Inductive Risk, Deferred Decisions, and Climate Science Advising[1]

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Abstract
This chapter discusses the philosophical viability of Ottmar Edenhofer and Martin Kowarsch's proposed pragmatic-enlightened model of science advising. Edenhofer and Kowarsch's (2015) model makes central use of a cartographic metaphor—one in which scientists and policy-makers craft and consider different scientific routes to various value-laden ethical, political, and social destinations. But the argument from inductive risk poses a significant challenge to the viability of the metaphor, and hence, to the workability of the model.

Introduction
The argument from inductive risk (Rudner 1953; Douglas 2000, 2009) holds that scientists must set standards of evidence for inferential decisions in science according to the possible consequences of error—including both false positives and false negatives—at least in those cases where there are predictable social, political, or ethical consequences of such error. Another way to put this point is to say that scientific practice requires non-epistemic value-laden judgments even at those so-called "internal" stages of science traditionally considered clear of non-epistemic values. Evidence, logic, and epistemic values can tell us something about the strength of support for some claim, but they alone cannot compel a scientist to make the choice to assert, infer, accept, or endorse that claim.[2] Thus, according to the argument from inductive risk, the scientist *qua* scientist must make classically normative judgments.

One major line of response to this argument holds that, in these kinds of cases, scientists can (and ought to) defer value-laden decisions on standards of evidence, and thus whether to accept or reject hypotheses—by simply communicating the evidence plus its attendant probabilities and leaving it for others (such as policy-makers) to choose the "correct" evidential standards (see Jeffrey 1956; Mitchell 2004; Betz 2013). This *deferred-decision response* acknowledges the value-ladenness of decisions to accept or reject hypotheses (and other decisions), but attempts to take those value-laden decisions out of the hands of scientists. For reasons already articulated philosophically by Rudner (1953) and

[1] Authorship is joint; the authors are listed reverse-alphabetically.
[2] So long as the claim is a non-trivial, empirical claim that amounts to an ampliative inference.

expanded upon by Douglas (2009), this line of response to the argument fails. Very briefly, those reasons include: that the assertion of claims about "the evidence plus its attendant probabilities" is itself subject to inductive risk; that the evidence thus presented is the result of inductively risky processes of data collection, characterization, and aggregation; and that even if scientists attempt to arbitrarily defer certain inductively risky decisions toward the end of their assessments, these decisions are inevitably preceded by a series of other inductively risky decisions requiring non-epistemic value judgments. Scientific practice necessarily incorporates a complex series of judgments whose complete deferral is unattainable. Furthermore, the technical complexity of many of those decisions makes the elimination of expert judgment impractical and undesirable.

Despite these objections, the deferred-decision style response to the argument from inductive risk continually reappears in new proposals for models of science advising, including models that have recently been designed for and applied to the case of climate science. For instance: Roger Pielke, Jr.'s (2007) *honest broker of policy alternatives* and Edenhofer and Kowarsch's (2015) *pragmatic-enlightened model* (PEM) are two examples of newly proposed models of science-policy interaction, both of which are meant to reform climate science advising. Yet because these newly proposed models each presume that deferral of value-laden scientific decisions is a viable response, they both fail to appropriately accommodate the problem of inductive risk. These ideals adopt a posture of neutrality, but they must in practice present a narrow, greatly simplified space of options. The presentation of options under the guise of neutrality serves to obscure, rather than to highlight, the value-laden series of decisions that precedes the presentation of those same options.

In this chapter, we focus on the PEM. This model is especially worthy of philosophical scrutiny because of its practical application: it was designed by the leaders of, and has been at least partially put into practice by, Working Group III (WGIII) of the Intergovernmental Panel on Climate Change (IPCC). The focus of WGIII of the IPCC is on mitigating the effects of climate change—an area where the likely social consequences of judgments of inductive risk are particularly salient. Most notably, the designers of the PEM seem to accept most of the inductive risk argument for the value-ladenness of science; but their response to this argument makes the same mistaken appeal to deferral of value-laden decisions as have so many others before it.

In what follows, we provide an initial sketch of the PEM. Then we demonstrate how—although the PEM improves on traditional models of science advising, such as the linear model and that of evidence-based policy—it unfortunately incorporates the untenable deferred-decision response to the argument from inductive risk. We thus argue that the PEM does not adequately model how to integrate non-epistemic values with climate science and policy. Next we suggest amendments to the PEM, in order that it might truly meet the challenges of the argument from inductive risk, and begin to comprehensively confront the value-ladenness of climate science. We conclude by summarizing our critique as well as the ongoing value of the PEM, and in closing we assess the ongoing popularity of deferred-decision style responses to the argument from inductive risk—cautioning against further pursuit of this style of response.

The Pragmatic-Enlightened Model (PEM)

The PEM was recently proposed (in 2012) by Ottmar Edenhofer, director of WGIII of the IPCC, and Martin Kowarsch, head of the working group on Scientific Assessments, Ethics, and Public Policy at the Mercator Research Institute on Global Commons and Climate Change.[3] Edenhofer and Kowarsch's "pragmatic-enlightened" model attempts to carve out a conceptual space for scientific results that is objective yet value-laden, while remaining true to the IPCC's commitment to providing science advice that is "policy-relevant and yet policy-neutral, never policy-prescriptive."[4] This commitment of the IPCC—to providing neutral and relevant but not prescriptive advice on climate policy—is a central one, and it's one that was negotiated quite early in the development of the organization's mission.[5]

It's also a commitment that's particularly hard to satisfy, given the argument from inductive risk.[6] Inquirers always need some kind of practical reason to accept a certain level of evidential support as sufficient. Purportedly neutral attempts remain value-laden; it's just that the values involved are unsuitably veiled or implicit, rather than properly reflective and explicit.[7] This consequence of the argument from inductive risk is why it poses such a powerful challenge to the value-free ideal—an ideal that, for better or for worse, has historically characterized and continues to characterize so much of the scientific ethos.

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[3] As far as we know, the PEM was first sketched by Edenhofer & Kowarsch in a working paper from 2012, called "A Pragmatist Conception of Scientific Policy Advice." An updated version of the model was recently published, in 2015, in a paper titled "Cartography of Pathways: A New Model for Environmental Policy Assessments." Ongoing references to the PEM will be to the model presented in the published version of the paper.

