William & Mary Environmental Law and Policy Review

Volume 35 (2010-2011)
Issue 3

Article 3

May 2011

Fourth Generation Environmental Law: Integrationist and Multimodal

Craig Anthony Arnold

FOURTH-GENERATION ENVIRONMENTAL LAW: INTEGRATIONIST AND MULTIMODAL*

CRAIG ANTHONY (TONY) ARNOLD**

ABSTRACT

Institutional arrangements to protect the environment, manage natural resources, or regulate other aspects of society and the environment are not merely matters of optimal institutional design or choice. These arrangements result, at least in substantial part, from the evolution of interconnected social, legal, and ecological systems that are complex, dynamic, and adaptive. This Article makes the case that environmental law is evolving to become more integrationist and multimodal: using multiple modes and methods of environmental protection, often across multiple scales, but in integrated ways. Integrated multimodality is a feature of much of social life. Building on generational analyses of environmental law and exploring complex problems at the intersection of climate change, land use, and water, this article contends that environmental law is undergoing pressure to adapt, because unimodal ("one-size-fits-all") and fragmented approaches to environmental problems are proving inadequate. On one hand, a variety of psychological, socio-structural, political, economic, and

---

* This article is a version of the Fall 2009 Distinguished Visiting Lecture in Environmental and Land Use Law, given on October 28, 2009, at Florida State University College of Law.
** Associate Dean for Academic Affairs and Faculty Development, Boehl Chair in Property and Land Use, Professor of Law, Affiliated Professor of Urban Planning, and Chair of the Center for Land Use and Environmental Responsibility, University of Louisville; Huber Hurst Visiting Eminent Scholar, University of Florida Levin College of Law, Fall 2009; Visiting Professor of Law and Symposium Visiting Professor, University of Houston Law Center, Spring 2010. The initial foundations of this research began while I was a Visiting Scholar in the School of Planning, College of Design, Architecture, Art, and Planning, University of Cincinnati, 2008–2009, and from an April 2008 presentation to the Environmental and Land Use Law Program Capstone Colloquium at the University of Florida Levin College of Law. I thank Michael Wolf, Alyson Flournoy, Mark Fenster, Danny Sokol, Michael Siebecker, Tom Ankersen, Yariv Brauner, Richard Hamann, J.B. Ruhl, Robin Craig, Donna Christie, Dave Markell, Jim Rossi, and the faculty at workshops at both Florida State University College of Law and the University of Florida Levin College of Law for their helpful comments and insights. I also thank Andy Long for his encouragement and facilitation of this project, and Dustin Wallen and Liz Edmondson for research on prior projects that proved useful on this project.

normative forces converge to produce unimodal fragmentation. On the other hand, several phenomena—"wet growth" policies that integrate water quality and conservation into land use planning and regulation; watershed planning and management; and local climate change action plans—reflect the evolution of integrationist multimodality. These examples illustrate four nodes of connectivity by which multiple modes are integrated and also suggest that integrationist and multimodal developments are occurring and will occur at the edges of environmental law. However, integrationist multimodality may not necessarily produce better environmental protection and therefore must be studied as an emerging phenomenon that can help us to better understand the functions and limits of environmental law.

INTRODUCTION

Environmental law and related fields of land use law, water law, and natural resources law continue to evolve rather rapidly.[1] Commentators now believe that we are in the third generation of environmental law in the United States,[2] even if there is not total agreement about how to characterize the various generations.[3] U.S. environmental law appears to have evolved from reliance primarily on common-law tort and property doctrines to government reservation and management of lands and natural resources to pollution control and prevention through command-and-control regulation, technology-based standards, and rule-of-law litigation. Some have characterized the latter collection of command-and-control statutes and regulations, administered with technology-based standards and enforced by rule-of-law litigation, as the first generation of environmental law.[4] This generational classification is in contrast to what are often referred to as second generation environmental law methods that emphasize regulatory flexibility and the harnessing of economic incentives.[5] These

---

[1] For sources on the evolution of environmental law, see *infra* Part I.

[2] This article focuses on U.S. environmental law. There are very good arguments that the evolution of environmental law towards integrationist multimodality has international or global dimensions. However, the interest of keeping this article manageable in length and scope requires that these dimensions be explored elsewhere, even though they are expressly acknowledged here. For an excellent article on the evolution of global environmental law, see Tseming Yang & Robert V. Percival, *The Emergence of Global Environmental Law*, 36 ECOLOGY L.Q. 615 (2009).

[3] *See infra* Part I.B.

[4] *See infra* Part I.B.

[5] *See infra* Part I.B.

include compliance incentives, negotiated rulemaking (or "reg. neg."), and market-based mechanisms. Some believe that the structure and practice of environmental law have now entered a third generational phase with the growing use of collaborative and voluntary processes, outcomes-based instrument choice, and reflexive law principles to achieve sustainable development and engage in ecosystem management.[6] In each case, the new features of environmental law have simply been added to the existing features, making some modifications to the older structure but mostly just adding new generations to the family of environmental law.

The pace and magnitude of ecological and social change, however, are creating pressures for environmental law to evolve further, particularly in light of problems that seem to evade effective solutions with current methods: climate change, threats to biodiversity, water scarcity, nonpoint source pollution of waters, land-development sprawl, children's nature-deficit disorder, deforestation, energy consumption and development, and others.[7] Even as relatively new generations of environmental law methods and instruments are being added to the environmental law system, lessening the primacy but not totally displacing earlier generations of methods and instruments, the system as a whole continues to undergo stress, transformation, experimentation, reaction, adaptation, and the rapid emergence of new methods and instruments.

We are just starting to see the emergence of a fourth generation of environmental law.[8] We do not yet know exactly which precise methods and instruments will compose this fourth generation of environmental law because it is just starting to develop. However, we can make a relatively educated prediction about its basic characteristics. Ecological and social forces of change—and the policy imperatives that they create—will move the next generation of environmental law towards integrationist and multimodal methods of addressing complex, interdependent, dynamic, and multiscalar environmental problems.[9]

---

[6] *See infra* Part I.B.

[7] *See, e.g.*, J.B. Ruhl & James Salzman, *Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away*, 98 CALIF. L. REV. 59 (2010); LeRoy C. Paddock, *Green Governance: Building the Competencies Necessary for Effective Environmental Management*, 38 Envtl. L. Rep. News & Analysis (Envtl. Law Inst.) 10609, 10609–33 (2008); Craig Anthony (Tony) Arnold, *The Structure of the Land Use Regulatory System in the United States*, 22 J. LAND USE & ENVTL. L. 441, 522 (2007) [hereinafter Arnold, *Structure*]; RICHARD LOUV, THE LAST CHILD IN THE WOODS: SAVING OUR CHILDREN FROM NATURE-DEFICIT DISORDER (2005).

[8] *See infra* Part I.C.

[9] *See infra* Part I.C.

Like the generations previous to it, the integrationist and multimodal generation of environmental law will share space, compete for resources, and develop mutually beneficial interactions with the existing methods and instruments of environmental law.[10] This will make environmental law ever more complex and difficult to model and assess with great accuracy. However, the new generation of environmental law will be about making effective use of a multitude of methods and instruments and integrating them across various points of connection or networking. Thus, it will not be merely additive or competitive. It will be a facilitative and transformative force. Moreover, the integrationist and multimodal evolution in environmental law will be about strengthening connections with other related sub-fields of law and policy and even centers of interconnected networks and hybridized forms with these other sub-fields, including land use law and planning, water law and management, energy law and policy, disaster planning and response, transportation planning and infrastructure, and public health law and policy.[11]

This article highlights the particularly pressing and vexing problems at the intersection of land use, water resources, and climate change to illustrate the social and ecological demands for integrationist multimodal environmental law and how the use of multiple methods, instruments, and institutions can occur in integrated yet multidimensional and multiscalar ways.[12] Nonetheless, this article is primarily descriptive and predictive about a set of changes that are underway, and is not prescriptive about a set of reforms that will inherently produce better environmental outcomes. Evolution does not necessarily result in optimization and does not necessarily produce uniform systemic emergence. To be sure, integrationist multimodality will be a necessary development in environmental law and policy. Nonetheless, it will develop in imperfect ways due to the political, economic, psychological, physical, social, and cultural forces that have impeded the effectiveness of earlier generations of environmental law in achieving good human relationships with our environment.[13] However, if we are to improve the functionality of integrationist and multimodal features in environmental law, we need to understand them and to identify their emergence.

Part I of this article situates the entire inquiry in the context of theory and research about the evolution of environmental law and legal

---

[10] *See infra* Part I.C.
[11] *See infra* Part V.
[12] *See infra* Parts II, IV.
[13] *See infra* Part III, Conclusion.

evolution generally. It describes the first three generations of environmental law and then sets forth the core features of the emerging fourth generation: integrationist forces and multimodality. Part II describes the imperatives that are driving environmental law towards integrationist and multimodal developments, including complex problems that evade solutions offered by the current state of environmental law. The features of these complex problems are described in general and then explored by working through increasing layers of complexity in the relationships among climate change, land use, and water resources. The interconnected and multidimensional problems of climate change, land use, and water tell us that even the most advanced legal and policy theories about massive environmental problems may not fully describe their scope or messiness.

Part III identifies two typical responses to complex and bedeviling environmental problems: 1) unimodality, whereby a single model, method, or instrument is selected and offered as the cure-all, or at least the preferred response, to the problem; or 2) fragmentation, whereby the response to the problem is divided, whether intentionally or unintentionally, among multiple actors (e.g., institutions, jurisdictions, organizations), multiple instruments or methods (e.g., market incentives, command-and-control regulation), and/or multiple aspects of the problem (e.g., stationary air pollution emissions, mobile air pollution emissions, land development, disaster preparation and response, forestry, water use, water quality). The forces pushing towards unimodality and fragmentation are deeply ingrained in our psyches, socio-cultural conditions, politics, economics, and normative values, and these forces tend to converge, producing unimodal fragmentation in law, policy, and environmental problem-solving. Unimodal and fragmented responses to complex and multidimensional environmental problems, however, are proving entirely inadequate, thus pressuring law, policy, and society to develop integrationist and multimodal responses.

Part IV describes emerging examples of integrationist multimodality at the intersection of land use, water, and climate change. One example, a new phenomenon known as "wet growth," is a set of developments attempting to integrate land use management, water supply planning and allocation, and water quality protections. A second example is the emergence of watershed planning and management. Finally, a third example is the development of local climate change action plans that address a variety of causes and effects of climate change.

Part V explores four key features of integrationist multimodality, or four nodes of connectivity by which efforts at integration emerge out of the use of multiple modes of action by multiple actors. One node centers on

connections between information and decisions. A second node involves connections among actors. A third node features connections across scales and functions. The fourth node occurs at the intersection of innovation and capacity (e.g., power, resources, and structure).

Part VI considers the future of environmental law if integrationist multimodality continues to emerge. In particular, it notes that changes are likely to occur at the "edges" of environmental law, where environmental law intersects with other legal, policy, and social systems. This part also briefly identifies several examples of integrationist concepts that may become increasingly multimodal as well as some examples of multimodal areas that may see increased integration.

Finally, the article concludes by reiterating the point that integrationist multimodality is not a proposal for improving environmental law. Efforts at both integration and multimodality are likely to be incomplete and inadequate in solving the complex and multidimensional environmental problems that society faces. There is no guarantee that integrationist multimodality will advance any particular environmental conservation or protection values. Nonetheless, this emerging evolutionary development in environmental law deserves further study and theory development. It may be that the nodes of integrationist multimodality are adaptive systemic and institutional responses, designed to improve the functioning of environmental law and other related fields of public policy and social action that address environmental problems. At the least, the complex and dynamic characteristics of nature and of society should tell us that experts' suggestions for improving environmental law should be weighed against the study of how environmental law itself evolves as a complex and dynamic system.

I. THE EVOLUTION OF ENVIRONMENTAL LAW

A. Legal Evolution

Law and legal institutions evolve. This statement means, of course, that specific laws change over time.[14] It further means that the structure

---

[14] *See, e.g.*, Anthony Niblett et al., *The Evolution of a Legal Rule*, 39 J. LEGAL STUD. 325 *passim* (2010) (discussing changes over time in the economic loss rule); Forrest Maltzman & Charles R. Shipan, Continuity and Change: The Evolution of the Law (June 30, 2006) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1019061 (discussing changes in congressional statutes over time).

and content of legal systems also change over time.[15] But it means much more than merely the concept of gradual change.[16]

Contemporary concepts of legal evolution draw on insights from evolutionary biology and ecosystem sciences to understand the dynamics of social systems generally and legal systems particularly.[17] Legal evolutionary concepts differ from classic evolutionary biology, which historically has been concerned with genetic differences among individuals and populations of species and multi-generational changes in species through natural selection, favoring those alterations of characteristics that are beneficially adaptive to the environment and changed conditions.[18] For

---

[15] *See, e.g.*, Abraham Bell & Gideon Parchomovsky, *The Evolution of Private and Open Access Property*, 10 THEORETICAL INQUIRIES L. 77 (2009) (describing the evolution of property rights systems between open access and private property); Daniel M. Katz et al., *Social Architecture, Judicial Peer Effects and the "Evolution" of the Law: Toward a Positive Theory of Judicial Social Structure*, 24 GA. ST. U. L. REV. 975 (2008) (discussing the evolution of judicial decision-making); Jeffrey Evans Stake, *Evolution of Rules in a Common Law System: Differential Litigation of the Fee Tail and Other Perpetuities*, 32 FLA. ST. U. L. REV. 401 (2005) (studying the evolution of common law systems through the lens of property law rules); Milena Sterio, *The Evolution of International Law*, 31 B.C. INT'L & COMP. L. REV. 213 (2008) (discussing the evolution of the content and structure of international law).

[16] J.B. Ruhl, *The Fitness of Law: Using Complexity Theory to Describe the Evolution of Law and Society and Its Practical Meaning for Democracy*, 49 VAND. L. REV. 1407, 1408–09 (1996) [hereinafter Ruhl, *Fitness*] (explaining that not all change qualifies as change resulting from inherent evolutionary processes); James E. Krier, *The Evolution of Property Rights: A Synthetic Overview* 1 (Univ. Mich. Law Sch. John M. Olin Ctr. for Law & Econ. Working Paper Series, Working Paper No. 91, 2008), *available at* http://law.bepress.com/cgi/viewcontent.cgi?article=1092&context=umichlwps (comparing the meaning of evolution as gradual change with evolutionary theory and study, which attempts to understand how and why systemic or large-scale change occurs).

[17] *See* E. Donald Elliott, *The Evolutionary Tradition in Jurisprudence*, 85 COLUM. L. REV. 38, 38 (1985); Herbert Hovenkamp, *Evolutionary Models in Jurisprudence*, 64 TEX. L. REV. 645, 645 (1985); Katz et al., *supra* note 15, at 980–81, 983–84; Ruhl, *Fitness*, *supra* note 16, at 1410–16, 1419–37. *See also* ALLAN C. HUTCHINSON, EVOLUTION AND THE COMMON LAW (2005). For classic works on the evolution of social systems, see generally TALCOTT PARSONS, SOCIETIES: EVOLUTIONARY AND COMPARATIVE PERSPECTIVES (Alex Inkeles ed., 1966) [hereinafter PARSONS, SOCIETIES]; TALCOTT PARSONS, THE SYSTEM OF MODERN SOCIETIES (1981) [hereinafter PARSONS, SYSTEM]; TALCOTT PARSONS, ON INSTITUTIONS AND SOCIAL EVOLUTION (Leon H. Mayhew ed., 1982) [hereinafter PARSONS, ON INSTITUTIONS].

[18] The Dictionary of Ecology and Environmental Science defines "evolution" as "[t]he process by which all existing organisms developed from earlier ones through changes in inherited characteristics over many generations." THE DICTIONARY OF ECOLOGY AND ENVIRONMENTAL SCIENCE 197 (Henry W. Art ed., 1993). For the seminal work on evolutionary biology, see generally CHARLES DARWIN, ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION, OR THE PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE (1859).

example, J. B. Ruhl uses ecology's development and application of evolutionary biological principles, which have been used to study and explain complex and stochastic ecological systems, to examine the interrelated evolution of legal systems and social systems (or the broader socio-legal system), with environmental law as a case study.[19] The kinds of changes with which legal evolution is concerned involve systems of rules, authority, norms, and institutions, not genetically defined collections of biological organisms.[20] Moreover, the changes result, at least in part, from human choice and behavior of individuals, groups, and institutional systems, not just from the deterministic outcomes of genetic mutations and biological, chemical, and physical variations among individual members of the group.[21] Institutional changes result from both purposeful design and unintentional or uncoordinated evolution, often from a complex combination of deliberate institutional design that is motivated, shaped, or mediated by spontaneous or organic evolutionary forces, and evolutionary variation and selection

---

[19] Ruhl, *Fitness*, *supra* note 16.

[20] *See id.* at 1412–19, 1434–37. For other evolutionary systems-based analyses, see, e.g., PARSONS, SOCIETIES, *supra* note 17; PARSONS, SYSTEM, *supra* note 17; PARSONS, ON INSTITUTIONS, *supra* note 17; and Arnold, *Structure*, *supra* note 7.

[21] *See generally* Eyal Benvenisti, *The Interplay Between Actors as a Determinant of the Evolution of Administrative Law in International Institutions*, 68 LAW & CONTEMP. PROBS. 319 (2005); Katz et al., *supra* note 15; Ruhl, *Fitness*, *supra* note 16. Recent theoretical work on how and why human organizations develop posits that instrumentally rational choices drive adaptive behavior at many levels of scale and in massive aggregation and that individual rationality is itself an adaptive feature of cultural ecology. *See* MURRAY J. LEAF, HUMAN ORGANIZATIONS AND SOCIAL THEORY: PRAGMATISM, PLURALISM, AND ADAPTATION 195–210 (2009). Moreover, Krier observes that evolution may result from cooperative collective action by individual actors or from the unplanned convergence of behaviors on conventions and norms, although he concludes that the former, which he labels a "social engineering" theory of evolution, is not a true evolutionary theory, whereas the latter "natural engineering" theory is evolutionary in nature. Krier, *supra* note 16, at 1. A different line of inquiry, though, seeks to apply evolutionary biological insights about human behavior and brain function to the adaptive design of legal institutions and rules. *See, e.g.*, Owen D. Jones, *Law, Evolution and the Brain: Applications and Open Questions*, 359 PHIL. TRANSACTIONS ROYAL SOC'Y BIOLOGICAL SCI. 1697 (2004). Moreover, the biological and ecological sciences study the evolutionary effects of intentional behaviors by organisms to alter their environments, as the following statement about disturbances and patch dynamics in tallgrass prairies indicates:

> Many disturbances are the natural consequences of common geological forces on the prairie, but some of the most interesting patches are the result of intentional attempts by animals to alter the environment for their benefit—what might be called 'behavioral patches.' Secondarily, the behaviors create patches that affect other members of the community.

O.J. REICHMAN, KONZA PRAIRIE: A TALLGRASS NATURAL HISTORY 51 (1987).

processes that arise out of the deliberate choices and behaviors of actors within the institutions.[22] Furthermore, the changes in laws and legal institutions that have received attention from legal evolutionary scholars have occurred much more rapidly than the evolutionary time frame employed by evolutionary biologists.[23]

The concept of legal evolution borrows certain ideas and metaphors from contemporary ecology's applications of evolutionary biology principles to describe and explain systemic change.[24] They include:

1. *Complexity of systems*: Socio-legal systems are complex, dynamic, and adaptive systems.[25]
2. *Chaos*: Change may appear random and chaotic due to the effects of sensitivity of conditions under deterministic rules.[26]
3. *Emergence*: Change results from "the appearance of unforeseen qualities from the self-organizing

---

[22] Christopher Kingston & Gonzalo Caballero, *Comparing Theories of Institutional Change*, 5 J. INSTITUTIONAL ECON. 151, 152 (2009). Carl Henning Reschke characterizes organizational strategy and management as socio-epistemological evolutionary processes by which information about the environment and effects of actions are tested and developed into shared knowledge embedded in the organization's structure and common "cognitive landscape." Carl Henning Reschke, Strategy, Information Organization, and Knowledge Evolution: Perspectives on Strategy and Innovation from Social and Natural Sciences (June 2009) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1570593.

[23] The Dictionary of Ecology and Environmental Science defines "evolutionary time" as "[a] period measured in hundreds of successive generations in a population, required for random mutations to show up as evolutionary changes." THE DICTIONARY OF ECOLOGY AND ENVIRONMENTAL SCIENCE, *supra* note 18, at 197. "Evolutionary time is generally hundreds of years to several million years." *Id.*

[24] *See* Ruhl, *Fitness*, *supra* note 16, at 1412–13.

[25] *See* Ruhl, *Fitness*, *supra* note 16; J.B. Ruhl, *Complexity Theory as a Paradigm for the Dynamical Law-and-Society System: A Wake-up Call for Legal Reductionism and the Modern Administrative State*, 45 DUKE L.J. 849 (1996); Arnold, *Structure*, *supra* note 7. On social systems as complex, dynamic, and adaptive systems, see generally PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS (Lance H. Gunderson & C.S. Holling eds., 2002) [hereinafter PANARCHY]; JOHN H. MILLER & SCOTT E. PAGE, COMPLEX ADAPTIVE SYSTEMS: AN INTRODUCTION TO COMPUTATIONAL MODELS OF SOCIAL LIFE (2007); NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS: BUILDING RESILIENCE FOR COMPLEXITY AND CHANGE (Fikret Berkes et al. eds., 2003) [hereinafter NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS], ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT 35–37 (C.S. Holling ed., 1978).

[26] *See* Ruhl, *Fitness*, *supra* note 16, at 1438–39; Mark J. Roe, *Chaos and Evolution in Law and Economics*, 109 HARV. L. REV. 641, 642 (1996).

interaction of large numbers of objects, which cannot be understood by studying any one of the objects."[27]

4. *Heterogenous dynamics*: Change results from the actions and interactions of numerous and diverse varieties of actors, groups, components, and subsystems within a system.[28]
5. *Nonlinear dynamics*: Change often does not happen in continuous, sequential fashion, but instead is characterized by discontinuities in space and time due to relationships and effects that are geographically and temporally nonlinear.[29]
6. *Fitness adaptation*: Systems and their components undergo behavioral and structural changes in response to environmental conditions, under deterministic rules, and subject to structural constraints in order to sustain or achieve the system's fitness for its environment.[30]
7. *Path dependence*: A system's possible pathways of change at any given point in time and under any given set of circumstances are limited or at least partially limited by the system's prior evolutionary paths.[31]
8. *Stabilizing influences of niches, self-organized structure, and critical states*: Systems develop a certain amount of non-static stability by occupying niches

---

[27] Ruhl, *Fitness*, *supra* note 16, at 1439. *See also* Fikret Berkes et al., *Introduction*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 25, at 1, 5; Charles Lord & Keaton Norquist, *Cities as Emergent Systems: Race as a Rule in Organized Complexity*, 40 ENVTL. L. 551 (2010).

[28] *See* J.B. Ruhl, *Law's Complexity: A Primer*, 24 GA. ST. U. L. REV. 885, 892, 898 (2008) [hereinafter Ruhl, *Primer*]; Benvenisti, *supra* note 21. *See also* Jennifer A. Howard-Grenville, *Inside the "Black Box": How Organizational Culture and Subcultures Inform Interpretations and Actions on Environmental Issues*, 19 ORG. & ENV'T 46 (2006); MILLER & PAGE, *supra* note 25, at 84–85.

[29] *See* Ruhl, *Primer*, *supra* note 28, at 892, 898; Roe, *supra* note 26, at 642; Berkes et al., *supra* note 27, at 1, 5. *See generally* DISCONTINUITIES IN ECOSYSTEMS AND OTHER COMPLEX SYSTEMS (Craig R. Allen & C.S. Holling eds., 2008) [hereinafter DISCONTINUITIES IN ECOSYSTEMS].

[30] *See* Ruhl, *Fitness*, *supra* note 16, at 1448–56.

[31] *See* Kingston & Caballero, *supra* note 22, at 5, 13; D. Daniel Sokol, *Antitrust, Institutions, and Merger Control*, 17 GEO. MASON L. REV. 1055, 1059 (2010).

(a place or role in its larger environment), self-organization around deep structural rules governing system behavior as the system scale grows, and incremental, surface, or edge changes under a "stable disequilibrium" that relieves pressures for radical and deep structural changes.[32]

9. *Resilience, resistance, and modularity*: Systems seek, develop, and survive through resilience to disturbances, threats, and changing conditions. Resilience comes not only from fitness adaptation (see number 6 above), but also from adaptive resistance to perturbations and from modular organization and functioning, which involves the uses and combinations of pre-organized response methods and actions in flexible, decentralized, and adaptive ways.[33]
10. *Disturbance, catastrophe, and tipping points*: Despite systemic stabilities and resilience, both small-scale and large-scale (structural) changes to the self-organized state can arise out of disturbances or perturbations, particularly of either a massive or cumulative nature and affecting systemic "tipping points" of potentially irreversible and nonlinear change to a new state.[34]
11. *Competition and cooperation*: Change results from the competition among systems or system components (including individuals, organizations, and groups) for scarce resources and the resulting pressures to reduce this competition (e.g., niche change, elimination of competitors).[35] Change also results from cooperation among systems or system components (including individuals, organizations, and

---

[32] *See* Ruhl, *Fitness*, *supra* note 16, at 1456–62; Ruhl, *Primer*, *supra* note 28, at 895, 899–900; Reschke, *supra* note 22, at 3; Berkes et al., *supra* note 27, at 6.

[33] *See* Ruhl, *Primer*, *supra* note 28, at 895–96, 900; Reschke, *supra* note 22, at 3; Berkes et al., *supra* note 27, at 5–6. *See also* Jody A. Freeman & Daniel Farber, *Modular Environmental Regulation*, 54 DUKE L.J. 795 (2005).

[34] *See* Ruhl, *Fitness*, *supra* note 16, at 1439–40; Ruhl, *Primer*, *supra* note 28, at 896, 900–01; Berkes et al., *supra* note 27, at 5.

[35] *See* Ruhl, *Fitness*, *supra* note 16, at 1463–64.

groups) to enhance mutual survival probabilities through share or collective action and functions.[36]

12. *Co-evolution*: Two systems or system components may evolve in interlinked ways, instead of through entirely separate lines of evolution, often through a combination of cooperation, competition, and conflict and due to larger-scale complex relationships among systems.[37] Complexities and unexpected outcomes arise when the two systems co-evolve under different temporal and spatial conditions.[38]
13. *Network connectivity and feedback*: System change occurs through the "high connectivity, or feedback, between agents, parts, and scales of the system, creating a network of nodes and channels through which information (energy, money, food) flows."[39] Diffusion of ideas, information, and innovation occur through networks, thus increasing the scope or pace of change.[40]

The features of socio-legal evolution call into question the completeness of environmental law scholarship emphasizing institutional design, instrument choice, or the optimization of particular goals or values.[41] This

---

[36] *See id.* at 1464.

[37] *See* J.B. Ruhl, *Reconstructing the Wall of Virtue: Maxims for the Co-Evolution of Environmental Law and Environmental Science*, 37 ENVTL. L. 1063 (2007) [hereinafter Ruhl, *Co-Evolution*].

[38] *See* Gus Koehler, Simulating the Timing Effects of Public Policy Interventions (2001) (unpublished manuscript), *available at* http://www.iccr-international.org/foresight/docs/time/paper-koehler.pdf.

[39] Ruhl, *Primer*, *supra* note 28, at 898.

[40] *See, e.g.*, Alexandre Steyer & Jean-Benoit Zimmerman, Social Networks and Diffusion: Avalanches and Links Evolution (Aug. 23, 2005) (unpublished manuscript), *available at* http://ssrn.com/abstract=882794; David Feldman & Helen Ingram, *Making Science Useful to Decision Makers: Climate Forecasts, Water Management, and Knowledge Networks*, 1 WEATHER, CLIMATE & SOC'Y 9 (2009); John R. Nolon, *Champions of Change: Reinventing Democracy Through Land Law Reform*, 30 HARV. ENVTL. L. REV. 1 (2006).

[41] *See, e.g.*, Robert M. Friedman et al., *Environmental Policy Instrument Choice: The Challenge of Competing Goals*, 10 DUKE ENVTL. L. & POL'Y F. 327 (2000); Jeffrey J. Rachlinski & Cynthia R. Farina, *Cognitive Psychology and Optimal Government Design*, 87 CORNELL L. REV. 549 (2002); Kenneth R. Richards, *Framing Environmental Policy Instrument Choice*, 10 DUKE ENVTL. L. & POL'Y F. 221 (2000); Jonathan B. Wiener & Barak D. Richman, *Mechanism Choice*, *in* RESEARCH HANDBOOK ON PUBLIC CHOICE AND PUBLIC LAW (Daniel A. Farber & Anne Joseph O'Connell eds., 2010); Lawrence H. Goulder

scholarship is quite valuable but experts' ideas about what is the best institutional design, instrument, normative framework, or legal reform in environmental law do not mean that institutional decision makers will actually choose the best option or that any decision maker's choice will actually survive the iterative impacts of other forces, institutions and actors, and obstacles to implementation.[42] The potential for environmental law change (including institutional design, instrument selection, or legal reform) will depend on the complex interactions of politics, economic behavior, limited resources, social forces such as globalization and mass

---

& Ian W.H. Parry, Instrument Choice in Environmental Policy (Apr. 1, 2008) (unpublished manuscript), *available at* http://ssrn.com/abstract=1117566 (evaluating instrument choice through the lens of emissions reductions); Freeman & Farber, *supra* note 33, at 799 ("[T]he challenge of environmental regulation and management . . . [is], essentially, a matter of conscious design"). Attention to optimal institutional design has captured other fields of law. *See, e.g.*, Sokol, *supra* note 31, at 1058–61 (exploring institutional design within the antitrust framework). For examples of competing proposals about how to design environmental laws and policies to address climate change, compare RICHARD B. STEWART & JONATHAN B. WIENER, RECONSTRUCTING CLIMATE POLICY: BEYOND KYOTO (2003) (making the case for an international emissions allowance trading system as the optimal method for addressing climate change), with Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L.J. 1 (2009) [hereinafter Camacho, *Adapting*] (calling for federal legislation and funding to improve federal agencies' adaptive capacities and processes), Robin Kundis Craig, *"Stationarity is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 40–70 (2010) [hereinafter Craig, *Stationarity*] (offering five principles to govern climate change adaptation), Victor B. Flatt, *Taking the Legislative Temperature: Which Federal Climate Change Legislative Proposal is "Best"?*, 102 NW. U. L. REV. COLLOQUY 123 (2007) (evaluating various federal climate change legislative proposals with attention to carbon trading systems' features and hard targets that will achieve substantial greenhouse gas reductions fairly and efficiently), Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153 (2009) [hereinafter Lazarus, *Super Wicked*] (urging federal legislation combining regulatory programs and economic incentives with imbedded pre-commitment strategies that create barriers to politically motivated and interest-driven changes to the law without depriving lawmakers of needed flexibility), Jonathan Zasloff, *The Judicial Carbon Tax: Reconstructing Public Nuisance and Climate Change*, 55 UCLA L. REV. 1827 (2008) (asserting the benefits of public nuisance litigation as a means of climate change regulation), and Sarah Krakoff, *Environmental Law, Tragedy and Community* (Univ. Colo. L. Sch., Working Paper No. 10-22), *available at* http://ssrn.com/abstract=1649089 (recommending policies that facilitate local and community-based efforts to mitigate climate change).

[42] For theoretical perspectives that environmental law is dynamic and iterative, see generally DANIEL FARBER, ECO-PRAGMATISM: MAKING SENSIBLE ENVIRONMENTAL DECISIONS IN AN UNCERTAIN WORLD (1999); THE JURISDYNAMICS OF ENVIRONMENTAL PROTECTION: CHANGE AND THE PRAGMATIC VOICE IN ENVIRONMENTAL LAW (Jim Chen ed., 2003).

culture, psychological phenomena such as bounded rationality and use of heuristics, physical and ecological conditions and processes, unexpected events (e.g., disasters), the iterative nature of American society's environmental ethics pluralism, and other influences on environmental law. Thus, calls for institutional actors to "make" environmental law evolve are puzzling and incomplete.[43] Insights about the evolution of socio-legal systems tell us that no system or its actors wholly control the system's evolution. Disturbances, systemic resistance and stability, nonlinear dynamics, heterogenous and networked components, path dependency, and other factors are as important as an institution's efforts to change to fit its landscape.[44] If, for example, Congress or a regulatory agency were to attempt to make a regulatory program more adaptive and resilient, this effort might be constrained or altered by political forces, competition for limited resources, social conflicts (or contestations) over the goals of the regulatory program, existing organizational structures, and the interrelationships between the program and other programs, institutions, and systems with conflicting or competing goals, among other factors. One of the best efforts to synthesize design-based theories of change with evolutionary theories of change contends that the two phenomena are often intricately and subtly interconnected in social systems and that intentional choices to change systems must be understood to arise in the context of uncoordinated evolutionary processes.[45]

Several caveats about legal evolution deserve mention. First, evolution does not necessarily produce optimization.[46] Evolution does not result from organisms or systems selecting from all possible pathways in order to optimize their functions, because: 1) small disturbances or changes can produce large, unpredictable, nonlinear changes; 2) past selected-out features may turn out to be the best for present or future conditions, but were eliminated for survival in past different conditions; and 3) adaptation to new conditions is shaped by the paths that have already been taken.[47]

---

[43] *See, e.g.*, Alejandro E. Camacho, *Can Regulation Evolve?: Lessons from a Study in Maladaptive Management*, 55 UCLA L. REV. 293, 344–57 (2007) [hereinafter Camacho, *Regulation*].

[44] *See supra* notes 25–40 and accompanying text.

[45] *See* Kingston & Caballero, *supra* note 22, at 152. For a discussion of optimal institutional design, institutional complexity, and evolutionary forces in the context of antitrust, see Sokol, *supra* note 31, at 1058–61.

[46] *See* Katz et al., *supra* note 15, at 980–82; Kingston & Caballero, *supra* note 22, at 163. *See generally* Roe, *supra* note 26.

[47] *See* Roe, *supra* note 26, at 642–44; Kingston & Caballero, *supra* note 22, at 13; Ruhl, *Primer*, *supra* note 28, at 894–95; Miller & Page, *supra* note 25, at 81. *See also* James H.

These features of chaos, fitness, and path dependence call into question any progressive or normative view of legal evolution: legal institutions and rules emerge out of complex dynamics, adaptation to new conditions, and past evolutionary pathways, not either intentional selection or natural production of optimal features.[48]

One particular branch of evolutionary thought about law and legal institutions is the law-and-economics theory that legal rules and institutions gradually change to produce efficient or wealth-maximizing arrangements. For example, Demsetz's classic work posits that property rights progressively evolve towards greater private property as the aggregate benefits of externality internalization exceed the costs of creating and securing private property rights.[49] Richard Posner and other law-and-economics scholars have theorized that the common law evolves towards efficiency.[50] James Krier and David Montgomery have argued that environmental law evolves to favor institutional arrangements that provide net wealth gains to society.[51] However, this efficiency-evolving theory of the law, with its several manifestations, has little support in the operation of evolutionary processes generally.[52]

Second, the forces for change in socio-legal systems encounter change-resistant forces among social and legal institutions. Evolutionary theory itself identifies several features of stability in systems, including niches, self-organized structure, critical states, resilience, resistance, modularity, and path dependence.[53] However, social systems have some particular characteristics of inertia and conservatism. Institutions create

---

Fetzer, *Is Evolution an Optimizing Process?*, *in* THE PLACE OF PROBABILITY IN SCIENCE 163, 174 (Ellery Eells and James H. Fetzer eds., 2010) (noting that there is no evidence that evolution is an optimizing process); Francisco J. Varela, *Laying Down a Path in Walking: A Biologists' Look at a New Biology and Its Ethics*, *in* HUMAN SURVIVAL AND CONSCIOUSNESS EVOLUTION 204, 210 (Stanislav Grof & Marjorie Livingston Valier eds., 1988) (observing that evolution does not produce trait optimization).

[48] *See* Roe, *supra* note 26, at 642–44; Katz et al., *supra* note 15, at 980–82; Sokol, *supra* note 31, at 1058–61.

[49] *See* Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347 (1967).

[50] *See* RICHARD POSNER, ECONOMIC ANALYSIS OF THE LAW (8th ed. 2011); George L. Priest, *The Common Law Process and the Selection of Efficient Rules*, 6 J. LEGAL STUD. 65 (1977); Paul Rubin, *Why is the Common Law Efficient?*, 6 J. LEGAL STUD. 51 (1977).

[51] *See* James E. Krier & W. David Montgomery, *Resource Allocation, Information Cost and the Form of Government Intervention*, 13 NAT. RESOURCES J. 89 (1973).

[52] *See* Katz et al., *supra* note 15, at 980–82; Niblett et al., *supra* note 14, at 3 (acknowledging that evolution-to-efficiency is purely theoretical without empirical support); Roe, *supra* note 26, at 641–44 (acknowledging that law-and-economics explanations of legal evolution are incomplete without insights from evolutionary biology).

[53] *See supra* notes 31–33 and accompanying text.

powerful groups that have a vested interest in maintaining the status quo, and they will resist the usually uncompensated redistributions of power and resources that result from change.[54] People have change-resisting emotional attachments to existing institutions.[55] Institutional norms and organizational practices serve to prevent institutions and organizations from engaging in adaptive responses to changing or increasing problems of complexity.[56] One result of static institutions may be the creation of a systemic "commons" of rival, layered, static, or residual institutions as new institutions arise even though old institutions remain and become increasingly rigid.[57] However, this process also might be considered adaptive diversification and a natural result of the evolution of complex multi-component systems, particularly if iterative interactions among the multiple institutions produce networks, cooperation, or incremental niche readjustments.

Third, the evolutionary perspective explored in this article is a systems-based analysis of institutional change, drawing on ecology's revisions to, and applications of, evolutionary biology principles.[58] Thus, the focus of this analysis is less on individual behavior and more on systemic development. For example, this article does not accept theories that morality in society comes from evolved biological determinants, as opposed to from God or reason,[59] or that human motivation, behavior, morality, culture, religion, and even altruism are explained by humans' interests in the reproduction and survival of their genes.[60] Human ethical choices about policies and behaviors affecting the environment should not be conflated

---

[54] Kingston & Caballero, *supra* note 22, at 5–6, 14. *See generally* GARY D. LIBECAP, CONTRACTING FOR PROPERTY RIGHTS (1989); MANCUR OLSON, THE RISE AND DECLINE OF NATIONS: ECONOMIC GROWTH, STAGNATION, AND SOCIAL RIGIDITIES (1982); ELINOR OSTROM, UNDERSTANDING INSTITUTIONAL DIVERSITY (2005).

[55] Kingston & Caballero, *supra* note 22, at 14.

