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Beyond Wickedness: Managing Complex Systems and Climate Change

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I. INTRODUCTION

“Everything that is, is wicked” — Giacomo Leopardi¹

“You must go on. I can’t go on. I’ll go on.” — Samuel Beckett²

The literature on policymaking for technically complex problems is rife with jargon for describing two fundamental challenges: First, natural science and engineering can very accurately describe the behavior of physical systems under controlled conditions, but cannot answer normative and political questions regarding what goals a policy ought to aim for; and second, while science can describe the behavior of a system, if the system is complex, it may not be feasible to predict its future behavior. Widely used terminology for such policymaking conundrums includes “trans-science,”³ “wicked problems,”⁴ “post-normal science,”⁵ “regulatory

¹ Adam Kirsch, *Under the Volcano*, THE NEW YORKER (Oct. 25, 2010), <https://www.newyorker.com/magazine/2010/10/25/under-the-volcano-adam-kirsch> [<https://perma.cc/8Y7Z-T8KB>] (quoting GIACOMO LEOPARDI, ZIBALDONE (Michael Caesar & Franco D’Intino eds., Farrar, Straus & Giroux rev. ed. 2015) (1898)).

² SAMUEL BECKETT, THE UNNAMABLE 577 (Samuel Beckett trans., Grove Press 1st ed. 1959) (1958)

³ See Alvin M. Weinberg, *Science and Trans-Science*, 10 MINERVA 209, 209 (2009):

Many of the issues which arise in the course of the interaction between science or technology and society—e.g., the deleterious side effects of technology, or the attempts to deal with social problems through the procedures of science—hang on the answers to questions which can be asked of science and yet *which cannot be answered by science*. I propose the term *trans-scientific* for these questions since, though they are, epistemologically speaking, questions of fact and can be stated in the language of science, they are unanswerable by science; they transcend science.

⁴ See Horst W. J. Rittel & Melvin M. Webber, Abstract, *Dilemmas in a General Theory of Planning*, 4 POL’Y SCI. 155, 155 (1973) (“The search for scientific bases for confronting problems of social policy is bound to fail, because of the nature of these problems. They are ‘wicked’ problems, whereas science has developed to deal with ‘tame’ problems.”); See also, C. West Churchman, *Guest Editorial: Wicked Problems*, 14 MGMT. SCI. B-141, B-141 (1967) (describing “wicked problems” as “that class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing”).

⁵ See Silvio O. Funtowicz & Jerome R. Ravetz, *Science for the Post-Normal Age*, 25 FUTURES 739, 744 (1993):

To characterize an issue involving risk and the environment, in what we call “post-normal science”, we can think of it as one where facts are uncertain, values in dispute, stakes high and decisions urgent. In such a case, the term ‘problem’, with its connotations of an exercise where a defined methodology is likely to lead to a clear solution, is less appropriate.

science,”⁶ “boundary work,”⁷ “scientizing” policy debates,⁸ and “stealth issue advocacy.”⁹ Of these terms and concepts, “wicked problem” has been widely adopted, perhaps because of the frisson of the word “wicked.”

Despite its wide use over half a century, both the definition of “wicked problem” and its lessons for planning remain disputed and unclear. Some analysts have embraced the notion of “wickedness” and even extended it to characterize “super-wicked” problems, such as climate change, which they see as even more

⁶ See Alvin M. Weinberg, *Science and Its Limits: The Regulator's Dilemma*, 2 ISSUES SCI. & TECH. 59, 68 (1985):

One way to deal with these assaults on scientists and scientific truth would be to define a new branch of science, called regulatory science, in which the norms of scientific proof are less demanding than are the norms in ordinary science. I should think that a far more honest and straightforward way of dealing with the intrinsic inability of science to predict the occurrence of rare events is to concede this limitation and not to ask of science or scientists more than they are capable of providing. Instead of asking science for answers to unanswerable questions, regulators should be content with less far-reaching answers.

⁷ See SHEILA JASANOFF, *THE FIFTH BRANCH: SCIENCE ADVISERS AS POLICYMAKERS* 14 (1990):

[S]cientists use a variety of boundary-defining strategies to establish who is in and who is out of relevant peer groups and networks of prestige or authority. The most consequential—and exclusionary—of all possible boundaries is that between “science” and other systems of cognitive authority, such as religion or law.

⁸ See Daniel Sarewitz, *How Science Makes Environmental Controversies Worse*, 7 ENVTL. SCI. & POL’Y 385, 386 (2004):

The argument, in brief, is this: nature itself—the reality out there—is sufficiently rich and complex to support a science enterprise of enormous methodological, disciplinary, and institutional diversity. I will argue that science, in doing its job well, presents this richness, through a proliferation of facts assembled via a variety of disciplinary lenses, in ways that can legitimately support, and are causally indistinguishable from, a range of competing, value-based political positions. I then show that, from this perspective, scientific uncertainty, which so often occupies a central place in environmental controversies, can be understood not as a lack of scientific understanding but as the lack of coherence among competing scientific understandings.

⁹ See ROGER A. PIELKE, JR., *THE HONEST BROKER: MAKING SENSE OF SCIENCE IN POLICY AND POLITICS* 94 (2007) (“Stealth issue advocacy refers to situations in which one claims to be serving as a Pure Scientist or Science Arbiter, but instead is focused on reducing the scope of choice available to decision-makers, which is the defining characteristic of an Issue Advocate.”).

intractable than merely wicked ones.¹⁰ Others criticize the conceptual coherence of wickedness, arguing that it rests on a confused notion of the relationships between natural and social sciences and between systems analysis and policy practice.¹¹ Others see that lack of coherence and clear definition as a deliberate response to overly formal methods of policy analysis.¹²

Horst Rittel and Melvin Webber introduced the term “wicked problem” in 1973, posing a stark distinction between “tame” and “wicked” problems in policy and planning—a dichotomy that has not held up well.¹³ Some critics suggest that the original definition, which characterized tame problems as those that could be solved by purely scientific or technical procedures and wicked problems as those that contained an irreducibly normative or political component, in essence defined all nontrivial policy problems as wicked.¹⁴ Other critics argue that Rittel and Webber’s

¹⁰ See Kelly Levin, Benjamin Cashore, Steven Bernstein & Graeme Auld, *Overcoming the Tragedy of Super Wicked Problems: Constraining Our Future Selves to Ameliorate Global Climate Change*, 45 POL’Y SCI. 123, 124 (2012) [*Overcoming the Tragedy*] (“Super wicked problems comprise four key features: time is running out; those who cause the problem also seek to provide a solution; the central authority needed to address them is weak or non-existent; and irrational discounting occurs that pushes responses into the future.”); see also Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153, 1157 (2008) (asserting that “[c]limate change legislation is especially vulnerable to being unraveled over time for a variety of reasons, but especially because of the extent to which it imposes costs on the short term for the realization of benefits many decades and sometimes centuries later.”); Kelly Levin, Benjamin Cashore, Steven Bernstein & Graeme Auld, *Playing it Forward: Path Dependency, Progressive Incrementalism, and the “Super Wicked” Problem of Global Climate Change*, 6 IOP CONF. SERIES: EARTH & ENVTL. SCI. 502002, 502002 (2009) [hereinafter *Playing it Forward*] (explaining that solving super wicked problems may require significant interventions long before the negative consequences manifest themselves).

¹¹ See Nick Turnbull & Robert Hoppe, *Problematising ‘Wickedness’: a Critique of the Wicked Problems Concept, from Philosophy to Practice*, 38 POL’Y & SOC’Y 315, 316 (2019) (“Contrary to many ‘wicked problem’ scholars, we conclude that there is no special ontological class of ‘wicked’ problems, and therefore these require no special research program, nor special approaches to problem solving.”); see also Catrien J. A. M. Termeer, Art Dewulf, & Robbert Biesbroek, *A Critical Assessment of the Wicked Problem Concept: Relevance and Usefulness for Policy Science and Practice*, 38 POL’Y & SOC’Y 167, 176 (2019) (explaining that, while furthering research in a number of fields, the notion of wicked problems has simultaneously created conceptual confusion).

¹² See Mirko Noordegraaf, Scott Douglas, Karin Geuijen, & Martijn Van Der Steen., *Weaknesses of Wickedness: a Critical Perspective on Wickedness Theory*, 38 POL’Y & SOC’Y 278, 281 (2019) (“Wickedness was formulated on the 1960s campus of UC Berkeley as a playful and intentionally abstract answer to the attempt of the government in Washington to slice and dice, structure and rationalize world problems. The fundamental strength of wickedness theory is that it replaces this technocratic response with a more holistic overview of the divisive mechanisms at play . . .”).

¹³ Rittel & Webber, *supra* note 4, at 155.

¹⁴ See Turnbull & Hoppe, *supra* note 11, at 318 (“Wicked problems are not, in fact limited

ten criteria of wickedness are too restrictive, so almost no problems satisfy the definition.¹⁵ Still others take a middle ground, seeing value in the conceptual perspective of wickedness, but finding that it is too extreme in categorizing problems as either “tame” or “wicked” and arguing for a more “finely grained” approach with different degrees and qualities of wickedness.¹⁶

The wicked problem concept emerged at a time of pessimism about progress. It was a time characterized by what Ulrich Beck and Anthony Giddens would later dub “reflexive modernization,” in which the Enlightenment’s project of rationality would turn its skeptical eye inward and critically analyze itself.¹⁷ In Beck’s analysis, the principal economic challenge had transformed from managing the distribution of scarce goods in early modernity to managing the distribution of abundant technological risks in late modernity.¹⁸ A few years earlier, the first Earth Day had mobilized an estimated 20 million Americans to demand action on pollution and environmental degradation.¹⁹ No wonder, then, Rittel and Webber presented pollution as a wicked problem.²⁰

More broadly, faith in rational management of societal problems had been badly eroded. A year before Rittel and Webber’s *Wicked Problems* paper, David Halberstam published *The Best and the Brightest*, in which he portrayed a group of accomplished technocratic leaders from industry and academia leading the United States into a tragic “quagmire” in the Vietnam War with “brilliant policies that

to particular types of problems. It is *societal problems in general* that belong in the wicked category, in stark contrast to the solvable mathematical problems of engineers, e.g., ‘Planning problems are *inherently wicked*.’”).

¹⁵ See B. Guy Peters & Matthew Tarpey, *Are Wicked Problems Really So Wicked? Perceptions of Policy Problems*, 38 POL’Y & SOC’Y 218, 222–25 (2019) (“Having this extensive list of attributes means that relatively few problems actually will fit the full definition.”).

¹⁶ See John Alford & Brian W. Head, *Wicked and Less Wicked Problems: a Typology and a Contingency Framework*, 36 POL’Y & SOC’Y 397, 398 (2017) (explaining that the term “wicked problem” is overused, and that a “more finely grained manner” must be employed to gain deeper insight into the nature of such problems); see also Peters & Tarpey, *supra* note 15, at 222–25 (finding little unified consensus on what constitutes a wicked problem); Noordegraaf & Douglas et al., *supra* note 12, at 281 (explaining that wicked problems were intentionally understood abstractly at their genesis).

¹⁷ See ULRICH BECK, *RISK SOCIETY: TOWARDS A NEW MODERNITY* 19–24 (Mark Ritter trans., Sage Publications 1st ed. 1992) (1986); ULRICH BECK, ANTHONY GIDDENS & SCOTT LASH, *REFLEXIVE MODERNIZATION: POLITICS, TRADITION AND AESTHETICS IN THE MODERN SOCIAL ORDER* 2–3 (1994).

¹⁸ BECK, *supra* note 17 at 19 (“In advanced modernity the social production of wealth is systematically accompanied by the social production of risks. Accordingly, the problems and conflicts relating to distribution in a society of scarcity overlap with the problems and conflicts that arise from the production, definition, and distribution of techno-scientifically produced risks”).

¹⁹ Jack Lewis, *The Birth of EPA*, EPA J., Nov. 1985, at 7.

