9-1-2020

# Social Science and the Analysis of Environmental Policy

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RPR
REVIEW OF POLICY RESEARCH



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## Abstract

*As much as environmental problems manifest themselves as problems with the natural environment, environmental problems—and their solutions—are ultimately social and behavioral in nature. Just as the natural sciences provide a basis for understanding the need for environmental policy and informing its design, the social sciences also contribute in significant ways to the understanding of the behavioral sources of environmental problems, both in terms of individual incentives and collective action challenges. In addition, the social sciences have contributed much to the understanding of the ways that laws and other institutions can be designed to solve environmental problems. In this review article, we distill core intellectual frameworks from among the social sciences that scaffold modern environmental policy in industrialized country contexts—focusing on key contributions principally from political science, economics, psychology, and sociology to the analysis of environmental problems and their solutions. These frameworks underlie how environmental problems are defined at multiple scales and the conceptualization and empirical testing of policy solutions that seek to shape human behavior in ways that improve environmental quality and promote sustainable economic growth. With the planet facing continued environmental threats, improving environmental policy decision-making depends on the insights and frameworks of social science research in addition to those of the natural sciences.*

**KEY WORDS:** environment, governance, economic development, pollution

正如与环境问题表现为自然环境问题的程度一样多的是，环境问题及其解决措施的本质最终是有关社会与行为的。正如自然科学为理解环境政策的必需性和影响其设计而提供基础一样，社会科学同样以显著的方式为理解环境问题的行为源（就个人激励与集体行动挑战而言）作贡献。此外，社会科学对理解法律和其他制度能通过哪些方式被设计于解决环境问题作出了诸多贡献。在这篇评论文中，我们从对工业化国家的现代环境政策予以支持的社会科学中提取核心智力框架，聚焦于主要从政治学、经济学、心理学、社会学到环境问题及其解决措施分析得出的关键贡献。这些框架强调了如何从多个层面定义环境问题，强调了对政策解决措施的概念化及实证检验，这些解决措施试图以提高环境质量和推动可持续经济发展的方式影响人类行为。鉴于地球正面临持续的环境威胁，提升环境政策决策取决于社会科学研究与自然科学的见解及框架。

**关键词:** 环境, 治理, 经济发展, 污染

*Tanto como los problemas ambientales se manifiestan como problemas con el medio ambiente natural, los problemas ambientales y sus soluciones son, en última instancia, de naturaleza social y conductual. Así como las ciencias naturales proporcionan una base para comprender la necesidad de una política ambiental e informar su diseño, las ciencias sociales también contribuyen de manera significativa a la comprensión de las fuentes de comportamiento de los problemas ambientales, tanto en términos de incentivos individuales como de desafíos de acción colectiva. Además, las ciencias sociales han contribuido mucho a la comprensión de las formas en que las leyes y otras instituciones pueden diseñarse para resolver problemas ambientales. En este artículo de revisión, destilamos marcos intelectuales centrales de las ciencias sociales que estructuran la política ambiental moderna en contextos de países industrializados, enfocándonos en contribuciones clave principalmente de la ciencia política, la economía, la psicología y la sociología al análisis de los problemas ambientales y sus soluciones. Estos marcos subyacen en cómo los problemas ambientales se definen a múltiples escalas y la conceptualización y prueba empírica de soluciones de políticas que buscan moldear el comportamiento humano de manera que mejore la calidad ambiental y promueva el crecimiento económico*

*sostenible. Con el planeta enfrentando continuas amenazas ambientales, mejorar la toma de decisiones de política ambiental depende de los conocimientos y marcos de investigación de las ciencias sociales, además de los de las ciencias naturales.*

**PALABRAS CLAVE:** medio ambiente, gobernanza, desarrollo económico, contaminación

## Introduction

Starting as early as the middle of the twentieth century, public values toward the environment have shifted greatly across the developed world. Both elites and members of the public have increasingly grown aware of and concerned about harms to public health and the environment from industrialization and urbanization (Inglehart, 1997). A series of new political and governmental institutions, ranging from specialized government regulatory agencies to green political parties to well-established nongovernmental advocacy organizations, have come into existence, and, in many countries, extensive laws and regulations have been established to address environmental concerns. In the name of environmental justice, marginalized communities have voiced their concerns and organized themselves in increasingly nuanced ways to challenge untenable status quos in their local backyards. Heightened international attention has also emerged over global environmental problems, including climate change and its associated implications for natural disasters, agricultural production, and ecosystem viability.

The contributions of the natural sciences to advancing environmental policy have been apparent in multiple ways—not the least being in the visible integration of scientific expertise into the identification of environmental problems and the understanding of the chemical, biological, and ecological relationships that underlie these problems. But at the same time, the social sciences have likewise made many contributions to the understanding of the sources of environmental problems, identifying them principally in individual and collective human behavior. The social sciences have also contributed much to understanding the ways that laws and other institutions can be designed to solve environmental problems—and the opportunities and challenges associated with their implementation. With the planet facing continued environmental threats, policy research related to the environment depends in important ways on the insights and frameworks of social science research in addition to research from the natural sciences. As much as environmental problems may manifest themselves as problems with the natural environment, in reality environmental problems—and their solutions—are ultimately social and behavioral ones.

In this review article, we distill core social science frameworks that undergird modern environmental policy analysis in industrialized country contexts—focusing on key contributions from political science, economics, psychology, and sociology. In so doing, we recognize that, as an umbrella term, the "social sciences" encompass a heterogeneous group of disciplines, each operating according to different sets of underlying assumptions, methods, and norms as knowledge producing, epistemic communities. A variety of social science disciplines, including anthropology, geography, and political ecology, have contributed key conceptual, normative, and empirical insights to understanding environmental politics, governance, and development.

In this article, we focus on a subset of social sciences that have been central to the approaches embraced by policy makers and analysts situated at the forefront of making environmental policy decisions in the increasingly technocratic settings of the developed world. In this respect, our discussion centers on those frameworks that underlie how environmental problems are defined at multiple scales and the conceptualization and empirical testing of policy solutions that seek to shape human behavior in ways that improve environmental quality and promote sustainable economic growth. As policies and institutions developed in industrialized contexts diffuse—for better or worse—to emerging economies seeking to establish or enhance their own domestic regulatory states, there is an even greater need for scholars, students, and practitioners to reflect on the underlying disciplinary insights and assumptions upon which such approaches are based—and to discern both the strengths and limitations of transferring policies, laws, norms, and other institutions across geophysical and political borders and institutional contexts. The social sciences we review here have been pivotal to the analysis of environmental policy decisions in many settings around the world.

## Environmental Problems

Central to the study and practice of any domain of public policy is the task of defining the problem to be addressed (Bardach & Patashnik, 2015). How environmental problems are framed may shape the set of policy alternatives proposed as possible solutions or the outcomes that policy can achieve.

