ELEMENTA
Science of the Anthropocene

Increasing the usability of climate science in political decision-making

Emily R. Newsom[1*] • Andrea J. Fassbender[2,3] • Ashley E. Maloney[2] • Seth M. Bushinsky[2,4]

[1]University of Washington, Department of Earth and Space Sciences, Seattle, Washington, United States
[2]University of Washington, School of Oceanography, Seattle, Washington, United States
[3]National Oceanic and Atmospheric Administration, Pacific Marine Environmental Laboratory, Seattle, Washington, United States
[4]Princeton University, Atmospheric and Oceanic Sciences, Princeton, New York, United States
*enewsom@uw.edu

Abstract

As climate-science graduate students at the University of Washington, we had the opportunity to engage in a political process focused on implementing legislation to reduce greenhouse gas emissions in Washington State. Our insights gained from this rare, first-hand, experience may be particularly relevant to other climate scientists. We argue that inflexible research goals within the United States climate-science community limit the relevance of the knowledge our community creates. The mismatch between climate-science research and the information needs of policy makers, while widely acknowledged in certain domains, has yet to be fully appreciated within many earth science disciplines. Broadening the climate-science training of graduate students to include education on the uses of climate information outside of academic settings would both inform and motivate new research directions, and engender validation of non-traditional research within disciplinary cultures.

Domain Editor-in-Chief
Anne R. Kapuscinski, Dartmouth

Associate Editor
Peter C. Frumhoff, Union of Concerned Scientists

Knowledge Domains
Atmospheric Science, Earth & Environmental Science, Ocean Science, Sustainability Transitions

Article Type
Commentary

Received: February 12, 2016
Accepted: August 20, 2016
Published: September 30, 2016

Introduction

The lack of substantive legislation in the United States to mitigate anthropogenic climate change suggests, to many climate scientists, a blatant disregard for a growing scientific consensus. Worse, it implies a disturbing political indifference towards the projected social and economic harm associated with physical climate changes. At least, these were the perceptions that we, a group of climate-science graduate students at the University of Washington (UW), held prior to engaging in a state-level, climate-policymaking process. We have become more aware of shortcomings within our own field that impede enacting effective climate change mitigation policy as a result of witnessing, in person, the challenges faced by these decision makers. Most importantly, the U.S. climate science community has not widely integrated existing information from other fields regarding what climate research would be most useful to political decision makers. Here we hope to convey to our fellow climate scientists some basic realities of policymaking that render integration of currently available scientific findings difficult in practice. These realities, widely acknowledged in many domains, are still underappreciated in many climate science settings, and are rarely considered when setting research goals. Here we suggest that targeted additions to graduate student training may facilitate broader engagement from our community in addressing climate change.

Background

For much of our graduate experience, the dormancy of climate change mitigation policy has been a concerning, but somewhat distant, condition under which we have carried out our individual, disciplinary research on the climate system. The politics of climate change mitigation became part of our education only through the UW's National Science Foundation (NSF)-funded Integrative Graduate Education Research and Traineeship (IGERT) Program on Ocean Change (POC). NSF IGERT programs were conceived to "establish new models

for graduate education… for collaborative research that transcends traditional disciplinary boundaries." To this end, the UW IGERT POC encourages interaction between physical and social scientists working to address issues of ocean and climate change. Through this program, we had the opportunity to act as scientific advisors to Washington State Senator Kevin Ranker as he served with three other state legislators and the governor on the bipartisan Climate Legislative and Executive Workgroup (CLEW). The task of the CLEW was to identify and recommend greenhouse gas emissions reduction policies that would allow Washington State to achieve statutory targets. Our motivation to participate was twofold: 1) to better understand causes of stagnation in climate policy development; and 2) to translate the complexities of climate science, so that we might increase its usefulness in the political process.

As scientific staffers, our role in the CLEW process was to aggregate and distill published scientific and economic literature and stay abreast of frequent reports, generated by the hired consultants, about projected economic impacts of a suite of potential carbon reduction policies (Leidos, 2013). Immersion in the unfamiliar realm of state policymaking gave us exposure to the burden on policymakers to digest and make decisions regarding nuanced topics with very limited time, information, and human resources. Senator Ranker, who was enthusiastic to have four extra staffers, asked us to search the literature for research concerning the economic impacts of local climate change on industries and resources valued by citizens of the Pacific Northwest. We were generally unable to find the information requested, and struggled to relate the available climate-science information to this particular policy discussion in a meaningful way.

