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Law and Resilience: Mapping the Literature

Tracy-Lynn Humby[†]

Resilience and the associated concepts of adaptive management and adaptive governance are increasingly coming to the fore in order to comprehend and respond to complex, adaptive change. These concepts highlight the need to cognize and respond to social-ecological systems that can absorb disturbance while still being able to remain within the same domain of attraction, self-organize, and adapt and transform over time; thus, representing a substantive advance from the more static notion of sustainable development. After outlining the theoretical development of resilience, adaptive management, and adaptive governance, this article discusses the general features of the law and resilience literature, demonstrating that these concepts are gaining increasing traction amongst legal scholars. Thematic findings in terms of the deficiencies of law and governance in the context of resilience for sustainability, and the manner in which law and governance should respond, follow. Aspects of law and governance marked deficient by legal commentators include incorrect understandings of the dynamics of natural systems; substantive goals that legitimize resource optimization; monocentric, uniscalar, and unimodal governing authority; and linear, front-loaded legal processes. On the other hand, law and governance can enhance resilience by opting for a “systems view” of the object of regulation by enhancing monitoring, reflexivity, and information generation and diffusion; supporting multiscalar, polycentric, and open governance; and by accommodating the adaptability of the legal system itself. The article concludes with suggestions for further research.

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I. INTRODUCTION

The wizardry of the information age provides some proof of the emerging protagonism of the discourse of resilience as an element of the broader discourse of sustainability. Utilizing Google's Ngram Viewer to graph the terms "sustainable development," "sustainability," and "resilience," one of the clearest trends to emerge is the decline in usage of "sustainable development" relative to both "sustainability" and "resilience."¹ Whilst the use of the term "sustainability" is consistently

1. The Ngram Viewer is a tool that charts the use of ngrams (combinations of letters), words, or phrases found in over 5.2 million books digitized by Google. The viewer charts the results graphically and in accordance to yearly use. One can search all digitized books published until 2009,

greater than “resilience,” reliance on the term “resilience” is on the rise. This trend is apparent across almost all of the language databases searchable by the Ngram function.²

The proliferation of talk about resilience can, in part, be ascribed to the recent enthusiasm for armoring the human race against the hydra-headed threat of climate change, and also to the emergence of “climate-resilient development” as a term of art in its own right.³ However, the turn to resilience is reflective of a broader paradigm shift in the disciplines of ecology, natural resources management, and natural resources and environmental law that extends as far back as the 1970s. This shift is marked by attempts to apprehend and develop conceptual resources to “manage”⁴ complexity in both natural and social systems.⁵

in databases of American English, British English, Chinese (simplified), French, and German books, amongst other languages. The Ngram viewer can be found at <http://books.google.com/ngrams>.

2. In the database of American English books, the use of ‘sustainability’ is far in the lead and since the 1990s, the use of the term ‘resilience’ has become almost as popular as references to ‘sustainable development.’ In the database of British English books, ‘sustainability’ occurs more frequently than the term ‘sustainable development’ (though not to such a great extent), and usage of ‘resilience’ has increased incrementally since the 1940s. The database of simplified Chinese illustrates a somewhat different trend: although dipping in the 1990s, the usage of ‘sustainable development’ is still greater than references to ‘sustainability’ and ‘resilience’ (both of whose usage is increasing marginally). The database of French books exhibits a trend similar to that of British English books, while the German database is similar to that of the Chinese (though with a much greater rise in the use of ‘sustainability’ and ‘resilience’).

3. International agencies, governments, donor organizations, and global consultancy firms have all appropriated this term. *See generally Low-Emission Climate-Resilient Development Strategies: Latest Publications*, UNITED NATIONS DEVELOPMENT PROGRAMME, http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/ (several of the listed publications exemplify the appropriation of the term); THE GOV'T OF THE REPUBLIC OF S. AFR., NATIONAL CLIMATE CHANGE RESPONSE WHITE PAPER (Oct. 2011), *available at* http://rava.qsens.net/themes/theme_emissions/111012nccr-whitepaper.pdf (commencing its articulation of the national climate change response objective with the words: “South Africa will build the climate resilience of the country”); *Climate Change Resilience*, ROCKEFELLER FOUNDATION, <http://www.rockefellerfoundation.org/our-work/current-work/climate-change-resilience/>; THE ECONOMICS OF CLIMATE ADAPTATION WORKING GROUP, SHAPING CLIMATE-RESILIENT DEVELOPMENT: A FRAMEWORK FOR DECISION-MAKING (2009), *available at* <http://mckinseysociety.com/downloads/reports/Economic-Development/ECA%20%20%20Shaping%20Climate%20Resilient%20Development%20%20%20Report%20Only.pdf>.

4. Bromley highlights the social and historical contingency of the notion that humans can manage the environment and refers to it as a ‘conceit’. *See* Daniel W. Bromley, *Environmental Governance as Stochastic Belief Updating: Crafting Rules to Live By*, 17 *ECOLOGY & SOC'Y* 14 (2012).

5. For a recent review of law and complexity in the context of natural resources and the environment *see* Robin Kundis Craig, *Learning to Think About Complex Environmental Systems in Environmental and Natural Resource Law and Legal Scholarship: A Twenty-Year Retrospective*, 24 *FORDHAM ENVTL. L. REV.* 87 (2013).

Theories of resilience, along with adaptive management and adaptive governance, therefore constitute a maturing conceptual frame for thinking about how law can contribute to sustainability in a complex world. However, the increased appropriation of resilience by different disciplines and communities of practice increases the potential for the term to become an empty signifier,⁶ a fate which others suggest has already befallen sustainability.⁷ As opposed to fuzzy concepts, which are still amenable to attempts at ongoing refinement, the use of empty signifiers continues precisely because they can mean both everything and nothing. They perform a quilting function; they enable vastly different societal interests to assume they are working toward a common project while their internal contradictions are so great that the signifier does little to change the status quo.

Brand and Jax refer to this use of resilience as a vague “boundary object,” arguing that a clearly specified, descriptive concept of resilience must be developed for operationalization and application as a counterbalance, at least in the discipline of ecology.⁸ Pointing to the imprecision and fuzziness of adaptive management, Doremus also warns against this concept being used as an empty symbol by agencies “as a ploy to placate demands for environmental protection without actually imposing any enforceable constraints on themselves.”⁹

Leaning more towards the fuzziness—as opposed to the emptiness of resilience, adaptive management, and adaptive governance—this article presents the findings of a review of the law and resilience literature. Stemming from my participation in a multi-disciplinary project on urban resilience in a developing country context, the review seeks to determine how legal scholars have appropriated resilience theory, the contexts and problems to which they have applied it, and—most importantly—the changes in law and governance structures they have deemed necessary to realize resilience for sustainability. Based on a close reading of 74 published items, this review is not an exhaustive

6. Drawing upon the theories of Lacan, Laclau’s concept of the ‘empty signifier’ refers to signifiers that are conceptually empty, but which have a nominal (and thus, hegemonic) status through their capacity to unify objects through the act of naming. Therefore, a whole host of objects may be unified under the banner of ‘sustainable development’ or ‘sustainability’ despite irreconcilable internal contradictions. See Ernesto Laclau, *Ideology and Post-Marxism*, 11 J. OF POL. IDEOLOGIES 103 (2006).

7. Mark Davidson, *Sustainability as Ideological Praxis: The Acting out of Planning’s Master Signifier*, 14 CITY 390 (2010).

8. Fridolin Simon Brand & Kurt Jax, *Focusing the Meaning(s) of Resilience: Resilience as a Descriptive Object and Boundary Concept*, 12 ECOLOGY & SOC’Y 23 (2007).

9. Holly Doremus, *Adaptive Management, the Endangered Species Act, and the Institutional Challenges of “New Age” Environmental Protection*, 41 WASHBURN L.J. 50, 53 (2001).

account of the literature. However, it arguably provides a representative sample of the central trends and issues in this particular branch of legal scholarship. Thus, it captures the manner in which resilience, adaptive management, and adaptive governance have been recontextualized in law, contributing to its clearer specification and application in this discipline.

The findings of the review are preceded by a brief outline of the key landmarks in the development of the theories of resilience, adaptive management, and adaptive governance. Section 3 outlines certain general features of the law and resilience literature, including the nature of the research, the key concepts used, the jurisdictional focus of the research, and the nature of the system under review. Sections 4, 5, and 6 present the thematic findings of the research. Section 4 describes how legal scholars have understood resilience as a concept, while section 5 focuses on what have been identified as the law's deficiencies in advancing the resilience project. Part 6 then examines what scholars have deemed the requirements resilience places on law and governance and covers the three broad thematic areas of cognizing the social-ecological system; taking the "adaptive turn" through a proceduralization of natural resource management; structuring polycentric, multiscale, and open governance; and advocating for the adaptability of law itself. The article concludes with some suggestions for future research.

II. LANDMARKING RESILIENCE, ADAPTIVE MANAGEMENT AND ADAPTIVE GOVERNANCE

A. Resilience

The theory of resilience has its roots in the discipline of ecology. The origins of the "resilience perspective" lie in studies on predation conducted by C.S. Holling during the 1960s and early 1970s. In his seminal paper "Resilience and Stability of Ecological Systems" (1973), Holling presented his findings on the "multi-stable states" he had discovered when applying his work to ecosystems.¹⁰ Contrary to the conventional belief that ecosystems oscillated around a single equilibrium—connoting fixed carrying capacity and the management goal of minimizing variability (manifesting in an "optimization" mindset that gears ecosystems to produce the maximum amount of food, fuel, fiber, or reduction of flood or other risks to communities)—Holling

10. Carl Folke, *Resilience: The Emergence of a Perspective for Social-Ecological Systems Analysis*, 16 GLOBAL ENVTL. CHANGE 253, 254 (2006).

discovered that ecosystems could “flip” between more than one stable state; they were both complex and adaptive and thus, characterized by surprise and inherent unpredictability.¹¹ Holling used the term “resilience” to describe the amount of disturbance a system could take before its controls shifted to a set of variables and relationships thus, dominating another stability region.¹² Holling’s use of the term serves as the basis for the most popular definition of resilience: “the capacity of a system to absorb disturbance and still retain its basic structure and function.”¹³

Walker and Salt explain these insights more fully: resilience thinking is foremost systems thinking.¹⁴ The complex and adaptive nature of ecosystems places limits on the predictability of how the system will behave.¹⁵ Complex adaptive systems have “emergent behavior”; i.e., the behavior of the system cannot be predicted by understanding the individual mechanics of its component parts or any pair of interactions but must take into account the feedbacks between the elements of the system and how those feedbacks in turn transform the component parts.¹⁶ The potential for multi-stable states means that a system will not necessarily “bounce back” after a shock or disturbance but may cross a threshold to a new state; i.e., undergo a “regime shift.”¹⁷ In a different regime, the structure, function, and feedbacks of the system will be different.¹⁸

Though ecosystems are affected by many variables, they are usually driven by only a handful of key controlling (often slow-moving) variables. Along each of these key variables are thresholds and if the system moves beyond them, it will start behaving in a different way. Changes in system behavior often has unforeseen and undesirable consequences.¹⁹ Once a threshold has been crossed it is usually difficult—and in some cases, impossible—to cross back and in many instances, it negatively affects the generation of ecosystem services.²⁰

11. *Id.*

12. *Id.*

13. BRIAN WALKER & DAVID SALT, *RESILIENCE THINKING: SUSTAINING ECOSYSTEMS AND PEOPLE IN A CHANGING WORLD* iii (2006).

14. *Id.* at 31.

15. *Id.* at 11.

16. *Id.* at 35.

17. *Id.* at 11.

18. *Id.* at 31.

19. *Id.* at 63.

20. Alexis Schäffler, *Enhancing Resilience Between People and Nature in Urban Landscapes* 39 (2011) (thesis presented in partial fulfillment of the requirements for the degree Master of Philosophy at the University of Stellenbosch), available at <http://hdl.handle.net/10019.1/6473>.

A system's resilience can be measured in terms of distance from the thresholds of key variables. The closer a system lies to any one threshold the less it takes to be pushed into a new regime.²¹ Thus, sustainability is also about knowing if and where thresholds exist and having the capacity to manage the system within them.²²

During the 1980s, Holling's findings were applied to a variety of natural media including boreal forest dynamics, the dynamics and management of rangelands, freshwater systems, and fisheries.²³ From the mid-1970s through to the 1990s, the resilience perspective exerted an increasing influence in the social sciences with contributions emerging in anthropology, ecological economics, environmental psychology, cultural theory, human geography, the management literature, and common property systems amongst others.²⁴ Work was done on the complex modeling of human and natural systems.²⁵ This laid the basis for recognition of social-ecological systems (SES),²⁶ i.e., the idea of the synergy and "fundamental interdependency" of the human and environmental subsystems in determining the condition, function, and response of either subsystem (and of the system as a whole) to a disturbance, perturbation, or hazard.²⁷

Ecological systems refer to biological and biophysical processes, while social systems are made up of rules and institutions that mediate human use of resources as well as the systems of knowledge and ethics that interpret natural systems from a human perspective.²⁸ Thus, human action and social structures are integral to nature and any distinction between social and natural systems is arbitrary.²⁹

21. WALKER & SALT, *supra* note 13, at 63.

22. *Id.*

23. Folke, *supra* note 10, at 255.

24. Early understandings of these social science systems also centered on theories of how the systems maintained an equilibrium state. One of the criticisms of first-generation systems thinking in the social sciences was that it failed to explain change. For this reason, Duit *et al.* argue that most contemporary theoretical models and analytical techniques are insufficient for capturing processes of change in SES. For an overview of thinking around systems in the social sciences, see Andreas Duit *et al.*, *Introduction: Governance, Complexity, and Resilience*, 20 GLOBAL ENVTL. CHANGE 363, 364 (2010).