Under one framing, environmental quality is an intrinsic moral good—a right or interest that inheres in nature itself, irrespective of the value humans place on ecosystems, species, or environmental conditions (Attfield, 2014; Naess, 1973; Rolston, 1988). Such a view undergirded the New Zealand government's decision in 2017 to designate the Whanganui River—the country's third largest—as a living entity, affording it the same legal rights as a person (Gordon, 2018). Under another conception of value, environmental quality constitutes a fundamental human right, a building block of individual capabilities (Holland, 2008). Still another way of conceiving environmental problems has been closely associated with aspirations for sustainable development or a "steady-state" economy (Daly, 1977).

The 1987 Brundtland Commission report, for example, articulated a vision for "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" (Mazmanian & Kraft, 2009; World Commission on Environment and Development, 1987). More recently, the pursuit of sustainable development, including transitions to less carbon- and resource-intensive economies, has diffused into the UN's 2030 Agenda for Sustainable Development via seventeen Sustainable Development Goals. These new goals integrate environmental criteria alongside poverty alleviation, security, and gender equality related goals, previously central to the Millenium Development Goals.

Concerns about environmental quality have often overlapped with broader concerns about social justice and inequality. Less powerful actors, including Indigenous Peoples, racial and ethnic minorities, and economically disadvantaged communities, have historically struggled to gain recognition of both existing and emergent

environmental problems in their backyards—from the siting of toxic waste sites and pipelines to the after-effects of hydraulic fracturing on drinking water safety and even contamination by genetically modified organisms (Bullard, 2018; Konisky, 2015; Taylor, 2014). These same actors have likewise faced uphill battles to design and advance policy solutions that effectively redress these problems. Even seemingly beneficent environmental policies can strip marginalized groups of their property or usufruct rights to land use. For example, "fortress conservation" has been critiqued for preserving hot spots of biodiversity or other unique wild places, like national parks, at the expense of local and Indigenous Peoples with historic claims to those places as customary fishing, foraging, farming, or herding grounds (Büscher, 2016). Nevertheless, despite power and resource asymmetries, otherwise disadvantaged groups or communities do sometimes prevail in the policy process (Starobin, 2018).

Much social science research has focused on the factors that explain the rise of modern environmental movements in many countries and the growing international consensus that status quo environmental conditions are no longer acceptable (Andrews, 1999; Coglianese, 2001; Guha, 2000; Schreurs, 2003). Like other policy problems, the framing of environmental problems can vary across institutional, cultural, and political settings (Douglas & Wildavsky, 1982; Dryzek, 2013; Kahan, Jenkins-Smith, & Braman, 2011; Schwarz & Thompson, 1990). This may especially be a concern when natural scientists have yet to develop a research consensus on an issue or develop valid instruments to test otherwise unobservable biological or chemical relationships. Furthermore, when policy entrepreneurs have yet to name the problem and seek solutions, adverse environmental conditions may never reach the public policy agenda (Kingdon, 1984).

Once environmental policy issues have reached a place on the policy agenda, social science research has contributed in important ways to the understanding of the sources of environmental problems by governmental officials and policy analysts. We focus in this section on social science understandings of the principal sources of environmental problems understood as the negative byproducts of economic activity—pollution—and other unintended consequences of that activity which pose risks to human health, loss of environmental amenities, damage to ecosystems, or resource-based reductions in quality of human life. How society can, and ought to, account for, prevent, or adapt to environmental and natural resource damages becomes the core problem for environmental policy to solve. We highlight here some of the most salient concepts that social scientists have contributed to the understanding of the sources of environmental problems which make up the foundation for environmental policy analysis.

### *Externalities and Transaction Costs*

Economists' conceptualization of environmental problems as a form of market failure has become widely accepted. Although markets in principle allocate goods and services efficiently, market failures can arise when transactions do not accurately reflect the full value of goods and services either to the parties to those transactions or to third parties who are affected by them. Environmental problems take the form of a market failure known as negative externalities—the imposition of harmful effects to third parties as a result of the production or consumption of a good. These externalities,

or spillovers, are not reflected in the price of goods and services, and hence the relevant goods and services are oversupplied in the market from the standpoint of society overall. If the price of coal, for example, fails to reflect the full costs borne by society associated with its production, then coal would be, in effect, artificially cheaper than it should be, leading more people to buy it than would be desirable from the standpoint of overall social welfare. If the coal industry could be forced to "internalize" these social costs, consumers would receive a more accurate price signal of the total costs (private and societal) associated with coal—compelling them to make different choices, such as using less coal or seeking out alternative energy technologies that may have fewer externalities (such as wind and solar) and which would then be more cost-competitive.

At a micro level, externalities can be understood by reference to economist Ronald Coase's well-known parable of a farmer and a rancher—a puzzle based on a conflict between two neighbors that provides a metaphor and analytic framework for understanding negative externalities (Coase, 1960). The Coase Theorem suggests that markets fail in the face of externalities largely due to the existence of transaction costs (Zerbe & McCurdy, 1999), for if transaction costs did not exist, the relevant parties could achieve an efficient allocation of resources (Coase, 1960; Ellickson, 1986). In Coase's parable-world (without transaction costs), the farmer and rancher would bargain between themselves to minimize the sum of both the damages from cattle straying into the farmer's crops and the costs of damage avoidance, such as building a fence. In reality, of course, as Coase himself understood, there do exist very real transaction costs associated with gathering information, negotiating agreements, and resolving disputes over pollution and the use of natural resources. The existence of these transaction costs means that many negative spillovers to market transactions will occur because it is too costly for the affected parties—often many thousands upon thousands of people, not just an individual farmer and rancher—to negotiate "win-win" agreements.

### *Public Goods and Commons Problems*

Environmental problems affect large numbers of people. The impact that any single polluting source has on any single individual within a large affected population may only be quite modest, even if in the aggregate, across all affected individuals, these adverse impacts are quite large. The asymmetry between the individual and collective impact of many environmental harms gives rise to the well-known problem of collective action (Hardin, 1982; Olson, 1965). This problem arises when each individual member of an affected group does not have enough at stake relative to the costs of avoiding the externality (or of mobilizing pressure to have a polluting source move or invest in pollution control). It is often rational under such circumstances for individuals to free-ride on the efforts of others. Collective action problems derive from the fact that many environmental amenities are public goods: that is, they are non-rivalrous (use by one person does not deplete from others) and non-excludable (cannot be kept from those who do not contribute to or pay for them). Environmental quality often possesses the characteristics of a public good; everyone can breathe clean air without having paid for it.

