Sampled from: http://philsci-archive.pitt.edu/10027/

Non-Epistemic Values and the Multiple Goals of Science

Kevin C. Elliott and Daniel J. McKaughan

3. Expedited Risk Assessments

For more than 30 years, risk assessment has played a central role in government approaches to regulating toxic chemicals. Traditionally, it has involved several science-intensive stages, in which researchers identify hazardous substances, develop dose-response curves for their toxic effects, create exposure assessments, and then characterize the resulting risks (NRC 1983). This process is highly time-consuming and can be strategically manipulated by regulated entities to slow the regulatory process to a stand-still (Cranor 2011; Michaels 2008). In response to these difficulties, Carl Cranor (1995) has argued that the social costs of relying on current risk assessment procedures (which are fairly accurate but very slow) are generally greater than they would be if regulatory agencies relied on less accurate but much quicker methodologies for assessing risks. Thus, his analysis shows that when scientists are accepting a methodological approach or a model for the purposes of guiding regulatory policy in ways that minimize social costs, they sometimes have to sacrifice epistemic values such as accuracy for the sake of non-epistemic values such as the ability to generate rapid conclusions.

The reason why conventional approaches to risk assessment generate such high social costs is that they are too slow to keep up with information about likely carcinogens. As Cranor (1995) explains, once an entity such as the International Agency for Research on Cancer (IARC) or the National Toxicology Program (NTP) identifies a substance as a carcinogen in animals, government agencies have to assess the severity of the risks that they pose in order to develop regulations. For chemicals other than pesticides and pharmaceuticals, the manufacturers do not have to show that their products are safe before putting them on the market in the United States; rather, the burden of proof is on the government to show via risk assessments that the chemicals ought to be restricted or removed from the market. Therefore, because conventional risk assessment methodologies are so time- and labor-intensive, only twenty or thirty percent of the animal carcinogens identified by the IARC or the NTP have actually received risk assessments and been regulated. This massive under-regulation of likely carcinogens is very costly to society in terms of human and environmental health effects. However, there would also be significant costs to the economy if policy makers attempted to regulate likely carcinogens without collecting information about the severity of the risks that they posed.

The beauty of Cranor's (1995) analysis is that he examines in a precise way the tradeoffs between more and less accurate modeling approaches for assessing risks. He notes that in the early 1990s the California Environmental Protection Agency (CEPA) used an expedited risk assessment methodology to estimate the carcinogenic potency of 200 chemicals in an eight month period, whereas they had been able to analyze only 70 chemicals in five years using traditional methodologies. However, the expedited approach was slightly less accurate, yielding roughly 2.7% more major overregulation (which was defined as estimates of potency more than 25-fold higher than traditional approaches), 12% more minor overregulation (defined as estimates of potency between 5- and 25-fold higher than traditional approaches), and 5% more minor underregulation (defined as estimates of potency between 5- and 25-fold lower than traditional approaches).

Cranor then calculated the difference between the social costs of using the CEPA's expedited methodology and the traditional risk assessment methodology. He calculated the social costs by assuming a scenario (very close to the actual scenario in California when Cranor was writing) in which 400 substances had been identified by IARC as animal carcinogens but only 74 of them had been regulated, because conventional risk assessment methodologies had been too slow to evaluate any more of them. Thus, assuming that the animal carcinogens all turned out to be human carcinogens, the remaining 326 substances counted as regulatory "false negatives" under the conventional approach, insofar as they were not regulated even though they posed some level of risk to the public. In contrast, Cranor assumed that an expedited methodology would make it possible to evaluate risks from all 400 carcinogens, but with the potential for a few more false negatives and false positives because scientists would be employing a less accurate risk assessment methodology. He calculated the costs of false negatives and false positives using a variety of different estimates, ranging from the typical figure given by economists (a 10:1 ratio between the social cost of false negatives and false positives) to figures that were much less favorable to the expedited approach (a 1:1 ratio).