25. Folke, *supra* note 10, at 255.

26. Within resilience literature, use of the term 'social-ecological system' is preferred over terms that relegate either the social or ecological component to a prefix (as in ecosocial systems or socioecological systems). See Carl Folke *et al.*, *Adaptive Governance of Social-Ecological Systems*, 30 ANN. REV. OF ENV'T & RES. 441, 443 (2005).

27. B.L. Turner II, *Vulnerability and Resilience: Coalescing or Paralleling Approaches for Sustainability Science?*, 20 GLOBAL ENVTL. CHANGE 570 (2010).

28. See W. Neil Adger, *Vulnerability*, 16 GLOBAL ENVTL. CHANGE 268 (2006).

29. *Id.*

One of the key insights of resilience theory is that the focus of the overwhelming majority of social-ecological systems is to expand the limits and reduce the vagaries of nature to improve provisioning and regulating ecosystem services and thereby, the material well-being of people.³⁰ Resource management strategies that attempt to optimize only particular elements of an ecosystem (such as crop yields through irrigation) frequently weaken the entire system. Such interventions are blind to the fact that while resource management practices keep one component of an ecosystem constant, the other elements continue to change at other spatial and temporal scales. This tends to tip the social-ecological system more precariously toward a regime shift.³¹ Thus the manner in which social systems manage ecosystem services is critical to holding a system in a desirable state.

During the early years however, much of Holling's pioneering work on ecological or ecosystem resilience was largely ignored or actively opposed by mainstream ecologists. Holling coined the term "engineering resilience" to describe the view of equilibrium-dominating mainstream ecology. Engineering resilience focuses on behavior near a stable equilibrium and the speed at which a system returns to a steady state after a disturbance.³² This engineering interpretation of resilience still exists in many facets of ecology.³³ The alternative conception of ecological or ecosystem resilience³⁴ emphasizes the stochastic and non-linear nature of ecosystems.

Theories of ecological or ecosystem resilience have evolved with the further study of complex adaptive systems. Work done during the 1990s and onwards revealed how complex adaptive systems are constituted of complex structures and patterns of interaction that arise from simple, yet powerful rules guiding change. Within a complex adaptive system, sustained diversity and individuality of components causes localized interactions. Based on the results of local interactions, an autonomous process selects from among the system components a

30. Understanding of ecosystems and ecosystem services has developed in a parallel and complementary fashion to resilience theory. Popularized by the *Millennium Ecosystem Assessment* in 2005, ecosystem services are commonly categorized as provisioning (e.g., food, water, fuel, fiber), regulating (e.g., climate and flood regulation), supporting (e.g., nutrient cycling, soil formation), and cultural (e.g., recreation and spiritual values). See Turner II, *supra* note 27, at 571. Their services can be conceptualized at interlinked global, regional and local scales. The fundamental problem relating to ecosystem services is that they have been undervalued or simply taken for granted.

31. WALKER & SALT, *supra* note 13, at 9.

32. Folke, *supra* note 10, at 256.

33. *Id.* at 257.

34. Brand & Jax, *supra* note 8, at 24.

subset for replication or enhancement.³⁵ This assures continual adaptation, “perpetual novelty,” and the emergence of cross-scale organization.³⁶

Advancement in the understanding of complex adaptive systems in turn led to the idea of the adaptive renewal cycle of development, a heuristic for understanding ecosystem development.³⁷ The notion of the adaptive renewal cycle (or simply, “the adaptive cycle”) recognizes that social-ecological systems change over time, conventionally moving through four phases; namely, the phases of rapid growth (r-phase), conservation (K-phase), release (omega phase), and reorganization (alpha phase).³⁸ The r-phase and K-phase constitute the “forward-loop” of the adaptive cycle—a period characterized by persistence, growth and enrichment—and the omega and alpha phases constitute the “backward-loop”—a period of crisis, collapse, and transformation.³⁹

The concept of panarchy, which Gunderson and Holling put forward in 2002, advances the idea of the adaptive cycle by proposing that adaptive cycles are nested at multiple scales, with slower cycles at larger scales and faster cycles at smaller ones. Interaction between adaptive cycles at different scales leads in turn to cross-scale dynamics with important implications for resilience. The ability for renewal and reorganization into a more desirable ecosystem state will strongly depend on the influences from states and dynamics at scales above and below the adaptive cycle in question.⁴⁰

This later work on the adaptive cycle has enriched the concept of resilience. While much work has gone into understanding how social-ecological systems absorb disturbance so as to retain essentially the same structure, function and feedbacks, emphasis is now also being increasingly placed on the capacity of systems to reorganize while undergoing change. This recognizes that disturbance opens up opportunities for recombination of evolved structures and processes, renewal of the system, and new trajectories.⁴¹

The importance and role of biodiversity in such processes of reorganization and regeneration has also been affirmed.⁴² It has been

35. *Id.*

36. *Id.*

37. C.S. Holling, *The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change*, in *SUSTAINABLE DEVELOPMENT OF THE BIOSPHERE* 292 (W.C. Clark & R.E. Munn eds., 1986).

38. WALKER & SALT, *supra* note 13, at 75.

39. C.S. Holling, *Response to “Panarchy and the Law,”* 17 *ECOLOGY & SOC’Y* 37 (2012).

40. Folke, *supra* note 10, at 259.

41. *Id.*

42. *Id.* at 257.

found that while only a small number of species are responsible for keeping an ecosystem within a certain domain of attraction at any one time, the existence of species groupings (in terms of the functions they perform) play a critical role in how well a system is able to reorganize and regenerate after a disturbance. This highlights redundancy as an attribute to be valued in ecosystem functioning.⁴³ Therefore, as a concept, resilience not only connotes persistence, but also adaptive capacity or adaptability; the capacity for both the human and ecological components of a system to respond to, learn from, create, and shape variability and change in the state of the system and influence resilience.⁴⁴ Assessment of the resilience of social-ecological systems can therefore proceed along three inter-dependent dimensions: (1) the degree to which the system can absorb disturbance and still remain within the same state or domain of attraction; (2) the degree to which the system can self-organize and the quality of that self-organization; and (3) the degree to which the system can build and increase the capacity for learning and adaptation.⁴⁵

Loss of resilience therefore implies loss of adaptability as well, meaning the loss of both the current anthropogenic benefits provided by a particular system, as well as the loss of capacity to be favorably positioned as the system changes.⁴⁶ Recognizing that many social-ecological systems are currently unsustainable over the long term, increasing emphasis is being placed on transformability. Transformability is “the capacity of people to create a fundamentally new social-ecological system when ecological, political, social, or economic conditions make the existing system untenable.”⁴⁷

The resilience perspective is not without criticism. Firstly, it is not clear whether principles derived from the study of ecological system dynamics can be applied to the human subsystem, composed as it is of reflexive agents and complex social structures.⁴⁸ Critics have said complexity and resilience theory have a long way to go before they can be considered part of mainstream social science.⁴⁹ Duit et al. point out that unlike ecological systems, social systems are comprised of reflexive agents, capable of reflection and holding normative convictions that

43. *Id.* at 258.

44. Schäffler, *supra* note 20, at 32.

45. Steve Carpenter et al., *From Metaphor to Measurement: Resilience of What to What?*, 4 ECOSYSTEMS 765 (2001).

46. Folke, *supra* note 10, at 262.

47. *Id.*

48. Turner II, *supra* note 27, at 573.

49. Duit et al., *supra* note 24, at 363.

allow them to intervene individually and collectively in distributing social goods.⁵⁰ This is a compelling point underlined by the very notion of resilience thinking; by increasing our reflexive understanding of the adaptive cycle we can possibly prolong the period of growth and enrichment, limit the chaos and destruction that occurs during the backward loop of the cycle, and enhance opportunities for rapid reorganization after a destructive event.

Secondly, the high levels of abstraction in which the theory of resilience and the adaptive cycle are couched do not fit well within the mid and micro levels of analysis that have served the social sciences well.⁵¹ In particular, the dynamics of the adaptive cycle are regarded as being not well supported by empirical evidence and as too deterministic.⁵² This is also an important point as many of the social sciences still theoretically and methodologically reject grand theory⁵³ on the basis that it reifies abstract concepts, smoothing over the variety and embedded nature of much of social life.

B. Adaptive Management

Adaptive management and adaptive co-management have developed as approaches to apply resilience theory to natural resources management. Stemming from the early work of Holling and Walters,⁵⁴ adaptive management is characterized by the use of management interventions themselves as tools to probe the functioning of complex ecosystems.⁵⁵ Thus, instead of a traditional “trial and error” management approach that uses a risk averse “best guess” management strategy, adaptive management applies the methodologies of science to the design, implementation, and evaluation of management strategies with the aim of not only improving environmental management but also understanding the impacts of incomplete knowledge.⁵⁶

Adaptive management has been used interchangeably with “adaptive learning.”⁵⁷ Therefore, it is as much a social process as it is a

50. *Id.* at 365.

51. *Id.*

52. Folke, *supra* note 10, at 258.

53. C. WRIGHT MILLS, *THE SOCIOLOGICAL IMAGINATION* (Oxford Univ. Press 1959).

54. *See generally* C. S. HOLLING, *ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT* (Blackburn Press 2005); CARL WALTERS, *ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES* (Blackburn Press 2002).

55. RESILIENCE ALLIANCE, *Adaptive Management*, http://www.resalliance.org/index.php/adaptive_management (last visited Aug. 15, 2013).

56. E. Sabine et al., *Adaptive Management: A Synthesis of Current Understanding and Effective Application*, 5 *ECOLOGICAL MGMT. & RESTORATION* 177 (2004).

57. WALKER & SALT, *supra* note 13, at 33.

scientific process, one that requires the creation of new and flexible institutions and institutional strategies that are constituted and developed by past, present, and future stakeholders.⁵⁸ It attempts to use a scientific approach, accompanied by collegial hypothesis testing, to build understanding amongst a community of stakeholders.⁵⁹ However, Plummer et al. note that adaptive management “focuses on learning by doing, takes place over the medium to long term through cycles of learning and adaptation, and concentrates on the relationships, requirements and capacity of managers” (thus ‘horizontal’ links).⁶⁰

Adaptive co-management, on the other hand, draws on the collaborative narrative in resource management; emphasizing the vertical and horizontal linkages between local managers at different government levels, resources users, and communities but tends to provide a short-to-medium snapshot of an ecosystem. The combination of adaptive and collaborative management engenders adaptive co-management as a distinctive approach that “forges links (both horizontal and vertical) for shared learning-by-doing between various actors, over a medium to long time horizon. It is multi-scale in spatial scope and is concerned with enhancing and including the capacity of all actors with a stake for sustainably managing the resource at hand.”⁶¹

Armitage et al. emphasize the contextual and flexible nature of adaptive co-management, in that it should be tailored to specific places and situations and supported by various organizations at different scales.⁶² Therefore, the virtues of adaptive co-management are perceived as its capacity to offer holistic, integrative, and multi-level institutional arrangements that respond to the complexity and uncertainty of dynamic social-ecological systems.

C. Adaptive Governance

New conceptual models for understanding the complexity of the natural world have been followed by the proliferation of new governance models aimed at responding to such complexity.⁶³ Governance is frequently defined as the structure and process by which societies share

58. RESILIENCE ALLIANCE, *supra* note 55.

59. *Id.*

60. Ryan Plummer et al., *Adaptive Co-management: A Systematic Review and Analysis*, 17 *ECOLOGY & SOC’Y* 11 (2012), available at <http://www.ecologyandsociety.org/vol17/iss3/>.

61. *Id.*

62. Derek R. Armitage et al., *Adaptive Co-Management for Social-Ecological Complexity*, 7 *FRONTIERS IN ECOLOGY & ENV’T* 95, 96 (2009).