[4] Quoted from: https://www.ipcc.ch/organization/organization.shtml

[5] For more on the *negotiation* of the IPCC's commitment to relevant yet neutral, non-prescriptive climate policy, please see Brown and Havstad, "The Disconnect Problem, Scientific Authority, and Climate Policy" (2017).

[6] For more on the *meaning* of the IPCC's commitment to relevant yet neutral, non-prescriptive climate policy, please see Havstad and Brown, "Neutrality, Relevance, Prescription, and the IPCC" (forthcoming in *Public Affairs Quarterly*).

[7] This is not a causal-explanatory claim, what Daniel Steel describes as the "descriptive interpretation" of the argument from inductive risk (Steel, forthcoming). Rather, even if no conscious or unconscious value judgment guides the decision, there is always a practical decision to accept a certain amount or type of evidential as sufficient, and as such the decision implies a practical reason (value). In this sense, all decisions subject to the *normative* argument from inductive risk are, as a matter of descriptive fact, value-laden.

Though the norms of objectivity, neutrality, and the value-free ideal may effectively guard against bias and corruption in many parts of science, as the argument from inductive risk shows, these norms may actually be hiding bias and encouraging illicit importation of values.[8] This is because the value judgments are essential to the scientific practice, yet when they're made they're hidden, in a mistaken effort to maintain the appearance of allegiance to the value-free ideal, or implicit, in a heads-in-the-sand way. In a sense, the deep challenge of the argument from inductive risk is to appreciate what the norms of objectivity, neutrality, and the value-free ideal have done for science while simultaneously constructing a method for functioning without them in cases where they simply cannot apply—like those cases covered by the argument from inductive risk.[9]

This is the challenge faced by Edenhofer and Kowarsch (hereafter E&K) in their attempt to (on the one hand) create a model of climate science advising that produces relevant but neutral, non-prescriptive policy advice, while they also (on the other hand) acknowledge that the argument from inductive risk forcefully applies in this arena. As they do much to try and meet this bivalent challenge, there is much to like in E&K's model.

On the latter hand, E&K seem to unreservedly admit that scientific knowledge is thoroughly value-laden. This admission is expressed in at least three distinct ways. First: the designers of the PEM cite a variety of approaches from the philosophy of science to confronting the value-ladenness of science—including Douglas' inductive risk approach and Putnam's "thick ethical concepts" approach (E&K 2015, 57). E&K especially seem to fully accept what Putnam (2002) calls "the entanglement of fact and value" (E&K 2015, 59). Second: E&K espouse a thoroughgoing pragmatism, and their model relies heavily on not just the neo-pragmatist philosophy of Putnam, but also on the classical American pragmatism of John Dewey (E&K 2015, 58). Third, and perhaps most radically: in a truly Deweyan vein, E&K insist on significant stakeholder engagement as part of the scientific process (E&K 2015, 61).

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[8] Douglas (2000, 577–8) divides science into four areas: (1) where there is low uncertainty, or chance of error; (2) where making a wrong choice, or erring, has no real impact outside of research; (3) where the science will likely be useful, but non-epistemic consequences of error are hard to predict; and (4) where there are predictable non-epistemic consequences of error. In the first two areas, the argument from inductive risk is not a salient consideration, and scientists generally will not need to consider non-epistemic values. In the third area, the argument from inductive risk is likewise not so salient, as the scientists cannot make value judgments about consequences they cannot reasonably foresee. This is a so-called "gray-area," and in this area the matter will have to be decided on a case-by-case basis. (Such situations do suggest the need for scientists to develop their moral imagination as far as reasonably possible). In the fourth area non-epistemic values are, Douglas argues, a necessary part of scientific reasoning.

[9] This challenge is taken up by Douglas in "The Irreducible Complexity of Objectivity" (2004) and in her *Science, Policy, and the Value-Free Ideal* (2009), especially chapter 6.

Elaborating on the second point: advocates of the inductive risk argument against the ideal of value-free science are generally committed to a very basic form of pragmatism, insofar as they deny that one can always and completely separate thought and action. In other words, adherents of the argument are at least in some form committed to rejecting the claim that one can, in general and correctly, evaluate beliefs or decide whether to accept, infer, assert, or endorse a hypothesis without taking into account the implications of that belief or hypothesis for decision-making and behavior. But E&K do not merely make this broad and vague commitment to pragmatism. Rather, E&K go much further and commit themselves to a fully pragmatist, Deweyan theory of inquiry.[10]

For E&K's purposes, the key points of the Deweyan theory are that: (a) inquiry is a means of resolving problematic situations; (b) the evaluation of a hypothesis is primarily done in terms of its practical problem-solving success (potential and then actual); (c) the results of inquiry are monitored and judged after the fact, in their implementation; and (d) the entire collection of practical objectives (both those whose problematic execution spurred inquiry in the first place, as well as any standing objectives incidentally affected by proposed hypotheses) are to be considered as inputs to, and evaluated for their validity, in the process of inquiry.[11]

E&K furthermore subscribe to the pragmatist meta-ethical commitment of the "interdependency of objectives and means" (2015, 58), articulated by Dewey and others as the "continuum of ends-means" (Dewey 1939; Waks 1999; Anderson 2014). On this view, there are no *a priori,* self-justifying, ends-in-themselves. Rather, we find ourselves in our activities with certain ends-in-view—themselves actual or potential means to further ends—as well as with ideas about the means to those ends. As inquiry is spurred by problems, in trying to reach those ends, not only the means but the ends too may themselves be revised. As a result and on this view, in the course of policy-relevant scientific inquiry many components of the processes—facts, data, hypotheses, plans, policies, values, goals, etc.—are all put up for grabs.[12]

Finally, with respect to the third point: the PEM commits itself to significant stakeholder participation not just at the very end of the pipeline, when it comes time to evaluate policy proposals, but at every stage of the inquiry—including the definition of the problem requiring scientific analysis and policy amelioration. This accords well with Deweyan conceptions of democracy as well as with Douglas'

[10] Elaborated on page 58 of E&K (2015).

[11] For more on Dewey's theory of inquiry, see Hickman (2007), Dorstewitz (2011), and Brown (2012).

[12] To use E&K's cartographic metaphor: when the map doesn't help us navigate where we want to go, it is not only our choice of map but also our choice of destination that is up for grabs, depending on further facts of our situation. More on E&K's cartographic metaphor very shortly.

(2009) insistence on a democratic analytic-deliberative process for policy-relevant science.