Unsurprisingly, Cranor found that the CEPA's expedited approach to risk assessment was vastly better than traditional risk assessment approaches if one's goal was to minimize social costs. This finding held for all ratios between the costs of false negatives and false positives (from 10:1 to 1:1). In this case, it was far better to accept a small decrease in accuracy for the sake of avoiding the huge number of regulatory false negatives associated with traditional risk assessment approaches. But it is particularly striking that Cranor obtained very similar results when he adjusted his assumptions to be much less favorable to the expedited approach. He considered a hypothetical case in which the expedited approach generated 50% more major overregulation than traditional risk assessment approaches and in which only 60% of the animal carcinogens identified by IARC actually turned out to be human carcinogens. Even under these assumptions, the expedited methodology generated fewer social costs when the ratio between the costs of false negatives and false positives fell between 10:1 and 2.5:1. Therefore, this case vividly illustrates the fact that when scientists are accepting modeling approaches for the sake of minimizing social costs in a regulatory environment, the ability to generate information rapidly may be a much higher priority than the ability to generate accurate results.

A critic of our approach to analyzing this case study might attempt to distinguish two kinds of scientific reasoning at work in this example. First, scientists have to determine their goals; in this case, Cranor's goal was to identify which risk-assessment model (i.e., the traditional model or the expedited model) would minimize overall social costs. Second, scientists have to determine which model or theory will best enable them to achieve their goals; in this case, Cranor concluded that the expedited model would be best for achieving his goal of minimizing social costs. The critic might then argue that neither of these two kinds of reasoning involves non-epistemic values taking priority over epistemic ones. In the first instance (setting goals), non-epistemic values are directly relevant to the decision, so it does not make sense to say that they take priority. In the second instance (determining which model best achieves those goals), non-epistemic values do not appear to have a legitimate role to play; determining which model actually minimizes social costs appears to be a purely epistemic or objective matter.

That second claim might be disputed, for the reasons spelled out by Kuhn (1977) and in Section 2. Even in cases where one's goal is purely epistemic (e.g., truth), desiderata relevant to the achievement of that end can stand in tension in ways that arguably make value judgments about how to balance those considerations inevitable. But suppose we grant that, once one sets the aims, the question of which representation most effectively achieves those aims is an entirely epistemic and objective matter. Notice that the critic's way of setting up the issue changes the subject in a subtle but significant way. Having allowed non-epistemic goals free rein in the first type of reasoning (i.e., goal-setting), in the second type the critic focuses on trying to determine which model most effectively achieves those goals. Our focus, however, is on deciding how to prioritize the various qualities that representations can exemplify. We are asking: Which set of epistemic and non-epistemic qualities should be considered when choosing a model or theory? And our answer is: It depends on one's aims. Unless one has aims that are purely epistemic, this opens the door to the relevance of practical considerations that facilitate the achievement of the aims.

Our point is that scientists often have goals that are not purely epistemic, so when they engage in the process of choosing a representation that will best enable them to achieve their goals they can legitimately prioritize qualities that are non-epistemic. Even if determining which representation best enables the achievement of certain ends is a purely epistemic and objective matter, it can still turn out that the representation that is best for accomplishing particular practical aims is not the one that would be chosen based solely on considering epistemic desiderata. In the risk-assessment case, for example, scientists can appropriately choose to accept an expedited model if its non-epistemic qualities (e.g., speed) make it better for achieving their goal of minimizing social costs even though the conventional modeling technique appears to have the best qualities from a purely epistemic standpoint.

Nevertheless, the critic might reply that decisions about how to prioritize the various qualities that representations can exemplify should be classified as part of the goal-setting process, and for that reason it remains misleading to claim that non-epistemic values are taking priority over epistemic values in a case like this one. In other words, once one sets the primary goal of minimizing social costs, scientists are forced to pursue various secondary goals, such as developing models with non-epistemic qualities like speed and ease of use. The critic would thus contend that within the constraints set by these non-epistemic values, scientists can still focus on developing the model with the best epistemic qualities—and therefore it does not make sense to say that epistemic values are being overridden by non-epistemic values.