²⁰ See Rittel & Webber, *supra* note 4, at 168 (“Now, when it is recognized that raw materials that enter the economy end up as residuals polluting the air mantle and the rivers, many are becoming wary of rising manufacturing production.”).

defied common sense.”²¹ A year earlier, the Club of Rome had released its report, *Limits to Growth*, which turned rational mathematical systems analysis against itself, predicting that technological progress could very well lead not to prosperity and security, but to scarcity and collapse.²² And as the *Wicked Problems* paper went to press, Robert Caro was putting the finishing touches on his devastating biography of Robert Moses, *The Power Broker*, in which he described the hubris and fall from glory of the most prominent city planner of the 20th century.²³ Although they would not have read *The Power Broker*, as city planners Rittel and Webber would surely have been intimately acquainted with the harsh turn of both public and expert opinion against Moses and his approach to planning.

In this Article, we argue that the wicked problem is best viewed as a rhetorical device that served a valuable function in the early 1970s, arguing against technocratic hubris, but that it is unhelpful and indeed counterproductive as a tool for policy analysis. Climate change has often been treated as a paradigmatic wicked problem because both its causes and its consequences permeate deeply into many aspects of society and the economy and leave no clear boundary between the scientific and normative aspects. However, characterizing climate change as wicked does little more than highlight the difficulty of the problem and does not offer much practical guidance for managing it. In contrast, we find that Charles Lindblom’s “science of muddling through” both supports the same rhetorical points for which the original wicked problem concept was introduced and supports a pragmatic and useful approach to making policy for complex and messy environmental problems.²⁴

II. FROM WICKEDNESS TO PARALYSIS

The historical moment when Rittel and Webber wrote *Dilemmas in a General Theory of Planning*²⁵ was characterized by a growing skepticism toward technocratic optimism, a growing awareness of complexity in systems and its implications for the predictive power of quantitative mathematical analysis, and growing political demands from the public for accountability on the part of planners

²¹ DAVID HALBERSTAM, *THE BEST AND THE BRIGHTEST* 578, 580 (1969).

²² See DONELLA H. MEADOWS, DENNIS L. MEADOWS, JØRGEN RANDERS & WILLIAM W. BEHRENS III, *LIMITS TO GROWTH* 23 (1972) (“If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity.”).

²³ See ROBERT A. CARO, *THE POWER BROKER: ROBERT MOSES AND THE FALL OF NEW YORK* 18–21 (1974) (explaining how the idealism of Moses’ movement slowly devolved into a mere play for power).

²⁴ See Charles E. Lindblom, *The Science of “Muddling Through”*, 19 PUB. ADMIN. REV. 79, 79–88 (1959) [hereinafter Lindblom, *Muddling Through*]; Charles E. Lindblom, *Still Muddling, Not Yet Through*, 39 PUB. ADMIN. REV. 517, 517–526 (1979) [hereinafter Lindblom, *Still Muddling*].

²⁵ Rittel & Webber, *supra* note 4.

and policymakers.²⁶ The paper does not merely describe a dilemma, but represents a polemical attack on rational systems analysis as a method for planning.²⁷ As such, the paper provides no positive guidance for the planner, but presents an inescapable Slough of Despond in which planners are doomed to failure no matter what they do.

Rittel and Webber's ten criteria continue to be used widely to define wickedness:

1. There is no definite formulation of the problem so different stakeholders have different criteria for what the goals of a response should be.
2. There is no stopping rule.
3. Solutions are not true or false, but better or worse.
4. There is no immediate or long-term test for evaluating solutions.
5. Any possible response to the problem is a "one-shot operation" that may fundamentally and irreversibly change the nature of the problem.
6. There is not a manageable set of possible responses to compare and choose from; the domain of possible responses is large and possibly infinite.
7. Every wicked problem is essentially unique, so there is no opportunity to learn from experience with other problems.
8. Every wicked problem may be the symptom of another problem, so responses are doomed to managing symptoms rather than root causes.
9. There are multiple competing explanations for what causes any wicked problem.
10. The political context is sufficiently fraught that the public will not tolerate mistakes or failures by the planner.²⁸

Three crucial properties stand out from this list and render wicked problems especially intractable: First, the seventh criterion, "every wicked problem is essentially unique," limits planners' ability to use their experience with other problems to guide their response to a new problem.²⁹

Second, the third and fourth items in the list imply that "there is no opportunity to learn by trial-and-error."³⁰ We cannot know how well an action is doing at solving the problem and even if we could, the irreversible effects of interventions make it impossible to back off from an action that is not working. This property is an extreme case of the more general principle of path dependence. As city planners themselves, Rittel and Webber illustrate the "one-shot" nature of interventions by observing that "one cannot build a freeway to see how it works and then easily correct it after

²⁶ See Turnbull and Hoppe, *supra* note 11, at 326–27 ("Scientists carefully craft their 'tame' or 'well-structured' problems in such a way that scientific methods are effective as justifications of their answers.").

²⁷ Noordegraaf et al., *supra* note 12 at 281 ("However, this abstract view also means wickedness can remain removed from daily practices, people, and places.").

²⁸ Peters & Tarpey, *supra* note 15, at 236 (summarizing the ten criteria in Rittel & Webber, *supra* note 4).

²⁹ Rittel & Webber, *supra* note 4, at 164.

³⁰ *Id.* at 162–63.

unsatisfactory performance.”³¹ It is tempting to imagine them thinking, as they wrote this, about Robert Moses’s Cross-Bronx Expressway, which was proposed and designed as an expression of rational technocratic efficiency applied to traffic flow, but without consideration of the devastating impact it would have on neighborhoods in the South Bronx.³² However, Webber was known for his automobile-centric approach to urban design,³³ and his paradigmatic example, in the early 1970s, of a failed large transportation project that could not be undone was the Bay Area Rapid Transit System.³⁴

Third, the tenth item on the list states that “the planner has no right to be wrong.”³⁵ Where the previous two properties reflected technical characteristics of complex systems, this one reflects a political context in which the public is agitated, unforgiving, and prone to judge planners only on results with no credit for honest and skillful, but imperfect, efforts.

The combination of a harshly judgmental and unforgiving public with an inability to learn from experience—either from working on previous wicked problems or from trial and error applied to the current one—dooms the planner to failure. Indeed, several policy analysts have declared that climate change “is a sort of ‘wicked problem’ that lacks anything resembling a solution.”³⁶ This perspective leads many who adopt it to seek to remove the wickedness with grand technological fixes, such as innovations that would make clean energy cheaper and easier to use than fossil fuels.³⁷

Critics of wickedness have commented at length about this dilemma of either responding to wickedness with a sense of defeat and paralysis, or else looking for a

³¹ *Id.* at 163.

³² See CARO, *supra* note 23, at 885–894 (providing an in-depth description of the tremendously expensive construction of the Cross-Bronx Expressway).

³³ Michael B. Teitz, *Melvin Webber and the “Nonplace Urban Realm,”* ACCESS, Winter 2006–2007, at 29, 34 (“The continuing growth of suburbia and of automobile dominance also seems to bear out Mel Webber’s vision of what was important in shaping urban growth in the 20th century.”).

³⁴ Teitz, *supra* note 33, at 14; Melvin M. Webber, *The Urban Place and the Non-place Urban Realm*, in EXPLORATIONS INTO URBAN STRUCTURE 79, 139–44 (Melvin M. Webber ed., 1964); Melvin M. Webber, *Order in Diversity: Community without Propinquity*, in CITIES AND SPACE: THE FUTURE USE OF URBAN LAND 23, 33–38 (Lowdon Wingo, Jr. ed., 1963).

³⁵ Rittel & Webber, *supra* note 4 at 166–167.

³⁶ ROGER PIELKE, JR., THE CLIMATE FIX: WHAT SCIENTISTS AND POLITICIANS WON’T TELL YOU ABOUT GLOBAL WARMING 122 (2010); see also MIKE HULME, WHY WE DISAGREE ABOUT CLIMATE CHANGE: UNDERSTANDING CONTROVERSY, INACTION AND OPPORTUNITY 336 (4th ed. 2009) (“[S]etting the overarching goal of humanity as the restabilisation of climate will, I believe, lead to disillusionment.”).

³⁷ PIELKE, *supra* note 36; see also GWYN PRINS, ISABEL GALIANA, CHRISTOPHER GREEN, REINER GRUNDMANN, MIKE HULME, ATTE KORHOLA, FRANK LAIRD, TED NORDHAUS, ROGER PIELKE JR., STEVE RAYNER, DANIEL SAREWITZ, MICHAEL SHELLENBERGER, NICO STEHR & HIROYUKI TEZUKA, THE HARTWELL PAPER: A NEW DIRECTION FOR CLIMATE POLICY AFTER THE CRASH OF 2009, at 5 (2010) [hereinafter THE HARTWELL PAPER] (“The ultimate goal of doing this is to develop non-carbon energy supplies at unsubsidised costs less than those using fossil fuels.”).

grand technological fix that will render a wicked problem tame.³⁸ Catrien Termeer, Art Dewulf, and Robbert Biesbroek ask, “Does the concept of wicked problems help policymakers deal with complex challenges or does it merely paralyze them?”³⁹

To escape this dilemma, the literature overwhelmingly focuses on addressing the irreducible uncertainty in predicting the impacts of interventions by working in small incremental steps, frequently invoking Lindblom’s “muddling through” approach.⁴⁰ This approach suggests addressing the political challenges of poorly defined problem definitions and goals, and the high political cost of failure, by involving diverse stakeholders throughout the planning and response process. Incremental management of wicked problems allows midcourse adjustments to address both the technological uncertainty over whether an intervention will have the desired effect on the system, and the challenge of maintaining public support for the chosen policy. It also argues for including diverse participants to ensure that planners receive feedback about the political feasibility of proposed responses and about the public’s judgment of the results.

However, this muddling through approach is only possible if the most challenging—the wickedest—aspect of wicked problems is omitted: “Every solution to a wicked problem is a ‘one-shot operation’ ” with “no opportunity to learn by trial-and-error.”⁴¹ If we take this attribute of wickedness seriously, it rules out any opportunity for incremental management.

When incremental management is not feasible, neither are the sort of technological fixes commonly invoked to render wicked problems tame. Daniel Sarewitz and Richard Nelson offer three rules for determining whether a societal problem is amenable to a technological fix:

1. The technology must fit into a straightforward cause-and-effect relationship that connects the problem to the solution.

³⁸ See Catrien J. A. M. Termeer & Art Dewulf, *A Small Wins Framework to Overcome the Evaluation Paradox of Governing Wicked Problems*, 38 POL’Y & SOC’Y 298, 299 (2019) (“Paralysis occurs when people experience or define the wickedness as so overwhelming that it discourages them and prevents them from doing anything about it. . . . Overestimation is the belief that wicked problems can actually be solved, implying a focus on one aspect or a single standpoint.”); see also Turnbull & Hoppe, *supra* note 11, at 317 (“Critics have commented that the wicked problem idea is too totalizing, unhelpfully resisting analysis and promoting an impossible idea of ‘success’ ”).

³⁹ Termeer, Dewulf et. al, *supra* note 11, at 169.)

⁴⁰ See Levin et al., *Overcoming the Tragedy*, *supra* note 10 **Error! Bookmark not defined.**, at 148 (suggesting an “applied forward reasoning approach” that focuses on “progressive incrementalism” to fight super wicked problems); Termeer & Dewulf, *supra* note 38, at 303 (arguing that an incremental framework that seeks “small wins” is especially effective at addressing wicked problems); Judith E. Innes & David E. Booher, *Collaborative Rationality as a Strategy for Working with Wicked Problems*, 154 LANDSCAPE & URB. PLAN. 8, 9 (2016) (describing how “collaborative rationality” can make wicked problems more manageable by encouraging participants to set more realistic goals); Nancy Roberts, *Wicked Problems and Network Approaches to Resolution*, 1 INT’L PUB. MGMT. REV. 1, 15 (2000) (suggesting that we “trust the process” and start taking steps toward a solution when faced with a wicked problem, rather than try to come up with the perfect solution before acting).