Ecosystems and natural resources also often possess the characteristics of public goods. Hardin (1968) showed how the public-goods nature of natural resources can lead to what he called the "tragedy of the commons" (Feeny, Berkes, McKay, & Acheson, 1990). When resources are shared in common and are non-excludable, it is individually rational for all the users of the resource to maximize their short-run gains from resource use and extraction—say, to graze as many cattle as possible—which leads to crowding, over-use, and eventual degradation of shared natural resources. Although all public goods problems involve issues related to goods possessing the dual characteristics of being non-rivalrous and non-excludable, many commons problems arise from the attributes of a common pool resource being non-excludable but rival in consumption—meaning that use by one person makes that same resource unavailable to another (or potentially diminishes the overall quality of the resource; Ostrom, 1990, 2008). Open ocean fisheries are a classic example of a common pool resource; boats "race to fish" to catch as many fish as possible, and fish taken by one vessel leave the fish stock depleted for subsequent fishing boats in the area. Furthermore, it is challenging, if not impossible, to exclude boats from fishing in open waters.

Still, some empirical social science research suggests that the "tragedy of the commons" is not inevitable (Apostle, McCay, & Mikalsen, 2002; McCay & Acheson, 1987; Ostrom, 1990, 2008). Under certain conditions, people can interact with common pool resources or other public goods in ways that counteract the tendency to free-ride, even absent governmental intervention. Such community-based self-regulation of local common pool resources can take on a diversity of institutional forms, involving a blend of formal and informal rules and customary norms—scaffolded by incentives and sanctions to elicit compliance—including shaming, social exclusion, and ex-communication. By and large, however, the broad decline in environmental quality in many countries, along with the emergence of wicked environmental problems such as climate change, tends to be consistent with the "tragedy of the commons" account and the free-riding tendency of various social actors (individuals, businesses, nations).

Natural science has shown how the decline of a single species or natural resource can cause major damage to or changes in an ecosystem. When the population of a species that makes up a fishery declines, for example, it may lead to a collapse not only of the species itself but it may also create a threat to the entire ecosystem. The effects of scarcity on ecosystems are sufficiently well established that natural scientists have at times forecasted eventual global environmental collapse as many species and resources disappear (Ehrlich, 1968). By contrast with the natural science perspective which sees scarcity as an important environmental problem, from the perspective of social sciences, particularly economics, scarcity can actually increase the value of a good or service and may prompt efforts to preserve it. This occurs with private goods (that is, goods that individuals can possess to the exclusion of others) because scarcity makes them more valuable, assuming constant demand. The increase in their value can, in turn, provide incentives for individuals to invest in new ways to protect or expand the private resource or to make other technological innovations (Simon, 1977).

Broadly, patterns of economic development have sometimes been seen to follow a pattern of increased scarcity or other environmental degradation to be followed by subsequent efforts at preservation. The Kuznets curve refers to a pattern showing that, as economies industrialize and achieve a peak in income and consumption growth,

environmental pollution actually begins to decrease, implying that economic growth might ultimately benefit the environment (Fiorino, 2018a; Kuznets, 1955). Inglehart's (1977) theory of post-materialism reflects a similar pattern, as populations have historically mobilized environmental political action after their basic material needs have been met. Despite these trends, "leapfrogging" has also occurred in several developing economies, wherein economic actors will skip over the use of polluting industrial technologies in favor of their more environmentally friendly counterparts. In this way, developing countries are often said to face the possibility of "tunneling through" the environmental Kuznets curve by learning from the mistakes of wealthy, industrialized nations (Munasinghe, 1999).

These kinds of dynamics, however, do not appear to occur without some kind of governmental intervention to compel polluters to bear the costs of environmental improvement. They especially do not apply in the same way to global public goods, where international institutions are weaker. Climate change, for example, results from scarcity occurring in terms of an atmosphere free of high levels of carbon dioxide, methane, and other greenhouse gases (GHGs). Scarcity in this sense—that is, of a clean atmosphere—does not automatically generate price signals or other market incentives to try to protect the planet from warming. On the contrary, each actor's principal incentives are to let someone else bear the costs of reducing GHG emissions. Meaningful benefits of reductions in GHGs will only accrue if many actors (individuals, companies, and countries) reduce their emissions. Each actor might reasonably ask why it should incur extra costs of emissions reductions if others are not also doing so. Furthermore, if others do in fact reduce emissions, the benefits from their reductions cannot be excluded from those actors who did not reduce. With public goods, market signals alone cannot erase the incentive to free ride.

## Policy Solutions

Whether environmental problems are understood in terms of the ill effects of pollution and resource depletion, or in terms of the more recent emphasis on sustainability, it is clear that they do not emerge in a vacuum. They manifest from the interaction of human activities with the environment, often arising from very complex, dynamic systems involving the interaction of economic and social behavior with the natural environment (Matson, Clark, & Andersson, 2016). Individuals, groups, businesses, and states endeavor to extract value from natural resources for a range of valuable purposes, but in the process they can degrade or exhaust those resources.

Understanding these underlying causes of environmental problems suggests a general approach to solving those problems. When environmental problems are understood as externalities of economic activity, then the general solution will lie in finding ways to ensure that individuals and businesses internalize those externalities. Although this general solution seems straightforward in concept, determining how best to motivate the internalization of externalities raises challenging policy issues. We consider here the contributions of social science to two main issues integral to environmental policy analysis: (1) the identification of the policy criteria against which solutions should be chosen or assessed, and (2) the general advantages and disadvantages of different environmental policy instruments.

### *Criteria and Values*

A perennial question in environmental policy analysis is, "How safe is safe?" This question arises most clearly in determining how stringent various limits on pollution should be set in government regulations. But in a fundamental way, it represents the core question undergirding almost all important environmental policy decisions. It is a question without an easy, uncontested answer, even though too often scholars and policy makers seem to treat "safety" or "environmental protection" as if they are self-evident concepts or ones that can be determined simply by marshaling scientific evidence.

This tendency has manifested itself in recent years in scholars' and policy makers' advocacy of a "risk-based" approach to regulation (Black, 2008; Bounds, 2010; Wiener, 2010), with the implication being that policy decisions can automatically follow from a clear and rigorous scientific understanding of effects on human health or ecological viability. But natural science by itself cannot determine how (or how stringently) environmental policy should be made, as policy determinations call for making normative judgments in addition to gathering scientific information (Coglianese & Marchant, 2004). To be coherent, any risk-based approach to environmental regulation needs to be grounded in a clear articulation of normative values or policy criteria (Finkel & Golding, 1995; Paoli & Wiles, 2015; Rothstein, Irving, Walden, & Yearsley, 2006). Principled environmental decision-making depends on choices about how much pollution should be deemed acceptable—or, more generally, by what criteria should environmental policy decisions be guided.

A variety of potential criteria can be discerned throughout the policy-analytic social science literature, although any thorough consideration of them will require some exploration of moral or political philosophy. For present purposes, we begin with a key criterion from standard welfare economics—namely, *efficiency*—and then proceed to discuss *cost-effectiveness* and *feasibility* as two major alternatives to efficiency. We then discuss *equity* as another vital criterion not captured by efficiency or cost-effectiveness, and perhaps even in tension with such economic criteria (Okun, 1975).