Our response is three-fold. First, as we clarified in section 2, in using the language of "taking priority" or "overriding" we should not be understood as claiming that allowing this sort of role for non-epistemic values would change what we think about the epistemic status of a theory. Instead, what we are claiming is that, in some cases, one can have good reason to accept a theory (take it as a basis for practical reasoning and action) that is recognizably inferior to a rival from an epistemic point of view.

Second, we think that characterizing the kind of reasoning that we are studying in the risk assessment case and in the other cases in this paper as a form of goal-setting or framing can be bought only at the price of a strained or artificial reconstruction of the actual reasoning involved. For example, Cranor and the risk assessors that he studied did not appear to set a particular goal for the speed of their models and then attempt to choose the most epistemically virtuous model that attained the desired level of speed. Instead, the need to act forced them to choose between two models, and Cranor tried to convince reluctant risk assessors that they should sacrifice their desire to use the most realistic model because it was more important to use a speedy model if they really wanted to minimize social costs.

Finally, even if the reasoning that we are discussing in this paper can be re-described as a form of goal-setting or framing rather than as a prioritizing of non-epistemic values, it is still significant and worthy of attention. Typically, when philosophers point out that non-epistemic values have a role to play in setting the goals of science, they are thinking about choosing which topics scientists should investigate. We are highlighting a much more subtle role for non-epistemic values, namely, determining what role epistemic qualities ought to play relative to non-epistemic qualities when choosing scientific representations in order to achieve the goals of scientific activity in a particular domain. Whether one describes this sort of reasoning as a prioritizing of non-epistemic values or instead as part of framing or goal-setting, we think that it deserves attention in the literature on values in science.

4. Rapid Assessment Methods for Wetland Banking

Recent efforts to engage in wetland mitigation banking provide another example of how non-epistemic values such as ease of use can sometimes take priority over epistemic values such as accuracy in making predictions, depending on scientists' particular goals or purposes for using scientific models and methods. Over the past 100 years, society has experienced a 180 degree shift in attitudes toward wetlands. Throughout much of American history, the drainage of wetlands was considered to be the responsible thing to do, both to maximize the productivity of land and to prevent diseases (Meyer 2004). However, over the course of the twentieth century, scientists began to recognize that wetlands performed a host of valuable functions, including water purification, storm protection, nutrient cycling, and animal habitat (Mitsch and Gosselink 2007). As a result, new policies have been put in place to make it more difficult to drain wetlands. Among the most important of these was Section 404 of the Clean Water Act, which requires the Army Corps of Engineers (in consultation with the Environmental Protection Agency) to provide a permit to individuals who wish to dredge or fill wetlands on their property (Hough and Robertson 2009).

In practice, neither the Corps nor the EPA has been eager to deny permits for damaging wetlands, but they have been somewhat more inclined to demand that mitigation measures be taken in response. In practice, the most common approach to mitigation is to preserve or restore one area of wetland in order to compensate for a wetland area that is destroyed elsewhere (Hough and Robertson 2009, 23). In recent years, regulatory agencies, developers, and entrepreneurs have developed a "banking" approach to handling this mitigation effort. Rather than forcing developers to preserve or restore wetlands themselves, regulatory agencies allow developers to purchase mitigation "credits" from specialists who create “banks” of preserved or restored wetlands. By 2005, there were over 350 active banks, 75 sold-out banks, and over 150 banks under review. Annually, almost 3 billion dollars are spent on compensatory mitigation, primarily for either contractor-operated replacement wetlands or for banked wetland credits (Hough and Robertson 2009, 24-25).