And yet, in the former hand lies the fundamental tool of the PEM—E&K's response to the other half of the bivalent challenge. This is where E&K's models differs from generally pragmatist models and standard inductive risk accounts: in the idea of "mapping out" a set of alternative, scientifically viable "policy pathways" that scientists, policy-makers, and stakeholders can then consider and adjudicate among (E&K 2015, 60).[13] These pathways are to be built by combining and mutually revising scientific evidence in concert with various policy means, objectives, and value judgments into potential policy solutions (E&K 2015, 60–1). Furthermore, once policies are implemented, the PEM requires that their consequences be carefully monitored, and the cartography of policy pathways re-applied, based on the analysis of those consequences (E&K 2015, 61 and 63). So these alternative policy pathways are also intended to respect the interdependency of objectives and means—and thus they are meant to include not only policies, along with the relevant scientific information, but also the objectives associated with those policies, and the expected (social) consequences of the implementation of those polices. In other words, the pathways incorporate value judgments both in the sense of policy goals and side-constraints on acceptable science and policy.

For instance: E&K are fundamentally concerned, as we are, with the development of viable policy pathways for addressing the problem of global climate change. They instantiate their theoretical model of pathway-creation with a proposal for climate science advising that imagines the "differential costs, risks, climate impacts as well as co-effects" (E&K 2015, 62) that might be associated with a 1.5°C, 2°C, or 3.5°C rise in global temperature. Considering different temperature outcomes gets assessment going down several different pathways. Considering not just impacts but also costs, risks, and co-effects ensures that assessment combines scientific predictions with predictions about the social, political, and ethical implications of going down particular pathways. And finally, considering the consequences of taking various pathways requires monitoring, revision, and adjustment. E&K are quite clear on this last point: "Mapping policy pathways in assessments is an iterative exercise that frequently requires adjustment if new forks in the road, alternative destinations, pitfalls and uncharted territories turn up" (2015, 63). More on E&K's proposed instantiation of the PEM in the case of global climate science and policy follows in the next section.

But returning now to their theoretical apparatus: providing a range of options is supposedly pragmatic; allowing stakeholders, etc. to choose among these options is meant to be democratic. The role of values in science is purportedly

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[13] Note the cartographic terminology. E&K speak, throughout their (2015) paper, of mapping, pathways, routes, and the like. Much of the intuitive appeal of the PEM lies in the suggestive force of this metaphor. As such, we will employ and extend E&K's cartographic metaphor in our own critique of the model (developed in the next section).

respected, but those doing the scientific advising on policy alternatives need not commit themselves to or apply controversial values; rather, those advising with respect to science and policy merely provide alternative assessments, taking various alternative values into account, and others more appropriately positioned to choose amongst the candidate value-laden options can then do so. The cartography of policy pathways putatively avoids the problem that Pielke (2007) refers to as "stealth issue advocacy"—by offering a variety of options—while simultaneously incorporating a more realistic and normatively adequate account of the role of values in science than does Pielke's own model of the *honest broker of policy alternatives* (at least according to E&K 2015, 57). To be clear, each "pathway" is supposed to instantiate responsible, value-laden science in the sense the inductive risk argument demands; the PEM's novelty comes in providing a range of different policy pathways, given different possible objectives and values, and deferring the decision between them to the policy-makers.

We hypothesize that the creation of this value-incorporated cartography of alternative policy-pathways is E&K's way of attempting to accommodate the argument from inductive risk while simultaneously following the IPCC's mandate to adopt a model of climate science advising that produces relevant but neutral, non-prescriptive policy advice. In order to avoid the charge of policy prescriptiveness, and retain the IPCC's stated aim of policy neutrality, the PEM recommends charting a variety of alternative policy pathways. The role of values in assessment of policy alternatives is admitted by the PEM—but where values are controversial, the model requires building in alternative pathways according to alternative sets of values. This is where the deferred-decision response to the argument from inductive risk kicks in; it is also where the PEM falters.

The Impossibility of Deferring Value-Laden Decisions

On the face of it, the PEM offers a happy compromise: values are incorporated into climate science advising; yet it's not the (unelected, unrepresentative) scientists who are making the non-epistemic value judgments. The scientist-advisers are merely offering a selection of value-incorporated scenarios for those (elected, appointed) public representatives who can properly choose among the attendant values to do so, and in an informed way that guides policy-making according to which non-epistemic values are the chosen ones and in combination with the relevant scientific facts.

But the PEM fails, in philosophical and practical terms, in both its attempts—to avoid policy prescription and to respect the role of non-epistemic values in those scientific cases where the argument from inductive risk applies. In philosophical terms, the nature of this joint failure is best understood in terms of the inductive risk argument and the relationship it reveals between uncertainty, choice, consequences, responsibilities, and normative value judgments.

The inductive risk argument relies on the endemic and pervasive uncertainties in science to show the need for non-epistemic value judgments throughout the course of scientific research. The fundamental requirements of empirical adequacy and logical consistency alone cannot compel scientists to do things one way rather than another—to choose this over that methodology, this characterization of ambiguous data over that, this or that conceptual framework, a higher or lower standard of evidence, etc. Rather, the scientific process involves a series of unforced choices which lead to results that, while significantly constrained by logic and evidence, are still highly contingent on the set of prior choices made. Such choices often incorporate, either directly or indirectly, non-epistemic as well as epistemic value judgments.

As the last half-century or more of philosophy of science has shown, these value-laden choices are generally made on the basis of a mix of background assumptions, methodological conventions, tacit knowledge, research tradition, etc., but they are nonetheless choices, in the most basic sense, that could be made differently than they are.[14] While many proponents and detractors of the inductive risk argument focus only on the final choice in the course of a scientific inquiry—that of accepting, believing, or certifying a hypothesis or theory on the basis of the evidence available—in fact, scientific inquiry consists in a cascading series of such value-laden choices.

The import of the argument from inductive risk is often limited: sometimes uncertainty is so low that the chance of error is vanishingly small; sometimes the chance of error is socially negligible because the relevant science has no ethically salient aspects; and sometimes the socially significant consequences of error simply cannot be anticipated (Douglas 2000, 577–8). But in those cases of significant uncertainty where readily foreseeable social consequences will pertinently follow from those innumerable value-laden choices made throughout the scientific process, the argument from inductive risk does have significant import for the choices made throughout the process.

