2013

Agency Decision-Making for Climate Change: Cost-Benefit Analysis, the Precautionary Principle, and the Bounds of Rationality

Laura Carr
Pomona College

Agency Decision-Making for Climate Change: Cost-Benefit Analysis, the Precautionary Principle, and the Bounds of Rationality

Laura Carr

In partial fulfillment of a Bachelor of Arts Degree in Environmental Analysis,
2012-13 academic year, Pomona College, Claremont, California.

Readers:
David Menefee-Libey
Richard Worthington

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

An explanation of how I came to write this thesis is deficient without weaving in acknowledgement of those who guided me on the intellectual journey leading to this point. The questions I discuss here were planted in my head, sometimes dramatically, sometimes subtly, by the following Pomona College faculty, to whom I am grateful for having introduced me to the theory that is now the rudder that will steer my life-long academic and career pursuits: Laura Perini, in ID1: Bad Science, early on invited me to question objectivity and factuality. David Menefee-Libey, in Policy Implementation and Evaluation, encouraged me to think deeply about rational policy-making and dissected the ways in which policymakers make decisions in the face of obstacles. Bo Cutter, in Environmental Economics, laid the foundations of cost-benefit analysis in an environmental context, introducing the concept of "the right amount of pollution" and exploring the policy implications of this economic "conclusion." Rick Worthington, in Introduction to Public Policy Analysis, gave me a first look at various policy pathways and models, and helped me confirm that my interest in policy-making lies primarily with the work done by agencies.

At Claremont McKenna College, Bill Ascher, in Processes of Environmental Policy-Making, impressed upon me the non-objectivity of cost-benefit analysis and gave me my first exposure to the precautionary principle. Also at Claremont McKenna College, Tom McHenry and Bill Christian, in Environmental Law, grounded me in the legal constraints confronting environmental policymakers and coloring their responses to uncertainty and risk.

My gratitude goes to Bowen Patterson Close ('06) and Ginny Routhe, coordinators of Pomona's Sustainability Integration Office, who have given me the invaluable opportunity to gain three years' hands-on experience in decision- and policy-making in a political setting.

I must also credit those who shaped my thinking before I arrived at Pomona. Jenny Macartney is principally responsible for getting me into this welcome mess: her Environmental Science class at San Luis Obispo High School was eye-opening and formative. Bill Preston, in Human Interaction with the Environment at Cal Poly San Luis Obispo, not only plied me with the intellectual sustenance I needed to pull me through my senior year of high school but made me realize I wanted to attend a college with a strong program in environmental studies. Thanks also to the folks of Heritage Shared who have been in and out of my living room since I was six, making a quirky scholar out of me, and whose votes of confidence I aspire to deserve.

To my tireless readers, David Menefee-Libey and Rick Worthington, I owe special thanks. DML urged me on to breakthroughs and propped me up during breakdowns with aquatic-themed dual reminders to just keep swimming and that, no matter how deep you go, it'll always be turtles all the way down. Prof. Worthington, also my sage faculty advisor, made time during a busy sabbatical semester to give his input. I'm more grateful than I can say.

And finally, I thank my family, my Mom, Dad, and Grandma, for all their love, given freely and unconditionally. I love you right back; you are my heroes.

INTRODUCTION

Climate change tests the limits of human understanding of complexity and uncertainty. It challenges assumptions about our presumed power of control over this planet. In an intellectual vacuum, climate change is a fascinatingly intricate and beautiful puzzle of ever-moving parts, and if nothing were at stake, its contemplation would be the perfect way to while away a pleasant lifetime, posing idly phrased "what ifs." As it is, of course, it is a genuine crisis that demands rigorous cross-disciplinary attention. We draw on sociology, history, economics, biology, ecology, politics, and countless other disciplines to try to wrap our heads around the problem's full magnitude. One important angle of the endeavor, and the one discussed here, is the policy effort to regulate the causes of climate change, particularly as made by governmental agencies.

Executive branch bureaucracies, federal, state, and local alike, are the oft-maligned or else simply overlooked agents of a substantial portion of the nation's climate change regulations. The role they play is vital. Yet, at a guess, very few bright-eyed elementary school students have ever proclaimed, "I want to be a bureaucrat when I grow up." The connotations of acting by rote, carrying out orders from on high, giving the little gray cells very little to do behind a gray desk in a gray cubicle are unattractive. Happily, reality is less grim than this tableau framed in red tape would suggest. Bureaucrats are "active participants in the policymaking process," endowed with substantial administrative discretion[1] and tasked with the important and creative work of "taking the lofty aspirations of political leaders and translating them into concrete

[1] Lindblom, Charles and Edward J. Woodhouse. *The Policy-Making Process*. 3rd ed. Englewood Cliffs, New Jersey: Prentice Hall, 1993. Print. 59, 61

proposals"[2]. Policy-making "rests overwhelmingly in the hands of the bureaucracy."[3] It is to the individuals working in decision-making agencies that we citizens assign responsibility for making the necessary, fine-tuned tradeoffs that come with living in a world with infinite demand on finite resources, for deciding the "level of acceptable risk"[4] society must face. It is up to them to take potentially vague, ambiguous legislative language and bring it down to earth, drafting feasible policies and practical programs that will satisfy intended social goals. The pressure to make policy choices that will effectively address policy problems and that will be well-received with the public and other constituents is immense.

Like many citizens, I want to know what these individuals working for relevant governmental agencies are doing to decide the level of climate change risk that society will accept. I am personally incentivized, not only out of academic or a citizen's interest, but as a budding bureaucrat: I find myself in the position of hoping to one day be a decision-maker in a governmental agency dealing with climate change regulation. To this end, the first of two broad intellectual goals of this thesis is to grasp the positive, descriptive theory on how agency employees might make decisions on complex topics, particularly climate change regulation. Chapter 1 explores theories of rational, optimal decision-making. Chapter 2 discusses the crowned king of decision-making methodologies, the rational ruler of the risk assessment realm, cost-benefit analysis. Chapter 3 establishes a challenger, the precautionary principle.

---

[2] Peters, B. Guy. *American Public Policy: Promise & Performance*. 8th ed. Washington, D.C.: CQ Press, 2010. Print. 80

[3] Lindblom 1993 59, 57

[4] Christoforou, Theofanis. "The Precautionary Principle, Risk Assessment, and the Comparative Role of Science in the European Community and the US Legal Systems." *Green Giants?: Environmental Policies of the United States and the European Union*. Eds. Norman J. Vig and Michael G. Faure. Cambridge, Massachusetts: The MIT Press, 2004. 17-51. Print. 36

The second goal of this document has a more forward-looking orientation. In line with my ambition to one day work in this field, I aim to craft a normative evaluation of the decision-making methods among which to choose when facing climate change. Chapter 4 is an analysis of rational decision-making, cost-benefit analysis, the precautionary principle, and the relationship between all three. It poses and attempts to answer theoretical questions about the utility of each in the case of regulating causes of climate change. Chapter 5 presents suggested guiding principles that emerge from this analysis, as well as as-yet-unanswered guiding questions for decision-makers on climate change to ask themselves repeatedly and reflectively about their work. Viewed through one lens, this analysis is essentially personal, intended to comb out intellectual tangles picked up over the last few years and to prime my career path by beginning to build a bridge from theory to practice. I hope, however, that the analysis can be usefully read by others as well. The wider audience in mind includes those individuals (already somewhat versed in the terminology of public policy analysis) who are willing to reflect on the theory in order to improve in practice, variously adopting and rejecting normative theoretical pointers as seen fit. It should also be noted as a final obvious and gratuitous reminder to the reader that any conclusions reached or principles established are those of a student who has not herself been in an agency decision-making position. Recommendations for practice are proffered on the basis of read and learned theory, are hortatory rather than presumptuously jussive, and are unavoidably under-informed by personal experience.