63. Annecoos Wiersema, *A Train Without Tracks: Rethinking the Place of Law and Goals in Environmental and Natural Resources Law*, 38 *ENVTL. L.* 1239 (2008).

power, creating the conditions for ordered rule and collective action.⁶⁴ This encompasses generating a shared vision for sustainability and resolving trade-offs.⁶⁵ Governance occurs through laws, regulations, discursive debates, negotiation, mediation, conflict resolution, elections, public consultations, and protests, amongst other decision-making processes. Importantly, “[g]overnance is not the sole purview of the state through government, but rather emerges from the interactions of many actors, including the private sector and not-for-profit organizations.”⁶⁶ This definition assumes, what has been called, “heterarchic”⁶⁷ or “pluralistic”⁶⁸ governance. Heterarchic or pluralistic governance is a “third way” of ordering society, not through top-down state regulation or market self-regulation, but through flexible regulations produced through deliberation and cooperation amongst a variety of stakeholders.⁶⁹ Polycentric governance has also been defined as involving systems in which “political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other.”⁷⁰ Polycentric governance thus requires bridging public and private power, recognizing that law is only one amongst a number of forms of coordination. Additionally, polycentric governance requires working with a more diffuse public order having different divisions of authority and a more complicated set of hierarchical relationships.⁷¹ Huitema *et al*, however, sound a warning that in polycentric governance economies of scale may be lost, collective decision-making is difficult, and transaction costs associated with the coordination necessary to overcome this difficulty are high.⁷²

64. Louis Lebel, John M. Anderies, Bruce Campbell, Carl Folke, Steve Hatfield-Dodds, Terry P. Hughes & James Wilson, *Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems*, 11 *ECOLOGY & SOC’Y* 19 (2006); Folke *et al.*, *supra*, note 26, at 444.

65. Folke *et al.*, *supra*, note 26, at 444.

66. Lebel *et al.*, *supra*, note 64, at 20.

67. Bob Jessop, *The Rise of Governance and the Risks of Failure: The Case of Economic Development*, 155 *INT’L SOC. SCI. J.* 29 (1998).

68. John Lea & Kevin Stenson, *Security, Sovereignty and Non-State Governance ‘From Below’*, 22 *CAN. J. OF L. & SOC’Y* 9, 10 (2007).

69. Cesar Rodríguez-Garavito, *Ethnicity.gov: Global Governance, Indigenous Peoples, and the Right to Prior Consultation in Social Minefields*, 18 *IND. J. GLOBAL LEGAL STUD.* 263, 276 (2011) (Paper presented at the SWOP Colloquium on Precarious Society, held on September 4-5, 2012 at the University of the Witwatersrand, South Africa).

70. Chris Skelcher, *Jurisdictional Integrity, Polycentrism, and the Design of Democratic Governance*, 18 *GOVERNANCE* 89 (2005).

71. Dave Huitema *et al.*, *Adaptive Water Governance: Assessing the Institutional Prescriptions of Adaptive (Co)management from a Governance Perspective and Defining a Research Agenda*, 14 *ECOLOGY & SOC’Y* 26 (2009).

72. *Id.*

Adaptive governance, as employed within resilience literature, conforms to the features of pluralistic, polycentric, collaborative governance but with a strong focus on linkages to adaptive management and, thereby, to improved social understanding of the dynamics of ecological systems. In other words, adaptive governance seeks to capitalize on both the reflexive, iterative, scientifically-based learning characteristic of adaptive management, as well as theories of new governance that extend the function of governing to a broader range of actors acting on a wider spatial and temporal scale. In 2003, Dietz, Ostrom, and Stern used the term adaptive governance to expand the focus from adaptive management of ecosystems to the broader social contexts that enable ecosystem-based management.⁷³ Cosens and Williams describe adaptive governance as a process that responds to feedback received from a managing agency undertaking adaptive management, through collaboration and cooperation across different levels of government, non-governmental and individual action.⁷⁴ Folke *et al.* maintains that adaptive governance is operationalized through adaptive co-management systems,⁷⁵ which then begs the question whether the two concepts mean the same thing. Adaptive governance, however, would seem to involve conscious arrangements that would facilitate adaptive co-management such as allowing the emergence and nurturing of social networks that could employ both social capital (trust, leadership, social networks, reciprocity, common rules, norms and sanctions) and social memory (experience for dealing with change, different role-players in social networks playing different social roles) in order to deal with common problems characterized by uncertainty and change.⁷⁶ Moreover, since there is some consensus that networked structures do not replace the accountability of existing hierarchical bureaucracies, but operate within and complement them,⁷⁷ adaptive governance would presumably also involve means to bridge and reconcile old and new forms of governance.

Adaptive governance arrangements could emerge through both statutory and non-statutory initiatives.⁷⁸ Folke *et al.* point to the role crises may play in triggering learning and knowledge generation and

73. Thomas Dietz, Elinor Ostrom & Paul C. Stern, *The Struggle to Govern the Commons*, 302 SCIENCE 1902 (2003).

74. Barbara A. Cosens & Mark Kevin Williams, *Resilience and water governance: Adaptive governance in the Columbia River Basin*, 17(4) ECOLOGY & SOC'Y 3 (2012).

75. Folke *et al.*, *supra*, note 26, at 444, 448, 453.

76. *Id.* at 444.

77. *Id.* at 450.

78. *Id.*

opening up space for new management trajectories of resources and ecosystems.⁷⁹ They also observe that successful transformation toward adaptive governance for ecosystem management tends to be preceded by the emergence of informal networks, orchestrated by key individuals. These help facilitate information flows, identify knowledge gaps, and create nodes of adaptive expertise that can be drawn upon in times of crisis.⁸⁰

With the above context in mind, the following sections of this article describe the general features of the law and resilience literature before outlining key themes and issues.

III. GENERAL FEATURES OF THE LAW AND RESILIENCE LITERATURE

A total of 74 published items were included in the review after applying the search and screening criteria.⁸¹ The general features of the law and resilience literature were analyzed according to the year of publication; the nature of the study (conceptual, doctrinal and/or empirical); key concepts used; jurisdictional focus of the research; the particular system under review; the nature of the environment studied; and the scale of governance. Each primary axis of analysis was broken down into further sub-categories, as detailed further below. Table 1 provides an overview of the categories, sub-categories and number of published items per sub-category:

79. *Id.* at 460.

80. *Id.* at 459

81. The literature review was undertaken by searching for articles and books containing the words “law” and “resilience” as well as “urban resilience” in the title or keywords in the relevant databases on Westlaw, Heinonline, SABINET (a South African database of electronic journals), the Social Sciences Research Network (SSRN) and Google Scholar. All articles and responses relating to law in the Resilience Alliance’s journal *Ecology & Society* were scanned. The search string ‘law AND ‘resilience’ did not capture all articles dealing with or relying upon the concept of resilience and the search criterion was later expanded to include ‘adaptive management’, ‘adaptive governance’ and ‘adaptive law’ as search terms. Articles on climate change adaptation more generally (which did not explicitly rely upon a resilience frame) as well as articles dealing with vulnerability and disaster response, but not resilience, were not included.

Table 1: Contextual aspects of the law and resilience literature

Contextual Aspect	Description	#	Contextual Aspect	Description ⁸²	#
<i>Year of publication</i>	1985 – 1990	1	<i>System reviewed</i>	Agriculture	3
	1991 – 1995	2		Biodiversity	3
	1996 – 2000	4		Climate change	8
	2001 – 2005	9		Coastal ecosystems	4
	2006 – 2010	27		Ecosystems	3
	2011 – 2013	27		Endangered species/protected areas	8
	Date not specified	4		Energy efficiency	1
				Fisheries	2
				Floods	1
				Marine environment	3
				Offshore oil and gas	3
				Public lands (incl. forests)	6
				Social systems (incl. law)	1
				Urban systems	6
		Watersheds/freshwater systems	1		
			8		
<i>Type of Study</i>	Conceptual	19	<i>Nature of environment</i>	Natural	5
	Conceptual+weak empirical	12		Natural and built	0
	Conceptual+strong empirical	9		Legal system/social system	8
	Conceptual+doctrinal	10			1
	Conceptual+doctrinal+weak empirical	10			6
	Conceptual+doctrinal+strong empirical	14			
<i>Key concepts</i>	Resilience	41	<i>Scale of governance</i>	Global/international	8
	Panarchy	5		Transboundary	6
	Adaptive management	37		Federal or mainly federal	1
	Collaborative management or CAM	3		Local/communities/tribal	4
	Adaptive governance	6		Cross-scale	9
	Adaptive planning:	6		Not specific	3
	Adaptive/reflexive law	3			6
	Vulnerability	2			1
	5				
<i>Jurisdiction</i>	United States	57			
	EU	6			
	Developing countries	6			
	Not specified or reference to multiple jurisdictions	11			

82. In some cases, a single article applied resilience theory to more than one specific context, hence the number of sub-categories in this section amounts to more than 74.

In order to determine whether the literature on law and resilience had been increasing, decreasing or stagnating, the published items were grouped into five-year publication bands (with the exception of the last band, which only spanned three years). The analysis demonstrated a clear increasing trend in scholarly legal articles centered on or utilizing the concept of resilience and related concepts such as adaptive management, adaptive co-management and adaptive governance, with an increase particularly noticeable after 2006. This trend appears to be continuing with the number of items for the three-year period from 2011 to 2013, already equal to the number of items for the five years spanning 2006 to 2010.

The nature of the research was characterized in terms of whether it was primarily conceptual (explaining a concept drawn from resilience theory and broadly applying it to law), doctrinal (applying the insights gained from resilience theory through detailed analysis of a particular law or laws), or empirical (illustrating how concepts and/or laws had been applied in specific cases). Empirical research was further distinguished between “weak empirical” and “strong empirical.” The former denoting research that incorporated cases as examples to illustrate or illuminate a particular conceptual or doctrinal point,⁸³ the latter denoting research fitting a case study methodology, i.e. an in-depth, multi-dimensional exploration of a particular case or cases. Various combinations of these sub-categories came to the forefront; for instance, work that was both conceptual and doctrinal (conceptual + doctrinal) or research that was both conceptual and weakly empirical (conceptual + weak empirical). I found that research having some empirical dimension (45 items either in its weak or strong forms) outweighed research items that were only conceptual (19 items) or conceptual and doctrinal in nature (10 items). Pieces that were strongly empirical (23 items⁸⁴) slightly outweighed weakly empirical ones (22 items⁸⁵). The strongly empirical case studies included analyses of adaptive management in the

83. See, e.g., A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121 (1994); Bradley C. Karkkainen, *Panarchy and Adaptive Change: Around the Loop and Back Again*, 7 MINN. J.L. SCI. & TECH. 59 (2005–2006); Elizabeth Burleson, *Energy revolution and disaster response in the face of climate change*, 22 VILL. ENVTL L. J. 169 (2011). None of the empirically strong items, however, appeared to rely on primary data collection methods.

84. The sum of the conceptual + strong empirical and conceptual + doctrinal + weak empirical categories.

85. The sum of the conceptual + weak empirical and conceptual + doctrinal + weak empirical categories.

Columbia River basin⁸⁶ and the Florida Everglades.⁸⁷ Three studies provided in-depth analyses of disasters within the conceptual framing of resilience and adaptive management focusing on Hurricane Katrina,⁸⁸ the oil spill at Deepwater Horizon Bay,⁸⁹ and Tropical Storm Irene⁹⁰ respectively. Angelo's account of the restoration of the health of Lake Apopka provided the most affirmative account of the use of resilience-based strategies.⁹¹

Across the literature, the most frequently employed concepts were resilience and adaptive management, with far fewer studies invoking the concepts of panarchy or adaptive governance. While the most frequently studied jurisdiction, by far, is the United States, developing country studies include Carmin, Roberts & Anguelovski's search on urban resilience and urban adaptation planning in South Africa and Ecuador;⁹² Monteiro's study on adaptive governance in Alcantara, Brazil and other developing countries;⁹³ and, Green, Cosens and Garmestani's analysis of transboundary water governance in the Okavango Basin.⁹⁴

Research applying resilience theory to systems of freshwater management and/or watersheds were the most common, interestingly followed by studies that focused on the implications of adopting a resilience approach for the legal system itself and other social systems J.B. Ruhl, with at least four contributions on the design implications for

86. See, e.g., Kai N Lee & Jody Lawrence, *Adaptive Management: Learning from the Columbia River Basin Fish and Wildlife Program*, 16 ENVTL. L. 431 (1985); Barbara A. Cosens, *Transboundary River Governance in the Face of Uncertainty: Resilience Theory and the Columbia River Treaty*, J. LAND RESOURCES & ENVTL. L. 229 (2010); Barbara A. Cosens, *Resilience and Law as a Theoretical Backdrop for Natural Resource Management: Flood Management in the Columbia River Basin*, 42 ENVTL. L. 241 (2012).

87. Thomas T. Ankersen & Richard Hamann, *Ecosystem Management and the Everglades: A Legal and Institutional Analysis*, 11 J. LAND USE & ENVTL. L. 473 (1996); Sandi Zellmar & 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 (2008).

88. B.E. Aguirre, *Dialectics of Vulnerability and Resilience*, 14 GEO. J. ON POVERTY L. & POL'Y 39 (2007).

89. Robin Kundis Craig, *Legal Remedies for Deep Marine Oil Spills and Long-Term Ecological Resilience: A Match Made in Hell*, 2011 BYU. L. REV. 1863 (2011).

90. David K. Mears & Sarah McKearman, *Rivers and Resilience: Lessons Learned from Tropical Storm Irene*, 14 VT. J. ENVTL. L. 177 (2012).

