community engagement specialists, may be needed to facilitate this work. In addition, universities should consider promoting collaborative research through strategic cluster hires of interdisciplinary faculty around topics of critical concern.

Despite internal motivations and efforts, academic institutions have complicated administrative structures that can be seemingly impenetrable. For example, it is not uncommon for researchers to be unaware that their colleagues are working with the same stakeholder group

with which they wish to engage. University and K–12 school district interactions are a good example of this challenge. Certainly, education departments or schools within a university have direct connections with K–12 schools. However, there are many opportunities for K–12 teachers across the entire university, such as research experiences in individual science laboratories. These opportunities can be difficult for K–12 educators to find without committing a good deal of time perusing webpages. Similarly, for policy makers, it may be relatively easy to identify researchers affiliated with a university’s public policy program, but more challenging to find researchers associated with policy-relevant research distributed throughout the institution.

One of the easiest mechanisms for a university to engage in dialogue with its surrounding community is through the university website. In an unscientific examination of the homepages of over a dozen top-ranked US academic institutions, we found that all had clearly demarcated links to academic programs or philanthropy, but no obvious links designated for members of the local community. Of those informally surveyed, two institutions had community-related links, but these were limited to campus tours. A notable standout was Columbia University’s neighbors.columbia.edu webpage (<http://neighbors.columbia.edu/>), which is accessible from a link on the school’s homepage. Academic institutions must be mindful of the message they are publically communicating through their web presence; for instance, the list of links on a university homepage can suggest an insular environment. Relatively simple changes that communicate openness can go a long way to promote relationship-building with community stakeholders.

The role of “interface” organizations, whose explicit purpose is to facilitate the dialogue between science and society, is covered elsewhere in this issue (Osmond *et al.* 2010). Within academic institutions, it may be useful to develop “interface” positions that function as connectors among faculty, between faculty and industry/government/K–12, and so forth; such positions can also be responsible for identifying impediments to collaboration and/or needed incentives. For example, in the mid-1990s, The Imperial College of Science, Technology and

Panel 3. The Sustainability Solutions Initiative: a novel institutional program for linking knowledge with action

The University of Maine and its partners recently launched the statewide Sustainability Solutions Initiative (SSI; www.umaine.edu/sustainabilitysolutions/), which is intended to eventually lead to the creation of a permanent interdisciplinary Center for Sustainability Solutions. SSI is an example of an institutional experiment in public engagement that is developing new models for how research universities can play more effective roles in solving sustainable development problems characterized by intersecting ecological, social, and economic dimensions. SSI is especially focused on: (1) supporting interdisciplinary teams committed to the solution of real-world problems; (2) establishing productive and durable university–stakeholder partnerships; and (3) understanding and strengthening connections between the production of scientific knowledge and the ways such knowledge affect individual and institutional behavior. One of SSI’s central assumptions is that environmental science is necessary but not sufficient for addressing a wide range of sustainability challenges, so the initiative has drawn together >40 faculty from nearly as many fields. SSI also offers team-taught graduate courses, in which interdisciplinary teams of students work in partnership with diverse stakeholders to help solve pressing problems in Maine. SSI is led by the University of Maine’s Senator George J Mitchell Center for Environmental and Watershed Research and is supported in part by a \$20 million, 5-year NSF Experimental Program to Stimulate Competitive Research (EPSCoR) grant.

Medicine in London (UK) established an Environment Office, with a professional scientist as Director. The Director encouraged and nurtured cross-departmental research and college–industry collaborations, with a focus on engaged work. The office is widely acknowledged to have been a success, and has resulted in an increase in grant income from collaborative projects focused on energy and environmental matters.

Seemingly insurmountable bureaucratic barriers often prevent academic researchers from transferring funds to non-institutional partners, such as local neighborhood organizations, or even to local government agencies. This is particularly the case when researchers would like to compensate community partners for small expenses or travel costs. Recognizing that access to financial, material, and support service resources reflects one of the greatest power differentials between academic researchers and many of their community partners, academic institutions need to develop ways to compensate partners for their considerable assistance.

Finally, the lack of reward – financial or otherwise – severely impedes the application of academic science to societal problems. While much remains to be done on this front, university administrators may already have the means at hand to begin remedying this problem. Perhaps the most powerful tool at their disposal is funding: designating funds (however limited) for solutions-oriented work sends a strong signal that such work is valued. Other helpful mechanisms include publicly recognizing the work of these researchers; supporting faculty in networking and collaborating to develop their research agendas; engaging students of all levels to impress the importance of this work; and publicly reinforcing the notion that research can contribute to both knowledge and solutions.

■ Summary

Society relies on academic research to address environmental issues, yet academic institutions have had limited success in communicating scientific findings outside of academia and even less success in involving society in developing a scientific agenda. Engaged research and societal interactions offer one approach to address this problem but are discouraged by institutional constraints within academic organizations. For example, institutional structure often restricts faculty members from collaborating outside of their department because of issues ranging from acknowledging teaching effort outside one's department to allocation of funds across department lines. Faculty evaluation methods can discourage collaboration by overvaluing first-author papers and individual grants and undervaluing outreach and public or policy participation. Many researchers pursue engaged research despite these hindrances, but the ability of academic institutions and individuals within academia to address complex environmental problems would be much improved if the system encouraged this kind of work.

Fortunately, there are several ways that academic institutions can move from discouragement or neutrality to proactive support. To start, institutions can evaluate faculty by (1) recognizing research and activities that advance scientific knowledge and improve outcomes for human and natural systems and (2) appreciating the challenges involved with such engagement. This would also require the academic community to articulate standards of excellence for engaged, collaborative research approaches. Academic institutions can demonstrate support for engaged scholarship by designating financial rewards (eg research dollars) to support solutions-oriented research. Public symposia that highlight this work and bring together researchers and stakeholders from across the campus and surrounding communities should be considered. Finally, training and mentorship should be fostered through innovative programs from the undergraduate to the faculty levels. By providing strong institutional support for engaged research, academic institutions can play a more important role in leveraging scientific and societal knowledge to solve environmental problems.

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