Idaho Law Review

Volume 50 | Number 2 Article 9

September 2014

Resilient Cities and Adaptive Law

Craig Anthony (Tony) Arnold

RESILIENT CITIES AND ADAPTIVE LAW*

CRAIG ANTHONY (TONY) ARNOLD**

TABLE OF CONTENTS

I. THE RESILIENCE OF CITIES.....245
II. RESILIENCE SCIENCE AND THE LEGAL SYSTEM 251
III. LOCAL GOVERNANCE AND RESILIENT CITIES 254
IV. PRIVATE PROPERTY RIGHTS AND RESILIENT CITIES.....257
V. ADAPTATION AND RESILIENT CITIES 260
VI. CONCLUSION.....263

I. THE RESILIENCE OF CITIES

Are cities resilient—or can they become more resilient—in the face of significant and uncertain disturbances that affect interconnected natural, physical, and social systems? These disturbances include climate change, water scarcity and/or flooding, disaster events, land-development pressures, food-supply insecurities, ecosystem collapse, pollution, political instability, economic decline, systemic injustices, patterns of distressed properties, fiscal crises, and the like.[1] Growing research on resilience science and legal institutions suggests that the answer to this question involves whether laws and legal systems can become more adaptive to nonlinear change in complex, interconnected systems.[2]

Resilience is the capacity of a system to withstand or adapt to disturbance while maintaining the same basic structures and functions.[3] If a system's resilience degrades sufficiently, the system may cross the threshold that represents the limits of the system, pushing the system to suddenly collapse and transform into a new system.[4] This concept is based on scientific research showing that ecosystems can exist in a vari-

---

* This essay is an adapted version of a series of blog posts on the Biophilic Cities website.

** Boehl Chair in Property and Land Use, Associate Dean for Research and Faculty Development, Professor of Law, Affiliated Professor of Urban Planning, and Chair of the Center for Land Use and Environmental Responsibility, University of Louisville. Faculty Affiliate, Vincent and Elinor Ostrom Workshop in Political Theory and Policy Analysis, University of Indiana, Bloomington.

1. *See* Steve Egger, *Determining a Sustainable City Model*, 21 ENVTL. MODELLING & SOFTWARE 1235, 1239–45 (2006), *available at* http://www.sciencedirect.com/science/article/pii/S1364815205001313#.

2. *See infra* Part II.

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

4. *See generally* DISCONTINUITIES IN ECOSYSTEMS AND OTHER COMPLEX SYSTEMS (Craig R. Allen & C.S. Holling eds., 2008).

ety of stable configurations, and that social systems and ecosystems are interconnected at multiple scales in complex and dynamic ways that can produce abrupt and unexpected changes.[5] Hurricane Katrina's impact on the New Orleans area is an often-cited example of the interplay of altered coastal wetlands systems, failed engineered levee systems, inadequate disaster planning and response systems, ill-conceived land use planning, and socio-economic and political dynamics, among other factors.[6]

A resilient system has a high level of adaptive capacity.[7] In other words, a resilient system has enough flexibility, redundancy, and learning capacity to adapt to disturbances and surprises without collapse or flipping into fundamentally different systems.[8] In general, resilient systems are healthy, well functioning, and vibrant.[9]

The concept of resilience is increasingly replacing the concept of sustainability as a desired policy goal and way of evaluating collective behaviors shaping interdependent environmental conditions and social conditions, including economic, political, and socio-cultural conditions.[10] Resilience is more grounded in scientific study than is sustainability.[11] Scientifically, resilience is an empirically observable phenomenon, not a normative goal.[12]

Whether resilience is a good thing or a bad thing depends on the system that is resilient.[13] On one hand, we do not want brutal dictatorships, patterns of injustice, landscapes or waterscapes dominated by

---

5. *See generally* C.S. Holling et al., *In Quest of a Theory of Adaptive Change*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 3 (Lance H. Gunderson & C.S. Holling eds., 2002) [hereinafter PANARCHY]; C.S. Holling, *Resilience and Stability of Ecological Systems, in* FOUNDATIONS OF ECOLOGICAL RESILIENCE 19 (Lance H. Gunderson et al. eds, 2010).

6. *See* Lance Gunderson, *Ecological and Human Community Resilience in Response to Natural Disasters*, 15 ECOLOGY & SOC'Y 18, 18 (2010), *available at* http://www.ecologyandsociety.org/vol15/iss2/; Colin D. Woodroffe et al., *Landscape Variability and the Response of Asian Megadeltas to Environmental Change*, *in* GLOBAL CHANGE AND INTEGRATED COASTAL MANAGEMENT: THE ASIA-PACIFIC REGION 277, 308 (Nick Harvey ed., 2006); Robert W. Kates et al., *Reconstruction of New Orleans After Hurricane Katrina: A Research Perspective*, 103 PROC. NAT'L ACAD. SCI. U.S. AM. 14653, 14654–55 (2006), *available at* http://www.pnas.org/content/103/40/14653.full.pdf+html?sid=31c060e1-7c6c-4fc2-bbdb-11a7c63bf3f0; CTR. FOR PROGRESSIVE REFORM, AN UNNATURAL DISASTER: THE AFTERMATH OF HURRICANE KATRINA 1 (2005), *available at* http://www.progressivereform.org/articles/Unnatural_Disaster_512.pdf; Manuel Pastor et al., *Environment, Disaster and Race After Katrina*, 13 RACE, POVERTY & THE ENV'T., no. 1, 2006 at 21, 21–22, *available at* http://reimaginerpe.org/files/Pastor.Bullard.etc.Env.Katrina.pdf.