⁴¹ Rittel & Webber, *supra* note 4, at 163.

2. It must be possible to assess the incremental effects of the technology as it is deployed.
3. The new technology itself must build incrementally upon an established base.⁴²

The influence of Sarewitz and Nelson's analysis is illustrated by Roger Pielke, who draws on Sarewitz's rules to argue that solar radiation management geoengineering ("SRM") is not a good candidate for a technological fix to climate change because it cannot be implemented incrementally, in small parts of the world, and because the variability of the climate system will make it impossible to assess its effects unambiguously.⁴³ Further, SRM fits the wicked criterion of being irreversible once it has been implemented,⁴⁴ which we will discuss at greater length below.

If technological fixes require incrementalism, then a truly wicked problem—one in which any intervention fundamentally and irreversibly changes the system so that learning from trial and error is impossible—is not suitable for any technological fix. Thus, a strict reading of Rittel and Webber's criteria leaves no escape from policy paralysis.

⁴² Daniel Sarewitz & Richard Nelson, *Three Rules for Technological Fixes*, 456 NATURE 871, 871–872 (2008). Sarewitz and Nelson address the feasibility of implementing a technological fix once it is chosen as a policy; assessing the political feasibility of enacting such a policy presents additional challenges outside the scope of Sarewitz and Nelson's analysis. For these political considerations see, for example, Edward A. Parson, *Climate Policymakers and Assessments Must Get Serious About Climate Engineering*, 114 PROC. NAT'L ACAD. SCIS. 9227 (2017); Daniel Edward Callies, *Institutional Legitimacy and Geoengineering Governance*, 21 ETHICS, POL'Y & ENV'T 324 (2019); JESSE L. REYNOLDS, THE GOVERNANCE OF SOLAR GEOENGINEERING: MANAGING CLIMATE CHANGE IN THE ANTHROPOCENE (2019); Simon Nicholson, Sikina Jinnah & Alexander Gillespie, *Solar Radiation Management: A Proposal for Immediate Polycentric Governance*, 18 CLIMATE POL'Y 322 (2018); and Sarah Burch, Aarti Gupta, Cristina Y.A. Inoue, Agni Kalfagianni, Åsa Persson, Andrea K. Gerlak, Atsushi Ishii, James Patterson, Jonathan Pickering, Michelle Scobie, Jeroen Van der Heijden, Joost Vervoort, Carolina Adler, Michael Bloomfield, Riyanti Djalante, John Dryzek, Victor Galaz, Christopher Gordon, Renée Harmon, Sikina Jinnah, Rakhyn E. Kim, Lennart Olsson, Judith Van Leeuwen, Vasna Ramasar, Paul Wapner & Ruben Zondervan, *New Directions in Earth System Governance Research*, EARTH SYS. GOVERNANCE, Jan. 2019, at 1.

⁴³ See PIELKE, *supra* note 36, at 130–132.

⁴⁴ For articles discussing the irreversibility of SRM, see, for example, Florian Rabitz, *Governing the Termination Problem in Solar Radiation Management*, 28 ENVTL. POL. 502 (2019); Catriona McKinnon, *Sleepwalking into Lock-In? Avoiding Wrongs to Future People in the Governance of Solar Radiation Management Research*, 28 ENVTL. POL. 441 (2019); Andy Parker & Peter J. Irvine, *The Risk of Termination Shock from Solar Geoengineering*, 6 EARTH'S FUTURE 456 (2018); and Alan Robock, Allison Marquardt, Ben Kravitz & Georgiy Stenchikov, *Benefits, Risks, and Costs of Stratospheric Geoengineering*, 36 GEOPHYSICAL RSCH. LETTERS L19703 (2009).

III. PARALYSIS AND THE RHETORIC OF REACTION

Rittel and Webber's writing betrays a nostalgia for planning by mathematical optimization, wherein the goals are clear and quantifiable and the planner can develop an optimal solution within the relevant constraints. They portray the challenge of wicked problems as almost entirely due to the messiness of human nature and human behavior: Behavior is not predictable or manipulable the way that physical objects and chemical reactions are. Preferences are changeable and inconsistent.

But it is well established that individual and collective human behavior is far more complex than Newtonian physics,⁴⁵ so critics remark that if wickedness is just a synonym for the presence of human behavior and values, then there is nothing distinctive in wickedness: "[T]he wicked/tame problem distinction is simply the old false distinction between social and natural sciences, rewritten in the language of policy and planning."⁴⁶

A great deal of the literature expands upon Rittel and Webber by adding nuance to the wicked/tame distinction. Rather than declaring problems to be categorically wicked or tame, many authors assess degrees of wickedness or qualitatively distinct types of wickedness.⁴⁷ However, if we start removing the distinctive criteria for wickedness, then it becomes harder to distinguish wicked problems from many of the other bits of jargon cited at the beginning of this Article, such as "trans-science" and "post-normal science." And where Rittel and Webber did not offer any guidance to applying the wicked problem concept to planning and policymaking, most of the authors of those other terms accompanied them with descriptions of how they could be applied in practice. To the extent that the distinctive characteristics of wickedness are watered down, it becomes less clear why the wicked problems framework is more useful than many other approaches to addressing tough planning and policy problems.

Experts are adding sophistication and nuance to the concept of wickedness, such as treating wickedness as a matter of degree rather than dichotomy. This literature also adds the concept of superwickedness for wicked problems that have additional constraints, including urgency driven by the fact that any delay makes the problem much harder to manage.⁴⁸ But a great deal of discourse, especially around climate change, continues to use Rittel and Webber's dichotomous treatment.

⁴⁵ See Weinberg, *supra* note 3, at 212–13 (describing the complexity of human behavior and the difficulty of studying it); Rittel & Webber, *supra* note 4, at 160–67 (explaining what makes problems related to human behavior more complex than problems based in mathematics and Newtonian physics).

⁴⁶ Turnbull & Hoppe, *supra* note 11, at 318; see also Noordegraaf et al., *supra* note 12, at 290–91 (describing the ways in which the practical limits on trust and collaboration tend to tame wicked problems by fragmenting opposition rather than by building consensus).

⁴⁷ On degrees of wickedness, see, for example, Termeer et al., *supra* note **Error! Bookmark not defined.**, at 171–172; and Brian W. Head & John Alford, *Wicked Problems: Implications for Public Policy and Management*, 47 ADMIN. & SOC'Y 711, 712 (2015). On qualitatively distinct types of wickedness, see, for example, Peters & Tarpey, *supra* note 15, at 223.

⁴⁸ See Lazarus, *supra* note 10, at 1160 (identifying climate change as a "super wicked

When a severe problem cannot be solved, when incremental management cannot learn by trial and error, and when time is running out, it is natural to feel paralyzed and defeated. A great deal of work on wicked problems addresses the danger of paralysis.⁴⁹ But outside the realm of specialists in planning and policy analysis, wickedness is often used rhetorically to argue against taking forceful measures or to make such actions seem futile or unattainable.

Examples of this rhetorical turn include Frank Incropera, who writes that the wicked nature of climate change means that “nothing less than a global sea change in cultural and behavioral norms” is sufficient to prevent the situation from becoming “hopeless.”⁵⁰ Mike Hulme does not say that it is futile to address climate change, but argues that the wickedness of the climate change implies that “setting the overarching goal of humanity as the restabilisation of climate will . . . lead to disillusionment.”⁵¹ Hulme further quotes Scott Hamilton, who writes that any attempt to govern or control climate change directly is fundamentally “broken, thereby engendering failure in a Sisyphean quest to fix what is conceptually unfixable.”⁵²

Atul Gawande observed a similar line of argument in U.S. healthcare policy, where the wickedness of public health policy is used to support a “rhetoric of intransigence” that opposes any proposed reform on the ground that it cannot work.⁵³ This suggests that the paralytic, defeatist aspects of the wicked problem paradigm may not be accidental. Rather than resulting unintentionally from a poor choice of analysis framework, the paralysis may be a desired outcome that motivates the choice to invoke wickedness.

Gawande connects the use of wickedness in justifying intransigence to a set of rhetorical tropes that A.O. Hirschman observed being deployed repeatedly through history to argue against the extension of citizenship to encompass all members of a nation.⁵⁴ Over the course of more than two centuries, proposals to expand the concept of citizenship to be more inclusive were frequently met with objections. These objections followed three distinct rhetorical tropes that Hirschman labeled futility, perversity, and jeopardy.⁵⁵

problem”); Levin et al., *Playing it Forward*, *supra* note 10, at 1 (noting that climate change poses such great policy challenges that it should be classified as a super wicked problem).

⁴⁹ See, e.g., Termeer & Dewulf, *supra* note 38.

⁵⁰ FRANK P. INCROPERA, CLIMATE CHANGE: A WICKED PROBLEM 15 (2015).

⁵¹ HULME, *supra* note 36, at 336.

⁵² MIKE HULME, WEATHERED: CULTURES OF CLIMATE 141 (Robert Rojek ed., 2017) (emphasis omitted) (quoting Scott Hamilton, *The Global Climate Has Always Been Broken: Failures of Climate Governance as Global Governmentality*, 5 CAUCASUS INT’L 141, 141 (2015)).

⁵³ See Atul Gawande, *Something Wicked This Way Comes*, NEW YORKER: DAILY COMMENT (June 28, 2012), <https://www.newyorker.com/news/daily-comment/something-wicked-this-way-comes> [<https://perma.cc/2HV3-NTDW>].

⁵⁴ *Id.*

⁵⁵ See ALBERT O. HIRSCHMAN, THE RHETORIC OF REACTION: PERVERSITY, FUTILITY, JEOPARDY 7 (1991).

Futility arguments assert that proposed reforms will achieve nothing.⁵⁶ Michael Moore and Jeff Gibb's recent movie *Planet of the Humans* echoed fringe policy analysts in arguing that using renewable energy to fight greenhouse gas emissions was futile and would cause just as much environmental damage as fossil fuels.⁵⁷ Another common use of futility is to argue that nothing the United States does to reduce its greenhouse gas emissions will matter so long as China does not also dramatically curtail its own emissions.⁵⁸

Perversity arguments go further and assert that the reforms will be worse than ineffectual: "everything backfires," so attempts to improve conditions will make them worse.⁵⁹ This argument often turns up in climate policy discussions as a variation on Jevons's paradox: as technology becomes more energy efficient, energy consumption will rise because people get more value for every kilowatt hour they consume.⁶⁰ One such analysis predicted that as energy-efficient solid-state lighting became prevalent, residential electricity consumption for lighting would rise almost two-fold.⁶¹ In fact, this pessimism was unwarranted and as solid-state lighting became prevalent, residential electricity consumption dropped.⁶²

Finally, jeopardy arguments assert that the reform can only be realized at the cost of "endanger[ing] some previous, precious accomplishment."⁶³ A frequent application of this to climate change policy is the claim that the cost of reducing greenhouse gas emissions significantly would imperil economic growth and thus

⁵⁶ *Id.* at 43.

⁵⁷ PLANET OF THE HUMANS (Rumble Media & Huron Mountain Films April 21, 2020); see also *Fact Check Bible*, PLANET OF THE HUMS., <https://planetofthehumans.com/fact-check-bible/> (last visited Aug. 11, 2020) [<https://perma.cc/3R6H-MD7D>] (quoting Jason Hickel, *The Limits of Clean Energy*, FOREIGN POL'Y: ARGUMENT (Sept. 6, 2019, 8:51 AM), <https://foreignpolicy.com/2019/09/06/the-path-to-clean-energy-will-be-very-dirty-climate-change-renewables/> [<https://perma.cc/ZKE9-YV7Q>]) (claiming that "renewable energy could become as destructive as fossil fuels."))