The CLEW policy discussions centered on the economic burden associated with regulating greenhouse gas emissions. We, like most climate scientists, were aware that the economics of climate change mitigation policies cannot be ignored. The policy options for large-scale emissions reduction (i.e. a carbon tax or carbon cap) are designed to raise the cost of carbon in order to reduce emissions - a cost passed on to voters. Thus, the discussion of a given policy was unavoidably rooted in the economics of its outcomes. However, we did not anticipate the extent to which the economic impacts would dominate the evaluation of each policy's merit. In this discovery, we were forced to acknowledge the stark difference in the types of information that climate scientists and political decision-makers perceive to be "relevant" to the issue of climate change.

The scarcity of research quantifying the avoided costs associated with greenhouse gas emissions reductions, or the economic benefits of reducing fossil fuel dependency at a regional scale, became abundantly clear in the face of this economic debate. The dearth of localized economic research was not unfamiliar. We recognized that model projections quantifying the local impacts of climate change are presently made with low levels of confidence (Hawkins and Sutton, 2009). As a result, regional economic analyses based on climate change impacts, or avoided costs, are rare, and this type of information was absent from the CLEW process. Herein lies what we perceive as the greatest obstacle for climate scientists attempting to conduct research "relevant" to policymakers: politicians cannot easily relate the most robust projections of future climate, made over large space and time scales and concerning variables like global mean temperature, to local impacts of reduced snowpack on water supply or the effect of ocean acidification on oyster harvests over the next decade. Further, the differing timelines for emerging costs (mainly short-term) and benefits (long-term) resulting from emissions reduction increase subjectivity in the valuation of the future relative to the present (e.g. Lind, 1995) and increase the difficulty in motivating political action. Witnessing the politically charged CLEW process revealed to us that, despite these innate challenges, our community could greatly increase the usefulness of our science by embracing research from economic, social, and psychological sciences to create more policy-relevant research.

Discussion

The climate knowledge usability gap

Although we were initially surprised that many published climate-science studies were of limited relevance to the CLEW process, we then found that these personal revelations were not novel; quite the contrary. Prior studies have established the gap between climate-science research and its effective use, commonly referred to as the "climate information usability gap" (see review by Lemos et al., 2012 and references within). Yet, the notion of this disconnect is omitted almost entirely from the disciplinary training of climate scientists. Lemos and coauthors (2012) acknowledged two main issues creating this usability gap: 1) researchers assume the information they produce is useful because they do not understand the decision-making processes of their intended users; and 2) users have unrealistic expectations of, or misunderstand how, existing information pertains to their decision-making. In both cases, intrinsically relevant information remains "on the shelf." Here, we frame our discussion of climate science training around these two key issues.

Our climate science community must acknowledge that we overestimate our work's relevance outside of academia. Social scientists and economists have long understood that people are most interested in, and motivated to act upon, information that pertains directly to themselves, their values, and their local community (e.g. Ostrom et al., 1994), but this concept is rarely discussed in our disciplinary training. Additionally, the fundamental features of the climate system emerge, and are studied over, large time and space scales. Regional

climate projections, those which might resonate in communities outside of academia, have an unavoidably elevated level of uncertainty due to internal variability in the climate system that is amplified on smaller time and space scales (e.g. Deser et al., 2014). Thus, the study of very-localized regions provides only limited insight about robust features of climate, and these studies are often considered less meaningful by the climate science community. Further, simulation of regional climate relies on an accurate representation of the large-scale circulation: if larger-scale dynamics are gravely biased in models, downscaling provides imperfect additional information (Xie et al., 2015). Finally, coupling regional-climate projections to economic models compounds their uncertainty, driving an "uncertainty cascade" (Schneider, 1983). This limits the likelihood that we could *conclusively* learn anything from such research, presenting a clear deterrent in attempting to do so from a traditional scientific perspective, and explaining, in part, why such research might be avoided in our field.