Climate science is obviously a case in point: there is significant uncertainty, especially with respect to the upcoming effects of anthropogenic global climate change; it is undeniable that some of these upcoming effects will have social consequences; and some of these looming social consequences are readily foreseeable. As a result, the choices made by climate scientists (and climate science advisors) throughout the scientific (and political) processes are covered by the argument from inductive risk.

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[14] Notably, researchers may often not see themselves as choice-makers. They can, however, be made to recognize this feature of their work, and this awareness can improve the social and ethical responsibility of the science in question. Erik Fisher's program of *Socio-Technical Integration Research* (STIR) consists in a process he calls "midstream modulation" aimed at doing just that—raising consciousness among scientists of their role as socially responsible choice-makers (Fisher et al 2006; Fisher 2007; Fisher and Schuurbiers 2013).

One of the premises of the argument is that "scientists have the same moral responsibilities as the rest of us" (Douglas 2000, 563). The argument (elaborated in Douglas 2009) reminds us that scientists are also moral agents—they don't shed their ordinary moral responsibilities when they step into the lab, the field, or the conference room. Insofar as climate scientists make choices, and the social consequences of those choices are reasonably foreseeable, climate scientists have a responsibility to weigh those consequences when making their choices, lest they be morally negligent.[15] And this process of weighing social consequences is just what making a value judgment consists in.[16]

Putting these points together—points about the integration of choice throughout the scientific process, the kinds of cases where the argument from inductive risk applies, the obvious fact that climate science is one of these cases, and the presumption that scientists are not excused from their normal moral responsibilities simply because they are scientists—raises a philosophical problem for the PEM. E&K seem to think that scientific advisors can and should defer their value-laden decisions throughout the scientific and advisory processes relating to anthropogenic global climate change; but this is impossible. Such decisions are inexorably laced throughout the relevant processes, and it does a disservice to scientific practitioners and practice alike to pretend that such decisions neither can nor should be made.

In practical terms, although E&K pay lip service to the philosophical point that scientific work is thoroughly value-laden, they are much less precise when it comes to how making such value judgments actually works in science. This lack of precision becomes a significant problem when they get down to the dirty work of constructing the alternative policy pathways that the PEM is supposed to offer. Consider E&K's set of three potential climate policy pathways, which happen to correlate with the aforementioned trio of potential raises in global temperature:

[15] This holds only, of course, when the choice is genuine and unforced. Insofar as evidence and logic constrain a scientific (or other kind of) choice, weighing consequences of the (forced) choice is just to fall into wishful thinking or outright deception.

[16] We prefer to read social "consequences" here in a maximally broad way, as there are competing value systems on offer, and utilitarianism is certainly not the only option—it is not the case that all the candidate options are broadly consequentialist, even. On such a broad reading of the term, even something like violating a person's rights counts as a negative social "consequence."

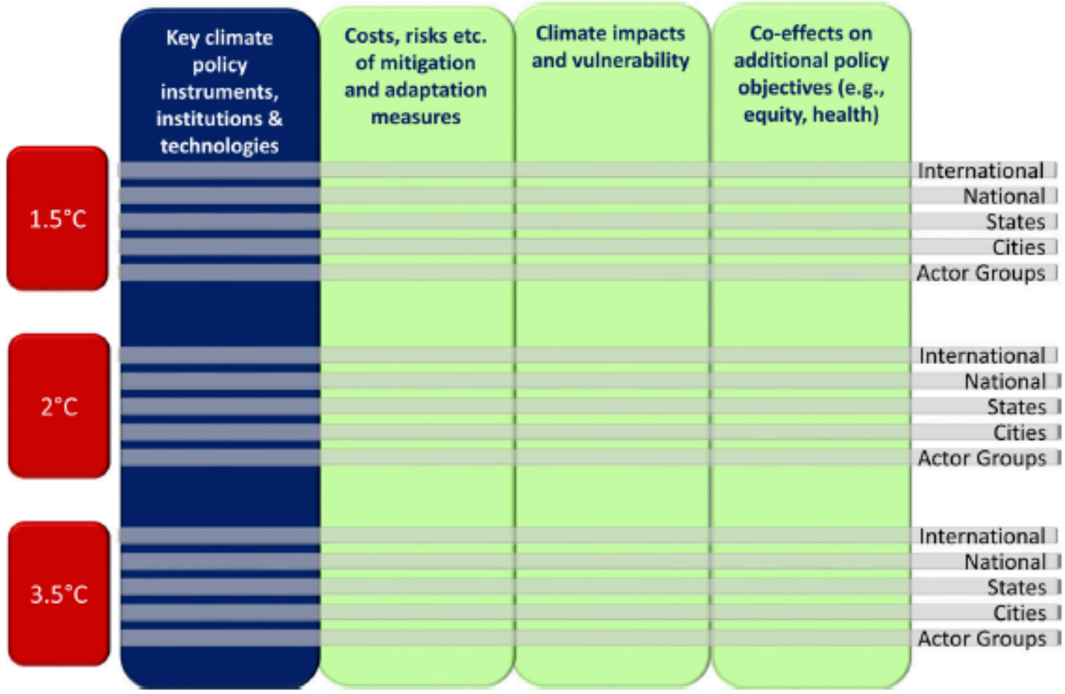

Figure 1: A reproduction of E&K's Figure 3 "Potential key dimensions of future IPCC WG III assessments" (2015, 62). In addition to demarcating three potential temperature outcomes, E&K also identify four different "assessment dimensions" and delineate five groups of affected parties for each outcome. Reproduced by permission.

Offering this set of three potential climate policy pathways presents the role of values in climate science as somehow limited to the question of which of these three global temperature change outcomes scientists ought to consider when assessing climate research and designing policy responses. It also raises more questions than it answers—about how E&K or anyone else could determine who might be affected by such global temperature changes, and how. It is unclear why E&K identify the assessment dimensions that they do, and whether the potentially affected parties ought to be demarcated as E&K have done so here. Yet what should be clear is that, in considering possible temperature outcomes as well as assessment dimensions and groups of affected parties, scientists don't just face just one or even a small number of choices. Instead—as E&K themselves at times admit, and as we stressed during our philosophical critique of the "cartographic" aspect of the PEM—scientists face a complex series of amplifying and interrelated choices with respect to everything from what the potential temperature outcomes are to who ought to be grouped together as affected by such outcomes.