Efficiency takes into account not only the benefits of environmental policy in terms of reductions in harm, but it also factors in and seeks to balance those benefits with the costs of achieving them. It does so in two ways. The first way follows the concept of Pareto efficiency, which demands that a policy make at least some individual better off but without making any individual worse off. It has sometimes been hypothesized that Pareto efficiency can be achieved with respect to environmental policy through supposed "win-win" options that deliver improvements in the environment as well as cost-savings or other private returns to businesses (Porter & van der Linde, 1995). But empirical evidence suggests that such win-win opportunities are relatively rare and, in any case, cannot achieve anything close to the full internalization of all negative externalities (Palmer, Oates, & Portney, 1995).

The second, and more commonly applied, test of efficiency is known as Kaldor-Hicks efficiency. Under this test, more than just literal win-win options can be efficient. The Kaldor-Hicks test also accepts as efficient any option where the "winners" under a policy (say, those whose water source becomes cleaner) benefit in the aggregate in an amount greater than the costs the policy will impose on the "losers" (say, those businesses that must pay to install equipment to reduce their water pollution).

This test calls for the estimation of *net* benefits, which is what is usually applied in benefit-cost analyses of environmental policies (Gramlich, 1990).

The application of an efficiency test, though, raises a host of analytical and methodological challenges. One initial challenge involves identifying and characterizing the underlying risks to be addressed. The enterprise of risk assessment has been largely driven by natural sciences, but not exclusively so (Jasanoff, 1987; Stern & Fineberg, 1996). It is an enterprise that is crucial even when relying on policy criteria other than efficiency.

When an efficiency test applies, any expected reduction in risks from different policy alternatives must be valued or monetized, either by revealed-preference methods (e.g., extrapolating from how labor markets offer a wage premium for riskier jobs; Cropper, Hammitt, & Robinson, 2011; Viscusi, 1993; Viscusi & Aldy, 2003) or by stated-preference or contingent valuation methods (e.g., relying on social-science surveys to estimate individuals' willingness-to-pay for improvements in environmental conditions; Carson et al., 1992; Covello & Mumpower, 1985). Often environmental policies deliver their risk reduction benefits years or decades into the future—something that is especially the case for policies that aim to reduce cancer-causing pollutants, as their effects can have long latency periods. In such instances, the monetized estimates of all policy impacts will be converted into present value terms, raising the need to identify an appropriate discount rate to use in converting estimates to present-value terms (Revesz, 1999).

The efficiency test—and the resulting use of benefit-cost analysis to determine whether that test is met—has also raised normative critiques and questions which hold implications either more narrowly for various methodological choices or more broadly about whether to use benefit-cost analysis at all (Ackerman & Heinzerling, 2005; Adler & Posner, 2006; Bronsteen, Buccafusco, & Masur, 2013; Kelman, 1981). Some of these questions center on how to value a policy's impacts on future generations (Arrow et al., 2013; Brown Weiss, 1990) or on individuals from countries other than those of the policymaker (Rowell & Wexler, 2014). Others ask how to value impacts on natural resources that go beyond "use value" to humans, such as whether and how to incorporate "non-use" or "existence" value (e.g., the value of just knowing that certain wilderness areas are protected, even if never planning to travel to them; Mendelsohn & Olmstead, 2009). In some societies, Indigenous or Aboriginal cultures view these valuation choices—as well as more fundamental epistemological assumptions—in ways different from members of industrialized cultures (Berkes, Reid, Wilbanks, & Capistrano, 2006; Bohensky & Maru, 2011; Douglas & Wildavsky, 1982). Even within industrialized cultures, significant differences can exist in how laypeople and experts view different risks (Slovic, Fischhoff, & Lichtenstein, 1981; Wynne, 1996).

These normative and methodological issues arise principally when the efficiency criterion is applied to environmental policy decisions. By and large, other applicable policy criteria will dispense with the need to make the valuation judgments involved when benefits must be monetized, as the efficiency test demands. One alternative along these lines is the criterion of cost-effectiveness, which also accounts for the costs of a policy but does not call for balancing those costs against benefits and thus does not necessitate any attempt to monetize benefits such as avoided mortality or morbidity or environmental amenities. The cost-effectiveness criterion would point

decision-makers toward policies that can achieve the desired level of environmental or health improvement at the lowest cost.

Others have proposed using feasibility as a policy criterion, seeking to maximize environmental protection within the constraint of what is feasible (Driesen, 2005; but see Masur & Posner, 2010). The feasibility criterion is a close cousin to the precautionary principle, which has been widely urged as the better way to make policy decisions about environmental risk (Freestone & Hey, 1996). In general, the precautionary principle shifts the burden of proof on those who create potential externalities—for example, those who create new products or processes that could harm the environment or human health. It forbids economic activities until they can be shown to impose no unacceptable externalities. Although the precautionary principle possesses considerable appeal to policy makers and members of the public, some scholars have questioned its coherence and wisdom (Sunstein, 2005).

Whether the criterion selected for a particular policy analysis might be efficiency, cost-effectiveness, or feasibility, policy analysis often focuses just on the aggregate effects of environmental policies—that is, on their overall benefits or costs—not on how those effects are distributed (Robinson, Hammitt, & Zeckhauser, 2016). From the standpoint of welfare economics, the principal concern with market failures lies with the overall social costs of economic activity; when externalities exist, pollution becomes over-produced (or natural resources become over-exploited). But environmental problems also raise critical distributional fairness concerns as well. The scarcity that underlies most environmental problems necessarily implicates what Young (2013) calls a "problem of allocation." This problem is one concerning "who gets what rather than a matter of sustainability or the avoidance of negative side effects" (Young, 2013, p. 12).

Equity issues are embedded in environmental problems themselves because the risks and environmental harms from economic activity are not equally borne by everyone in society (Adler, 2012). Especially palpable in this regard are socioeconomic and racial disparities in the imposition of harms from industrial activity, concerns that have been reflected in an "environmental justice" movement in the United States and elsewhere (Cole & Foster, 2001).

Equity issues also are fundamentally embedded in choices about policy solutions. The Coasean parable, for example, not only illustrates what a negative externality is, but it also reveals equity's centrality in how rights get distributed whenever establishing policies or setting up legal regimes. Given the presence of transaction costs, it matters whether farmers are given the right to exclude others from their farmfields or ranchers are given the right to allow their cattle to roam freely. Which is the fair distribution? This question arises not just in parables but in the real world of policy decision-making whenever choices must be made between policy options that will reap benefits to some people and impose costs on still others. It also arises whenever tradeable emissions permit systems are established, as policy makers must decide to whom and in what proportion to award the initial allocation of permits (Young, 2013).

Attentiveness to distributional fairness raises several other environmental policy issues as well. One of these centers on how trade-offs between efficiency and equity ought to be resolved (Adler, 2012; Okun, 1975). Another concerns the extent to which benefits accruing to residents in foreign countries should be factored into the policy calculus, a particularly salient issue in the context of global climate change

policy (Gayer & Viscusi, 2016). Still another issue—intergenerational equity—focuses on the moral obligations that present-day individuals and businesses owe to future generations, an issue also implicated by climate change (Brown Weiss, 1989).

