Guess Who's Coming For Dinner: The Scientist and the Public Making Good Environmental Decisions

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Introduction

The National Research Council's report *Understanding Risk* (National Research Council 1996) offers an opportunity to consider the way we make environmental and public health policy using science and public considerations. In light of this work, some aspects of policy-making in the face of scientific uncertainty bear further discussion.

First, growing criticism of risk assessment by environmentalists challenges us to rethink ethical and scientific issues involved in risk characterization. Specifically, at its heart, *Understanding Risk* addresses the ethics and epistemology of decision-making about problems with high societal stakes. The National Research Council (NRC) issued its report in a climate where risk assessment has been the primary decision-making tool and so the NRC used risk assessment as its "case study." However, in the friendly environment of professional societies we have the opportunity to ask whether risk assessment is the best tool to deal with problems characterized by uncertainty and high stakes, even with increased public participation.

Second, by significantly redefining the role of the scientist to more closely fit with the notions of analysis and deliberation portrayed in *Understanding Risk*, the vision of a more democratic decision making process can be fulfilled. The NRC introduced a new process for scientists, decision-makers, and stakeholders engaged in issues of risk. It also provided a job description for the public: the public has the right and responsibility to deliberate about analyses leading to decision-making. But the process will change more quickly if all the participants, and particularly the scientists, get new job descriptions and read from new scripts.

Finally, the NRC committee argued for involving stakeholders in risk characterization ostensibly because it makes better policy. I will also argue that it makes better science.

This paper will examine other decision-making tools, offer an alternative role for scientists other than that of "expert" and argue for a philosophy of science that expands on traditional views of "good" science. It is not a critique of the NRC's report, which makes an important and radical contribution to policy-making. Rather, this paper extends those ideas. In fact, this paper might be read as a prospectus for Volume Two of *Understanding Risk*.

The Shape of the Table

The most famous painting of the Last Supper is by Leonardo da Vinci. In this artwork, da Vinci portrays a long skinny table with Jesus in the center facing the observer. Jesus is seated so that he is illumined by the large central window which functions like a halo. Six disciples are seated on either side.

Contrast this with the image of King Arthur and the Knights of the Round Table who gather around the table that Merlin made for Arthur's father in-law and who gave it to Arthur on the occasion of his marriage to Guinevere. This table is described as 200 feet in diameter, designed so all 150 knights could sit at the table during a feast. The gathering was called a "fellowship."

These vivid images of tables illustrate the different ways we can establish relationships between scientists and lay people for environmental problem-solving. The old model was to have the scientist central to the decision and announce his findings and opinions to the decision-maker — the Last Supper model. The public received the benefit of the scientist's wisdom and public relations provided information to the public. It was a unidirectional information flow to the public. The NRC's report challenges this model and, in effect, says that we need to create a round table that has a place for the public as well as scientists.

The National Research Council committee made seven points (National Research Council 1996, 1-10):

1) Risk characterization should be a decision-driven activity.

2) Coping with a risk situation requires a broad understanding of the relevant harms or consequences to the stakeholders.

3) Risk characterization is the outcome of an analytic-deliberative process that encompasses all aspects of the problem facing the decision makers and requires the participation of diverse stakeholders.

4) Those responsible for a risk characterization should begin by developing a provisional diagnosis of the decision situation so they can match the process to the required decision.

5) This process should focus early on problem formulation and should include stakeholders at this stage.

6) The analytic-deliberative process should be mutual and recursive: analysis and deliberation feeding back into each other.

7) Organizations engaging in this process need to build organizational capability to conform to these principles.

Use the Right Tool

The main dish on the NRC's table was risk characterization, a key component of risk assessment. Risk assessment has dominated federal decision-making for the past fifteen years, mostly as a result of past NRC reports which delineated the process of doing a risk assessment. In fact, in *Understanding Risk*, the committee says that "[g]overnment and industry have devoted considerable resources to [risk assessment] to make better informed and more trustworthy decisions about hazards to human health, welfare and the environment..." (National Research Council 1996, 1). The NRC has been a major recipient of those resources.

While no other decision-making tools were assessed in *Understanding Risk*, risk assessment is not the only tool we now have. Risk analysis is, perhaps, best suited for prioritizing clean-up tasks. But, it is a poor tool for deciding the merits of introducing a new chemical, technology, or process into the environment. For instance, risk assessment could not have predicted the outcome of introducing CFC's into the atmosphere.

It is no secret that environmentalists do not believe that: *"QRA [quantitative risk assessment] methods sufficiently characterize the danger of environmental hazards to humans and to ecological systems. They widely agree that too much energy goes into quantifying risks, and too little is done to reduce or eliminate them. Almost unanimously, environmentalists resent the technocratic, exclusionary nature of risk assessments that undermine democratic participation in local environmental decisions." (Tal 1997, 470)*
We do not need to spend as much time on risk assessment and management. We do need to spend more time on risk reduction.