⁵⁸ See Michael P. Vandenbergh, *Climate Change: The China Problem*, 81 S. CAL. L. REV. 905, 906–910 (2008) (discussing climate mitigation opponents' use of Chinese emissions as a reason not to reduce emissions in the United States).

⁵⁹ HIRSCHMAN, *supra* note 55, at 11–12.

⁶⁰ See Blake Alcott, *Jevons' Paradox*, 54 ECOLOGICAL ECON. 9, 11 (2005).

⁶¹ See J. Y. Tsao, H. D. Saunders, J. R. Creighton, M. E. Coltrin & J. A. Simmons, *Solid-State Lighting: An Energy-Economics Perspective*, J. PHYSICS D: APPLIED PHYSICS, Sept. 8, 2010, at 8 tbl.1 (showing an increase in per-capita electricity consumption for residential lighting from 0.42 to 0.76 megawatt hours per person per year if the real cost of electricity remains constant).

⁶² See Lucas W. Davis, *Evidence of a Decline in Electricity Use by U.S. Households*, 37 ECON. BULL. 1098, 1098 (2017) (finding a six percent decrease in per capita residential electricity consumption from 2010 to 2015); Jonathan M. Gilligan & Michael P. Vandenbergh, *A Framework for Assessing the Impact of Private Climate Governance*, ENERGY RSCH. & SOC. SCI., Feb. 2020, at 2–3 (discussing the recent drop in per capita residential energy consumption); see also Kenneth Gillingham, Matthew J. Kotchen, David S. Rapson & Gernot Wagner, *The Rebound Effect is Overplayed*, 493 NATURE 475, 476 (2013) (reviewing studies on energy efficiency and noting that "rebound effects are small and are therefore no excuse for inaction").

⁶³ HIRSCHMAN, *supra* note 55, at 7.

throw great numbers into poverty, or that global limits on fossil fuel consumption would threaten economic growth in poor nations and trap them in permanent poverty.⁶⁴

For someone attempting to block progress, the wicked problem paradigm provides a rich source of futility, perversity, and jeopardy arguments. The lack of a definitive statement of the problem or the criteria for a solution, the lack of tests for evaluating the performance of an attempted solution, and the inability to apply lessons learned in managing other problems all contribute to a sense of futility. The one-shot nature of solutions and the way they irreversibly transform the nature of the problem contribute to perversity and jeopardy. And the fact that any wicked problem is itself only the symptom of a deeper wicked problem can feed further jeopardy arguments that solving one problem will only make another, deeper one worse.

These connections are worrying enough in the hands of someone intent on obstructing progress, but they can be just as problematic in good-faith planning efforts. In a separate essay, Hirschman examined case studies of failed economic development projects and observed that theoretical paradigms often give rise to “compulsive and mindless theorizing,” which can badly derail good-faith planning because they can provide so many possible explanations for failure that failure comes to seem overdetermined and success impossible.⁶⁵ The wicked problem paradigm can be particularly seductive and dangerous in this way, which is why so many writers have cautioned against the temptation to “throw up our hands” when confronted with a wicked problem.⁶⁶

Hirschman observes that there can be some comfort or relief in throwing up one’s hands and declaring defeat: “[W]ouldn’t it be reassuring if a society that has been unable to meet some standard of social justice . . . were *ipso facto* condemned to economic stagnation and deterioration? For that very reason we should be rather on our guard against any theory purporting to *prove* what would be so reassuring.”⁶⁷ If a project is doomed to fail regardless what one does, then there is no need to try hard or to feel badly about failure.

⁶⁴ See Christiana Figueres & Benjamin Zycher, *Can We Tackle Both Climate Change and COVID-19 Recovery?*, FIN. TIMES (May 6, 2020), <https://www.ft.com/content/9e832c8a-8961-11ea-a109-483c62d17528> [<https://perma.cc/GVJ8-ML3N>] (“Inexpensive energy is necessary for economic advancement by the world’s poor and for recovery from the staggering economic effects of Covid-19. Ideological opposition to fossil fuels is an anti-human stance . . . Prioritising climate policy will harm the ability of most people to improve their conditions . . .”); see also BJORN LOMBORG, *COOL IT: THE SKEPTICAL ENVIRONMENTALIST’S GUIDE TO GLOBAL WARMING* 155–156 (Vintage 1st ed. 2007) (describing the harms that can come if too much focus is placed on cutting CO₂ emissions).

⁶⁵ See Albert O. Hirschman, *The Search for Paradigms as a Hindrance to Understanding*, 22 WORLD POL. 329, 329 (1970) (emphasis omitted).

⁶⁶ See e.g., Innes & Booher, *supra* note 40, at 8 (“Experts do not have workable answers to wicked problems. Nonetheless wicked problems are the norm in planning, and we cannot throw up our hands. . . . As planners, we have to find ways to improve the situation, to untangle knots, and to end paralysis around important issues.”).

⁶⁷ Hirschman, *supra* note 65, at 337.

To avoid facile declarations of failure, Hirschman proposes a rule that “anyone who believes he has discovered a new obstacle to development is under an obligation to look for ways in which this obstacle can be overcome”⁶⁸ To this end, “he who looks for large-scale social change must be possessed . . . by ‘the passion for what is possible’ rather than rely on what has been certified as probable by factor analysis.”⁶⁹

In 1973, Rittel and Webber’s caution against technocratic arrogance was fitting and useful. But as Kelly Levin and Richard Lazarus emphasized in introducing the concept of superwickedness, the pressing and messy problems of the early 21st century, such as climate change, have the additional attribute of urgency because failure to take prompt action will severely constrain the options available at a later time.⁷⁰ The political rhetoric around climate policy has produced greater partisan polarization in the United States than exists for any other topic.⁷¹ A significant contributor to this polarization has been a concerted and well-funded political disinformation campaign to discourage and confuse the public.⁷² The rhetoric of wickedness can be exercised both cynically by those who wish to obstruct action and sincerely by those who wish to understand the failure to make political progress. In today’s fraught political climate, sincere and cynical uses alike can deepen the type of paralysis and political gridlock that Hirschman feared.

⁶⁸ *Id.* at 340.

⁶⁹ *Id.* at 343.

⁷⁰ For more on this messiness see, for example, Lazarus, *supra* note 10; Levin et al., *Playing it forward*, *supra* note 10.

⁷¹ See PEW RESEARCH CENTER, AS ECONOMIC CONCERNS RECEDE, ENVIRONMENTAL PROTECTION RISES ON THE PUBLIC’S POLICY AGENDA 6 (2020), https://www.pewresearch.org/politics/wp-content/uploads/sites/4/2020/02/PP_2020.02.13_Political-Priorities_FINAL.pdf [<https://perma.cc/G8LF-VF6Q>] (showing that seventy-eight percent of Democrats believe that climate change should be a policy priority, while only twenty-one percent of Republicans share this sentiment); see also Oliver Milman, *Climate Crisis More Politically Polarizing than Abortion for US Voters, Study Finds*, GUARDIAN (May 22, 2019, 1:00 AM), <https://www.theguardian.com/us-news/2019/may/21/climate-crisis-more-politically-polarizing-than-abortion-for-us-voters-study-finds> [<https://perma.cc/C5NG-XJZ8>] (discussing a Yale University study that showed climate change to be more polarizing than “traditionally divisive topics such as abortion and gun control.”); and ANTHONY LEISEROWITZ, EDWARD MAIBACH, SETH ROSENTHAL & JOHN KOTCHER, POLITICS & GLOBAL WARMING, APRIL 2019, at 9 (2019), <https://climatecommunication.yale.edu/publications/politics-global-warming-april-2019/> [<https://perma.cc/LL2C-FQ33>] (noting the difference in the amount of concern about climate change among Democrats and Republicans).

⁷² For more information on this campaign, see, for example, NAOMI ORESKES & ERIK M. CONWAY, MERCHANTS OF DOUBT: HOW A HANDFUL OF SCIENTISTS OBSCURED THE TRUTH ON ISSUES FROM TOBACCO SMOKE TO GLOBAL WARMING (1st ed. 2010); Myanna Lahsen, *Technocracy, Democracy, and U.S. Climate Politics: The Need for Demarcations*, 30 SCI., TECH., & HUM. VALUES 137 (2005); and Heather Douglas, *Bullshit at the Interface of Science and Policy: Global Warming, Toxic Substances, and Other Pesky Problems*, in BULLSHIT AND PHILOSOPHY 213 (Gary L. Hardcastle & George A. Reisch eds., 2006).

IV. ESCAPING PARALYSIS

The paralyzing nature of wicked problems arises in large part from the ten-point list in Rittel and Webber's original paper.⁷³ These ten criteria are repeated in a large fraction of subsequent papers on wicked problems. They feed directly into Hirschman's observation that a rich theoretical paradigm can easily generate so many reasons why a project can fail that failure comes to seem not only inevitable but overdetermined, so that if one reason for failure is removed, many more remain to seal its doom.⁷⁴

If we apply Rittel and Webber's list of criteria rigidly, then wicked problems are not merely unsolvable (in the sense of coming to a definitive resolution), but they are intractable, meaning that there is nothing a planner can do with even a little confidence in achieving minor improvements. This is truly a paralyzing situation, and to escape it, almost all analysts relax the fifth criterion, which states that there is no opportunity to learn by trial and error because any operation inevitably and irreversibly transforms the problem into something very different.⁷⁵ With this criterion relaxed, incremental progress becomes possible and the planner has a way forward.

A. *Muddling Through as an Alternative to the Paralysis of Wickedness*

However, all incremental approaches to wicked problems owe a great debt to Lindblom's pioneering work more than a decade earlier on what he described as "muddling through."⁷⁶ Lindblom did not attempt to define a new class of problem, but rather began from the observation that virtually all policymaking and planning involves messy and complex systems that blend the technical with the human, the social, and the political. And where Rittel and Webber focus on building a theoretical framework for describing intractable problems, Lindblom focuses on what a planner or policymaker can realistically do and emphasizes methods of bounded rationality. Indeed, once the criteria of wickedness that blocked incremental management are removed, many of the remaining criteria become very amenable to satisficing or other established methods for addressing decisionmaking under a combination of

⁷³ See Rittel & Webber, *supra* note 4, at 161–67.

⁷⁴ See Hirschman, *supra* note 65, at 339–340 (describing the effects of this theoretical paradigm).

⁷⁵ See, e.g., Termeer et al., *supra*, note 11, at 170 (observing that "the majority of wicked problem scholars have attempted to reduce the 10 criteria to a smaller number of distinguishing characteristics."); B. Guy Peters, *What Is so Wicked about Wicked Problems? A Conceptual Analysis and Research Program* 36 POL'Y & SOC'Y 385, 388–390 (2017) (observing that "some problems, or interventions, may indeed be reversible and even forgettable once other attempts at a solution have been offered."); Lazarus, *supra* note 10, at 1180, 1193 ("Environmental law must be flexible and responsive to new information" and "[t]he requirements of federal climate change legislation have to be steadfast or 'sticky' in some respects and flexible in others.").

⁷⁶ See Lindblom, *Muddling Through*, *supra* note 24 (introducing the concept of "muddling through"); Lindblom, *Still Muddling*, *supra* note 24 (expanding on his earlier analysis).

uncertainty and limited cognitive resources,⁷⁷ and the remaining criteria merely describe politics as it has ever been: an attempt to build working agreements among people with different values and priorities.