Yet, climate scientists may be missing the opportunity to inform regional policy altogether by overly adhering to traditional research motivations. Some in our community may not consider this problematic - not all climate scientists intend to inform policy, and for good reason. Fundamental research is an *essential* tenent of our field. However, because many climate scientists are genuinely interested in contributing to a solution for this global problem, we feel that keeping our research "on the shelf" is unacceptable. As argued by Moss and Schneider (2000), it is far more rational for experts to provide estimates and probabilities of outcomes relevant to decision-making than to leave it to non-experts to make their own guesses. As it stands, legislators are often provided with highly uncertain cost estimates for pricing carbon. Estimates of avoided costs from mitigating climate change, even if highly uncertain, could, therefore, balance the evaluation of a policy's viability. Together, both sets of estimates could communicate that predicting the behavior of complex systems is inherently uncertain.

On the other side of the knowledge information gap, users might ignore data if they have limited understanding or unrealistic expectations of how it relates to their decision-making (Lemos et al., 2012). Users won't use information if they don't *perceive* information as relevant, regardless of its content. Misperceiving research to be irrelevant can stem from many sources, for instance: the misunderstanding of a complex idea; an underestimation of its salience or reliability; or a mismatch between its message and a user's intuition (Lemos et al., 2012). In the specific case of climate change mitigation policymaking, political decision-makers might also disregard climate projections, or perceive them to be irrelevant, because these projections involve timescales that extend far beyond their shorter-term priorities. The emergence of climate change impacts and their associated costs will occur for decades and centuries to come (IPCC, 2014). Determining the appropriate discount rate for climate change impacts is a fundamentally subjective and controversial decision - one that regards the ethics of intergenerational equity and how to cope with uncertainty (i.e. Lind, 1995; Azar and Sterner, 1996). Yet, political decision-makers tend to choose discount rates that are higher than what may be societally beneficial or representative of constituent preferences due to personal agendas. This myopic behavior is incentivized by the drive for reelection and thus favors political results that occur on short timescales (Carson and Roth Tran, 2009). So long as decision makers assess the ramifications of policy options on short timescales, it may be difficult to motivate action regarding climate change, even if climate scientists translate the consequences and risks of climate change more effectively. Altering this reality extends far beyond the influence and responsibility of climate scientists as it hinges on entrenched political culture. It is possible, however, that by actively engaging with information users while incorporating lessons from maturing science-policy communication research, climate scientists could motivate decision makers to consider the longer-term consequences of delayed climate change mitigation.

Accepting the information usability gap and moving forward

The fundamental work that climate scientists aspire to create will improve our understanding of the climate system and the long-term ramifications of greenhouse gas emissions. However, we now recognize how difficult it will be to generate radically new, fundamental scientific arguments to motivate a national political response to climate change more compelling than those already in existence. Although this conclusion could be viewed as discouraging, in it we found renewed purpose. The failure of our community to create publicly-funded climate science that is societally meaningful exposes one reason for the frustrating lack of political response to our work. In other words, our community may inadvertently be impeding the effective use of climate science by maintaining a traditional and insular approach to climate-change research and communication. Conveying the impacts of climate change using societally relevant variables and scales would enable our representatives to make more informed policy decisions, potentially galvanizing a more pragmatic, risk-conscious response to our research efforts.

Perhaps the best way our community can address this issue is to stop perpetuating the status quo, and deviate from tradition to acknowledge the existence of the climate information usability gap in our education. Integrating discussion of this gap into disciplinary climate science curricula would allow graduate students to establish an early appreciation for how scientific information is used outside of academia. Further, it would enable students to make informed choices about how to approach their research and build their skillset. We specifically recommend that this training include exposure to: why this gap exists; guidance in how to target

climate research towards political or social decision making (e.g., Lemos et al., 2012; Feldman and Ingram, 2009; Ekroos et al., 2016); efforts underway to inform environmental decision making (e.g., the BioEarth project, as discussed by Allen et al., 2013); examples of transdisciplinary research (DeLorme et al., 2016); and ways to better communicate uncertainty and risk (e.g., Pidgeon and Fischhoff, 2011). We believe that even a broad-strokes discussion of these ideas will convince many members of our community to rely less on intuition, and more on evidence-based research, when considering how our work is used and perceived outside of academia. Educating students about why traditional climate-science research may not result in policy-relevant products could stimulate more active participation from the academic community in interdisciplinary work, and in more effective outreach with the general public.