Two important tools approach the question of risk, and risk reduction, quite differently. The first approach is called *alternatives assessment*, and as a decision making process it is similar to the Environmental Impact Statement required under the National Environmental Policy Act (NEPA). Under NEPA a proposed action cannot go forward until decision-makers have considered all the alternatives, including the "no action" alternative. Alternatives assessment provides the opportunity to avoid risk, rather than manage it (O'Brien 1998).

The second approach to decision-making is the precautionary principle, which in its most elemental form says: act with prudence or caution in the face of scientific uncertainty and the likelihood of societal or environmental harm.[1] The fulcrum of the precautionary principle is scientific uncertainty. And, in this way it differs from risk assessment which seeks certainty before action can be taken. The precautionary principle requires action *before* certainty is in place, if there is a possibility of substantial harm. Some have coupled the precautionary principle with the reverse onus which requires the proponent of a new technology or chemical to prove that it is safe — rather than the public having to prove that it is harmful. Others consider alternatives assessment as a method for implementing the precautionary principle. These notions more closely parallel the environmentalist's concern about risk reduction and prevention, rather than risk characterization.

In contrast to the temperate, almost common-sense, language of the precautionary principle and alternatives assessment, risk analysis is a gambler's term. The focus isn't on harm or damage, it is on this blackjack notion of risk: we decide the probability of an unfortunate outcome and then choose whether to play or not.

The NRC report appropriately circles another issue which illustrates the contrasts between the precautionary principle and risk assessment, and that is the problem of ethics and science. Risk assessment is not well suited to handling the values component of decision-making. Many of the harms that can happen are not measurable by scientific criteria and touch on those things we hold most dear. Some have said that risk assessment addresses the risk of death while most people are afraid of fates worse than death. Consequently, the NRC recommendation that coping with a risk situation requires a broad understanding of the relevant losses, harms, or consequences, would be applied more wisely using a different decision-making tool.

Who is at the Table?

Perhaps the stone soup fable is helpful here. A group of refugees come into a town, set up a cast iron pot and describe a fabulous dish called "stone soup." They put a stone in the pot and soon every household, marveling at this recipe, brings a vegetable, soup bone, herb or grain to add. The soup feeds the entire town.

In order for a truly analytic-deliberative process to occur, everyone who comes to the table must bring something and be recognized for what they bring—much like the stone soup. On too many occasions, the scientists are viewed as the experts who have everything to contribute while government agencies want the public to be quiet and accept the interpretation offered by the scientists. This results in bad science and bad policy.

When diverse people come to the table as equals there is more room for the valuable processes of questioning, observing, analyzing, describing and creating to take place. That makes for better science. One way to do better science is to redefine the task. Rather than characterizing risk we could strive for learning and problem-solving. Scientists and farmers working in Montana have done just that by establishing Farm Improvement Clubs which are learning environments (rather than research institutions) and scientists are invited in as co-problem-solvers, rather than experts (Matheson 1996).

When scientists are co-learners and co-problemsolvers, everyone at the table brings something. All are equals, in large part, because of the diversity of skills. The public brings observations, wisdom about place, and an ethic of place. Scientists bring scientific training. I have seen farmers, residents near a large Department of Energy facility, or women treated as if they were stupid by scientists or government agency staff simply because of their occupation or gender. No matter that they had a Ph.D. or had more direct experience with the problem than the scientist or bureaucrat. If we can create situations where gender and occupations (farmer or scientist) are valued because of the unique contributions that each can make to problem solving, we will have created a situation where real analysis and deliberation can take place.

Co-problemsolvers Result in Better Science

The committee that wrote *Understanding Risk* had a grasp on why the analytic-deliberative model moves us in the direction of good science, but it didn't fully elaborate on *how* this model makes better science. Skeptics may rightly question the value of including citizens in research and the analytic process. However, another story, this time about scientific research, demonstrates how science and policy are enhanced when scientists solicit all relevant information.

Many readers are familiar with the experiment done by Raymond W. Tennant of the National Institute of Environmental Health Sciences (NIEHS), where seven groups of researchers predicted the outcome of rodent bioassays for 44 chemicals being tested by the National Toxicology Program for rodent carcinogenicity. The team of researchers that most accurately predicted which chemicals would cause cancer in the rodents used what is called "expert intuition." Expert intuition factored all available information about the chemicals into the prediction. Using all the available information was far more successful than using a single parameter or a limited combination of parameters (Raffensperger 1996).