CHAPTER 1: RATIONAL DECISION-MAKING

Let us start with a common and pleasing assumption: human beings are rational. "Virtually all of modern economics and large parts of the rest of social science… embrace the idea that human action is the result of human choice and that human choice is intendedly rational."[5] We suppose that we have knowledge of alternatives, consequences, consistent values by which we evaluate them, and decision-making rules.[6] We might go so far as to believe that we know "the probability distribution of consequences conditional on each alternative, and the subjective value of each possible consequence."[7] As rational, economic beings, we then select "the alternative with the highest expected value."[8]

To enable this rational thinking, we employ decision-making models, on the theory that "the process of making policy plays a significant part in determining the outcome."[9] A structured approach is useful for reminding us of "important tasks and choices that otherwise might slip [our] mind."[10] An approach known as "the stages model" is the most "conventional process model of policy-making": it "begins with agenda setting or problem definition; then proceeds through a series of steps such as program design, legitimation, budgeting, and evaluation."[11] A more detailed conception could be to define the policy problem; assemble evidence relevant to the case; construct possible policy alternatives; select criteria for judging between these alternatives; project

[5] March, James G. "Understanding how decisions happen in organizations." *Organizational Decision Making*. Zur Shapira, ed. United States of America: Cambridge University Press, 1997. 9-32. Print. 10
[6] Ibid. 10-11
[7] Ibid. 11
[8] Ibid. 11
[9] Peters 45
[10] Bardach, Eugene. A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving. 3rd ed. Washington, D.C.: CQ Press, 2009. Print. xvii
[11] Peters 46

outcomes of each alternative; confront the tradeoffs each policy would present; and then finally decide which policy alternative to adapt.[12] In practice, "the order may be less linear… than it appears in the model," but nevertheless, the stages model is a "useful heuristic device for mapping the route that policies take from being just a good idea to being a functioning program."[13]

We attempt to go about decision-making in as logical a fashion as possible. The process of conducting organized policy analysis is "a pragmatic and responsible effort to facilitate reasonable discourse about a policy future that is inherently uncertain," a method of helping define "common ground… by the rules and conventions of rational discourse."[14] The conventional model of reasoned decision-making may enable "analytical procedures to resolve disagreements," and through a formalized decision-making process, stakeholders with opposing views "may discover that at least some seemingly irreducible values conflicts can be recast as dry-as-dust technical disagreements."[15] An open-season, less structured policy-making approach would be less likely to facilitate this result.

Decision-makers operating in a traditional framework characterized by "economic and utilitarian values" will "assum[e] that policies are best understood in terms of improving the economic well-being of those affected by them."[16] Seen through this economic lens, the goal of linear policy-making models is to "define optimal policy outcomes and to design institutional arrangements that may be capable of producing

[12] Bardach
[13] Peters 47, 48
[14] Bardach 24, xix
[15] Ibid. xix
[16] Peters 59

those desirable outcomes."[17] These "optimal" policies envisioned as the logical, natural end product or output of the linear decision-making models may, however, be decidedly unachievable in the "real world of politics."[18] We have traditionally embraced models of policy-making founded on impossible ideals that do not in reality exist. If we are to understand how decisions are made in the non-ideal world, we should be aware of the factors that constrain decision-makers.

Limits on Rational Decision-Making

Modern theorists have pointed out that the assumption that humans are perfectly rational is merely a wave of an economist's hand: perfect models behave well, but they are unlikely to reflect the world accurately. Real-life decision-making "is bounded by significant individual and organizational constraints on finding and implementing an optimal solution."[19] We cannot presume "omniscient rationality" in human beings, since we are faced with "limitations of computational capability, [and] the organization and utilization" of the mind.[20] The "uncertainty and disagreement" that will arise because of these limitations "are fundamental facts… that cannot be wished away even by the most rigorous analysis."[21] This is especially true in the case of climate change, when uncertainty pervades not only the policymaking sphere but the scientific as well: the all-important technical details are hotly contested, and no perfectly certain policy can be written around irreducibly uncertain scientific evidence.

[17] Ibid. 57
[18] Ibid. 57
[19] March 1997 11
[20] March 1986 146
[21] Lindblom 1993 vii

To explain the gap between "the perfect human rationality that is assumed in classical and neoclassical economic theory and the reality of human behavi[o]r as it is observed in economic life," theorists developed the term "bounded rationality."[22] The concept originated out of "dissatisfaction with the models that adhere to the 'perfect rational man' paradigm."[23] Bounded rationality points to "the extreme difficulty of making fully rational decisions and argue[s] that rationality can best be seen as bounded by organizational, political, and cultural parameters,"[24] including excessive agency focus on budget, staking out policy turf, rigid adherence to process above achievement of socially desirable results, and perceived obligation to special interest groups[25]. Add to all this the limitations intrinsic within humans, and we are at quite a distance from a fully rational man.

One theorist cautions that unless these "limits are taken very seriously, it is impossible to appreciate the magnitude of the task facing the political system; and unless political action is adjusted to take account of the fact that complex problems cannot be understood fully, policy making will fare much worse than it needs to."[26] Another adds, even more forcefully, that we should recognize that "we would reach different conclusions in our economic analyses if we substituted the concept of bounded rationality for the concept of global optimization."[27] The expectation of perfect rationality throughout the decision-making process, particularly for the complex problem of climate

---

[22] Simon, Herbert. With Massimo Egidi, Robin Marris and Riccardo Viale. *Economics, Bounded Rationality and the Cognitive Revolution*. Massimo Egidi and Robin Marris, eds. Worcester, Great Britain: Billing and Sons Ltd., 1992. Print. 3
[23] Rubinstein, Ariel. *Modeling Bounded Rationality*. Cambridge, Massachusetts: The MIT Press, 1998. Print. 2
[24] Peters 54-55
[25] Lindblom 1993 64
[26] Ibid. 5-6
[27] Simon 3

change regulation, is "impossible and perhaps even unwise"[28]. To assume perfect rationality is to dismiss a richer, more complex, and hence more accurate view of reality.[29]