Science becomes important to this mitigation banking process, because regulators have to decide whether restored wetlands are sufficiently similar to the destroyed wetlands in order to justify trading the two. Thus, they need to employ models as part of assessment methods that yield comparisons of different wetlands in terms of their key socially relevant features. Geographer Morgan Robertson (2004; 2006) has analyzed these methods and emphasized how the models for characterizing wetlands in the banking context differ from those that one would employ if one were aiming for the most ecologically sophisticated characterization. These differences arise in large part because bankers need assessments to be authoritative, cheap, and quick (Salzman and Ruhl 2000, 665). In other words, in order to develop a flourishing mitigation banking system, these non-epistemic values must sometimes be prioritized over epistemic values like predictive accuracy when choosing assessment models. The influence of these values affects numerous aspects of the assessment process.

First, in order to decide whether a natural wetland (which is to be destroyed) and a restored wetland should be classified as equivalent, scientists and regulators focus on a specific bundle of features (e.g., particular functions or ecosystem services) that are regarded as most relevant for exchange. Second, they employ “rapid assessment methods” (RAMs), which consist of algorithms that convert a variety of data about a wetland into numerical scores that estimate a wetland’s functional value for providing the features of interest (Robertson 2006, 373). Third, in order to keep the process simple, a wetland is typically represented by one main score rather than a variety of different functional scores. For example, because plants are relatively easy to look at, and because botanists have developed some relatively high-quality analyses of the plants in various sorts of wetlands, the function of “floristic biodiversity” has become a rough indicator for most other wetland functions. Fourth, even the assessment of floristic biodiversity depends on simplifying assumptions. For example, Robertson explains that regulatory guidelines require that the identification of plant species be performed in May or June, when most plants have not yet flowered. Therefore, the assessors have to base their assessments on the observation of plant features that may indicate the identity of particular species but that are not compelling by rigorous botanical standards.

References

Biddle, Justin. 2013. "State of the Field: Transient Underdetermination and Values in Science." *Studies in History and Philosophy of Science* 44:124-133.

Brown, M. (forthcoming). "Values in Science beyond Underdetermination and Inductive Risk," *Philosophy of Science* (Proceedings).

Cohen, Jonathan (1992): *An Essay on Belief and Acceptance*. New York: Oxford University Press.

Cranor, C. (1995). "The Social Benefits of Expedited Risk Assessments," *Risk Analysis* 15: 353-358.

Cranor, C. (2011). *Legally Poisoned: How the Law Puts Us at Risk from Toxicants.* Cambridge, MA: Harvard University Press.

Douglas, H. (2009). *Science, Policy, and the Value-Free Ideal.* Pittsburgh: University of Pittsburgh Press.

Duhem, P. (1906). *La théorie physique, son objet et sa structure.* Paris: Chevalier et Rivière, 2nd ed. 1914. Translated by P.P. Wiener. *The Aim and Structure of Physical Theory.* Princeton: Princeton University Press, 1954.

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

Elliott, K. (2013), "Douglas on Values: From Indirect Roles to Multiple Goals," *Studies in History and Philosophy of Science* 44: 375-383.

Elliott, K. and D. Willmes (forthcoming), "Cognitive Attitudes and Values in Science," *Philosophy of Science* (Proceedings).

Froelich, A. (2003). "Army Corps: Retreating or Issuing a New Assault on Wetlands," *BioScience* 53: 130.

Giere, R. (1988). *Explaining Science: A Cognitive Approach.* Chicago: University of Chicago Press.

Giere, R. (2004). "How Models are Used to Represent Reality," *Philosophy of Science* 71 (Proceedings): 742-752.

Giere, R. (2006). *Scientific Perspectivism.* Chicago: University of Chicago Press.

Hough, P. and M. Robertson (2009). "Mitigation under Section 404 of the Clean Water Act: Where It Comes from, What It Means," *Wetlands Ecology and Management* 17: 15-33.

Howard, D. (2006). "Lost Wanderers in the Forest of Knowledge: Some Advice on How to Think about the Relation between Discovery and Justification," *Revisiting Discovery and Justification: Historical and Philosophical Perspectives on the Context Distinction,* edited by Jutta Schickore and Friedrich Steinle. Dordrecht: Springer, 3-22.

Kitcher, P. (2001). *Science, Truth, and Democracy.* New York: Oxford University Press.