Basic exposure to the uses of climate-science information outside of academia may also motivate and help validate user-targeted climate research in our field. Armed with real data regarding the alternative uses of scientific information, individual students could choose how to proceed as a climate scientist and citizen, navigating their role in research and in society individually. Institutionalized pathways for engaging with policy-makers would serve students who aim to pursue research oriented for decision making and are interested in creating ties outside of academia. State universities could establish collaborations with state government through academic programs (the UW Program on Climate Change and UW NSF IGERT POC are two examples) aiming to enhance university outreach and involvement in local affairs. This would have numerous benefits, including: giving state agencies access to experts who are privy to the best academic resources; providing new perspectives to academic researchers (principal investigators and students) about what information is useful to agencies that work to address local environmental issues; and supplying students the opportunity to network with non-academics and conceptualize alternative career paths around which to build their skillset. In addition, within the past decade, major U.S. funding agencies have begun to require statements of broader impacts in grant proposals. Graduate training regarding the broader societal context of climate science would, thus, be a pragmatic educational addendum to assist young scientists in achieving these intended impacts.

There are key logistical hurtles to implementing these suggestions. While we recommend an influx of non-traditional expertise into our disciplinary education, it isn't immediately clear how to incentivize social scientists and experts from other fields to devote their efforts to climate science graduate education. Further, for a subset of students to work more directly with decision makers, such opportunities must exist. Funding, and institutional resources, must be allocated towards these ends. We do not claim to have solutions to these hurdles, as the distribution of limited resources should be based on the priorities of the national climate science community. We only attest to the eye-opening and transformative experience we had working in the policy-making realm, which recalibrated our understanding of the larger societal context in which we conduct climate-change research.

Closing remarks

The Paris Agreement negotiated during the 2015 United Nations Climate Change Conference (COP21) presents new hope for international action to mitigate anthropogenic climate change. Thus, it is a fitting moment for the climate science community at large to reflect on our role in informing the public. Working to bring useful scientific research into Washington State legislation gave us an appreciation for the practical challenges faced by our legislators as they wrestle with the future of our climate, ecosystems, and economy. This experience forced us to consider our own trajectories as climate scientists as well as our hopes as citizens. Repeatedly debating the appropriate role of scientists in the political process led to introspection that is uncommon in a traditional climate science education. In particular, we were reminded of the original motive driving many of us to pursue climate science: the opportunity to apply our research to a larger societal context and be part of a solution. Yet, we are not suggesting that all climate scientists should actively participate in policymaking or policy-relevant research. Although our experience was incredibly valuable to our own education, this type of opportunity is rare and might be less compelling to some. In addition, we are aware that our perspective regarding the obligations of the climate science community may not resonate with all of its members.

Our primary goal is to convey to other climate scientists that the research directives for the climate science community do not align well with the current information needs of broader society, creating a "climate information usability gap". A deliberate evolution in graduate training, which we hope would engage the greater climate science community in a dialogue regarding the goals of our research, is needed to address this gap. Without acknowledging the different information needs required for decision making outside of academia, our community is not fully participating in mitigating the current climate conundrum. As citizens, many climate scientists see that science alone is ineffective in achieving a rational societal response; however, as a community, we are making few discernible changes in our approach. Acknowledging that scientific evidence has not incited a satisfactory national or international response thus far, and due to the increasing urgency for action, we suggest a more interdisciplinary scientific approach from our community. By embracing research from fields outside our own, we can participate in a solution by more effectively informing decision making outside of the halls of academia.

References

Allen E, Kruger C, Leung F-Y, Stephens JC. 2013. Diverse Perceptions of Stakeholder Engagement within an Environmental Modeling Research Team. *Journal of Environmental Studies and Sciences* **3**(3): 343–356. doi: 10.1007/s13412-013-0136-x.