This leads us to ask whether the wicked problem paradigm is valuable. In its strict application, all wicked problems are utterly intractable, and in a looser application it does not seem to offer any distinctive insights that Lindblom did not achieve earlier and more pragmatically. Indeed, Lindblom's "muddling through" approach is frequently cited in the literature of incremental approaches to wicked problems.⁷⁸

Nevertheless, we need not see Rittel and Webber's ideas as being in conflict with Lindblom's. The insights developed in both lines of work are valuable and far from trivial. There is a reason why variations on them are regularly reinvented or rediscovered, as we observed at the beginning of this Article. And even today, one of the great obstacles to making progress on climate policy is the persistent confusion among many activists and many scientists over why climate change policy cannot be effectively derived from scientific understanding of the physical climate system.⁷⁹

⁷⁷ See, e.g., Herbert A. Simon, *Theories of Bounded Rationality*, in DECISION AND ORGANIZATION 161 (C. B. McGuire & Roy Radner eds., 1972) (describing satisficing and other methods for decisionmaking in the face of uncertainty); Herbert A. Simon, *Theories of Decision-Making in Economics and Behavioral Science*, 49 AM. ECON. REV. 253, 257–62 (1959) (discussing how the theory of utility, among other methods, can be used to make decisions under uncertain parameters).

⁷⁸ See, e.g., Termeer & Dewulf, *supra* note 38, at 302; Falk Daviter, *Coping, Taming or Solving: Alternative Approaches to the Governance of Wicked Problems*, 38 POL'Y STUD. 571, 580 (2017); Emery Roe, *Policy Messes and Their Management*, 49 POL'Y SCIS. 351, 352 (2016); Steven Ney & Marco Verweij, *Messy Institutions for Wicked Problems: How to Generate Clumsy Solutions?*, 33 ENV'T & PLAN. C: GOV'T & POL'Y 1679, 1684 (2015); Head & Alford, *supra* note 47, at 719; Levin et al., *Overcoming the Tragedy*, *supra* note 10, at 131; Roberts, *supra* note 40, at 15.

⁷⁹ See HULME, *supra* note 36, at 74:

Implicit in this appeal to science as the basis for a lobbying campaign is that science has the authority to make definitive and universal statements about what is and what is not dangerous for people and societies and, ultimately, for the world. Science is being used to justify claims not merely about how the world is (what are called 'positive' statements), but about what is or is not desirable —about how the world *should* be ('normative' statements);

PIELKE, *supra* note 36, at 149 ("Not only does the notion of 'dangerous interference' [in the United Nations Framework Convention on Climate Change] compel science to serve as the arbiter of what ultimately are political considerations that science cannot resolve, but it is inconsistent with how the climate in all of its complexity actually affects society . . ."); SHEILA JASANOFF, SCIENCE AND PUBLIC REASON 155 (2012) ("One looks in vain for explicit acknowledgment that expert deliberations are a site of hybrid judgment, combining technical and normative considerations.").

As many scholars of science policy have observed, climate change fits many criteria of wickedness because there are so many different aspects to climate and to the ways in which it is changing. In addition, there are simultaneously so many different preferences and priorities about what climatic conditions are better or worse than others that there is no definitive statement of what the climate change problem is.⁸⁰ Attempts to develop policy for managing climate change often begin with a negotiation among stakeholders about what the goals should be. In a pluralistic society, agreement about goals can be difficult to achieve even in the best circumstances, and under the current atmosphere in the United States of hostile partisan polarization, this task is especially difficult.⁸¹

Even when the goals of policy are established, the means for pursuing them are additional sources of conflict and dissension. Lindblom observed that the distinction between means and ends breaks down for complex policy issues: values and preferences are contingent and context-dependent rather than absolute, so they cannot be treated separately from the context of the policies under consideration.⁸² Especially in the United States, ideological and partisan divisions over the role of government regulation, especially at the federal level, contribute to political gridlock over many issues, especially environmental ones.⁸³ Psychological effects contribute to this by creating an ideological dimension to what people believe about purely factual and scientific matters. One powerful example of this is solution aversion, where people who are told that the solution to a problem requires actions that they find ideologically repugnant often respond by denying that the scientific basis of the problem exists.⁸⁴ Thus, people who are strongly ideologically opposed to government regulation tend to deny the scientific facts of climate change.⁸⁵ We see

⁸⁰ See HULME, *supra* note, at 142 (“With global climate as an object of governance, climate-change cannot but be an idea which mobilises powerful actors in pursuit of their different interests.”); PIELKE, *supra* note 36, at 143 (“[T]he main scientific and policy institutions responsible for climate change in the international arena do not even agree on what the phrase ‘climate change’ actually means.”).

⁸¹ See Michael P. Vandenbergh & Jonathan M. Gilligan, *Beyond Gridlock*, 40 COLUM. ENVTL. L. J. 217, 233–37 (2015) (noting the political and institutional barriers to public action on climate change).

⁸² Lindblom, *Muddling Through*, *supra* note 24, at 83.

⁸³ See MICHAEL P. VANDENBERGH & JONATHAN M. GILLIGAN, *BEYOND POLITICS: THE PRIVATE GOVERNANCE RESPONSE TO CLIMATE CHANGE* 18 (2017); see also LEISEROWITZ ET AL., *supra* note 71 **Error! Bookmark not defined.** (discussing public opinion polls on climate change topics among different political affiliations); PEW RESEARCH CENTER, *supra* note 71 **Error! Bookmark not defined.** (documenting partisan public opinion divide on climate change); Riley E. Dunlap, Aaron M. McCright & Jerrod H. Yarosh, *The Political Divide on Climate Change: Partisan Polarization Widens in the U.S.*, 58 ENV’T: SCI. & POL’Y FOR SUST. DEV. 4, 14–19 (2016) (analyzing data showing increased partisan polarization on environmental issues).

⁸⁴ See Troy H. Campbell & Aaron C. Kay, *Solution Aversion: On the Relation Between Ideology and Motivated Disbelief*, 107 J. PERSONALITY & SOC. PSYCH. 809, 820–21 (2014) (showing correlation between respondents’ ideological aversion to a proposed solution to a problem and their willingness to recognize the existence of the problem itself).

⁸⁵ See *id.* at 821 (linking solution aversion findings to views on climate change issues).

this in Senator James Inhofe's statement that "I assumed like everybody else, way back when everyone was talking about global warming and all that, I assumed that that was probably right, until I found out what it was going to cost."⁸⁶

B. Oblique Strategies as Alternatives to the Paralysis of Wickedness

Presenting a panoply of different means to achieve policy goals on climate change, such as reducing greenhouse gas emissions, may serve an important function in defusing solution aversion and other psychological barriers to reaching agreements about policy. As to goals, Mike Hulme and Roger Pielke offer an "oblique" alternative to achieving consensus about goals: they advocate focusing on identifying policy actions that can address a diverse set of goals.⁸⁷ This relates to Cass Sunstein's concept of "incompletely theorized agreements," in which people with very different goals and values can nonetheless agree on an action to take, while disagreeing about the reasons for taking the action.⁸⁸ Pielke couches this in a paraphrase of Walter Lippmann: "[T]he goal of politics is not to get everyone to think alike, but, rather, to get people who think differently to act alike."⁸⁹

One example of this oblique approach is an intensive research and development program to produce clean energy technology that can scale up to the utility level and be cheaper than fossil fuels.⁹⁰ Some people may want clean cheap energy because it reduces greenhouse gas emissions. Others may want it because it reduces local and regional particulate matter pollution. Others may want it because it contributes to the nation's energy security. Others may want it simply because it costs less than

⁸⁶ Inhofe has repeated this statement multiple times, see, for example, *Energy and Climate Policy Summit, Senator James Inhofe and Corbin Robertson*, C-SPAN (DEC. 8, 2016), <https://www.c-span.org/video/?419785-3/senator-james-ihofe-discusses-energy-policy> (last visited June 5, 2020) [<https://perma.cc/R69B-648Z>]; Jeanne Cummings, *Transcript: Interview with Sen. Jim Inhofe*, POLITICO (Apr. 19, 2010), <https://www.politico.com/news/stories/0410/35971.html> (last visited June 5, 2020) [<https://perma.cc/494G-8WZU>].

⁸⁷ See MIKE HULME, CAN SCIENCE FIX CLIMATE CHANGE?: A CASE AGAINST CLIMATE ENGINEERING 117 (2014) ("The task [of climate policy] is to find the 'soft underbelly' of climate change, to find oblique policies that advance human welfare while at the same time delivering outcomes consistent with the goal of minimizing climatic risks."); PIELKE, *supra* note **Error! Bookmark not defined.**, at 222 (quoting John Kay, *Obliquity*, JOHN KAY (Jan. 17, 2004), <https://www.johnkay.com/2004/01/17/obliquity/> [<https://perma.cc/T6E4-USBC>]) ("Paradoxical as it sounds, goals are more likely to be achieved when pursued indirectly Oblique approaches are most effective in difficult terrain, or where outcomes depend on interactions with other people Obliquity is characteristic of systems that are complex, imperfectly understood, and change their nature as we engage with them.") (ellipses in the original); THE HARTWELL PAPER, *supra* note 37, at 9 ("If one seeks long-lasting impact, the best line of approach may not be head-on.").

⁸⁸ Cass R. Sunstein, *Incompletely Theorized Agreements*, 108 HARV. L. REV. 1733, 1735–36 (1995).

⁸⁹ PIELKE, *supra* note **Error! Bookmark not defined.**, at 44–45.

⁹⁰ HULME, *supra* note 87, at 127–28; PIELKE, *supra* note **Error! Bookmark not defined.**, at 222; PRINS ET AL., THE HARTWELL PAPER *supra* note **Error! Bookmark not defined.**, at 5.

fossil fuels. And still others may want it for the jobs it creates. People with these different views can agree on a policy that would significantly reduce the rate of global warming by curtailing greenhouse gas emissions without needing to agree on goals for climate change.

However, such a policy would not address a critical aspect of what makes climate change not merely wicked, but superwicked: the time factor. This policy approach may also underestimate the power of political opposition from economic sectors, such as the fossil fuel industry, that would suffer from a transition to clean energy.⁹¹ It may also underestimate the importance of entrenched ideological opposition to clean energy.⁹² The latter obstacle is not distinctive to wicked or superwicked problems, but it characterizes many political controversies.

The time problem is central to superwicked problems, though, especially climate change, and thus merits further examination. Greenhouse gases are stock pollutants, so climate change depends not just on the current level of emissions, but on the cumulative emissions since the industrial revolution.⁹³ The world is rapidly approaching a quantity of cumulative emissions that will raise the planet's temperature by 2°C and once we cross that threshold, limiting warming to 2°C will be impossible without new technology to actively remove carbon dioxide from the atmosphere.⁹⁴ Any delay in rapidly reducing greenhouse gas emissions threatens our ability to meet a goal of stabilizing the planet's temperature at no more than 2°C above the pre-industrial climate. Accounting for this time factor makes it especially important to avoid paralysis, and thus requires us to return and reconsider from a new perspective the irreversible nature of actions to manage wicked problems.

⁹¹ See, e.g., Stanley Reed, *Oil Companies Ponder Climate Change, but Profits Still Rule*, NY TIMES Oct. 15, 2019 at B4 (reporting that despite acknowledging the dangers of global warming, oil and gas companies prioritize their profits and “argue[] that it would be a mistake to force well-run companies to reduce their oil and gas production.”). Available at <https://www.nytimes.com/2019/10/07/business/energy-environment/oil-companies-climate-change-profits.html>

⁹² See, e.g., Brad Plumer, *Trump Orders a Lifeline for Struggling Coal and Nuclear Plants*, NY TIMES June 2, 2018 at A17 (reporting that “President Trump has ordered Energy Secretary Rick Perry to ‘prepare immediate steps’ to stop the closing of unprofitable coal and nuclear plants around the country” even though this would “would force consumers to pay more for electricity.”). Available at <https://www.nytimes.com/2018/06/01/climate/trump-coal-nuclear-power.html>

⁹³ See DAVID G. VICTOR, *GLOBAL WARMING GRIDLOCK: CREATING MORE EFFECTIVE STRATEGIES FOR PROTECTING THE PLANET* 3–4 (2011) (“CO₂ lingers in the atmosphere for a century or longer, which is why climate policy experts call it a ‘stock pollutant.’”); see also H. Damon Matthews et al., *The Proportionality of Global Warming to Cumulative Carbon Emissions*, 459 NATURE 829, 829–832 (2009) (analyzing the relationship between climate change and cumulative carbon emissions).