[56] *See* Denise Lach et al., *Maintaining the Status Quo: How Institutional Norms and Practices Create Conservative Water Organizations*, 83 TEX. L. REV. 2027 (2005).

[57] *See* Brigham Daniels, *Emerging Commons and Tragic Institutions*, 37 ENVTL. L. 515 (2007).

[58] *See, e.g.*, Ruhl, *Fitness*, *supra* note 16, at 1412–19, 1434–37.

[59] *See, e.g.*, Edwin S. Fruehwald, A Biological Basis for Rights (July 28, 2009) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1440247. For a critique of using evolutionary biology to resolve normative legal issues, see D. Benjamin Barros, *Human Behavior, Evolution, and the Law; The Case of the Biology of Possession* (Feb. 25, 2010) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1559390.

[60] *See* E. Donald Elliott, *The Tragi-Comedy of the Commons: Evolutionary Biology, Economics and Environmental Law*, 20 VA. ENVTL. L.J. 17, 23–27. *See generally* LEE ALAN DUGATKIN, THE ALTRUISM EQUATION: SEVEN SCIENTISTS SEARCH FOR THE ORIGINS OF GOODNESS (2006).

with survival-of-the-fittest biological determinism. Just as the normative issues of environmental protection arise in the context of an evolving socio-legal system that must be understood, the evolution of environmental law arises in the context of profoundly moral issues about human relationships with one another and with nature.

Fourth, the evolution of environmental law should be understood to be a particular type of legal or socio-legal evolution. This article does not make a claim for environmental law "exceptionalism" or an entirely *sui generis* evolution of environmental law. In fact, I have previously made the case that environmental law should be understood as resulting not only from the functions and limits of the legal system, but also from multiple forces in society.[61] However, an ecological evolutionary perspective on complex socio-legal systems emphasizes context and adaptation to changing conditions. Environmental law is defined in part by the biological, chemical, and physical conditions and processes of the human and natural environments that are the subject of environmental law. Ecology and geography influence environmental law more than other fields of law, such as constitutional law, antitrust law, or criminal law. In addition, the problems, values, and forces that created environmental law differ in some material respects from those that gave rise to other fields of law. Different areas of law can be viewed as systems or subsystems that serve different functions in society and should not be seen as merely fungible manifestations of some grand theory of law and legal institutions.[62] Thus, while the concepts of socio-legal evolution may apply to all or most fields of law, the specific features of U.S. environmental law—arguably moving into its fourth generation—deserve particular attention.

B. The First Three Generations of Environmental Law

Many scholars have used the "generation" metaphor to describe the evolution of environmental law.[63] The ways of characterizing the generations vary, even if there is agreement on the general features of environmental law's development. For example, some would characterize

---

[61] *See* Craig Anthony (Tony) Arnold, *Working Out an Environmental Ethic: Anniversary Lessons from Mono Lake*, 4 WYO. L. REV. 1 (2004) [hereinafter Arnold, *Mono Lake*].

[62] For the case that land use planning and regulation should be understood as a system that is not merely a form of environmental, administrative, constitutional, or property law, see Arnold, *Structure*, *supra* note 7.

[63] *See, e.g.*, Jeffrey G. Miller, *A Generational History of Environmental Law and Its Grand Themes: A Near Decade of Garrison Lectures*, 19 PACE ENVTL. L. REV. 501 (2002).

the pre-statutory use of common law litigation for environmental protection purposes as the first generation,[64] whereas others would characterize the explosion of federal command-and-control regulatory statutes in the 1970s as creating the first generation of environmental law.[65] Several scholars have recognized the challenges in identifying the generations in environmental law. For example, Zygmunt J.B. Plater asks of the current generation of environmental law: "Is this the third generation of environmental law, or the fourth, or fifth?"[66] Lincoln Davies refers to:

> six clear stages in modern environmental law's evolution: the pre-1945 common law era, the federal assistance era from 1945–62, modern environmental law's rise in the 1960s, construction of the new federal environmental law "infrastructure" in the 1970s, refinement of federal strategies during the 1980s, and a regulatory "recoil and reinvention" from 1991 to the present.[67]

The precise numbering of generations is not particularly critical to this article's primary thesis that environmental law is evolving to become more integrationist and multimodal. However, ease of communication and analytical-framework functionality require some choice of taxonomy and terminology. Therefore, this article adopts the generational classification

---

[64] *E.g.*, *id.* at 505–06. J.B. Ruhl highlights the historical role of common law doctrines, such as nuisance law, in protecting the environment, a role that was de-emphasized following the enactment of federal environmental regulatory statutes but may be reemerging. *See* J.B. Ruhl, *Making Nuisance Ecological*, 58 CASE W. RES. L. REV. 753, 753–56 (2008) [hereinafter Ruhl, *Nuisance*].

[65] *E.g.*, J.B. Ruhl, *The Co-Evolution of Sustainable Development and Environmental Justice: Cooperation, Then Competition, Then Conflict*, 9 DUKE ENVTL. L. & POL'Y F. 161, 172 [hereinafter Ruhl, *Environmental Justice*] (acknowledging that "the flurry of federal environmental law enactments in the 1970s" is "considered by many as the dawn of modern American environmental law"); Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 CAP. U. L. REV. 21, 21 (2001) (referring to the "'first generation' system of centralized federal command-and-control regulation"); *see also* Mary Jane Angelo, *Embracing Uncertainty, Complexity, and Change: An Eco-Pragmatic Reinvention of a First-Generation Environmental Law*, 33 ECOLOGY L.Q. 105, 106, 108 (2006) (treating the Federal Insecticide, Fungicide, and Rodenticide Act, enacted by Congress in 1972, as a first-generation environmental law). *See generally* RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 43–97 (2004).

[66] Zygmunt J.B. Plater, *Environmental Law in the Political Ecosystem—Coping with the Reality of Politics*, 19 PACE ENVTL. L. REV. 423, 427 n.9 (2002).

[67] Lincoln L. Davies, *Alternative Energy and the Energy-Environment Disconnect*, 46 IDAHO L. REV. 473, 486 (2010) [hereinafter Davies, *Alternative Energy*].

scheme used by Richard Stewart,[68] which is generally consistent with works by Dan Tarlock[69] and Richard Lazarus.[70]

The first generation of U.S. environmental law featured primarily command-and-control regulation, technology-based standards, and rule-of-law litigation, all primarily to control or prevent pollution (e.g., emission of air pollutants, end-of-pipe discharges of waste into waters) or specific environment-degrading actions (e.g., destruction of endangered species' habitat, short-sighted clear-cutting of federal forests).[71] This generation was born out of: 1) early environmental protection efforts that sought to enforce common-law tort remedies and property rights against environmental harm; 2) government reservation and management of lands and natural resources; 3) early but limited federal statutes; and 4) a strong grassroots social and political movement of environmentalism.[72] However, the scope and pace of environmental protectionist legal developments in the 1970s arguably created the field of environmental law as a stand-alone area of law.[73] Congress enacted statutes with both substantive and procedural requirements, created and/or empowered administrative agencies to adopt and enforce regulations, and created opportunities for members of the public and environmental groups to sue agencies or regulated entities in order to enforce environmental statutes' provisions.

---

[68] *See* Stewart, *supra* note 65; *see also* Magali A. Delmas, *Barriers and Incentives to the Adoption of ISO 14001 by Firms in the United States*, 11 DUKE ENVTL. L. & POL'Y F. 1, 1–2 (2000) (adopting a similar classification); Ruhl, *Fitness*, *supra* note 16, at 1443 (describing the transition from command-and-control regulation to market approaches to flexible conservation and sustainable development methods as the result of complex system evolution).

[69] *See* A. Dan Tarlock, *The Future of Environmental "Rule of Law" Litigation*, 17 PACE ENVTL. L. REV. 237 (2000) [hereinafter Tarlock, *Litigation*].

[70] *See* Richard J. Lazarus, *The Greening of America and the Graying of United States Environmental Law: Reflections on Environmental Law's First Three Decades in the United States*, 20 VA. ENVTL. L.J. 75, 77–79 (2001) [hereinafter Lazarus, *Greening*]. *See generally* LAZARUS, *supra* note 65.

[71] *See* LAZARUS, *supra* note 65, at 43–97; Stewart, *supra* note 65, at 21; Ruhl, *Environmental Justice*, *supra* note 65, at 172 & n.30; Tarlock, *Litigation*, *supra* note 69, at 241–42; Lazarus, *Greening*, *supra* note 70, at 77–82.

[72] *See* Miller, *supra* note 63, at 502–06; Ruhl, *Nuisance*, *supra* note 64, at 753–56; LAZARUS, *supra* note 65, at 47–66. *See generally* KARL BOYD BROOKS, BEFORE EARTH DAY: THE ORIGINS OF AMERICAN ENVIRONMENTAL LAW, 1945–1970 (2009).

[73] *See, e.g.*, LAZARUS, *supra* note 65, at 43–97; Ruhl, *Environmental Justice*, *supra* note 65, at 172. *But see* A. Dan Tarlock, *Is There a There There in Environmental Law?*, 19 J. LAND USE & ENVTL. L. 213 (2004) [hereinafter Tarlock, *There*] (questioning whether environmental law has sufficient content and resilience to be or remain an independent field of law).

The second generation of U.S. environmental law arose out of the limits of the first generation: criticisms that command-and-control regulation

> is unduly rigid, cumbersome, and costly; fails to accommodate and stimulate innovation in resource-efficient means of pollution prevention; fails to prioritize risk management wisely; is patchwork in character, focusing in an uncoordinated fashion on different environmental problems in different environmental media and often ignoring functional and ecosystem interdependencies; and relies on a remote centralized bureaucratic apparatus that lacks adequate democratic accountability.[74]

In contrast, second generation environmental law methods emphasize regulatory flexibility and the harnessing of economic incentives.[75] These include greater use of cost-benefit analysis, compliance incentives, negotiated rulemaking (or "reg. neg."), negotiated environmental agreements (i.e., negotiated regulatory implementation and compliance), and market-based mechanisms.[76]

The structure and practice of environmental law have arguably now entered a third generational phase with the growing use of collaborative and participatory processes, outcomes-based instrument choice, reflexive law principles, distributive justice concerns, sustainable development principles, and adaptive ecosystem management.[77] While these

---

[74] Stewart, *supra* note 65, at 21.
[75] *Id.*; Delmas, *supra* note 68, at 1–2.
[76] Stewart, *supra* note 65, at 38–94; Delmas, *supra* note 68, at 1–2.
[77] *See* AGENDA FOR A SUSTAINABLE AMERICA (John C. Dernbach ed., 2009); Stewart, *supra* note 65, at 21, 127–73; Tarlock, *Litigation*, *supra* note 69, at 254–62; Lazarus, *Greening*, *supra* note 70, at 91–105. Hari Osofsky's work illustrates the transformation of environmental law as pluralism and deliberative discourse about sustainable development occur among multi-scalar litigation, regulation, and multi-participant networks from global to local levels. I consider Osofsky's work essentially to be about the transition from the third generation of environmental law to the fourth generation, as discussed in this article. *See generally* Hari M. Osofsky, *Is Climate Change "International"? Litigation's Diagonal Regulatory Role*, 49 VA. J. INT'L L. 585 (2009) [hereinafter Osofsky, *International*]; Hari M. Osofsky, *Scaling "Local": The Implications of Greenhouse Gas Regulation in San Bernardino County*, 30 MICH J. INT'L L. 689 (2009) [hereinafter Osofsky, *Scaling Local*]; Hari M. Osofsky, *Climate Change Legislation in Context*, 102 NW. U. L. REV. COLLOQUY 245 (2008); Hari M. Osofsky, *The Geography of Climate Change Litigation Part II: Narratives of* Massachusetts v. EPA, 8 CHI. J. INT'L L. 573 (2008); Hari M. Osofsky & Janet Koven

third-generation features depart from the rule-based command-and-control regulatory features of the first generation, they are not as concerned with economic efficiency and market-based methods as the second generation. Instead, they emphasize the socio-political benefits of decentralized and holistic processes of environmental management.[78]

As each generation has developed, it has not replaced prior generations. Instead, new generations add to the family of environmental law, with new features, instruments, and methods supplementing existing features or competing with existing features for resources, support, and use in addressing environmental problems.[79] Thus, new environmental law generations share "policy space" with older generations.

C. The Fourth Generation: Integrationist Multimodality

Environmental law, as a complex and adaptive institutional system within the larger law-and-society system, continues to evolve, not settling on some optimal equilibrium, but instead adapting to the many forces and conditions that shape it. The new generation emerging in environmental law is characterized by integrationist developments and multimodal methods.

In environmental law, "multimodal" means the use of multiple modes or methods of protecting the environment.[80] Across a range of

---

Levit, *The Scale of Networks?: Local Climate Change Coalitions*, 8 CHI. J. INT'L L. 409 (2008); Hari M. Osofsky, *Climate Change Litigation as Pluralist Legal Dialogue?*, 26A STAN. ENVTL. L.J. 181 (2007); Hari M. Osofsky, *Local Approaches to Transnational Corporate Responsibility: Mapping the Role of Subnational Climate Change Litigation*, 20 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 143 (2007); Hari M. Osofsky, *The Geography of Climate Change Litigation: Implications for Transnational Regulatory Governance*, 83 WASH. U. L.Q. 1789 (2005).

[78] *See* Stewart, *supra* note 65, at 152–53.

[79] *Id.* at 175–80 (arguing that new environmental law systems do not replace prior systems, and that environmental law has retained the same basic command-and-control regulatory structure and instruments developed in the 1970s); Lazarus, *Greening*, *supra* note 70, at 99 (arguing that environmental law is a hybrid between first and second generation models, preventing any fundamental transformation of environmental law). On the related phenomenon of regulatory accretion, see generally J.B. Ruhl & James Salzman, *Mozart and the Red Queen: The Problem of Regulatory Accretion in the Administrative State*, 91 GEO. L.J. 757 (2003). For a view that this creates an institutional tragedy of the commons, see generally Daniels, *supra* note 57.

[80] *Cf.* Niels Ole Bernsen, *Multimodality Theory*, *in* MULTIMODAL USER INTERFACES: FROM SIGNALS TO INTERACTION 5, 5–6 (Dimitrios Tzovaras ed., 2008) (describing more generally the definitions of multimodality).

responses to a range of environmental problems there is no single dominant mode.[81]

Multimodality is a much broader phenomenon that appears in complex evolutionary systems and in human efforts to interact with complex problems or tasks by using multiple methods. A modality can be described simply as "a manner of something."[82] In statistics, multimodality is a continuous probability distribution with two or more peaks of relatively frequent or numerous values.[83] In the study of ecosystems, multimodality refers to the observation that multiple clusters or aggregations of organism characteristics appear across scales, although whether these distributions are characterized as continuous or discontinuous may depend on the granularity of the study methodology.[84] In information systems, modality has been defined as "a way of representing information in some physical medium."[85] Multimodality is the use of multiple technological methods of human interactivity for inputs and outputs.[86] For example, computers use tactile inputs, graphics, visual motion, sound, voice recognition, digital storage, and other such modes. In human communication, a mode is a "fully semiotically articulated means of representation and communication," and multimodality involves ensembles of more than one mode of communication.[87] These forms of representation include spoken language, written

---

[81] See, for example, the description of several different methods of environmental protection that have emerged in the first three generations of environmental law, discussed in Part I.B.

[82] Bernsen, *supra* note 80, at 5.

[83] *See, e.g.*, THOMAS HILL & PAWEL LEWICKI, STATISTICS: METHODS AND APPLICATIONS, A COMPREHENSIVE REFERENCE FOR SCIENCE, INDUSTRY, AND DATA MINING 665 (2006); GRANINO A. KORN & THERESA M. KORN, MATHEMATICAL HANDBOOK FOR SCIENTISTS AND ENGINEERS: DEFINITIONS, THEOREMS, AND FORMULAS FOR REFERENCE AND REVIEW 596 (2000); Hsueh-Shih Chen & Ramachandran Vasant Kumar, *Direct Synthesis of Quantum Dots with Controllable Multimodal Size Distribution*, 113 J. PHYS. CHEM. 12236 (2009).

[84] *See, e.g.*, Crawford S. Holling et al., *Panarchies and Discontinuities*, *in* DISCONTINUITIES IN ECOSYSTEMS, *supra* note 29, at 3, 6–14; Graeme S. Cumming & Tanya D. Havlicek, *Discontinuity, Multimodality, and the Evolution of Pattern*, *in* DISCONTINUITIES IN ECOSYSTEMS, *supra* note 29, at 31–44; Ahjond S. Garmestani et al., *Discontinuities in Urban Systems: Comparison of Regional City-Size Structure in the United States*, *in* DISCONTINUITIES IN ECOSYSTEMS, *supra* note 29, at 136, 140.

[85] Bernsen, *supra* note 80, at 7.

[86] *Id.* at 6–10. *See generally* ADVANCES IN NATURAL MULTIMODAL DIALOGUE SYSTEMS (Jan van Kuppevelt et al. eds, 2005); MULTIMODAL INTELLIGENT INFORMATION PRESENTATION (Oliviero Stock & Massimo Zancanaro eds., 2005); Meera M. Blattner & Ephraim P. Glinert, *Multimodal Integration*, IEEE MULTIMEDIA, Dec. 1996, at 14.

[87] PIPPA STEIN, MULTIMODAL PEDAGOGIES IN DIVERSE CLASSROOMS: REPRESENTATION, RIGHTS AND RESOURCES 24–25 (2008). On multimodal theories of semiotics, see generally PERSPECTIVES ON MULTIMODALITY (Eija Ventola et al. eds., 2004).

language, image, space, gesture, color, sound, and movement, "all of which function to communicate meaning in an integrated, multilayered way."[88] Integrating communication multimodality with pedagogical theory, multimodal pedagogy involves the intentional use of multiple modes of communication, media, conceptualization, and learning in pedagogical design.[89] In a multimodal approach to therapy, mental health and social work professionals use multiple techniques, strategies, and processes for assessing situations and facilitating solutions to problems.[90] Another common use of multimodality can be found in human transportation systems, where transportation systems use and connect multiple modes of transportation.[91]

The use of multiple modes or methods in environmental protection can occur in at least three different ways. Multimodality may involve the use of multiple categories of policy instruments, such as command-and-control regulation, tort liability, public education, and market incentives. Multimodality can also describe the use of more than one specific tool or mechanism for environmental protection, such as water usage restrictions, water conservation pricing methods, concurrency requirements in land development approvals (i.e., requiring demonstration of adequate water supplies and infrastructure), and monetary damages for excessive groundwater pumping. Finally, multimodality might refer to the use of multiple institutions, organizations, groups, or authoritative entities to engage in environmental protection, such as the U.S. Fish and Wildlife Service, the U.S. Forest Service, state wildlife agencies, state natural resource agencies, timber industry groups or the timber industry generally, particular timber companies, local governments, environmental groups, local civic groups, universities and colleges, schools, informal multi-participant groups and networks, groups or networks of scientific experts, federal courts, state courts, and the like. This multi-agent concept of multimodality could be criticized as conflating the notion of agent or actor with that of method

---

[88] STEIN, *supra* note 87, at 1. *See generally* GUNTHER KRESS & THEO VAN LEEUWEN, MULTIMODAL DISCOURSE: THE MODES AND MEDIA OF CONTEMPORARY COMMUNICATION (2001).
[89] *See, e.g.*, STEIN, *supra* note 87; MULTIMODAL LITERACY (Carey Jewitt & Gunther Kress eds., 2003).
[90] *See, e.g.*, SHARON-ANN GOPAUL-MCNICOL, A MULTICULTURAL/MULTIMODAL/MULTISYSTEMS APPROACH TO WORKING WITH CULTURALLY DIFFERENT FAMILIES (1997); DONALD B. KEAT II, CHILD MULTIMODAL THERAPY (1990).
[91] *See, e.g.*, EDWARD WEINER, URBAN TRANSPORTATION PLANNING IN THE UNITED STATES: AN HISTORICAL OVERVIEW (1999); VUKAN R. VUCHIC, TRANSPORTATION FOR LIVABLE CITIES (1999); Stephanie N. Murray, Intermodal and Multimodal Transportation: Analysis of Policy and the Impact of Plans for Connectability of Transportation Systems Between Seaports and Airports (2009) (Master's Thesis, University of Florida) (on file with author).

or mode, but it loosely reflects the reality that many methods or modes of environmental protection differ qualitatively by the institution, entity, or actor that is using these methods or modes. For example, federal regulation of actions altering endangered or threatened species' critical habitat is not entirely the same as local zoning to protect sensitive habitat areas, even though both qualify as command-and-control regulation.

Multiple modes or methods of environmental protection develop in response to complex and multidimensional environmental problems that evade unimodal solutions: an emergence of policy diversity. However, multimodality by itself may not effectively achieve the desired goals or outcomes if the multiple modes or methods conflict with one another, work at cross-purposes, or undermine the overall system's resilience. Multimodality in systems such as computers and transportation is *integrated* multimodality: the rational and interconnected use of multiple modes to accomplish particular goals or functions that would not be possible either with a single mode or with disconnected or fragmented use of separate modes. More broadly, integrationist multimodality may be an emergent characteristic of complex human and social systems generally. For example, influential sociologist Talcott Parsons theorized that social systems evolve adaptively towards both greater specialization and differentiation (multimodality) and greater integration of components and information coordination (integration).[92]

The need for multimodal responses to environmental problems to be integrated with one another stimulates the environmental law system to become more integrationist.[93] "Integrationist" means processes that seek to connect or link multiple aspects of a system in a holistic, synthesized, or coordinated way.[94] I purposefully use the term "integrationist," because the complexity and multidimensionality of ecological and social systems and subsystems render a truly integrated outcome virtually impossible to achieve. Complex systems are characterized by diversity, discontinuities, and a sort of organized chaos that befuddles human cognitive capacity to grasp and implement complete and pure integration.[95] Despite cognitive,

---

[92] *See generally* PARSONS, SOCIETIES, *supra* note 17; PARSONS, SYSTEM, *supra* note 17; PARSONS, ON INSTITUTIONS, *supra* note 17.

[93] Rob Fischman observes that environmental law aims at holistic, integrated, or interconnected solutions to environmental problems. Robert L. Fischman, *The Divides of Environmental Law and the Problem of Harm in the Endangered Species Act*, 83 IND. L.J. 661, 663 & nn.6–8 (2008) [hereinafter Fischman, *Divides*].

[94] *See, e.g.*, Carl Folke et al., *The Problem of Fit Between Ecosystems and Institutions: Ten Years Later*, 12 ECOLOGY & SOC'Y 30, 30 (2007), *available at* http://www.ecologyandsociety.org/vol12/iss1/art30/.

[95] *See* Fischman, *Divides*, *supra* note 93, at 664–65; Lazarus, *Super Wicked*, *supra* note 41, at 1173–79. *See generally* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 25;

methodological, and behavioral barriers to total holism, though, the task of mediation between complex social systems and complex ecological systems—the fundamental task of law and policy in the areas of the environment, land use, water, and natural resources—will push environmental law towards creating, facilitating, or supporting nodes of connections among multiple modes of environmental protection and adaptation. Multimodality is merely disjointed policy pluralism and ad hoc fragmentation if there are no meaningful efforts at integrating multiple methods of environmental protection or no useful means for doing so.[96]

Here, integration has three meanings.[97] First, at the level of problem framing, environmental law and policy are starting to and will increasingly focus on the interconnectedness within ecological systems, the interconnectedness within social systems, and the interconnectedness between the two types of systems.[98] Problems will be increasingly understood in integrated or interconnected ways, such as spanning levels of political jurisdiction or disciplinary and professional expertise, having discontinuous effects at multiple scales of space and time, or having relationships among different categories of problems. Second, the formulation and implementation of responses to these problems—laws, policies, programs, actions, and so forth—will increasingly require interconnected, coordinated, or collective action by multiple institutions, jurisdictions, agencies, organizations, communities, and individuals in society.[99] Third, at the level of responses or solutions themselves, there is pressure on environmental law to integrate different instruments and methods.[100]

PANARCHY, *supra* note 25; Ruhl & Salzman, *supra* note 7. For a narrow view of the conditions under which integration can be achieved, see Katrina Brown, *Human Development and Environmental Governance: A Reality Check*, *in* GOVERNING SUSTAINABILITY 32 (W. Neil Adger & Andrew Jordan eds., 2009). For efforts at improving synthesis or integrated understandings of complex social and ecological dynamics, see, for example, BRIDGING SCALES AND KNOWLEDGE SYSTEMS: CONCEPTS AND APPLICATIONS IN ECOSYSTEM ASSESSMENT (Walter V. Reid et al. eds., 2006) [hereinafter BRIDGING SCALES]; INSTITUTIONS AND ENVIRONMENTAL CHANGE: PRINCIPLE FINDINGS, APPLICATIONS, AND RESEARCH FRONTIERS (Oran R. Young et al. eds., 2008) [hereinafter INSTITUTIONS AND ENVIRONMENTAL CHANGE]; PANARCHY, *supra* note 25.

[96] *See, e.g.*, Barton H. Thompson, Jr., *Providing Biodiversity Through Policy Diversity*, 38 IDAHO L. REV. 355 (2002) [hereinafter Thompson, *Policy Diversity*].

[97] J.B. Ruhl & Robin Kundis Craig, *New Sustainable Governance Institutions for Estuaries and Coasts*, *in* 12 TREATISE ON ESTUARINE AND COASTAL SCIENCE ch. 14, § 14.2.7 (forthcoming 2011) (manuscript 32–33).

[98] *See id.*

[99] *See id.*

[100] *See id.*; *see also* Thompson, *Policy Diversity*, *supra* note 96. For a discussion of the need to integrate a large number of tools and techniques in order to achieve environmentally

In environmental law, evidence and theory indicate that integrationist multimodality is emerging and will emerge as a component of the institutional system of environmental protection. The sheer complexity of environmental problems is putting great pressure on environmental law to adapt in ways that integrate multiple modes of environmental protection.[101] Moreover, environmental law is already exhibiting some uses of integrationist multimodality, which may be early empirical evidence of an evolutionary trend towards increased integrationist multimodality.[102] Finally, we may be able to make early identification of the structure of environmental-law integrationist multimodality: nodes of connection that link multiple methods of environmental protection.[103]

II. THE INTEGRATIONIST AND MULTIMODAL IMPERATIVE: COMPLEX PROBLEMS AT THE INTERSECTION OF CLIMATE CHANGE, LAND USE, AND WATER

A. Complex Problems

The intersection of climate change, land use, and water is the kind of messy, chaotic, rapidly changing, multiscalar, and multidimensional set of problems that are evading solutions or even effective prevention or adaptation methods under the existing generational iterations of environmental law. These problems have been called "massive"[104] or "wicked."[105] In particular, these problems, including their causes and effects, are characterized by so many interconnected forces, relationships, and interactions that legal and policy systems cannot rely on single modes of response.

---

sustainable management of freshwater resources and systems, see Walter Rast & Marjorie Holland, *Sustainable Freshwater Resources: Achieving Secure Water Supplies*, *in* ACHIEVING SUSTAINABLE FRESHWATER SYSTEMS: A WEB OF CONNECTIONS 283, 287 (Marjorie M. Holland et al. eds., 2003).

[101] *See infra* Part II.

[102] *See infra* Part IV.

[103] *See infra* Part V.

[104] *E.g.*, Ruhl & Salzman, *supra* note 7, at 64–65, 67.

[105] *E.g.*, John T. Scholz & Bruce Stiftel, *The Challenges of Adaptive Governance*, *in* ADAPTIVE GOVERNANCE AND WATER CONFLICT: NEW INSTITUTIONS FOR COLLABORATIVE PLANNING 1, 5 (John T. Scholz & Bruce Stiftel eds., 2005); David L. Feldman & Helen Ingram, *Multiple Ways of Knowing Water Resources: Enhancing the Status of Water Ethics*, 7 SANTA CLARA J. INT'L L. 1, 1 (2009); Donald Ludwig, *The Era of Management Is Over*, 4 ECOSYSTEMS 758, 759 (2001); Lazarus, *Super Wicked*, *supra* note 41, at 1159–60. On the definition of "wicked problems," see Joshua Farley, *Wicked Problems*, 57 BIOSCIENCE 797, 797 (2007).

Likewise, diverse but fragmented responses are also inadequate under these conditions. Previously dominant ways of understanding environmental problems do not suffice.

Eight features characterize the interconnections among the many ecological forces and processes and social forces and processes in these complex environmental problems:

1. *Multiplicity*: the numerosity of relationships;
2. *Diversity*: the variety of relationships;
3. *Mutual effects*: the interdependence of relationships;
4. *Complexity*: the intricacy of interwoven relationships;
5. *Multiscalarity*: the embeddedness of relationships;
6. *Dynamism*: the changing nature of relationships;
7. *Nonlinearity*: the discontinuity of relationships and their effects; and
8. *Uncertainty*: incomplete understanding of and information about relationships.

These features characterize complex ecological systems, complex social systems, and the relationships between ecological and social systems, which multiply the complexity of each system.[106] These problem dynamics demand that environmental law and policy become increasingly integrationist and multimodal.

B. Land Use and Water

To understand the problems, we must first begin with relatively basic impacts of land use on water. Land use and development generate pollutants that enter waters not only directly from point sources but indirectly from diffuse water running off of land surfaces, picking up various pollutants along the way, and from surface and subsurface contamination that migrates into and through groundwater aquifers.[107] Of course,

---

[106] *See generally* PANARCHY, *supra* note 25; NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 25; INSTITUTIONS AND ENVIRONMENTAL CHANGE, *supra* note 95; BRIDGING SCALES, *supra* note 95.

[107] NAT'L RESEARCH COUNCIL, NEW STRATEGIES FOR AMERICA'S WATERSHEDS 20 (1999); Robert W. Adler, *Addressing Barriers to Watershed Protection*, 25 ENVTL. L. 973, 990 (1995); David F. Boutt et al., *Identifying Potential Land Use-Derived Solute Sources to Stream Baseflow Using Ground Water Models and GIS*, 39 GROUND WATER 24, 24–34 (2001); C. Leitch & J. Harbor, *Impacts of Land Use Change on Freshwater Runoff into*

different kinds of land uses generate different kinds of pollutants. Agricultural operations use pesticides and fertilizers.[108] Industrial operations produce toxic wastes.[109] Runoff from roads, driveways, and parking lots contain many pollutants, such as vehicular oil, transmission fluid, and carcinogenic sealcoat that abrades as tires drive over new coats of it.[110] Sewage may enter waterways from failing septic systems and illegal straight-pipe discharges into waterways in rural areas and from aging urban sewer systems and combined sewer-stormwater systems overflows.[111] The list of pollutants and their impacts is lengthy:

> Fertilizers, pesticides and herbicides, and pet waste come from lawns, golf courses, parks, and other humanly landscaped areas especially prevalent in sprawling communities. Freeways, streets, parking lots, car wash locations, automotive repair and storage facilities, and driveways are sources of automobile oil, coolants, other fluids, and contaminated car-washing runoff. Other pollution sources include commercial and household cleaning fluids; sediment and soil from construction, grading, landscaping, or other land alteration; decomposing litter; industrial and commercial chemicals and wastes; gas stations and their underground storage tanks; and landfills.[112]

---

the Near-Coastal Zone, Holetown Watershed, Barbados: Comparisons of Long-Term to Single-Storm Effects, 54 J. SOIL & WATER CONSERV. 584, 592 (1999).

[108] *See, e.g.*, Larry C. Frarey et al., *Conservation Districts as the Foundation for Watershed-Based Programs to Prevent and Abate Polluted Agricultural Runoff*, 18 HAMLINE L. REV. 151, 152 (1994); J.B. Ruhl, *Farms, Their Environmental Harms, and Environmental Law*, 27 ECOLOGY L.Q. 263, 272–92 (2000); Angelo, *supra* note 65, at 124–25.

[109] *See, e.g.*, CHRISTOPHER KLOSS & CRYSTAL CALARUSSE, ROOFTOPS TO RIVERS: GREEN STRATEGIES FOR CONTROLLING STORMWWATER AND COMBINED SEWER OVERFLOWS 3, tbl. 2 (2006); Claudia Copeland, *Comprehensive Clean Air and Clean Water Permits: Is the Glass Still Just Half Full?*, 21 ENVTL. L. 2135, 2168–69 (1991).

[110] Craig Anthony (Tony) Arnold, *Is Wet Growth Smarter Than Smart Growth?: The Fragmentation and Integration of Land Use and Water*, 35 Envtl. L. Rep. News & Analysis (Envtl. Law Inst.) 10152, 10162–63 (2005) [hereinafter Arnold, *Is Wet Growth Smarter*]; Barbra J. Mahler et al., *Parking Lot Sealcoat: An Unrecognized Source of Urban Polycyclic Aromatic Hydrocarbons*, 39 ENVTL. SCI. & TECH. 5560, 5560 (2005); U.S. ENVTL. PROT. AGENCY, Pub. No. EPA-841-B-05-004, NATIONAL MANAGEMENT MEASURES TO CONTROL NONPOINT SOURCE POLLUTION FROM URBAN AREAS, at 0-16 to 0-18, 0-28 to 0-36 (2005) [hereinafter EPA, NATIONAL MANAGEMENT MEASURES].

[111] *See, e.g.*, Cameron Griffith, *No Swimming: Kentucky's Wasted Waterways*, 1 J. ANIMAL & ENVTL. L. 249, 249–50 (2010).

[112] Arnold, *Is Wet Growth Smarter*, *supra* note 110, at 10162–63.

Just in stormwater runoff alone, there are many pollutants:

> Rainfall drained from urban streets and other heavily populated areas is often tainted with a wide variety of hazardous substances: road salts, nutrients, suspended solids, trace metals, pesticides, herbicides, fungicides, fertilizers, petroleum products, and other chemicals widely disposed of in urban areas. Additionally, airborne pollutants, such as those contained in automobile emissions, are highly concentrated in urban areas and wash off into stormwater. Stormwater drains often become the repositories for used oil and antifreeze that wash off into drainage systems. Industrial dischargers to municipal storm sewer systems and illicit dischargers also contribute significantly to the stormwater pollution problem.[113]

Land use and development also increase the quantity and velocity of stormwater runoff through the addition of impervious surfaces to land, soil compaction, and removal of trees and vegetation.[114] Impervious surfaces include buildings, roads, sidewalks, parking lots, recreational facilities, lined drainage channels, and any other paved or hard-cover surfaces that do not allow water to go directly into permeable soils.[115] The resulting impacts on waters are: 1) increased collection and transportation of pollutants from land to water; 2) decreased filtration and uptake of pollutants by soils and vegetation; 3) water bodies degraded by sediment accumulation, altered water temperature and clarity, stream bank erosion and channel widening, and altered basic stream bed structure; 4) degraded aquatic habitat for species; 5) decreased groundwater recharge; 6) increased overflows of combined sewer systems into waters; 7) alteration of watershed hydrology, including increased stream peakflow and peakflow duration,

---

[113] Joel B. Eisen, *Toward A Sustainable Urbanism: Lessons from Federal Regulation of Urban Stormwater Runoff*, 48 WASH. U. J. URB. & CONTEMP. L. 1, 14–15 (1995) (internal citations omitted).

[114] CRAIG ANTHONY (TONY) ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS FOR SUSTAINABLE DEVELOPMENT: A HANDBOOK ON LAND USE AND WATER FOR KENTUCKY COMMUNITIES 7 (2009) [hereinafter ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS]; U.S. ENVTL. PROT. AGENCY, Pub. No. EPA-841-F-07-006, REDUCING STORMWATER COSTS THROUGH LOW IMPACT DEVELOPMENT (LID) STRATEGIES AND PRACTICES 1 (2007) [hereinafter EPA, REDUCING STORMWATER COSTS].

[115] EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-16 to 0-18.

and decreased stream baseflow (stream flow from groundwater sources); and 8) more flooding of both human and natural environments.[116]

Land use and development also alter the features of watersheds that support their integrity and healthy functioning. Watersheds are areas of land that drain to a common point on a surface body of water.[117] Watersheds are characterized as having nested hierarchies—small catchments are nested within subwatersheds, which are nested within watersheds, which are nested within subbasins, which are nested within basins, to put it perhaps too simplistically but sufficient to convey the basic concept.[118] Watersheds are ecological systems—or ecosystems—that serve a variety of functions: 1) support of all biological life in the watershed; 2) contributions to nutrient and energy cycles; 3) flow, including the channeling, moderation, pacing, retention, and release of water; 4) removal or neutralization of pollutants in the environment; 5) soil enrichment and deposition; 6) temperature control for both waters and the climate; 7) formation and maintenance of aquatic habitat for species; 8) shaping of landscape; and 9) preservation of the integrity and resilience of the overall watershed structure.[119] In addition to the impacts of land-use related pollutants and

---

[116] *Id.* at 0-20 to 0-27; *see also* JOHN RANDOLF, ENVIRONMENTAL LAND USE PLANNING AND MANAGEMENT 363, 373, 375 tbl.13.1, 392–93, 486–87 (2004); Craig Anthony (Tony) Arnold, *Clean-Water Land Use: Connecting Scale and Function*, 23 PACE ENVTL. L. REV. 291, 294–96 (2006) [hereinafter Arnold, *Clean-Water Land Use*]; Samuel D. Brody et al., *The Rising Costs of Floods: Examining the Impact of Planning and Development Decisions on Property Damage in Florida*, 73 J. AM. PLANNING ASS'N 330, 332–34 (2007); Timothy N. McPherson et al., *Dry and Wet Weather Flow Nutrient Loads from a Los Angeles Watershed*, 4 J. AM. WATER RESOURCES ASS'N 959, 959–60 (2005); Alfonso I. Mejia & Glenn E. Moglen, *Spatial Patterns of Urban Development from Optimization of Flood Peaks and Imperviousness-Based Measures*, 14 J. HYDROLOGICAL ENGINEERING 416 (2009); Douglas A. Miltenberger, *Development on the Banks of the Letort Spring Run: What Can Be Done to Save Pennsylvania's Waterways from Post Construction Stormwater Runoff?*, 11 PENN. ST. ENVTL. L. REV. 127, 127 (2002); BETSY OTTO ET AL., ECOLOGICAL RIVERFRONT DESIGN: RESTORING RIVERS, CONNECTING COMMUNITIES 20 (2004); BETSY OTTO ET AL., PAVING OUR WAY TO WATER SHORTAGES: HOW SPRAWL AGGRAVATES THE EFFECTS OF DROUGHT 1, 4–5 (2002).

[117] THOMAS E. DAVENPORT, THE WATERSHED PROJECT MANAGEMENT GUIDE 21 (2003); DAVID LEWIS FELDMAN, WATER POLICY FOR SUSTAINABLE DEVELOPMENT 36 (2007); William Goldfarb, *Watershed Management: Slogan or Solution*, 21 B.C. ENVTL. AFF. L. REV. 483, 484 (1994); NAT'L RESEARCH COUNCIL, *supra* note 107, at 14.