Classical policymaking models are driven by the desire to create the optimal policy. But some theorists point out that since our rationality is internally flawed and externally constrained, fatalistically but realistically we should not expect to optimize. "Even when extended by a range of devices from written language to… computers, the mind at its best simply cannot grasp the complexity of social reality," and even "the very best professional analysis never rises to infallibility."[30] Another argues that, instead of optimizing, decision-makers instead engage in "satisficing," a term coined as "a short-hand label" for decision-makers' "develop[ing] decision procedures that are sensible, given the constraints."[31] This "adaptiveness falls far short of the ideal of 'maximizing' postulated in economic theory. [We] adapt well enough to 'satisfice'; [we] do not, in general, 'optimize.'"[32] These adaptive strategies,

> [o]n superficial examination,… are often dismissed as irrational. For they are seen as indecisiveness, patching up, timidity, triviality, narrowness of view, inconclusiveness, caution, and procrastination. But we have seen them to be useful devices for structuring man's analytic capacities. Man has had to be devilishly inventive to cope with the staggering difficulties he faces. His analytical methods cannot be restricted to tidy scholastic procedures. The… satisficer may not look like [a] heroic figure. He is nevertheless a shrewd,

[28] Peters 54
[29] Ibid. 60, 57
[30] Lindblom 1993 5, 17
[31] March 1986 146
[32] Simon 39

> resourceful problem-solver who is wrestling bravely with a universe that he is wise enough to know is too big for him.[33]

Two of the analytical methodologies we have developed to try to grasp our complex scientific and social surroundings are presented in the following two chapters. Each evinces an endorsement, to a greater or lesser extent, of either the perfectly rational man paradigm or the concept of bounded rationality, and the choice between them has implications for the decision-making process and ultimately the nature of the policies and programs developed. With that in mind, we turn now to cost-benefit analysis.

[33] Lindblom 1968 27

CHAPTER 2: COST-BENEFIT ANALYSIS

Apart from "intuition and experience," cost-benefit analysis can be considered the "most commonly employed" decision-making tool.[34] A decision-maker using cost-benefit analysis, as the name implies, "reduce[s] all the costs and benefits of [a] proposed government program[] to a quantitative, economic dimension and then compare[s] available alternative policies using that standard."[35] In simplest terms, if a decision-maker calculates that the benefits of the project outweigh the costs, then he will decide the project is a good idea, and will take action to implement it. For public projects, governmental agency employees weigh social costs and benefits, seeking a program that will "produce a benefit for society greater than its cost."[36] This goal rests on "utilitarian, economic logic," presuming that "total wealth is… of paramount importance" and that "the best policies are those that create the greatest net benefit for society."[37] To perform cost-benefit analysis, a decision-maker must "enumerate, and attach a monetary value to," both positive and negative features of a policy alternative, using money as a "single measuring rod" to allow comparisons of discrete features.[38] We can, in a sense, compare apples to oranges if we first "convert" apples into these abstract units of "dollars," and do the same for oranges. We also take the term "cost-benefit analysis," in the strictest sense and as a starting point, to imply "the commensurability of all goods"[39]: we presuppose that the cost-benefit analysis methodology has the power to measure and value all intangibles.

---

[34] Peters 443
[35] Ibid. 87
[36] Ibid. 443
[37] Ibid. 443, 444
[38] Ibid. 444
[39] Sunstein, Cass. *Risk and Reason: Safety, Law, and the Environment*. Cambridge, United Kingdom: Cambridge University Press, 2002. Print. 123-124

Advantages of Cost-Benefit Analysis

Policymakers are entrusted with public well-being and granted a slim margin of error. Their decisions must be "right," ideally without fail, and are not only high-stakes, but complex, requiring consideration of a near infinite number of factors. Cost-benefit analysis is seen by many decision-makers as a tool to "overcome cognitive limitations" inherent in humans: often there are too many factors to consider at once without carefully assessing them.[40] Cost-benefit analysis is meant to generate "a full… sense of what is at stake," making possible "sensible priority-setting."[41] To its proponents, it is "a helpful input into the decision," and "a pragmatic tool to guide analysis and to allow informed comparisons."[42] In other words, it is intended to be a highly rational approach to comprehensively consider all factors relevant to the decision. It can be seen as an essential corrective to the pitfalls of human fallibility: we need a structured, rational approach to compensate for our individual capacity failings. Whereas intuitive, "ordinary thinking goes wrong" and is "unreliable," cost-benefit analysis is "a means of overcoming predictable problems in individual and social cognition" by "putting 'on screen' important social facts that might otherwise escape private and public attention."[43] For a dizzyingly complex policy problem like climate change, employing a tool that attempts to systematically account for all potential benefits and costs in due course sounds hugely helpful.

Cost-benefit analysis has the added plus of generating numbers, which can have palliative effect on agitated stakeholders, giving the impression of inarguable bottom-line

[40] Ibid. 107
[41] Ibid. 107
[42] Ibid. 292, 111
[43] Ibid. 29

certainty. If the numbers show that costs outweigh benefits, then they effectively mandate the abortion of the policy or program. Apolitical numbers that seemingly write their own policy implementation plans automatically are a decision-maker's dream answer to critiques that there is "a high level of arbitrariness in modern regulation,"[44] and the appearance of neutrality and inevitability is unquestionably politically advantageous in contentious policy debates.

Complications of Cost-Benefit Analysis

The reader may have noticed a pattern in the above descriptions of cost-benefit analysis, namely that the impregnability of the method's conclusions is repeatedly qualified. Numbers do not give certainty—they give the *illusion* of certainty. Costs and benefits are not self-evident—they are *seemingly* so. Results are not neutral—they are *apparently* apolitical. Cost-benefit analysis, as with any other tool employed by human hand or human mind, is not devoid of human judgment. Therefore it is not devoid of human fallibility and error. Critics of cost-benefit analysis point out that "values are in action throughout the policy process,"[45] and that cost-benefit analysis is no exception. During the valuation and monetization process, decision-makers must "adopt a number of assumptions and approximations to reach a decision…. [T]hat answer should not remain unquestioned."[46] Cost-benefit analysis has been notoriously called "nonsense on stilts," "impl[ying] that there are so many assumptions involved in the calculations, and so many imponderables about the future effect of projects, that cost-benefit analysis is the

[44] Sunstein, Cass. *Worst-Case Scenario*s. Cambridge, Massachusetts: Harvard University Press, 2007. Print. 205
[45] Peters 459
[46] Ibid. 455

functional equivalent of witchcraft in the public sector."[47] In performing formal cost-benefit analysis, "regulators must make difficult and often speculative judgments about the likely effects of alternative regulatory strategies"; they add another layer of assumption when they "turn those effects into monetary equivalents."[48] If we follow the perfectly rational man paradigm, then this is unproblematic—we can believe that each calculation is rational. If, however, we doubt the limitless extent of human rationality, then each holds the potential for dangerous missteps.