Considerations of equity and fairness over environmental quality bear some affinity with the view that environmental protection is a human right. Even though rights-based thinking may seldom explicitly factor into formal policy analyses of environmental problems in many developed economies, such a view does seem to permeate much political and legal discourse over environmental policy. Any such right may be invoked or framed at the level of the individual or at the level of a community, such as in the latter case when Indigenous Peoples suffer targeted environmental degradation (Boyle, 2006; Shelton, 1991). As noted previously, some observers have also suggested that ecosystems or species themselves possess intrinsic value, if not rights, even when humans incur no instrumental harm (Naess, 1973; Sagoff, 1988; Stone, 2010). Others ask whether a human right to environmental quality comes into tension with other human rights or with a commitment to democratic governance (Bartley, 2018; Fiorino, 2018b; Ophuls, 1977).

### *Policy Instruments*

One or more of the principal policy criteria we have highlighted—especially efficiency, cost-effectiveness, feasibility, and equity—are commonly used in policy analysis to inform decisions about a variety of possible policy responses to environmental problems. In this section, we briefly review the key findings from social science research on the major tools available to the environmental policy maker (National Academies of Sciences, Engineering & Medicine, 2018; Richards, 2000). All of the tools discussed here have been adopted and implemented by national governmental bodies, so for our present purposes, we will treat such bodies as the key policy makers, even though most of the instruments discussed here could be applied by other decision-makers, whether private or public, international or local.

As these various policy tools have been adopted in practice, social science researchers have sought to understand the conditions under which each may be best implemented and the extent to which each proves effective in addressing environmental problems and meeting relevant policy criteria (Richards, 2000). A distillation of this research suggests that decision-makers do well to consider three principal factors when deciding which tool to use: the nature of the environmental problem, characteristics of the industry actors or other sources of that problem, and the capacity of governmental institutions to implement and enforce the tool (National Academies of Sciences, Engineering & Medicine, 2018). Generally speaking, the more flexible the regulatory tool, the more likely it will produce outcomes that are more efficient or cost-effective. However, if that flexibility is not accompanied by a sufficient set of incentives for businesses to improve their environmental performance—either from market pressures or through effective compliance monitoring and enforcement—environmental policy might not prove effective at all (Bennear & Coglianese, 2013; Kamieniecki & Kraft, 2013).

We discuss the tools below roughly in the order with which they have emerged in response to environmental problems in many countries, with interest in more flexible strategies seeming to grow over time (Press, 2007). In many countries, the initial

response to environmental problems tended to focus mainly on liability followed by the imposition of "command and control" standards, such as means-based and performance-based regulation (Andrews, 1999). Concerns about the bluntness and costs of these approaches eventually led to an interest in more flexible regulatory designs, such as market-based policy instruments and management-based regulation (Bennear & Coglianese, 2013; Keohane, Revesz, & Stavins, 1998; Rabe, 2018a). Policy makers and scholars have also focused attention on voluntary programs established to encourage firms to go beyond compliance with environmental rules (Auld, Bernstein, & Cashore, 2008; Borck & Coglianese, 2009; Durant, Fiorino, & O'Leary, 2017; Fiorino, 2006). Today, all of these tools are deployed to varying degrees by most governments around the world.

*Ex-Post Liability*—One tool for addressing environmental problems is to impose liability on polluters after they cause harm to others. Sometimes referred to as the "polluter pays" principle, ex-post liability can, at least in theory, provide a deterrent effect that leads polluters to adopt preventative measures. Although ex-post liability may be deemed appropriate for special types of environmental concerns or as a general backstop to other options, such liability by itself is generally thought to be insufficient as a principal means of addressing environmental concerns, mainly for the very same kinds of reasons that environmental problems arise in the first place: transaction costs and the problems of collective action (Bardach & Kagan, 1982). Even with liability, harmed individuals will have an incentive to free ride on others, rather than seek their own costly forms of redress through a liability regime. This dynamic presumably leads to a less-than-optimal level of deterrence—and to the continued existence of the very environmental problems policy makers seek to solve. To overcome the shortcomings in ex-post liability, and in an effort to try to prevent environmental harm from occurring in the first place, governments have adopted protective, proactive environmental regulation.

*Means-Based Regulation*—Proactive regulation can take a variety of forms. One form consists of rules directing regulated entities (e.g., businesses) to use a particular means of pollution control or to take other specified actions to reduce environmental problems. Sometimes characterized as technology or specification standards, examples of these "means standards" include requirements for the installation of catalytic converters on automobiles or the operation of emissions scrubbers on factory smokestacks. This type of regulation is not uncommon in environmental policy. Means standards generally offer greater certainty that regulated firms will take the desired environmentally protective action, and they may also be easier than other types of regulation for regulatory officials to enforce (National Academies of Sciences, Engineering & Medicine, 2018). Despite these advantages, means standards will often be less cost-effective than other forms of regulation because they mandate the same "one-size-fits-all" action for every regulated firm. Some firms may not really need to take the required action, or they may have available to them other actions that would prove more effective or less costly.

*Performance-Based Regulation*—Instead of mandating means, regulation can also mandate the attainment or avoidance of certain outcomes—setting a goal of "what" to achieve but not specifying "how" to achieve it. Such a performance standard

does not require the use of any particular technology or other action; on the contrary, it leaves the means of achieving or avoiding the specified outcome up to the regulated firm. All that firms must do is deliver on the outcome (Coglianese, Nash, & Olmstead, 2003; May, 2011). An emissions limit is a common example of a performance standard.

By specifying requirements in terms of outcomes and giving firms flexibility in meeting those outcomes, performance standards can overcome the one-size-fits-all disadvantage of means standards (May, 2003). Performance standards can also better allow for innovation to occur (Jaffe, Newell, & Stavins, 2004). For these reasons, many social scientists have recommended performance standards as more cost-effective regulatory instruments.

Yet performance standards are not without their disadvantages either. As a fundamental matter, performance standards need a reliable method for measuring firms' satisfaction of the required outcome conditions. Yet sometimes measurement of outcomes can be difficult with respect to environmental standards. As a practical matter, regulators typically cannot monitor on an ongoing basis the emissions from every smokestack and exhaust pipe that contributes pollution to the air.

Furthermore, performance standards can be susceptible to a type of gaming known as "teaching to the test," which occurs when regulated firms find ways to meet the required outcome but in ways that work to the detriment of the larger purpose of the regulation. An example can be found in the 2015 Volkswagen's diesel scandal; the company had installed software that ensured its engines optimized for emissions control while connected to the required testing machine, but then recalibrated and spewed out more pollution when operating under normal, on-the-road conditions (Coglianese, 2017). Performance standards may also be somewhat more prone to the incidence of unintended consequences as firms use their flexibility in creative ways that produce new, unanticipated problems (May, 2003).