91. Mary Jane Angelo, *Stumbling Towards Success: A Story of Adaptive Law and Ecological Resilience*, 87 NEB. L. REV. 950 (2008).

92. JoAnn Carmin, Debra Roberts & Isabelle Anguelovski, *Preparing Cities for Climate Change: Early Lessons from Early Adaptors*, in CITIES AND CLIMATE CHANGE: RESPONDING TO AN URGENT AGENDA (D. Hoornweg, M. Freire, M. J. Lee, P. Bhada-Tata, & B. Yuen, eds., 2012).

93. Lia Helena Monteiro de Lima Demange, *The Principle of Resilience*, 30(2) PACE ENVTL. L. REV. 697 (2013).

94. Olivia O. Green, Barbara A. Cosens & Ahjond S. Garmestani, *Resilience in Transboundary Water Governance: The Okavango River Basin*, 18(2) ECOLOGY & SOC'Y 23 (2013).

law of resilience, appears to be the leading scholar on this issue,⁹⁵ although recent contributions by Arnold and Gunderson⁹⁶ and Garmestani, Allen and Benson⁹⁷ cannot be ignored. Apart from the contribution by Carmin, Roberts & Anguelovski,⁹⁸ and to an extent the studies of the resilience of coastal ecosystems, the application of resilience thinking to the urban environment (thinking of cities as social-ecological systems) was not featured at all in this body of literature.

Most of the contributions applied a resilience approach to specific natural ecosystems, followed by a focus on the legal system itself. Of the eight studies that also incorporated a focus on the built environment, there was a focus on both infrastructural, form and fabric aspects, particularly in the contexts of restrictions on flood plain development⁹⁹ and coastal developments threatened by sea-level rise.¹⁰⁰ Burleson makes a passing reference to the need for disaster-resilient green building,¹⁰¹ and Ruppert's book review of Timothy Beatley's *Planning for coastal resilience: Best practices for calamitous times* (2009, Island Press) mirrors the book's focus on resilience and built form, social resilience and economic resilience.¹⁰²

The majority of contributions focus on cross-scale governance, in other words governance across global-federal-regional-local structures. Studies of governance at the local/community/tribal level included D'Agostino's analysis of the linkages between State and local governments in the context of coastal hazard planning;¹⁰³ the need for cities and local communities to adapt to climate change,¹⁰⁴ and Aslan's detailed case study of how dependence on fossil fuel revenues and

95. J.B. Ruhl, *Regulation by Adaptive Management -- Is It Possible?*, 7 MINN. J. L. SCI. & TECH. 21 (2005); J.B. Ruhl, *Climate Change Adaptation and the Structural Adaptation of Environmental Law*, 40 ENVTL L. 363 (2010); J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems -- With Applications to Climate Change Adaptation*, 89 N.C. L. REV. 1373 (2011); J.B. Ruhl, *Panarchy and the Law*, 17 ECOLOGY & SOC'Y 31 (2012).

96. Craig Arnold & Lance Gunderson, *Adaptive Law and Resilience*, 43 ENV. L. REPORTER NEWS & ANALYSIS 10426 (2013).

97. Ahjond S. Garmestani, Craig R. Allen & Melina H. Benson, *Can Law Foster Social-Ecological Resilience?*, 18 ECOLOGY & SOC'Y 37 (2013).

98. Carmin *et al.*, *supra* note 92.

99. Barbara Cosens, *Transboundary River Governance in the Face of Uncertainty: Resilience Theory and the Columbia River Treaty*, J. LAND RESOURCES & ENVTL L. 229.

100. John R. D'Agostino, *Resistance to Resilience: Coastal Hazard Policy, Science and Planning in New Jersey*, in 1 SEA GRANT L. & POL'Y J. 116 (2008).

101. Burleson, *supra* note 83, at 101.

102. Thomas Ruppert, *Tools in the Resilience Toolbox: But Are We Willing to Use Them?*, 16 OCEAN & COASTAL L.J. 551 (2011).

103. D'Agostino, *supra* note 100.

104. Peter Hayes, *Resilience as Emergent Behavior*, 15 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 175 (2009).

subsidies has reduced the resilience and changed traditional subsistence economies of indigenous communities living at Fort Yukon, Alaska.¹⁰⁵

IV. UNDERSTANDING OF RESILIENCE

Almost all of the contributions to the law and resilience literature under review connected the concept of resilience to the necessity of dealing with uncertainty, surprise and complexity at multiple scales. There is acknowledgement, at times expressed and at other times implied, that resilience is an element of (and cannot be conflated with) sustainability.¹⁰⁶ A number of authors orientated their understanding of resilience around the distinction between engineering and ecological resilience,¹⁰⁷ or on the first conception of resilience as ‘the capacity of a system to absorb disturbance and still retain its basic structure and function’.¹⁰⁸

More recent contributions to this literature, however, reflect the revised understanding of resilience as connoting, not only the capacity of a social-ecological system to stay within the same basin of attraction, but also the capacity to self-organize, adapt and thus, transform. Benson draws directly upon Carpenter *et al*’s formulation,¹⁰⁹ while Barnes holds that the four essential concepts to understanding resilience are (1) identity or state (the variables that constitute the system); (2) persistence (the capacity to withstand pressure and change); (3) adaption (the nature

105. Jeff Aslan, *Building Alaska Native Village Resilience in a Post-Peak World*, 37 VT. L. REV. 239 (2012).

106. Melinda Harm Benson, *Intelligent Tinkering: The Endangered Species Act and Resilience* 17 ECOLOGY & SOC’Y 28 (2012). Since resilience is a *property* of a system, an evaluation of how well the various parts cohere notwithstanding external shocks and the emergent characteristics that arise from the system’s own internal dynamics, it is correct to apply the term even to social-ecological systems that are not sustainable, at least over the short to medium term. Such unsustainable systems may be propped up by a host of social practices (pumping of underground water, the application of fertilizer, use of fossil fuels, subsidies, insurance, property rights; etc) that are very difficult to change and thus exhibit a form of resilience. Over the long term, however, the capacity of these various elements to hold together will be eroded. WALKER & SALT’S discussion (*supra* note 13, at 39) of the struggle of farmers in the Goulburn-Broken Catchment in Australia to keep a salty water table at bay serves as a good example of this. In order to avoid confusion however, the term ‘resilience’ will be reserved for sustainable social-ecological systems, while ‘endurance’ or ‘persistence’ will be reserved for systems that are both unsustainable yet resistant to change.

107. *See, e.g.*, Tarlock, *supra* note 83, at 1121; Angelo, *supra* note 91, at 950.

108. *See, e.g.*, Robert W. Adler, *Resilience, Restoration and Sustainability: Revisiting the Fundamental Principles of the Clean Water Act*, 32 WASH. U. J. L. & POL’Y 139, 149 (2010); Barbara Cosens, *Resilience and Law as a Theoretical Backdrop for Natural Resource Management: Flood Management in the Columbia River Basin*, 42 ENVTL L. 241, 245 (2012); Arnold & Gunderson, *supra* note 96, at 10427.

109. Benson, *supra* note 106, at 28.

of a system's response to change); and (4) transformation (the capacity of a system to fundamentally change when social, economic, political or ecological conditions make the continuation of the old system untenable).¹¹⁰

In a similar vein, Kundis Craig's discussion of the distinction between complex and complicated systems notes that the distinguishing properties of complex systems include the self-organizing nature of the individual components of the system—their capacity to drive hard-to-predict emergent behavior; their capacity to use information and signals from both their internal and external environments which results in both temporal and spatial linkages at different scales; and their capacity to change behavior (adapt) through learning or evolutionary processes.¹¹¹ All the authors in the literature under review affirm the need to respond to complexity and unpredictability and have not argued against the use of resilience as a conceptual frame in this regard. Although some later contributors have adopted a critical stance toward the uncritical and wholesale adoption of adaptive management.¹¹²

The scholars that discuss panarchy and the law draw directly upon Gunderson and Holling's work, emphasizing both the forward and backward loops of the adaptive cycle, as well as the simultaneous 'nested' operation of adaptive cycles at multiple spatial and temporal scales.¹¹³ In an early contribution to the literature, Karkkainen describes himself as agnostic toward panarchy, pointing out that the large empirical claims upon which the panarchy thesis rests are difficult to rebut from a law professor's desk, and expressing some reserve as to the apparently deterministic features of the theory.¹¹⁴ Ruhl argues that panarchy theory is unlikely to gain traction in practice until it is endorsed and implemented through specific laws and regulations. But this in turn requires adaptively managing the complex legal system. Beyond this argument, he merely sounds the alarm for work on panarchy to begin in earnest.¹¹⁵

110. Richard A. Barnes, *The Capacity of Property Rights to Accommodate Social Ecological Resilience*, 18 *ECOLOGY & SOC'* 6 (2013).

111. Kundis Craig, *supra* note 5, at 4–5.

112. See Holly Doremus, *Adaptive Management as an Information Problem*, 89 *N.C. L. REV.* 1455 (2011); Lawrence Susskind, Alejandro E. Camacho & Todd Schenk, *Collaborative Planning and Adaptive Management in Glen Canyon: A Cautionary Tale*, 35 *COLUM. J. ENVTL L.* 1 (2010).

113. Karkkainen, *supra* note 83, at 59; Melinda Harm Benson & Ahjond S. Garmestani, *Embracing Panarchy, Building Resilience and Integrating Adaptive Management Through a Rebirth of the National Environmental Policy Act*, 92 *J. ENVTL MGMT.* 1420 (2011); Ruhl (2012), *supra* note 95, at 31.

114. Karkkainen, *supra* note 83, at 63.

115. Ruhl (2012), *supra* note 95, at 36.

Similarly, Benson and Garmestani had already taken up the gauntlet through their 2011 analysis of how the National Environmental Policy Act could be ‘re-birthed’ to embrace panarchy, build resilience, and integrate adaptive management. Spoiling the stance of Benson and Garmestani’s embrace, and Ruhl’s position regarding the importance of laws, regulations and lawyers in implementing policies based on the panarchy thesis, Holling himself (in a reply to Ruhl’s article) expresses doubt as to whether law has any meaningful role to play in periods of great social change that are unknown, beyond experience and occurrences on a global and regional scale.

Law’s fundamental role, in its assurance of persistence of social and economic relationships among people, may have a greater role to play in the forward-loop of the adaptive cycle rather than the backward-loop of crisis collapse and transformation. In the latter context, law would do well, he suggests, to simply facilitate extensive and continuous monitoring over large scales to anticipate shifts in human and ecosystem behavior; introduce policies to maintain or enhance diversity; and accelerate technological transformations, such as, moves from fossil-fuel to renewable energies.¹¹⁶

In the literature under review, Aguirre’s contribution stands out for bringing the concepts of vulnerability and resilience in relation to each other in a legal context. In contrast to most approaches in vogue in the social sciences, which assert that resilience is the antidote to vulnerability, Aguirre argues that the relationship between vulnerability and resilience is a dialectical unity.¹¹⁷ Vulnerabilities expose exhaustion, impotence, weakness or exposure to harm. These are risks that simultaneously constitute a window of opportunity for mitigations that may improve resilience and adaptive capacity.¹¹⁸ However, because efforts at mitigating risks are invariably based on incomplete knowledge, the creation of new and frequently unanticipated vulnerabilities is inherent in every solution to bring about temporary adaptation. Vulnerability and resilience are thus bound to each other in a never-ending, open process.¹¹⁹

V. DEFICIENCIES OF THE LAW

One strand of the law and resilience literature under review focuses on how current legal administrative systems fall short of creating an

116. Holling, *supra* note 39, at 37.

117. Aguirre, *supra* note 88, at 39.

118. *Id.* at 42.

119. *Id.* at 43.

enabling regulatory environment for coping with complex and adaptive social-ecological systems.¹²⁰ This literature is of course predominantly focused on the administrative system and environmental laws of the United States of America, so it is not clear whether these shortfalls apply in other jurisdictions. A popular claim, encapsulating the deficiencies of the administrative law system in the United States, is that the laws are locked into an engineering resilience paradigm.¹²¹

In a recent contribution, Arnold and Gunderson group the maladaptive qualities of current laws in the United States into four categories, namely: (1) systemic goals that are too narrowly focused on advancing the stability of political and economic goals; (2) monocentric (too centralized), unimodal (placing too much emphasis on uniform models) and fragmented structures of government; (3) inflexible methods that employ rules and legal abstractions and promote resistance to change; and (4) rational, linear, legal-centralist processes that assume away uncertainty.¹²² They note further that traditional features of common law systems, such as *stare decisis*, checks and balances on government authority, judicial self-restraint, *res iudicata*, and protection of individual rights and freedoms, also make the US legal system resistant to change.¹²³

For purposes of this review, the current deficiencies of the law and administrative systems in light of the needs of resilience, adaptive management and adaptive governance will be discussed in terms of perspectives of nature, substantive goals, the structure of governing authority, and structuring of practice and decision-making.