A decision-maker may assert that he has enumerated "all costs and benefits," but "all" to him may not be "all" to another. Decision-makers have individual opinions about what factors deserve to be valued, what constitutes a cost and a benefit, and finally the magnitude, translated approximately into dollars, of the cost or benefit. Market forces, usually relied upon to correctly assign value to tangibles and intangibles, "may not reflect… costs and benefits fully," leaving some externalized.[49] If cost-benefit analysis "is used naïvely and uncritically" by a decision-maker who "let[s] the method make decisions for them," then "the result can be decisions that many people would deem socially undesirable."[50] Cost-benefit analysis is based on the principle of the utilitarian maximization of social wealth. Utilitarian norms are "important bases for evaluating a program, but they may not be the only relevant criteria."[51] But it would be "controversial and implausible" indeed to assert that "all regulatory decisions should be made by aggregating private willingness to pay, as if economic efficiency is or should be the goal

[47] Ibid. 457
[48] Sunstein 2007 199-200
[49] Peters 448
[50] Ibid. 456
[51] Peters 473

of all regulation."[52] While cost-benefit analysis provides valuable information about a policy's economic desirability, it is silent on other vital dimensions, including the distribution of those costs and benefits, justice, and ethics, all at play in the case of climate change. Cost-benefit analysis does not provide guidance towards an answer when decision-makers ask to whom the benefits of a policy will accrue, who will bear the costs, and whether or not this is a morally acceptable outcome for society.

The definitional bounds of the term "cost-benefit analysis" are unclear and may be drawn narrowly to mean exclusively quantitative analysis, or may stretch to include qualitative description as well. It is difficult to imagine that any decision-makers employ cost-benefit analysis in its purest, most simply utilitarian form. More open-eyed practitioners will recognize that "dollar numbers cannot substitute for a fuller inquiry," and that quantitative results should not stand alone, but "should supplement rather than displace qualitative description of relevant effects."[53] Some go so far as to recommend that these qualitative effects should be considered a strong enough basis for an agency "to make adjustments in the analysis."[54] There is reason to believe that exclusively quantitative analysis of costs and benefits is incomplete, unreliable, and socially undesirable.

[52] Sunstein 2002 29
[53] Sunstein 2002 123, 111
[54] Ibid. 111

Taking a Step Towards Precaution

Time now for a hypothetical question: What is the monetized value of the human race?[55] Luckily, this is a hypothetical question (although some have taken it as a challenge have determined an answer)[56]. But just for a moment, imagine it is not. If a decision-maker were forced to reckon up, in US dollars, the value of the human race, or even the value of planet Earth, how might he go about it? Probably he would have to make a few assumptions and judgment calls. The point of this extreme example is to illustrate that we humans have difficulty rationally judging the value of intangibles, especially in aggregate and on a large scale. Assumptions are unavoidable: they should not be covered up, but acknowledged and presented openly.

Non-expert evaluations of cost and benefit can be derided by professionals as misguided and overly reliant on emotional, intuitive responses. But, of course, even expert "estimates of both costs and benefits often turn out to be wrong," largely because the "[overwhelming] informational demand on agencies" is not matched with correspondingly extensive information.[57] Furthermore, while we may be able to reach relatively high levels of certainty about some low probability risks, there is a distinction between this and other forms of uncertainty which are irreducible,[58] inherent within ecosystems and planetary systems, and that no amount of money or time invested will make knowable to the last degree. Uncertainty is a defining feature of climate change, and must be factored into policy decisions about greenhouse gas emissions. In cases such

[55] Sunstein 2007 217
[56] Apparently it is $600 trillion. Sunstein, Cass. "Cost-Benefit Analysis and the Environment." *Ethics* Jan. 2005: 351–385. Web. 3 Dec. 2012. <http://www.masonlec.org/wp-content/uploads/2011/06/C-B-Analysis-and-the-Environment.pdf>.
[57] Sunstein 2007 129-130
[58] Brown, Donald. "The Precautionary Principle as a Guide to Environmental Impact Analysis: Lessons Learned from Global Warming." Tickner 141-156. 154

as these, governments are increasingly "concerned with… risks… and need to be able to link the probability of their occurring with their relative costs and benefits,"[59] but they face considerable obstacles in doing so.

Some theorists consider these challenges to be insurmountable, and inadequately addressed by the cost-benefit analysis methodology. They dispute the commensurability of intangibles, and argue that a policy founded on valuations of costs and benefits does not accurately deal with uncertainty. When faced with unknown risk, we ought to err on the side of precaution. Variations on this stance are collected together under the term the "precautionary principle."

[59] Peters 456

CHAPTER 3: THE PRECAUTIONARY PRINCIPLE

As with cost-benefit analysis, there are definitional ambiguities concerning the precautionary principle. One definition states that the principle "references the potential for harm to persons and the environment, scientific uncertainty about those harms, and taking anticipatory action."[60] It is meant to apply "in situations of environmental risk where by the time unambiguous scientific evidence of a serious problem becomes available, the danger may already have materialized and perhaps become irreversible."[61] Proponents of a precautionary approach question the bounds of human cognition and scientific knowledge, arguing that we should exercise precaution in those cases when we are at unknown or unknowable but presumably large risk.

Historical Emergence of the Precautionary Principle

The precautionary principle has more direct historical relevance to environmental thought than does cost-benefit analysis, a more general public policy tool. The late 1970s and early 1980s saw increasing "need to prevent environmental degradation, which was perceived to be growing rapidly."[62] The "overall scientific uncertainty" surrounding environmental damage that "could not be clearly attributed to a specific agent or source of contamination or pollution" meant that these environmental problems "could not be approached on the basis of the old principle that allowed intervention only in situations of full scientific knowledge and established causality."[63] In the US, much of our landmark environmental legislation reflects this shifted attitude, "requir[ing] that action be taken to

[60] Whiteside, Kerry H. *Precautionary Politics: Principle and Practice in Confronting Environmental Risk.* Cambridge, Massachusetts: The MIT Press, 2006. Print. 150
[61] Ibid. viii
[62] Christoforou 22
[63] Ibid. 21

anticipate, prevent, or reduce risk where there is scientific uncertainty or a lack of clear evidence or risk."[64] The Endangered Species Act (1966), Clean Air Act (1970), the Clean Water Act (1972), and the chlorofluorocarbon ban (1978) all contain precautionary language in view of the scientific uncertainty surrounding the regulated substances.[65]

Towards the end of this period, a pivotal US Supreme Court decision was handed down that halted this trend. In view of the considerations listed above, regulatory agencies typically "regarded risk assessment as a highly judgmental and largely qualitative exercise," and "resisted quantification."[66] The 1980 "Benzene Decision" (*Industrial Union Dept., AFL-CIO v. American Petroleum Institute*) marked a turning point, effectively establishing that agencies were legally required to perform *quantitative* risk assessment, relying on numbers and valuation and monetization techniques. The Benzene Decision "provided a huge impetus for quantitative risk assessment" because it established that the "only language in which agencies could credibly balance regulatory costs against the health of workers and citizens or the value of ecosystems was the language of numbers."[67] Just at the time of rising consciousness about immeasurably complex environmental problems, then, also came a shift away from the kind of qualitative assessment that may be best suited to tackling those problems.