This problem of choice amplification and interrelation is masked by the fact that E&K discuss these policy pathways, based in varying long-term global temperature rise targets, in only the most general and abstract of terms, rather than delving into the concrete details of these choices. The climate projections that form these pathways are based in enormously complex computer models, both climate models and "integrated assessment models" (IAMs) (which include not only physical processes, but model technical and human systems and impacts, see IPCC 2014, 51). As Eric Winsberg (2012) points out, "climate modeling involves literally thousands of unforced methodological choices" (130), a result of the fact that such models are highly idealized and incredibly complex, and doubly so when we consider IAMs that include human factors like economic systems and agricultural development. Such choices might include decisions about different possible parameterizations and model structures, particular parameter values, choice between different approximation methods, decisions about which climate forcings to include in the model or exclude as insignificant or approximate with a simple parameter, choice of higher or lower model resolution (or grid size), decisions about aggregating ensembles of models, and so on.

By unmasking the complexities of climate change modeling, and combining these complexities with the unresolved issues of outcome and assessment demarcation, it becomes easy to see that E&K's "cartographic" project quickly runs into a multiplying effect. For every new climate modeling choice—how to model cloud formation, say, or the effect of melting sea ice[17]—there are multiple options, multiple ethical and political considerations relevant to those options, multiple dimensions of uncertainty about just what the consequences will be, multiple ways of grouping sets of such consequences according to different dimensions, multiple ways of considering who will be affected by such consequences, and so on. By carefully considering what it means to really get into these permutations, we can see just how flawed the cartographic project actually is.

Applying and extending E&K's own metaphor: it is not as though there are only three routes up, say, Mount Everest.[18] Rather, there are many potential routes that any given climber can take—perhaps a handful of well-supported ones—and on any given day—depending on the season, the weather, how many people are going up the route, how skilled the guides are, how much and what kinds of assistance the climber accepts, and many more (some unknown) variables—the "route" taken might have a wildly variable chance of successfully getting the climber up the mountain, and may or may not be "safe."

So what does the "map" look like now? Instead of three neat "pathways," there are dozens, each with different degrees of solidity, each "route" with different chances of leading to multiple "destinations." And if there are any outcomes that the climber absolutely wants to avoid (say, death while attempting to summit) or the climber absolutely insists must result (say, making the summit), then this is drastically going to affect the selection of potential routes genuinely available to the

[17] See Biddle and Winsberg (2010) and Winsberg (2012).
[18] Also known as Sagarmāthā (in Nepal) or Chomolungma (in Tibet).

climber, and the risk that they're willing to assume—of false negatives or false positives—with respect to the likelihood of those outcomes as projected by their "pathways."

Now reconsider the main application of the PEM that E&K pursue. Our figure 1 (their figure 3) represents E&K's attempt to apply the PEM to the case of climate science advising—specifically, to their work on potential mitigation of the effects of global climate change, via policy recommendation by WGIII in the current cycle of IPCC reports (AR5).[19] As shown in the figure, and discussed above, E&K have chosen to consider three possible mitigation targets in terms of global temperature rise (1.5°C, 2°C, and 3.5°C). But of course there are more than three potential outcomes, even using global temperature change as the only relevant dimension. There is a gradual range of possibilities here: global temperature alone could change by anything between a reasonable lower bound (considering mitigation alone, probably not 0°C, at this point) to some unknown but large upper bound. In the Synthesis Report for the previous IPCC cycle (AR4), for instance, six different potential temperature outcomes were considered, given in ranges (2.0–2.4°C, 2.4–2.8°C, 2.8–3.2°C, 3.2–4.0°C, 4.0–4.9°C, and 4.9–6.1°C).[20] So, why do E&K think their three potential outcomes are the relevant ones for WGIII in this IPCC cycle (AR5)? Furthermore, why consider global temperature change as the relevant dimension at all? (More on that latter question in the next, penultimate section).

Perhaps it is unfair to pick on E&K for suggesting policy pathways associated with just these three targets for global temperature rise. After all, E&K are simply trying to give us a sense of how the assessment process would work according to the PEM. Actual application would involve a more complicated picture. But it is precisely what happens when we move from E&K's vaguely specified example of three temperature targets to a more realistic picture that shows how the PEM is unworkable. The increasing complexity, and the associated value-relevance of each decision, show that crafting alternative policy pathways that defer all significant value judgments to policy-makers is either unworkable, because of the problem of the multiplying effect, or a wretched subterfuge, because the vast majority of relevant value judgments have been made prior to presenting a small number of policy pathways to decision-makers. The overwhelming variety and particularity of the value judgments that must be made in the course of this

[19] In their contribution to the IPCC's Fifth Assessment Report (AR5), WGIII's mission is rather narrowly defined as providing "a comprehensive and transparent assessment of relevant options for mitigating climate change through limiting or preventing greenhouse gas (GHG) emissions, as well as activities that reduce their concentrations in the atmosphere" (IPCC 2014, vii).

[20] See Table 5.1 in the Synthesis Report (IPCC 2007, 67) from the IPCC's Fourth Assessment Report (AR4).

kind of inquiry makes the PEM unworkable in the case of climate change and, we suspect, in many other important environmental assessment situations.

To demonstrate this point, let's pretend that E&K's three temperature-based target outcomes are the obvious and only relevant ones. For each of these three potential results, E&K present four kinds of factors ("assessment dimensions") that are relevant sources of scientific information for each target: (i) available policy instruments, institutions, and technologies; (ii) costs and risks of mitigation and adaptation policy options; (iii) climate impacts and vulnerabilities; and (iv) what E&K call co-effects on additional policy objectives, which we can think of as side effects or social consequences of climate policy measures not directly related to climate or environment. Even presuming that these four are the only candidate sources of relevant scientific information, what the philosophical critique of the PEM reminds us is that, for each of these four factors, there are presumably dozens if not hundreds of key value-laden choices to be made. Even imagining that there are only something like ten such choices for each of the four streams of scientific information, and given that E&K also identify five groups (once again, a likely underestimate) of stakeholders (international; national; states; cities; actor groups) for whom relevant consequences and values must be chosen, those "low" numbers result in at least (4 x 10 x 5 =) 200 permutations of the relevant choices or considerations per each of the three "cartographic" options. That's 600 potential "routes"—and we know that this is an underestimate along every relevant dimension.

E&K tell us that "the PEM-guided cartography of the political solution space is clearly an immense and time-consuming effort" (2015, 63), but the situation is far worse than that. It is an impossible fiction.