*Market Instruments*—Although performance standards can prove more cost-effective than means standards, they still can be less cost-effective than so-called market-based regulatory instruments. This is because performance standards can suffer from their own type of one-size-fits-all problem: they require uniform levels of emissions control even when the marginal costs for controlling those emissions can vary across different sources. Rather than demanding every firm meet the same emissions limit, market instruments allow for—and even provide incentives for—different businesses to choose their own level of emissions. Market instruments operate either by setting a per-unit tax on emissions or by establishing a system of tradable emissions permits (Tietenberg, 1985).

A marginal pollution tax set at the level equal to the social costs of pollution would solve the Coasian bargaining problem discussed above and would ensure that firms fully internalize their externalities (Pigou, 1932). However, the precise marginal social cost of pollution can be difficult to determine, and while a tax provides certainty in terms of costs imposed on firms, it does not provide much certainty about the overall level of pollution that will be reduced.

An alternative market-based approach called emissions trading—or simply "cap and trade"—can provide greater certainty about the overall level of pollution reductions. Under a cap and trade system, an overall desired level of emissions is established

and a number of aggregate emissions "credits" issued that total the desired level. Each individual firm then receives credits equaling a portion of the overall emissions level; they must keep their emissions below the amount allowed by the credits they possess—much like with any performance standard. But unlike with uniform performance standards, firms can exchange credits under cap and trade, thus varying the level of control each firm must achieve. Those firms with lower marginal costs of control can free up some of their emissions credits by reducing pollution more than required and then selling excess credits to other firms with higher marginal costs of control, ultimately achieving the same overall level of pollution reductions but at a lower cost. These theoretical expectations of greater cost-effectiveness have been confirmed by empirical research (Cropper & Oates, 1992; Stavins, 2007).

Market instruments are, of course, susceptible to some of the same potential limitations as performance standards. They very much depend, for instance, on a reliable means of measuring emissions. Moreover, market-based environmental policy instruments may lead to another problem: hot spots. If those firms that buy credits and those that sell credits are located in different areas, pollution levels could become more concentrated in some regions. Research has also investigated whether cap and trade systems tend to disadvantage smaller firms (Newell & Rogers, 2003).

*Management-Based Regulation*—Management-based regulation does not require that firms meet a specific targeted outcome nor even adopt any direct means that aim toward a desired outcome, but instead it mandates that firms collect information, develop internal plans and procedures, and engage in other management-related actions that aim indirectly toward reducing environmental problems (Bennear, 2006; Coglianese & Lazer, 2003). For example, some laws direct companies using toxic chemicals to engage in pollution prevention planning to try to reduce their use of toxics, even without requiring those companies to take any specific pollution prevention activity or adopt particular control measures—and sometimes without even demanding that they carry out their required plans. In short, management-based regulation aims to solve environmental problems simply by spurring improvements in private-sector environmental management (Coglianese & Nash, 2006).

Management-based regulations appear to be suitable when addressing environmental problems where one-size-fits-all means do not exist and where monitoring outcomes is not feasible. It has been used, for example, to encourage reductions in the use of toxic chemicals and to try to prevent catastrophic industrial accidents. Empirical evidence shows that these regulations can lead to improvements in some measures of environmental quality (Bennear, 2006, 2007; Coglianese & Lazer, 2003). However, research also suggests that improvements induced by management-based regulations may not be long-lived. Firms appear initially to find low-hanging fruit once they start to manage their environmental affairs more self-consciously in response to management-based requirements, but over time the required planning appears to become more routinized and environmental improvements taper off.

*Information Disclosure*—Another regulatory approach requires not just the gathering of information for internal planning purposes, but the affirmative public disclosure of certain kinds of information (Sunstein, 1999; Tietenberg, 1998). The U.S. Toxics Releases Inventory (TRI) regulation serves as a prominent example of this policy

instrument. TRI requires certain industrial facilities to disclose to the public the volume of toxic chemicals they release into the environment. Some researchers have attributed the decline over time in chemicals reported under TRI as a sign of the policy's success (Fung & O'Rourke, 2000; Thaler & Sunstein, 2008). Others have shown that observed reductions can be explained instead by other, more traditional forms of regulation operating in the background or by factors other than real improvements in environmental performance (Bennear, 2008; de Marchi & Hamilton, 2006; Natan & Miller, 1998; Poje & Horowitz, 1990). Indeed, some empirical research suggests that the impact of toxics disclosure requirements might even depend on their combination with strong conventional environmental regulations and pressures from environmental groups (Kraft, Stephan, & Abel, 2011).

Studies of state programs in the United States that promote the disclosure of toxic emissions information have failed to find evidence that disclosure has produced any significant effects on facilities' environmental performance (Grant & Jones, 2004; Kraft et al., 2011). The precise effects, if any, of the federal TRI law remain unknown (Hamilton, 2005). That said, other research has shown that, in other settings, information disclosure can sometimes contribute to at least some modest levels of environmental improvement (Bennear & Olmstead, 2008). Researchers theorize that information disclosure can reinforce various other legal, market, and social pressures for companies to reduce pollution (Hamilton, 1995; Khanna, Quimio, & Bojilova, 1998; Konar & Cohen, 1997). Furthermore, if the aphorism that "what gets measured, gets managed" rings true, then information disclosure may also operate as a partial form of management-based regulation and induce spillover managerial changes at regulated firms (Karkkainen, 2001).

*Subsidies*—The public goods nature of environmental quality can impede private financing for certain kinds of environmental solutions, such as water supply systems or storm-water management. Public financing and subsidies can fill in gaps in private financing of public environmental amenities. Tax credits for investments in nonrenewable sources of energy are another example of a type of subsidy available to address environmental problems.

*Voluntary Programs*—A related approach is to reward firms that voluntarily adopt environmentally responsible actions or achieve high levels of environmental performance. Through so-called voluntary environmental programs, governments sometimes offer qualifying firms technical assistance, awards and public recognition, special eco-labels, or specified forms of regulatory relief. Examples include the U.S. government's "Energy Star" product labeling program or the U.S. Environmental Protection Agency's National Environmental Performance Track partnership program (Coglianese & Nash, 2014). Some research shows that these kinds of voluntary programs can have a discernible effect on certain environmentally relevant metrics (Morgenstern & Pizer, 2007; Pizer, Morgenstern, & Shih, 2010). But because the rewards offered firms through these programs are typically modest, they are likely to have only limited value for solving most major environmental problems (Coglianese & Nash, 2014).

## Institutions

Just as social science research has helped identify and evaluate different policy instruments for addressing environmental problems, it has also clarified several key institutional choices relevant to environmental policy. These include choices about the types of institutions that should bear the primary responsibility for addressing environmental problems—specifically, the public or private sector—as well as about the appropriate scale of policy responses—top down or bottom up. In addition, social science research about policy decision-making has made contributions to the design of processes used to make and implement environmental policy.