[64] Ibid. 19
[65] Ibid. 19
[66] Jasanoff, Sheila. "A Living Legacy: The Precautionary Ideal in American Law." Tickner 227-240. 234-235
[67] Ibid. 234-235

New Kinds of Risks, New Methods of Analysis

Some theorists are proponents of a methodology that recalls decision-making before the legal push towards quantification. Our understanding of environmental degradation in the last forty years has matured considerably, perhaps in no way more importantly than in the recognition that we know so little in the face of hugely complex, global-scale problems. Climate change, the foremost modern environmental crisis, is "so widespread and associated with such a long timescale" that it inherently "brings with it enormous uncertainties."[68] These extreme uncertainties arise "from both limitations in current scientific tools and the nature of complex systems."[69] They are new risks that manifest themselves on a "large scale and develop slowly, often with irreversible consequences," and the "magnitude of potential dangers is unprecedentedly large."[70]

It would be comforting in the face of such alarming assertions if we knew our decision-makers—tasked with "selecting" social risk—were equipped with the best, most appropriate decision-making tools to confront these new perils. But advocates of precaution insist that our current tools are inadequate, arguing that "[e]ffects on the scale of climate change… confound existing approaches of risk management" and that the "long-term delayed, global dangers… can exceed the ability of current strategies to contain them."[71] In theory, this "particular category of new risks" is where the precautionary principle has the greatest relevance.[72] Cost-benefit analysis is "complex,

[68] Woodward, Alistair. "Uncertainty and Global Climate Change: The Case of Mosquitoes and Mosquito-Borne Disease." Tickner 127-140. 127
[69] Tickner, Joel A. "The Role of Environmental Science in Precautionary Decision-Making." Tickner 3-10. 4-5
[70] Whiteside 30
[71] Ibid. 32, 30
[72] Ibid. 30

value laden, and contentious,"[73] yet it is frequently assumed to provide neutral, simple, indisputable answers. Critics of traditional cost-benefit analysis highlight the fact that attempts to value ecosystem intangibles "require the papering over of many uncertainties and using so many patently inadequate methods of cost calculation that the results are, at best, extremely controversial. At worst, they are simply absurd, because many of these ecological services are irreplaceable."[74] Rather than trying to hide uncertainty and value judgments behind a numerical veneer, the precautionary principle proposes a more open relationship with uncertainty. While it is standard "to demand scientifically verified evidence of a problem before regulating it," in cases where "scientific consensus is… slow in coming, partial, contested, and fallible," requiring "high levels of scientific proof before acting is… an *irrational* strategy"[75] (emphasis in original). Thus the precautionary principle would permit action before results are completely verifiable.

There are two broad conceptions of how to best incorporate precaution into decision-making. First, one view holds that "[w]e need the precautionary principle for special situations in which ordinary assumptions about risk management do not hold."[76] This language implies a threshold, below which uncertainty is able to be enfolded into traditional cost-benefit analysis or risk analysis methods, and above which the levels of uncertainty are extraordinary and require "a supplementary dose of precaution."[77] The precautionary principle is not necessarily tailored to apply to "situations where risks are

[73] Tickner, Joel A.. ed. *Precaution, Environmental Science, and Preventive Public Policy*. Washington: Island Press, 2003. Print. 193
[74] Whiteside 31-32
[75] Ibid. 34, 146
[76] Ibid. 30
[77] Ibid. 30

relatively well understood"; instead, it is "precisely for cases of serious potential danger where risks are poorly understood."[78]

As an alternative to the notion of a threshold for precaution, the precautionary principle could be considered "an omnipresent decision-making screen through which all goals, potential alternative courses of action, and options for midcourse corrections are examined."[79] Seen in this light, precaution "is not simply a process that is or is not triggered," [80] but a tool in continual use, across the spectrum of analysis, from quantitative to qualitative, in cases of certain and uncertain risk. Any decision we make employing a precautionary approach—including cost-benefit calculations—we make consciously and respectfully in view of our limitations.

Critiques of the Precautionary Principle

We recur again to definitional vagueness. Just as "cost-benefit analysis" may expand or contract to include varying amounts of qualitative analysis, the "precautionary principle" can be interpreted literally or more broadly. One academic draws special attention to the word "principle" in the term, stating, "It should be clarified that the United States does not deny that precautionary *measures* or a precautionary *approach* may be adopted to regulate risk. What it is contesting is the existence or emergence of a precautionary *principle* that can trump or override provisions in existing agreements"[81] (emphasis in original). Another does not seem to ascribe so specific a meaning to the term, instead arguing that the precautionary principle, taken to mean a precautionary

[78] Ibid. 48-49
[79] O'Brien, Mary. "Science in the Service of Good: The Precautionary Principle and Positive Goals." Tickner 279-296. 279
[80] Ibid. 279
[81] Christoforou 27

approach, is already integrated into traditional cost-benefit analysis-driven decision-making processes: a comprehensive, "competent cost-benefit analysis… takes good account of the precautionary principle by asking regulators to attend to low-probability risks of significant harms. [Cost-benefit analysis] subsumes this risk… into the overall assessment."[82] Advocates of cost-benefit analysis might insist that insufficiently precautious decisions are not the result of a fundamentally faulty cost-benefit model: rather, the analysis can be enhanced by incorporating precaution into calculations. This statement reflects both a broad conception of the precautionary "principle" and a broad conception of cost-benefit analysis. Middle-ground theorists seem to support a decision-making technique based on both quantitative and qualitative assessment, in which precautionary thinking influences the valuation of costs and benefits. A decision-maker placing a monetary value on an intangible benefit of climate change reduction, for example, could buffer his calculation, accounting cautiously for unknowable risk.

There are also more strident objections to the idea of a precautionary principle. Some fear it will lead to "massive overregulation of private enterprise."[83] Others worry that, "[t]aken literally, the precautionary principle would lead to indefensibly huge expenditures," since, if "we take costly steps to address all risks, however improbable they are, we will quickly impoverish ourselves."[84] Some paint a caricature of the precautionary principle as stymieing any action at all: it can be seen as an alarming mandate that '"whatever it is you're doing, you've got to stop,'"[85] or as "literally paralyzing":

[82] Sunstein 2002 104
[83] Whiteside 42
[84] Sunstein 2002 103
[85] Whiteside 29

> [A] failure to regulate will run afoul of the precautionary principle because potential risks are involved. But regulation itself will cause potential risks, and hence run afoul of the precautionary principle too; and the same is true for every step in between. Hence the precautionary principle… bans every imaginable step, including inaction itself.[86]

Moving Forward: A New Method of Analysis

Precaution is often slandered as being the enemy of scientific inquiry, as founded on fear and an irrational doubt of the power of science to "know." Proponents of precaution do not dispute that scientific evidence "helps avoid… irrational outcomes."[87] Perhaps they would not go so far as to wholeheartedly endorse a "positivist view of science," holding that it is "a powerful and neutral tool capable of predicting risk and causality,"[88] but nevertheless, far from rejecting the information it provides, precaution makes "a demand for better science"[89]. Rigorous scientific inquiry has a vital role to play in precautionary decision-making, since precaution "implies research, experimentation, phased introduction, [and] traceable usage."[90] Fuller reporting could include "a more comprehensive quantitative and qualitative (descriptive) analysis and discussion of uncertainty" that would candidly disclose any unknowns and unknowables in the scientific process.[91] It could discuss "sources of uncertainty…; the type of uncertainty…; the degree of uncertainty and certainty in conclusions; how much uncertainty can or