Expert intuition is enhanced when experts have access to the information citizens have about the world in which they live. Citizens bring information about environmental and public health problems to the table, which must be added to the scientific equation if the resulting decisions will have scientific credibility and political viability. There are many situations where observations by lay people mapped a new scientific landscape. The deformed frogs found by schoolchildren in Minnesota are but one example of how citizens open new dimensions of environmental science.

Science engaged in environmental and public health is being transformed from a process of investigating the natural world through predictive, replicated experiments on single organisms to a process of iterative, multi-disciplinary, probabilistic studies of complex systems. These require what Silvio Funtowicz and Jerome Ravetz (1993) call "post-normal science." Funtowicz and Ravetz discuss the requirements of the scientific method when complex issues are characterized by irreducible scientific uncertainty and numerous societal values. In such cases the scientific method must have a systemic perspective, be synthetic and humanistic, and incorporate a dialogue between stakeholders and scientists about the shape and structure of the scientific study. This demands that scientists tolerate the initial confused phases and ambiguity in problem solving, and engage in what is essentially an inductive process to establish the kind of scientific framework in which the research will be carried out. Some of the

Table 1
Good Science: Two Paradigms (Raffensperger 1997)

Risk Characterization Model	Risk Prevention Model
Hero scientist (The Lone Ranger)	Scientist as team player (e.g. participatory research)
Reductionism	Context dependent
Certainty (Beyond a shadow of a doubt)	Precaution (Preponderance of the evidence)
Causes cancer?	Disrupts biological systems?
Replicability	Multiple lines of evidence
Empirical	Analytic
Quantitative	Qualitative and Quantitative (e.g., ecosystem "health")
Biochemical and organismic time frames	Ecologic and evolutionary time frames
Deductive	Inductive and Deductive
More Type II errors[a]	More Type I errors[b]
Peer Review	Peer Review

[a] A Type II error — the null hypothesis was in fact false, but you found it to be true. When testing a new chemical, the null hypothesis is usually that the chemical does not cause cancer (i.e., there is no effect.) If we make a Type II error, we fail to conclude that this chemical causes cancer.

[b] A Type I error — the null hypothesis was in fact true, but you found it to be false. For instance, the new chemical did not cause cancer, but you concluded that it did.

aspects of this kind of "post-normal science" are presented in Table 1.

Citizens may have different questions than scientists. Scientists may want to quantify the risk of a certain technology and citizens may want to prevent the risk. However, while citizens may redirect the scientific enterprise with these questions, it is essential for scientists to recognize the legitimacy of citizens' questions or scientists will be increasingly marginalized in the democratic process.

Fully involving relevant stakeholders in post-normal science's analytic and deliberative process makes better policy. Good public policy is a course of action which protects the public good and holds accountable those who harm the commons or the public. It is paternalistic to assume that a government agency or a scientist can understand a problem or hazard better than the public. Yet when a group of scientists and the public define the problem, and then solve it together, it is more likely that public resources (agency funding, natural resources, etc.) will be used wisely. This is particularly true when the problem has large scientific uncertainties and high societal stakes.

In conclusion, changing the process of environmental and public health decision-making from characterizing risk to learning and problem-solving honors the intent of the NRC report. It permits stakeholders, scientists and agency staff to come to the table as equals to resolve the issues together. It necessarily entails deliberation and analysis, but in a different culture. It leads to better science and better public policy. The questions and the tools may be entirely different than those needed to understand risk (risk characterization and management). I invite the NRC to write Volume Two of *Understanding Risk*, which would consider the scientists and public as co-learners addressing the twin issues of scientific uncertainty and risk reduction. Perhaps the title of Volume Two should be *Beyond Risk: Using Analysis and Deliberation to Implement the Precautionary Principle*.

Endnote

1. Following the presentation of this paper, the Science and Environmental Health Network with the Johnson Foundation, W. Alton Jones Foundation, and the C. S. Fund convened a *Conference on Implementing the Precautionary Principle*. The participants issued a consensus statement, the *Wingspread Statement on the Precautionary Principle*:

The release and use of toxic substances, the exploitation of resources, and physical alterations of the environment have had substantial unintended consequences affecting human health and the environment. Some of these concerns are high rates of learning deficiencies, asthma, cancer, birth defects and species extinction; along with global climate change, stratospheric ozone depletion and worldwide contamination with toxic substances and nuclear materials.

We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and the environment — the larger system of which humans are but a part.

We believe there is compelling evidence that damage to humans and the worldwide environment is of such magnitude and seriousness that new principles for conducting human activities are necessary.

While we realize that human activities may involve hazards, people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists and other individuals must adopt a precautionary approach to all human endeavors.

Therefore, it is necessary to implement the Precautionary Principle: When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

In this context the proponent of an activity, rather than the public, should bear the burden of proof.

The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.

Wingspread Participants (Affiliations are noted for identification purposes only.):

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