[118] *See* RANDOLPH, *supra* note 116, at 255–58; Davenport, *supra* note 117, at 23–24; NAT'L RESEARCH COUNCIL, *supra* note 107, at 37–54; Adler, *supra* note 107, at 1091–92 & n.742.

[119] *See* John M. Blair et al., *Ecosystems as Functional Units in Nature*, 14 NAT. RESOURCES & ENV'T 150, 153 (2000); C.E. Griffith et al., *Ecoregions, Watersheds, Basins, and HUCs: How State and Federal Agencies Frame Water Quality*, 54 J. SOIL & WATER CONSERVATION 666 (1999); Sandra Postel & Stephen Carter, *Freshwater Ecosystem Services*, *in* NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS 195 (Gretchen C. Dailey ed.

runoff on watershed features and functions, our land use patterns have developed and altered lands that are especially sensitive or critical in watershed processes and functions.[120] These include wetlands, floodplains, forested lands, hillsides, ridges, slopes, riparian lands, aquifer recharge zones, karst and sinkhole features, stream banks, and stream channels themselves.[121] Alterations of sensitive watershed lands have come from sprawling urban, suburban, and exurban development.[122] They also come from agricultural practices, deforestation and unsustainable timber practices, resource extractive industries (e.g., mining, oil, gas), and projects aimed at manipulating hydrology or topography, such as flood control projects, slope stabilization, and navigation-supporting dredging.[123]

Both land development and ongoing uses of land disturb soils, which create sediment (eroded soil). This sediment enters water bodies, diminishes water quality, alters species' habitats, impairs fish spawning, and increases the cost to treat drinking water.[124] Construction sites are common and significant sources of sediment and erosion.[125] However, sediment and erosion also come from agricultural uses of land, mining and forestry practices, and even activities on developed sites, such as grading, landscaping, removing vegetation, wearing pathways, and allowing grass or plants to die.[126] Moreover, channel erosion from the impacts of stormwater runoff and impervious cover, dams, and human alterations to stream channels increase channel erosion and therefore sedimentation and siltation in the stream.[127]

1997); NAT'L RESEARCH COUNCIL, *supra* note 107, at 42–43; Adler, *supra* note 107, at 1093–94.

[120] *See, e.g.*, ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 7–11.

[121] *See, e.g.*, *id.* at 20–25.

[122] *See, e.g.*, *id.* at 32.

[123] *See, e.g., id.* at 27–30.

[124] U.S. ENVTL. PROT. AGENCY, Pub. No. EPA-840-R-00-001, PROTECTING AND RESTORING AMERICA'S WATERSHED: STATUS, TRENDS, AND INITIATIVES IN WATERSHED MANAGEMENT 17 (2001) [hereinafter EPA, PROTECTING AND RESTORING]; OTTO ET AL., *supra* note 116, at 21–22.

[125] *See, e.g.*, EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-29, 8-2 to 8-3 & tbl.8.1; NAT'L ACAD. OF PUB. ADMIN, POLICIES TO PREVENT EROSION IN ATLANTA'S WATERSHED: ACCELERATING THE TRANSITION TO PERFORMANCE 3, 6–7 (2001); OTTO ET AL., *supra* note 116, at 21.

[126] *See* EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-29; EPA, PROTECTING AND RESTORING, *supra* note 124, at 17; OTTO ET AL., *supra* note 116, at 21; REBECCA PINEO & SUSAN BARTON, COOP. EXTENSION, UNIV. OF DEL. BOTANIC GARDENS, SUSTAINABLE LANDSCAPES SERIES BULL. NO. 129, PREVENTING EROSION 2 (2009), *available at* http://ag.udel.edu/udbg/sl/hydrology/Preventing_Erosion.pdf.

[127] *See* OTTO ET AL., *supra* note 116, at 21–22.

Land use and development also use water, often in unsustainable ways. Specifically, there are five major water impacts of land uses, development, and growth on the use or consumption of water: 1) inefficiency and waste; 2) demand generation; 3) reduced instream flows; 4) re-engineering projects; and 5) groundwater over-pumping.[128]

First, many land use practices can be thirsty and wasteful. For example, although there have been impressive improvements in the efficiency of agricultural uses of water, many agricultural uses of water, particularly for crop irrigation, could be substantially more efficient with available technology and methods.[129] Moreover, many urban, suburban, and exurban uses of water are inefficient.[130] Urban, suburban, and exurban development is characterized by especially "water-intensive land use practices, including large grassy lawns even in dry and hot climates, swimming pools, golf courses, water recreational parks, fountains, non-native landscaping, vehicle washing activities, and even lush lawns for commercial and industrial centers."[131] From 1950 to 1990, the U.S. population grew 92%, while water use grew by 106% with even higher increases in domestic use.[132] Outdoor water use constitutes 58% of all residential water use, with homes that have in-ground sprinkler systems using 35% more water than homes without these systems, and homes with pools having 55% more water leaks than homes without pools.[133] The thirsty nature of our land development

---

[128] *See* Arnold, *Is Wet Growth Smarter*, *supra* note 110, at 10160–61. For an excellent resource on the impacts of land development on water in Florida, see CYNTHIA BARNETT, MIRAGE: FLORIDA AND THE VANISHING WATER OF THE EASTERN U.S. (2007). *See also infra* notes 129–54.

[129] *See* TEX. WATER DEV. BD., AGRICULTURAL WATER CONSERVATION PRACTICES 1 (2009), *available at* http://www.twdb.state.tx.us/assistance/conservation/conservationpublications/agbrochure.pdf. *See generally* COUNCIL FOR AGRIC. SCI. & TECH., ISSUE PAPER NO. 44, WATER, PEOPLE, AND THE FUTURE: WATER AVAILABILITY FOR AGRICULTURE IN THE UNITED STATES (2009), *available at* http://www.cast-science.org/displayProductDetails.asp?idProduct=167 (follow "free download" hyperlink). On the increasing efficiency of irrigation practices in California, but recognizing the lack of a single universal method of efficiency due to variable climate and water use conditions in agriculture, see AGRIC. WATER MGMT. COUNCIL, EFFICIENT WATER MANAGEMENT: IRRIGATION DISTRICT ACHIEVEMENTS (2009), *available at* http://www.agwatercouncil.org/images/stories/pdfs/AWMC_final.pdf.

[130] *See* FELDMAN, *supra* note 117, at 299–301; ROBERT GLENNON, UNQUENCHABLE: AMERICA'S WATER CRISIS AND WHAT TO DO ABOUT IT 171–81 (2009). *See generally* PAC. INST. FOR STUDIES IN DEV., ENV'T, AND SEC., A REVIEW OF WATER CONSERVATION PLANNING FOR THE ATLANTA, GEORGIA REGION (2006), *available at* http://www.pacinst.org/reports/atlanta/atlanta_analysis.pdf.

[131] Arnold, *Is Wet Growth Smarter*, *supra* note 110, at 10161.

[132] *Id.*

[133] FELDMAN, *supra* note 117, at 300–01.

patterns flows out of our culture of consumption, landscaping preferences, drive for more and better recreational opportunities, expectations of instant physical comfort, lack of awareness and understanding, and inefficient existing features of our built environment.[134]

Second, growth and development create demands for water resources. These demands incentivize the expansion of water supply services to newly developed areas by creating excess supply capacity to accommodate future growth cost-effectively, which in turn stimulates more development and growth and draws land development away from locations of older, existing water infrastructure.[135] This perpetual growth bias[136] encourages sprawl, increases the quantity and distribution of impervious cover, and alters or destroys water sensitive lands, vegetation, and natural topographical and hydrologic features on which watersheds depend.[137] It also draws resources away from improving the use of existing infrastructure and instead invests them in new infrastructure.[138]

Third, our land use practices have resulted in substantial diversions of surface waters from streams, rivers, and lakes, reducing (or in some cases entirely eliminating) instream flows.[139] Demands for instream diversions arise from agriculture, residences, industry and commerce, energy production, mining, flood control, and off-stream recreation.[140] The effects are severe:

---

[134] *See* GLENNON, UNQUENCHABLE, *supra* note 130, at 171–81; FELDMAN, *supra* note 117, at 299–301.

[135] *See, e.g.*, 10,000 FRIENDS OF PA., WATER AND GROWTH: TOWARD A STRONGER CONNECTION BETWEEN WATER SUPPLY AND LAND USE IN SOUTHEASTERN PENNSYLVANIA (2007), *available at* http://10000friends.org/sites/10000friends.org/files/water_report_07_final_with_covers.pdf.

[136] *See* A. Dan Tarlock, *We Are All Water Lawyers Now: Water Law's Potential But Limited Impact on Urban Growth Management*, *in* WET GROWTH: SHOULD WATER LAW CONTROL LAND USE? 57, 57–94 (Craig Anthony (Tony) Arnold ed. 2005); Barton H. Thompson, *Water Management and Land Use Planning: Is It Time for Closer Coordination?*, *in* WET GROWTH: SHOULD WATER LAW CONTROL LAND USE?, *supra*, at 95, 95–100.

[137] *See* GLENNON, UNQUENCHABLE, *supra* note 130, at 311–12; Arnold, *Is Wet Growth Smarter*, *supra* note 110, at 10160–61; Thompson, *supra* note 136, at 107–15.

[138] *See, e.g.*, AGRIC. RES. & COOP. EXTENSION, PENN STATE COLL. OF AGRIC. SCI., WATER CONSERVATION FOR COMMUNITIES 6 (2010).

[139] *See generally* DAVID M. GILLILAN & THOMAS C. BROWN, INSTREAM FLOW PROTECTION: SEEKING A BALANCE IN WESTERN WATER USE (1997) (addressing threats to instream flows in the Western U.S.); Christine A. Klein, *Water Transfers: The Case Against Transbasin Diversions in the Eastern States*, 25 UCLA J. ENVTL. L. & POL'Y 249, 259–67 (2007) (describing demands to transfer water not only out of streams but out of watersheds to meet growth-related demands not only in the Western United States but increasingly in the Eastern United States).

[140] GILLILAN & BROWN, *supra* note 139, at 39–40.

> Low, fluctuating, or blocked instream flows harm plant and animal species that depend on the water, decrease groundwater recharge, result in higher concentrations of pollutants (due to less water to dilute them), change water temperatures, and alter basic stream structure. Lack of sufficient instream flows degrade the aesthetic and community values of waters and reduce opportunities to use the waters for commercial navigation, recreation, or fishing. Overuse of surface bodies of water can dry up the waterway in times of drought, or in some cases, dry it up permanently.[141]

Fourth, our land use practices and growth patterns have demanded the re-engineering of nature's hydrologic systems.[142] We seek to control flooding.[143] We dam waters to capture and control them, and build reservoirs to store them for future uses.[144] We divert waters from surface bodies.[145] We pump waters from groundwater sources.[146] We fill wetlands.[147] We channelize and line what would naturally be meandering or fluctuating streams and rivers.[148] These alterations impair hydrological processes,

---

[141] ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 32.

[142] *See generally* Janet C. Neuman, *Dusting Off the Blueprint for a Dryland Democracy: Incorporating Watershed Integrity and Water Availability into Land Use Decisions*, *in* WET GROWTH, *supra* note 136, at 119, 119–69.

[143] *See, e.g.*, Brody et al., *supra* note 116, at 333–34; Christine A. Klein, *On Integrity: Some Considerations for Water Law*, 56 ALA. L. REV. 1009, 1015–17 (2005) (describing harm to the Florida Everglades due to decades of flood control that deprived the Everglades of needed water, while protecting growing agricultural and urban uses of land).

[144] *E.g.*, GILLILAN & BROWN, *supra* note 139, at 40; OTTO ET AL., *supra* note 116, at 16; SANDRA POSTEL & BRIAN RICHTER, RIVERS FOR LIFE: MANAGING WATER FOR PEOPLE AND NATURE 13–17 (2003).

[145] *See, e.g.*, GILLILAN & BROWN, *supra* note 139, at 39–40.

[146] *See generally* ROBERT GLENNON, WATER FOLLIES: GROUNDWATER PUMPING AND THE FATE OF AMERICA'S FRESH WATERS (2002).

[147] *See, e.g.*, OTTO ET AL., *supra* note 116, at 16–17; Brody et al., *supra* note 116, at 332–33; Trevor B. Rockstad, Comment, *The Three-Legged Stool: Ensuring Protection of Mississippi's Isolated Wetlands Through Increased State and Local Regulation*, 79 MISS. L.J. ONLINE 82, 87–88 (2010). Even when we aim to maintain the overall number of wetlands acres (the "no net loss" policy), allowing mitigation offsets and mitigation banking so that some wetlands can be developed in exchange for the development or restoration of other wetlands, the replacement wetlands often fail to match the overall quality, functions, and health of the destroyed wetlands. *See generally* S. Scott Burkhalter, Comment, *Oversimplification: Value and Function: Wetland Mitigation Banking*, 2 CHAP. L. REV. 261 (1999); Victoria Steinbach, *Wetland Mitigation Banking: An Assessment of the Ohio Wetlands Foundation*, 1 J. ANIMAL & ENVTL. L. 330 (2010).

[148] *See, e.g.*, KLOSS & CALARUSSE, *supra* note 109, at 24; OTTO ET AL., *supra* note 116, at 16, 26–28; Brody et al., *supra* note 116, at 331.

destroy aquatic habitats, harm watershed health and functioning, decrease water supply capacity, and contribute to flooding.[149]

Fifth, the combination of growth, competing demands for water (especially both agriculture and municipal water supply systems), and patterns of water uses has produced the over-pumping of many of our groundwater supplies.[150] The rates of withdrawal exceed the rates of recharge.[151] This practice results in yields that cannot be sustained over the long run, subsidence, saltwater intrusion, degraded water quality, increased water treatment costs, and conversion of a renewable resource into a non-renewable and continually declining resource.[152] The amount of impervious cover in our developed landscapes exacerbates the problem by reducing recharge of stormwater into soils and aquifers.[153] Pollution that migrates into groundwater from uses on the land's surface further degrades overstressed groundwater sources.[154]

Water use practices also affect land use. As discussed above with respect to the perpetual growth bias, the creation of water infrastructure induces growth and new development, often in sprawling patterns.[155] Thus, water use is a self-perpetuating engine of growth, stimulating not only increased land development but also the increased demand for water and the increased runoff and water quality impacts that result from growth.

The pollution of water and overexploitation of watersheds can degrade the quality of the adjacent landscapes and can lead to community decline.[156] For example, a study of residents in the Anacostia area of Washington, D.C. showed that the combination of both crime and severely degraded conditions in the Anacostia River and along its riverfront led to residents' aversion to the area and created substantial barriers to watershed protection and restoration efforts.[157] It is not surprising that some

---

[149] *See, e.g.*, POSTEL & RICHTER, *supra* note 144, at 17–36; Brody et al., *supra* note 116, at 331–34.
[150] GLENNON, WATER FOLLIES, *supra* note 146, at 23–34.
[151] *See id.* at 25–26.
[152] *See id.* at 32–34.
[153] PAVING OUR WAY, *supra* note 116, at 1.
[154] *See generally* RUTH PATRICK ET AL., GROUNDWATER CONTAMINATION IN THE UNITED STATES (2nd ed. 1987); Robert Glicksman & George Coggins, *Groundwater Pollution I: The Problem and the Law*, 35 U. KAN. L. REV. 75 (1986).
[155] *See supra* notes 135–38 and accompanying text.
[156] *See, e.g.*, *In re* Howard Sleeper, No. RA 84-53(C) (N.M. Dist. Ct. 1985) (evaluating the impacts of water rights transfers to a proposed ski resort development on the public welfare of a Hispanic agricultural community), *rev'd* 760 P.2d 787 (N.M. Ct. App. 1988); GLENNON, UNQUENCHABLE, *supra* note 130, at 327–33 (case study of the Salton Sea).
[157] Michael L. Kronthal, Envtl. Anthropology Project, Soc'y for Applied Anthropology, Local

of our most difficult challenges concerning both water resources and land uses center on degraded and altered urban waters.[158]

Flooding is a major water-related impact on land use with multiple dimensions. Floods—with both natural and human causes—can discourage development, destroy existing communities and land uses, pose risks to human health and safety, kill trees and vegetation, and push development and land uses elsewhere.[159] However, flood-prone areas are attractive for agricultural land uses due to the richness of the soils and proximity to water sources.[160] These areas also attract residential and resort development due to high demand for locations on or close to waters.[161] Flood insurance programs facilitate land uses in floodplains and on or near the edges of our waters.[162] Moreover, the uses of waters and alterations of watershed structural features, such as wetlands, stream beds and banks, and surface waters, can exacerbate flooding by reducing the capacity of the watershed's natural hydrology to capture, store, and absorb fluctuating stormwaters and floodwaters.[163] Finally, our water development projects, such as dams and reservoirs, have converted many lands—including prime agricultural lands, forests and grasslands, rich ecosystems, and even entire human communities—to water storage by flooding them.[164]

Reduced instream flows and lake levels alter the zones at which land and water intersect, such as stream banks and lake shores, which

---

Residents, the Anacostia River and "Community" (unpublished manuscript), *available at* http://www.sfaa.net/eap/kronthal/kronthal.pdf.

[158] *See, e.g.*, OTTO ET AL., *supra* note 116, at 1–28. *See generally* RIVERTOWN: RETHINKING URBAN RIVERS (Paul Stanton Kibel ed., 2007).

[159] *See* Elizabeth C. Black, *Climate Change Adaptation: Local Solutions for a Global Problem*, 22 GEO. INT'L ENVTL. L. REV. 359, 364–65 (2010); *see also* RANDOLPH, *supra* note 116, at 43, 206–07. *See, e.g.*, G. TYLER MILLER, JR. & SCOTT SPOOLMAN, LIVING IN THE ENVIRONMENT: CONCEPTS, CONNECTIONS, AND SOLUTIONS 338–40 (16th ed. 2009); Mejia & Moglen, *supra* note 116 (analyzing the tendency of urbanization to promote flooding).

[160] *See, e.g.*, MILLER & SPOOLMAN, *supra* note 159, at 338–39.

[161] *See, e.g.*, *id.*; Robert W. Adler, *The Law at the Water's Edge: Limits to "Ownership" of Aquatic Ecosystems*, *in* WET GROWTH, *supra* note 136, at 201, 222; Black, *supra* note 159, at 364–65.

[162] *See* Christine M. McMill, Comment, *Federal Flood Insurance Policy: Making Matters Worse*, 44 HOUS. L. REV. 471, 498–501 (2007).

[163] *See* OTTO ET AL., *supra* note 116, at 19–20.

[164] *See, e.g.*, Niki Christopher, *Cattle Ranch with Park Rangers: The Battle for a Tallgrass Prairie National Park in Kansas*, 18 STAN. ENVTL. L.J. 211 (1999); Susan Kelly et al., *History of the Rio Grande Reservoirs in New Mexico: Legislation and Litigation*, 47 NAT. RESOURCES J. 525 (2007). For an example of liability to landowners for flooding of their land by a dam and reservoir, see Tarrant Reg'l Water Dist. v. Gragg, 151 S.W.3d 546, 558 (Tex. 2004).

in turn affect the land uses along those water-land edges.[165] Pumping groundwater at high rates of extraction or pressure or at levels that exceed recharge levels can create subsidence and sinkholes.[166] Depriving vegetation and wildlife of the water it needs to thrive or even survive, in order to use water for human consumption, produces landscapes that have lower resiliency and may decline in times of water stress.[167] These altered landscapes can change from biologically rich composition to monocultures (perhaps even dominated by invasive non-native species).[168] They decreasingly support agricultural, forestry, aesthetic, recreational, educational, and community-based uses of land.

C. Layers of Complexity: Land and Water

The picture is considerably more complex than the basic impacts that land use has on water and that water use has on land, though. The interactions among land uses, water uses, the land environment, and the water environment occur at multiple scales.[169] The multiscalar nature of our land and water problems is complicated by the fact that our classifications for various scales of land, water, and watersheds are artificial, failing to match ecological or hydrologic reality.[170] Furthermore, human actions with respect to land and water occur at multiple scales that do not match

---

[165] *See, e.g.*, GILLILAN & BROWN, *supra* note 139, at 2, 51–55, 83, 85–86 (discussing the impact of instream flow on vegetation growth); Adler, *Water's Edge*, *supra* note 161, at 201, 215–16.

[166] *See* GLENNON, WATER FOLLIES, *supra* note 146, at 32–34, 73, 79–81; DEBORAH L. MYERSON, URB. LAND INST., WATER AND THE FUTURE OF LAND DEVELOPMENT 2 (2002); J. Letey, *Science and Policy in Integrated Watershed Management: A Case Study*, 35 J. AM. WATER RESOURCES ASS'N 603, 604 (1999).

[167] *See* GILLILAN & BROWN, *supra* note 139, at 51–55.

[168] *See* R. McMurtrie & L. Wolf, *A Model of Competition Between Trees and Grass for Radiation, Water and Nutrients*, 52 ANNALS BOTANY 449, 455–56 (1983); *see, e.g.*, Adler, *Water's Edge*, *supra* note 161, at 212–22 (discussing biological changes and/or the decline of the Colorado River's native flora & fauna). On the definition of invasive species, see EPA, PROTECTING AND RESTORING, *supra* note 124, at 18–19.

[169] *See generally* Arnold, *Clean-Water Land Use*, *supra* note 116. On the various watershed scales at which different hydrological, ecological, and human effects occur, see DAVENPORT, *supra* note 117, at 23–25; NAT'L RESEARCH COUNCIL, *supra* note 107, at 42–43; RANDOLPH, *supra* note 116, at 258.

[170] *See* JAMES H. THORP ET AL., THE RIVERINE ECOSYSTEM SYNTHESIS: TOWARDS CONCEPTUAL COHESIVENESS IN RIVER SCIENCE 1–7 (2008) (illustrating the complexities of riverine ecosystems); Griffith et al., *supra* note 119, at 667–68. *See generally* JOHN COPELAND NAGLE & J.B. RUHL, THE LAW OF BIODIVERSITY AND ECOSYSTEM MANAGEMENT 318–34 (2d ed. 2006) (discussing ecosystem management).

ecologic or hydrologic scale. They occur at levels of property parcel ownership, land development site operations, service-provision geography, local and state political/jurisdictional boundaries, allocation of legal authority, and the like.[171] The complexities of culture, norms, human behavior, and social systems make it difficult to get a handle on what determines our uses of land and water.[172] We also have a basic difficulty with getting a handle on the impacts of our actions on the environment. Our uses of land and water have cumulative and synergistic impacts.[173] They result in discontinuities in effects, including downstream effects, distant effects geographically, and future effects that do not proceed temporally in a continuous fashion.[174] They have unanticipated consequences.[175] Moreover, ecosystems respond in unanticipated, discontinuous, complex, and multi-dimensional ways that frustrate our ability to predict impacts, responses, or critical tipping points at which disastrous consequences occur.[176]

---

[171] *See, e.g.*, DAVENPORT, *supra* note 117, at 1–3. *See generally* STEWARDSHIP ACROSS BOUNDARIES (Richard L. Knight & Peter B. Landres eds., 1998); Arnold, *Is Wet Growth Smarter*, *supra* note 110. On the mismatch of scales of human activity and ecological processes, see generally Rebecca L. Kihslinger & James M. McElfish, *The Scale Problem for Land Use Decisions*, *in* NATURE-FRIENDLY LAND USE PRACTICES AT MULTIPLE SCALES 1 (Rebecca Kihslinger & James McElfish, eds., 2009).

[172] For books exploring socio-cultural contributors to unsustainable land use and water practices, see generally FELDMAN, *supra* note 117; GLENNON, UNQUENCHABLE, *supra* note 130; CHARLES F. WILKINSON, CROSSING THE NEXT MERIDIAN: LAND, WATER, AND THE FUTURE OF THE WEST (1992). On the complexities of interrelationships between social and ecological systems, see generally PANARCHY, *supra* note 25; Arnold, *Structure*, *supra* note 7.

[173] *See* Lee H. MacDonald, *Evaluating and Managing Cumulative Effects: Process and Constraints*, 26 ENVTL. MGMT. 299, 299 (2000); Roy C. Sidle & James W. Hornbeck, *Cumulative Effects: A Broader Approach to Water Quality Research*, 46 J. SOIL & WATER CONSERVATION 268, 268 (1991); David M. Theobald et al., *Estimating the Cumulative Effects of Development on Wildlife Habitat*, 39 LANDSCAPE & URB. PLAN. 25, 25–26 (1997). *See also, e.g.*, Ruhl & Salzman, *supra* note 7, at 87–88 (discussing Gulf hypoxia). On the cumulative and synergistic impacts of many site-, project-, and locality-specific decisions about land and water uses on landscape ecology see Kihslinger & McElfish, *supra* note 171, at 6.

[174] *See* Ger Bergkamp, *A Hierarchical View of the Interactions of Runoff and Infiltration with Vegetation and Microtopography in Semiarid Shrublands*, 33 CATENA 201, *passim* (1998); R.A. Pielke et al., *Nonlinear Influence of Mesoscale Land Use on Weather and Climate*, 4 J. CLIMATE 1053, *passim* (1991); Ruhl & Salzman, *supra* note 7, at 87–88; Jack A. Stanford et al., *Serial Discontinuity in a Large River System*, 23 PROC. INT'L ASSOC. THEORETICAL & APPLIED LIMNOLOGY 1114, *passim* (1988).

[175] For a call for improved study of interrelationships among land use patterns, watershed conditions, and hydrological processes due to the potential for unanticipated consequences, see R. DeFries & K. N. Eshleman, *Land-Use Change and Hydrologic Processes: A Major Focus for the Future*, 18 HYDROLOGICAL PROCESSES 2183, 2183, 2185 (2004).

[176] *See* MILLER & SPOOLMAN, *supra* note 159, at 117–19; Ruhl & Salzman, *supra* note 7, at 77 n.62, 78. *See, e.g.*, Colin D. Woodroffe et al., *Landscape Variability and the Response*

Take, for example, the problem of pollution from urban runoff. A fairly simple analysis of the problem might be that impervious surfaces in urban areas increase stormwater runoff that carries pollutants into our waters.[177] However, neither the causes nor the effects are quite so simple.

First, impervious cover itself is not the only source of polluted urban runoff. There are at least five other causes that act together to cause the problem: 1) the placement of pollutants and polluting substances on lands from which they can run off; 2) choices to use certain amounts and concentrations of impervious cover in certain locations; 3) choices to use certain pollutants in certain ways in certain locations; 4) legal and regulatory systems that allow the impervious cover choices that were made; and 5) legal and regulatory systems that allow the pollution choices that were made.

Second, urban runoff is not the only source, not even the only nonpoint source, of pollution in our waters. For example, agricultural runoff is a major nonpoint source of water pollution.[178] These pollutants include sediments, nutrients, pesticides, and minerals that adversely affect the health of waterways, aquatic species, and humans.[179]

Third, the contribution of any impervious landscape to degraded waters is both cumulative with other impervious landscapes and synergistic with other degradations to watersheds that reduce the capacity of

---

of Asian Megadeltas to Environmental Change, *in* GLOBAL CHANGE AND INTEGRATED COASTAL MANAGEMENT: THE ASIA-PACIFIC REGION 277, 307–08 (Nick Harvey ed., 2006) (describing the unanticipated impacts of sea level rise and storm-related coastal flooding, including the example of Hurricane Katrina on the U.S. Gulf Coast). In general, this point is related to the complexity and nonlinear dynamics of ecosystem adaptation and resilience. *See also* Alyson C. Flournoy, *The Case for the National Environmental Legacy Act*, *in* BEYOND ENVIRONMENTAL LAW: POLICY PROPOSALS FOR A BETTER ENVIRONMENTAL FUTURE 3, 17–18 (Alyson C. Flournoy & David M. Driesen eds., 2010) (addressing the importance of resilience analysis in statutory design). *See generally* FOUNDATIONS OF ECOLOGICAL RESILIENCE (Lance H. Gunderson et al. eds., 2010).

[177] *See, e.g.*, EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-16 to 0-17, 01-21 to 0-24, 0-26, 0-28 to 0-29; *Stormwater Strategies: Community Responses to Runoff Pollution—Chapter 2*, NATURAL RES. DEF. COUNCIL (last visited Apr. 3, 2011), http://www.nrdc.org/water/pollution/storm/chap2.asp.

[178] "In the 2000 *National Water Quality Inventory*, states reported that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts on surveyed rivers and lakes, the second largest source of impairments to wetlands, and a major contributor to contamination of surveyed estuaries and ground water." U.S. ENVTL. PROT. AGENCY, EPA-841-F-05-001, PROTECTING WATER QUALITY FROM AGRICULTURAL RUNOFF 1 (2005), *available at* http://www.epa.gov/owow/NPS/Ag_Runoff_Fact_Sheet.pdf. *See also* Ivette Perfecto, *Sustainable Agriculture Embedded in a Global Sustainable Future: Agriculture in the United States and Cuba*, *in* ENVIRONMENTAL JUSTICE: ISSUES, POLICIES, AND SOLUTIONS 172, 175 (Bunyan Bryant ed., 1995).

[179] PROTECTING WATER QUALITY, *supra* note 178, at 1; Ivette Perfecto, *supra* note 178, at 175.

watersheds and waters to adapt to polluted runoff.[180] Research shows that the impacts of impervious surfaces occur at smaller levels of watersheds, usually at catchment or subwatershed levels.[181] Thus, any larger-scale effects are the result of widespread use of impervious cover and the influence of multiple causes in interaction with one another. Loss of wetlands to land development, deforestation, the development or alteration of riparian zones and steep slopes, the channelization and lining of streams and rivers, reduced instream flows that could divert pollutants. All these effects interact with polluted urban runoff to increase the total amount of pollution in our waters.[182]

Fourth, runoff from developed impervious surfaces not only transports pollutants but also is characterized by increased quantities and velocities of water running off of land.[183] The effects include multiplier effects on pollution entry into waters from erosion, decreased filtration opportunities, and more runoff to uptake more pollutants.[184] They also include hydrologic impacts, such as flooding and alterations of the structures of waterways and watersheds.[185] Nonetheless, even problems like flooding may involve flash flooding, storm surge flooding (particularly in coastal areas), or widening of flood plains, and each of these problems has a different set of dynamics.[186]

Fifth, impervious cover and polluted urban runoff affect not only surface water but also groundwater recharge.[187] Groundwater is interconnected with surface waters in complicated and multifaceted ways that

---

[180] *See supra* note 173.

[181] EPA, NATIONAL MANAGEMENT MEASURES, *supra* 110, at 0-18.

[182] *See* EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-29; POSTEL & RICHTER, *supra* note 144, at 14–15 tbl.1–2; THE TRUST FOR PUB. LAND, SOURCE PROTECTION HANDBOOK: USING LAND CONSERVATION TO PROTECT DRINKING WATER SUPPLIES 9 (2005), *available at* http://www.tpl.org/content_documents/source_protect_hbook.pdf.

[183] *See* EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-22, 0-23 fig.0.5; PETER FLINKER, R.I. DEP'T OF ENVTL. MGMT., THE NEED TO REDUCE IMPERVIOUS COVER TO PREVENT FLOODING AND PROTECT WATER QUALITY, 6 (2010), *available at* http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/imperv.pdf.

[184] *See, e.g.*, EPA, NATIONAL MANAGEMENT MEASURES, *supra* note 110, at 0-21 to 0-27; RANDOLPH, *supra* note 116, at 363, 373; Flinker, *supra* note 183, at 4–6.

[185] *See supra* note 183.

[186] *See* Charles Todd Schartung, A Study of Severe Repetitive Loss Flooding: Identifying Costs, Risks, Vulnerable Populations, Community Values and Response Through a Natural Hazards System Model 5 (2010) (unpublished Ph.D. dissertation, University of Louisville) (on file with author).

[187] *See* AMERICAN RIVERS, ET AL., *supra* note 116, at 11; Glicksman & Coggins, *supra* note 154, at 75. *See generally* PATRICK ET AL., *supra* note 154.

resist simple modeling and certainty about effects.[188] Thus, we cannot predict with accuracy the likely impacts of a combined, interactive mix of: ever-changing land development patterns; impervious cover ratios and locations; precipitation amounts, rates, and timing; extreme weather events; surface vegetation patterns; temperature; aquifer structure and morphology; streamflows; the structures of stream channels and banks; water usage rates and quantities and the relative water-usage portions/percentages of surface water and groundwater; and other conditions.

Sixth, these last several points tell us that the impacts of impervious cover and urban runoff are felt discontinuously or remotely in space and time—far downstream and well into the future. Indeed, as Robin Craig has warned us, the often-forgotten endpoint of our unsustainable land use and water practices are the oceans, which ultimately receive the cumulative and synergistic impacts of many upstream and already-made choices.[189] The nonlinear temporal and spatial discontinuities between problem causes and effects are typical of nonpoint source pollution and runoff issues, such as the large hypoxia zone in the Gulf of Mexico.[190] However, if we work forward instead of backward and start with the unsustainable causes of environmental problems to assess their effects, instead of starting with environmental problems to identify their unsustainable causes, we see that a variety of actions and practices are interacting with one another to produce a variety of problems that are interconnected although often in nonlinear relationships.

Finally, there are no simple solutions. Simply reducing the amount of impervious cover will not be sufficient to reduce all of the human-generated or human-enhanced runoff from sites. This "solution" does not necessarily provide for green infrastructure or conserve natural features that aid in managing precipitation from major storm events.[191] It may

---

[188] *See* JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES: CASES AND MATERIALS 397–411 (4th ed. 2006) (section on "Hydrogeology and Informational Limits" in chapter on groundwater).

[189] Robin K. Craig, *Climate Change, Regulatory Fragmentation, and Water Triage*, 79 U. COLO. L. REV. 825, 825–27, 831 (2008).

[190] Ruhl & Salzman, *supra* note 7, at 86–88.

[191] *See, e.g.*, ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 141–57 (discussing various types of green infrastructure and the positive impact such use is having on the environment and the community); THE TRUST FOR PUB. LAND, *supra* note 182, *passim*; Nancy Stoner & Alexandra Dapolito Dunn, *From Rooftops to Rivers: Green Infrastructure Yields Economic and Environmental Benefits*, AM. PUB. WORKS ASS'N REP., Feb. 2008, at 1–5, *available at* http://www.apwa.net/publications/reporter/reporteronline/index.asp?DISPLAY=ISSUE&ISSUE_DATE=022008&ARTICLE_NUMBER=1691 (discussing the barriers faced when implementing green infrastructure); *Managing Wet*

conflict with other goals such as transportation connectivity, pedestrian walkability, or emergency-vehicle access.[192]

Alternatively, focusing on site design with green infrastructure features to retain, store, and filter waters and pollutants on-site, such as rain gardens, vegetated bioswales, vegetated channels, and green roofs,[193] will help. However, this method is an inadequate substitute for larger-scale watershed features, such as wetlands, forests, vegetated riparian zones, aquifer recharge zones, karst geology, instream flows, and natural stream meanders.[194] These larger features contribute to overall watershed structure and hydrologic dynamics that cannot be merely replicated in small-scale, site-specific features.[195] These larger features also provide a variety of ecological functions, including habitat for species and moderation of temperatures and climate.[196] Moreover, the water storage functions (e.g., flood control) and water filtration functions (e.g., pollution removal) of these various watershed features are interrelated but do not operate in the same way, at the same rate, or at the same capacity.[197] Natural and/or

---

Weather with Green Infrastructure, U.S. ENVTL. PROT. AGENCY (last visited Apr. 3, 2011), http://cfpub.epa.gov/npdes/home.cfm?program_id=298.

[192] *See, e.g.*, REID EWING, SMART GROWTH NETWORK, PEDESTRIAN- AND TRANSIT-FRIENDLY DESIGN: A PRIMER FOR SMART GROWTH, *passim* (1999), *available at* http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf (emphasizing transit and pedestrian infrastructure); NEIGHBORHOOD STREETS PROJECT STAKEHOLDERS, NEIGHBORHOOD STREET DESIGN GUIDELINES: AN OREGON GUIDE FOR REDUCING STREET WIDTHS, 2 (2000), http://www.oregon.gov/LCD/docs/publications/neighstreet.pdf?ga=t (acknowledging legitimate concerns of emergency service providers to proposed standards for narrower streets).

[193] *See, e.g.*, *Consensus Agreement on Model Development Principles to Protect Our Streams, Lakes, and Wetlands*, CTR. FOR WATERSHED PROT. (1998), *available at* http://www.cwp.org/documents [hereinafter Site Planning Roundtable]; PROGRAMS AND PLANNING DIV., PRINCE GEORGE'S CNTY., MD. DEP'T OF ENVTL. RES., LOW-IMPACT DEVELOPMENT DESIGN STRATEGIES: AN INTEGRATED DESIGN APPROACH 4-21 to 4-22 (1999), *available at* http://www.lowimpactdevelopment.org/pubs/LID_National_Manual.pdf. *See generally* ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 102–20 (discussing the benefits and different types of low-impact development).

[194] *See, e.g.*, ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 57–100 (chapter addressing the characteristics, steps, and barriers of large-scale watershed planning); NAT'L ASS'N OF LOCAL GOV'T ENVTL. PROF'L ET AL., SMART GROWTH FOR CLEAN WATER: HELPING COMMUNITIES ADDRESS THE WATER QUALITY IMPACTS OF SPRAWL 8–10 (2003), *available at* http://www.nalgep.org/publications/PublicationsDetail.cfm?LinkAdvID=42157.

[195] *See, e.g.*, DAVENPORT, *supra* note 117, at 25; NAT'L RES. COUNCIL, *supra* note 107, at 42–43; OTTO ET AL., *supra* note 116, at 20; THORP ET AL., *supra* note 170, at 1–7.

[196] *See, e.g.*, POSTEL & CARTER, *supra* note 119.

[197] *See, e.g.*, NAT'L RESEARCH COUNCIL, *supra* note 107, at 42–43; OTTO ET AL., *supra* note 116, at 19–20; Arnold, *Clean-Water Land Use*, *supra* note 116, at 315–16.

human disturbances can change the characteristics, processes, and functions of these ecological features in ways that do not simply revert to the original features when the disturbances cease or restoration activities are undertaken. For example, recent ecological research on the Everglades suggests that variations in water flows to the Everglades—not only deprivations of traditional flows but also increased flows as part of intended releases and as part of wet years and seasons—have altered the basic levels of peat, topography, and other ecological functions such that merely restoring water flows will not recreate the historic Everglades ecology.[198] A different kind of ecosystem is emerging.[199] In short, due to the complexity of ecological systems and human or societal interrelationships with ecological systems, it will simply not work to select single—unimodal or uniform—solutions that are disconnected from their complex and multiple likely effects.