[86] Sunstein 2002 103-104
[87] Whiteside 44-45
[88] Christoforou 34-35
[89] Whiteside xi
[90] Ibid. 55-56
[91] Tickner 12

cannot be reduced through additional research; and the implications of uncertainty."[92] Thus, a "commitment to precaution" as a decision-making metric could be seen as more honest, more open than analysis based predominantly on valuations of costs and benefits: a precautionary approach would not force scientists or decision-makers "to pretend that they can quantify, make commensurate, and maximize benefits when, in truth, the conditions for such operations are unavailable"[93]. Precaution "has the advantage of bringing the elements of judgment out into the open and making them subject to debate, rather than burying them in methodologies understandable only by experts."[94] This transparency has the potential to enhance the democratic element of policy-making, but it may also be opposed by experts who are not eager to have to defend qualitative assumptions to a public more willing to accept numerically justifiable, quantitative conclusions.

Interestingly, academic proponents of cost-benefit analysis and the precautionary principle both make the case that their approach is the more progressive. On one hand, cost-benefit analysis is a helpful tool because we can use it to make informed, rational decisions that rise above of cognitive errors.[95] On the other hand, "[t]he emergence of the precautionary principle is a classic example of social learning in environmental affairs…. Societies, like individuals, are capable of evolving more sophisticated means of cognition…. Precaution is a corrective factor built into our societies' means of environmental cognition."[96] Precaution is already embedded in some of America's most hallowed environmental laws, as mentioned previously. It is also "a settled matter of

[92] Ibid. 12
[93] Whiteside 57
[94] Ibid. 57
[95] Sunstein 2002
[96] Whiteside 146

international law," specifically under the United Nations Framework Convention on Climate Change, which "include[s] a version of the precautionary principle as a mandatory guide to all nations that are parties to the UNFCCC."[97] The oxymoronic phrase "mandatory guide" aside, it is remarkable that such language made its way into the document at all. Its inclusion marks a shift in human perception of our own capabilities. After at least two centuries marked by both the rhetoric and industrial-scale evidence of human dominion over the earth, "[f]or the first time, progress consists in recognizing our inability to master the world"[98].

Institutionalized precaution in political and regulatory structures naturally follows theoretical discourse: "creating new institutional structures that promote precaution" is an important step towards making precautionary decision-making habitual.[99] But doing so has the potential of sapping the method's strength, since institutionalized precaution would face disciplinary demands. The pressure "to transform it into easily performable bureaucratic routines that can survive judicial review and meet citizens' demands for objectivity [would] prove irresistible," and the method might "lose the active engagement with the uncertain and the unfathomable, and the commitment to moral reflection."[100]

This rather defeatist viewpoint—that precaution must be embedded in decision-making institutions if we are to be expected to consistently make acceptable policy decisions but that the very act of institutionalizing it might defeat the purpose—brings us to an evaluation of the potentials for operationalization of the two analytical methods of cost-benefit analysis and the precautionary principle.

---

[97] Brown 142
[98] Whiteside xiii
[99] Jasanoff 237
[100] Ibid. 237

CHAPTER 4: ANALYSIS AND EVALUATION

The object of this analysis is to synthesize the preceding theory of cost-benefit analysis and precaution, exploring what differentiates and what connects them, through considering the role of the decision-maker's perception of human rationality in analyzing risk and uncertainty. Running below the surface of this analysis are questions about the value of these theories to practitioners tackling complex problems like climate change in real life. Do decision-makers know enough through intuition and experience that they needn't rely on theory put forth by academics? Should we concern ourselves with developing perfectly descriptive models in the theoretical realm, and should we make an effort to match practice to normative theories? And if so, which ones? In short, do the theories analyzed here amount to a kind of cohesive manifesto that should be paid any heed by practitioners? Furthermore, we should consider the utility and relevance of these normative conclusions in the context of climate change regulation.

For now, I must believe that consideration of the theory—leading either to its ultimate adoption or dismissal—is valuable. It is worth reiterating here that this document reflects the transitional stage of its author, versed in academic theory and poised to enter the real world of the practitioner. From this vantage point, I can only analyze practice by pointing out theory; I cannot do the reverse and draw on experience and practice to critique theory. This chapter imagines how future decisions might be formed. Rhetorical questions that are unanswerable from my current standpoint (or perhaps from anyone's) are reserved for the list of guiding questions in Chapter 5. The experience needed to discern the actual limitations on operationalizing theory is currently missing, but hopefully yet to come.

Analysis of Cost-Benefit Analysis and Precaution

I disbelieve that optimal regulations can be achieved simply by following a linear, quantitative method of integrating the best available scientific evidence and accounting for costs and benefits. Numbers are valuable insofar as they are the most able to stolidly rebuff challenges, including legal ones, to their validity. It is true that they facilitate negotiation, an important advantage in a world with finite resources in which we must consider tradeoffs carefully. Numbers can add to our store of knowledge, decreasing the amount of things that remain outside our comprehension. But there will still be a gap in which uncertainty remains. And even numbers that constitute our knowledge should be questioned. Quantification of all relevant aspects—of intangible, incommensurable social costs and benefits—is not inevitable; it is contextually driven. It may resolve some debates by reducing unknown risks, but after a point, quantification can only serve to further complicate the debate. Valuation and monetization of extreme intangibles, as we see so often in the case of climate change, is not always helpful to a regulatory discussion: factors can be "on screen" and have recognized value without bearing an explicit price tag. There are some debates that must be argued without numbers, along metrics that cost-benefit analysis does not and cannot speak to, such as distribution, justice, and ethics. These are uncomfortably vague terms, of course, but attaching a number to them will make them only more unwieldy, not any more manageable. Crafting an appropriate policy is not simply a matter of demanding more research and collecting more information in the hopes of being able to quantify a greater slice of the uncertainty. To a point this will serve, but thereafter, the marginal benefit received from the extra knowledge is not worth the marginal cost of collecting it.

Decision-makers should carefully consider the role they allow cost-benefit analysis to play in their decision-making process. They should evaluate how successfully they believe cost-benefit analysis captures and values complex, intangible costs and benefits. If not very successfully, then the decision-maker should seek some method of more comprehensively valuing those features. For some, this may be a method of modified cost-benefit analysis, a "comprehensive" cost-benefit analysis that incorporates qualitative as well as strictly quantitative factors into its calculations.

Cost-benefit analysis and the precautionary principle imply differing mindsets on rationality and its ability to cope with uncertainty. It may be tempting to conceptualize cost-benefit analysis and the precautionary principle as contrasting methodologies; indeed in their most reductionist, extreme theoretical forms, this may be true. It will be more useful, however, to think of these two approaches as situated not in opposition, but towards the ends of a spectrum, a sliding scale of greater to lesser integration of precaution.