⁹⁴ See Thomas F. Stocker, *The Closing Door of Climate Targets*, 339 SCIENCE 280, 280–282 (2013) (explaining that as cumulative carbon emissions increase, the likelihood of achieving climate targets through mitigation decreases); see also David J. Frame et al., *Cumulative Emissions and Climate Policy*, 7 NAT. GEOSCI. 692, 692–93 (2014) (emphasizing the utility of cumulative emissions analysis in making and evaluating the efficacy climate change policy).

V. IRREVERSIBILITY AND FORKS IN THE ROAD

A. *Opportunity Costs and Irreversibility under Status Quo*

The original definition of wicked problems includes the criterion that

[E]very solution to a wicked problem is a ‘one-shot operation’; because there is no opportunity to learn by trial-and-error, every attempt counts significantly. . . . [E]very implemented solution . . . leaves ‘traces’ that cannot be undone. . . . And every attempt to reverse a decision or to correct for undesired consequences poses another set of wicked problems, which are in turn subject to the same dilemmas.⁹⁵

Some possible responses to climate change entail these kinds of irreversible consequences. Geoengineering by solar radiation management is an important example because it is subject to potentially catastrophic “termination shock”: the geoengineering project requires constant renewal of stratospheric aerosol injection and if this ceases, the climate will warm very rapidly as the aerosols precipitate out of the atmosphere.⁹⁶ Warming that otherwise would have taken many decades will occur in over a few years, and the final temperature might even be higher than it would have been under the same emissions scenario if the geoengineering project had never begun.⁹⁷ A less dramatic example would be a decision to replace fossil fuels in the energy supply with certain clean-energy technologies. Path dependence and lock-in effects are commonly seen in technological innovation, and after developing one set of clean-energy technologies, these effects can make it difficult and expensive to switch to different clean-energy technologies.⁹⁸ Some contributing factors to path dependence and lock-in are investments in creating expertise in particular technologies; establishing a manufacturing base and associated supply chains; and training a skilled workforce to produce, distribute, install, operate, and maintain the new technologies. Changing course to focus on different technologies would require starting over to a great extent on all these requirements. This is especially true if one set of technologies applies to centralized large-scale generation

⁹⁵ Rittel & Webber, *supra* note 4, at 163.

⁹⁶ See Parker & Irvine, *supra* note 44, at 456–57 (explaining the concept of “termination shock” as it relates to changes in the deployment of solar geoengineering).

⁹⁷ See Rabitz, *supra* note 44, at 503–04 (describing studies that detail the potentially extreme effects of abrupt SRM termination); McKinnon, *supra* note 44, at 447 (suggesting abrupt suspension of SRM deployment could produce a swift return to pre-deployment temperatures); Parker & Irvine, *supra* note 44, at 458 (noting how accelerated warming occurs in the event of termination shock); see also Robock et al. *supra* note 44, at 5–8 (discussing a variety of SRM-related risks and costs).

⁹⁸ See Roger Fouquet, *Path Dependence in Energy Systems and Economic Development*, 1 NATURE ENERGY 1–5 (2016) (discussing the lock-in effect and path dependence of clean energy innovation and development); Jurgen Essletzbichler, *Renewable Energy Technology and Path Creation: A Multi-scalar Approach to Energy Transition in the UK*, 20 EUR. PLAN. STUD. 791, 794 (2012) (addressing the existing lock-in and path dependence of the UK energy sector).

and the other to distributed small-scale generation.⁹⁹ In addition to technological effects, regulatory law and policy can create additional path dependencies and lock-in.¹⁰⁰ Planning cities for autonomous electric cars would make it difficult to change course later to expanding mass transportation if autonomous vehicles do not pan out.¹⁰¹

However, these appear to be more the exception than the rule. Indeed, market-based carbon-pricing regulatory instruments are attractive in part because at least in theory the carbon price or the number of permits issued can easily be adjusted in response to new information about climate change and about supply and demand schedules for energy. Research and development policies to encourage innovation in new clean-energy technologies can encompass a wide variety of technologies and energy markets can easily accommodate many entrants, allowing different technologies to find niches where they have competitive advantages (e.g., solar energy may be more competitive in locations that have little cloud cover and where the seasonal and diurnal demand is higher at times when incident sunlight is most intense, whereas wind may be more competitive in places where there is high cloud cover or where there is high demand at night or during dark winter months).

Indeed, there is considerable interest in replacing the notion of a “silver bullet” policy that would address all the challenges of climate change in a unified manner with “silver buckshot” that would accommodate many different but complementary policy approaches, with each addressing a subset of the climate challenge.¹⁰² The “silver buckshot” idea has gained currency not only among policy scholars, but also among some activists, such as Bill McKibben,¹⁰³ and politicians, such as Jay

⁹⁹ Fouquet, *supra* note 98, at 1–5 (emphasizing the economic and technological factors that contribute to energy development lock-in and the difficulties they pose for downstream changes in policy).

¹⁰⁰ See Amy L. Stein, *Breaking Energy Path Dependencies Symposium: The Post-Carbon World: Advances in Legal and Social Theory*, 82 BROOK. L. REV. 559, 559–61 (2016) (explaining how the “institutional stickiness” of energy regulations contributes to path dependence).

¹⁰¹ See ROBERT CERVERO, ERICK GUERRA, & STEFAN AL, BEYOND MOBILITY: PLANNING CITIES FOR PEOPLE AND PLACES 199–206 (2017) (explaining the transformative impact that driverless cars would have on urban planning, such as parking needs); see also Dimitris Milakis et al., *Policy and Society Related Implications of Automated Driving: A Review of Literature and Directions for Future Research*, 21 J. INTELLIGENT TRANSP. SYSS. 324, 340–42 (2017) (discussing more broadly the implications of redirecting urban planning decisions to accommodate automated driving).

¹⁰² See MAXWELL BOYKOFF, CREATIVE (CLIMATE) COMMUNICATIONS 190, 215 (2019) (explaining how the concept of “silver buckshot” allows for multimodal communication of climate change challenges and solutions); Elke U. Weber, *Climate Change Demands Behavioral Change: What Are the Challenges?*, 82 SOC. RSCH.: INT’L Q. 568 (2015) (preferring the “buckshot” approach to climate change problem-solving); Barry W. Brook et al., *Silver Buckshot or Bullet: Is a Future “Energy Mix” Necessary?*, 10 SUSTAINABILITY 302 (2018) (considering the “buckshot” theory as it relates to a proposed sustainable energy mix response to climate change).

¹⁰³ Bill McKibben, *Welcome to the Climate Crisis: How to Tell Whether a Candidate Is*

Inslee.¹⁰⁴ The silver buckshot approach remains very controversial and many other activists argue that it will dilute support for comprehensive and largely monolithic policies, which they view as the only way to address the scale of the climate problem.¹⁰⁵ Lindblom observed, however, that comprehensive policies that entail drastic change are almost always politically unfeasible: “A fast-moving sequence of small changes can more speedily accomplish a drastic alteration of the *status quo* than can an only infrequent major policy change.”¹⁰⁶

By focusing on the irreversible consequences of taking action, Rittel and Webber, and a considerable portion of the subsequent literature on wicked problems, divert attention from the far more significant irreversible opportunity costs of not taking action. Levin and Lazarus’s superwicked concept begins to correct for this by introducing the urgency of taking rapid action. Climate change differs from many other pollution problems because, whereas the Clean Air Act criteria pollutants disperse and are removed from the atmosphere rapidly if emissions are curtailed, atmospheric concentrations of carbon dioxide will remain high for millennia after emissions cease.¹⁰⁷ This means that climate change is driven not by changes in the

Serious About Combating Global Warming, WASH. POST (May 27, 2006), <https://www.washingtonpost.com/archive/opinions/2006/05/27/welcome-to-the-climate-crisis-span-classbankheadhow-to-tell-whether-a-candidate-is-serious-about-combating-global-warmingspan/26b2ac5a-a4a3-46ff-b214-3fc07a3a5ab3/> [https://perma.cc/XJK8-LCSX].

¹⁰⁴ Benjamin Wallace-Wells, *Jay Inslee Wants to Be a Presidential Candidate for the Climate-Change Era*, NEW YORKER (Feb. 28, 2019), <https://www.newyorker.com/news/the-political-scene/jay-inslee-wants-to-be-a-presidential-candidate-for-the-climate-change-era> [https://perma.cc/8NWQ-UA5C].

¹⁰⁵ See, e.g., Michael Mann, *Lifestyle Changes Aren’t Enough to Save the Planet. Here’s What Could*, TIME (Sept. 12, 2019), <https://time.com/5669071/lifestyle-changes-climate-change/> [https://perma.cc/Q249-U6UU]; Michael Mann, *You Can’t Save the Climate by Going Vegan. Corporate Polluters Must Be Held Accountable*, USA TODAY (June 6, 2019), <https://www.usatoday.com/story/opinion/2019/06/03/climate-change-requires-collective-action-more-than-single-acts-column/1275965001/> [https://perma.cc/44F7-U8EB]; Natalie Hanman, Naomi Klein: “We Are Seeing the Beginnings of the Era of Climate Barbarism,” GUARDIAN (Sept. 14, 2019), <https://www.theguardian.com/books/2019/sep/14/naomi-klein-we-are-seeing-the-beginnings-of-the-era-of-climate-barbarism> [https://perma.cc/PK78-LEQ6] (advocating for a transformation of the economy to stop climate change); Dawn Stover, “Silver Buckshot” Isn’t Enough to Fix the Climate, BULL. ATOMIC SCIS. (Apr. 1, 2019), <https://thebulletin.org/2019/04/silver-buckshot-isnt-enough-to-fix-the-climate/> [https://perma.cc/V2JK-JSPA].

¹⁰⁶ Lindblom, *Still Muddling*, *supra* note 24, at 520.

¹⁰⁷ See S. Solomon et al., *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 PROCS. NAT’L ACAD. SCIS. 1704, 1704–06 (2009); David Archer & Victor Brovkin, *The Millennial Atmospheric Lifetime of Anthropogenic CO₂*, 90 CLIMATIC CHANGE 283, 294 (2008) (concluding that a “substantial fraction” of carbon emissions will remain in the atmosphere for thousands of years); David Archer, Michael Eby, Victor Brovkin, Andy Ridgwell, Long Cao, Uwe Mikolajewicz, Ken Caldeira, Katsumi Matsumoto, Guy Munhoven, Alvaro Montenegro & Kathy Tokos, *Atmospheric Lifetime of Fossil Fuel Carbon Dioxide*, 37 ANN. REV. EARTH & PLANETARY SCIS. 117 (2009) (concluding the same).

annual emissions of greenhouse gases so much as by the cumulative total of emissions from the beginning of the industrial revolution.¹⁰⁸ Thus, if cumulative emissions exceed a threshold for dangerous or even catastrophic harm, rapidly curtailing emissions will not remove that harm.¹⁰⁹

The world experienced a similar, but far milder, example of this when a hole appeared in the ozone layer over Antarctica in 1979. Chlorofluorocarbon (“CFC”) chemicals, the dominant cause of ozone depletion, have atmospheric lifetimes of roughly 50 to 140 years.¹¹⁰ CFC emissions largely ceased in the mid-1990s, but the annual ozone hole has persisted over the subsequent two-and-a-half decades, showing only a slow contraction so that the size and severity of the ozone hole in recent years remains comparable to the late 1980s.¹¹¹

When the cost of delay is severe, as it is for climate change, any paralysis or indecisiveness induced by worrying about wickedness becomes very expensive. Delays can arise both in formulating policy and in enacting and implementing it. Delays in formulating policy often arise from an aversion to uncertainty and a desire to obtain robust scientific knowledge, capable of making reliable predictions about the consequences of different courses of action. When the cost of delay makes it necessary to act without hesitation despite considerable scientific uncertainty, this changes the role of science in guiding policymaking. Sheila Jasanoff identified time pressure as one of the most important characteristics separating regulatory science from research science:

While scientists working in a “pure” research setting have relatively unlimited time . . . for testing hypotheses or proving conjectures, scientists working to meet policy needs are under constant pressure to deliver results quickly. In the regulatory context, a decision to wait for more data amounts to (or is perceived as) a decision not to act.¹¹²

Regardless of how effective and efficient a policy would be once implemented, it will be useless if political opposition prevents it from being enacted. Where the cost of delay is great, even a minor delay in enacting a policy can greatly reduce its value. Even when a policy has majority support among the public and public officials, concerted political opposition can obstruct the policy.¹¹³ Thus, policy

¹⁰⁸ See Matthews et al., *supra* note 93, at 829–32; Frame et al., *supra* note 94, at 692–93.