D. More Layers of Complexity: Climate Change as it Relates to Land and Water

Climate change is adding layers of complexity to the relationships between our land and water actions, complicating our environmental problems even further. Our land use patterns contribute to climate change.[200] Our low-density sprawling form of development, facilitated by a vast vehicular transportation infrastructure, produces relatively high amounts of vehicle miles traveled ("VMT"), which in turn produce carbon emissions.[201] According to 2005 figures, one-third of all U.S. carbon emissions came from transportation, and fifty-seven percent of this transportation-related share was attributable to trips in automobiles, sports utility vehicles, and light trucks.[202] The effects of continued sprawl have been estimated as essentially offsetting most or all decreases in carbon emissions resulting from increased fuel efficiency.[203] The energy consumption of the built environment

---

[198] Christa L. Zweig & Wiley M. Kitchens, *The Semiglades: The Collision of Restoration, Social Values, and the Ecosystem Concept*, 18(2) RESTORATION ECOLOGY 138, 140–41 (2010), *available at* http://aquaticcommons.org/4673/1/ZweigandKitchensRestEco2009.pdf.
[199] *Id.* at 138–41.
[200] Alice Kaswan, *Climate Change, Consumption, and Cities*, 36 FORDHAM URB. L.J. 253, 258–59 (2009).
[201] *Id.*
[202] MARILYN A. BROWN ET AL., SHRINKING THE CARBON FOOTPRINT OF METROPOLITAN AMERICA 8 & fig.2 (2008), *available at* http://www.brookings.edu/~/media/Files/rc/reports/2008/05_carbon_footprint_sarzynski/carbonfootprint_report.pdf. The remaining portion is attributable to freight trucks, buses, and air, water, and rail transportation. *Id.*
[203] REID EWING ET AL., GROWING COOLER: THE EVIDENCE ON URBAN DEVELOPMENT AND CLIMATE CHANGE 2–4 & fig.1–2 (Urb. Land. Inst. ed., 2007).

also contributes to greenhouse gas emissions. In fact, thirty-nine percent of the nation's carbon emissions are attributable to energy usage by buildings.[204] Energy consumption occurs in both the construction and use of new buildings.[205] Furthermore, land uses and development alter land and surface cover, which serve as carbon sinks.[206] Both soils and vegetation, including trees, sequester various greenhouse gases, which are released when soils are disturbed and vegetation is killed or removed.[207]

One of the more problematic crises that is looming has to do with the vast amount of privately owned forests, which are beginning to be taken out of timber and planned for land development.[208] Forests play a critical role in carbon sequestration, as well as moderation of the impacts of climate change.[209] However, any economic benefits of maintaining

---

[204] BROWN ET AL., *supra* note 202, at 9–10. Of this figure, a little over half is attributable to residential buildings, with commercial and institutional buildings making up the rest.

[205] *See* PARTNERSHIP FOR A GREEN CITY CLIMATE ACTION REPORT 64 (2009) [hereinafter PARTNERSHIP FOR A GREEN CITY] on the energy used in construction.

[206] Gregg Marland, et al., *The Climatic Impacts of Land Surface Change and Carbon Management, and the Implications for Climate-Change Mitigation Policy*, 3 CLIMATE POL'Y 149, 152 (2003).

[207] *Id.* at 151; NAT'L SCI. & TECH. COUNCIL, SCIENTIFIC ASSESSMENT OF THE EFFECTS OF GLOBAL CHANGE ON THE UNITED STATES: A REPORT OF THE COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES NATIONAL SCIENCE AND TECHNOLOGY COUNCIL 48 (2008), *available at* http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf [hereinafter SCIENTIFIC ASSESSMENT]. For example, a study in the journal *Science* uses empirical data and extrapolation to predict that dying vegetation from Hurricanes Katrina and Rita may release as carbon into the atmosphere equal to 50% to 140% of all the carbon that all the forests in the United States absorb for photosynthesis in a given year. Jeffrey Q. Chambers, et al., *Hurricane Katrina's Carbon Footprint on U.S. Gulf Coast Forests*, 318 SCI. 1107 (2007).

[208] *See* SUSAN M. STEIN ET AL., U.S. DEP'T OF AGRIC., GEN. TECH. REPORT PNW-GTR-636, FORESTS ON THE EDGE: HOUSING DEVELOPMENT ON AMERICA'S PRIVATE FORESTS 1 (2005), *available at* http://www.fs.fed.us/openspace/fote/fote-6-9-05.pdf; Christine A. Klein, *The New Nuisance: An Antidote to Wetland Loss, Sprawl, and Global Warming*, 48 B.C. L. REV. 1155, 1214 (2007); Michael J. Mortimer, *Private Property Rights and Selective Private Forest Conservation: Could a Nordic Hybrid Policy Address a United States Problem?*, 41 ENVTL. MGMT. 640, 640–41, 646, 648 (2008). However, despite urbanization's encroachment on forest lands, forest cover may actually have increased in some areas, particularly due to the conversion of agricultural land to second-growth forests, which are less ecologically diverse and structurally rich than primary forests. *See, e.g.*, REED F. NOSS ET AL., BIOLOGICAL RES., U.S. GEOLOGICAL SURVEY, ENDANGERED ECOSYSTEMS OF THE UNITED STATES: A PRELIMINARY ASSESSMENT OF LOSS AND DEGRADATION (1995), *available at* http://biology.usgs.gov/pubs/ecosys.htm.

[209] *See* Charlotte Streck et al., *Climate Change and Forestry: An Introduction*, *in* CLIMATE CHANGE AND FORESTS 4 (Charlotte Streck et al. eds., 2008); PETER BACKLUND ET AL., U.S. CLIMATE CHANGE SCIENCE PROGRAM, SYNTHESIS AND ASSESSMENT PRODUCT 4.3, THE EFFECTS OF CLIMATE CHANGE ON AGRICULTURE, LAND RESOURCES, WATER RESOURCES,

private forests for carbon sequestration purposes even under cap-and-trade programs or other ways of valuing mitigation land-uses could easily be outweighed by the economic benefits of developing these forests for residential communities.[210] People may seek to migrate away from rising coastlines, areas of increasing drought, and exceedingly hot urban or Southwestern micro-climates, and to places with environmental amenities, such as forest remnants or small conservation areas.[211] Current private forests may meet these development demands. It would be fairly typical of environmental and land use regulation to accede to timber companies' and developers' demands to be awarded significant credits or incentives to preserve only portions of the existing forests, as if development potential, rather than forest preservation, is the proper economic and regulatory baseline.

Water use contributes to climate change in the energy used to transfer water substantial distances.[212] Water use and runoff—with too little or too much water for the environment—can destroy carbon-sequestering vegetation and erode soils, releasing stored greenhouse gases into the atmosphere.[213] Water use practices facilitate sprawling, unsustainable

---

AND BIODIVERSITY IN THE UNITED STATES 86 (2008); SCIENTIFIC ASSESSMENT, *supra* note 207, at 135–36; TREE TRUST & BONESTROO, CITY TREES: SUSTAINABILITY GUIDELINES & BEST PRACTICES 10 (2007).

[210] *See, e.g.*, Univ. of Cal. Berkeley Ctr. for Forestry & the Pac. Forest Trust, *Fact Sheet: Problems of Loss*, CAL. FOREST FUTURES 2 (2005) (identifying economic land development pressures on private forests).

[211] On threats to coastal, urban, and arid areas, see for example, CONG. BUDGET OFFICE, POTENTIAL IMPACTS OF CLIMATE CHANGE IN THE UNITED STATES 7, 10–13 (2009) [hereinafter CBO, POTENTIAL IMPACTS].

[212] *See* Ashlynn Stillwell, Doctoral Candidate, Univ. of Tex. Cockrell Sch. of Eng'g, The Energy Water Nexus in Texas: An Overview and Case Study of Water Management via Thermoelectric Power Generation, Presentation in the Environmental and Water Resources Engineering Seminar Series (Sept. 16, 2010), *available at* http://www.ce.utexas.edu/ewre/documents/EWRE-Seminar_Stillwell_091610.pdf.

[213] *See, e.g.*, ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 9–11 (discussing effects of runoff on flooding, erosion, and vegetation); Henry D. Adams et al., *Temperature Sensitivity of Drought-Induced Tree Mortality Portends Increased Regional Die-Off Under Global-Change-Type Drought*, 106 PNAS 7063, 7063–64 (2009), *available at* http://www.pnas.org/cgi/doi/10.1073/pnas.0901438106 (follow "Full Text" hyperlink) (identifying the carbon release potential from drought-related vegetation die-off); Carol Franco et al., *Impacts of Urban Runoff on Native Woody Vegetation at Clark Reservation State Park, Jamesville, NY*, 5 URB. HABITATS 43, 43, fig.7 (2008), *available at* http://www.urbanhabitats.org/v05n01/runoff_full.html (discussing effects of urban runoff on tree mortality and soils); Julie C. Stromberg & Duncan T. Patten, *Riparian Vegetation Instream Flow Requirements: A Case Study from a Diverted Stream in the Eastern Sierra Nevada, California, USA*, 14 ENVTL. MGMT. 185, 185 (1990) (discussing effects of water diversions

development, which in turn generates substantial greenhouse gas emissions and elimination of carbon-sequestering landscape features.[214] Alterations of wetlands and riparian zones have multiple effects, creating far-reaching harms to watershed functioning that can be distant in time and space, while also diminishing these lands' sequestration of greenhouse gases and even releasing greenhouse gases into the environment.[215]

In addition to the contributions of land and water uses to climate change, climate change will affect land and water resources in the United States. Predicted changes in climate patterns will increase the intensity and severity of weather patterns, including the intensity of storm events and storm cycles, the incidence of extreme weather, and the length and intensity of periods of drought and precipitation.[216] These changes will likely widen floodplains and increase flooding during storm events.[217] They will heighten the effects of urban and suburban runoff.[218] They will create serious water shortages in some areas and create periods of water scarcity.[219] Infill development in our cities may run headlong into the effects of flooding, climate-related disasters, runoff patterns, and water scarcity. In particular, ongoing patterns of population growth and metropolitan development in the American Southeast, Southwest, and West are very likely to be affected by a disproportionate effect of climate change impacts.[220] Conflicts over water resources will likely increase, and demands

---

for urban supply from stream on riparian vegetation). For multiple interrelated effects of temperature, precipitation, land and water alterations, erosion, and net carbon uptake, see for example, SCIENTIFIC ASSESSMENT, *supra* note 207, at 9.

[214] On water use's contribution to sprawl see for example, 10,000 FRIENDS OF PA., *supra* note 135; Tarlock, *supra* note 136, at 66; Thompson, *supra* note 136, at 96. On sprawl's contribution to climate change see for example, EWING ET AL., GROWING COOLER, *supra* note 203, at 3–4.

[215] Fred Bosselman has identified wetlands as a target for biofuels, greenhouse gas sequestration, and management of greenhouse gas emissions. Fred Bosselman, *Planning for a Bull Market for Wetlands*, 61 PLAN. & ENVTL. L. 3, 3 (2009). On the degradation from the alteration of watersheds and riparian lands, see for example, BACKLUND ET AL., *supra* note 209, at 8.

[216] CBO, POTENTIAL IMPACTS, *supra* note 211, at 5–7, 10–13; SCIENTIFIC ASSESSMENT, *supra* note 207, at 5.

[217] CBO, POTENTIAL IMPACTS, *supra* note 211, at 10–11, 13; SCIENTIFIC ASSESSMENT, *supra* note 207, at 13–14.

[218] CBO, POTENTIAL IMPACTS, *supra* note 211, at 12–13; SCIENTIFIC ASSESSMENT, *supra* note 207, at 12–13.

[219] CBO, POTENTIAL IMPACTS, *supra* note 211; SCIENTIFIC ASSESSMENT, *supra* note 207, at 12–13.

[220] CBO, POTENTIAL IMPACTS, *supra* note 211, at 12–13; SCIENTIFIC ASSESSMENT, *supra* note 207, at 12–13.

for transbasin transfers of water also will likely increase. In any event, while total average annual rainfall will increase in some areas and decline in some areas, most communities will experience less certainty regarding water supplies and flooding and more extreme conditions overall.[221] Furthermore, some parts of the nation, particularly in the West and Southwest, are predicted to experience significant reductions in water supplies due to decreased precipitation, decreased percentages of precipitation falling as snow, and earlier snowmelts, all of which will alter society's capacity to use water according to current patterns.[222] Coastal areas will experience significant sea level rise,[223] but will likely find their groundwater sources of drinking water contaminated from saltwater intrusion even before large amounts of coastal lands are lost to ocean levels.[224] Moreover, some predictions include greater numbers and intensities of hurricanes, which will create destruction to human communities and possibly alter spatial distributions of people and migration patterns.[225]

Climate change will increase average temperature in many areas, which will pose public health planning and response issues.[226] Demands for energy consumption to cool buildings will increase, as will demands for water consumption for pools, lawns and landscape maintenance, and human cooling.[227] Higher temperatures will exacerbate the heat island effect in built environments, particularly central cities (which will likely experience a larger temperature rise than global temperature rise generally).[228]

---

[221] CBO, POTENTIAL IMPACTS, *supra* note 211, at 5–7; SCIENTIFIC ASSESSMENT, *supra* note 207, at 12–13.
[222] CBO, POTENTIAL IMPACTS, *supra* note 211, at 7, 10, 13; SCIENTIFIC ASSESSMENT, *supra* note 207, at 12–13.
[223] CBO, POTENTIAL IMPACTS, *supra* note 211, at 10–11; SCIENTIFIC ASSESSMENT, *supra* note 207, at 6–7.
[224] CBO, POTENTIAL IMPACTS, *supra* note 211, at 13; Robin Kundis Craig, *Adapting Water Law to Public Necessity: Reframing Climate Change Adaptation as Emergency Response and Preparedness*, 11 VT. J. ENVTL. L. 709, 724 (2010).
[225] CBO, POTENTIAL IMPACTS, *supra* note 211, at 10; SCIENTIFIC ASSESSMENT, *supra* note 207, at 7, 13. On the pressures of climate change on population migration in the U.S., see for example, SCIENTIFIC ASSESSMENT, *supra* note 207, at 13.
[226] *See* Ann E. Carlson, *Heat Waves, Global Warming, and Mitigation*, 26 UCLA J. ENVTL. L. & POL'Y 169, 171–73, 176 (2008); Lisa Heinzerling, *Climate Change, Human Health, and the Post-Cautionary Principle*, 96 GEO. L.J. 445, 447 (2008).
[227] *See* Carlson, *supra* note 226, at 207–09; Matthew D. Zinn, *Adapting to Climate Change: Environmental Law in a Warmer World*, 34 ECOLOGY L.Q. 61, 69 (2007). However, net energy use may be lower because warmer temperatures overall may reduce energy demand for heating in the winter, which consumes more energy than summer cooling uses of energy. CBO, POTENTIAL IMPACTS, *supra* note 211, at 13.
[228] *See* Carlson, *supra* note 226, at 213–14.

The increased number of days with warmer temperatures may combine with air pollution dynamics to reduce overall air quality in many areas.[229] Sprawl may be stimulated even further than it currently is by people seeking to move away from the heat of the city to the "cool countryside."

Climate change will alter the composition (variety, numbers, and proportions) of tree species in forests and native landscapes.[230] Climate change may reduce the resilience of forests to various stresses and increase their exposure to tree-harming pests.[231] Increased flooding, drought, and fire from climate change could kill a substantial number of trees.[232] Indeed, the carbon sequestration benefits of tree planting and tree conservation policies could be offset, perhaps even entirely negated, by the release of greenhouse gases from trees dying due to extreme flood, fire, and wind-storm events associated with climate change.[233] In addition, as discussed above, human migration patterns from other effects of climate change on existing built environments could create substantial demand to convert privately owned forest lands into developed communities, particularly as timber production in the United States shifts overseas, primarily to Southeast Asia.[234]

Climate change will likely affect the composition, range, yield, and production of agricultural crops and livestock.[235] Various models for the United States show climate change causes northward shifts in zones of agricultural production.[236] The impacts of agriculture on runoff and nonpoint source pollution, erosion, soil depletion, removal of native or existing vegetation and landscape features, use of chemicals, demand for water for irrigation, and other such impacts could shift in location from already impacted areas to new areas of impact.[237] In addition, there may be a rise in demand for irrigation for crops and livestock during periods of

---

[229] CBO, POTENTIAL IMPACTS, *supra* note 211, at 13; SCIENTIFIC ASSESSMENT, *supra* note 207, at 15.
[230] *See* BACKLUND ET AL., *supra* note 209, at 7–8.
[231] *See* CBO, POTENTIAL IMPACTS, *supra* note 211, at 12; BACKLUND ET AL., *supra* note 209, at 7–8, 146, 167–169.
[232] *Id.* at 12; BACKLUND ET AL., *supra* note 209, at 7–8, 145–46.
[233] *See* Chambers et al., *supra* note 207, at 1107.
[234] *See generally* Keith Andrew Bettinger, *A Forest Falls in Cambodia*, ASIA TIMES ONLINE (2005), http://www.atimes.com/atimes/southeast_asia/ga06ae01.html; STEIN ET AL., *supra* note 208.
[235] *See* CBO, POTENTIAL IMPACTS, *supra* note 211, at 11–12; SCIENTIFIC ASSESSMENT, *supra* note 207, at 11.
[236] *See* CBO, POTENTIAL IMPACTS, *supra* note 211; SCIENTIFIC ASSESSMENT, *supra* note 207, at 11–12.
[237] *See generally* SCIENTIFIC ASSESSMENT, *supra* note 207.

drought, increases in agricultural pest infestations, and changes in crop yields.[238] It remains to be seen whether efforts at environmentally and socially sustainable agricultural practices, such as organic farming and the locally grown foods movement, can adapt to changing climate conditions and their effects.

More generally, climate change will alter the overall ecological functions and resiliency, the biodiversity, and the life cycles, distribution, and ranges of species in our landscapes.[239] One problem will be the northward spread of disease-carrying insects, which will likely stimulate public demand for using harmful chemicals to control their populations.[240] Watershed functions and processes will be altered, increasing the number, variety, and intensity of stresses on them in ways that are more than merely cumulative.[241]

Demands for alternate energy sources—biofuels, wind energy, geothermal power, hydropower, solar energy, and so forth—will likely change landscapes and affect water uses, levels, and flows.[242] Competition among various types of energy use, water use, and land use will be heightened and further complicated as climate conditions change.[243]

E. Policy Super-Jungles of Policy Jungles

The many impacts of land and water use on climate change and impacts of climate change on land and water use illustrate the complexity and interconnectedness of the environmental problems that we face. J.B. Ruhl and Jim Salzman have created a very helpful typology of massive

---

[238] See CBO, POTENTIAL IMPACTS, *supra* note 211, at 11–12; SCIENTIFIC ASSESSMENT, *supra* note 207, at 11.
[239] CBO, POTENTIAL IMPACTS, *supra* note 211, at 11; SCIENTIFIC ASSESSMENT, *supra* note 207, at 9. *See generally* BACKLUND ET AL., *supra* note 209, at 151–81.
[240] BACKLUND ET AL., *supra* note 209, at 167–69; SCIENTIFIC ASSESSMENT, *supra* note 207, at 130, 142; Heinzerling, *supra* note 226, at 447.
[241] *See* BACKLUND ET AL., *supra* note 209, at 109–10, 112, 119–20; SCIENTIFIC ASSESSMENT, *supra* note 207, at 12–13.
[242] *See, e.g.*, SCIENTIFIC ASSESSMENT, *supra* note 207, at 16–17; Mary Jane Angelo, *Corn, Carbon and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 GEO. MASON L. REV. 593, 637, 640 (2010); John R. Nolon, *Shifting Ground to Address Climate Change: The Land Use Law Solution*, 10 N.Y. ST. B.A. GOV'T, L. & POL'Y J. 23, 28 (2008); Todd Woody, *Tree Deal Revives Southwest Desert Solar Plan*, L.A. TIMES (Feb. 14, 2010), http://articles.latimes.com/2010/feb/14/business/la-fi-solar-water14 -2010feb14; Stillwell, *supra* note 212.
[243] *See, e.g.*, A. Dan Tarlock, *Water Demand and Energy Production in a Time of Climate Change*, 5 ENVTL. & ENERGY L. & POL'Y J. 325.

environmental problems: 1) simple aggregation, in which things add up proportionately in all dimensions; 2) spaghetti bowl, in which different sources respond to different and potentially offsetting incentives; 3) feedback, in which different sources, causal mechanisms, or effects interact with one another; 4) discontinuity, which has large, often nonlinear spatial or temporal gaps between sources and impacts, and 5) policy jungle, which has all of these attributes mixed.[244] Climate change is their prototypical example of policy jungle.[245] However, as they acknowledge in their attempts to classify different massive environmental problems according to their typology, many of these problems are interconnected with one another.[246] Arguably, it is all a "policy jungle" out there. The problems at the intersection of land use, water, and climate change certainly illustrate this point. The complexities of climate change have complex relationships with the complexities of land use problems, both of which have complex relationships with the complexities of water resources issues.[247] Thus, we are trying to work our way through impenetrable policy super-jungles composed of intersecting policy jungles. There is no single autonomous rational policy maker or lawmaker that is solving these problems. Instead, the aggregate of many actors, organizations, institutions, subsystems, and systems are responding to these conditions, attempting to adapt. Sociolegal emergence occurs in the policy super-jungles. One direction in which the environmental law system may evolve—or perhaps more accurately devolve—is towards unimodal and fragmented responses. Alternatively, the environmental law system may evolve towards multimodal and integrationist responses.

III. UNIMODAL FRAGMENTED RESPONSES: FORCES AND INADEQUACIES

The combination of integration and multimodality will not be easy to achieve. It runs counter to human tendencies to either: a) seek out new models or uniform methods of addressing complex problems that we attempt to simplify, or b) engage in ad hoc and fragmented uses of different methods and modes as available or contextualized, without any real integration of these methods or modes. As we have begun to grasp the characteristics of interrelated problems like climate change, unsustainable

---

[244] Ruhl & Salzman, *supra* note 7, at 80.
[245] *Id.* at 88–90.
[246] *Id.* at 88.
[247] *See supra* Part III.B–D.

land use patterns and practices, water quality degradation, and the consumptive uses and alterations of our waters, we have become increasingly aware of just how much environmental law and related fields are dominated by fragmented and unimodal methods.[248] Environmental law is evolving in the context of fragmented unimodality, which both operates as a competing or resistant force to integrationist and multimodal responses and also creates systemic demand and opportunity for the emergence of integrationist multimodality.[249]

A. The Allure of Unimodal Responses

People individually and collectively are drawn to unimodal responses to complex social problems. Many different labels describe unimodal responses: model solution, uniform or model code, optimal instrument or design, master plan, single method, standard operating procedure, habitual practice, standardized technique, foundational methodology, unitary or singular vision, united approach, preferred or favored policy, one-size-fits-all solution, the-right-answer, simple rule or answer, off-the-shelf policy, ideal response, panacea, and cure-all.[250] While some of these terms

---

[248] *See, e.g.*, Holly Doremus, *Crossing Boundaries: Commentary on "The Law at the Water's Edge," in* WET GROWTH, *supra* note 136, at 271; LAZARUS, *supra* note 65, at 29–42; WALTER A. ROSENBAUM, ENVIRONMENTAL POLITICS AND POLICY 103–07 (6th ed. 2005); William W. Buzbee, *Recognizing the Regulatory Commons: A Theory of Regulatory Gaps*, 89 IOWA L. REV. 1, 6 (2003); Freeman & Farber, *supra* note 33, at 809–10; Ruhl & Salzman, *supra* note 7, at 68–72; Zinn, *supra* note 227, at 83.

[249] Holly Doremus characterizes the rejection of unimodal centralized governance and the alternate use of networks and new governance structures to link fragmented institutional structures as "optimal fragmentation," which is quite similar to the integrationist multimodality concepts discussed *supra* Part II.C. Holly Doremus, *CALFED and the Quest for Optimal Institutional Fragmentation*, 12 ENVTL. SCI. & POL'Y 729, 730 (2009). However, she concludes that CALFED, which is the collaborative multi-participant, multi-jurisdictional effort to allocate water and restore ecosystems in the California Bay-Delta, did not produce optimal fragmentation, because it did not create any mechanism for making water tradeoffs and resolving conflicts over water resources. *Id.* at 731.

[250] *See, e.g.*, Camacho, *Regulation*, *supra* note 43, at 348 n.321 (off-the-shelf habitat conservation plan templates); Flatt, *supra* note 41, at 126 ("best" legislation); Ruth Meinzen-Dick, *Beyond Panaceas in Water Institutions*, 104 PNAS 15200, 15200 (2007) (panaceas); Rachlinski & Farina, *supra* note 41, at 307 (optimal institutional design); B. Suzi Ruhl & Jeffrey Roseman, *Locking in Environmental Risk: A Model Environmental and Health Assessment Baseline Ordinance*, 9 J. LAND USE & ENVTL. L. 307, 307–08 (1994) (model); Ruhl & Salzman, *supra* note 7, at 106 ("uniform one-size-fits-all"); Wiener & Richman, *supra* note 41 (optimal mechanism); Site Planning Roundtable, *supra* note 193 (model principles). Here, I am using the term "model" in its sense as a prescriptive template of actions, regulations, management methods, or solutions that is offered for a particular

have negative connotations in a society that recognizes the complexity of social and environmental problems and has experienced the inadequacies of promised singular solutions, the tendency to propose or adopt unimodal solutions to problems runs deep in human nature and social dynamics.

Psychological forces facilitate unimodality. Humans have limited cognitive capacity, or bounded rationality, and therefore use heuristics—mental shortcuts—to mentally process information and stimuli.[251] Given these cognitive limits to the human ability to comprehend highly complex and uncertain phenomena, such as the multidimensional environmental problems discussed in this article, we have the tendency to simplify problems and to seek simple or simplified solutions.[252] These cognitive coping mechanisms intersect with framing effects. Each person has mental schema that shape the way in which he or she perceives the world (e.g., experiences, situations, information, stimuli), which has a strong effect on the way in which he or she frames any particular problem, which in turn has a strong effect on the way in which he or she frames the solution to a particular problem.[253] Thus, for example, if one is predisposed to frame climate change as a problem of vehicular greenhouse gas emissions, he or she may be likely to favor unimodal solutions that focus on transportation policy or vehicular emissions reduction. In contrast, if one sees climate change as a problem of industrialized nations' consumption patterns, he or she is more likely to advocate global governance or cultural reform solutions. Furthermore, if one sees climate change as presenting problems of sea level rise, coastal erosion, and increased frequency and intensity of hurricanes, the favored solution will involve coastal management and protection. A particular framing bias that is prevalent among people involved

---

problem, instead of its sense as a representation of real-world phenomena that are used in predicting effects of particular actions or decisions. *See* Robert L. Glicksman, *Bridging Data Gaps through Modeling and Evaluation of Surrogates: Use of the Best Available Science to Protect Biological Diversity Under the National Forest Management Act*, 83 IND. L.J. 465, 477–79, 490 (2008).

[251] *See generally* JAMES G. MARCH, DECISIONS AND ORGANIZATIONS (1988); JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES (Daniel Kahneman et al. eds., 1982); Charles E. Lindblom, *The Science of "Muddling Through,"* 19 PUB. ADMIN. REV. 79 (1959). With respect to some commonly used heuristics to oversimplify or avoid climate change problems, see Lazarus, *Super Wicked*, *supra* note 41, at 1173–79.

[252] *See* BILL JENSEN, SIMPLICITY: THE NEW COMPETITIVE ADVANTAGE IN A WORLD OF MORE, BETTER, FASTER 16 (2000).

[253] *See, e.g.*, Barbara Gray, *Framing of Environmental Disputes*, *in* MAKING SENSE OF INTRACTABLE ENVIRONMENTAL CONFLICTS: FRAMES AND CASES 11 (Roy J. Lewicki et al. eds., 2003); Amos Tversky & Daniel Kahneman, *The Framing of Decisions and the Psychology of Choice*, 211 SCI. 453, 453 (1981).

in addressing environmental, land use, natural resources, and related problems is rational scientific or problem-solving thinking: the rational identification of a discrete problem, comprehensive gathering and processing of data, systematic and rational identification of an optimal solution, and implementation of the solution.[254] While scientists, planners, and environmental policy specialists have come to identify the inadequacies of this way of thinking and addressing problems under complex, uncertain, and dynamic conditions,[255] the ingrained way of thinking is hard to overcome. Finally, humans have a basic fear of complexity, chaos, and the unknown or unknowable.[256] We find unimodal solutions to be comforting in the face of overwhelmingly complex and uncertain problems,[257] and these solutions' inadequacies may not become apparent until some later point in time, when a different unimodal solution is offered as the solution *du jour*.

Socio-structural forces favor unimodality. One phenomenon is the well-theorized and well-documented social force of specialization or

---

[254] *See, e.g.*, Rebecca M. Bratspies, *Regulatory Trust*, 51 ARIZ. L. REV. 575, 608–10 (2009) (describing the scientific-rational-technocratic foundations of environmental regulation in Progressive Era framing of government regulation); Glicksman, *supra* note 250, at 466, 468–69 (considering the use of models and the best available scientific data in making environmental and natural resources management decisions); A. Dan Tarlock, *Slouching Toward Eden: The Eco-Pragmatic Challenges of Ecosystem Revival*, 87 MINN. L. REV. 1173, 1173, 1207–08 (2003) (discussing the scientific rationality paradigm of environmental law and process-based attacks on it); A. Dan Tarlock, *A First Look at a Modern Legal Regime for a "Post-Modern" United States Army Corps of Engineers*, 52 U. KAN. L. REV. 1285, 1294 (2004) (noting that rational science is still the dominant decision making paradigm of the U.S. Army Corps of Engineers).

[255] SIDNEY A. SHAPIRO & ROBERT L. GLICKSMAN, RISK REGULATION AT RISK: RESTORING A PRAGMATIC APPROACH 22–23 (2003); Bratspies, *supra* note 254, at 578 (discussing throughout the article issues of the legitimacy of regulatory decisions in the context of uncertainty); Holly Doremus, *Constitutive Law and Environmental Policy*, 22 STAN. ENVTL. L.J. 295, 319 (2003); Glicksman, *supra* note 250, at 469–71, 479–82; Lindblom, *supra* note 251; Ruhl & Salzman, *supra* note 7, at 59, 62, 64–65 (analyzing throughout the article environmental problems of such complexity, uncertainty, and nonlinear dynamics as to evade comprehensive, rational, scientific problem-solving). An alternative "scientific" way of thinking about complex problems is to recognize and embrace uncertainty, complexity, change, and bounded human cognitive capacity by using trial-and-error scientific methods of adaptive management. *See generally* HOLLING ET AL., *supra* note 25.

[256] *See* Holly Doremus & Michael Hanemann, *The Challenges of Dynamic Water Management in the American West*, 26 UCLA J. ENVTL. L. & POL'Y 55, 56, 61–64, 70–75 (2007); Holly Doremus, *Takings and Transitions*, 19 J. LAND USE & ENVTL. L. 1, 4, 22–23 (2003); Holly Doremus, *The Endangered Species Act: Static Law Meets Dynamic World*, 34 WASH. U. J. L. & POL'Y 175, 175–77.

[257] *See* Doremus & Hanemann, *The Challenges of Dynamic Water Management*, *supra* note 256, at 62.

differentiation in society.[258] Specialists—professionally, within organizations, as institutional actors—obtain, secure, and enhance their roles and functions by mastering a particular methodology or mode of response to a particular problem or problem manifestation, often to the exclusion of considering related problems, other aspects of the problem, or other methods or modes of response.[259] The expert in the government regulation of surface-water toxics may give limited consideration to land-use planning, market-based instruments, or even other kinds of water degradation. The structural organization of specialization in society tends to produce "silos" of specialists and organizations that face constraints to cross-specialty cooperation.[260] Alternatively, the phenomenon of institutional or organizational isomorphism is that institutions or organizations tend to mimic one another, producing a convergence on a single way of doing things, due to coercive forces (e.g., regulation, public opinion, litigation), mimetic forces (e.g., imitation of other entities as a cost-minimization strategy), and normative forces (e.g., professional or industry standards, best practices, conventional wisdom).[261] Finally, a model can play a culturally communicative role as a symbol or means of communicating goals, values, and norms in society or a sector of society.[262]

Political forces can contribute to unimodality in several ways. Interest groups may form and thrive around a particular mode of policy

---

[258] *See generally* Max Weber's well-known analysis of bureaucracy in MAX WEBER, ECONOMY AND SOCIETY: AN OUTLINE OF INTERPRETIVE SOCIOLOGY 956–1005 (Guenther Roth & Claus Wittich, eds., 1978) (1922).

[259] *See, e.g.*, ALI FARAZMAND, HANDBOOK OF BUREAUCRACY 364 (1994).

[260] *See, e.g.*, MICHAEL A. DIAMOND & SETH ALLCORN, PRIVATE SELVES IN PUBLIC ORGANIZATIONS: THE PSYCHODYNAMICS OF ORGANIZATIONAL DIAGNOSIS AND CHANGE 49–156, 166–67 (2009); Fiona McKenzie, *Informing Regional Policy: Using a Regional Atlas to Develop Shared Understanding*, *in* PARTICIPATION AND GOVERNANCE IN REGIONAL DEVELOPMENT: GLOBAL TRENDS IN AN AUSTRALIAN CONTEXT 249, 249 (Robyn Eversole & John Martin, eds., 2005).

[261] *See, e.g.*, Mark B. Milstein et al., *Coercion Breeds Variation: The Differential Impact of Isomorphic Pressures on Environmental Strategies*, *in* ORGANIZATIONS, POLICY, AND THE NATURAL ENVIRONMENT: INSTITUTIONAL AND STRATEGIC PERSPECTIVES 151, 152–53 (Andrew J. Hoffman & Marc J. Ventresca eds., 2002); Paul J. DiMaggio & Walter W. Powell, *The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields*, 48 AM. SOC. REV. 147, 147–48 (1983); Rachel Ashworth et al., *Escape from the Iron Cage? Organizational Change and Isomorphic Pressure in the Public Sector*, 19 J. PUB. ADMIN. RES. & THEORY 165, 165 (2007).

[262] *See, e.g.*, SETHA M. LOW, ON THE PLAZA: THE POLITICS OF PUBLIC SPACE AND CULTURE 48–49 (2000). *See generally* Robert V. Wells, *The Nature of Meaning: The Role of the Trial Lawyer in Creating and Shaping Meaning*, 32 AM. J. TRIAL ADVOC. 297, 300–10 (2008).

solution, and government agencies may be directly or indirectly influenced by interest groups to favor a particular policy or instrument.[263] Likewise, policy entrepreneurs gain power and influence by advancing a particular policy proposal or mode of solution to a public problem.[264] Unimodal responses may result from existing stakeholders' resistance to redistribution of power and resources that would come from more multimodal responses or from merely symbolic responses to complex problems.[265] The power of "sound bites" in the media's communication of political activity favors unimodal policies and responses; complex, multimodal responses do not reduce well to "sound bites," therefore making it harder for political leaders or groups to obtain political credit for "solutions."[266]

Economic forces incentivize unimodal solutions. Model responses to problems that are off-the-shelf, one-size-fits-all, or quick-and-easy-to-implement may reduce costs to users and maximize the use of limited resources over alternatives that call for multiple modes of response and more complex coordination and administration.[267] Likewise, unimodal responses may be efficient or even necessary responses, given the availability of resources, such as funding, expertise, information, or tools.[268] Moreover, firms and individuals can capture or create value by developing and advancing unitary models, programs, or methods.

Finally, *ethical or normative forces* may facilitate unimodal responses. Hierarchical thinking in moral judgment and development can favor the moral or normative superiority of a particular policy solution or mode.[269] Conversely, multimodality in the area of environmental protection, which has substantial but contested ethical or normative content, can invite distrust—too many compromises, too little environmental

---

[263] *See, e.g.*, JOHN W. KINGDON, AGENDAS, ALTERNATIVES, AND PUBLIC POLICIES 125–26 (1984); William P. Browne, *Organized Interests and Their Issue Niches: A Search for Pluralism in a Policy Domain*, 52 J. POL. 477, 477 (1990).
[264] Kingdon, *supra* note 263, at 129–30.
[265] *See, e.g.*, Lach et al., *supra* note 56.
[266] On the relationships between "sound bites" and unimodality see for example, Demetrios Argyriades, *Good Governance, Professionalism, Ethics and Responsibility*, 72(2) INT'L REV. ADMIN. SCI. 155 (2006).
[267] *See* Camacho, *Regulation*, *supra* note 43, at 348; Glicksman, *supra* note 250, at 477–79.
[268] *See, e.g.*, Glicksman, *supra* note 250, at 477–79.
[269] For hierarchical thinking about moral judgment see for example, LAWRENCE KOHLBERG, THE PHILOSOPHY OF MORAL DEVELOPMENT: MORAL STAGES AND THE IDEA OF JUSTICE (1981); LAWRENCE KOHLBERG ET AL., MORAL STAGES: A CURRENT FORMULATION AND A RESPONSE TO CRITICS (1983); LAWRENCE KOHLBERG, THE PSYCHOLOGY OF MORAL DEVELOPMENT: THE NATURE OF MORAL STAGES (1984).

protection, too much accommodation of the status quo.[270] Faith in human rationality to design and implement optimal solutions arguably also has a normative element.

B. The Pressures Towards Fragmentation

Despite the human and socio-legal temptation to develop and implement a comprehensive and unitary "silver bullet" solution to environmental problems, which is the tendency towards unimodality, the environmental law system also tends towards highly fragmented responses to environmental problems. The fragmentation of U.S. environmental law is well-known and well-documented.[271] The power, authority, and tools to address interconnected environmental problems are divided and dispersed across: 1) federal, state, and local governments; 2) jurisdictionally distinct state and local units of government that do not correspond to ecosystem geography; 3) legislative, executive, and judicial branches of government; 4) many different government agencies each with its own mission, culture, structure, and influences; 5) different statutes, statutory provisions, and regulatory programs that treat different media (e.g., air, water, biological species, waste) or even different aspects of a problem (e.g., point source pollution, non-point source pollution, agricultural sources, ambient water quality, watershed planning, wetland filling, aquatic restoration projects) differently; 6) different instruments and methods (e.g., endangered species' habitat regulations, conservation easement tax incentives, federal acquisition and management of ecologically sensitive lands); 7) public and private sectors; 8) formal and informal institutions.[272] Furthermore, different

---

[270] *See, e.g.*, JUDITH A. LAYZER, NATURAL EXPERIMENTS: ECOSYSTEM-BASED MANAGEMENT AND THE ENVIRONMENT 28–32 (2008). *See generally* George Cameron Coggins, *Of Californicators, Quislings, and Crazies: Some Perils of Devolved Collaboration*, *in* ACROSS THE GREAT DIVIDE: EXPLORATIONS IN COLLABORATIVE CONSERVATION AND THE AMERICAN WEST 163, 163–71 (Philip Brick et al. eds., 2001); David J. Sousa & Christopher McGrory Klyza, *New Directions in Environmental Policy Making: An Emerging Collaborative Regime or Reinventing Interest Group Liberalism?*, 47 NAT. RESOURCES J. 377 (2007); Annecoos Wiersema, *A Train Without Tracks: Rethinking the Place of Law and Goals in Environmental and Natural Resources Law*, 38 ENVTL. L. 1239 (2008).