A Spectrum of Precaution

It is important to recognize that cost-benefit analysis is not synonymous with quantitative analysis; nor is the precautionary principle synonymous with qualitative analysis. Characteristics of quantitative analysis include: valuation, monetization, cardinal comparison and ranking, and the assumption of commensurability. Qualitative analysis is marked by: description, estimation, ordinal comparison and ranking, and the assumption of incommensurability. Both quantitative and qualitative analyses are both inevitably influenced by human fallibility and subjectivity. While cost-benefit analysis

may lie closer to the quantitative analysis end of the spectrum and the precautionary principle closer to the qualitative, there is still a considerable gray area of overlap between the goals of cost-benefit analysis and of the precautionary principle. The two extremes are politically untenable. A regulation based on cold numerical analysis alone would fail to impress citizens who are also concerned with non-utilitarian values such as morality; a regulation based on nothing more than the decision-makers' opinions about what is important with no attempt made at numerical justification would be rejected because those same citizens also care about the decision's economic impacts. But decision-makers are more subtle and can walk this fine line. We can conceive of a kind of decision-making for regulating risk that merges quantitative and qualitative analysis: less strict, more comprehensive cost-benefit analysis that can also exhibit the characteristics of qualitative analysis. Comprehensive cost-benefit analysis may describe, estimate, rank ordinally, and acknowledge the incommensurability of certain factors. We would expect most decision-making on climate change regulation to lie somewhere in the middle of the spectrum, occurring in an environment of comingling assessment methodologies, integrating precaution into numerical calculations, qualitatively accounting for any remaining, incommensurate anticipated costs and benefits, as well as incommensurate, unanticipated, uncertain risk. The calculation would be comprehensive and cautious.

What can we call this gray area? Proponents of cost-benefit analysis might insist that it is still cost-benefit analysis, with precaution sprinkled throughout. Precautionary supporters might say that the principal mode of decision-making thought is caution, aided along by quantification. It may even be possible for the same decision-making behavior

to be called both cost-benefit analysis and the precautionary principle in action by different theorists in a term turf war.

This spectrum from more or less integration of precaution is matched by—is in fact generated by—a corresponding sliding scale of faith in human rationality in the decision-making process.

A Spectrum of Rationality

The active, if tautological, phrase "decision-makers make decisions" is a more evocative and accurate conceptualization of the process than the passive "decisions are made." It serves to indicate that decisions do not make themselves; fallible humans are in the driver's seat, making, even with their best ability, only an attempt at objectivity, and having, even with their best intentions, only aspirations towards complete rationality. Humans are fallible. Is fully "rational" decision-making possible?

Where along the quantitative-qualitative spectrum of the integration of precaution decision-makers choose the locus for their own decision-making depends upon where they situate themselves along the spectrum of faith in human rationality. How we make decisions relates back to our confidence in ourselves, in our scientific investigative abilities, and in linear, inclusive, rational thought to enable us to make optimal decisions. If we believe that we are highly capable of rational decision-making, then we will believe more strongly that costs and benefits are commensurable, that they can be valued, monetized, and compared. We will be towards the quantitative end of the spectrum, with comparatively less integrated precaution. If, on the other hand, we believe that our rationality is bounded and our decision-making flawed, we will believe more strongly

that the world around us is incommensurable, that we should not attempt to rank cardinally, but should instead rely on description and ordinal comparison, doing so in a cautious way, fully conscious that we are not and cannot be in full possession of the facts, and that we do not know all we need to know to make a perfectly optimal decision. We will be towards the qualitative end of the spectrum, with greater integrated precaution.

As optimal a decision as we can make—that is, a satisfactory decision—will be based on a healthy attitude towards rationality. The case is clear that we should not expect our rationality to be perfect, much as we would like it to. For anyone to assume that he is a perfectly rational man would be hubris. If we accept human fallibility, there are important decision-making implications. The solution is not to abandon all hope of rationality; clearly the tools we have developed are an aid to rational thought. We can assume some but not perfect rationality. This translates into a decision-making technique that integrates a combination of quantitative and qualitative analysis, highlighting the importance of integrating precaution throughout the decision-making process, including into cost-benefit calculations. Middling faith in human rationality acknowledges the inability to rationalize perfectly. A conscious awareness that we cannot know the full consequences of our policy choices is requisite for appropriate decision-making. Acknowledge uncertainty and the lack of perfect rationality. Be well informed, but be both cautious about the knowledge acquired and the unknowns that remain. A decision-maker who airs, to himself and to constituents, the assumptions made in the scientific process and in the social scientific political process, recognizing and owning up to any uncertainties, will stand the best chance of achieving a satisfactory policy. The perfectly rational man paradigm is not useful—it is unattainable, and pulls attention excessively

towards the quantitative end of the spectrum, away from the middle where decisions may be more appropriately made. It is in the middle of the spectrums of rationality and of precaution that we satisfice.

In the case of climate change in particular, the magnitude and intricacy of the problem would seem to advise that our confidence in our ability to master the complexity and reduce uncertainty be correspondingly low. Our traditional rational decision-making models are simply not built to deal with a crisis of this scale. Consequently, decision-makers should integrate more precaution into both their cost-benefit analysis and in those regions where cost-benefit analysis cannot extend, relying on qualitative or descriptive analysis to paint a fuller picture of the policy alternatives and consequences.

CHAPTER 5: GUIDING PRINCIPLES AND QUESTIONS

The hypothetical question, "What would I do if I were in a position to make these decisions?" seems less and less hypothetical all the time. The hope is that some day it will not be hypothetical at all. This leap from academic theory into practice is exciting, but slightly daunting. What *would* I in fact do if I were in a position to make these decisions? Also to the point, what do those currently in the position in fact do when they make these decisions?

What follows is a guide for "reflective practitioners"[101]—those who aspire to be better decision-makers through consciously reflecting on their thought processes and actions. The intent is to compile a list of normative suggestions for practitioners to be better and more effective. It is aimed primarily at an audience of newcomers to the field (it is at least partially intended as a personal document), but it could perhaps also be read by long-time practitioners to give them new eyes for looking at familiar situations. It is a tentative plan of action.

The goal is not to craft a "perfect" model for policy-making: the preceding discussion of rational decision-making would preclude that. The list is nonetheless intended to be a useful compilation of principles and questions derived from the theory, all speaking to how a reflective practitioner can best respond to academic theory, integrating it in part or in whole into their practice.

[101] Thanks to Professor Menefee-Libey for this useful term.

Guiding Principles

These principles are conclusions distilled from the preceding chapters' discussion and evaluation of theory. They are normative conclusions, principles which may be valuable to a decision-maker in moving forward in cases of uncertainty such as climate change. The caution included at the outset of this project is well remembered here: the conclusions reached are proffered suggestions, not dictums, accumulated by a student who has only theory, not yet experience, to bolster her claims.