A. Perspectives of Nature

The first area of deficiency is that underlying the incapacity of current laws to advance resilience for sustainability is an incorrect

120. Tarlock, *supra* note 83; Timothy H. Profeta, *Managing Without a Balance: Environmental Regulation in Light of Ecological Advances*, 7 DUKE ENVTL L. & POL'Y F. 71 (1996); Warrant T. Coleman, *Legal Barriers to the Restoration of Aquatic Ecosystems and the Utilization of Adaptive Management*, 23 VT. L. REV. 177 (1998); Julie Thrower, *Adaptive Management and NEPA: How a Non-Equilibrium View of Ecosystems Mandates Flexible Regulation*, 33 ECOLOGY L.Q. 871 (2006); Alyson C. Flournoy, *Protecting a Natural Resource Legacy while Promoting Resilience: Can It Be Done?*, 87 NEB. L. REV. 1008 (2008); Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L. J. 1 (2009); Adler, *supra* note 108; Alejandro E. Camacho, *Transforming the Means and Ends of Natural Resources Management*, 89 N.C. L. REV. 1405 (2011); Benson and Garmestani, *supra* note 113; Benson, *supra* note 106; Kundis Craig, *supra* note 89.

121. See, e.g., Ruhl (2011), *supra*, note 95 at 1392.

122. Arnold & Gunderson, *supra* note 96, at 10428.

123. *Id.* at 10427.

perspective of natural systems and their interconnections with humans. Early contributions by Tarlock and Profeta, for example, pointed out that ecologists had dismissed the “balance-of-nature” metaphor that had driven powerful environmental law reforms in the United States in the 1960s and 1970s.¹²⁴ Inherent in this metaphor were two key assumptions, namely that humans should be considered separate from ecosystems, and that ecosystems tended towards steady-state equilibrium that would remain perpetually in balance. In natural resource conservation laws, this metaphor manifested in “fencing off” strategies that propagated the fiction that fenced-off areas could remain in a ‘state of nature’ free from human-induced impacts,¹²⁵ and in pollution control laws, in the establishment of fixed standards for emissions and resource quality criteria.¹²⁶ Ward notes, that the resilience paradigm, while at least insisting upon an integrated understanding of social-ecological systems and their complex and emergent nature, is still ultimately anthropocentric in nature.¹²⁷ Highlighting the importance of ethics (one of the key elements of social systems, together with knowledge, rules and institutions), he warns against laws promoting a view of nature as a limitless source of lifeless commodities to be used and traded instead of an astounding web of living communities that includes us.¹²⁸

B. Substantive Goals

The second area of deficiency relates to the substantive goals of laws affecting natural resources. Arnold and Gunderson’s point that the use of natural resources is too narrowly focused on ensuring stability, certainty, and security of supply is well-made. However, Zellmar and Gunderson add another dimension in pointing to “multiple use, maximum sustainable yield” mandates as one of the key factors contributing toward weakening the resilience of ecosystems.¹²⁹ Not only do existing environmental laws mandate the optimal use of natural resources, they allow for multiple uses and thus a push for optimization from multiple interest groups. As discussed in section 2.1, one of the key insights of resilience theory is that a focus on optimization weakens

124. A. Dan Tarlock, *Slouching Toward Eden: The Eco-Pragmatic Challenges of Ecosystem Revival*, 87 MINN. L. REV. 1173, 1183 (2003); Profeta, *supra* note 120, at 71.

125. Tarlock, *supra*, note 124 at 1174.

126. *See* Adler, *supra* note 108, at 139 (Adler’s discussion of water quality criteria in terms of the United States of America’s Clean Water Act).

127. Chip Ward, *Dance, Don’t Drive: Resilient Thinking for Turbulent Times*, 31 UTAH ENVTL. L. REV. 107 (2011).

128. *See* Adger, *supra* note 28.

129. Zellmar & Gunderson, *supra* note 87, at 901–906.

ecosystems over the long term, increasing the vulnerability of dependent social-ecological systems.

Resilience theory does not necessarily require that ecological values should trump economic values whenever a conflict arises. A too radical shift to orientating legal and governance systems towards ecological primacy, especially as this affects property rights, may even unleash a psychological and political backlash against environmental laws.¹³⁰ A resilience perspective nevertheless supports the notion that there are ecological limits to social systems, which are ultimately all reliant on a natural resource base. This understanding should at least engender respect for the intricate and interconnected nature of ecological systems, a precautionary approach to disrupting the web of relationships that hold such systems together, a commitment to increasing knowledge and understanding of the relationships within and between ecological and social systems over time, and a willingness to limit existing and future rights to resources if this is required to keep a social-ecological system within a particular basin of attraction. There is however little recognition in existing laws of this form of primacy. Averill observes that there is no guidance in existing laws on which uses should receive priority and, when choices have to be made, economics tends to trump conservation.¹³¹ Zellmar and Gunderson regard Congress' failure to articulate the primacy of ecological values as one of the primary impediments to making the most of adaptive management in the Grand Canyon.¹³² And Bromley notes that the central challenge in collective action for global resource policy is to reconcile the multitude of contending ideas about the future (although his piece also explains the inherent impossibility of this ever occurring).¹³³ The place of substantive goals in laws that aim to facilitate adaptive management and governance, as discussed below in section 6.2, is not settled.

Existing legislation (and in particular, the allocation of rights and entitlements) also contributes to path dependency that could reinforce maladaptation. As Zellar and Gunderson note, in ecological restoration efforts, future goals are closely tied to a complex array of pre-existing social structures constituted by laws, policies, and institutions. These frame and constrain the options for advancing resilient social-ecological

130. Arnold & Gunderson, *supra* note 96, at 10438.

131. Marilyn Averill, *Introduction: Resilience, Law and Natural Resource Management*, 87 NEB. L. REV. 821, 824–825 (2009).

132. Zellmar & Gunderson, *supra* note 87, at 930.

133. Bromley, *supra* note 4, at 17.

systems.¹³⁴ In the massive Florida Everglades restoration project, for instance, Congress' legislative framing of the project—the Water Resources Development Act of 2000—contained a provision protecting the existing water allocation regime created under Florida state law.¹³⁵ Similarly, the Grand Canyon Protection Act, passed by the United States Congress in 1992, specified that nothing in the Act be intended to affect, in any way, “allocations of water secured to the Colorado Basin States by any compact, law or decree”¹³⁶ The defense of these allocations through litigation perpetuates degraded social-ecological systems.¹³⁷ The continuing entrenchment of stability, certainty, and security of supply—even in these flagship adaptive management projects—avoids squaring up to the difficult social consequences of a worldview that acknowledges the thresholds and limitations of natural systems. Efforts to restore the ecological integrity of the Murray-Darling river in Australia, however, included the need to modify harmful resource use decisions, thus limiting existing entitlements throughout the system.¹³⁸ In general, however, the extent to which unsustainable, yet persistent natural resource decisions can be revisited and existing rights and entitlements can be modified or taken away, was not a strong focus of the law and resilience literature under review.

C. Structure of Governing Authority

The third area of deficiency pertains to the structure of governing authority. Deficiencies of law relating to the structure of governing authority have been identified as including the extent to which law centralizes power (as opposed to diffusing it); the modes through which the law allows an authority to exercise power; and the manner in which governing authority operates across spatial scales (local, regional, federal or national and global). In their account of the features of adaptive law, Arnold and Gunderson critique the extant legal structuring of governing authority along these lines, arguing against a monocentric, uniscalar, and unimodal approach toward governing complex systems.¹³⁹

Monocentric approaches to governing authority manifest in arguments for strong national or global authorities that would control

134. Zellmar & Gunderson, *supra* note 87, at 894.

135. *Id.* at 920.

136. *Id.* at 925.

137. Angelo, *supra* note 91, at 975.

138. Tarlock, *supra* note 124, at 1191.

139. Arnold & Gunderson, *supra* note 96, at 10433–10436.

behavior through command-and-control regulation and the rule of law.¹⁴⁰ A variant of such leanings toward centralization is also evident in Bosselman's suggestion for the creation of an Adaptive Planning Organization that would serve as a single point for the review of state policies and recommend revisions to adapt them to changing conditions.¹⁴¹ Proponents of monocentric governance contend that sub-national governments and private-sector actors lack sufficient incentives, power, expertise, or resources to respond appropriately to complex multiscale challenges, and that strong central governments are needed to coordinate the multiple responses of these actors.¹⁴² However, Arnold and Gunderson, and other proponents of polycentric governance (as detailed in section 6.3 below), argue that monocentric governing authority is insufficiently flexible and fails to allow for experimentation and innovation in governance and management; that it is vulnerable to the risk that a single approach taken by the central authority will fail; and that it is usually not matched to the scale, scope, and speed at which complex adaptive problems should be addressed.¹⁴³

The issue of scale mismatches is a common theme in the law and resilience literature. Cumming, Cumming, and Redman define scale mismatches as misalignments of the scale of environmental variation and the scale of organization in which the responsibility for management resides such that one or more functions of the social-ecological system are disrupted, inefficiencies occur, and/or important components of the systems are lost.¹⁴⁴ Scale mismatches are believed to decrease social-ecological resilience and lead to an increased likelihood of mismanagement of natural resources, with a concomitant decrease in human well-being.¹⁴⁵ While noting the difficulties associated with defining ecosystems, Karkkainen notes that whatever their "precise geography" we should expect that "conventional, legal, political, institutional, and jurisdictional divisions of authority will not map well onto them"¹⁴⁶ Examining the conventional territorially-delimited

140. *Id.* at 10433.

141. Fred Bosselman, *A Role for State Planning: Intergenerational Equity and Adaptive Management*, 12 U. FLA J.L. & PUB. POL'Y 311 (2000).

142. Arnold & Gunderson, *supra* note 96, at 10433.

143. *Id.*

144. Graeme S. Cumming, David H. M. Cumming & Charles L. Redman, *Scale Mismatches in Social-Ecological Systems: Causes, Consequences, and Solutions*, 11 ECOLOGY & SOC'Y 14 (2006).

145. Graeme S. Cumming, *Scale Mismatches and Reflexive Law*, 18 ECOLOGY & SOC'Y 15 (2013).

146. Bradley C. Karkkainen, *Collaborative Ecosystem Governance: Scale, Complexity and Dynamism*, 21 VA. ENVTL L. J. 189 (2002).

lines of authority of landowners (and other proprietary rights-holders), local governments, state governments, and the federal government,¹⁴⁷ he observes that the territorial jurisdictions of existing institutions are invariably either too large or too small for ecosystem governance (or both simultaneously).¹⁴⁸ In their stead, he advocates for the emergence of hybrid ecosystem governance institutions that would allow for both horizontal and vertical linkages across government institutions and between the public and private spheres.¹⁴⁹ Inherent in Karkkainen's advocacy for hybrid ecosystem governance institutions is the assumption that particular government functions cannot be allocated to any particular scale, and that complex adaptive problems require a multiscalar approach. Karkkainen stresses intergovernmental coordination, which in his view includes interagency coordination as well as collaboration between the legislative and executive branches across traditional jurisdictional divides. As discussed in section 6.3 however, multiscalar approaches may also include coordination of public and private modes of governance, brought together in various network formations. These new approaches to the structure of governing authority challenge traditional debates on the appropriate division of authority between federal power and state or local power.¹⁵⁰

Arnold and Gunderson's critique of a unimodal approach in extant laws—by which they mean the choice of a particular mode, instrument, method, or design as “optimal” (a one-size-fits-all approach)¹⁵¹—is echoed by the chorus of scholars who observe that a new awareness of the complexity and emergent features of social-ecological systems mitigates against any one instrument being a “silver bullet.”¹⁵² A unimodal frame of reference manifests, for instance, in debates over whether command-and-control regulations or market mechanisms are more effective at achieving policy goals in a particular context.¹⁵³ In contrast to this, critics of a unimodal approach advocate “integrationist multimodality,” which references the use of multiple modes or

147. *Id.* at 212–217. Karkkainen's research speaks to the governance arrangements in the United States of America.

148. *Id.* at 212.

149. *Id.* at 217.

150. Arnold & Gunderson, *supra* note 96, at 10435.

151. *Id.* at 10434; Karkkainen, *supra* note 146, at 198, 206.

152. Jonas Ebbesson, *The Rule of Law in Governance of Complex Socio-Ecological Changes*, 20 GLOBAL ENVTL CHANGE 414, 417 (2010); Benson & Garmestani, *supra* note 113, at 1421; Barbara Cosens, *Resilience and Law as a Theoretical Backdrop for Natural Resource Management: Flood Management in the Columbia River Basin*, 42 ENVTL L. 241, 246 (2012); Barnes, *supra* note 110, at 12.