[271] *See, e.g.*, Buzbee, *supra* note 248; Doremus, *Crossing Boundaries*, *supra* note 248; Freeman & Farber, *supra* note 33. *See also* Zygmunt J.B. Plater, *Environmental Law and Three Economies: Navigating a Sprawling Field of Study, Practice, and Societal Governance in Which Everything Is Connected to Everything Else*, 23 HARV. ENVTL. L. REV. 359, 359 (1999) (recognizing that the landscape of environmental law encompasses a wide range of problems or subjects, methodologies, and areas or sources of law).

[272] *See* Arnold, *Is Wet Growth Smarter*, *supra* note 110, at 10165–68; Rosenbaum, *supra* note 248, at 82–107, 140–44.

fields and professions frame the issues differently, creating even more fragmentation. For example, land use experts conceive of problems in a spatial dimension; water quality experts conceive of problems in terms of compositional quality; and water supply experts think primarily about quantities, directions, and flows.[273]

As with unimodality, fragmentation is a deeply human and social phenomenon. Fragmentation has foundations in *psychological forces*.[274] For example, one way to cope with limited cognitive capacity and overwhelmingly complex problems is to compartmentalize them with differentiated and contextualized solutions, response modes, policies, and programs for each different category of problem.[275] Likewise, while framing effects tend to lead an individual or group with common schema elements to select a problem response that matches the problem frame, the clustering of people in groups, organizations, and institutions with common frames that differ from those in other groups, organizations, and institutions can result in fragmented ways of conceptualizing problems and solutions between different collectivities of people.[276] Moreover, an adaptive psychological response to the cognitive dissonance that can result from holding multiple conflicting or at least competing goals at the same time is to compartmentalize different arenas for pursuit of different goals, such as a local land use regulatory system that facilitates sprawling land development and a federal environmental regulatory system that attempts to reduce or mitigate the adverse environmental impacts of sprawling land development.[277]

Fragmentation arises from *socio-structural forces*.[278] The previously mentioned trend towards specialization in modern society, combined

---

[273] *See* Arnold, *Is Wet Growth Smarter*, *supra* note 110, at 10164 (comparing the differentiated framing of land and water issues by experts in land use, water quality, and water supply).

[274] *See* Fischman, *Divides*, *supra* note 93, at 664–65.

[275] *See, e.g.*, *id.*; DIVERSITY IN THE KNOWLEDGE ECONOMY AND SOCIETY: HETEROGENEITY, INNOVATION AND ENTREPRENEURSHIP 247 (Elias G. Carayannis et al. eds., 2008); Heinz Mandl et al., *Misconceptions and Knowledge Compartmentalization*, *in* THE COGNITIVE PSYCHOLOGY OF KNOWLEDGE 161, 162, 170–71 (Gerhard Strube & Karl Friedrich Wender eds., 1993).

[276] *See generally* FRAMES OF PROTEST: SOCIAL MOVEMENTS AND THE FRAMING PERSPECTIVE (Hank Johnston & John A. Noakes eds., 2005); KINGDON, *supra* note 263, at 126, 127 tbl.6-1.

[277] On cognitive dissonance and compartmentalization, see for example, LEON FESTINGER, A THEORY OF COGNITIVE DISSONANCE 271 (1957); Timur Kuran, *Social Mechanisms of Dissonance Reduction*, *in* SOCIAL MECHANISMS: AN ANALYTICAL APPROACH TO SOCIAL THEORY 147 (Peter Hedström & Richard Swedberg eds., 1998).

[278] *See supra* notes 258–60 and accompanying text; *see also* KINGDON, *supra* note 263, at 122–28.

with bureaucratic organizational structures and differentiation, produces fragmentation of authority, roles action, knowledge, and expertise.[279] Local culture and local knowledge are important features of resilient social systems,[280] but they tend to produce highly localized and diverse responses to socio-ecological problems. More generally, diversity in social systems is an adaptive development for system resiliency and is a result of path dependence in social evolution.[281]

Fragmentation can satisfy *political forces*.[282] Policy makers can benefit many different interest groups by creating multiple, diverse policies and programs.[283] More generally, political and institutional competition can create multiple centers of power and multiple sets of policy responses to environmental problems.[284] Parties with vested interests in the status quo and its distribution of power and resources are likely to resist change that would create new, more integrated institutions, producing a proliferation of institutions sharing a crowded and diverse socio-legal system.[285] In addition, political and legal culture and theory in the United States favor the diffusion of power through federalism, separation of powers, private rights, and other concepts.[286] For example, the political culture of

---

[279] *See supra* notes 258–60; *see also* KINGDON, *supra* note 263, at 122–28.

[280] On local culture and local knowledge, see for example, J. Peter Brosius, *What Counts as Local Knowledge in Global Environmental Assessments and Conventions?*, *in* BRIDGING SCALES, *supra* note 95, at 129; CLIFFORD GEERTZ, LOCAL KNOWLEDGE: FURTHER ESSAYS IN INTERPRETIVE ANTHROPOLOGY (3d ed. 2000) (1983); Low, *supra* note 262; Lea S. VanderVelde, *Local Knowledge, Legal Knowledge, and Zoning Law*, 75 IOWA L. REV. 1057 (1990). For applications to place-based environmentalism see for example, FELDMAN, *supra* note 117, at 278–85; WILKINSON, *supra* note 172; Nancy Perkins Spyke, *Charm in the City: Thoughts on Urban Ecosystem Management*, 16 J. LAND USE & ENVTL. L. 153 (2001).

[281] *See, e.g.*, Bobbi Low et al., *Redundancy and Diversity: Do They Influence Optimal Management?*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 25, at 83; Stacy J. Silveira, *The American Environmental Movement: Surviving Through Diversity*, 28 B.C. ENVTL. AFF. L. REV. 497, 518–20 (2001); Sokol, *supra* note 31, at 159.

[282] *See infra* note 298.

[283] *See generally* ROSENBAUM, *supra* note 248, at 82–125, 141–45; Burdett A. Loomis & Allan J. Cigler, *Introduction: The Changing Nature of Interest Group Politics*, *in* INTEREST GROUP POLITICS 1, 5–6, 31 n.12 (Allan J. Cigler & Burdett A. Loomis eds., 7th ed. 2007) (summarizing the core aspects of interest group pluralism and interest group liberalism and citing, *inter alia*, THEODORE J. LOWI, THE END OF LIBERALISM (2d ed. 1979)). In addition, regulation itself can be a discrete good that proliferates as it is distributed to many different interests in the political system. *See* Pietro S. Nivola*, Regulation: The New Pork Barrel*, 16 BROOKINGS REV. 6 (Winter 1998).

[284] ROSENBAUM, *supra* note 248, at 82–125, 141–45; KINGDON, *supra* note 263, at 128–30; Browne, *supra* note 263.

[285] *See generally* Daniels, *supra* note 57.

[286] *Cf.* KINGDON, *supra* note 263, at 8; Lawrence Friedman & Neals-Erik William Delker, *Preserving the Republic: The Essence of Constitutionalism*, 76 B.U. L. REV. 1019, 1019–20

private property or localism may be equally or more influential than the law of private property rights or federalism.[287]

Fragmentation, while arguably inefficient for dealing with complex, integrated, multidimensional problems, may actually be efficient in light of a number of *economic forces*.[288] Fragmented responses can diversify risk, particularly given that any response to uncertain, dynamic, and complex environmental problems can have a high risk of failure or unintended consequences.[289] Fragmentation may result from the high costs of coordination or integration, particularly if resources are already dispersed.[290] Polycentric environmental protection institutions can create markets for environmental solutions.

Finally, fragmentation relates to *ethical or normative forces*. Fragmentation in environmental protection methods and solutions may correspond to moral pluralism, particularly in environmental ethics.[291] The moral value of diversity may extend to legal and policy diversity.[292]

(1996) (book review); Kenneth L. Karst, *Paths to Belonging: The Constitution and Cultural Identity*, 64 N.C. L. REV. 303, 306, 337 (1986); Loomis & Cigler, *supra* note 283, at 6–7. For a thought-provoking argument that the cultural, political, and legal commitment to federalism as a power diffusion mechanism is a collective "neurosis" (with which I disagree), see Edward L. Rubin & Malcolm Feeley, *Federalism: Some Notes on a National Neurosis*, 41 UCLA L. REV. 903, 907–08 (1994).

[287] *See, e.g.*, Arnold, *Structure*, *supra* note 7, at 486–91 (discussing the role of localism and private property rights norms on the practice of land use planning and regulation); Richard Briffault, *Our Localism: Part I—The Structure of Local Government Law*, 90 COLUM. L. REV. 1 (1990) (discussing the dominance of localism in the United States); Jonathan Cannon, *Environmentalism and the Supreme Court: A Cultural Analysis*, 33 ECOLOGY L.Q. 363, 372, 376 (2006) (observing that support for private property rights is a dominant element of U.S. culture); Sheryll D. Cashin, *Localism, Self-Interest, and the Tyranny of the Favored Quarter: Addressing the Barriers to New Regionalism*, 88 GEO. L.J. 1985 *passim* (2000) (discussing the dominance of localism in the United States).

[288] *See generally* Krešimir Pirši, *Trends, Developments, and Mutual Influences Between United States Corporate Law(s) and European Community Company Law(s)*, 14 COLUM. J. EUR. L. 277, 280–84 (2008) (discussing the pros and cons of both centralized and diversified economic systems).

[289] *See id.* at 283 (discussing the lower risks and easier fixes of decentralized systems).

[290] *See, e.g.*, *id.* at 330–31 (recognizing the slowness and high cost of integrating economic regulations).

[291] *See, e.g.*, Robert E. Manning, *Social Climate Change: A Sociology of Environmental Philosophy*, *in* RECONSTRUCTING CONSERVATION: FINDING COMMON GROUND 207, 207–22 (Ben A. Minteer & Robert E. Manning eds., 2003); *see also* Arnold, *Structure*, *supra* note 7, at 506–09 (describing moral pluralism in the land ethic).

[292] On the moral value of diversity, see, e.g., LAWRENCE M. HINMAN, ETHICS: A PLURALISTIC APPROACH TO MORAL THEORY 25–56 (2007) (distinguishing ethical pluralism from ethical relativism); NOAM PIANKO, ZIONISM AND THE ROADS NOT TAKEN: RAWIDOWICZ, KAPLAN, KOHN 48–51 (2010) (distinguishing cosmopolitanism from universalism); Nancy DiTomaso

Likewise, the value of contextualization in making decisions and judgments[293] may be advanced by decentralized, localized, particularized, and therefore fragmented decision-making.

C. The Convergence of Unimodality and Fragmentation

As should now be obvious, many of the forces that facilitate unimodality also facilitate fragmentation and vice-versa.[294] The result is that unimodality and fragmentation tend to converge in U.S. environmental law in a system of unimodal fragmentation. For example, social forces of specialization and differentiation tend to produce institutional fragmentation with each discrete unit favoring its own unimodal response to the problems that fall within its authority or function. Likewise, bounded rationality and framing effects may lead people to mentally process or frame complex problems in both unimodal and compartmentalized ways. Moreover, the two trends tend to reinforce one another as responses to one another: the inadequacies of unimodal solutions are often met with calls for decentralized policy diversity, and the problems of fragmentation typically provoke recommendations of uniform, model solutions, or optimal institutional design. Thus, we get both more fragmentation and more unimodality.

D. The Inadequacies of Unimodal Fragmentation

Unimodal fragmentation fails to meet the challenges of complex, interrelated, nonlinear, dynamic environmental problems that have arisen and loom even larger on our policy response horizon.[295] Numerous studies have shown that the use of diverse, polycentric modes of environmental

---

& Robert Hooijberg, *Diversity and the Demands of Leadership*, 7 LEADERSHIP Q. 163 (1996) (discussing the social and moral effects of ethical diversity); Markku Oksanen, *The Moral Value of Biodiversity*, 26 AMBIO 541 (1997) (contrasting biocentric and anthropocentric views of the value of biodiversity); Peter J. Paris, *The Ethics of African American Religious Scholarship*, 64 J. AM. ACAD. RELIGION 483 (1996) (describing the growing influence of African-American religious scholarship).

[293] For thinking about moral judgment as contextualized, see, e.g., CAROL GILLIGAN, IN A DIFFERENT VOICE: PSYCHOLOGICAL THEORY AND WOMEN'S DEVELOPMENT 32–33 (1982). *See also* SUSAN J. HEKMAN, MORAL VOICES, MORAL SELVES: CAROL GILLIGAN AND FEMINIST MORAL THEORY 3–8 (1995); MAKING CONNECTIONS 57–69 (Carol Gilligan et. al. eds., 1990); MAPPING THE MORAL DOMAIN 24–32 (Carol Gilligan et. al. eds., 1988).

[294] *See supra* notes 248–293 and accompanying text.

[295] *See* Stephen R. Carpenter & William A. Brock, *Spatial Complexity, Resilience, and Policy Diversity: Fishing on Lake-Rich Landscapes*, 9 ECOLOGY & SOC'Y 8 (2004), *available at* http://www.ecologyandsociety.org/vol9/iss1/art8; Doremus, *supra* note 249, at 729–30.

problem response in interconnected or linked ways is better than uniform, centralized solutions or persistently disenabling fragmentation.[296] Some of the responses to problems at the intersection of climate change, land use, and water illustrate the inadequacies of unimodal and fragmented responses.

Consider first, though, development of unimodal and fragmented responses to these problems. Several forces combined to stimulate cities' interest in addressing urban stormwater runoff: federal stormwater discharge permit requirements for municipalities ("MS4s"),[297] state designation of water quality standards ("WQS") and total maximum daily loads ("TMDLs") for impaired waters affected strongly by nonpoint source (runoff) pollutants,[298] the high costs of floodwater and stormwater management by localities,[299] and increasing understandings about the impacts of land uses and their runoff.[300] Cities predictably began turning to model principles of low-impact development ("LID"),[301] also called "better site design,"[302] and accompanying templates of municipal ordinances aimed at the amount of impervious cover and green infrastructure on development sites.[303]

---

[296] *See, e.g.*, Carpenter & Brock, *supra* note 295 (making the point that in complex socio-ecological dynamics, coordinated heterogeneous and flexible policies are superior to one-size-fits-all policies); Doremus, *supra* note 249; Plater, *supra* note 271, at 389 (arguing that environmental regulation is better when pluralistic, multipolar, polycentric processes are used).

[297] John H. Minan, *Municipal Separate Storm Sewer System (MS4) Regulation Under the Federal Clean Water Act: The Role of Water Quality Standards?*, 42 SAN DIEGO L. REV. 1215 (2005); *Wendy E. Wagner, Stormy Regulation: The Problems that Result when Stormwater (and Other) Regulatory Programs Neglect to Account for Limitations in Scientific and Technical Information*, 9 CHAP. L. REV. 191 (2006); *National Pollutant Discharge Elimination System (NPDES): Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s)*, U.S. ENVTL. PROT. AGENCY, http://cfpub.epa.gov/npdes/stormwater/munic.cfm (last visited Apr. 3, 2011).

[298] 33 U.S.C. § 1313(d) (2006); Minan, *supra* note 297, at 1230–32.

[299] KLOSS & CALARUSSE, *supra* note 109, at 7; THE TRUST FOR PUBLIC LAND, *supra* note 182, at 47–48.

[300] KLOSS & CALARUSSE, *supra* note 109, at v, 16.

[301] *See* EPA, REDUCING STORMWATER COSTS, *supra* note 114, at 2–5 (describing low impact development strategies).

[302] CTR. FOR WATERSHED PROT., BETTER SITE DESIGN: A HANDBOOK FOR CHANGING DEVELOPMENT RULES IN YOUR COMMUNITY (1999), *available at* http://www.cwp.org/Resource_Library/Better_Site_Design (must register to view); Site Planning Roundtable, *supra* note 193.

[303] *See, e.g.*, CTR. FOR WATERSHED PROT., *supra* note 302; Site Planning Roundtable, *supra* note 193; *Model Ordinances to Protect Local Resources*, ENVTL. PROT. AGENCY, http://www.epa.gov/owow/nps/ordinance (last visited Apr. 3, 2011) (providing links to model ordinances); STORMWATER MANAGER'S RESOURCE CTR., http://www.stormwatercenter.net (click on "Ordinance Selector" to see templates of municipal ordinances) (last visited Apr. 3, 2011).

Moreover, as we have begun to focus on energy efficiency and consumption and the contribution of energy usage to climate change,[304] we have turned to green building standards, such as Leadership in Energy and Environmental Design ("LEED") certification and green building codes,[305] and energy-efficient transportation options.[306] We have become concerned with urban sprawl for many reasons: traffic commute times and the pollution and energy impacts of growing vehicle miles traveled ("VMT"), conversion of agricultural and environmentally sensitive lands to development, disaffection with suburban form and life, the water-quality runoff impacts of sprawl, and decline of central cities.[307] In response, we have turned to

---

[304] Despite the trend towards unimodal responses to climate change, the American Planning Association developed a relatively multifaceted, even if not thoroughly integrated, policy guide that addresses the many relationships of local planning and land use with climate change. *See Policy Guide on Planning and Climate Change*, AM. PLANNING ASS'N, http://www.planning.org/policy/guides/pdf/climatechange.pdf (last visited Apr. 3, 2011).

[305] *See* Sarah Fox, Note, *A Climate of Change: Shifting Environmental Concerns and Property Law Norms Through the Lens of LEED Building Standards*, 28 VA. ENVTL. L.J. 295, 296 (2010); Keith H. Hirokawa, *At Home with Nature: Early Reflections on Green Building Laws and the Transformation of the Built Environment*, 39 ENVTL. L. 507 (2009) (describing mandatory green building standards that have been implemented); Patricia E. Salkin, *Sustainability and Land Use Planning: Greening State and Local Land Use Plans and Regulations to Address Climate Change Challenges and Preserve Resources for Future Generations*, 34 WM. & MARY ENVTL. L. & POL'Y REV. 121, 139–40 (2009) [hereinafter Salkin, *Sustainability*]; Edna Sussman, *Reshaping Municipal and County Laws to Foster Green Building, Energy Efficiency, and Renewable Energy*, 16 N.Y.U. ENVTL. L.J. 1, 2–10 (2008) (describing how some localities have used LEED certification to implement green building standards); Bradford Swing, *Project-Based Policy Development: Building the Case for Boston's Green Building Policy*, 11 N.Y.U. J. LEGIS. & PUB. POL'Y 33 (2007) (describing Boston's adoption of LEED building standards).

[306] *See, e.g.*, *Transportation*, U.S. DEP'T OF ENERGY, http://www.energy.gov/energyefficiency/transportation.htm (last visited Apr. 3, 2011); *Clean Cities*, U.S. DEP'T OF ENERGY, http://www.eere.energy.gov/cleancities/ (last visited Apr. 3, 2011); *Center for Transit-Oriented Development*, RECONNECTING AMERICA, http://www.reconnectingamerica.org/public/tod (last visited Apr. 3, 2011); SURFACE TRANSP. POLICY P'SHIP, http://www.transact.org/ (last visited Apr. 3, 2011) (providing links to various reports describing the benefits of mass transit to communities).

[307] *See, e.g.*, F. KAID BENFIELD ET AL., SOLVING SPRAWL: MODELS OF SMART GROWTH IN COMMUNITIES ACROSS AMERICA (2001); ANDRES DUANY ET AL., SUBURBAN NATION: THE RISE OF SPRAWL AND THE DECLINE OF THE AMERICAN DREAM (2000); GEORGE A. GONZALEZ, URBAN SPRAWL, GLOBAL WARMING, AND THE EMPIRE OF CAPITAL (2009); SPRAWL CITY: RACE, POLITICS, AND PLANNING IN ATLANTA (Robert D. Bullard et al. eds., 2000); Robert H. Freilich & Bruce G. Peshoff, *The Social Costs of Sprawl*, 29 URB. LAW. 183 (1997); Jerry Frug, *The Geography of Community*, 48 STAN. L. REV. 1047 (1996); Patrick Gallagher, *The Environmental, Social, and Cultural Impacts of Sprawl*, 15 NAT. RESOURCES & ENV'T 219 (2001); Francesca Ortiz, *Biodiversity, the City, and Sprawl*, 82 B.U. L. REV. 145

smart growth policies of allowing, encouraging, or perhaps even requiring multi-use, transit-oriented, high-density infill development in the urban core.[308]

Several water policies and reforms have grown out of our increasing concern about water consumption patterns that alter watershed hydrology and structure, deprive species and waterways of sufficient instream flows, deplete groundwater sources faster than they are replenished, make inefficient uses of water, and favor private commodification of water over public and community interests in water.[309] We have incorporated environmental and public interest criteria into water allocation and management decisions,[310] created water conservation

---

(2002); J.B. Ruhl, *Taming the Suburban Amoeba in the Ecosystem Age: Some Do's and Don'ts*, 3 WIDENER L. SYMP. J. 61 (1998); Philip J. Tierney, *Bold Promises but Baby Steps: Maryland's Growth Policy to the Year 2020*, 23 U. BALT. L. REV. 461 (1994).

[308] *See, e.g.*, U.S. ENVTL. PROT. AGENCY, PROTECTING WATER RESOURCES WITH SMART GROWTH (2004), *available at* http://www.epa.gov/dced/pdf/waterresources_with_sg.pdf; BANK OF AMERICA & GREENBELT ALLIANCE, BEYOND SPRAWL: NEW PATTERNS OF GROWTH TO FIT THE NEW CALIFORNIA (1995), *available at* http://www.greenbelt.org/resources/reports/report_beyondsprawl.html; SMART GROWTH NETWORK, GETTING TO SMART GROWTH: 100 POLICIES FOR IMPLEMENTATION (2002), *available at* http://www.smartgrowth.org/pdf/gettosg.pdf; SMART GROWTH NETWORK, GETTING TO SMART GROWTH II: 100 MORE POLICIES FOR IMPLEMENTATION (2003) *available at* http://www.smartgrowth.org/pdf/gettosg2.pdf; Benfield et al., *supra* note 307; James A. Kushner, *Smart Growth: Urban Growth Management and Land-Use Regulation Law in America*, 32 URB. LAW. 211 (2000); Patricia E. Salkin, *Squaring the Circle on Sprawl: What More Can We Do? Progress Toward Sustainable Land Use in the States*, 16 WIDENER L.J. 787 (2007); Amanda Siek, *Smart Cities: A Detailed Look at Land Use Planning Techniques that Are Aimed at Promoting Both Energy and Environmental Conservation*, 7 ALB. L. ENVTL. OUTLOOK 45 (2002); Tierney, *supra* note 307; Edward H. Ziegler, *Urban Sprawl, Growth Management and Sustainable Development in the United States: Thoughts on the Sentimental Quest for a New Middle Landscape*, 11 VA. J. SOC. POL'Y & L. 26 (2003).

[309] *See, e.g.*, ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 31–33.

[310] *See, e.g.*, Endangered Species Act, 16 U.S.C. § 1531 (1973); Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. § 1251 (1972); FLA. STAT. § 373.223 (2010); Harloff v. City of Sarasota, 575 So.2d 1324 (Fla. 1991); Sw. Fla. Water Mgmt. Dist. v. Charlotte Cnty., 774 So.2d 903 (Fla. Dist. Ct. App. 2001); *In re* Water Use Permit Applications (Waiāhole Ditch), 9 P.3d 409 (Haw. 2000); Shokal v. Dunn, 707 P.2d 441 (Idaho 1985); *In re* Application for Change of Appropriation Water Rights, 816 P.2d 1054 (Mont. 1991); Nat'l Audubon Soc'y v. Super. Ct. of Alpine Cnty., 658 P.2d 709 (Cal. 1983); Consuelo Bokum, *Implementing the Public Welfare Requirement in New Mexico's Water Code*, 36 NAT. RESOURCES J. 681 (1996); Jesse A. Boyd, *Hip Deep: A Survey of State Instream Flow Law from the Rocky Mountains to the Pacific Ocean*, 43 NAT. RESOURCES J. 1151 (2003); Robin Kundis Craig, *A Comparative Guide to the Western States' Public Trust Doctrines: Public Values, Private Rights, and the Evolution Toward an Ecological Public Trust*, 37 ECOLOGY L.Q. 53 (2010); *see also* Sandra B. Zellmer, *United States: The*

policies,[311] and adopted concurrency requirements for new land development.[312]

However, these responses, by themselves, are inadequate and illustrate environmental law's need and demand for integrated multimodality. For example, green building policies and other policies aimed at energy efficiency do not address other problems at the intersection of land use, climate change, and water, such as sprawl, runoff, water consumption, or development of critical watershed lands. Climate change and land use policies based solely or primarily on green building principles quite possibly could produce landscapes of sprawling energy-efficient green McMansions connected to multiple destinations by travel in hybrid vehicles or on extensive networks of mass transit.[313]

Alternatively, policies pushing development towards multi-use, transit-oriented infill development in central cities could increase development and populations in expanding urban-core floodplains, areas with substantial heat-island effects, and catchments and subwatersheds that are already burdened by high percentages of impervious cover and low

---

Emergence of Environmental Considerations, *in* THE EVOLUTION OF THE LAW AND POLITICS OF WATER 205 (Joseph W. Dellapenna & Joyeeta Gupta eds., 2009).

[311] *See, e.g.*, AGRIC. WATER MGMT. COUNCIL, *supra* note 129; Keith H. Hirokawa, *The Relevance of Land Use Law to Climate Change Preparedness: The Case of Sustainable Water Practices*, 40 TRENDS (ABA Sec. Env't, Energy & Resources) 6 (May/June 2009) (reporting on a variety of water conservation practices adopted by U.S. localities); PAC. INST., *supra* note 130 (critiquing Atlanta's policy but identifying many different conservation techniques that are used by urban areas); TEX. WATER DEV. BD., *supra* note 129; *Water Conservation*, TOWN OF CARY, N.C., DEP'T OF PUB. WORKS & UTIL., http://www.townofcary.org/Departments/Public_Works_and_Utilities/Conservation/Water_Conservation.htm (last visited Apr. 3, 2011).

[312] *See, e.g.*, Lincoln L. Davies, *Just a Big, "Hot Fuss"?: Assessing the Value of Connecting Suburban Sprawl, Land Use, and Water Rights Through Assured Supply Laws*, 34 ECOLOGY L.Q. 1217 (2007) [hereinafter Davies, *Assured Supply*]; Bobbie Klein & Douglas Kenney, *The Land Use Planning, Water Resources and Climate Change Adaptation Connection: Challenges and Opportunities—A Review*, U. Colo. Western Water Assessment Paper, *available at* http://wwa.colorado.edu/water_management_and_drought/Land%20use%20water%20final.pdf.

[313] *See, e.g.*, U.S. ENERGY ASS'N, NATIONAL ENERGY SECURITY POST 9/11, at 20 (2002), *available at* http://www.usea.org/Publications/Documents/USEAReport.pdf; Martin John Brown, *Debunking the Green Building Myth*, ALTERNET (Oct. 11, 2006), http://www.alternet.org/story/42827/; Jason Kambitsis, *High-Speed Rail as a Conduit of Sprawl*, AUTOPIA (Mar. 16, 2010 3:42 PM), http://www.wired.com/autopia/2010/03/high-speed-rail-and-sprawl/; *"Green" McMansions*, YOUTUBE, http://www.youtube.com/watch?v=uuvrVmtzKnA (last visited Apr. 3, 2011).

percentages of green infrastructure.[314] Gentrification of low-income and minority communities may occur, and it is not clear that the new smart-growth development will really prevent more sprawl or instead will merely draw people out of existing and aging inner-ring suburbs.[315]

Communities that adopt water conservation policies may find themselves having to modify their plans for unanticipated substantial population migration from people seeking to leave places of drought, heat, or sea level rise. They may find that the water supplies that they are conserving for instream flows or future needs become targets for transbasin transfers to distant communities that are under considerable water stress or have failed to engage in conservation measures. Or, conservation-minded communities may experience demand hardening that limits their options for reducing water uses during periods of drought that may increase with climate change.[316] Degradations to the quality of efficiently used water supplies may also prevent reaching conservation targets. Thus, water conservation policies that do not plan for various climate change, water-quality, and growth scenarios are likely not to be effective.

These and other examples illustrate the potential to respond to environmental problems with single-minded methods or approaches that are fragmented from one another, failing to consider the many, various, complex, interdependent, dynamic, discontinuous, multiscalar, and uncertain relationships among and between environmental problems. Thus, many of the initial responses to climate change, land use, or water problems have started out as both unimodal and fragmented. They are unimodal in the sense of framing the problem narrowly and proposing "model" policies that are often meant to be uniform, off-the-shelf, universally applicable solutions to these problems. They are fragmented in the sense that each is a different response to a different problem, often relying on different kinds of instruments, methods, and institutions and often involving uncoordinated action across many different actors. This illustrates the potential for environmental law to be simultaneously unimodal and fragmented, responding to each single manifestation or dimension of a complex multidimensional problem with a different method or mode. As a result, we end up with a disparate collection of one-size-fits-all approaches.

---

[314] *See* THE NEW TRANSIT TOWN: BEST PRACTICES IN TRANSIT-ORIENTED DEVELOPMENT (Hank Dittmar & Gloria Ohland eds., 2004).

[315] *See* James A. Kushner, *Smart Growth, New Urbanism and Diversity: Progressive Planning Movements in America and Their Impact on Poor and Minority Ethnic Populations*, 21 UCLA J. ENVT'L L. & POL'Y 45 (2002).

[316] Thompson, *supra* note 136, at 111.

IV. INTEGRATIONIST MULTIMODALITY: EMERGING EXAMPLES IN CLIMATE CHANGE, LAND USE, AND WATER

Nonetheless, environmental law evolves, adapting to needs created by new environmental problems or new understandings of environmental problems and the inadequacies of existing approaches. Several developments in addressing issues at the intersection of land use, water, and climate change reflect characteristics of integrated multimodal responses.

A. Wet Growth

One such development is the concept of "wet growth."[317] Wet growth is a set of land use, development, and growth policies that aim for sustainability with respect to water quality, water supply, and watershed health and integrity.[318] It is based on a "tool box" concept that communities can select among a variety of different methods and tools for adapting land use practices and patterns to protect waters.[319] However, the wet growth approach is based on thirteen principles: 1) integration; 2) watershed-based action; 3) regional or inter-local cooperation; 4) study, assessment, learning,

---

[317] An early use of the term "wet growth" to refer to integrated approaches to land use and water issues was in the 2002 planning and development of a conference, which was held at Chapman University School of Law in February 2003 and resulted in a book published by the Environmental Law Institute in 2005. *See* WET GROWTH, *supra* note 136; *see also* Arnold, *Is Wet Growth Smarter*, *supra* note 110. These early works focused more on water supply issues. Later works gave greater attention to water quality and runoff issues. *See, e.g.*, Arnold, *Clean-Water Land Use*, *supra* note 116; *Symposium, The Slippery Slope: Urban Runoff, Water Quality, and the Issue of Legal Authority*, 9 CHAPMAN L. REV. 187 (2006). Recent work provides a more systematic and integrated description of the wet growth concept and phenomena. *See* ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114 (book of over 700 pages, drawing on examples of wet growth practices and theories nationwide to identify principles, methods, and tools available to Kentucky communities to address the relationships between land use and water, prepared under a grant from the U.S. Environmental Protection Agency). For other examples of wet growth scholarship, see, e.g., William L. Andreen, *Developing a More Holistic Approach to Water Management in the United States*, 36 ENVTL. L. REP. (Envtl. Law Institute) 10277 (2006); Davies, *Assured Supply*, *supra* note 312; Kyle Harwood, *The Evolution of Wet Growth Regulations: City of Santa Fe*, 7 WATER RESOURCES IMPACT 5 (2005); A. Dan Tarlock & Lora A. Lucero, *Connecting Land, Water, and Growth*, 34 URB. LAW. 971 (2002); Michael Allan Wolf, *Supreme Guidance for Wet Growth: Lessons from the High Court on the Powers and Responsibilities of Local Governments*, 9 CHAPMAN L. REV. 233 (2006); Dave Owen, *Urbanization, Water Quality, and the Regulated Landscape* 82 U. COLO. L. REV. 431 (2011) [hereinafter Owen, *Urbanization*].

[318] ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 2.

[319] *Id.* at 3.

and adaptation; 5) planning; 6) implementation; 7) policy diversity; 8) the conservation and use of natural features and processes; 9) low-impact development; 10) pollution prevention; 11) efficiency (no waste); 12) broad participation and engagement; and 13) investment.[320]

The wet growth approach uses any combination of seven possible methods (i.e., systematic approaches with organizing principles): 1) watershed planning; 2) low-impact development; 3) water conservation; 4) green infrastructure; 5) smart growth; 6) land conservation; and 7) restoration, remediation, and re-use.[321] These seven methods are accomplished with any combination of seven possible tools (ways of implementing the methods): 1) planning; 2) regulation; 3) incentives, markets, and private efforts; 4) public infrastructure; 5) impact assessment; 6) participatory processes; and 7) public education and engagement.[322] The point of the tool box concept of wet growth is that decision makers can mix and match any of these various methods and tools as needed or appropriate to the particular problems of land use impacts on water resources and watersheds, creating linkages among the methods or tools that are selected.

Moreover, each of the seven method categories contains a number of different principles, techniques, processes, specific methods, policies, and strategies that can be used, and each of the seven tool categories contains a number of specific types or examples of tools that can be used.[323] For example, just within the area of regulatory tools, there are at least twenty-four different types of local-government regulatory tools that can be used. They are: 1) stormwater management ordinances; 2) sediment and erosion control ordinances; 3) subdivision regulations; 4) building codes; 5) development approval standards (for rezoning, use permits, variances, subdivision approvals, site plans, etc.); 6) riparian buffer zones; 7) watershed or water resource overlay zones; 8) groundwater, aquifer, wellhead, and sinkhole protections; 9) wetlands regulation; 10) floodplain protection ordinances; 11) steep slope protections; 12) open-space zoning, cluster development, and conservation subdivisions; 13) agricultural lands conservation zoning; 14) tree preservation ordinances; 15) forest conservation ordinances; 16) native landscaping ordinances; 17) water conservation ordinances; 18) concurrency requirements; 19) real estate transfer regulations; 20) low-impact development ("LID") zoning; 21) development agreements

---

[320] *Id.* at 50–53.
[321] *Id.* at 54.
[322] *Id.*
[323] *Id.*

and planned unit developments ("PUDs"); 22) impact fees; 23) transferable development rights ("TDRs"); and 24) incentive zoning.[324]

While these lists may seem unwieldy or overwhelming at first, they turn out to be quite useful to local communities, multi-stakeholder groups, inter-jurisdictional planning groups, and state and federal agencies that are attempting to address the many different and intertwined effects of many different types of land use practices on the multiple scales and characteristics of waters and watersheds. A very wide and diverse range of examples of wet growth practices from throughout the United States illustrates that there is no one-size-fits-all model or template for integrating water resource conservation and watershed quality protection with land use policies and practices.

This range includes low-impact development regulations adopted by the City of Olympia, Washington for its rapidly urbanizing Green Cove Basin watershed, which involved changes to the City's Comprehensive Plan, zoning and tree protection ordinances, street, sidewalk, and parking standards, and drainage design and erosion control standards, as well as the adoption of a new zoning ordinance creating a new Residential Low Impact district, establishing several low-impact development and design requirements in the district, and increasing tree protection and replacement requirements for designated sensitive basins.[325] It includes a partnership among Durham (North Carolina) City and County, the North Carolina Ecosystem Enhancement Program, and several other organizations to develop the Little Lick Creek Local Watershed Plan, which recommends nine comprehensive watershed management strategies (e.g., stormwater retrofits, critical lands protection, better site design, and watershed outreach and education programs) and addresses watershed restoration, prevention of future degradation, watershed stewardship, and monitoring the success of the proposed techniques and overall condition of the watershed.[326] The range of wet growth examples includes an ordinance adopted by the Town of Cape Elizabeth, Maine, to establish developments restrictions for various resource protection districts, including the "critical wetland district," the "critical wetland buffer overlay district," the "wetland protection district," and the "floodplain district," by using both overlay

---

[324] ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 225–40.

[325] CITY OF OLYMPIA, WASH., LOW IMPACT DEVELOPMENT STRATEGY FOR GREEN COVE BASIN: A CASE STUDY IN REGULATORY PROTECTION OF AQUATIC HABITAT IN URBANIZING WATERSHEDS (2002), *available at* http://www.psparchives.com/publications/our_work/stormwater/lid/ordinances/Green_Cove.pdf.

[326] N.C. ECOSYSTEM ENHANCEMENT PROGRAM, LITTLE LICK CREEK LOCAL WATERSHED PLAN (2006), *available at* http://www.unrba.org/littlelick/downloads.shtml.

zoning and buffer zoning, as well as a table of various permitted uses, uses permitted with a resource protection permit (granted or denied according to "Resource Protection Performance Standards"), and prohibited uses in each of the four types of districts. It includes assured supply laws in a number of states,[327] such as: Arizona's Groundwater Management Act[328] requiring developers in groundwater Active Management Areas to show an assured supply of water subject to restrictions that discourage or prevent nonrenewable extraction of groundwater;[329] California's S.B. 221 requiring developers to provide written verification of sufficient and reliable twenty-year water supplies before a local unit of government can approve any subdivision of over 500 units;[330] and Oregon's mix of state planning requirements and varying local practices incorporating water supply planning and availability into local land use regulations and ordinances.[331] The range of wet growth examples also includes water conservation incentive programs offered by the Town of Cary, North Carolina, featuring affordable rain barrel kits along with a free build-your-own rain barrel workshop, $150 rebate available to residential and business water customers for each new WaterSense certified high-efficiency toilet, and a $500 Turf Buy Back for replacing a minimum of 1000 square feet of turf with either a naturally landscaped area or warm season grass.[332] They also include conservation easements on sensitive watershed lands, such as conservation easements in the Anacostia River watershed that protect "rural legacy" lands, "legacy open space" areas, forests, and streamside lands and similar watershed-sensitive lands in Montgomery County, Maryland's upstream portion of the watershed.[333]

These various examples illustrate that states, localities, multi-participant groups, and private parties are attempting to address interconnected land use, water quality, and water supply problems and phenomena in integrated ways but by using multiple methods or modes to do so.

---

[327] *See* Davies, *Assured Supply*, *supra* note 312; Klein & Kenney, *supra* note 312.
[328] ARIZ. REV. STAT. ANN. §§ 45-401 to -704 (2010).
[329] *See* ARIZ. ADMIN. CODE §§ R12-15-703 to -707 (2010); Davies, *Assured Supply*, *supra* note 312.
[330] CAL. WATER CODE § 66473.7 (2010) (enacted by S.B. 221, 2001–2002 Sess., Cal. Stat. ch. 642).
[331] Davies, *Assured Supply*, *supra* note 312, at 1257–62.
[332] TOWN OF CARY, N.C., *supra* note 311. Naturally landscaped areas save as much as one-quarter to one-third of the water used by traditional landscaping methods, and warm season grasses require 21% less water in spring and summer. *Id.*
[333] *See* Craig Anthony (Tony) Arnold, *For the Sake of Water: Land Conservation and Watershed Protection*, 14 SUSTAIN: J. ENVTL. & SUSTAINABILITY ISSUES 16, 25 (2006) [hereinafter Arnold, *Land Conservation*].