¹⁰⁹ See Stocker, *supra* note 94, 280–82 (explaining how cumulative emissions may foreclose the possibility of mitigating climate harms); Solomon et al., *supra* note 107, at 1704–06 (discussing the potential for irreversible harm when cumulative emissions thresholds are reached).

¹¹⁰ M. Rigby et al., *Re-evaluation of the Lifetimes of the Major CFCs and CH₃CCl₃ Using Atmospheric Trends*, 13 ATMOSPHERIC CHEMISTRY AND PHYSICS 2691, 2698 (2013).

¹¹¹ NASA Ozone Watch, NATIONAL AERONAUTICS SPACE ADMINISTRATION: GODDARD SPACE FLIGHT CENTER, https://ozonewatch.gsfc.nasa.gov/statistics/annual_data.html (last updated Oct. 18, 2018) [<https://perma.cc/9PFL-R6JQ>].

¹¹² JASANOFF, *supra* note Error! Bookmark not defined., at 78.

¹¹³ See Gilligan & Vandenbergh, *supra* note 62 at 2 (“[L]egislative gridlock can delay or

analysis for climate change must account for initiative feasibility.¹¹⁴ And incrementally muddling through with a diverse set of small initiatives may succeed far better than focusing on large policies, which may attract much more powerful opposition.¹¹⁵

B. Muddling Through when the Road Forks

In addition to accounting for initiative feasibility, muddling through approaches to climate policy must address forks in the road: many climate mitigation initiatives confront the long lifetime of built infrastructure and the interactions between different types of infrastructure in facilitating or obstructing additional actions to reduce emissions. These characteristics of infrastructure create critical forks in the policy road, where it is much easier and cost-effective to take certain policy choices early on, and missing those opportunities makes it much more difficult and expensive to pursue them later on.¹¹⁶ For instance, once a power plant has been built, often at the cost of billions of dollars, it has a lifetime of many decades and the incremental costs of providing fuel can be much smaller than the sunk cost of construction. This rapidly raises the marginal cost of switching from fossil fuels to clean energy as new fossil fuel energy infrastructure is built.¹¹⁷ These rising costs

prevent action even when a large majority of the public supports it.”); VANDENBERGH & GILLIGAN, *supra* note 83, at 66–73 (emphasizing both how delaying climate policies can severely limit their impact and why structural and ideological features of the American political system impede the implementation of even popular such policies).

¹¹⁴ See VANDENBERGH & GILLIGAN, *supra* note 83, at 91 (advocating for climate policy analysis that considers potential political costs and delays in determining an initiative’s feasibility); Jonathan M. Gilligan & Michael P. Vandenbergh, *Accounting for Political Feasibility in Climate Instrument Choice*, 32 VA. ENVTL. L. J. 1 (2014) (proposing that political opportunity costs help determine the feasibility of climate policy instruments).

¹¹⁵ See Lindblom, *Still Muddling*, *supra* note **Error! Bookmark not defined.**, at 520–21 (explaining how incremental politics can achieve policy goals piecemeal, without generating the opposition often wrought by drastic change).

¹¹⁶ See Michael P. Vandenbergh & Jonathan M. Gilligan, *Climate Law and Policy: Forks in the Road*, 30 DUKE ENVTL. L. & POL’Y F. (forthcoming 2020) (contending the need for urgent climate change action in part stems from the likely inefficacy of delayed policies), https://papers-ssrn-com.proxy.library.vanderbilt.edu/sol3/papers.cfm?abstract_id=3543639 [<https://perma.cc/5WC4-SEGQ>].

¹¹⁷ See Steven J. Davis et al., *Future CO2 Emissions and Climate Change from Existing Energy Infrastructure*, 329 SCIENCE 1330, 1333 (2010) (discussing the long-term energy commitments and “infrastructural inertia” of carbon emissions sources worldwide); Martin I. Hoffert, Ken Caldeira, Atul K. Jain, Erik F. Haites, L. D. Danny Harvey, Seth D. Potter, Michael E. Schlesinger, Stephen H. Schneider, Robert G. Watts, Tom M. L. Wigley & Donald J. Wuebbles, *Energy Implications of Future Stabilization of Atmospheric CO₂ Content*, 395 NATURE 881, 884 (1998) (noting the “massive transition” required to decarbonize existing energy production and infrastructure).

can lead to carbon lock-in: the more new fossil-powered energy is constructed, the harder and more expensive it becomes to transition to clean energy.¹¹⁸

We have identified a number of forks in the road for climate policy: opportunities to take policy choices in the near future that will steer the evolution of America's infrastructure and built environment—energy generation and transmission, transportation, and buildings—along a clean path, but where failing to take the opportunity soon will make it much harder to do so later on, both because of lock-in effects and also because of synergies among many aspects of green infrastructure.¹¹⁹ For instance, if a transition to electric vehicles and a transition of the electrical grid from fossil to clean power are coordinated, emissions associated with the energy used by the vehicles will drop and the battery storage in the vehicles can help to stabilize the transmission grid against supply and demand fluctuations, thus easing the transition to high-penetration of renewable energy sources.¹²⁰ If neither transition is pursued in the near future, the number of new gasoline-powered vehicles on the road, with expected lifetimes close to twenty years, and the number of new fossil-fuel power plants that would be built, with expected lifetimes of forty years or more, would make it difficult to reverse course and pursue these two synergetic policies later on. Other forks in the road connect the transition to clean electricity with policies that would encourage the electrification of appliances such as furnaces, stoves, and water heaters.¹²¹

We emphasize that accounting for forks in the road is not inconsistent with a muddling through approach. Indeed, when we take account of initiative feasibility and the cost of delay, a diverse and incremental approach of policymaking by muddling through is essential. Combining these approaches enables us to focus on the most important, viable actions and to take at least some action before the forks in the road recede into the distance in our rearview mirror.

Where the traditional wicked-problem paradigm promotes paralysis and an attitude of defeat, the superwicked problem paradigm restores a sense of urgency in taking action, even if the actions are imperfect. When we realize that there is no complete solution to the problem of climate change, that inaction is likely to impose irreversible and unrepairable costs and dangers far more severe than flawed actions, and that the longer we wait to take action, the fewer options will remain, wickedness can become a stimulus to act rather than a source of paralysis. As Samuel Johnson noted, “when a man knows he is to be hanged in a fortnight, it concentrates his mind

¹¹⁸ See Peter Erickson, Sivan Kartha, Michael Lazarus & Kevin Tempest, *Assessing Carbon Lock-In*, ENV'T'L RSCH. LETTERS, Aug. 2015 (explaining the difficulty in moving away from carbon-intensive energy sources); Christoph Bertram, Nils Johnson, Gunnar Luderer, Keywan Riahi, Morna Isaac & Jiyong Eom, *Carbon Lock-In Through Capital Stock Inertia Associated with Weak Near-Term Climate Policies*, 90 TECH. FORECASTING & SOC. CHANGE 62, 70–71 (2015) (discussing the challenge carbon lock-in poses for transitioning energy sources).

¹¹⁹ See Vandenberg & Gilligan, *supra* note 116, (outlining the importance of decarbonizing the electric grid, electrifying transportation, and electrifying buildings, and emphasizing the risks and costs of delaying their implementation).

¹²⁰ *Id.*

¹²¹ *Id.*

wonderfully.”¹²² Returning to Lindblom’s notion of managing complex problems by muddling through, we need to learn how to muddle quickly and decisively under this time pressure.

C. Addressing the Urgency of Climate Change through Polycentric and Private-Sector Governance

Two keys to muddling quickly are to recognize first that there will be no single best policy and second that a silver buckshot approach, with many small complementary and hopefully synergetic policies, is more likely to achieve high initiative feasibility and rapid implementation than a large monolithic policy.¹²³ Moreover, when multiple policies are deployed it will be possible to assess their performance in practice and either make mid-course adjustments or drop policies that do not produce results.

Polycentric governance can play an important role in muddling quickly.¹²⁴ International treaties and national governments are far from the only powerful players in shaping climate policy. State and provincial governments, municipal governments, and the private sector can all play important roles in mitigating greenhouse gas emissions.¹²⁵ Initiative feasibility varies considerably across the different levels of public and private governance.

¹²² JAMES BOSWELL, *THE LIFE OF SAMUEL JOHNSON* 612 (D. Womersley ed., Penguin Classics, 2008).

¹²³ But see Dawn Stover, “Silver Buckshot” Isn’t Enough to Fix the Climate, *BULLETIN OF THE ATOMIC SCIENTISTS* (April 1, 2019), <https://thebulletin.org/2019/04/silver-buckshot-isnt-enough-to-fix-the-climate/> [<https://perma.cc/V2JK-JSPA>] (criticizing the “silver buckshot” ideas as a vague and incoherent restatement of Pacala & Socolow’s stabilization wedges). See also S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 *SCIENCE* 968, 969–971 (2004) (arguing that carbon dioxide emissions could be stabilized by increased use of multiple existing technologies).

¹²⁴ See Elinor Ostrom, *Nested Externalities and Polycentric Institutions: Must We Wait for Global Solutions to Climate Change Before Taking Actions at Other Scales?*, 49 *ECON. THEORY* 353 (2012) (arguing that a global response to climate change should be bolstered by local and regional responses); Elinor Ostrom, *Polycentric Systems for Coping with Collective Action and Global Environmental Change*, 20 *GLOB. ENVTL. CHANGE* 550 (2010) (same).

¹²⁵ See Angel Hsu, Oscar Widerberg, Amy Weinfurter, Sander Chan, Mark Roelfsema, Katharina Lütkehermöller & Fatemeh Bakhtiari, *Bridging the Gap: The Role of Non-State and Subnational Actors*, in *EMISSIONS GAP REPORT 2018*, at 29 (2018) (discussing efforts by sub-national governments and private entities to address climate change); Angel Hsu, Niklas Höhne, Takeshi Kuramochi, Mark Roelfsema, Amy Weinfurter, Yihao Xie, Katharina Lütkehermöller, Sander Chan, Jan Corfee-Morlot, Philip Drost, Pedro Faria, Ann Gardiner, David J. Gordon, Thomas Hale, Nathan E Hultman, John Moorhead, Shirin Reuvers, Joana Setzer, Neelam Singh, Christopher Weber & Oscar Widerberg, *A Research Roadmap for Quantifying Non-State and Subnational Climate Mitigation Action*, 9 *NATURE CLIMATE*

Some initiatives are most feasible at the large scale of national government, due to coordination and collective action. Other initiatives will be most feasible at the state or local level, if federal legislative and regulatory institutions are trapped in partisan gridlock. Still other initiatives may be more feasible at the private-sector level. For instance, private corporate buyers have far more power, through their supply chain contracting, to influence greenhouse gas emissions by manufacturers in China than the U.S. government does because they are neither constrained by the checks and balances of public government nor by international free-trade treaties.¹²⁶ Private governance initiatives can also avoid the ideological opposition to regulation that obstructs many public governance initiatives in the United States.¹²⁷

Private-sector governance of greenhouse gas emissions can also serve an important role in overcoming the political and ideological obstacles that result from solution aversion and other related psychological phenomena.¹²⁸ Significant challenges must still be addressed, however, in using private-sector governance effectively without allowing it to undermine parallel efforts to expand public governance.¹²⁹

D. Climate Governance by Muddling Through

What would it mean in practice to govern climate change by muddling through? The muddling through approach has two aspects: incremental policy analysis and incremental political praxis.¹³⁰ The incremental analysis aspect addresses the problem of bounded rationality: it is generally not possible to examine all possible responses to a policy problem in sufficient detail to reliably assess and compare their merits, even when there is an agreed scale on which to measure them. This relates to Alvin Weinberg's concept of trans-science and Jasanoff's concept of regulatory science.¹³¹ The political praxis aspect focuses on the process of obtaining sufficient agreement to adopt a policy. Lindblom argues that comprehensive "big-step" reforms are rarely politically feasible because "[t]oo many conflicting interests pull them apart. . . . The odds of agreement among political elites or citizens on [all the

CHANGE 11, 11 (2019) ("Non-state and subnational actors are undertaking climate mitigation efforts (many of them independent of national policy) that are leading to measurable emissions reductions."); VANDENBERGH & GILLIGAN, BEYOND POLITICS, *supra* note 83 (discussing efforts to address climate change by private actors).