153. Arnold & Gunderson, *supra* note 96, at 10434.

methods—legal and non-legal—to achieve a policy goal, but in a manner that also aims to integrate or interconnect the tools used.¹⁵⁴

Another strand of debate relates to whether governing authority should be juridified at all. Law by its nature connotes formality and a certain degree of inflexibility. Since there is more adaptability, learning, and resilience when cooperation is undergirded by informal stakeholder networks, some have argued (or assumed) that the legal and administrative hierarchy is less important than the other means, processes, and relations in a society by which particular individuals and groups gain, control, and maintain access to particular resources. For instance, in examining how four communities in northern California acquired access to water, and how access was implicated in differential levels of resilience to water scarcity, Langridge et al. rely on Ribot and Peluso's distinction¹⁵⁵ between more traditional "rights" sanctioned by law, custom, or convention, and the broader concept of "access," which incorporates mechanisms such as technology, capital, markets, labor, knowledge, authority, and identities.¹⁵⁶ Their analysis suggests a movement away from a focus on legal rights and instead to strengthening and diversifying the full range of "structural and relational access mechanisms" in order to increase the social resilience of particular groups.¹⁵⁷ In contrast, Van Rijswick and Salet argue in favor of an institutionalist view of law that establish codes of behavior in order to inform people what they can expect of one another, as opposed to the prevailing instrumentalist or responsive view of law driven by goal rationality.¹⁵⁸ Arnold, in an earlier contribution, also appears to weigh in favor of the governance of social-ecological systems being supported by some law. However, the basic conundrum of too much law (constraining agency experimentation and spontaneous collaboration amongst stakeholders) or too little (not vesting governing authorities with a sufficient legal mandate) has no clear or simple answer.¹⁵⁹

154. *Id.*

155. Jesse C. Ribot & Nancy Lee Peluso, *A Theory of Access*, 68 RURAL SOCIOLOGY 153.

156. R. Langridge, J. Christian-Smith & K. Lohse, *Access and Resilience: Analyzing the Construction of Social Resilience to the Threat of Water Scarcity*, 11 ECOLOGY & SOC'Y 18 (2006).

157. *Id.*

158. Marleen Van Rijswick & Willem Salet, *Enabling the Contextualization of Legal Rules in Responsive Strategies to Climate Change*, 17 ECOLOGY & SOC'Y 18 (2012).

159. Craig A. Arnold, *Adaptive Watershed Planning and Climate Change*, 5 ENVTL & ENERGY L. & POL'Y J. 417, 480 (2010).

D. Nature of Legal Processes and Values

The final set of deficiencies afflicting law when viewed through a resilience lens center on the nature of legal processes and values. Arnold and Gunderson summarize the maladaptive features in this regard as including a preference for establishing predetermined linear pathways of action for planning and development; a preference for certainty and security in resources and social structures; a preference for risk avoidance and allocation of liability for mistakes; and a preference for decisions based on universally applicable legal abstractions (the “one-size-fits-all” approach referred to above).¹⁶⁰

A number of scholars have criticized the linear, front-end nature of legal processes. Ruhl notes that the administrative law system’s fixation on pre-decisional environmental assessment, cost-benefit analysis, records of decisions, and judicial review have pushed the system to a “front-end” focus that elevates the importance of reliability and efficiency, making adaptive management exceptionally difficult.¹⁶¹ Many environmental and natural resources laws lack meaningful feedback-loop processes or, where they are instituted, agencies do not employ them.¹⁶² This linear process is supposed to constitute rational planning, but in effect it depends too heavily on assumptions of stationarity and predictability.¹⁶³ Front-end approaches also assume that resource managers are sufficiently cognizant of the intricacies of social-ecological systems, and that they can predict the environmental impact of an activity before it occurs.¹⁶⁴ The presumed linearity of legal processes conflicts with the much more complex ways in which law intersects with both society and nature and in practice, the train-track trajectory of statutory process may be derailed by any combination of limited cognitive capacity, knowledge, organizational behavior, or other political objectives.¹⁶⁵

Legal process is also associated with a number of key “rule of law” values, including certainty,¹⁶⁶ accountability, and liability for harm. These values are often perceived as coming into conflict with the flexible experimentation required by adaptive management and governance.

160. Arnold & Gunderson, *supra* note 96, at 10436.

161. Ruhl (2011), *supra* note 95, at 1393.

162. Arnold & Gunderson, *supra* note 96, at 10440.

163. Ruhl (2011), *supra* note 95, at 1396.

164. Benson & Garmestani, *supra* note 113, at 1424.

165. Arnold & Gunderson, *supra* note 96, at 10439.

166. Linked to legal finality in the form of a record of decision for environmental impact assessment, rules of prescription, the doctrine of *res iudicata* and the doctrine of vested rights, amongst others. See Tarlock, *supra* note 83, at 1140.

Angelo presents a striking instance of this in her discussion of the restoration efforts undertaken at Lake Apopka. After the agency in charge of the restoration project, the St. Johns River Water Management District (SJRWMD), had undertaken some initial measures to restore the lake, success seemed apparent in the record numbers of species that had returned to the area by 1998. Approximately four months later, however, the scene turned into an ecological nightmare when hundreds of birds started dying. Scientists involved ascribed the deaths to incorrect models for estimating pesticides in soils, and later developed improved methods for modeling this phenomenon based on what they had learned from the bird deaths.¹⁶⁷ In the immediate aftermath of the tragedy, however, and although the federal agencies had been cooperating with the agency, the U.S. Justice Department initiated a criminal investigation into the matter. The Justice Department seized the carcasses of the birds, preventing a proper scientific investigation into the cause of their deaths, and the scientists were no longer able to work together or share information.¹⁶⁸ The criminal and civil issues arising from the bird killing were later resolved in a Memorandum of Understanding between the SJRWMD and the United States,¹⁶⁹ but the case dramatically depicts the extent to which values associated with conventional legal processes can come into conflict with the requirements of adaptive management. Yet the counter-argument, as Karkkainen puts it, is that “the absence of clear, legally enforceable, fixed procedural rules and substantive standards will translate into a kind of open-ended discretion likely to yield to unprincipled compromise, self-dealing, and a lack of accountability in basic governance processes.”¹⁷⁰ The manner in which scholars have addressed the tension between rule of law values and the need for flexible experimentation is discussed, with reference to examples, in section 6.2 below.

VI. WHAT DOES A RESILIENCE APPROACH REQUIRE OF GOVERNANCE AND LAW?

Having outlined the key debates and positions focusing on the deficiencies of the law, this section focuses on the features deemed

167. Angelo, *supra* note 91, at 985-986.

168. *Id.* at 986.

169. *Id.* at 987.

170. Bradley C. Karkkainen, *Adaptive Ecosystem Management and Regulatory Penalty Defaults: Toward a Bounded Pragmatism*, 87 MINN. L. REV. 943, 944 (2003)

necessary for governance and law to support resilience.¹⁷¹ A number of studies in this category are also empirical studies of “restoration projects”¹⁷² The features are discussed in terms of the need to cognize the social-ecological system; the proceduralization of the law and governance for resilience; structuring polycentric multiscalar and open governance; and ensuring adaptability of the law itself.

A. Cognizing the Social-Ecological System

As a first step, resilience theory requires that law adopt a systems view when regulating natural resources.¹⁷³ Instead of a focus on harm to individual species or an assessment of a particular risk in isolation, a systemic approach necessitates would-be resource exploiters to comprehensively explore the full range of ecosystem services within which they will be working, and the multiple social pressures on such services—an approach Kundis Craig explicates in her discussion of the Deepwater Horizon oil disaster.¹⁷⁴ As Bromley reminds, however, a social-ecological system is a social construct and there is no necessarily plausible, reliable, irrefutable, or true delineation of one.¹⁷⁵ This is reflected in the variety of constructs various resource management agencies have employed in their attempts to cognize the social-ecological system. These have included the notions of ecoregions, watersheds, and

171. See e.g., Lee & Lawrence, *supra* note 86; Bosselman, *supra* note 141; Doremus, *supra* note 9; Karkkainen, *supra* note 170; Bryan G. Norton, *The Rebirth of Environmentalism as Pragmatic Adaptive Management*, 24 VA. ENVTL. L. J. 353 (2005); Ruhl (2005), *supra* note 95; Thrower, *supra* note 120; Lee Jackson, *Agricultural Trade and Climate Change: Can the WTO Promote Resilience in the Face of Uncertainty?*, 9 GEO. J. INT'L AFFAIRS 25 (2008); Anna K. Schwab & David J. Brower, *Increasing Resilience to Natural Hazards: Obstacles and Opportunities for Local Governments Under the Disaster Mitigation Act of 2000*, 38 ENVTL. L. REPORTER NEWS & ANALYSIS 10171 (2008); D'Agostino, *supra* note 100; Green, Cosens & Garmestani, *supra* note 94; Garmestani, Allen & Benson, *supra* note 97; Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 NEB. L. REV. 833 (2008); D. Schramm & A. Fishman, *Legal frameworks for adaptive resource management in a changing climate*, 22 GEO. INT'L. ENVTL. L. REV. 491 (2010); J.B. Ruhl & Robert L. Fischman, *Adaptive Management in the Courts*, 95 MINN. L. REV. 424 (2010).

172. See Coleman, *supra* note 120, at 177; John H. Davidson and Thomas Earl Geu, *The Missouri River and Adaptive Management: Protecting Ecological Function and Legal Process*, 80 NEB. L. REV. 816 (2001); Ankersen & Hamman, *supra* note 87; Alfred R. Light, *Tales of the Tamiami Trail: Implementing Adaptive Management in Everglades Restoration*, 22 J. LAND USE & ENVTL. L. 59 (2006); Angelo, *supra* note 91, at 970.

173. Benson, *supra* note 106, at 28.

174. Kundis Craig, *supra* note 89, at 1893.

175. Bromley, *supra* note 4, at 16. Hence, as noted in the section on the deficiencies of law above, there can be no institutional mechanism that completely integrates the management of structure, components and functions of complete ecosystems. See Ankersen & Hamann, *supra* note 87, at 477.

place as Ankersen and Hamann discuss.¹⁷⁶ Within the literature reviewed, however, there was a bias toward basing the constructs employed to bind the social-ecological system on ecological, rather than social, functions.

A number of contributors offer guidance on the criteria one can employ in order to cognize the social-ecological system. Karkkainen notes, for instance, that a resilience perspective highlights the importance of local and regional natural resource management.¹⁷⁷ Because the natural characteristics of ecosystems and the particular anthropogenic stressors that need to be brought under control may vary considerably from locality to locality, it should be possible to cognize social-ecological systems differently in different regions. Karkkainen suggests, for instance, that the scale of watershed management in the southeastern United States would not necessarily have to be the same as the scale adopted for the much drier conditions in the American West.¹⁷⁸ Further, the management scale adopted may itself be subjected to an experimentalist approach.¹⁷⁹ In this regard, Bromley provides a trenchant criticism of Oran Young's notion of FIT—a management prescription for exploring issues in global environmental governance, which holds that to be effective institutional arrangements must be well-matched to the defining features of the problems they address and must introduce behavioral mechanisms crafted to address such problems.¹⁸⁰ Bromley argues, however, that it is not just the physical characteristics of an ecosystem that are determinative of the management arrangements that will be brought to bear on the system. More importantly, it is the social construction of that ecosystem, its shared mental objectification by different epistemic communities that will be decisive. This shared mental objectification is dynamic, contested, contingent, and frequently unknowable prior to a process of learning.¹⁸¹ This insight legitimates an experimentalist approach to the appropriate scale of management and governance.

The inherent indeterminacy associated with cognizing the social-ecological system can also be alleviated through the administrative processes of devolution, delegation, deference to the appropriate management unit on the one hand, or processes of consolidation, co-

176. Ankersen & Hamann, *supra* note 87, at 476–477.

177. Karkkainen, *supra* note 146, at 207.

178. *Id.* at 208–209.

179. *Id.* at 209.

180. Oran R. Young, *The Architecture of Global Environmental Governance: Bringing Science to Bear on Policy*, 8 GLOBAL ENVTL. POL. 14 (2008).

181. Bromley, *supra* note 4, at 19.

location, and coordination on the other.¹⁸² In this regard, Cosens also notes that it is more important to have a mechanism for coordination that can work at the scale of the particular social-ecological system involved, than it is to designate a single authority to manage the system at that scale.¹⁸³

B. The Adaptive Turn: Proceduralization of Environmental Management and Governance

Apart from necessitating a systems perspective, the adaptive turn in law and governance for resilience mandates a certain level of proceduralization of the law in the service of science that is focused on knowledge generation, information flows, and reflexivity amongst key agents.

Legal scholars have recognized the procedural logic and scientific protagonism underlying adaptive management. Karkkainen observes, for instance, that “adaptive management is at bottom a set of procedural principles—simultaneously a method of inquiry and a procedural mechanism of agency decision-making, based on rigorous observation through monitoring (‘passive’) and experimentation (‘active’), reassessment, and adjustment in light of what is learned.”¹⁸⁴ Further, it requires “scientific justification based on integrative cross-disciplinary modeling and monitoring data.”¹⁸⁵ In this brief definition, Karkkainen (like others) recognizes a distinction between “active” and “passive” adaptive management: the former connoting a conscious effort to tailor management interventions so as to test scientific hypotheses, and involving integrative ecological monitoring, conscious generation of testable scientific hypotheses, and field experimentation; the latter connoting the more modest endeavor of heightened monitoring of key indicators and subsequent adjustment of policies in light of what is learned (thus lacking the “deliberate probing” of hypothesis-testing experimentation).¹⁸⁶ For instance, both passive and active adaptive management strategies have been employed in the Comprehensive Everglades Restoration Project. A guide developed to explain the integration of adaptive management into the project defines adaptive management generically as “a formal process for continually improving management policies and practices by learning about their outcomes . . .