Moreover, the wet growth concept, both as an organizing category and as integrating principles, is at its core an integrationist multimodal development in environmental conservation and protection.

B. Watershed Planning and Management

A second example of integrated multimodality is the broad category of watershed-based actions, including watershed planning, watershed management, watershed restoration, and watershed-based regulation. For quite a number of years now, efforts to address the environmental problems associated with land and water have been organized at the watershed level.[334]

---

[334] The large number and range of scholarship on watershed-based actions demonstrate both the popularity and variety of watershed-based initiatives. *See* ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS, *supra* note 114, at 57–101; FELDMAN, *supra* note 117, at 2–3, 100–75, 286–87; DOUGLAS S. KENNEY ET AL., THE NEW WATERSHED SOURCE BOOK: A DIRECTORY AND REVIEW OF WATERSHED INITIATIVES IN THE WESTERN UNITED STATES (2000); LARGE-SCALE ECOSYSTEM RESTORATION: FIVE CASE STUDIES FROM THE UNITED STATES (Mary Doyle & Cynthia A. Drew eds., 2008) [hereinafter LARGE-SCALE ECOSYSTEM RESTORATION]; THE PRACTICE OF WATERSHED PROTECTION (Thomas R. Schueler & Heather K. Holland eds., 2000); EDELLA SCHLAGER & WILLIAM BLOMQUIST, EMBRACING WATERSHED POLITICS (2008); SWIMMING UPSTREAM: COLLABORATIVE APPROACHES TO WATERSHED MANAGEMENT (Paul A. Sabatier et al. eds., 2005) [hereinafter SWIMMING UPSTREAM]; EPA, PROTECTING AND RESTORING, *supra* note 124; U.S. ENVTL. PROT. AGENCY, THE WATERSHED APPROACH (1996), *available at* http://water.epa.gov/type/watersheds/framework.cfm; NATIONAL RESEARCH COUNCIL, *supra* note 107; Adler, *supra* note 107; Arnold, *Clean-Water Land Use*, *supra* note 116; Jeffrey A. Ballweber, *A Critique of Watershed Management Efforts in the Lower Mississippi Alluvial Plain*, 35 J. AM. WATER RESOURCES ASS'N 643 (1999); Blair et al., *supra* note 119; James M. Burson, *Middle Rio Grande Regional Water Resource Planning: The Pitfalls and the Promises*, 40 NAT. RESOURCES J. 533 (2000); Jon Cannon, *Choices and Institutions in Watershed Management*, 25 WM. & MARY ENVTL. L. & POL'Y REV. 379 (2000); John Cobourn, *Integrated Watershed Management on the Truckee River in Nevada*, 35 J. AM. WATER RESOURCES ASS'N 623 (1999); Tenley Conway, *Getting Watershed Management to Work: A Framework for Understanding Interorganizational Relationships*, 35 MIDDLE STATES GEOGRAPHER 1 (2002); S.A.K. Derrickson et al., *Watershed Management and Policy in Hawaii: Coming Full Circle*, 38 J. AM. WATER RESOURCES ASS'N 563 (2002); Brent Foster, *The Failure of Watershed Analysis Under the Northwest Forest Plan: A Case Study of the Gifford Pinchot National Forest*, 5 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 337 (1999); Kara Gillon, *Watershed Down?: The Ups and Downs of Watershed Management in the Southwest*, 5 U. DENV. WATER L. REV. 395 (2002); Goldfarb, *supra* note 117; C.B. Griffin, *Watershed Councils: An Emerging Form of Public Participation in Natural Resource Management*, 35 J. AM. WATER RESOURCES ASS'N 505 (1999); Griffith et al., *supra* note 119; Dawn Hottenroth et al., *Effectiveness of Integrated Stormwater Management in a Portland, Oregon, Watershed*, 35 J. AM. WATER RESOURCES ASS'N 633 (1999); Douglas S. Kenney, *Historical and Sociopolitical Context of the Western Watersheds Movement*, 35 J. AM. WATER RESOURCES ASS'N 493 (1999); Peter Lavigne, *Watershed Councils East and West: Advocacy, Consensus and Environmental Progress*, 22 UCLA J.

This phenomenon is what Dan Tarlock calls "the revival of watershed management in the United States."[335]

Many different types of actions are organized around and occur at watershed scales, depending on: 1) socio-cultural and political forces and demands; 2) the structures and functions of the relevant institutions; 3) the available resources, expertise, and legal authority; and 4) the ways by which individuals, groups, communities, and organizations frame problems regarding watersheds.[336] The following list, while likely not exhaustive, reflects the many different actions that might be included in a relatively inclusive category of "watershed management":

- water supply planning
- water supply allocations
- water supply storage and control
- water development and manipulation

ENVTL. L. & POL'Y 301 (2004); Letey, *supra* note 166; Mark Lubell et al., *Watershed Partnerships and the Emergence of Collective Action Institutions*, 46 AM. J. POL. SCI. 148 (2002); Mark Lubell & Allan Fulton, *Local Policy Networks and Agricultural Watershed Management*, 18 J. PUB. ADMIN. RES.& THEORY 673 (2007); Sean T. McAllister, *The Confluence of a River and a Community: An Experiment with Community-Based Watershed Management in Southwestern Colorado*, 3 U. DENV. WATER L. REV. 287 (2000); Michael Vincent McGinnis et al., *Bioregional Conflict Resolution: Rebuilding Community in Watershed Planning and Organizing*, 24 ENVTL. MGMT. 1 (1999); David R. Montgomery et al., *Watershed Analysis as a Framework for Implementing Ecosystem Management*, 31 WATER RESOURCES BULL. 369 (1995); Michael William Mullen & Bruce E. Allison, *Stakeholder Involvement and Social Capital: Keys to Watershed Management Success in Alabama*, 35 J. AM. WATER RESOURCES ASS'N 655 (1999); Owen, *Urbanization*, *supra* note 317; J.B. Ruhl, *The (Political) Science of Watershed Management in the Ecosystem Age*, 35 J. AM. WATER RESOURCES ASS'N 519 (1999); J.B. Ruhl et al., *Proposal for a Model State Watershed Management Act*, 33 ENVTL. L. 929 (2003); MICHAEL SCOZZAFAVA, U.S. ENVTL. PROT. AGENCY, OFFICE OF WETLANDS, OCEANS, AND WATERSHEDS, THE BEST WATERSHED-BASED PLANS IN THE NATION, (May 11 2006); A. Dan Tarlock, *Putting Rivers Back in the Landscape: The Revival of Watershed Management in the United States*, 14 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 1059 (2008) [hereinafter Tarlock, *Rivers*]; A. Dan Tarlock, *The Potential Role of Local Governments in Watershed Management*, 20 PACE ENVTL. L. REV. 149 (2003); Jack E. Williams et al., *Understanding Watershed-Scale Restoration*, *in* WATERSHED RESTORATION: PRINCIPLES AND PRACTICES 1 (Jack E. Williams et al. eds., 1997); L.P. Wagenet et al., *Adult Education and Watershed Knowledge in Upstate New York*, 35 J. AM. WATER RESOURCES ASS'N 609 (1999); John T. Woolley et al., *The California Watershed Movement: Science and the Politics of Place*, 42 NAT. RESOURCES J. 133 (2002).

[335] Tarlock, *Rivers*, *supra* note 334.

[336] Craig Anthony (Tony) Arnold, *Adaptive Watershed Planning and Climate Change*, 5 ENVTL. & ENERGY L. & POL'Y J. 417 (2010) [hereinafter Arnold, *Adaptive Watershed Planning*].

- restoration of waterway conditions or particular watershed features
- flood control
- stormwater runoff control
- pollution control generally
- nonpoint source pollution control
- ambient water quality planning
- ambient water quality regulation and treatment
- public land management
- growth and development planning
- land use regulation
- study
- monitoring
- education and public engagement
- incentive programs
- advocacy
- dispute resolution
- collaboration and inter-entity cooperation.[337]

In addition, certain environmental protection activities, such as management and protection of aquatic species or forests, might occur at the watershed level.[338]

For example,[339] each of the following could be characterized as "watershed management": large-scale ecosystem restoration projects, such as the Comprehensive Everglades Restoration Plan[340] or the Upper Mississippi River Basin ecosystem restoration project;[341] an interstate river commission created by interstate compact to control water diversions and uses, such as the Delaware River Basin Commission;[342] multi-participant groups or councils created to plan, manage, or resolve disputes

---

[337] *Id.* at 13–14.
[338] *See id.* at 12, 42–43.
[339] *Id.* at 14–15.
[340] *See* LARGE-SCALE ECOSYSTEM RESTORATION, *supra* note 334, at 1–53; LAYZER, *supra* note 270, at 103–36; Alfred R. Light, *Beyond the Myth of Everglades Settlement: The Need for a Sustainability Jurisprudence*, 44 TULSA L. REV. 253, 255 (2008); Klein, *supra* note 143, at 1017.
[341] *See generally* LARGE-SCALE ECOSYSTEM RESTORATION, *supra* note 334, at 255–89 (describing the Mississippi River Basin's history as a managed watershed).
[342] Delaware River Basin Compact, Pub. L. No. 87-328, 75 Stat. 688 (1961); Joseph W. Dellapenna, *Interstate Struggles over Rivers: The Southeastern States and the Struggle over the 'Hooch*, 12 N.Y.U. ENVTL. L. J. 828, 831, 840–49 (2005).

over competing uses of waters in a watershed, such as the Middle Rio Grande Water Assembly in New Mexico;[343] multi-participant cooperation and perhaps even the creation of a watershed-based management entity to protect water quality and control urban or agricultural runoff in the shadow of Clean Water Act requirements for TMDLs, National Permit Discharge Elimination System ("NPDES") permits, and stormwater ("MS4") permits or state regulation, as in the case of Long Creek in Maine[344] or the Sacramento Valley Water Quality Coalition in California;[345] comprehensive integrated multi-participant planning processes for watersheds, perhaps authorized or required by state law, such as the State of Washington's Water Resource Inventory Areas program;[346] federal agencies' management of public lands and resources by assessing and protecting watershed features, such as watershed analyses and management of the Gifford Pinchot National Forest under the Northwest Forest Plan;[347] the adoption of land use and development regulations to protect watershed features applicable in certain sensitive watershed zones, such as the Chatham County (North Carolina) Watershed Protection Ordinance[348] or New York City's extraterritorial land-use regulatory and eminent domain powers in the source watershed for its drinking water supplies;[349] and watershed protection advocacy groups formed around particular watersheds, such as the Connecticut River Watershed Council and the Nashua River Watershed Association.[350] John Cobourn's study of integrated watershed management in the Truckee River basin in Nevada encompasses nine different watershed projects occurring within the basin: 1) the Truckee River Operating Agreement; 2) Steamboat Creek Restoration Plan; 3) Small Ranch Water Quality Program; 4) Storm Drain Stenciling Program; 5) Champions of the Truckee Program; 6) Truckee River Habitat Restoration Group; 7) Regional Water Management Plan; 8) Emergency Response Planning; and 9) Lower River Restoration.[351]

---

[343] Burson, *supra* note 334, at 554–67.
[344] Owen, *Urbanization*, *supra* note 317.
[345] Lubell & Fulton, *supra* note 334, at 674, 678–79.
[346] Watershed Planning Act, WASH. REV. CODE § 90.82 (1997).
[347] Foster, *supra* note 334.
[348] CHATHAM CNTY., N.C. CODE, WATERSHED PROT. ORDINANCE (1993, rev. 2010).
[349] NAT'L RESEARCH COUNCIL, WATERSHED MGMT. FOR POTABLE WATER SUPPLY: ASSESSING THE NEW YORK CITY STRATEGY (2000), *available at* http://www.nap.edu/openbook.php?record_id=9677&page=R1.
[350] Lavigne, *supra* note 334, at 307–08.
[351] Cobourn, *supra* note 334, at 627–31.

Among the broad range of actions aimed at environmental protection and natural resource management and conservation at watershed levels, there are patterns of integrationist multimodality.[352] The central organizing feature of this phenomenon—the focus on problems at the watershed, or aquatic ecosystem, level—is an integrationist opportunity to address problems in a coordinated or holistic manner at the *scale* at which they affect natural systems, functions, and processes.[353] However, organizers of and participants in watershed planning, management, and other activities can choose among a number of different watershed scales.[354] Some efforts have been organized at macro-levels of river basins,[355] some at meso-levels of watersheds,[356] and some at micro-levels of subwatersheds.[357] There is no one-size-fits-all geographic or ecological scale at which aquatic environmental problems and resource management issues are addressed.[358] From both ecological and socio-legal perspectives, the choice of geographic scale requires attention to multiscalar functions of ecosystems and social systems.[359] Moreover, it is not uncommon for watershed activities to coordinate with or address actions, issues, or phenomena that occur at larger and smaller levels of scale, sometimes called scaling up and scaling down.[360]

---

[352] The analysis in this paragraph and the following ten paragraphs is based on a synthesis of the sources cited in notes 342–60, *supra* and 371–422, *infra*.

[353] *See* D. Scott Slocombe, *Implementing Ecosystem-Based Management*, 43 BIOSCIENCE 612, 612–22 (1993).

[354] *See infra* notes 355–94.

[355] *See, e.g.*, SANTA ANA WATERSHED PROJECT AUTH., ONE WATER, ONE WATERSHED: 2009 SANTA ANA INTEGRATED WATERSHED PLAN: AN INTEGRATED REGIONAL WATER MGMT. PLAN (2009), *available at* http://www.sawpa.org/owow-generalinfo.html (2650-square mile Santa Ana river basin).

[356] *See, e.g.*, N.J. WATER SUPPLY AUTH., PRESERVATION OF CRITICAL AREAS IN THE MANASQUAN RIVER WATERSHED (2005), (eighty-two-square mile watershed of Manasquan River), *available at* http://www.raritanbasin.org/Projects/manasquan/CriticalArea.pdf.

[357] *See, e.g.*, UNIV. OF LOUISVILLE LAND USE AND PLANNING LAW SERV. LEARNING TEAM FOR THE DARBY CREEK WATERSHED, DARBY CREEK LEGAL SERVICE-LEARNING PROJECT (2008), http://www.kwalliance.org/Portals/3/pdf/darby_creek_codes_and_ordinances.pdf (analysis of planning and regulatory tools available to multi-participant planning process in a 9.4-square mile HUC-14 (i.e., 14-digit Hydrologic Unit Code) watershed in rural/suburban Oldham County, Kentucky). For an explanation of the 14-digit Hydrologic Unit Code System, *see* KENTUCKY WATERWAYS ALLIANCE, DARBY CREEK WATERSHED PLAN, CH.APTER 2, at 2 (May 13, 2009), *available at* http://kwalliance.org/portals/3/darby%20Creek%20Chapter%202%20Version%206a.pdf.

[358] *See supra* notes 340–51 and accompanying text.

[359] Arnold, *Clean-Water Land Use*, *supra* note 116.

[360] On scaling up and down generally, see Jules N. Pretty & Ian Scoones, *Institutionalizing Adaptive Planning and Local-Level Concerns: Looking to the Future*, in POWER AND

The *types of problems or issues* addressed at the watershed level also reflect integrationist multimodality. In general, watershed-based activities are aimed at some level of coordinated attention to a variety of problems and issues that are interconnected at the watershed scale or by their effects on watershed functions.[361] Although the degree to which plans, policies, and actions actually achieve an integrated, holistic approach to these multiple problems or issues varies quite a bit, watershed-based efforts typically achieve a greater level of integration than previous or other more conventional and more fragmented efforts.[362]

However, watershed-based activities also vary in the number, type, and scope of problems and issues that they address.[363] Some address a very broad range of watershed-related problems and issues.[364] Others focus on particular sets or subsets of watershed problems or issues, such as storm-water runoff and pollution, the development of ecologically sensitive watershed lands, restoration of degraded watershed conditions, water supply planning, or instream flows, aquatic species, and competing uses of surface waters.[365] This diversity implicates multimodality in two respects. In any particular watershed effort, the framing of the problems or issues to be addressed allows the participants to use or select from among any combination of methods or modes for addressing the problems and issues, thus allowing for various modes of watershed action to be linked to one another and to the particular problems or issues being addressed. Across all watershed planning, management, and other activities in the United States, a richly diverse range of approaches has emerged and continues to evolve, reflecting the complexity and variety of watershed problems and issues in our society.

The *genesis and processes* of watershed planning, management, and other activities also reflect the integrationist and multimodal imperative in United States society. Commentators observe that many watershed-based efforts are ad hoc, informal, multi-stakeholder collaborations, but

---

PARTICIPATORY DEVELOPMENT: THEORY AND PRACTICE 157, 161–63 (Nici Nelson & Susan Wright eds., 1995); Craig, *Stationarity*, *supra* note 41, at 9, 54–55 & nn. 233–36 (2010); Osofsky, *International*, *supra* note 77.

[361] *See supra* notes 340–351 and accompanying text.

[362] *See* Slocombe, *supra* note 353. The effectiveness of these integrationist efforts at achieving environmental protection, resource conservation, or even the state goals of the watershed-based effort is another matter, which is addressed in a subsequent paragraph in this subsection, text accompanying *infra* notes 363–366.

[363] *See supra* notes 340–51 and accompanying text.

[364] *See id.*; *see also supra* notes 340, 346, 351.

[365] *See supra* notes 340–51 and accompanying text.

this observation is a broad over-generalization that fails to capture a more subtle and multi-faceted reality.[366] Some watershed-based actions have been created or enabled by legislative policies and statutory mandates.[367] Others have arisen in the context of a government agency's management of particular resources within the watershed or implementation of a regulatory mandate.[368] Others have had considerable federal, state, or local government agency leadership and involvement.[369] While a number of watershed efforts have operated with consensus decision-making (or the failure to make decisions due to lack of consensus), others have involved more traditional political or administrative decision-making by government officials, have arisen out of or involved litigation and judicial decisions, have been responses to regulatory enforcement actions, and/or have been characterized by political conflict and advocacy.[370] Watershed planning and management processes should not be conflated with consensus-based decision-making processes.

Watershed planning and management processes, though, typically share five noteworthy features. First, most are multi-participant.[371] There may be a relatively small percentage of watershed-based actions that are tightly confined to a single government agency or organization, but the vast bulk of watershed-based actions require the involvement of multiple government agencies, jurisdictions, organizations, groups, and individuals.[372] In some cases, this participation may involve input into decisions, but not

---

[366] *Id.*

[367] Watershed Planning Act, WASH. REV. CODE § 90.82 (1997); Delaware River Basin Compact, Pub. L. No. 87-328, 75 Stat. 688 (1961); CHATHAM CNTY., N.C. CODE, WATERSHED PROT. ORDINANCE (1993, rev. 2010).

[368] Delaware River Basin Compact, *supra* note 342, 367; Owen, *Urbanization*, *supra* note 317; Foster, *supra* note 334.

[369] *See supra* notes 340–51 and accompanying text.

[370] *See infra* note 404 and accompanying text.

[371] I am purposefully not using the term "multi-stakeholder" for two reasons. First, all of us have a stake in the health and integrity of watersheds, not just those persons and entities that participate in watershed planning and management activities. Second, the term "stakeholder" can sometimes connote a person or entity with a rather narrowly defined economic self-interest in the outcome of watershed planning and management decisions, thus suggesting that the process is meant to be something like a multi-party business transaction. I prefer the term "multi-participant" to mean the participation of multiple persons or entities who may be affected by watershed planning and management decisions. I especially thank Donna Christie for noticing my use of the term and asking about it during the distinguished visiting lecture presentation of this article at Florida State University College of Law, which in turn has prompted me to be more explicit about my choice of terminology.

[372] *See* Arnold, *Adaptive Watershed Planning*, *supra* note 336, at 46.

shared power over decision making.[373] In some cases, the participation may be limited to implementation and management actions, not policy and planning decisions.[374] However, in many circumstances, many different participants have significant roles in decision making, and in nearly all circumstances, very little watershed protection or conservation activity can occur without some amount of participation by multiple affected persons and entities.

Second, watershed planning and management is collaborative in the sense of involving some amount of cooperative activity among the multiple participants. This does not mean that decisions have to be made by consensus.[375] It does not mean absence of conflict.[376] It is not inconsistent with other non-cooperative actions and processes, such as command-and-control regulation, litigation and judicial decisions, interest-based adversarial advocacy, and political choices by government officials among competing policies and interests, all of which appear in the iterations of many watershed-based actions.[377] However, watershed planning, management, and other activities usually arise because there is no single actor with effective power over the watershed or unilateral authority to make and implement decisions about activities affecting the watershed.[378] Therefore, watershed-based processes not only have to rely on some amount of cooperation or coordination among the multiple actors who affect the watershed and decisions made regarding it, but they emerge to facilitate this cooperation or coordination.

Third, watershed planning and management are concerned with process. This does not mean that all watershed-based actions are standardless.[379] In fact, a significant number of watershed-based actions have resulted in greater environmental protections than pre-existing conventional processes had been able to achieve, or have been necessary iterations of implementing legislative, regulatory, or common-law standards.[380] However, the phenomenon of organizing planning, management, restoration, regulation, and other such activities around watersheds does not

---

[373] *See id.* at 46–47 (contrasting the multi-participant model with the consensus and interactive-feedback models).
[374] *Id.*
[375] *Id.* at 45.
[376] *Id.* at 47.
[377] *See id.* at 23–25.
[378] Arnold, *Adaptive Watershed Planning*, *supra* note 336, at 22–23.
[379] *See id.* at 23, 77–79 (distinguishing standardless watershed planning from the implementation of multiple standards from different sources).
[380] *See id.* at 61 (describing how adaptive watershed planning can improve the capacity, resilience, and adaptability of existing watershed management organizations).

inherently contain specific standards or principles to govern or measure these activities.[381] Arguably, the general principle of protecting overall watershed health and integrity is a useful guide, but this formulation is fairly vague, general, and malleable.[382] Likewise, watershed sustainability or aquatic sustainability is also a vague, general, and malleable standard.[383] In fact, the emergence of watershed-based action could be the poster child for "no-there" environmental law that some experts lament: the standardless, process-obsessed ascendancy of politics and discretion over law, as represented by theories of new governance, post-modernism, deliberative democracy, collaboration, adaptive ecosystem management, and other process-oriented concepts of environmental protection.[384] However, watershed-based processes may serve to create standard-setting or standard-developing processes, institutions, and decisional space that do not exist or are not being utilized in existing processes, institutions, and decision-making authorities.[385]

Fourth, watershed planning and management are flexible. While every institution, set of processes, and particular set of social actions is subject to constraints and various forces, watershed-based actions tend to lack the rigid structures and narrow institutional boundaries that inhibit the consideration of multiple modes or methods of problem solving, integrated processes and actions, or policy or process innovations.[386] The demand for flexibility in addressing complex, dynamic, and interconnected problems at a watershed level is one of the important forces that has contributed to the rise of watershed-based actions.[387]

Fifth, watershed-based processes are iterative. In many cases, specific watershed planning or management processes evolve, emerge, adapt, and change over many iterations.[388] However, even when watershed planning or management actions, processes, or groups seemingly have specific time limits, to have disbanded, to be "dead," or to have

---

[381] *Id.* at 51, 65.
[382] *Id.* at 63–64, 69–76.
[383] *Id.*
[384] *See, e.g.*, Tarlock, *There*, *supra* note 73, at 215–21; *see also* Coggins, *supra* note 270, at 163–71; Sousa & Klyza, *supra* note 270, at 378–80, 441; Wiersema, *supra* note 270, at 1243, 1261.
[385] *See* Arnold, *Adaptive Watershed Planning*, *supra* note 336, at 41–42 (describing the limitations of comprehensive watershed management policies).
[386] *See id.*
[387] *See id.* at 4–6, 39 (describing the benefits of adaptive watershed planning and pointing to a growing number of watershed plans that are exhibiting some characteristics of adaptive planning).
[388] *See id.* at 4–6, 24–25, 43–47.

stagnated,[389] they may be "resurrected" in the future or may be part of larger and longer iterations of actions with respect to the watershed.[390] Any particular group, project, planning cycle, or other rather specific focal point of watershed action is typically an adaptive, emergent component of a broader set of iterative and evolutionary efforts to address watershed problems and issues.[391]

All five features suggest that watershed planning and management have at least some adaptive features as characterized by theories of adaptive planning and management.[392] However, it is less clear whether watershed planning and management inherently have the features of scientific learning and social (or public) learning, which are critical components of adaptive planning, management, and governance.[393] Scholars disagree about whether such learning occurs in the absence of imbedded features that mandate that participants learn from the effects of their plans, policies, and management actions.[394] Although there are plenty of examples of watershed-based activities producing scientific and social learning both within the watershed itself and within United States society generally,[395] there are also plenty of examples of watershed-based activities that have failed to be attentive to scientific and social learning.[396]

This observation leads to the final point about the integrationist and multimodal features of watershed-based actions: *actions and outcomes*. Most obviously, watershed-based actions make use of a variety of modes, methods, instruments, and tools for addressing watershed problems and issues, both at the level of general categories (e.g., command-and-control regulation; incentives for private behavior; public education) and at the level of specific types (e.g., conjunctive management of surface water and groundwater; low-impact-development design requirements; wetlands

---

[389] *See, e.g.*, Doremus, *supra* note 249, at 729–31; Griffin, *supra* note 334, at 515; Sandra Zellmer & Lance Gunderson, *Why Resilience May Not Always Be a Good Thing: Lessons in Ecosystem Restoration from Glen Canyon and the Everglades*, 87 NEB. L. REV. 893, 934–42 (2009).

[390] *See* Arnold, *Adaptive Watershed Planning*, *supra* note 336, at 47–48.

[391] *See id.* at 44–47.

[392] *See, e.g.*, Arnold, *Adaptive Watershed Planning*, *supra* note 336.

[393] *See, e.g.*, Camacho, *Adapting*, *supra* note 41, at 1, 64–77; Scholz & Stiftel, *supra* note 105, at 8–9.

[394] *Compare* Mary Jane Angelo, *Stumbling Toward Success: A Story of Adaptive Law and Ecological Resilience*, 87 NEB. L. REV. 950, 952 (2009) (taking a more optimistic view), *with* Camacho, *Adapting*, *supra* note 41, at 1, 64–77 (taking a more pessimistic view).

[395] *See* Angelo, *Stumbling Toward Success* at 951–52; SANTA ANA WATERSHED PROJECT AUTH., *supra* note 355.

[396] *See* Camacho, *Adapting*, *supra* note 41, at 6, 65–69.

restoration projects).[397] These multiple methods are typically organized around or result from systematic efforts to address watershed-related problems and issues.

One example is the Santa Ana Watershed Project Authority's 2009 Santa Ana Integrated Watershed Plan for the Santa Ana River watershed in California.[398] The plan articulates a vision of "a sustainable Watershed that is drought proofed, salt-balanced, and supports economic and environmental viability."[399] The plan's working goals and objectives include providing a reliable water supply, preserving and enhancing the environment, promoting sustainable water solutions, ensuring high-quality water, providing economically efficient solutions, improving regional integration and coordination, using rainfall as a resource, providing recreational opportunities, and maintaining quality of life.[400] Specific ideas about how to achieve these general goals are discussed with respect to ten different "pillar" areas: water supply reliability; water quality improvement; water recycling; water use efficiency; water and land use; flood risk management; environment and habitat enhancement; parks, recreation, and open space; climate change; and environmental justice.[401] Some examples of these specifics include developing additional storage for recycled water, developing new pathogen indicators and new residual chlorine standards, reconsidering whether flood risk management should continue to be based on the 100-year flood probabilities created from historical data, and changing landscape design elements to increase pervious hard surfaces, pavers, bio-swales, new irrigation technology, and water-efficient gardens in comprehensive landscape planning and consumer packages.[402] Moreover, the Santa Ana Integrated Watershed Plan adopts twelve "next step" strategies to guide water resource adaptability to changing conditions:

- Increase storage;
- Reduce demand;
- Value water differently;
- Desalt groundwater;
- Develop risk-based water quality improvement programs;
- Incorporate integrated water planning into General Plans;

---

[397] Arnold, *Adaptive Watershed Planning*, *supra* note 336, at 53–54.
[398] SANTA ANA WATERSHED PROJECT AUTH., *supra* note 355.
[399] *Id.*
[400] *Id.*
[401] *Id.*
[402] *Id.*

- Maximize preservation and use of native plants;
- Manage public property for more than one use;
- Recycle water;
- Consider stormwater as water supply;
- Create watershed governance; and
- Implement watershed-wide education programs.[403]

Each of these strategies has specific content beyond its general strategy description.

An alternate example of a less structured and centralized approach to watershed protection that uses multiple methods to address integrated principles of watershed restoration and protection has been occurring in the degraded Anacostia River watershed of Maryland and the District of Columbia.[404] These methods have included:

- A multi-jurisdictional agreement among Maryland, the District of Columbia, Montgomery County (MD), and Prince George's County (MD) for watershed restoration and protection;
- The Eastern Montgomery County Master Plan with policies for headwater protections, down-zoning in trout-spawning areas, impervious cover limits, and land acquisition in stream valleys;
- A comprehensive plan for the Paint Branch watershed (a subwatershed);
- The designation of the upper Paint Branch area as a Special Protection Area in the County Code, with conservation buffers for streams, wetlands, springs, and floodplains, requirements of a water quality plan for all public and private projects in the area, and limits on impervious cover to ten percent of the surface area or any development site unless the developer uses off-site mitigation or obtains a waiver;
- The designation of an Environmental Overlay Zone that restricts certain land uses near the upper Pain Branch's headwaters;
- The conditioning of land use and environmental permits on stormwater runoff minimization and mitigation, best management practices to avoid erosion

---

[403] *Id.*

[404] Arnold, *Land Conservation*, *supra* note 333, at 20–21.

or sediment runoff, dedication of open space and buffer areas, and limits on impervious cover;

- Park acquisition planning for government acquisition of identified riparian and sensitive headwater lands, and implementation of plans with significant acquisitions of carefully selected critical lands;
- Altering public land and facility operations that were polluting the Anacostia River, such as a bus depot leeching oil or the National Zoo dumping animal waste;
- Upgrading wastewater and sewer facilities;
- Trash and litter cleanup projects;
- Restoration projects that have stabilized stream bank erosion, replaced artificial channels with natural streambed characteristics, restored degraded wetlands, returned native species to creeks, and planted trees and vegetation in riparian zones;
- The protection of watershed-serving features of privately owned lands with conservation easements on tens of thousands of acres;
- An environmental compliance outreach program for auto repair shops in the Hickey Run subwatershed;
- A project to involve local residents, including low-income inner city school children, in small-scale watershed restoration efforts, such as stream cleanup projects, planting native trees, stenciling storm drains, and offering public education about the watershed and its conditions;
- Extensive activities of the Anacostia Watershed Society, involving tens of thousands of volunteers in public engagement with and support for watershed protection through activities such as watershed stewardship photo essays, recreation-based education about the watershed, elementary school science programs based on student interaction with the river ecosystem, teacher training, newsletters, fish propagation projects, tree and native-plant planting projects, storm drain stenciling, non-native plant removal projects, river and trash cleanup, stream bank stabilization projects, and river tours.[405]

---

[405] *Id.* at 22–27.

The outcomes of watershed-based efforts vary. Some watershed-based processes have produced plans and policies that have been implemented with specific actions and have even produced new local or state regulations and decisions,[406] whereas others have produced primarily information or suggested guidelines for action.[407] Others have produced never-implemented plans, vague agreements on highly general goals without any tough choices, a limited amount of inter-jurisdictional or inter-organizational cooperation on relatively minor points, or even nothing at all. Experts disagree about the successes and failures of various watershed efforts, particularly large-scale, complex, and highly visible watershed collaborations, such as the Chesapeake Bay Program,[408] the Comprehensive Everglades Restoration Plan ("CERP"),[409] and the California Bay-Delta Accord ("CALFED").[410]

---

[406] *See* U.S. ENVTL. PROT. AGENCY, OFFICE OF WATER, A REVIEW OF STATEWIDE WATERSHED MANAGEMENT APPROACHES, 52–65 (2002), [hereinafter EPA, OFFICE OF WATER], *available at* http://www.epa.gov/owow/watershed/approaches_fr.pdf.

[407] *See, e.g.*, *Watershed Inspection Guidelines*, SOURCE WATER PROT. COMM. CONN. SECTION AWWA (2010), http://www.ct.gov/dph/lib/dph/drinking_water/pdf/WATERSHED_INSPECTION_GUIDELINES_2010.pdf.

[408] *Compare* Cannon, *supra* note 334, at 394–407 (generally successful), *with* HOWARD R. ERNST, CHESAPEAKE BAY BLUES: SCIENCE, POLITICS, AND THE STRUGGLE TO SAVE THE BAY (2003) (extensive analyses of history, successes, failures, and ongoing challenges, with overall favorable assessment but recommendations for specific improvements to the existing framework) *and* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-06-96, CHESAPEAKE BAY PROGRAM: IMPROVED STRATEGIES ARE NEEDED TO BETTER ASSESS, REPORT, AND MANAGE RESTORATION PROGRESS (2005) (analyzing underperformance and management problems); Erin Ryan, *New Orleans, the Chesapeake, and the Future of Environmental Assessment: Overcoming the Natural Resources Law of Unintended Consequences*, 40 U. RICH. L. REV. 981, 982–85, 1003–16 (2006) (wetland loss due to unintended consequences of well-intentioned wetlands protection policies).

[409] *Compare* LAYZER, *supra* note 270, at 103–36 (few tangible gains from collaborative ecosystem restoration planning process); Light, *supra* note 340 (restoration process lacks dispute resolution mechanisms and substantive sustainability rules); J. Walter Milon et al., *Adaptive Ecosystem Management and the Florida Everglades: More than Trial-and-Error?*, 113 WATER RESOURCES UPDATE, Fall 1998, at 37 at 38–39 (discussing engineering and cost biases in CERP); Zellmer & Gunderson, *supra* note 389, at 934–42 (too many compromises and bureaucratic inertia); Zweig & Kitchens, *supra* note 198 (concluding that the ecosystem restoration goals of CERP are impossible to achieve, because ecosystem changes prevent return to pre-disturbance conditions); *with* Klein, *supra* note 143, at 989–90 (a promising opportunity); Terrence "Rock" Salt et al., *The Challenges of Restoring the Everglades Ecosystem*, *in* LARGE-SCALE ECOSYSTEM RESTORATION, *supra* note 334, at 5, 27–31 (identifying ten success lessons from the creation of CERP).

[410] *Compare* FELDMAN, *supra* note 117, at 154–170 (describing CALFED as a major achievement in introducing collaborative adaptive management to complex water conflicts in the Western U.S., somewhat successful in some particular respects, and too soon to tell if significant challenges can be overcome); Freeman & Farber, *supra* note 33, at 837–76 (a model of

In general, though, the phenomenon of watershed planning, restoration, management, and regulation has produced demands for better information, new models, feedback loops, and improved use of these tools in decision making.[411] Attention to environmental, land use, water resources, and other problems at watershed levels has pushed watershed-related problems and issues onto the agendas of various institutions, organizations, political jurisdictions, policy makers, and resource managers, whether at the watershed level or at other levels of governance and management.[412] Watershed efforts in general have become an important means to engage the public in complex environmental issues and to educate them about the causes and effects of these problems, the science behind environmental issues, and the policy and value choices that people and communities face.[413] Watershed efforts have been responsible for the generation of data and data-gathering and data-reporting processes that are ongoing.[414] These data provide valuable information for other institutions and decision makers, subsequent watershed efforts, regulatory or policy reform efforts, resource managers, and the like.[415] The benefits flow to larger-scale systems of environmental and resource decision making, not just to a specific watershed effort. Moreover, watershed processes have created, facilitated, or strengthened networks, relationships, and patterns

---

modular environmental regulation that overcomes the constraints of inflexible approaches); Elizabeth Ann Rieke, *The Bay-Delta Accord: A Stride Toward Sustainability*, 67 U. COLO. L. REV. 341 (1996) (assessing CALFED as a success); *with* LAYZER, *supra* note 270, at 137–71 (fails to prevent or reduce serious ecological stresses on Bay-Delta system due to primacy of gaining consensus); Dave Owen, *Law, Environmental Dynamism, Reliability: The Rise and Fall of CALFED*, 37 ENVTL. L. 1145 (2007) [hereinafter Owen, *CALFED*] (assessing CALFED as a failure); *see also* David E. Booher & Judith E. Innes, *Complexity and Adaptive Policy Systems CALFED as an Emergent Form of Governance for Sustainable Management of Contested Resources*, 50 INTL. SOC'Y SYS. SCI. (2006), *available at* http://www.csus.edu/ccp/publications/isss_complexity_and_adaptive_policy_systems.pdf (example of increasingly needed form of collaborative complex adaptive system governance); Doremus, *supra* note 249 (nuanced assessment of CALFED's successes and failures).

[411] *See* U.S. GEN. ACCOUNTING OFFICE, GAO-04-382, WATERSHED MANAGEMENT: BETTER COORDINATION NEEDED TO SUPPORT KEY DECISIONS (2004), [hereinafter U.S. GAO, WATERSHED MANAGEMENT] *available at* http://www.gao.gov/new.items/d04382.pdf; CONN. DEP'T OF ENVTL. PROT., NORTH BRANCH PARK RIVER WATERSHED MANAGEMENT PLAN (2010), *available at* http://www.ct.gov/dep/lib/dep/water/watershed_management/wm_plans/nbparkr/nbpr_wbp.pdf.

[412] *See* EPA OFFICE OF WATER, *supra* note 406.

[413] *See, e.g.*, *Science in Your Watershed*, U.S. GEOLOGICAL SURVEY, http://water.usgs.gov/wsc/wshed_education.html (last visited Apr. 3, 2011).

[414] *See generally* U.S. GAO, WATERSHED MANAGEMENT, *supra* note 411 (describing efforts by various entities to collect water quantity and quality data).

[415] *Id.*

of inter-jurisdictional cooperation that stimulate further iterations of watershed protection or coordination activity and that serve to aid in addressing other environmental problems or pursuing other integrated multimodal solutions.[416] The variety of methods and outcomes of various watershed-based activities are thus playing critical cross-issue, cross-actor, cross-scale, cross-action integration roles over time, when observed from the perspective of a larger socio-legal-ecological phenomenon.