Amending the PEM

E&K as much as recognize the failure of their "cartographic" model, in their own presentation of the PEM, when they talk about narrowing the selection of policy pathways:

> …the scope of possible future pathway analyses has to be narrowed down because of the vast range of environmental policy pathways and related consequences and the limited resources available for assessment processes. However, there is a danger of being biased in this selection of pathways… (2015, 60)

This "narrowing down" is how E&K keep the PEM from recommending that the IPCC's WGIII adopt the absurd position of "mapping" 600 or more potential "pathways." But it also transforms E&K's valiant effort to meet the bivalent challenge—of combining the IPCC's mandate of policy-neutrality with genuine accommodation of the argument from inductive risk—into a failure on both counts. While the narrowing down process is still supposed to result in options that "reflect several politically important and disputed objectives, ethical values and prevalent policy narratives" (E&K 2015, 60), there is no plausible account of the "narrowing down" process that avoids making any non-epistemic, policy-prescriptive value judgments. Neither has the argument from inductive risk been properly accommodated, since the process makes non-epistemic, policy-prescriptive value judgments in such a disguised, implicit, and unreflective way.

All is not lost, however. The means to amend the PEM are suggested by E&K's own presentation of the pragmatist principles behind the design of their model. Recall our discussion of E&K's commitment to the notion that science is thoroughly value-laden—especially, the third way in which E&K expressed this commitment. Taking seriously the Deweyan idea of the continuum of means-ends, E&K purportedly designed the PEM with significant stakeholder participation in mind: not just at the very end of the pipeline, when it comes time to evaluate policy proposals, but at every stage of the inquiry. According to E&K's own presentation of the overall process and their discussion of what should ideally occur, stakeholders and policy-makers ought to be involved in, for instance, the process of selecting alternatives to narrow down the list of possible pathways. We suggest that actually implementing stakeholder participation at this and all other stages of the process of climate science and policy advising is the crucial factor that can rescue the PEM—although this implementation will result in significant attendant amendments to E&K's model as presented.

What would such a stakeholder-engaged process look like? Again, consider a figure from E&K's own work:

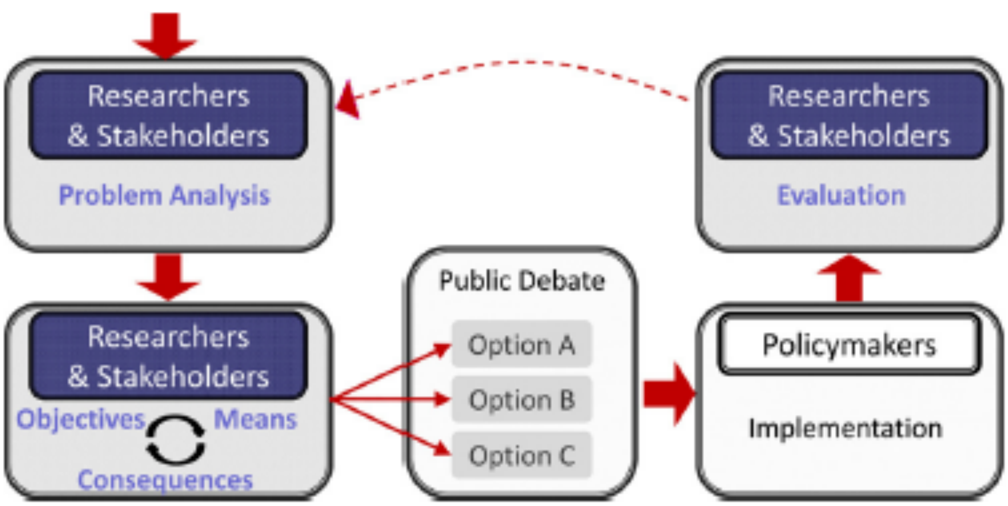

Figure 2: A reproduction of E&K's Figure 2 "The PEM model" (2015, 61). Reproduced by permission.

In the figure, both researchers and stakeholders are present at the initial stage in the process, that of problem analysis (upper-left box). In the caption to the figure, E&K attempt to add depth to the process depicted:

> The PEM as a model for solution-oriented assessments suggests that after researchers and stakeholders have jointly framed the problem, they explore the objectives, means and consequences. The two white boxes indicate steps in the policy process that are outside the assessment-process per se, such as public debate on alternative policy pathways, as well as policy decisions and implementation by policymakers. Next, there is a scientific ex-post evaluation of the actual means-consequences, which is also the starting point for a new assessment cycle. (2015, 61)

Although researchers and stakeholders are identified as working together in many aspects of the process as E&K have depicted and described it, it is less clear how they are meant to work together and what such an engaged process would look like, post-engagement. Neither the simplistic flow of this diagram, nor the blithely optimistic caption really takes into account what genuine stakeholder involvement at this and other parts of the process might entail or produce.

For one, it seems naïve to presume that stakeholders will likely think that the relevant outcomes of global climate change will come in a set of three distinct options—particularly, options having to do with a 1.5°C, 2°C, or 3.5°C increase in global temperature. Those are relative measurements that are, presumably, loosely and uncertainly correlated with a set of actual phenomena that stakeholders are much more likely to care directly about—such as loss of coastal property value due to rising sea levels, increased chance of tropical storms, rising fuel prices, constraints on energy use for personal consumption and economic development, higher food costs, national and international instability, loss of environmental resources and diminished biodiversity, etc. Some of these phenomena may be inexorably incurred by certain global temperature changes; others may be individually mitigated despite the overall temperature change occurring; still others may be more or less readily adapted to. Because these phenomena can come apart from one another and from overall changes in global temperature, it seems highly unlikely that stakeholders (or anyone, really) would want to only, or even primarily, pursue unequivocal policy solutions—solutions which respond merely to the relative measure as opposed to the many diverse effects of the comprehensive phenomenon of global climate change. E&K's choice of outcomes seems motivated by technical features of the modeling process rather than genuine value judgment or stakeholder interest.