182. Ankersen & Hamann, *supra* note 87, at 492.

183. Cosens (2010), *supra* note 86, at 240.

184. Karkkainen, *supra* note 83, at 75.

185. *Id.*

186. *Id.* at 70.

.¹⁸⁷ Emphasizing that adaptive management is not a “trial and error” management approach (which simply involves trying a new or alternative design or scheme when the existing one is found not to work),¹⁸⁸ the guide goes on to distinguish between passive and adaptive management in terms of whether single or multiple designs or operational plans are developed to test hypotheses. In a passive management approach, a single design or operational plan is used to test hypotheses pertaining to hydrological, ecological, or water quality responses to particular management actions. These hypotheses are iteratively tested and adjusted as the monitoring of results are fed back into the design or operational plan. The guide indicates that this brand of adaptive management has been applied at both a program and project level with examples including Biscayne Bay Coastal Wetlands, Picayune Strand, and Assateague Island.¹⁸⁹ Active adaptive management on the other hand, utilizes multiple designs or operational criteria to test competing hypotheses about the same phenomenon. Thus, hypotheses are tested concurrently to determine which of several possible management alternatives produce the best results. The guide indicates that this active approach to adaptive management has been implemented in the Caloosahatchee River, West Basin, St Lucie River and in the Everglades Agricultural Area reservoir test cells, which were constructed to test competing hypotheses relating to subsurface seepage and embankment durability.¹⁹⁰

Active and passive approaches to adaptive management have potentially different implications for administrative laws, particularly as regards mandate, standards for accountability, and liability with active adaptive management obviously requiring a greater degree of flexibility and deference toward agency decision-making since the greater variety in design and operational planning introduces a greater risk of things going wrong.

What role does law play in supporting either passive or active adaptive management? Schramm and Fishman observe that the three core functional needs of adaptive management where the role of law is most acute are baseline setting and monitoring requirements; periodic adjustment and review (institutionalizing reflexivity); and facilitating,

187. U.S. ARMY CORPS OF ENGINEERS & SOUTH FLORIDA WATER MANAGEMENT DISTRICT, ADAPTIVE MANAGEMENT INTEGRATION GUIDE: THE COMPREHENSIVE EVERGLADES RESTORATION PLAN 4 (2011).

188. *Id.*

189. *Id.* at 5.

190. *Id.*

mandating and directing information sharing across bureaucratic categories.¹⁹¹ Ruhl similarly highlights the importance of monitoring, reflexivity, and information in holding that “adaptive management requires institutionalization of monitoring-adjustment frameworks that allow incremental policy and decision adjustments at the ‘back end,’ where performance results can be evaluated and the new information can be fed into the ongoing regulatory process.”¹⁹²

Doremus hones in on adaptive management as an information problem and the potential for learning as a criterion to determine whether an adaptive management approach should be adopted in the first place.¹⁹³ Other contributors have also highlighted the importance of the capacity for learning: Angelo, for instance, notes that the nature of learning in social-ecological systems can be incremental, episodic, or transformational, and illustrates these categories with reference to the Lake Apopka restoration project.¹⁹⁴ Camacho talks about the need for a “learning infrastructure” constituted of intergovernmental information sharing.¹⁹⁵ Doremus, however, probably provides the most astute critical analysis of the policy and institutional context for the acquisition and use of information in the course of adaptive management. She finds that for a particular resource problem, learning could improve management but it could also prove to be costly and challenging.¹⁹⁶ Apart from suggesting the need for institutionalizing independent scientific review of the potential for learning prior to the adoption of adaptive management as a management approach, she outlines a number of general policy steps that could improve the prospects of learning, focused in terms of the broad categories of facilitating information production and improving information diffusion.¹⁹⁷

191. Schramm & Fishman, *supra* note 171, at 492.

192. Ruhl (2005), *supra* note 95, at 30.

193. Doremus, *supra* note 112, at 1460-1461.

194. Angelo, *supra* note 91, at 1043.

195. Camacho, *supra* note 120, at 65.

196. Doremus, *supra* note 112, at 1483.

197. *Id.* at 1483–1496. In the case of information production, Doremus highlights a number of serious impediments to conducting experiments in managed natural systems and then goes on to suggest ways in which these impediments may be overcome by modeling, simulations, and conducting small-scale experiments in limited parts of the system. She also highlights the importance of budgeting for learning and where the costs for research and development are located. In respect of information diffusion, she notes the impediments to information sharing posed by the archival practices of different administrative agencies, and by the fact that information is not generated in a common format. She discusses the potential for standardizing information generation relating to natural resources, modernizing archives, and drawing upon the role of information intermediaries.

Translating the foregoing needs into more specific legal mandates, Doremus argues, in an earlier piece, that clear and enforceable information collection and disclosure requirements are part of any adaptive management requirement or authority; that responsibility for research design and data collection should be delegated to a politically insulated research agency; and that the tendency to interpret data politically, rather than scientifically, could be counterweighed by the legal requirement to disseminate data widely.¹⁹⁸ Furthermore, Schramm and Fishman provide additional insight into the content of the legal mandates by illustrating examples in developing countries.

In the case of legal mandates for scientific baselines, monitoring, and reporting, Schramm and Fishman highlight how law should also frame the temporal scale applying to the determination of the baseline. For example, the drafters of the Seychelles 2007 Action Plan for the Conservation and Management of Sharks were able to determine the dramatic reduction in shark populations by going as far back in the historical record as they could (to sailor journals of the 1700s), rather than relying upon the current state of shark fisheries or even records from the late-twentieth century.¹⁹⁹

Legal mandates can also affect monitoring by determining the range of factors natural resource managers should be tracking. In this regard, a systems-wide view, as noted in the preceding section, should be institutionalized.²⁰⁰ In the case of reflexivity (periodic review and adjustment), Schramm and Fishman note that such mandates can be used at multiple levels, technical regulatory standards to legislation itself.²⁰¹ In their discussion of Vietnam's "Scheme on the Protection of Endangered Precious and Rare Aquatic Species to 2015, and Vision to 2020," it is notable that interagency cooperation with regards to information production and diffusion was achieved not through the law expressly directing the agencies to cooperate, but by requiring protection of endangered aquatic species be based on regularly updated specific groups.²⁰²

Other authors have similarly highlighted the importance of incorporating a necessary standard of scientific evidence into legal standards for decision-making. Doremus points out, for instance, that in the United States' Endangered Species Act, it is required that decisions

198. Doremus, *supra* note 9, at 81–82.

199. Schramm & Fishman, *supra* note 171, at 500.

200. *Id.* at 501.

201. *Id.*

202. *Id.* at 504.

be based on “the best scientific data available.”²⁰³ The standard will influence the nature of data and information produced to potentially play a role in framing the natural resource agency’s accountability and liability. In this regard, Davidson and Geu argue that the standard for decision-making must be flexible, not straightjacket experimentation, and also be fail-safe by setting minimum parameters to guard against catastrophic loss.²⁰⁴ The apparent objectivity of the best science also guards against (at least theoretically) individual or agency bias in setting the parameters. Schramm and Fishman note that in addition to the scientific standard for decision-making, the extent to which the law allows for public participation, and the challenging of an agency’s decisions through the courts also influences the type and quality of information in circulation.²⁰⁵

The foregoing discussion, therefore, illustrates the trend away from specifying particular substantive standards in the law, towards law structuring and framing the science-based inquiries of administrative agencies. Some contributors support this procedure,²⁰⁶ whilst others offer a variety of critical perspectives.²⁰⁷ Ruhl, for instance, points out that two potential concerns with backend decision-making include the possibility of agency volatility and drift. Volatility refers to an agency altering its initial decision substantially after making an initial decision. Whilst drift captures the concern that small adjustments over time may situate the agency too far from its initial position.²⁰⁸ Volatility and drift could occur on the basis of an agency’s engagement with the science alone. However, commentators are more concerned about the possibility of interest group capture and political interference.²⁰⁹ Other contributors capture broader concerns, pointing out that the lack of substantive standards raise difficult questions for environmental law regarding which ecological changes should be regulated, and which left alone;²¹⁰ thus shifting the

203. Doremus, *supra* note 9, at 81.

204. Davidson & Geu, *supra* note 172, at 889.

205. Schramm & Fishman, *supra* note 171, at 506.

206. *See, e.g.*, Lee & Lawrence, *supra* note 86; Profeta, *supra* note 120; Coleman, *supra* note 120; Karkkainen, *supra* note 170; Camacho, *supra* note 120; Bryan G. Norton, *The Rebirth of Environmentalism as Pragmatic Adaptive Management*, 24 VA. ENVTL. L.J. 353 (2005).

207. *See* Davidson & Geu, *supra* note 172; Light, *supra* note 172; Wiersema, *supra* note 63; Angelo, *supra* note 91.

208. Ruhl (2005), *supra* note 95, at 55. *See also* Karkkainen, *supra* note 83, at 75 (a critical perspective on Ruhl’s notions of volatility and drift).

209. *See* Ankersen & Hamann, *supra* note 87, at 72-73, 80-81; Aguirre, *supra* note 88, at 45; Zellmar & Gunderson, *supra* note 87, at 946, 947; Bromley, *supra* note 4, at 19.

210. Thrower, *supra* note 120, at 877.

basis of moral justification for environmental law.²¹¹ Ruhl suggests that this shift is one from preservationism to transitionalism,²¹² but this also seems to affirm the procedural character of law and governance in the context of resilience for sustainability.

Suggested solutions to the overarching problem of balancing flexibility with certainty and accountability are of at least three kinds. First, a number of authors argue for incorporating substantive standards into laws that frame adaptive management and governance, linked to prohibitions against exceeding particular ecological limits. Angelo, for instance, argues that in order to protect natural or restored resilience, it is necessary to ensure that future anthropogenically-induced perturbations do not exceed natural thresholds. In this regard, the SJRWMD developed a nutrient budget identifying allowable nutrient loadings for Lake Apopka, linking this to land use development decisions.²¹³ Flournoy's substantive standard for a future Natural Resource Legacy Act requires managing public resources in a manner that conserves the stock of resources for future generations, linking this to the prohibition of all actions that would deplete the desired natural resource legacy.²¹⁴

Secondly, commentators have suggested using default rules or 'triggers' that must apply if a particular ecological threshold is reached. For example, to guard against the possibility of agencies using their discretion to avoid political controversy or failing to take controversial decisions, Karkkainen introduces the notion of 'regulatory penalty default rules', whereby the threat of legal regulation induces agents (including private agents) to modify their behavior.²¹⁵ Along with Doremus,²¹⁶ he considers the potential for listing of species under the Endangered Species Act as an example of such a regulatory penalty default rule as well as an illustration of how command-and-control type regulation can merge with new tools of governance. Schulz and Nie, in turn, discuss the use of decision-making triggers in adaptive management. This relates to pre-negotiated commitments made by an agency within an adaptive management framework in the event that monitoring indicates x or y.

Lastly, the third type of solution focuses on the role of litigation instituted by interested and affected parties. Some contributors see the

211. Profeta, *supra* note 120, at 75.

212. Ruhl (2010), *supra* note 95, at 392.

213. Angelo, *supra* note 91, at 1005.

214. Flournoy, *supra* note 120, at 1018.

215. Karkkainen, *supra* note 170.

216. Doremus, *supra* note 9, at 60.

threat of litigation as a way to potentially force parties to come together in new and surprising ways. According to this view, litigation can serve as a healthy source of destabilization that could shift a social-ecological system along the adaptive cycle.²¹⁷ Contrastingly, others recognize that the potential for litigation can seriously disrupt the objectives and function of adaptive management programs.²¹⁸

All these discussions, however, take place against the backdrop of the explicit adoption of resilience and adaptive management in legislative instruments being comparatively rare. As late as 2011, Benson and Garmestani held that adaptive management is unexplored and underutilized.²¹⁹ In 2008, Angelo maintained that adaptive management has not been seriously incorporated into environmental law.²²⁰ While a number of resource management programs and agencies have adopted adaptive management policies,²²¹ existing laws have demonstrated the potential for adopting an adaptive management approach.²²² Some laws have been passed with an express resilience orientation.²²³ Moreover, as discussed by Schramm and Fishman,²²⁴ aspects of resilience theory, adaptive management, and adaptive governance are filtering into actual laws and policy documents. In general, however, there remains huge scope for interpreting existing laws within this conceptual frame or passing new laws and policies that expressly give effect to it.