C. Local Climate Change Plans

A third example, perhaps weaker and less developed than wet growth or watershed planning and management, is the relatively recent phenomenon of local governments and communities creating climate action plans. While progress on international climate change agreements has stalled[417] and the federal government has been mired in primarily iterative inaction on climate change,[418] many localities throughout the United States have created action plans to address climate change mostly by assessing current impacts, attempting to mitigate local contributions to climate change, and, in some cases, attempting to adapt to climate change.[419]

---

[416] *See, e.g.*, *Watershed Coordination Grants*, CAL. DEP'T OF CONSERVATION, http://www.consrv.ca.gov/dlrp/wp/grants/Pages/wcgp_intro.aspx (last visited Apr. 3 2011); Kenneth Genskow & Stephen Born, *Organizational Dynamics of Watershed Partnerships: A Key to Integrated Water Resources Management*, 135 J. CONTEMP. WATER RES.& EDUC., Dec. 2006, at 56, 56–57.

[417] *See, e.g.*, Daniel Bodansky, *The Copenhagen Climate Change Conference—A Postmortem*, 104 AM. J. INT'L L. 230 (2010), *available at* http://ssrn.com/abstract=1553167 (a hopeful analysis of the potential for the Copenhagen Accord, which was not adopted, to lead to "bottom up" action under international public pressure, but recognizing that the future of global climate change action is uncertain after failure to adopt the Accord); *see also Climate Change Talks "Backslide" at Bonn*, BBC NEWS (Aug. 6, 2010), http://www.bbc.co.uk/news/science-environment-10900798.

[418] *See, e.g.*, Eric Pooley, *Where Next for the Wrecked US Climate Bill?*, GUARDIAN (July 29, 2010), http://www.guardian.co.uk/environment/2010/jul/29/wrecked-us-climate-bill; Robin Bravender & Katie Howell, *Fallout Begins After Senate's Failure to Act on Energy, Oil Spill*, N.Y. TIMES (Aug. 5, 2010), http://www.nytimes.com/gwire/2010/08/05/05greenwire-fallout-begins-after-senates-failure-to-act-on-54000.html.

[419] *See, e.g.*, Stephen Wheeler, *State and Municipal Climate Change Plans: The First Generation*, 74 J. AM. PLANNING ASS'N 481, 481–82 (2008); Salkin, *Sustainability*, *supra* note 305, at 140–41; Patricia E. Salkin, *Can You Hear Me Up There?: Giving Voice to Local Communities Imperative for Achieving Sustainability*, 4 ENVTL. & ENERGY L. & POL'Y J. 256, 264–86 (2009) [hereinafter Salkin, *Voice*]; Zhenghong Tang, et al., *Moving from Agenda to Action: Evaluating Local Climate Change Action Plans*, 53 J. ENVTL. PLANNING & MGMT. 41, 42 (2010); CAL. GOVERNOR'S OFFICE OF PLANNING AND RESEARCH, *Cities and Counties Addressing Climate Change* (rev. Apr. 5, 2010), http://www.opr.ca.gov/ceqa/pdfs/

Contrary to assumptions about the lack of local incentives to invest time, resources, and authority in addressing a massive and overwhelming global problem, this phenomenon has surprised many experts or at least attracted attention as being a noteworthy development.[420] Some scholars have attempted to assess or theorize the motives that are driving local governments and communities to address climate change mitigation,[421] such as rational self-interested behavior in getting credit for taking symbolic action on a major public problem,[422] or a race-to-the-top among localities marketing themselves as desirable "green" communities for residents and businesses.[423] In addition, local climate action planning is often treated as an issue of federalism and the optimal solutions for reducing greenhouse gas emissions in the United States and globally.[424] However, a different, emerging literature situates local efforts to address climate change within complex, adaptive, multi-scalar institutional and social-system dynamics that are evolving and that demand polycentric approaches.[425] This collection

---

City_and_County_Plans_Addressing_Climate_Change.pdf (listing and providing Internet links to plans adopted by California cities and counties to address greenhouse gas emissions, and local programs in other states); *Climate Change Action Plans*, U.S. ENVTL. PROT. AGENCY, STATE AND LOCAL CLIMATE AND ENERGY PROGRAM, http://www.epa.gov/statelocalclimate/local/local-examples/action-plans.html (listing and providing Internet links to plans adopted by local governments nationwide) (last visited Apr. 3, 2011).

[420] *See, e.g.*, Kevin L. Doran, *U.S. Sub-Federal Climate Initiatives: An Irrational Means to a Rational End?*, 26 VA. ENVTL. L.J. 189 (2008); Nicholas Lutsey & Daniel Sperling, *America's Bottom-Up Climate Change Mitigation Policy*, 36 ENERGY POL'Y 673 (2008); Katherine A. Trisolini, *All Hands on Deck: Local Governments and the Potential for Bidirectional Climate Change Regulation*, 62 STAN. L. REV. 669 (2010).

[421] *See* Katherine Trisolini & Jonathan Zasloff, *Cities, Land Use, and the Global Commons: Genesis and the Urban Politics of Climate Change*, *in* ADJUDICATING CLIMATE CHANGE: STATE, NATIONAL, AND INTERNATIONAL APPROACHES 72 (William C.G. Burns & Hari M. Osofsky eds., 2009).

[422] *See* Kirsten H. Engel & Barak Y. Orbach, *Micro-Motives for State and Local Climate Change Initiatives*, 2 HARV. L. & POL'Y REV. 119, 121 (2008); Kirsten H. Engel & Scott R. Saleska, *Subglobal Regulation of the Global Commons: The Case of Climate Change*, 32 ECOLOGY L.Q. 183, 215–23 (2005) ("Given the notoriety associated with adopting climate-related policies at the state and local level, politicians have much to gain from even a mostly symbolic measure.").

[423] Michael Burger, *"It's Not Easy Being Green": Local Initiatives, Preemption Problems, and the Market Participant Exception*, 78 U. CIN. L. REV. 835 (2010).

[424] *See, e.g.*, *id.*; Kirsten H. Engel, *State and Local Climate Change Initiatives: What is Motivating State and Local Governments to Address a Global Problem and What Does this Say About Federalism and Environmental Law?*, 38 URB. LAW. 1015 (2006); Kaswan, *supra* note 200.

[425] *See, e.g.*, Doran, *supra* note 420; Victor B. Flatt, *Act Locally, Affect Globally: How Changing Social Norms to Influence the Private Sector Shows a Path to Using Local Government to Control Environmental Harms*, 35 B.C. ENVTL. AFF. L. REV. 455 (2008); Lutsey &

of scholarship moves beyond questions about whether devolved localist governance is optimal or suboptimal, to observe that local action and governance beneficially affect action and governance at larger scales (e.g., state and federal government, global governance and dispute resolution) and at smaller scales (e.g., individual and community action),[426] address actions that are particular to or best managed at the local scale,[427] produce integrally-related but ancillary or supplemental local-scale benefits from addressing climate change (e.g., improved physical activity, community-building, economic values of "green places"),[428] shape social norms and build social capital,[429] and take diverse approaches to climate change that stimulate and diffuse innovation.[430] All this is because the dynamics of climate, ecosystems, social systems, and human behavior are so complex and multi-faceted that the structure of climate-change response cannot be adopted or imposed but can only emerge.[431]

Thus, it is not surprising that despite frameworks recommended by experts for local governments to use, such as the Cities for Climate Protection Campaign,[432] there is great variety among local climate action plans. Out of forty plans studied by one set of researchers, 87.5% included emissions inventories; 82.5% calculated base year emission data and forecast emission trends; 65% engaged in cost-benefit analysis for greenhouse gas emission reductions; but only 15% conducted vulnerability assessments for impacts on various populations.[433] Moreover, 85% included policies for public awareness, participation, and education; 47.5% included greenhouse

---

Sperling, *supra* note 420; Osofsky, *Scaling Local*, *supra* note 77; Osofsky & Levit, *supra* note 77; Trisolini, *supra* note 420; Krakoff, *supra* note 41; Elinor Ostrom, *A Polycentric Approach for Coping with Climate Change* (World Bank Research Working Paper No. 5095, 2009), *available at* http://wdronline.worldbank.org/worldbank/a/nonwdrdetail/162.

[426] *See, e.g.*, Lutsey & Sperling, *supra* note 420 (arguing that state level initiatives targeting GHGs may result in nationwide emission reductions and spur federal action); Osofsky, *Scaling Local*, *supra* note 77 (discussing the multi-scalar effects of climate change mitigation efforts in San Bernardino County); Trisolini, *supra* note 420, at 734 (arguing that local efforts to mitigate climate change trickle up to effect change at the national level).

[427] *See, e.g.*, Osofsky & Levit, *supra* note 77, at 410–11 (noting that localities serve on the "front line" in regulating some of the major GHG contributors, such as private transportation activities); Ostrom, *supra* note 425, at 4; Trisolini, *supra* note 420, at 698.

[428] *See, e.g.*, Ostrom, *supra* note 425, at 15; Burger, *supra* note 423.

[429] *See, e.g.*, Flatt, *supra* note 425; Krakoff, *supra* note 41 (discussing small-scale climate mitigation efforts and their relationship to environmental values and norms).

[430] *See, e.g.*, Ostrom, *supra* note 425, at 39.

[431] *See supra* note 425 and accompanying text (describing the complex multi-scalar, multi-faceted relationship between climate change, social norms, and climate change regulation).

[432] Tang, *supra* note 419, at 42.

[433] *Id.* at 50–51.

gas reduction fees; 37.5% called for carbon taxes; 65% included policies for mixed-use and compact development; 60% included green-building and green-infrastructure policies; 37.5% had policies on infill development and brownfield remediation/reuse; 35% had area-wide growth control policies; 17.5% addressed disaster-resistant land use and building codes; 80% included alternative transportation strategies; 77.5% called for transit-oriented development and corridor improvements; 72.5% addressed community design for pedestrian, bicycle, and transit use; 65% modified existing parking standards; 82.5% had energy efficiency and energy star policies; 80% planned to use renewable energy; 70% included a landfill methane capture strategy; 82.5% had a waste reduction and recycling strategy; 20% included stormwater management strategies; only 7.5% addressed critical environmental areas' conservation or ecosystem-based land management; 70% gave attention to continuous monitoring, evaluation, and updating; 55% created implementation priorities; but only 20% established financial and budget commitments for implementation.[434]

Three different cities' approaches to climate change planning illustrate the nature of this development in environmental protection and the variety of approaches that have been taken. The Chicago Climate Action Plan, which was created by a multi-participant task force appointed by Mayor Richard M. Daley and aided by scientists and other experts, adopted thirty-five action items organized around five climate change strategies for Chicago: 1) energy efficient building; 2) clean and renewable energy sources; 3) improved transportation options; 4) reduced waste and industrial pollution; and 5) adaptation.[435] The central goal is an eighty percent reduction in Chicago's greenhouse gas emissions below its 1990 levels by the year 2050.[436] However, the plan has many elements. "The Action Plan has been described as 'silver buckshot' because of its comprehensive approach to this complex issue, in contrast to the typical 'silver bullet' strategy that concentrates all energies on just one solution."[437]

Second, the Louisville, Kentucky plan, The Partnership for a Green City Climate Action Report, was developed by a multi-participant Climate Change Committee with the leadership of the Louisville Metro Air Pollution Control District and under the auspices of the Green City Partnership,

---

[434] *Id.* at 51–53.

[435] CITY OF CHICAGO, CHICAGO CLIMATE ACTION PLAN 18 (2008), *available at* http://www.chicagoclimateaction.org/filebin/pdf/finalreport/CCAPREPORTFINALv2.pdf; *see also* Jay Walljasper, *Surprise Climate Leader*, CITISCOPE, *available at* http://citiscope.org/2010/surprise-climate-leader (last visited Apr. 3, 2011).

[436] CITY OF CHICAGO, *supra* note 435, at 14.

[437] Walljasper, *supra* note 435.

composed of the three major public-sector entities in Louisville: the Louisville Metro Government (consolidated city-county government); the Jefferson County Public School System; and the University of Louisville.[438] The Report includes:

- greenhouse gas inventories and recommendations concerning updated and future inventories and data;
- analysis of climate change's impacts on the Louisville region and its environment, with recommendations concerning adaptation;
- emission reduction strategies related to energy efficiency in buildings and facilities, renewable and alternative energy strategies, and utility regulations, policies, and practices;
- land use impacts and policies (e.g., alternatives to automobile-dependent development, efficient use of the existing built environment, energy-efficient buildings and sites, environmental impact information, long-range planning with climate change scenarios, green infrastructure, land conservation, urban runoff control, low-impact development methods, sustainable local agriculture, regional land-use collaboration, improved enforcement tools, and public education);
- transportation impacts and policies (integration of land use and transportation planning, transit-oriented development, public transit policies, multimodal infrastructure, parking practices, telecommuting incentives, compressed work week incentives, reduced speed limits, vehicle operating practices, vehicle technology, fuel and energy efficient standards, heat island effect mitigation measures, and practices for construction equipment and marine vehicles);
- urban forestry policies concerning the urban forester, prevention of net tree loss, tree cover in densely paved areas, and highway forests, among other urban forestry conditions;

---

[438] PARTNERSHIP FOR A GREEN CITY, *supra* note 205, at i–iii, 1–3. I served on the Climate Change Committee and co-chaired its Land Use, Transportation, and Urban Forestry Working Group.

- waste practices recommendations concerning multiple sectors, the commercial sector specifically, composting, and landfill operations; and
- a variety of education and outreach goals and programs.[439]

Not surprisingly, the Report made 175 recommendations.[440] However, the Report expressly recognized that the economic downturn and state and local budget crises that were emerging as the Report was being finalized could delay or prevent the implementation of many of the recommendations.[441]

A third example is Denver, Colorado. Professor Salkin has summarized its features:

> Denver's 2007 climate action plan was prepared by an advisory council through a process that included significant public participation and expert contributions, and includes a set of recommendations for reducing emissions. After finding that the city's initial goal of reducing emissions by ten percent of 1990 levels "appears to be attainable," the plan recommends a second target of reducing emissions to below 1990 levels. The plan lists 10 specific goals: (1) encourage residents and businesses to adopt energy saving and sustainable practices; (2) incentivize energy conservation through tiered utility rates; (3) create a voluntary travel offset program; (4) lead by example by developing carbon neutral city buildings and other city programs; (5) enhance recycling programs; (6) adopt mandatory energy efficiency standards for new buildings; (7) increase energy efficiency in existing homes; (8) require the use of "green" concrete; (9) support compact, pedestrian, and bicycle-friendly transit oriented development; and (10) promote alternative transportation strategies of all types. The Climate Action Plan also contains information about the city's GHG inventory, which sought to determine the amount of emissions produced by various sectors of the city. It also lists a number of specific policy recommendations for emissions reductions strategies at the regional, state and federal levels.

---

[439] *See id.* at 5–84.
[440] *Id.* at 83.
[441] *Id.* at iii.

> Denver's climate action plan also stands out for its accessibility. It is part of a broader public outreach campaign with an excellent website that contains background information on climate change and suggests ways in which community members can get involved. This type of public outreach component to municipal sustainability campaigns, while not universal, is common.[442]

Local climate action plans have some major limitations that make it unlikely that they will, by themselves, be adequate responses to climate change causes and effects, even at local levels.[443] Perhaps most broadly, they are addressing actions that are only a portion of the human contributions to global climate change across multiple geographic and temporal scales and dynamics and face a variety of institutional and systemic obstacles to undertaking sufficiently effective action.[444] Local action on climate change will not be enough to achieve either sufficient mitigation of climate change's human causes or adequate adaptation to climate change's impacts that will extend beyond local boundaries.[445] More specifically, initial local climate change plans have been more limited than they potentially could be.[446] Some have focused primarily on local governments' improved energy efficiency and greenhouse-gas emission reductions.[447] The plans tend to focus more on the built environment than the natural environment.[448] Many did not address adaptation at all.[449] Typically goals have been modest and implementation weak.[450]

Despite these limitations, though, local climate change plans have exhibited some important characteristics of emergent integrationist multimodality. First, an increasing number of localities are addressing a wide range of interrelated aspects of climate change in their plans.[451] Even when

---

[442] Salkin, *Voice*, *supra* note 419, at 271–72 (citing CITY OF DENVER, CLIMATE ACTION PLAN i, 5–7(2007), *available at* http://www.greenprintdenver.org/docs/DenverClimate ActionPlan.pdf).
[443] *See* Trisolini, *supra* note 420, at 672–73.
[444] *See id.* at 672–73, 680–87; Kaswan, *supra* note 200, at 289–95.
[445] *See* Trisolini, *supra* note 420, at 673–74.
[446] *See* Wheeler, *supra* note 419, at 484 (describing early climate change plans that were seemingly "intended in large part to generate policy alternatives and stimulate discussion.").
[447] *See* Wheeler, *supra* note 419, at 484–85.
[448] Tang, *supra* note 419, at 55.
[449] Wheeler, *supra* note 419, at 481, 484, 488, apps. B, D, E; *see also* Tang, *supra* note 419, at 51–53, 55–66.
[450] See Tang, *supra* note 419, at 41, 54–57; Wheeler, *supra* note 419, at 486–88.
[451] *See* Kaswan, *supra* note 200, at 285 (describing land use, transportation, and buildings strategies identified within the U.S. Conference of Mayors' Climate Protection Agreement,

early plans were more likely to be limited to public-sector greenhouse gas emissions and energy efficiency, many of these plans included urban forestry components.[452] Adaptation was ignored initially in many plans,[453] but a growing number of climate change planning efforts are now addressing adaptation and at least struggling with how to evaluate the possible relationships between mitigation and adaptation.[454] Local planning is addressing a wide range of actions and sectors affecting and affected by climate change.[455] "[P]lans usually include recommendations in a broad range of areas including energy, transportation, land use, buildings, industry, and agriculture."[456] Some plans may address these different areas in discrete and fragmented ways, but some consider the relationships among them.[457] If nothing else, the plan itself links aspects of climate change problems that have been historically treated entirely separately.[458]

---

signed by 910 mayors).

[452] *See* Wheeler, *supra* note 419, at 484, 485.

[453] *See id.* at 484, 488.

[454] *See, e.g.*, PARTNERSHIP FOR A GREEN CITY, *supra* note 205, at 13–26, 48–55. In addition, separate local planning processes for adapting to climate change with respect to particular resources, such as watersheds or water resources, may involve many of the same participants as local climate action planning and may draw on or contribute to local climate change plans. *See, e.g.*, Arnold, *Adaptive Watershed Planning*, *supra* note 336. Thus, there may be more coordinated or integrated attention to adaptation than may appear on the face of particular local climate action plans.

[455] *See* Wheeler, *supra* note 419, at 484.

[456] *See id.* at 484.

[457] For example, the Louisville, Kentucky Climate Action Report to the Partnership for a Green City, in which I participated, organized specific working groups around cross-cutting topics that were considered in relationship to one another, such as land use, transportation, and urban forestry being coordinated by one working group, and adaptation policies for public health, water and watershed, natural hazards, and agriculture and horticulture impacts of climate being coordinated by another working group. Specific working groups expressly considered the impacts of other working groups' areas, such as the relationships between adaptation actions and land use planning or regulation or urban forestry programming, or the relationships between energy efficiency improvements and transportation patterns. In addition, the multi-participant Climate Change Committee met regularly to discuss interconnections among the research and recommendations of the individual working groups. The resulting plan was not a paragon of holistic integration. Integrationist efforts depended more on individual leadership, ad hoc processes, and networks stimulated by the planning process than on systematic, structured process design. The greatest weakness was a lack of systematic study, modeling, and analysis of interconnections among various topics and policy options addressed in the plan, which could have taken years to develop. Nonetheless, compared to the conventional fragmented "silo" approach of environmental policy generally or local policy generally, the Louisville climate action planning process was a relatively cross-sector, cross-agency, cross-discipline/profession, cross-issue, cross-policy integrationist effort.

[458] *See* PARTNERSHIP FOR A GREEN CITY, *supra* note 205, at 2–3.

Second, local climate change action plans serve as catalysts for multimodal responses to climate change. Plans include not only policies governing government vehicles and buildings, but also green infrastructure projects, changes to recycling policies, land use plans and regulatory reforms, public education programs, incentives, technology development, and other features.[459] For example, Olympia, Washington, not only addressed greenhouse gas emissions but also "develop[ed] plans to relocate city wells further inland to avoid salt water intrusion and [took] steps to avoid flooding. The city has also reconsidered the site for a new city hall because this location in the city's low-lying downtown may eventually be underwater."[460] As might be expected, there has been more emphasis on voluntary action than on regulation,[461] but some plans have proposed local regulations.[462] Moreover, local climate change planning has intersected with local sustainability goals, the development of "green building" standards in the building industry, such as LEED certification, and growing examples of "green building" regulatory requirements in local zoning and building codes.[463]

Third, some localities are linking climate change planning to larger planning, such as local comprehensive planning or local sustainability plans.[464] In addition, state environmental impact assessment requirements and processes have either required or facilitated local attention to climate change impacts of major projects and policy decisions in states with relatively strong environmental impact assessment laws.[465]

---

[459] *See* Salkin, *Voice*, *supra* note 419, at 264–86; Tang, *supra* note 419, at 52; Wheeler, *supra* note 419, at 485.

[460] Wheeler, *supra* note 419, at 484.

[461] *Id.* at 487.

[462] *See* Salkin, *Voice*, *supra* note 419, at 268 (noting that green building regulations have been enacted in dozens of municipalities).

[463] On green building standards and regulations and local sustainability policies, see generally Salkin, *Sustainability*, *supra* note 305, at 140–41; Fox, *supra* note 305 (analyzing the rise of LEED standards and the subsequent reaction); Hirokawa, *supra* note 311 (explaining the evolution of green building); Sussman, *supra* note 305 (arguing local governments can positively influence global warming through green building and other energy programs); Swing, *supra* note 305 (examining the case study of Boston's pilot green building).

[464] *See* Wheeler, *supra* note 419, at 483. *See generally* Salkin, *Sustainability*, *supra* note 305 (discussing various examples of state and local attention to climate change in comprehensive planning, sustainability planning, environmental impact analysis, adaptation planning, and other local policies and actions).

[465] *See, e.g.*, Catherine J. LaCroix, *SEPAs, Climate Change, and Corporate Responsibility: The Contribution of Local Government*, 58 CASE W. RES. L. REV. 1289, 1294 (2008); *see also* STATE OF CALIFORNIA DEPT. OF JUSTICE, THE CALIFORNIA ENVIRONMENTAL QUALITY ACT: ADDRESSING GLOBAL WARMING IMPACTS AT THE LOCAL AGENCY LEVEL (2008).

Fourth, local climate change planning is improving information about and awareness of the many aspects of climate change.[466] The planning processes, structures, and networks themselves serve as means for developing and diffusing information and ideas about the many related dimensions of climate change in local communities and beyond.[467] For example, local government planning to reduce greenhouse gas emissions in the Pacific Northwest and British Columbia has focused attention on the need for new or revised multi-scalar and multi-sector tools to evaluate urban-form policy choices for their climate change implications and to integrate the analysis into policy decision-making and implementation.[468] Policy makers and technical experts from Portland, Seattle, and Vancouver participated in collaborative meetings that identified needs both to engage in collaborative, coordinated, multi-scalar, and multi-sector development of a suite of multiple tools for context-appropriate and problem-appropriate selection based on research and experience and to adapt the existing mosaic of tools by synthesizing them into a meta-tool or comprehensive integrated suite of tools that could be deployed quickly to meet the urgency of climate change.[469]

Fifth, local climate change planning has stimulated or strengthened networks of people, groups, agencies, and even institutions that are sharing information and engaging in some level of collective planning or action across the traditional "silos" that have existed in local governments and in local communities (e.g., transportation, land use, procurement, energy, agriculture, water, economic development, education, and so forth).[470]

---

[466] *See infra* notes 467–72 and accompanying text.

[467] *See* John R. Nolon, *Climate Change and Sustainable Development: The Quest for Green Communities*, 61 PLANNING & ENVTL. L., 3, 4–6 (2009) (exploring "the role of local governments in mitigating and adapting to climate change through sustainable development strategies"). *See generally* Lutsey & Sperling, *supra* note 420 (exploring climate change policy and regulation at the state, local, and regional levels); Nicole Miller et al., *Policy, Urban Form, and Tools for Measuring and Managing Greenhouse Gas Emissions: The North American Problem*, 80 U. COLO. L. REV. 977 (2009) (explaining the necessity of, and yet the challenges to, local and regional policy planning processes).

[468] *See* Miller et al., *supra* note 467, at 978–80.

[469] *See id.* at 980, 995–98.

[470] *See, e.g.*, Miller et al., *supra* note 467, at 979, 984, 995–96 (explaining that "[l]ocal and regional planning processes must be robust enough to speak to decision makers engaged in various disciplines who manage efforts at different scales and who regulate different elements of public infrastructure or private enterprise . . . ."); Walljasper, *supra* note 435 (reporting that the Chicago Climate Action Plan cut across many segments of the Chicago city government and society and across many participants: "business, scientists, civic institutions, neighborhood associations, [and] citizens.") The plan also brought together commissioners from key city departments to coordinate actions and meet regularly on

Many local climate change plans have resulted from multi-participant processes.[471] Merely having to talk with one another does not necessarily mean that different agencies, officials, or groups will coordinate their responses to climate change or cooperate in integrated ways.[472] However, the local climate change planning process has improved the capacity for local institutions and communities to act in more coordinated or collaborative ways on complex and multidimensional environmental problems.[473]

Finally, by understanding local climate change plans as emergent and adaptive responses within complex institutional, social, and environmental dynamics,[474] we see that they are likely to continue to evolve in the nature of the methods and integrative features used in local climate change planning. They are also likely to continue to evolve in their multiscalar impacts and functions among an array of interconnected institutions in society.

V. FEATURES OF INTEGRATIONIST MULTIMODALITY: NODES OF CONNECTIVITY

How are multiple modes of environmental protection integrated? To borrow a concept from other examples of integrated multimodal

---

implementation. *See also* Lutsey & Sperling, *supra* note 420 ("US climate change policy is far more complex and rich than what is commonly thought. A wide variety of subnational initiatives are underway."); Nolon, *supra* note 467, at 4–6.

[471] *See* Wheeler, *supra* note 419, at 484. Louisville, Kentucky's plan was formally a project of the Partnership for a Green City, a sustainability-oriented partnership among Louisville Metro government (consolidated city-county government), the University of Louisville, and the Jefferson County Public School System, which are the three largest government entities in Louisville, and was coordinated by the Louisville Metro Air Pollution Control District. *See* PARTNERSHIP FOR A GREEN CITY, *supra* note 205, at i–iii. However, it involved participants from major energy providers, other utility and public infrastructure providers, large corporations and industries, environmental advocacy groups, recreation and natural-resource managers, planners, lawyers, educators/scholars, and interested citizens. *Id.* at i–iii, 90–92.

[472] *See generally* Ostrom, *supra* note 425 (explaining that cooperation exists at multiple levels of global society, and exploring the reasons why such cooperation has formed and its effectiveness).

[473] *See, e.g.*, Walljasper, *supra* note 435 (reporting that the Chicago Climate Action Plan cut across many segments of the Chicago city government and society and across many participants such as "business, scientists, civic institutions, neighborhood associations, [and] citizens.") The plan also brought together commissioners from key city departments to coordinate actions and meet regularly on implementation.

[474] *See, e.g.*, Ostrom, *supra* note 425; Trisolini, *supra* note 420; Osofsky & Levit, *supra* note 77; Osofsky, *Scaling Local*, *supra* note 77; Lutsey & Sperling, *supra* note 420; Doran, *supra* note 420; Krakoff, *supra* note 41; Flatt, *supra* note 425.

structure, the integration of multiple modes occurs at intersections of connectivity called *nodes*.[475] The evolution of integrationist multimodality in environmental law, as illustrated by wet growth, watershed-based action, and local climate change planning, is about the emergence of these nodes of connectivity. Four categories of nodes are briefly identified and discussed below.

A. Connections Among Actors

In a complex and dynamic socio-legal system, no single actor, entity, or institution can effectively solve massive or wicked environmental problems, nor does any single actor, entity, or institution act unilaterally, free of the effects of other actors, entities, or institutions.[476] Therefore, the integrated use of multiple modes of environmental protection is likely to arise, if at all, only where connections among multiple actors, entities, and institutions within socio-legal systems exist.[477] In some cases, these connections may arise around existing networks of interactions among a variety of actors.[478] In other cases, networks may develop out of the need for multiple actors to work together to address complex and multi-scalar problems.[479] In both cases, these networks often lack formal and hierarchical structures, instead having more diverse, informal, and decentralized structures.[480] For example, wet growth policies, watershed-based actions, and local climate change plans are multi-participant innovations that have

---

[475] *See, e.g.*, Bhanu M. Yerra & David M. Levinson, *The Emergence of Hierarchy in Transportation Networks*, 39 ANNALS OF REGIONAL SCI. 541, 543 (Oct. 2004) (using the node concept to explain transportation networks).

[476] *See generally* Ostrom, *supra* note 425 (advocating for a polycentric approach to establishing climate change coping mechanisms or implementation plans).

[477] *See generally* Feldman & Ingram, *supra* note 40 (explaining that knowledge networks assist in overcoming impediments to the exchange of information); Carl Folke, et al., *Synthesis: Building Resilience and Adaptive Capacity in Social-Ecological Systems*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 25, at 352; Victor Galaz et al., *The Problem of Fit Among Biophysical Systems, Environmental and Resource Regimes, and Broader Governance Systems: Insights and Emerging Challenges*, *in* INSTITUTIONS AND ENVIRONMENTAL CHANGE 147, *supra* note 95, at 147–49; Ostrom, *supra* note 425 (advocating for a polycentric approach to establishing climate change coping mechanisms or implementation plans).

[478] *See generally* Ostrom, *supra* note 425 (explaining that cooperation exists at multiple levels of global society, and exploring the reasons why such cooperation has formed).

[479] *See id.*

[480] *See id.*

both used existing networks and developed new networks, depending on a variety of context-specific conditions.[481]

One of the more confusing issues about nodes of multi-actor connections is the degree to which integrationist multimodality requires cooperative behavior or the development of consensus among networked stakeholders. A central feature of many "new governance" theories about how complex and dynamic socio-legal systems will need to address complex and dynamic environmental problems is devolved collaboration that uses multi-stakeholder processes and informal networks.[482] This feature, though, has received considerable criticism for enabling the avoidance of hard trade-offs among outcomes and values, preserving the status quo, failing to build hard law and formal institutions, and resulting in ineffective, vague, unimplemented or unimplementable plans.[483] For example, the multi-institutional collaborative CALFED process for addressing complex and pressing water supply and ecosystem conservation issues in California's Bay-Delta system has been both praised and criticized for its use of collaborative methods.[484]

---

[481] *See, e.g.*, Walljasper, *supra* note 435 (explaining the cooperative organizational structure of Chicago's Action Plan); Craig Arnold, *Introduction: Integrating Water Controls and Land Use Controls: New Ideas and Old Obstacles*, *in* WET GROWTH, *supra* note 136 (explaining wet growth policies); Robert Adler, *Addressing Barriers to Watershed Protection*, 25 ENVTL. L. 973 (1995) (discussing watershed based actions).

[482] *See, e.g.*, Ruhl & Salzman, *supra* note 7, at 106–07; Bradley C. Karkkainen, *Collaborative Ecosystem Governance: Scale, Complexity, and Dynamism*, 21 VA. ENVTL. L. J 189, 200–04 (2002); Jody Freeman, *Collaborative Governance in the Administrative State*, 45 UCLA L. REV. 1 (1997). For further general examples on this topic, see ROBERT J. MASON, COLLABORATIVE LAND USE MANAGEMENT: THE QUIETER REVOLUTION IN PLACE-BASED PLANNING (2008); ADAPTIVE CO-MANAGEMENT COLLABORATION, LEARNING, AND MULTI-LEVEL GOVERNANCE, (Derek Armitage et al. eds. 2007); SWIMMING UPSTREAM, *supra* note 334; BIOLOGICAL DIVERSITY: BALANCING INTERESTS THROUGH ADAPTIVE COLLABORATIVE MANAGEMENT (Louise E. Buck et al. eds., 2001); JULIA M. WONDOLLECK & STEVEN L. YAFFEE, MAKING COLLABORATION WORK: LESSONS FROM INNOVATION IN NATURAL RESOURCE MANAGEMENT (2000); Lubell et al., *supra* note 334.

[483] *See, e.g.*, LAYZER, *supra* note 270, at 30–31, 273–74; Wiersema, *supra* note 270; Sousa & Klyza, *supra* note 270; Coggins, *supra* note 270, at 163–71; Cary Coglianese, *The Limits of Consensus*, 41(3) ENV'T 28 (1999); Cary Coglianese, *Is Consensus an Appropriate Basis for Regulatory Policy?*, *in* ENVIRONMENTAL CONTRACTS 93–113 (Eric W. Orts & Kurt Deketelaere eds., 2001); Zellmer & Gunderson, *supra* note 389, at 929–34.

[484] *Compare* Booher & Innes, *supra* note 410 (providing an example of increasingly needed form of collaborative complex adaptive system governance), FELDMAN, *supra* note 117, at 154–170 (highlighting a major achievement in introducing collaborative adaptive management to complex water conflicts in the Western U.S., somewhat successful in some particular respects, and too soon to tell if significant challenges can be overcome), Freeman & Farber, *supra* note 33, at 837–76 (giving a model of modular environmental regulation that overcomes the constraints of inflexible approaches), *and* Rieke, *supra* note 410

On one hand, the criticisms of collaboration suffer from four major weaknesses. They compare the outcomes of collaborative processes to desired, or perhaps promised, environmental protection outcomes, whereas the "success" of some of these processes might be to prevent, minimize, or mitigate environmental harms or degradation that would have occurred in the absence of the multi-participant collaboration and informal governance developments.[485] They also take a static snapshot of the collaborative processes' outcomes, instead of seeing these processes as iterative and interacting with other processes, forces, and aspects of environmental protection; it may be that the benefits of collaborative processes emerge over time.[486] More broadly, these criticisms often assume that their preferred more-formal or less-consensual decision making or problem solving processes are available, when it is quite possible, maybe even probable, that the same forces inhibiting the effectiveness of collaborative methods will also inhibit other methods, such as command-and-control regulation, litigation, or centralized formal governance.[487] Finally, the reality is that sociolegal systems seek to accomplish a number of goals and serve a variety of values that are not limited to environmental protection goals.[488] Collaborative processes may simply be accomplishing a different set of objectives than their critics value, as evidenced by the fact that collaborative processes tend to be successful at creating trust, social capital, relationships, participatory empowerment, education, commitment, and information.[489]

(assessing CALFED as a success), *with* Doremus, *supra* note 249 (providing yet another example of a nuanced assessment of CALFED's successes and failures), LAYZER, *supra* note 270, at 137–71 (failing to prevent or reduce serious ecological stresses on Bay-Delta system due to primacy of gaining consensus), *and* Owen, *CALFED*, *supra* note 410 (assessing CALFED as a failure).

[485] *See generally* Arnold, *Mono Lake*, *supra* note 61, at 43–55 (exploring and answering criticisms concerning multi-participant and collaborative involvement in issues involving Mono Lake).

[486] *See id.*

[487] *See id.*

[488] *See id.*

[489] *See generally* ARMITAGE ET AL., *supra* note 482. *See also* Chris Ansell & Allison Gash, *Collaborative Governance in Theory*, 18 J. PUB. ADMIN. RES. & THEORY 543, 543 (2007) (highlighting the benefits of "face-to-face dialogue, trust building, and the development of commitment and shared understanding"); Dorothy M. Daley, *Interdisciplinary Problems and Agency Boundaries: Exploring Effective Cross-Agency Collaboration*, 19 J. PUB. ADMIN. RES. & THEORY 477, 488 (2008) (measuring "partnership synergy as a series of positive measurable outcomes resulting from interagency collaboration"); Feldman & Ingram, *supra* note 40; Mark Schneider et al., *Building Consensual Institutions: Networks and the National Estuary Program*, 47 AM. J. POL. SC. 142, 142 (2003) (showing that networks "span more levels of government, integrate more experts into policy discussions, nurture

On the other hand, advocates of collaborative approaches mistakenly assume, or easily can be misunderstood as assuming, that collaboration means cooperation and the building of consensus among multiple participants. From the perspective of socio-legal evolution and the emergence of integrationist multimodality, the term "collaboration" and the roles and functions of "networks" should be more accurately understood as "working together" or "connected interactions" that could involve conflict, the use of more formal decision making and dispute resolution processes, hard (distributive) choices made by authoritative decision makers, and feedback loops that unsettle "consensus" agreements.[490] Patterns of multimodal integration through multi-actor connections are likely to emerge over time through iterative and dynamic processes. For example, relatively successful environmental conservation efforts to save California's Mono Lake from water diversions by Los Angeles resulted from multi-participant relationships that developed over decades of litigation, political activity, scientific study, advocacy, public education and engagement, negotiated problem solving, administrative decision making, restoration, water conservation and reclamation, and other processes, some of which might be viewed as cooperative and others of which would be viewed as conflictual.[491]

B. Connections Among Scales and Functions

A second type of connective node in integrationist multimodality is centered on the multi-scalar and multifunctional characteristics of complex environmental problems and socio-legal responses to these problems. For example, ecosystem-level scale of environmental and natural resource management is viewed as preferable to management of environmental problems along politically and socially constructed boundaries of political and legal jurisdiction.[492] Increasingly, laws, policies, and programs are

---

stronger interpersonal ties between stakeholders, and create greater faith in the procedural fairness of local policy, thus laying the foundation for a new form of cooperative governance."); SWIMMING UPSTREAM, *supra* note 334; *see also* LAYZER, *supra* note 270, at 26–27 (summarizing benefits of collaboration before engaging in study questioning the environmental benefits of collaboration).

[490] *See, e.g.*, Arnold, *Mono Lake*, *supra* note 61, at 43–55.

[491] *See generally* LAYZER, *supra* note 270, at 233–65; Arnold, *Mono Lake*, *supra* note 61 (exploring multi-participant and collaborative involvement in issues involving Mono Lake).

[492] *See generally* NAGLE & RUHL, *supra* note 170, at 318–34; Karkkainen, *supra* note 482; Charles P. Lord et al., *Natural Cities: Urban Ecology and the Restoration of Urban Ecosystems*, 21 VA. ENVTL. L.J. 317, 325–27 (2003); Tarlock, *Rivers*, *supra* note 334, at 1059–60, 1063–64, 1067.

being organized around ecosystems.[493] The examples of watershed-based action exemplify this trend.[494]

However, integration must happen across multiple scales, given the multi-scalar nature of the problems and the systems in which they arise.[495] Watershed-based actions often, although not always, are linked to analyses, conditions, and actions at larger or smaller watershed levels.[496] Local climate change action plans play a key role in connecting local activities, conditions, and responses to larger, variable, and even discontinuous scales at which climate change causes and effects occur.[497]

Furthermore, good integration considers the range of systemic functions at different scales and attempts to find appropriate linkages.[498] For example, the systems for the provision of transportation infrastructure and networks or for the planning and regulation of land use or for the management, allocation, and conservation of water serve different functions than systems for the protection of the environment and the regulation of impacts on the environment. Therefore, any of those other systems cannot simply be subsumed under environmental regulatory or conservation systems, regardless of the impacts of transportation, land use, or water use on the environment. Instead, the methods and modes of non-environmental functions need to be connected to the methods and modes of environmental protection functions. I have explored the nuances of integrating and connecting the multiple scales and functions of watersheds—including nested geographic scales, diverse ecological functions, scales of watershed problems, and evolutionary temporal scales—with the multiple scales and functions of land use—including diverse functions of land use planning and regulation, the political, social, and economic functions of local control over land use, resource-determined relative institutional competencies, and land-use adaptation over time—to address the

---

[493] *See supra* note 492.