Azar C, Sterner T. 1996. Discounting and distributional considerations in the context of global warming. *Ecol Econ* **19**: 169–184. doi: 10.1016/0921-8009(96)00065-1.

Carson RT, Roth Tran B. 2009. Discounting behavior and environmental decisions. *Journal of Neuroscience Psychology and Economics* **2**(2): 112–130. doi: 10.1037/a0017685.

Deser C, Phillips AS, Alexander MA, Smoliak BV. 2014. Projecting North American climate over the next 50 years: Uncertainty due to internal variability. *J Clim* **27**: 2271–2296. doi: 10.1175/JCLI-D-13-00451.1.

DeLorme DE, Kidwell D, Hagen SC, Stephens SH. 2016. Developing and Managing Transdisciplinary and Transformative Research on the Coastal Dynamics of Sea Level Rise: Experiences and Lessons Learned. *Earth's Future*. doi: 10.1002/2015EF000346.

Ekroos J, Leventon J, Fischer J, Newig J, Smith HG. 2016. Embedding Evidence on Conservation Interventions Within a Context of Multilevel Governance. *Conserv Lett* (December): 1–7. doi: 10.1111/conl.12225.

Feldman DL, Ingram HM. 2009. Making science useful to decision makers: Climate forecasts, water management, and knowledge networks. *Weather Climate and Society* **1**(1): 9–21.

Hawkins E, Sutton R. 2009. The potential to narrow uncertainty in regional climate predictions. *B Am Meteorol Soc* **90**: 1095–1107. doi: 10.1175/2009BAMS2607.1.

IPCC. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.

Leidos. 2013. Evaluation of approaches to reduce greenhouse gas emissions in Washington State – Final Report. *Prepared for: State of Washington Climate Legislative and Executive Workgroup*. http://www.governor.wa.gov/boards-commissions/workgroups-and-task-forces/climate-legislative-and-executive-workgroup-clew.

Lemos MC, et al. 2012. Narrowing the climate information usability gap. *Nat Clim Change* **2**(11): 789–794. doi: 10.1038/nclimate1614.

Lind RC. 1995. Intergenerational equity, discounting, and the role of cost-benefit analysis in evaluating global climate policy. *Energ Policy* **23**: 379–389. doi: 10.1016/0301-4215(95)90162-Z.

Moss R, Schneider S. 2000. Uncertainties in the IPCC TAR: Recommendations to Lead Authors for More Consistent Assessment and Reporting. *Guidance Papers on the Cross Cutting Issues of the Third Assessment Report of the IPCC. Pachauri R, Taniguchi T, Tanaka K, eds*. Geneva, Switzerland: World Meteorological Society: pp. 33–51.

Ostrom E, Gardner R, Walker J. 1994. *Rules, Games, and Common-pool Resources*. Ann Arbor, MI: The University of Michigan Press.

Pidgeon N, Fischhoff B. 2011. The role of social and decision sciences in communicating uncertain climate risks. *Nat Clim Change* **1**(4): 35–41. doi: 10.1038/NCLIMATE1080.

Schneider S. 1983. CO_2, climate and society: A brief overview, in Chen S, Boulding E, and Schneider S, eds., *Social Science Research and Climate Change: An Interdisciplinary Appraisal*. Boston: D. Reidel: pp. 9–15.

Xie S-P, Deser C, Vecchi GA, Collins M, Delworth TL, et al. 2015. Towards predictive understanding of regional climate change. *Nat Clim Change* **5**(10): 921–930. doi: 10.1038/nclimate2689.

Contributions

- Contributed to conception and design: ERN, AJF, AEM, SMB
- Drafted and/or revised the article: ERN, AJF, AEM, SMB
- Approved the submitted version for publication: ERN, AJF, AEM, SMB

Acknowledgments

The authors would like to thank Terrie Klinger, Ryan Kelly, and Senator Kevin Ranker and his staff, for their valuable insights and additions.

Funding information

The authors would like to thank the UW IGERT Program on Ocean Change award #NSF1068839 for funding this work, and providing unique educational opportunities.

Competing interests

The authors have declared that no competing interests exist.