For another, it's not just the contents of any one box that are up for grabs—rather, it's the shape of the whole diagram. Commitment to genuine, integrated stakeholder participation ought to call into question any presuppositions with respect to what the shape of the relevant inquiry will look like. Stakeholders should be involved in a discussion of the process in which they will participate; stakeholder participation should be expected to change the shape of the process as it goes. It's unclear why E&K think they know what the process will look like, before any substantive incorporation of stakeholder participation. Conceivably, stakeholder participation might call into question the notion that policy implementation really is “outside the assessment-process per se” or that satisfactory problem analysis in terms of large-scale global climate change could really occur entirely prior to evaluation of local efforts to craft and implement successful small-scale and context-specific mitigation or adaptation strategies.

Or, stakeholder participation might undermine the presupposition that public debate with respect to properly narrowed down cartographic options ought to occur only at one, intermediate stage in the process of inquiry. Especially taking into account the inductive risk argument and the deeply pragmatist commitments of the PEM, the way that E&K focus their model on producing multiple policy options at one particular stage seems unprincipled and arbitrary. Why are only these options subject to public debate? Perhaps stakeholder participation will reveal that the really crucial value judgments and choices, from the public’s point of view, are ones that play a role much earlier in the process—in the problem analysis, or data characterization, or narrowing of options. Having admitted that it is not possible to fully defer the decisions about value judgments and incorporate all controversial value-laden questions into pathways in the cartographic project, the solitary placement of three policy options for public debate at the center of the process seems to be a rather haphazard result, and one that is unlikely to survive significant stakeholder involvement.

The need for stakeholder involvement raises crucial practical questions about what stakeholder engagement processes would look like. Detailed discussion of such processes is beyond the scope of the present essay, and while E&K emphasize the importance of stakeholder engagement, they likewise are unable to provide details about how such engagements would work.[21] There is, however, a rich and developing literature on public and stakeholder engagement and participation in science and science-based policy, which offers many proposals and raises many problems (see Stern and Fineberg 1996; Douglas 2005; M.B. Brown 2009, Chs. 9-10; Douglas 2009, Ch. 8; Elliott 2011, Ch. 5; M.J. Brown 2013). What is most relevant to our discussion is not the particular form of the public and stakeholder engagement *process*, but rather the *role* that engagement plays in the scientific inquiry and assessment. Namely, the public and stakeholders must be the ultimate source of the objectives, outcomes, and values that must guide the process. Because of the complexities of the process, a variety of appropriate processes may be expected to play a role—some more direct, others more representative, some more and less deliberative, etc. We suspect any guidance here to be fairly context-dependent. Certainly, as Douglas (2003) argues, scientists will often have to face the burden of making value judgments themselves, as they are the only ones with the technical competencies to do so. Stakeholder engagement in some broad sense is necessary for the legitimacy of those

[21] E&K also acknowledge that such a discussion is important, but they punt for lack of space. They do refer to the fact that “the IPCC WG III conducted an interesting multi-stakeholder meeting” in Washington, DC in 2012 (E&K 2015, 62).

judgments, but scientists cannot avoid the burden of judgment—the decision cannot be deferred.

In sum: we encourage E&K to revisit what is entailed by their commitment to the utterly value-laden, deeply pragmatist, and stakeholder-enriched consequences of the argument from inductive risk. Is it really possible to narrow down a range of possible "pathways" without making non-epistemic value-laden judgments? Can even just the proper dimension on which to represent possible outcomes be determined without a thoroughly pragmatist interrogation of not only the ends-in-view but also the interdependency of means with these ends? Would most stakeholders even want non-prescriptive recommendations of policy?

We think that the answer to each of these three questions is likely no. But even if we're wrong about that, anyone committed to the value-ladenness of science, the properly pragmatist nature of inquiry, and the necessity of stakeholder involvement is also committed to the importance of asking these questions and not presuming to know the answers for certain before acquiring sufficient data to resolve the inquiry. In short, we're asking for stakeholder participation to begin in earnest—in order to address the comprehensively value-laden nature of climate science, and with the possibility open of needing to revise expectations about how the process of climate science advising is going to proceed once stakeholder participation begins.

Concluding Remarks

Despite our objections to the deferred-decision style response to the argument from inductive risk, we think that E&K's PEM can still be a valuable tool. But this, we have argued, requires initiating stakeholder participation.

In the case of climate science advising, this correspondingly entails a shift in focus: from thinking of IPCC reports as a finished product to thinking of these reports as intermediate stages in an ongoing process of science-informed policymaking. In general, if science advisors are going to be consulting regularly with stakeholders and policy-makers in the course of their assessment process (because they will need to be considering values and re-evaluating policy objectives in the course of this assessment process), then they will also require some mode of communication about the options in place. Far from trying to represent a choice between finished "policy pathways," the PEM could be used to represent the likely consequences for various choices in the middle of the assessment process. Stakeholder input and political discourse could help decide the best among those options, and the process could be iterated again with the next set of key choices.

But this alteration in thinking requires a parallel adjustment to the PEM. Even though E&K claim to think of the relationship between assessment and policy as part of an iterative feedback loop, their purportedly pragmatist model still contains a remnant of the old decisionist approach. On the decisionist model, assessment does its job, hands over the information to the policy-makers, policy-makers decide based on policy objectives and public values, and finally the chosen policy is implemented. By thinking of the map of policy pathways as the end result of the scientific assessment process, the PEM fails to integrate science and policymaking to the degree necessary to make dynamic, scientifically-informed policy choices in response to these problems. Yet as E&K themselves admit, the process requires constant feedback and only comes to a close when a policy is implemented and found, by subsequent monitoring, to be a stable solution to the particular problem it was put in place to resolve.

Finally, our critique of the PEM implies that an adjustment to the archetypal distinction between scientific experts and legislative policy-makers is also required. E&K themselves call for "cooperative knowledge production and a role for mutual learning between experts and decision-makers in environmental policy" (2015, 57). But our discussion has shown that science advisors are decision-makers, too, and as such are at least somewhat responsible to the public. Likewise, policy-makers are (or ought to be) conceived of as experts in their own field—in the field of responding to public concern and of putting in place regulations, laws, institutions, and so forth to resolve those concerns. While scientists and policy-makers are used to thinking differently about their responsibilities and working at different time scales, they need to learn to work according to a model of interdisciplinary collaboration, rather than in conceptually strict and opposing roles.

There is much to like about E&K's approach: their acknowledgement of the value-ladenness of science; their emphasis on post-implementation monitoring of policy, driving a feedback look on the assessment process; their guarding against misuse or misguided use of science as advocacy; and their attempt to forge a close relationship between science advisors and policy-makers. But at the center of the PEM as E&K are currently presenting it, there is an unstable and incoherent compromise between the crucial insights inspiring the model, and the demand that the work still draw a line between scientific assessment and policy processes—in order, we presume, that climate science advising retain a superficial appearance of value-neutrality.