Kuhn, T. (1977). “Objectivity, Value Judgment, and Theory Choice,” in *The Essential Tension: Selected Studies in Scientific Tradition and Change.* Chicago: University of Chicago Press, 320-339.

Lacey, H. (2005), *Values and Objectivity in Science: The Current Controversy about Transgenic Crops.* Lanham, MD: Lexington.

Longino, H. (1996). “Cognitive and Non-cognitive Values in Science: Rethinking the Dichotomy,” in *Feminism, Science, and the Philosophy of Science*, ed. Lynn Hankinson Nelson and Jack Nelson, 39-58. Dordrecht: Kluwer.

Longino, H. (2002). *The Fate of Knowledge.* Princeton: Princeton University Press.

Malakoff, D. (2004). “The River Doctor,” *Science* 305 (13 August): 937-939.

Matthewson, J. and Weisberg, M. (2009). “The Structure of Tradeoffs in Model Building,” *Synthese* 170:169–190.

McKaughan, D. (2007). *Toward a Richer Vocabulary for Epistemic Attitudes: Mapping the Cognitive Landscape.* Ph.D. Dissertation (History and Philosophy of Science Program, University of Notre Dame).

McKaughan, D and Elliott, K. (2013). “Backtracking and the Ethics of Framing: Lessons from Voles and Vasopressin,” *Accountability in Research* 20: 206-226.

Meyer, W. (2004). “From Past to Present: A Historical Perspective on Wetlands,” in S. Spray and K. McGlothlin (eds.) *Wetlands.* Lanham, MD: Rowman and Littlefield, p. 84-100.

Michaels, D. (2008). *Doubt is Their Product: How Industry’s Assault on Science Threatens Your Health.* New York: Oxford University Press.

Mitsch, W. and J. Gosselink (2007). *Wetlands,* 4th ed. Hoboken, NJ: John Wiley and Sons.

Nordmann, A., H. Radder, and G. Schiemann (2011). “Science after the End of Science? An Introduction to the ‘Epochal BreakThesis’,” in A. Nordmann, H. Radder, and G. Schiemann (eds.), *Science Transformed? Debating Claims of an Epochal Break.* Pittsburgh: University of Pittsburgh Press, p. 1-15.

Potochnik, A. (2012). “Feminist Implications of Model-based Science,” *Studies in History and Philosophy of Science* 43: 383–389

Rescher, N. (1999). *The Limits of Science.* Revised edition. Pittsburgh: University of Pittsburgh Press.

Robertson, M. (2004). “The Neoliberalization of Ecosystem Services: Wetland Mitigation Banking and Problems in Environmental Governance,” *Geoforum* 35: 361-373.

Robertson, M. (2006). “The Nature that Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services,” *Environment and Planning D: Society and Space* 24: 367-387.

Rooney, P. (1992). “On Values in Science: Is the Epistemic/Non-Epistemic Distinction Useful?” in *Proceedings of the 1992 Biennial Meeting of the Philosophy of Science Association*, ed. David Hull, Micky Forbes, and Kathleen Okruhlik, 13-22. East Lansing, MI: Philosophy of Science Association.

Ruhl, J. and R. Gregg (2001). “Integrating Ecosystem Services into Environmental Law: A Case Study of Wetlands Mitigation Banking,” *Stanford Environmental Law Journal* 20: 365-392.

Steel, D. (2010). “Epistemic Values and the Argument from Inductive Risk,” *Philosophy of Science* 77: 14-34.

Steel, D. and K. P. Whyte (2012). “Environmental Justice, Values, and Scientific Expertise,” *Kennedy Institute of Ethics Journal* 22: 163-182.

van Fraassen, B. (1980). *The Scientific Image.* Oxford: Oxford University Press.

van Fraassen, B. (2008). *Scientific Representation: Paradoxes of Perspective.* Oxford: Oxford University Press.

Weisberg, M. (2007). “Three Kinds of Idealization,” *The Journal of Philosophy,* Vol. 104, No. 12 (Dec.), 639-659.