C. Structuring Polycentric, Multiscalar and Open Governance

The law and resilience literature assumes that pluralistic governance is the mode of governance necessary to respond to the complexity of the natural world. A number of contributors have attempted to define its essential qualities. Cosens, for instance, holds that adaptive governance facilitates resilience in social-ecological systems in various ways: multiple, overlapping levels of control; horizontal and vertical transfer of

217. Karkkainen, *supra* note 83, at 68.

218. See Ruhl & Fishman, *supra* note 172, at 167.

219. Benson & Garmestani, *supra* note 113, at 1421.

220. Angelo, *supra* note 91, at 954.

221. These include the Columbia River Basin Fish and Wildlife Program; management of the Glen Canyon Dam; the US Forest Service's adoption of adaptive management for federal lands in Oregon, Washington and northern California; management of the Missouri River Basin by the US Army Corps of Engineers; and restoration of the Everglades. See Angelo, *supra* note 91, at 957–958.

222. The most prominent example is probably the Habitat Conservation Program under the U.S. Endangered Species Act. See Angelo, *supra* note 91.

223. Examples include the European Union's Marine Strategy Framework Directive and the Marine and Coastal Access Act 2009 of England and Wales. These instruments appear to be based on the approach of collaborative adaptive management. See Barnes, *supra* note 110, at 10.

224. Schramm & Fishman, *supra* note 171.

information and coordination of decision-making; meaningful public participation; local capacity building; and authority to respond to change in circumstances across a range of scenarios.²²⁵ Within the law and resilience literature reviewed, contributors offered insights with regards to designing public participation processes, achieving stakeholder consensus, and capacitating a variety of governance agents.

While the importance of participative processes for adaptive management and adaptive governance was not refuted, a number of authors flagged the potential for participative processes to derail successful approaches. The potential for interest groups, even those representing environmental interests, to derail attempts to introduce adaptive management is highlighted in numerous articles. Ruhl discusses how citizen groups representing environmental interests responded with ‘vociferous and litigious opposition’ to the U.S. Fish and Wildlife Service’s attempt to introduce greater agency flexibility into the Habitat Conservation Program.²²⁶ Additionally, in her assessment of the Lake Apopka restoration project, Angelo concluded that substantial public participation, whether in the form of structured participatory processes or a generous interpretation of *locus standi*, may impede adaptive management.²²⁷ In her view, public participation is good for setting objectives in adaptive management processes, but should take a backseat thereafter.²²⁸ In an earlier piece, Karkkainen poses a number of questions relating to the nature and extent of participation, the problem solving process and democratic legitimacy.²²⁹ He dismisses two forms of stakeholder engagement: those in which governmental policy makers cobble together a process that involves some avenues for participation by more-or-less-diverse parties, and those that involve “naked deal making among the right set of local parties.”²³⁰ He finds these forms of stakeholder engagement as ill-suited to the demands of ecosystem governance. These do not capture “the full flavor of deep collaboration, deliberative problem-solving, genuine openness to learning, and ongoing redefinition of self-interest” necessary for success in this regard.²³¹ He also highlights the importance of deciding upon the appropriate ‘decision-rule’ in participatory processes, questioning whether ‘hard’ or

225. Cosens (2012), *supra* note 86, at 256.

226. Ruhl (2005), *supra* note 95, at 33.

227. Angelo, *supra* note 91, at 1002.

228. *Id.* at 1003.

229. Karkkainen, *supra* note 146, at 238.

230. *Id.*

231. *Id.*

'soft' forms of consensus should apply.²³² On this point, Zellmar and Gunderson maintain that consensus based management can obstruct restoration progress.²³³ In a recent contribution, however, Susskind, Camacho, and Schenk identify and discuss six best practices for collaborative adaptive management drawn from *The Consensus Building Handbook* (a technical guide compiled by the United States' leading dispute resolution professionals) and the Department of Interior's *Adaptive Management Technical Guide*.²³⁴ These best practices relate to the identification of appropriate stakeholder representatives, the coordination of clear goals, the use of professional neutrals, the commitment to establishing common ground, the incorporation of methods for joint fact finding, and the production of collectively supported written agreements, amongst others.²³⁵

Contributors to the law and resilience literature affirm the need to tap into the decentralized behavior of a variety of agents, including individual property owners, citizen monitoring groups and non-governmental organizations.²³⁶ In this regard, the most interesting discussions center on mechanisms for coordination. In addition to multiparty collaboration on specific projects, negotiated project specific permits and market-based mechanisms, the importance of information based programs and property rights have also been highlighted. In the case of information-based programs, one of the clear trends is to incorporate citizen-generated information into official reports. This use of citizen-generated data has in turn influenced the manner in which citizen-based monitoring networks are set up and operated. For instance, in his discussion of the National Phenology Network, Adelman notes that the institutional framework for the NPN involves a multi-level partnership between governmental agents, university scientists, and citizens. The network is supported by detailed guidelines on the production of information and independent checks to ensure data quality.²³⁷ In the case of property rights, Barnes provides an outstanding contribution on how private and communal property rights regimes can enhance knowledge generation, flexibility, optionality, responsiveness, and multi-scalar organization. He argues that the rich diversity of property rights renders it a highly flexible institution seemingly well-

232. *Id.* at 240.

233. Zellmar & Gunderson, *supra* note 87, at 929.

234. Susskind, Camacho & Schenk, *supra* note 112, at 31.

235. *Id.*

236. See David E. Adelman, *The Challenge of Abrupt Climate Change for US Environmental Regulation*, 58 EMORY L. J. 379, 400 (2008); D'Agostino, *supra* note 100, at 118.

237. Adelman, *supra* note 236, at 403.

suited to promoting social-ecological resilience, at least at local scales.²³⁸ The two core weaknesses of current systems of private property rights appear to ensure the persistence of a single thing, divorced from the context of the broader ecosystem, while placing emphasis on protecting security of expectations.²³⁹

D. The Adaptability of Law

In addition to considering how law supports the resilience and adaptability of underlying social-ecological systems, legal scholars have highlighted the nature of the legal system as a complex, adaptive system. Building on his earlier work,²⁴⁰ Ruhl notes that legal systems can be defined in terms of their structure and functions, and that such systems exhibit features of both stability and change operating at multiple scales.²⁴¹ A distinction can moreover be drawn between the resilience of a legal system's underlying structure and processes, and the stability of the substantive content of law.²⁴² Ebbesson notes that the popular view of law, emphasizing its certainty and predictability, exaggerates its static and fixed nature.²⁴³ In practice, law has an inherently defeasible character, based not only in the potential to amend and draft new laws, but also in the possibilities that emerge from reading different legal instruments together and from the open-texture of the language used in laws. Laws may both respond to processes of creative destruction²⁴⁴ or initiate such processes. For example, litigation may be used to pull the plug on established institutional arrangements when it becomes clear they are failing.²⁴⁵

Arnold and Gunderson make two important points regarding the adaptability of law in their support of the resilience of social-ecological systems. First, they point out that many critiques of the law often point to the need for substantive, if not radical, transformations of law and society in the face of the myriad of environmental threats humanity is facing. They emphasize that legal changes that afford primacy to ecosystems of biodiversity may have unintended consequences. The

238. Barnes, *supra* note 110, at 6.

239. *Id.* at 15.

240. J.B. Ruhl, *Thinking of Environmental Law As A Complex Adaptive System: How to Clean Up the Environment by Making A Mess of Environmental Law*, 34 HOUS. L. REV. 933 (1997).

241. Ruhl (2011), *supra* note 95, at 1379, 1383.

242. *Id.* at 1383.

243. Ebbesson, *supra* note 152, at 415.

244. See Karkkainen, *supra* note 83, at 66 (noting the linkages between various environmental disasters and the development of new environmental laws).

245. *Id.* at 67.

unintended consequences may include political backlash to environmental laws, no implementation or under implementation of the reforms, political and social conflict, and fiscal and economic hardship.²⁴⁶ Therefore, they argue for incremental and gradual changes to new legal arrangements, while monitoring, assessing and adjusting their changes and effects.²⁴⁷ Secondly, noting the importance of feedback loops for adaptation generally, they argue that the legal system should develop and improve its own feedback loops through the systematic, multivariate, and longitudinal study of the impacts of legal decisions, actions and processes, including judicial decisions.²⁴⁸

VII. CONCLUDING REMARKS AND DIRECTIONS FOR FUTURE RESEARCH

This article has aimed to provide a representative overview of the manner in which legal scholars have engaged with the concepts of resilience, adaptive management, and adaptive governance. It has sought to reduce the fuzziness of these concepts by land marking important milestones in their development, pointing the way toward other reviews, and highlighting their essential features. This article has provided an analysis of the general features of the law and resilience literature to show that the theory of resilience, adaptive management, and adaptive governance are gaining increasing traction. Much work has gone into studying the application of this theory in the context of a diverse range of social-ecological systems. Most of the literature at this stage, however, has been focused on the United States of America. There is considerable room for exploring whether similar claims can be made in other legal systems, especially in developing country contexts. Similarly, there is massive scope for investigating the extent to which international law displays the maladaptive features of law highlighted by legal scholars. Additionally, whether this would contribute toward understanding why the implementation and enforcement of multilateral environmental agreements is generally quite poor.

Legal scholars have tended to focus on social-ecological systems defined by ecological contexts and on the law as a social system. As has been noted, however, social-ecological systems are social constructs and there is no necessarily right way of cognizing them. This opens up scope for bounding social-ecological systems in terms of non-ecological criteria. For instance, linked to the interdisciplinary work that initiated

246. Arnold & Gunderson, *supra* note 96, at 14029.

247. *Id.* at 14038.

248. *Id.* at 10441.

this review, there does not appear to have been any attempt to focus on urban resilience,²⁴⁹ and understand how the law and governance arrangements in respect of city-level government—such as governance of urban form, provision of urban infrastructure, regulation of natural resource use, and promotion of local economic development—are differentially positioned in respect of the social-ecological systems that course through the city as a spatial area.

In terms of how law and governance should promote adaptive management, there is still much work to be done in understanding how the need for flexibility intersects with the important and time-honored legal values of certainty, finality and accountability. In this regard, the inter-relationship between traditional methods of legal regulation and the new tools of environmental governance is worthy of further exploration. While a critical perspective on the adoption of adaptive management appears to be emerging, legal scholars have been less critical of the notion of adaptive governance, assuming that greater decentralization, poly-centrism, openness, and diversity will lead to the enhanced resilience of social-ecological systems. This claim should however be subjected to further empirical testing. Further, the relationship between resilience, adaptive management, and adaptive governance to environmental human rights and environmental justice does not appear to have been explored at all. These concepts are critically important for understanding how various forms of governance entrench power relations and allow for the emergence and resolution of conflict and contestation.

The place of substantive standards linked to ecological limits, particularly impairing or taking away existing rights, requires urgent attention as it appears that, in many instances, such rights impair long-term sustainability. Additionally, legal scholars might start paying greater attention to the self-organizing mechanisms that emerge in the back-loop of the adaptive cycle, including forms of ‘illegal governance’ or governance against the State from below.²⁵⁰

Some will perhaps see in resilience and its associated concepts simply the emergence of a new set of buzzwords that allow us to believe

249. For recent literature on the concept of urban resilience see Michael Fleischhauer, *The Role of Spatial Planning in Strengthening Urban Resilience*, in RESILIENCE OF CITIES TO TERRORIST AND OTHER THREATS: LESSONS LEARNED FROM 9/11 AND FUTURE RESEARCH ISSUES 273 (Hans. Pasman & Igor Kirillov eds., 2008); BUILDING URBAN RESILIENCE: PRINCIPLES, TOOLS, AND PRACTICE (Abhas K. Jha, Todd W. Miner, & Zuzana Stanton-Geddes eds., 2013), available at http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2013/03/08/000356161_20130308155433/Rendered/PDF/758450PUB0EPI0001300PUBDATE02028013.pdf.

250. See Lea & Stenson, *supra* note 68.

we are doing something about the long-term ecological degradation of Mother Earth, while very little changes. This review and analysis suggests, to the contrary, that resilience theory, adaptive management, and adaptive governance may indeed be a substantive advance on sustainable development. Sustainable development is arguably still the dominant paradigm for thinking about environmental and natural resource law. It is heartening, for instance, that the provenance of resilience theory is in the discipline of ecology, emerging from a desire to understand the genuine complexity, emergent and dynamic behavior of both ecosystems and later social-ecological systems. Rather than simply being an additional consideration requiring integration into traditional and static notions of economic and social development, resilience appears to provide a more scientifically-grounded basis for recognizing and working toward social limits based on ecological thresholds. It meshes well with the emerging understanding of complexity in other spheres of social life²⁵¹ and theories of governance more generally.²⁵² It provides a brand new vista for thinking through the long-standing relationship between law and science. Moreover, resilience theory does not advocate a one-size-fits-all approach to management and governance, but rather advocates for the emergence of contextually appropriate structures and processes. In moving forward, however, lawyers and legal scholars have a significant responsibility to ensure that values of accountability, fairness and justice reinforce application of the best science. Best science practices are not immune to abuses of power or unintended consequences.

251. JAN BOGG & ROBERT GEYER, *COMPLEXITY, SCIENCE, AND SOCIETY* (2007).

252. Jessop, *supra* note 67.