### *Public versus Private*

Although governments are major sources of environmental policy, a variety of non-governmental actors also fulfill governance roles (Büthe & Mattli, 2011; Vandenbergh & Gillian, 2017). Especially in societies lacking in state capacity or for problems that governments are unable or unwilling to address, private third parties can serve as surrogates for (or at times supplements to) governmental actors (Büthe, 2010). Sometimes called "private regulators," business associations or NGOs operating in this capacity derive their authority and legitimacy more through moral persuasion and market power than coercion or force (Cashore, Auld, & Newsom, 2004; Green, 2013). For example, a variety of privately created labeling and certification schemes have emerged to provide global consumers and businesses credible information and assurances related to niche preferences for more sustainable or ethical forms of agriculture and manufacturing (Starobin & Weinthal, 2010). These non-state schemes can impose means or performance standards—or any of the types of rules that governments could impose—but they lack the ability to mandate compliance with the threat of state-imposed sanctions. As a result, private forms of environmental governance will bear many similarities to voluntary programs adopted by governments. That said, the market pressures available to business associations, NGOs, and even multinational corporations like Wal-Mart can sometimes create incentives for compliance that rival or even exceed those provided by state authority (Starobin, 2013).

Social scientists have investigated why firms willingly undertake to "self-regulate" and voluntarily go beyond bare compliance with the law. Conventional wisdom holds that private certification schemes offer firms a club good—exclusive reputational benefits available only to those members that achieve the desired level of compliance—thereby distinguishing leaders from laggard competitors in their sector (Prakash & Potoski, 2006). Other incentives for self-regulation include product differentiation, access to markets, and, in some cases, a reduction in the probability of eventual governmental regulation. Researchers have sought to evaluate private forms of environmental governance and on occasion have found that they generate improvements in certain metrics, such as days in compliance with regulations and paperwork processing (Prakash & Potoski, 2006). As with voluntary programs more generally, it has been harder for researchers to find substantively significant improvements associated with these private voluntary efforts. Concerns exist about the adequacy of implementation of, and compliance monitoring associated with, non-state forms of environmental governance.

In reality, the choice between private and public governance is seldom truly binary. Instead the public and private sectors are intertwined in environmental governance (Steinberg & VanDeveer, 2012). The shadow of public governance, such as through regulatory threats, shapes what otherwise seems to be voluntary private action (Lyon & Maxwell, 2004). In turn, though, public governance depends vitally on private firms for information and action (Coglianese, 2007). Research reveals an intertwined public-private governance, especially in transnational business governance interactions, with multiple actors across sectors and countries collaborating in the creation of private regulations while cooperating within existing state regulatory structures (Bartley, 2011, 2018; Eberlein, Abbot, Black, Meidinger, & Wood, 2014; Levi-Faur & Starobin, 2014). The choice for environmental policy often is a matter of emphasis on one sector over the other, or in allocating different roles and responsibilities to actors from each sector.

### *Top-Down versus Bottom-Up*

A perennial issue in environmental policy concerns the scale at which solutions should be sought (Young, 2002). With the exception of problems with highly localized impacts, environmental problems often transcend political boundaries, raising the question of whether the responsibility for addressing them should be assumed by national bodies or devolved to lower levels of scale. The choice between a top-down versus a bottom-up set of solutions assumes particular significance for transnational environmental problems, such as climate change.

Countries have long relied on international treaties as core policy tools employed to elicit compliance from states to provide global public goods, prevent environmental harms, and protect human rights (Mitchell, 2003; O'Neill, 2009; Susskind, 1994). Yet, in the era of globalization, both states and non-state actors, including businesses, perform nuanced roles that go beyond treaty formation, negotiation, and ratification—and often they must consider whether other, bottom-up policy tools, including private, voluntary initiatives or other innovative policy alternatives, might prove more effective (Andrews et al., 2017; Starobin, 2018).

Top-down approaches to governing the global environment like multilateral treaties have long been the classic approach to tackling the collective action challenges associated with managing commons at the international scale—seeking to impose on countries a regime under which they make specific commitments (e.g., on ozone depletion, greenhouse gas reductions) related to ameliorating or preventing environmental damages if not also contributing funds toward their remedy, even in other jurisdictions. Yet, these approaches have also struggled at times with issues of effectiveness and inclusivity (Haas, Keohane, & Levy, 1993; Young, 1999). Treaties require ratification at the level of the nation-state to become "binding"—even though they still rely upon signatories for enforcement, ultimately depending on the willingness and capability of state-level bureaucracies to integrate international ideas, norms, and institutions with domestic ones (DeSombre, 2000).

Top-down approaches have not only generated concerns about their effectiveness but also about global equity, as top-down treaties may reflect the preferences of the developed countries whose industrialization and development have fueled accelerated environmental degradation, to the exclusion of developing and emerging

economies, many of which stand to face more of the negative consequences, such as rising temperatures, sea-level rise, and resource scarcity (Baland & Platteau, 1996; Escobar, 2011). In addition to developing countries feeling left behind, affected individuals and communities—those at the bottom of the global economic pyramid who are likely to experience environmental harms most directly—may not have their interests and concerns reflected very well in top-down policy discussions.

Although bottom-up approaches to environmental governance may ameliorate disadvantages of top-down approaches, when problems transcend a smaller scale, a bottom-up approach may simply not be up to the task (Keohane & Ostrom, 1994). Furthermore, when governance is devolved to lower scales, a concern arises for a "race-to-the-bottom" effect, as local jurisdictions may have an incentive to compete for business activity through less stringent policy measures. A related concern is that jurisdictional or scale spillovers may occur; that is, as some localities or regions respond to environmental problems more aggressively, they may only find that they push more-polluting businesses to other jurisdictions with weaker policies, without fully solving the trans-boundary environmental problem (Wiener, 2007). The extent to which these problems with bottom-up approaches manifest themselves, however, remains an open question, with some research offering counterexamples and theoretical reasons to question the significance of race-to-the-bottom effects (Revesz, 1992; Vogel, 2009).

Although multilateral action by nations is an important component of global environmental governance, there is much being done to address climate change across varying levels of government. Transnational climate governance initiatives have emerged all over the world, made up of governments of all sizes and locations—including cities, states, countries, and regions—that are collaborating in nuanced ways to govern climate change (Andonova, Hale, & Roger, 2017; Bulkeley et al., 2014; Green, 2013; Hoffman, 2011; Rabe, 2004, 2018b; Roger, Hale, & Andonova, 2017). An important issue is the extent to which these various bottom-up approaches can substitute for top-down strategies as well as how policies developed at different scales can be coordinated or integrated.