- Numbers facilitate negotiation, but quantification is not inevitable, and in some cases may be extraneous or even deleterious to functional debates about non-utilitarian values, including justice and ethics.
- Precaution can be integrated throughout the information-gathering and decision-making process, not just after a threshold of uncertainty is reached.
- An individual decision-maker's level of faith in human rationality will influence to what extent they incorporate precaution into their decisions.
- Decision-makers will make the most socially acceptable decisions when they do not rely on humans' "omniscient rationality" and integrate comprehensive calculations and precaution accordingly.
- Decision-makers can confer with theorists and academics to debate the potential for operationalizing normative theory in practice, in order to ground their decisions—where intuition may desert them or prove inadequate—in sound policy theory.

Guiding Questions

What cannot be captured in principles may be left best expressed as questions. These are thoughts that cannot quite be confidently phrased as guiding principles. The questions take three forms: some questions are unanswered, the possible subject of future research and thought, or that may find resolution through situational context and experience. Some are unanswerable, irreducibly complex, but nonetheless worth asking repeatedly. A third type includes questions that a practitioner could ask to understand and situate herself in her agency context. In striving to be a better decision-maker, a reflective practitioner might ask:

- What does it mean to be a "better" decision-maker? "Better" with respect to what?
- What is the "best" policy? "Best" with respect to what?
- How do my personal values and agency culture shape my decision-making, and my determination of what a hypothetical optimal policy is?
- Does my knowledge of theory consciously influence my decisions?
- Should I endeavor to make practice match normative theories, and if so, which ones? Or is that impractical? How practical is the theory, and how much heed should I pay it? Do I know enough through experience and intuition to not need to rely on theory put forth by academics who have not had real-world exposure to the decision-making situations in which practitioners find themselves?
- Can I develop my intuition into a justifiable metric? If so, how?
- In what ways is a theoretical understanding inadequate to comprehend decision-making in the real world?

- To what extent does theory inform decisions made about climate change in the agency, and to what extent are the decisions made by intuition?
- What are my moral and ecosystemic worries and worst-case scenarios? Can they be minimized and avoided? If so, how?
- How can I use policy to narrow the gulf between the status quo and my imagined future desired world?
- How can I build personal and agency capacity to cope with uncertainty as comprehensively as possible?
- What are my individual coping strategies? In what ways do I characteristically cope with uncertainty to make a decision? Are my decisions more or less precautionary than those of my peers?
- How would I characterize the decision-making process in the agency? Do I feel that this decision-making process results in satisfactory decisions? If not, what procedural and substantive obstacles in the decision-making process exist that prevent reaching those decisions? Can these obstacles be minimized or removed? In an ideal world, what would my decision-making process be, and what real-world factors thwart that?
- Do I consider myself a pragmatist or an idealist? How does this affect how I respond to uncertainty?
- How do I feel about the compromises that I have to make in view of the seriousness and urgency of climate change?
- Does the process of vetting decisions to the public have the effect of introducing more precautionary buffers into calculations?

CONCLUSION

Public policy is not produced by a single, monolithic entity. Ultimately, individuals facing personal and institutional constraints are responsible for making complex decisions employing both quantitative and qualitative, and more or less precautious, methods of analysis in a way consistent with their personal and institutional faith in the ability of human rationality to conceptualize difficult problems. Regardless of where on the scale of rationality and the corresponding scale of precaution a decision-maker may be, those parameters which they use in their assessment are "pivotal and have important normative implications" for policy creation and implementation.[102]

Despite the room for decision-making discretion, even creativity, there is, of course, reason to be less than thrilled about the prospect of having to make these high-stakes policy decisions on climate change. The realm of public policy in general, and perhaps especially so for climate change regulation, is "'is a world of settled institutions designed to allow imperfect people to use flawed procedures to cope with insoluble problems.'"[103] We could also suppose that "[a] wise policy maker will not even try for completion."[104] Nevertheless, the challenge of making the "best" decision is an irresistible siren song, and the appeal of the pernicious problem of climate change is magnetic.

[102] Christoforou 35
[103] Lindblom 1993 72
[104] Lindblom 1968 14

WORKS CITED

Bardach, Eugene. *A Practical Guide for Policy Analysis: The Eightfold Path to More Effective Problem Solving*. 3rd ed. Washington, D.C.: CQ Press, 2009. Print.

Brown, Donald. "The Precautionary Principle as a Guide to Environmental Impact Analysis: Lessons Learned from Global Warming." Tickner 141-156.

Christoforou, Theofanis. "The Precautionary Principle, Risk Assessment, and the Comparative Role of Science in the European Community and the US Legal Systems." *Green Giants?: Environmental Policies of the United States and the European Union*. Eds. Norman J. Vig and Michael G. Faure. Cambridge, Massachusetts: The MIT Press, 2004. 17-51. Print.

Jasanoff, Sheila. "A Living Legacy: The Precautionary Ideal in American Law." Tickner 227-240.

Lindblom, Charles and Edward J. Woodhouse. *The Policy-Making Process*. 3rd ed. Englewood Cliffs, New Jersey: Prentice Hall, 1993. Print.

-----. *The Policy-Making Process*. Englewood Cliffs, New Jersey: Prentice Hall, 1968. Print.

March, James G. "Bounded Rationality, Ambiguity, and the Engineering of Choice." *Rational Choice*. Jon Elster, ed. New York: New York University Press, 1986. Print. Readings in Social and Political Theory. 142-170.

-----. "Understanding how decisions happen in organizations." *Organizational Decision Making*. Zur Shapira, ed. United States of America: Cambridge University Press, 1997. 9-32. Print.

O'Brien, Mary. "Science in the Service of Good: The Precautionary Principle and

Positive Goals." Tickner 279-296.

Peters, B. Guy. *American Public Policy: Promise & Performance*. 8th ed. Washington, D.C.: CQ Press, 2010. Print.

Rubinstein, Ariel. *Modeling Bounded Rationality*. Cambridge, Massachusetts: The MIT Press, 1998. Print.

Simon, Herbert. With Massimo Egidi, Robin Marris and Riccardo Viale. *Economics, Bounded Rationality and the Cognitive Revolution*. Massimo Egidi and Robin Marris, eds. Worcester, Great Britain: Billing and Sons Ltd., 1992. Print.

Sunstein, Cass. "Cost-Benefit Analysis and the Environment." *Ethics* Jan. 2005: 351–385. Web. 3 Dec. 2012. <http://www.masonlec.org/wp-content/uploads/2011/06/C-B-Analysis-and-the-Environment.pdf>.

-----. *Risk and Reason: Safety, Law, and the Environment*. Cambridge, United Kingdom: Cambridge University Press, 2002. Print.

-----. *Worst-Case Scenario*s. Cambridge, Massachusetts: Harvard University Press, 2007. Print.

Tickner, Joel A. ed. *Precaution, Environmental Science, and Preventive Public Policy*. Washington: Island Press, 2003. Print.

-----. "The Role of Environmental Science in Precautionary Decision-Making." Tickner 3-10.

Whiteside, Kerry H. *Precautionary Politics: Principle and Practice in Confronting Environmental Risk*. Cambridge, Massachusetts: The MIT Press, 2006. Print.

Woodward, Alistair. "Uncertainty and Global Climate Change: The Case of Mosquitoes and Mosquito-Borne Disease." Tickner 127-140.