¹²⁶ Vandenbergh, *supra* note 58, at 934; Michael P. Vandenbergh, *The New Wal-Mart Effect: The Role of Private Contracting in Global Governance*, 54 UCLA L. REV. 913 (2007).

¹²⁷ VANDENBERGH & GILLIGAN, BEYOND POLITICS, *supra* note 83, at 161.

¹²⁸ *Id.* at 9, 161 ("Private initiatives . . . can address solution aversion among moderates and conservatives, bypassing resistance to government climate efforts that arises from concerns about big government.").

¹²⁹ *See id.* at 23–25, 149–151 (discussing regulatory avoidance as a motivating factor for private climate change initiatives); Gilligan & Vandenbergh, *Initiative Feasibility*, *supra* note 114 (discussing the feasibility of multiple climate change initiatives working together).

¹³⁰ Lindblom, *Still Muddling*, *supra* note 24, at 517.

¹³¹ Weinberg, *supra* note 3; Weinberg, *supra* note 6; Jasanoff, *supra* note 7.

parts of such initiatives] are extremely slim,”¹³² whereas “[i]ncremental steps can be made quickly because . . . [t]hey do not rock the boat, do not stir up the great antagonisms and paralyzing schisms as do proposals for more drastic change.”¹³³

These two aspects of muddling through interact, so one way of making the scope of analysis manageable is to eliminate any policy measures that are deemed politically unfeasible.¹³⁴ Moreover, by focusing on smaller, more incremental policies, it becomes easier to draw on existing knowledge to assess both their likely effects and their initiative feasibility.¹³⁵ Combining the analysis and praxis aspects, muddling through consists of making progress through a succession of incremental changes, each of which focuses on making an adequate amount of progress within the scope of what is both politically and technologically feasible at the time. Lindblom’s approach has had a large and lasting impact on policy analysis and continues to be widely cited and discussed.¹³⁶

Subsequent developments that build on Lindblom draw on the biological metaphor of punctuated equilibrium to describe incremental policy progress as a sequence of small changes, interrupted by the occasional large and dramatic change

¹³² Lindblom, *Still Muddling*, *supra* note 24, at 521.

¹³³ *Id.* at 520.

¹³⁴ Lindblom, *Muddling Through*, *supra* note 24, at 85 (noting that by ignoring policies that “are politically impossible and so irrelevant, [a] simplification of analysis [may be] achieved”).

¹³⁵ *Id.*:

[G]iven the limits on knowledge within which policy-makers are confined, simplifying by limiting the focus to small variations from present policy makes the most of available knowledge. Because policies being considered are like present and past policies, the administrator can obtain information and claim some insight. Non-incremental policy proposals are therefore typically not only politically irrelevant but also unpredictable in their consequences.

¹³⁶ See, e.g., Michael Howlett & Andrea Migone, *Charles Lindblom is Alive and Well and Living in Punctuated Equilibrium Land*, 30 POL’Y & SOC’Y 53 (2011) (exploring the ongoing relevance of incrementalism to policy studies); MICHAEL HOWLETT, *DESIGNING PUBLIC POLICIES: PRINCIPLES AND INSTRUMENTS* (Routledge 2d ed. 2019) (2010) (recognizing Lindblom as an early scholar of policy studies); Leonore Haelg, Sebastian Sewerin & Tobias S. Schmidt, *The Role of Actors in the Policy Design Process: Introducing Design Coalitions to Explain Policy Output*, 53 POL’Y SCIS. 309 (2020) (discussing incrementalism); Greg Marsden, Antonio Ferreira, Ian Bache, Matthew Flinders & Ian Bartle, *Muddling Through with Climate Change Targets: A Multi-level Governance Perspective on the Transport Sector*, 14 CLIMATE POL’Y 617 (2014) (same); David F. Prindle, *Importing Concepts from Biology into Political Science: The Case of Punctuated Equilibrium*, 40 POL’Y STUD. J. 21 (2012) (same); Kelly Levin, Benjamin Cashore, Steven Bernstein & Graeme Auld, *Overcoming the Tragedy of Super Wicked Problems: Constraining Our Future Selves to Ameliorate Global Climate Change*, 45 POL’Y SCIS. 123 (2012) (same); Kelly Levin, Benjamin Cashore, Steven Bernstein & Graeme Auld, *Playing it Forward: Path Dependency, Progressive Incrementalism, and the “Super Wicked” Problem of Global Climate Change*, 6 IOP CONF. SERIES: EARTH & ENVTL. SCI. 502002 (2009) (same).

that reframes the political landscape.¹³⁷ However, these large jumps cannot be predicted, and there is no consensus on how to incorporate them into operational politics and policymaking.¹³⁸

Marsden et al. provide a detailed example in the specific case of the transport sector in the UK.¹³⁹ This work joins Lindblom's muddling through to a multi-level view of governance that emphasizes the role of local governments and nongovernmental actors, including but not limited to private industry, in bypassing political gridlock at the national scale. It examines case studies of four cities in the UK and compares the ways they pursued emissions-reduction targets for the transportation sector in the absence of an overarching national target. The study finds inconsistent and mostly small progress by the different cities, and concludes that while a theoretical framework of muddling through combined with multi-level governance is useful for understanding and evaluating progress, it does not identify an easy or straightforward path to emissions reduction:

In complex policy spaces, such as climate change, incrementalism is perhaps inevitable. If incrementalism is to achieve progress along a pathway to significant carbon reduction, then a clearer remit for carbon reduction for governmental and non-governmental actors at all levels is required, and greater emphasis needs to be placed on the delivery framework for steering change.¹⁴⁰

In contrast to this, our own work on private-governance approaches to emissions reduction provides greater reason to hope for important emissions reductions through incremental nongovernmental initiatives.¹⁴¹ One example of this is corporate supply-chain contracting initiatives to reduce greenhouse gas emissions. Large corporate buyers have used supply-chain contracting to reduce the annual emissions from their suppliers by more than 560 million metric tons of carbon-dioxide equivalent, with the potential to expand this to more than one billion tons through straightforward actions.¹⁴² This is a small fraction of the emissions reductions necessary to stabilize global greenhouse gas concentrations, but it represents meaningful incremental progress that other initiatives can build upon. We argue that in assessing the impact of incremental measures, it is important not to hold any one measure against the total scope of the climate challenge, but to ask

¹³⁷ Prindle, *supra* note 136; Howlett & Migone, *supra* note 136.

¹³⁸ Howlett & Migone, *supra* note 136, at 59.

¹³⁹ Marsden et al., *supra* note 136.

¹⁴⁰ *Id.* at 633.

¹⁴¹ Gilligan & Vandenberg, *Political Feasibility*, *supra* note 114; VANDENBERGH & GILLIGAN, *BEYOND POLITICS*, *supra* note 83.

¹⁴² CDP, *CHANGING THE CHAIN: MAKING ENVIRONMENTAL ACTION IN PROCUREMENT THE NEW NORMAL* 10-11 (2019), https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/004/811/original/CDP_Supply_Chain_Report_Changing_the_Chain.pdf?1575882630 [https://perma.cc/F2EK-XGGY].

whether it makes meaningful progress and whether it complements other measures that could add up to large-scale change.¹⁴³

VI. CONCLUSION

Rittel and Webber's paper on wicked problems identifies real and serious challenges for making policy at the messy and complex intersection of natural science and technology with social science and politics, but it does not offer any practical guidance about how to address these challenges. The subsequent literature has refined the concept of wicked problems and has made important advances in managing wicked problems. The literature on wicked problems, however, remains hobbled by the focus on the ten criteria spelled out in Rittel and Webber's original paper. These criteria induce paralysis in the policy analyst and the manager, which subsequent work is only able to escape by watering down the definition of wickedness. At the same time, other approaches to addressing problems at the intersection of technology with society—such as Weinberg's trans-science, Jasanoff's regulatory science, and Lindblom's muddling through—avoid the paralyzing flaws of the wicked problems paradigm and offer greater pragmatic guidance to the manager or policymaker.

The concept of superwickedness introduces an important new dimension to wicked problems—something that is also present in Jasanoff's regulatory science: the element of time and the acknowledgement that delaying a policy decision is itself a consequential policy decision. This is especially important to the challenge of climate change, and this need for haste demands incremental approaches to managing complex problems.

There is no escaping the challenge of achieving consensus on policy in a pluralistic society. This challenge is not unique to wicked problems, and to the extent that it becomes identified with wicked problems, every problem with a political element becomes wicked. If there is value to the concept of wicked problems, it is in reminding us that policy cannot be reduced to technocratic methods, such as mathematical optimization. But this is no longer the novel insight it was in the late 1960s and early 1970s.

We conclude that the wicked problem concept brings more problems than help to the policymaker or manager and that there are better ways to think about and respond to complex socio-technical problems. Among these, Lindblom's muddling through approach, which preceded wicked problems by more than a decade, has stood the test of time far better, and remains one of the most useful ways to think about these problems.¹⁴⁴

Lindblom, Rittel and Webber, and many others have observed that in the complex and messy realm of socio-technical policy problems, the distinction

¹⁴³ See Kevin M. Stack & Michael P. Vandenbergh, *The One Percent Problem*, 111 COLUM. L. REV. 1385 (2011) (arguing that reducing emissions requires regulation of sources that account for a low percentage of overall emissions); VANDENBERGH & GILLIGAN, *BEYOND POLITICS*, *supra* note 83.

¹⁴⁴ See Jonathan Bendor, *A Model of Muddling Through*, 89 AM. POL. SCI. REV. 819 (1995) (providing a formal model of incrementalism); Greg Marsden et al., *supra* note 136 (viewing contemporary climate challenges through incrementalism).

between means and end blurs, so the two cannot be treated separately. The oblique strategies advocated by Hulme and Pielke are a promising response to this and other challenges, but these strategies require greater attention to the urgency inherent in superwicked problems. Polycentric governance, with clear attention to the role of the private sector, is crucial to overcoming political gridlock caused by the ideological aversion to public governance.

There is urgent work to do in governing greenhouse gas emissions and other aspects of climate change. If there is one lesson that emerges clearly from the wicked problems paradigm, it is that there will be no perfect solution, and indeed, no political agreement over what characteristics would make a potential solution perfect. Every year, atmospheric concentrations of greenhouse gases rise ever higher, and every year that policymaking is delayed further constrains the options available for addressing the challenge of climate change.

Whether through our preference for an incremental process of muddling through with polycentric governance or others' preference for thinking about wickedness and oblique strategies, it is less important that we agree on a theoretical paradigm for policymaking than that we overcome inertia and gridlock by any means possible.