### *Policy Processes*

Choices about policy criteria, instruments, and institutions all implicate values and interests over which different individuals have different preferences and views. Understanding *how* these choices should be made, and who makes them, has motivated the vast field of political science across all policy domains, including environmental policy (Vig & Kraft, 2018). Relevant issues for environmental policy analysis include accountability and transparency of policy decision-making and the type and extent of participation by affected parties, including the broader public, in decision-making processes. With environmental policy, democratic values are implicated in important, sometimes distinctive, ways, often because the key institutions lack traditional electoral accountability connections. At the level of domestic governance, for example, many pivotal institutions can be bureaucratic and technical in orientation—and not directly accountable through elections but through oversight by other electorally based institutions. As a result, particularly relevant social science research has focused on the role of experts (Haas, 1992; Jasanoff, 2009), consensus-building in

the administrative context (Coglianese, 2003), and public participation in decisions by regulatory bodies (Fraser, Dougill, Mabee, Reed, & McAlpine, 2006; Singleton, 2000; Tyler & Markell, 2008). In addition, courts play consequential roles in shaping environmental policy at the domestic level, and their role vis-à-vis other governmental institutions has not escaped attention (Melnick, 1983; Rose-Ackerman, 1995).

At the level of global environmental governance, what it means to secure democratic accountability creates further complications because typical electoral mechanisms do not exist and direct participation by members of the public is practically difficult to accommodate (Cohen & Sabel, 2005; Keohane, 2001). Accountability arises as an issue not only for the design of international legal institutions, such as multilateral treaties, but also for voluntary transnational initiatives, such as international environmental management standards or certification programs for sustainable forestry practices. Policy decision-making in these global settings tends to be fragmented and diffuse, with multiple interests at stake and networks of public and private actors interacting in a variety of policy venues (Slaughter, 2005). Efforts to address the global accountability deficit can take the form of delegation strategies that strengthen principal-agent relationships between state representatives and global institutions or strategies of so-called stakeholder participation involving diverse governmental and nongovernmental organizations in the global policy process (Grant & Keohane, 2005). Accountability strategies can also be both internally and externally oriented—the former comprising standards that in effect govern participants in the transnational regime, and the latter involving efforts to build broader support for the regime from those outside of it but who are nevertheless affected by it (Gulbrandsen & Auld, 2019; Keohane, 2003). Research has suggested that information disclosure—one of the substantive tools for addressing environmental problems—may be deployed to promote accountability in global governance regimes (Büthe, 2012; Kelley & Simmons, 2019). However, it should be noted that increased accountability may not always lead to improvements in environmental performance, especially if the accountability mechanism leads a global institution to take a lowest-common-denominator path (Park & Kramarz, 2019).

Similar approaches to promoting accountability and legitimacy of environmental institutions, both domestic and international, can be applied to environmental policy analysis itself. Analysis will have a greater impact on actual decisions when it is viewed as more credible. Taking steps to involve others in participation in the generation of policy analysis not only can enhance the information base on which analysts conduct their work but can also make the findings of the analysis more broadly salient and trusted (Matson et al., 2016; Mitchell, Clark, & Cash, 2006).

Finally, process choices emerge even after the analysis of and decision-making about environmental policy tools. How policy tools are implemented can prove as vital as how they are designed. Policies as they appear "on the books" do not always mirror how they are applied at the "street level" (Kaufman, 1967; Lipsky, 2010; Pressman & Wildavsky, 1984). Social science research has also contributed in important ways to the understanding of how policy tools are implemented and enforced (Ayres & Braithwaite, 1995; Bardach & Kagan, 1982; Hawkins, 1984).

Ultimately, the processes by which policy decisions are both made and implemented provide the methods by which societies will solve environmental problems. The social sciences have made important contributions to understanding how such

processes operate and how they might be structured to generate improved environmental outcomes.

## Conclusion

In this review article, we have endeavored to illuminate some of the many intellectual contributions from social sciences to the understanding of environmental problems and to the design of effective policy solutions that will change individual and collective behavior in ways that enhance environmental quality. We take as given the role for the *natural* sciences in addressing environmental problems, as designing effective solutions depends on understanding risks and their causes. Reliable natural science research is a necessary foundation for developing policies to address environmental problems. Yet it is also not sufficient. To generate sound environmental policy decisions, governments, businesses, and global civil society actors also need *social* science research. Environmental problems and their solutions both involve human behavior, and they implicate key normative or policy questions that policy decision-makers must confront. Effective environmental policy analysis, in other words, must be interdisciplinary (Mattor et al., 2014). It must be grounded in research from the natural sciences as well as in the careful consideration of theories, concepts, and findings from the social sciences.

The underlying causes of environmental problems can be conceptualized in relatively straightforward terms as a failure of individual actors to internalize externalities, but given the sheer number of actors, and the variety of activities they engage in, effectuating a meaningful internalization of environmental costs will often prove challenging and complex. Devising effective solutions requires a nuanced understanding of the complex economic and social sources of human-induced problems, as well as sources of countervailing pressure because, most often, environmental harm occurs from people acting in ways that are privately rational but collectively suboptimal. Those individuals and businesses currently imposing spillovers on others can be expected to resist efforts that would force them to internalize those costs, and if they generally possess greater resources or are better organized politically than environmental cost-bearers, the distribution of environmental amenities may tend to mirror that of other resources in society.

An awareness that environmental harms are not evenly distributed, whether in individual societies or around the world, reinforces the relevance of finding ways to ensure a more complete elaboration of environmental policy's impacts and a search for still better ways to improve the well-being of all members of society. Social science's longstanding interest in collective decision-making not only illuminates the causes of environmental problems but helps identify the tools and processes needed to solve them more optimally and fairly.

In the future, social science research will continue to be needed to explore environmental problems, solutions, and institutions. Additional research can help refine and improve each of the concepts and theories presented in this article. Policy analysis could benefit, for example, from still more research on the comparative performance of different policy tools and the conditions for their success. In addition, as social and economic conditions are in constant flux—as exemplified recently by the emergence

of populism and nationalism on multiple continents—these changing conditions will need to be studied for their implications for environmental policy.

Changing *natural* conditions will also prompt the need for additional social science research. It will also foster the need for research that more fully integrates the natural sciences with the social sciences. For example, as climate change further strains liveability conditions in many parts of the world—such as due to water shortages or the ravages of floods and storms—social conflicts can be expected to be exacerbated. Under such conditions, societies are likely to face the need for policy tools that do not merely prevent or mitigate environmental problems but help us adapt to them. Such tools could include those needed to manage the relocation of entire communities, an undertaking that will likely be pursued in many countries around the world and that will depend on integrative research if it is to be executed effectively. As changing environmental conditions place societies under stress, the need for rigorous social science research as part of environmental policy analysis will not disappear.

## Acknowledgments

The authors would like to thank Hannah Kass for excellent research assistance and Matt Adler, Helga Nowotny, and several anonymous reviewers for helpful comments on earlier drafts. This review article draws on a paper prepared by the authors for the International Panel on Social Progress.

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