At this point we can only reiterate something that Douglas herself, echoing Hempel, said at the conclusion of her re-introduction of the argument from inductive risk to philosophers of science: "the argument 'I want X to be true, therefore X is true' remains a bad argument, both within and without science" (2000, 578). This is a point that pertains not just to those wary of biases in science, but also to those who think science ought to remain purportedly value-free, or that scientists can and should simply defer their decisions in response to inductive risk.

References

Anderson, Elizabeth. 2014. "Dewey's Moral Philosophy." *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta.

Betz, Gregor. 2013. "In Defence of the Value Free Ideal." *European Journal for Philosophy of Science* 3(2): 207–20.

Biddle, Justin B., and Eric Winsberg. 2010. "Value Judgements and the Estimation of Uncertainty in Climate Modeling." In *New Waves in Philosophy of Science*, edited by P. D. Magnus and J. Busch, pages 172-197. Basingstoke, Hampshire: Palgrave MacMillan.

Brown, Mark B. 2009. *Science in Democracy: Expertise, Institutions, and Representation*. Cambridge, MA: MIT Press.

Brown, Matthew J. 2012. "John Dewey's Logic of Science." *HOPOS* 2(2): 258-306.

Brown, Matthew J. 2013. "The Democratic Control of the Scientific Control of Politics." In *EPSA11 Perspectives and Foundational Problems in Philosophy of Science*, edited by V. Karakostas and D. Dieks, pages 479–491. Dordrecht: Springer.

Brown, Matthew J., and Joyce C. Havstad. 2017. "The Disconnect Problem, Scientific Authority, and Climate Policy." *Perspectives on Science* 25(1): 67–94.

Dewey, John. 1939. *Theory of Valuation*. Chicago: The University of Chicago Press.

Dorstewitz, Philipp. 2011. "Dewey's Science: A Transactive Model of Research Processes." In *The Continuing Relevance of John Dewey: Reflections on Aesthetics, Morality, Science, and Society*, edited by L. Hickman, M. Flamm, K. Skowronski, and J. Rea, pages 205-224. New York: Rodopi.

Douglas, Heather E. 2000. "Inductive Risk and Values in Science." *Philosophy of Science* 67(4): 559–579.

Douglas, Heather E. 2003. "The Moral Responsibilities of Scientists: Tensions between Autonomy and Responsibility." *American Philosophical Quarterly* 40(1): 59–68.

Douglas, Heather E. 2004. "The Irreducible Complexity of Objectivity." *Synthese* 138(3): 453–473.

Douglas, Heather E. 2005. "Inserting the Public into Science." In *Exploring Novel Forms of Scientific Advice in Political Decision-Making*, edited by S. Maasen and P. Weingart, pages 153–169. Dordrecht: Springer.

Douglas, Heather E. 2009. *Science, Policy and the Value-Free Ideal*. Pittsburgh: University of Pittsburgh Press.

Edenhofer, Ottmar, and Martin Kowarsch. 2015. "Cartography of Pathways: A New Model for Environmental Policy Assessments." *Environmental Science & Policy* 51: 56–64.

Elliott, Kevin C. 2011. *Is a Little Pollution Good for You? Incorporating Societal Values in Environmental Research*. New York: Oxford University Press.

Fisher, Erik. 2007. "Ethnographic Invention: Probing the Capacity of Laboratory Decisions." *NanoEthics* 1(2): 155–165.

Fisher, Erik, Roop L. Mahajan, and Carl Mitcham. 2006. "Midstream Modulation of Technology: Governance from Within." *Bulletin of Science, Technology & Society* 26(6): 485–496.

Fisher, Erik, and Daan Schuurbiers. 2013. "Socio-Technical Integration Research: Collaborative Inquiry at the Midstream of Research and Development." In *Early Engagement and New Technologies: Opening up the Laboratory*, edited by N. Doorn, D. Schuurbiers, I. van de Poel, and M. E. Gorman, pages 97–110. New York: Springer.

Havstad, Joyce C., and Matthew J. Brown (forthcoming). "Neutrality, Relevance, Prescription, and the IPCC." *Public Affairs Quarterly*.

Hickman, Larry A. 2007. "Beyond the Epistemology Industry: Dewey's Theory of Inquiry." In *Pragmatism as Post-Postmodernism: Lessons from John Dewey*, chapter 12, pages 206–230. Bronx, N.Y.: Fordham University Press.

IPCC. 2007. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* edited by Core Writing Team, R.K. Pachauri, and A. Reisinger. Geneva: IPCC.

IPCC. 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate* Change, edited by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx. Cambridge: Cambridge University Press.

Jeffrey, Richard C. 1956. "Valuation and Acceptance of Scientific Hypotheses." *Philosophy of Science* 23(3): 237–246.

Mitchell, Sandra D. 2004. "The Prescribed and Proscribed Values in Science Policy." In *Science, Values, and Objectivity*, edited by P. Machamer and G. Wolters, pages 245-255. Pittsburgh: University of Pittsburgh Press.

Pielke, Roger A., Jr. 2007. *The Honest Broker: Making Sense of Science in Policy and Politics*. New York: Cambridge University Press.

Putnam, Hilary. 2002. *The Collapse of the Fact/Value Dichotomy and Other Essays*. Cambridge, MA: Harvard University Press.

Rudner, Richard. 1953. "The Scientist Qua Scientist Makes Value Judgments." *Philosophy of Science* 20(1): 1–6.

Steel, Daniel (forthcoming). "Climate Change and Second-Order Uncertainty: Defending a Generalized, Normative, and Structural Argument from Inductive Risk." *Perspectives on Science*: 696–721.

Stern, Paul C. and Harvey V. Fineberg, eds. 1996. *Understanding Risk: Informing Decisions in a Democratic Society*. Washington, DC: National Academies Press.

Waks, Leonard J. 1999. "The Means-Ends Continuum and the Reconciliation of Science and Art in the Later Works of John Dewey." *Transactions of the Charles S. Peirce Society* 35(3): 595–611.

Winsberg, Eric. 2012. "Values and Uncertainties in the Predictions of Global Climate Models." *Kennedy Institute of Ethics Journal* 22(2): 111–137.