[494] *See, e.g.*, Robert Adler, *Addressing Barriers to Watershed Protection*, 25 ENVTL. L. 973 (1995) (discussing watershed based actions).

[495] *See* Craig, *Stationarity*, *supra* note 41, at 54–55 & nn. 233–36. *See generally* Arnold, *Clean-Water Land Use*, *supra* note 116; Kihslinger & McElfish, *supra* note 171; Osofsky, *International*, *supra* note 77; Ostrom, *supra* note 425.

[496] *See* Robert Adler, *Addressing Barriers to Watershed Protection*, 25 ENVTL. L. 973, 1088–91 (1995) (discussing watershed based actions at larger and smaller watershed levels).

[497] *See, e.g.*, Walljasper, *supra* note 435 (explaining the local cooperative organizational structure of Chicago's Action Plan).

[498] *See* Arnold, *Clean-Water Land Use*, *supra* note 116 (explaining a mixed regional local model "matches various institutional functions to appropriate scales . . . ."); Kihslinger & McElfish, *supra* note 171, at 2–7.

multiscalar and multi-functional water quality and watershed impacts of land use.[499]

C. Connections Between Information and Decisions

Perhaps one of the less well-understood phenomena of the evolving environmental law system and systems in related areas is how information is generated and transmitted, often in diffused ways, both by and to many different actors—institutions, organizations, groups, and individuals—for use in decisions that may be remote in time and space from the information-generating processes.[500] For example, ideas and knowledge developed in the voluntary industry-driven LEED certification program have informed the creation of local "green building" regulations and codes.[501] Watershed planning processes have generated information that has been used by various actors within the watershed for a variety of decisions about potential impacts on the watershed, but this information has also been used in federal and state regulatory programs, land development design principles generally, and other watersheds. Nonetheless, a critical component of integrationist multimodality is that information about the complex interrelationships between human actions and environmental conditions actually be considered and used in making decisions, whether by rules, standards, norms, or practices. Likewise, integrationist multimodality requires feedback loops by which the outcomes or effects of decisions are studied and then considered when making adaptive modifications to plans or actions or when making new decisions.[502] Otherwise,

---

[499] Arnold, *Clean-Water Land Use*, *supra* note 116.

[500] On the complex, polycentric, networked, and iterative generation of knowledge and information, see generally BRIDGING SCALES, *supra* note 95; Feldman & Ingram, *supra* note 40; Folke, *supra* note 477, at 366–82; Galaz et al., *supra* note 477, at 147, 163, 182–84.

[501] *See* Fox, *supra* note 305 (explaining the evolution of LEED standards from a voluntary program to mandatory programs in an array of projects at the local, state, and federal levels); Hirokawa, *supra* note 311 (explaining the voluntary origins of LEED programs); Salkin, *Sustainability*, *supra* note 305, at 140–41 (analyzing Denver's 2007 climate plan as "an example of a local sustainability plan developed separately from its comprehensive plan"); Sussman, *supra* note 305 (explaining that the LEED system "serves the critical purposes of promoting sustainable design features and creating a standard that can be applied universally and credibly."); Swing, *supra* note 305 (analyzing Boston's LEED program).

[502] *See, e.g.*, Helen Briassoulis, *Theoretical Orientations in Environmental Planning: An Inquiry into Alternative Approaches*, 13 ENVTL. MGMT. 381, 386–87 (1989); Camacho, *Adapting*, *supra* note 41; George Rzevski, *Planning Under Conditions of Uncertainty*, *in* E.A. FEDOSOV ET AL., COMPLEX SYSTEMS: CONTROL AND MODELLING PROBLEMS (2007), *available at* http://www.emergentintelligence.com/Knowledge_Base_files/07%20Planning%20under%20Uncertainty%20Paper.pdf.

the use of multiple modes only has the appearance but not the substance of integration.

D. Connections Between Innovation and Capacity

A fourth connectivity node links innovation with institutional or organizational capacity. Despite the short-term institutional or systemic benefits of resistance to change, the long-term resilience of socio-legal systems, subsystems, and institutions requires their capacity to innovate under changing conditions and stresses.[503] The availability of a range of different modes or methods of response enhances the capacity to adapt relatively quickly.[504] This availability might exist in modular structure,[505] but it also might come through the diffusion of innovation through networks and shared learning and knowledge generation,[506] or from the lessons learned from improved information generation, monitoring, and outcomes assessments (feedback loops).[507]

Likewise, the utilization of a diversity of responses may be an adaptive risk diversification strategy that is effective if the multiple responses

---

[503] *See, e.g.*, HOLLING ET AL., *supra* note 25, at 1 (arguing that the restrictive view of current environmental policy "will inhibit laudable economic enterprises as well as violate critical environmental constraints"); Galaz, *supra* note 477.

[504] *See* HOLLING ET AL., *supra* note 25, at 35–37.

[505] Freeman & Farber, *supra* note 33, at 795, 877.

[506] *See generally* ARMITAGE ET AL., *supra* note 482; BRIDGING SCALES, *supra* note 95; Feldman & Ingram, *supra* note 40.

[507] For concepts of systemic resilience from learning through adaptive management methods, see generally HOLLING ET AL., *supra* note 25 (arguing that human systems share four properties with ecological systems that allow for adaptive management); CARL WALTERS, ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES vii (1986) (concluding that "actively adaptive probing, deliberately experimental policies should indeed be a basic part of renewable resource management"); Camacho, *Adapting*, *supra* note 41, at 1 (a "learning infrastructure would promote agency learning and accountability, help manage uncertainty, and reduce the likelihood and magnitude of mistakes expected to come. . . ."); Holly Doremus, *Precaution, Science, and Learning While Doing in Natural Resource Management*, 82 WASH. L. REV. 547, 568 (2007) (highlighting the opportunity for "learning-while-doing" in natural resource management); Bradley C. Karkkainen, *Adaptive Ecosystem Management and Regulatory Penalty Defaults: Toward a Bounded Pragmatism*, 87 MINN. L. REV. 943, 945 (2003) (situating adaptive management in the "experimental method of inquiry"); Kai N. Lee & Jody Lawrence, *Adaptive Management: Learning from the Columbia River Basin Fish and Wildlife Program*, 16 ENVTL. L. 431 (1986) (explaining the importance of learning from the implementation of a program). For the role of systemic scientific and social learning in planning and governance, see Scholz & Stiftel, *supra* note 105, at 8–9 (describing the importance of "scientific learning" and "public learning" in environmental regulation); Arnold, *Adaptive Watershed Planning*, *supra* note 336 (analyzing the systemic adaptions that water institutions must make in the face of climate change).

are loosely but sufficiently linked to avoid the responses from undermining or conflicting with one another.[508] For example, we may be seeing the exercise of adaptive capacity in the choices by various governmental institutions, multi-participant processes, and even specific entities or groups to use different wet growth tools uses in responding to land use impacts on runoff, water quality, water supplies, and watershed features.[509]

However, the linkages work both ways. Institutions and systems need to invest the power, resources, and structural design in their capacity to innovate. Both unimodality and high levels of fragmentation could possibly deter institutions and systems from enhancing their innovation capacity, and therefore their adaptive capacity.

VI. THE FUTURE OF COMPLEX ENVIRONMENTAL LAW: INTEGRATIONIST MULTIMODALITY AT THE EDGES OF ENVIRONMENTAL LAW

Many of the developments towards integrationist multimodality in U.S. environmental law are at the edges of environmental law, where environmental law interacts or engages with other fields of law, policy, and collective action: land use planning and regulation, water allocation and management, natural resources law and management, disaster preparedness and response, public health policies and programs, transportation policy and infrastructure, food production and distribution, energy law and policy, and others.[510] Moreover, the integrated use of multiple modes or methods of environmental protection will require the insights of many different disciplines and fields, as well as efforts to transcend the traditional boundaries of different disciplines and professions with their separate methodologies, terminologies, and theoretical models.[511]

---

[508] *See* Lee & Lawrence, *supra* note 507, at 458 (explaining adaptive management requires a "working relationship among the scientific, utility, and resource management communities").

[509] *See generally* Scholz & Stiftel, *supra* note 105.

[510] On the increasing integration of environmental law and water law, see, e.g., Zellmer, *supra* note 310. On the increasing integration of environmental law and land use law, see, e.g., Arnold, *Structure*, *supra* note 7; David L. Callies, *The Quiet Revolution Revisited: A Quarter Century of Progress*, 26 URB. LAW. 197 (1994); Francesca Ortiz, *Biodiversity, the City, and Sprawl*, 82 B.U. L. REV. 145 (2002); Michael Allan Wolf, *Fruits of the "Impenetrable Jungle": Navigating the Boundary Between Land-Use Planning and Environmental Law*, 50 WASH. U. J. URB. & CONTEMP. L. 5 (1996). For discussions of the necessity of increasing integration between environmental law and energy law, see, e.g., Davies, *Alternative Energy*, *supra* note 67, at 504–06.

[511] *See, e.g.*, Jack Ahern, *Theories, Methods and Strategies for Sustainable Landscape Planning*, *in* FROM LANDSCAPE RESEARCH TO LANDSCAPE PLANNING: ASPECTS OF

A number of scholars have cautioned against treating environmental law as indistinguishable from other fields of law or from non-law fields, such as environmental science.[512] Yet, an unmistakable conclusion from all that has been discussed in this article is that U.S. environmental law is not a tightly bound and autonomous system.[513] The environmental problems that challenge U.S. society are multi-dimensional and are far greater in scale and complexity than the current capacity of environmental law to address them.[514] The pressures for environmental law to form and strengthen relationships with other legal and non-legal systems are great.[515]

From an ecological evolutionary perspective on socio-legal systems, it is not surprising that change occurs at the edges of a system, where it interacts with other systems.[516] Alterations and transitions in species' habitat patches or in ecosystems occur substantially more at their edges where structural complexity, dynamic behaviors, and both external and internal disturbances produce evolutionary adaptation or variability.[517]

INTEGRATION, EDUCATION, AND APPLICATION 119, 122 (Bärbel Tress et al. eds., 2006); Helena Sousa Ferreira & André Botequilha Leitão, *Integrated Landscape and Water-Resources Planning with Focus on Sustainability*, *in* FROM LANDSCAPE RESEARCH TO LANDSCAPE PLANNING: ASPECTS OF INTEGRATION, EDUCATION, AND APPLICATION 143 (Bärbel Tress, et al., eds., 2006); K. Matthias Weber, *Foresight and Adaptive Planning as Complementary Elements in Anticipatory Policy-Making: A Conceptual and Methodological Approach*, *in* REFLEXIVE GOVERNANCE FOR SUSTAINABLE DEVELOPMENT 189, 215–16 (Jan-Peter Voß et al. eds., 2006); Feldman & Ingram, *supra* note 40. *See also* Holly Doremus, *Data Gaps in Natural Resources Management: Sniffing for Leaks Along the Information Pipeline*, 83 IND. L.J. 407, 421–23, 459–60 (2008) (discussing the importance of interdisciplinary and transdisciplinary knowledge and data in natural resources management generally).

[512] *See, e.g.*, Arnold, *Structure*, *supra* note 7, at 448–54 (explaining a "common misunderstanding of land use regulation is to think of it as a sub-field of another area of law."); Ruhl, *Co-Evolution*, *supra* note 37 (using the Endangered Species Act as an example of the necessary connection between environmental law and science); Tarlock, *There*, *supra* note 73 (examining the relationships between environmental law and environmental science); Wolf, *supra* note 510 (examining the common confusion between land use law and environmental law).

[513] *See supra* notes 244–47 and accompanying text.

[514] *See, e.g.*, Ruhl, *Co-Evolution*, *supra* note 37 (analyzing the Endangered Species Act to explain that an effective approach to confronting environmental problems requires the proper marriage of scientific and legal principles).

[515] The countervailing pressures and obstacles are also great and are discussed elsewhere in the article. *See supra* Parts IV–VI.

[516] Craig R. Allen & Crawford S. Holling, *Cross-Scale Structure and the Generation of Innovation and Novelty in Discontinuous Complex Systems*, *in* DISCONTINUITIES IN ECOSYSTEMS, *supra* note 29, at 219, 223–31.

[517] *See* ANDRÉ BOTEQUILHA LEITÃO, MEASURING LANDSCAPES: A PLANNER'S HANDBOOK 98–99 (2006); Allen & Holling, *supra* note 516, at 219, 223–31; HOLLING ET AL., *supra*

These edge dynamics can produce innovation and increase system resilience or they can introduce harmful threats and produce declines.[518] Not all interactions between environmental law and other socio-legal systems or subsystems will necessarily produce beneficial results, and some may threaten the health and resilience of one or more of these systems. Therefore, the integrationist and multimodal developments at the edges of environmental law will need to be watched and evaluated carefully, as discussed further in the Conclusion of this article. Moreover, every effort to adapt to these changing conditions in environmentally beneficial and resilience-building ways should be undertaken.

In order to engage in both monitoring and fitness adaptation, environmental law experts should identify the possible areas of integrationist multimodal evolution of environmental law that deserve attention, while recognizing that some change may be unpredictable or require considerable time to observe. Integrated and integrating sets of principles of environmental protection that currently lack multimodal applications may become increasingly multimodal. Examples include the concept of land health,[519] principles of ecological democracy,[520] environmental justice

---

note 25, at 3, 16–17; Fred Bosselman, *What Lawmakers Can Learn From Large-Scale Ecology*, 17 J. LAND USE & ENVTL. L. 207 (2002).

[518] *See supra* note 517 and accompanying text.

[519] For example, Eric Freyfogle's work on land health integrates Aldo Leopold's concept of a land ethic, conservation science, and socio-cultural perspectives on property, but has yet to be systematically applied through multiple modes in U.S. society. *See, e.g.*, ERIC T. FREYFOGLE, BOUNDED PEOPLE, BOUNDLESS LANDS: ENVISIONING A LAND ETHIC *passim* (1998); ERIC T. FREYFOGLE, ON PRIVATE PROPERTY: FINDING COMMON GROUND ON THE OWNERSHIP OF LAND *passim* (2007); ERIC T. FREYFOGLE, THE LAND WE SHARE: PRIVATE PROPERTY AND THE COMMON GOOD *passim* (2003); Eric T. Freyfogle, *Fostering a Culture of Land*, 14 SCIENCE & ENGINEERING ETHICS 545 (2008); Eric T. Freyfogle, *Private Rights in a Connected Land*, *in* WET GROWTH, *supra* note 136, at 315; Eric T. Freyfogle, *The Tragedy of Fragmentation*, 32 ENVTL. L. REP. (Envtl. L. Inst.) 11321 (2002); Eric T. Freyfogle, *The Owning and Taking of Sensitive Lands*, 43 UCLA L. REV. 77 (1995).

[520] ROBYN ECKERSLEY, THE GREEN STATE: RETHINKING DEMOCRACY AND SOVEREIGNTY 111–15 (2004). The foundational premise is that ecological health and civic health are inextricably intertwined, and therefore, a robust, vibrant democracy is necessary for a robust, vibrant environment and vice-versa. *See* JOHN S. DRYZEK, DELIBERATIVE DEMOCRACY AND BEYOND: LIBERALS, CRITICS, CONTESTATIONS 147–52 (2000). Elements of ecological democracy include deliberative and participatory processes, environmental citizenship, Deweyan civic pragmatism, and physical design principles that enable both ecological vitality and community vitality. *See, e.g.*, RANDOLPH T. HESTER, DESIGN FOR ECOLOGICAL DEMOCRACY (2006). *See generally* WALTER F. BABER & ROBERT V. BARTLETT, DELIBERATIVE ENVIRONMENTAL POLITICS: DEMOCRACY AND ECOLOGICAL RATIONALITY (2005); DEMOCRACY AND THE CLAIMS OF NATURE: CRITICAL PERSPECTIVES FOR A NEW CENTURY (Ben A. Minteer & Bob Pepperman Taylor eds., 2002); ENVIRONMENTAL CITIZENSHIP (Andrew Dobson & Derek Bell eds., 2006); BEN A. MINTEER, THE LANDSCAPE OF REFORM: CIVIC PRAGMATISM AND

principles and movements,[521] and the concept of ecosystem services.[522]

ENVIRONMENTAL THOUGH IN AMERICA (2006); WILLIAM A. SHUTKIN, THE LAND THAT COULD BE: ENVIRONMENTALISM AND DEMOCRACY IN THE TWENTY-FIRST CENTURY (2000); THE STRUGGLE FOR ECOLOGICAL DEMOCRACY: ENVIRONMENTAL JUSTICE MOVEMENTS IN THE UNITED STATES (Daniel Faber ed., 1998). On the related concept of watershed democracy, see Neuman, *supra* note 142, at 119–69; Donald Worster, *Watershed Democracy: Recovering the Lost Vision of John Wesley Powell*, 23 J. LAND RESOURCES & ENVTL. L. 57 (2003).

[521] *See, e.g.*, CLIFFORD RECHTSCHAFFEN ET AL., ENVIRONMENTAL JUSTICE: LAW, POLICY AND REGULATION 3–5 (2d ed. 2009). The central concept of environmental justice is about the empowerment and meaningful participation of low-income communities and communities of color in environmental, land use, natural resources, and related decision making: "we speak for ourselves" is a common mantra. *See id.*; LUKE W. COLE & SHEILA R. FOSTER, FROM THE GROUND UP: ENVIRONMENTAL RACISM AND THE RISE OF THE ENVIRONMENTAL JUSTICE MOVEMENT (2001); CONFRONTING ENVIRONMENTAL RACISM: VOICES FROM THE GRASSROOTS (Robert D. Bullard ed., 1993). There is some increasing evidence of multimodal applications of environmental justice principles to land use issues, natural resources issues, and climate change. *See, e.g.*, CRAIG ANTHONY (TONY) ARNOLD, FAIR AND HEALTHY LAND USE: ENVIRONMENTAL JUSTICE AND PLANNING (2007) (land use issues); JUSTICE AND NATURAL RESOURCES: CONCEPTS, STRATEGIES, AND APPLICATIONS (Kathryn M. Mutz et al, eds., 2002) (natural resources issues); NATURAL ASSETS: DEMOCRATIZING ENVIRONMENTAL OWNERSHIP (James K. Boyce & Barry G. Shelley, eds., 2003) (natural resource issues); Maxine Burkett, *Just Solutions to Climate Change: A Climate Justice Proposal for a Domestic Clean Development Mechanism*, 56 BUFF. L. REV. 169 (2008); Alice Kaswan, *Environmental Justice and Domestic Climate Change Policy*, 38 ENVTL. L. REP. 10287 (2008) (climate change issues); Rebecca Tsosie, *Indigenous People and Environmental Justice: The Impact of Climate Change*, 78 U. COLO. L. REV. 1625 (2007) (climate change issues).

[522] Ecosystem services are the valuable services that natural ecosystems provide to human economies and societies. *See* J.B. RUHL ET AL., THE LAW AND POLICY OF ECOSYSTEM SERVICES 15 (2007); Geoffrey Heal et al., *Protecting Natural Capital Through Ecosystem Service Districts*, 20 STAN. ENVTL. L.J. 333 (2001). The concept is integrationist in that it aims environmental protection at ecosystem scales, which are nature's integrated scales of organization, and at the metrics of the cross-cutting economic values (whether or not commodified or quantified) of the services that ecosystems provide to humans. *See generally* RUHL ET AL., *supra*, at 75–77 (2007). The concept is currently not well applied in environmental law and policy despite increasing curiosity and interest. The literature on ecosystem services includes, GEOFFREY HEAL, NATURE AND THE MARKETPLACE: CAPTURING THE VALUE OF ECOSYSTEM SERVICES (2000); NATURE'S SERVICES: SOCIETAL DEPENDANCE ON NATURAL ECOSYSTEMS (Gretchen C. Daily ed., 1997); RUHL ET AL., *supra*; Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253 (1997); Robert Costanza & Herman E. Daly, *Natural Capital and Sustainable Development,* 6 CONSERVATION BIOLOGY 37 (1992); Stephen C. Farber et al., *Economic and Ecological Concepts for Valuing Ecosystem Services*, 41 ECOLOGICAL ECON. 375 (2002); Geoffrey Heal et al., *supra*; Ruhl, *Nuisance*, *supra* note 64; James Salzman, *A Field of Green? The Past and Future of Ecosystem Services*, 21 J. LAND USE & ENVTL. L. 133 (2006); James Salzman, et al., *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309 (2001); *Proceedings from the Symposium on the Law and Policy of Ecosystem Services*, 22 J. LAND USE & ENVTL. L. 157 (2007); James Salzman, *Valuing Ecosystem Services*, 24 ECOLOGY L.Q. 887 (1997).

Likewise, sets of multimodal environmental protection that lack integrating and coordinating principles or relationships may become increasingly integrated over time.[523] Examples include sustainable forestry,[524] sustainable agriculture,[525] and adaptive management.[526]

---

[523] *Cf. supra* note 519 and accompanying text. While Freyfogle's work has successfully integrated Leopold's array of concepts, it has yet to be implemented in U.S. society, but shows the potential for integration and coordination in environmental protection.

[524] Forest management in the United States is a hodgepodge of several federal statutes governing U.S. Forest Service management of the national forests (including planning, conservation, timber harvesting and sales, and multi-use management), wide agency discretion to use a variety of forest management methods in the national forests, private forest timber practices, various private conservation tools and incentives, species' regulatory protections, land use planning and regulation, carbon-sequestration value, land-development value, and international standards. *See, e.g.*, Multiple Use-Sustained Yield Act of 1960, 16 U.S.C. § 528 (2006); National Forest Management Act of 1976, 16 U.S.C. § 1600 (2006); CHRISTINE A. KLEIN ET AL., NATURAL RESOURCES LAWS: A PLACE-BASED BOOK OF PROBLEMS AND CASES 281–344 (2d ed. 2009); BRENDA LIND, WORKING FOREST CONSERVATION EASEMENTS (2001); NAGLE & RUHL, *supra* note 170, at 508–09; Robert L. Fischman, *Stumbling to Johannesburg: The United States' Haphazard Progress Toward Sustainable Forestry Law*, 32 ENVTL. L. REP.(Envtl. Law. Inst.) 10291 (2002); Robert L. Glicksman, *Sustainable Federal Land Management: Protecting Ecological Integrity and Preserving Environmental Principal*, 44 TULSA L. REV. 147, 156–67, 169–73 (2008); Andrew Long, *Auditing for Sustainable Forest Management: The Role of Science*, 31 COLUM. J. ENVTL. L. 1 (2006); Andrew Long, *Tropical Forest Mitigation Projects and Sustainable Development: Designing U.S. Law for a Supportive Role*, 36 WM. MITCHELL L. REV. 968 (2010).

[525] Many diverse efforts and proposals aim to make agriculture more sustainable or to conserve environmentally beneficial agricultural resources. *See, e.g.*, David E. Adelman & John H. Barton, *Environmental Regulation for Agriculture: Towards a Framework to Promote Sustainable Intensive Agriculture*, 21 STAN. ENVTL. L.J. 3 (2002) (acknowledging the several environmentally friendly agricultural practices and the several "modestly successful" U.S. conservation programs). They include organic farming, the locally grown foods movement and locally grown food networks (including farmers' markets), ecosystem services compensation or incentives for farmers and ranchers, soil and water conservation programs, reforms to agricultural subsidies, agricultural land conservation easements, agricultural and open space zoning, food certification programs (e.g., organic, fair-trade, shade-grown, and so forth), regulation of food production (including regulation of genetically modified foods), and food security plans. However, there is very little real integration among these disparate methods of agricultural sustainability, despite the conceptual possibilities. *See, e.g.*, Angelo, *supra* note 242; Barbara L. Atwell, *Obesity, Public Health and the Food Supply*, 4 IND. HEALTH L. REV. 3 (2007); Marne Coit, *Jumping on the Next Bandwagon: An Overview of the Policy and Legal Aspects of the Local Food Movement*, 4 J. FOOD L. & POL'Y 45 (2008); John H. Davidson, *Agriculture*, *in* STUMBLING TOWARD SUSTAINABILITY 347–67 (John C. Dernbach ed., 2002); John H. Davidson, *Sustainable Development and Agriculture in the United States*, 32 ENVTL. L. REP. (Envtl. Law. Inst.) 10543 (2002); William S. Eubanks II, *A Rotten System: Subsidizing Environmental Degradation and Poor Public Health with Our Nation's Tax Dollars*, 28 STAN. ENVTL. L. J. 213 (2009); Carmen G. Gonzalez, *Markets, Monocultures, and Malnutrition: Agricultural*

CONCLUSION: SEEKING TO UNDERSTAND ENVIRONMENTAL LAW EVOLUTION

This article seeks to understand how environmental law is evolving. There are indications that integrationist multimodality may be an

---

Trade Policy Through an Environmental Justice Lens, 14 MICH. ST. J. INT'L L. 345 (2006); Neil D. Hamilton, *Putting a Face on Our Food: How State and Local Food Policies Can Promote the New Agriculture*, 7 DRAKE J. AGRIC. L. 407 (2002); Neil Hamilton, *Food Democracy and the Future of American Values*, 9 DRAKE J. AGRIC. L. 9 (2004); Jess Phelps, *A Vision of the New Deal Unfulfilled? Soil and Water Conservation Districts and Land Use Regulation*, 11 DRAKE J. AGRIC. L. 353 (2006); J.B. Ruhl, *Agriculture and Ecosystem Services: Strategies for State and Local Governments*, 17 N.Y.U. ENVTL. L.J. 424 (2008); Susan A. Schneider, *Reconnecting Consumers and Producers: On the Path Toward a Sustainable Food and Agriculture Policy*, 14 DRAKE J. AGRIC. L. 75 (2009). For an effort at integration, see, for example, IVETTE PERFECTO ET AL., NATURE'S MATRIX: LINKING AGRICULTURE, CONSERVATION AND FOOD SOVEREIGNTY (2009).

[526] Despite adaptive management's theoretical foundations and great utility in ecosystem and natural resources management as "learning while doing," this is primarily a directive to engage in a particular type of multimodality—a variety of incremental experiments and management measures that are monitored, evaluated, and modified. *See* Doremus, *supra* note 507. There is no particular mechanism for integrating various experiments and management measures other than faith in the experiment-feedback-learning process. Moreover, federal agencies are not engaged in much true or complete adaptive planning in practice, which reinforces the fear of some skeptics that adaptive management could be essentially an ad hoc, passive, reactive incrementalism. *See* Mary Jane Angelo, *Harnessing the Power of Science in Environmental Law: Why We Should, Why We Don't, and How We Can*, 86 TEX. L. REV. 1527, 1552 (2008) (explaining that adaptive management has not yet been integrated into environmental regulatory agencies); Camacho, *Regulation*, *supra* note 43, at 346–49 (highlighting a lack of Congressional funding impeding agencies' ability to implement adaptive regulation management). On adaptive management and its utility and limits, see generally HOLLING ET AL., *supra* note 25; WALTERS, *supra* note 507; Ahern, *supra* note 511, at 129; Mary Jane Angelo, *supra*, at 1552; Camacho, *Adapting*, *supra* note 41; Camacho, *Regulation*, *supra* note 43; Doremus, *supra* note 507; Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 NEB. L. REV. 833, 873 (2009); Karkkainen, *supra* note 507; Lee & Lawrence, *supra* note 507; J.B. Ruhl, *Regulation by Adaptive Management—Is It Possible?*, 7 MINN. J. L. SCI. & TECH. 21, 28 (2005); J.B. Ruhl & Robert Fischman, *Adaptive Management in the Courts*, 95 MINN. L. REV. 424 (2010); Lawrence Susskind et al., *Collaborative Planning and Adaptive Management in Glen Canyon: A Cautionary Tale*, 35 COLUM. J. ENVTL. L. 1 (2010). Over time, the theory and practice of adaptive management is likely to evolve if it is to remain a viable method of ecosystem and resource management. A greater integrationist component will be a critical development in adaptive management's evolution. I have recently made the case that adaptive planning should accompany adaptive management and could improve it by providing standards, goals, and plans to guide the use of adaptive management methods. Arnold, *Adaptive Watershed Planning*, *supra* note 336.

emerging feature of environmental law, at least to some degree, as a response to complex problems and the inadequacies of unimodal and fragmented approaches.

However, integrationist multimodality may very well prove to be a failure at improving environmental protection or addressing complex environmental problems.[527] The evolving ways of connecting multiple modes of environmental protection may also be susceptible to serving interests that are inconsistent with environmental protection. For example, integrationist and multimodal methods may facilitate the development of "consensus" agreements on vague principles that do not make tough choices. Alternatively, they may devolve into costly conflict. They may promote short-term action while ignoring long-term consequences. They may build overconfidence in human capabilities and result in gross misjudgments and mistakes. They may use environmental law and policy to serve special interests. They may experience slippage and ineffectual implementation. They may encounter strong resistance, obstacles, or competition from the forces favoring unimodality and fragmentation, as previously discussed.[528] By themselves, integrationist and multimodal developments do not resolve competing goals, ethical choices, or normative problems in society.

If we are to improve environmental protections and the outcomes of environmental law, though, we must first understand how environmental law operates and evolves. And we must do so by studying it on its own terms. A combination of a legal pluralist perspective, the concept that law and legal institutions are among many forces shaping society and are themselves shaped by many forces in society,[529] and an evolutionary perspective, that social systems, including law and its particular fields like environmental law, are complex, adaptive, evolving systems,[530] suggests that we need to study evolutionary developments in law as systemic adaptations to changing conditions in ways that are good, bad, neutral, and mixed.[531]

---

[527] *See supra* Introduction ("Evolution does not necessarily result in optimization and does not necessarily produce uniform systemic emergence.").
[528] *See supra* Part IV.
[529] *See, e.g.*, Arnold, *Mono Lake*, *supra* note 61, at 8–9.
[530] *See supra* Part II.
[531] This effort could be considered part of a scholarly effort that is being called the "new legal realism." *See* Victoria Nourse & Gregory Shaffer, *Varieties of New Legal Realism: Can a New World Order Prompt a New Legal Theory?*, 95 CORNELL L. REV. 61 (2009). For criticisms of scholarship on the evolution of environmental law for its failure to include a normative or prescriptive component, see, for example, Jeffrey Rudd, *J.B. Ruhl's "Law-*

Prescriptive scholarship excels at analyzing what should be done but too often gives little to no attention to how proposed solutions will actually be adopted and implemented in complex socio-legal systems.[532] One problem is that much of it tends to be essentially presented in the passive voice, that a particular concept, institutional design, legal principle, instrument, method or policy should be adopted, without identifying precisely which actor(s) will adopt it. This kind of scholarship essentially has a *deus ex machina* nature to it.[533] Even when a specific institutional actor, such as Congress or the U.S. Fish and Wildlife Service, is identified, very little systematic, comprehensive, and rigorous attention is given to the multitude of forces that may shape the adoption, mutation, or non-adoption of the proposal. Most, perhaps even all, decisions are political in nature and shaped by political interests and forces.[534] The empirical fact of multiple competing goals and interests has to be taken seriously, even if authors contend that one set of principles is normatively superior to others.[535] Serious problems and even crises sometimes prompt legal reform but sometimes do not, despite the serious consequences of inaction. Limited resources constrain adoption and implementation of responses to environmental problems; not surprisingly, resource allocators, such as Congress, often do not heed experts' assertions that the need is so great and the goals are so important that officials will just have to come up with the funding, personnel, or other resources. Proposed solutions often undergo modification, structural alteration, synthesis with other approaches, and competition with other solutions not only within a particular organization or

---

and-Society System": Burying Norms and Democracy Under Complexity Theory's Foundation, 29 WM. & MARY ENVTL. L. & POL'Y REV. 551, 554 (2005) (hypothesizing that the "unifying approach" neglects the necessary normative questions in environmental law); Robert F. Blomquist, Book Review, *The Beauty of Complexity*, 39 HASTINGS L.J. 555, 567–68 (1988) (acknowledging an error in scholars failure address normative questions regarding the legal systems' need to better aggregate factions).

[532] Nonetheless, some prescriptive scholarship wrestles with the complexities and realities of socio-legal systems and institutions. *See, e.g.*, Doremus, *Endangered Species Act*, *supra* note 256, at pt. IV (addressing psychological, political, and structural/practical barriers to proposed reforms that would make the Endangered Species Act more adaptive and discussing possible pathways to achieving reform, given these institutional dynamics).

[533] Donald Elliott offers the same critique of the private property rights solutions or environmental regulatory solutions to Garrett Hardin's tragedy of the commons: they are offered without any explanation about how they will come about in society. Elliott, *supra* note 60, at 25–26.

[534] *See, e.g.*, Nourse & Shaffer, *supra* note 531, at 132 (a key concept of New Dynamic Realism is the "simultaneity of law and politics").

[535] *See id.* at 132–34 (explaining that new legal theorists recognize the benefits and drawbacks at the extremes of multiple spectrums in legal implementation).

institution, but in the larger system in which the organization or institution exists. Not only is non-implementation or weak implementation a possibility in general, but there is the very real possibility that decision makers will adopt a law, regulation, or policy in which they intentionally include features that prevent its effective implementation, or even implementation at all. All of these systemic forces and processes, and others, shape the empirical environment in which normative proposals are considered.

We need empirical research that precedes, or at least accompanies, attempts at solutions—the research of the scientist, not just the engineer. Yet, in order to improve understanding, we also need to engage in theory development: to survey the broad landscape of particular legal fields and to apply existing theoretical understandings of social systems.[536] Empirical research will just be a random collection of narrow questions and narrow answers if it is not informed by broader theoretical questions and hypotheses that can be studied and tested in the real world. This article aims to identify some emerging evolutionary developments in environmental law that deserve further attention and study. The development of a variety of integrationist multimodal nodes in environmental law and at the intersection of environmental law and other fields of law and policy is one of the ways by which environmental law is seeking to adapt to the complex problems that it is facing, such as the interrelationships among climate change, land use, and water. These nodes are responses to needs for improved systemic resiliency, flexibility, and functioning. As empirical and theoretical work in the integrationist and multimodal features of environmental law grows, we will be able to better evaluate their effectiveness at achieving environmental protection, responding to our current and future environmental problems, and mediating between society and the environment in

---

[536] *See* Nourse & Shaffer, *supra* note 531. The famed evolutionary biologist Edward O. Wilson criticizes the social sciences for lacking widely accepted and empirically supported theoretical foundations that could be used to solve social problems, despite the rigor of social science methods. *See* EDWARD O. WILSON, CONSILIENCE: THE UNITY OF KNOWLEDGE 197–228 (1998). He argues that the starting point has to be theory that makes broad predictions about social systems, their behaviors, and the causes of these behaviors, and that these predictions have to be made by grasping phenomena that transcend time, space, and other categories of organization. *See id.* at 206 ("If social scientists choose to select rigorous theory as their ultimate goal, as have the natural scientists, they will succeed to the extent they traverse broad stretches of time and space . . . avoiding, except at cocktail time, playful definitions. . . ."). On a much smaller scale, beginning to understand the emergence of integrationist multimodality in environmental law requires surveying the terrain of environmental law and policy decisions as they are occurring today. The goal is to identify possible evidence of emerging connections among multiple modes of environmental protection.

beneficial ways. In addition, we will be more able to improve them in the context of the multiple forces shaping them.

Some readers may find some common themes and observations between this article and the thoughtful and important work of Jody Freeman and Dan Farber on modular environmental regulation.[537] Nonetheless, there are several important differences between the integrationist multimodality evolutionary concept and the modular environmental regulation concept. Freeman and Farber are concerned primarily with institutional design and instrument choice,[538] whereas I am much more concerned with institutional and instrument evolution.[539] Any design or choice will be only part of a series of iterations within the system, or even within systems of systems, will be subjected to a variety of forces and influences, will adapt over time, and could change in unanticipated ways or could have unanticipated consequences. Freeman and Farber are enthusiasts for multi-stakeholder agreements,[540] whereas I view multi-stakeholder, or what I would prefer to frame as multi-participant, agreements as only one of many possible nodes for integration of multiple modes of environmental protection.[541] Indeed, litigation and conflict can be useful in effectuating integrationist multimodality; agreement is not necessary.[542] Freeman and Farber seem to have a normative element to their modular environmental regulation concept, suggesting that it is a superior means of environmental protection,[543] whereas I take more of a critical eye to integrationist multimodality and recognize that the development and use of integrationist multimodal nodes is adaptive not only to environmental protection goals and forces but also to a number of goals and forces that compete with or possibly undermine environmental protection.[544] Integrationist multimodality will not, by itself, achieve environmental protection and will

---

[537] *See* Freeman & Farber, *supra* note 33.
[538] *See id.* Farber and Freeman analyze the two traditional questions of environmental regulation: "which level of government ought to regulate or manage? And, second, using which tools?" *Id.* at 797. They recognize that "[t]here is rarely a single tool, or a lone agency at either the federal or state level, that is capable of producing the desired environmental benefit by itself. . . ." *Id.*
[539] *See supra* Part II.
[540] *See generally* Freeman & Farber, *supra* note 33.
[541] *See supra* Part VI.A.
[542] *See supra* Part II.A–B and *supra* notes 346–53 and accompanying text.
[543] *See* Freeman & Farber, *supra* note 33. "We think of modularity as both a descriptive and a normative concept. It describes how some environmental initiatives actually work, and it suggests how many more might be improved." *Id.* at 799.
[544] *See supra* Part V.

need evaluation and improvement if it is to function effectively at achieving environmental protection goals.

Good scholarship points the way to the need for further research, data, theory development, and application. It does not assume that it contains all the answers or has the definitive solution. This project has identified a phenomenon in the evolution of environmental law that should be studied further. In particular, this project raises several research questions:

1) Are all of the nodes identified in this article functioning to integrate multiple modes of environmental protection?
2) Are there other such nodes?
3) What are the essential characteristics of an integrationist multimodal node, and how do they function?
4) How effective are they at achieving environmental protection (as defined and measured in various ways) and how can we develop metrics and analytical methods to evaluate their impact and effectiveness?
5) How do they advance, inhibit, or co-exist with other goals in society, such as equity or efficiency (or any number of other goals)?
6) Can they be improved and how?
7) What are the forces and factors that undermine their effectiveness, functioning, or benefits?
8) How are they evolving and according to what processes and influences?

These questions deserve our attention as the next generation of environmental law emerges.