7. *See* Egger, *supra* note 1, at 1237–39.

8. *See id.*

9. *See generally id.*

10. Robin Kundis Craig & Melinda Harm Benson, *Replacing Sustainability*, 46 AKRON L. REV. 841, 862 (2013).

11. *See generally id.*

12. *See generally id.*

13. *See generally* Sandra Zellmer & Lance Gunderson, *Why Resilience May Not Always Be a Good Thing: Lessons in Ecosystem Restoration from Glen Canyon and the Everglades*, 87 NEB. L. REV. 893, 895 (2009).

aggressive invasive species (e.g., kudzu, Asian carp), or environmentally harmful consumer behaviors to be resilient to change or disturbances. On the other hand, we want democracy, just laws, native ecosystems, and local economies to thrive and be resilient to disturbances. Even when systems have bad or undesired features, the onset of unexpected, rapid events that cause the total collapse of the system is a very hard way to learn lessons about the system's inadequacies.[14]

Building the adaptive capacity of a system can include ensuring the capacity to make needed changes incrementally or gradually, as well as the capacity to resist change. Resilience science rejects the idea that a single stable state sustains a system; even if well-functioning systems maintain their core characteristics, they will adapt to changing conditions and disturbances and undergo some degree of change from time to time.[15]

The term "resilient cities" has grown in popularity, and many cities seek to become or remain resilient.[16] Numerous organizations focus on enhancing the resilience and adaptive capacity of cities. Among these are:

- ICLEI, Local Governments for Sustainability;[17]
- Rockefeller Foundation;[18]
- Center for Resilient Cities;[19]
- United Nations Office for Disaster Risk Reduction;[20]
- Next City;[21]
- International Federation for Housing and Planning;[22]
- Ceres;[23]

---

14. *See generally* CTR. FOR PROGRESSIVE REFORM, *supra* note 6 (discussing the lessons learned from Hurricane Katrina).

15. *See generally* Egger, *supra* note 1 (discussing the various disturbances experienced by resilient cities); WALKER & SALT, *supra* note 3 (discussing change as an action of resiliency); DISCONTINUITIES IN ECOSYSTEMS AND OTHER COMPLEX SYSTEMS, *supra* note 4 (discussing ecosystems' adaptations to change by collapsing and transforming into new systems).

16. *See* Tod Newcombe, *Do Cities Need Chief Resilience Officers to Combat Climate Change?*, GOVERNING (June 12, 2013), http://www.governing.com/columns/urban-notebook/gov-a-city-job-that-requires-resilience.html.

17. ICLEI: LOCAL GOV'T FOR SUSTAINABILITY, (2012), http://resilient-cities.iclei.org.

18. *100 Resilient Cities: Centennial Challenge*, ROCKEFELLER FOUND. (2014), http://100resilientcities.rockefellerfoundation.org.

19. CENTER FOR RESILIENT CITIES, http://www.resilientcities.org/Resilient_Cities/PROFILE.html (last visited May 21, 2014).

20. *Making Cities Resilient: My City is Getting Ready*, UNITED NATIONS OFF. FOR DISASTER RISK REDUCTION (2012), http://www.unisdr.org/campaign/resilientcities/.

21. *Resilient Cities: Surviving, Adapting, and Growing in a Changing Environment,* NEXT CITY, http://www.nextcity.org/column/resilientcities (last visited May 21, 2014).

22. *Climate Resilient Cities: Knowledge Creation by Knowledge Sharing*, INT'L FED'N FOR HOUSING AND PLANNING, http://www.ifhp.org/content/climate-resilient-cities#.Uzx9dtzxbwJ (last visited May 21, 2014).

23. *See generally* Jeb Brugmann, *Building Resilient Cities: From Risk Assessment to Redevelopment* CERES (2013), *available at* http://www.ceres.org/resources/reports/building-resilient-cities-from-risk-assessment-to-

● Beijer Institute of Ecological Economics Project SUPER: Sustainable Urban Planning for Ecosystem Services and Resilience;[24] and
● Biophilic Cities.[25]

Likewise, a growing body of scholarship explores the meanings and features of resilient cities. Some resilient-cities scholarship focuses primarily on disaster preparedness and risk reduction or on climate change.[26] Some focus on economic development, land development, and infrastructure that manage risk for resilience.[27] A body of urban resilience scholarship addresses the resilience of urban ecosystems.[28] A different strand of scholarship examines the social resilience of urban communities and neighborhoods.[29]

However, the best scholarship on urban resilience takes a more integrated approach to the social-ecological resilience of cities.[30] Social-ecological resilience is the interdependent resilience of linked social systems and natural systems (or ecosystems).[31] Thinking about social-

---

redevelopment (a joint publication of Ceres, The Next Practice, and the University of Cambridge Programme for Sustainability Leadership).

24. *SUPER – Sustainable Urban Planning for Ecosystem Services and Resilience*, BEIJER INST. OF ECOLOGICAL ECON., http://www.beijer.kva.se/research_under.php?id=30 (last visited May 21, 2014).

25. BIOPHILIC CITIES, http://www.biophiliccities.org (last visited May 21, 2014).

26. *See, e.g.*, PETER NEWMAN ET AL., RESILIENT CITIES: RESPONDING TO PEAK OIL AND CLIMATE CHANGE 1–14 (2009); CLIMATE AND DISASTER RESILIENCE IN CITIES (Rajib Shaw & Anshu Sharma eds., 2011); David R. Godschalk, *Urban Hazard Mitigation: Creating Resilient Cities*, 4 NAT. HAZARDS REV. 136, 136–38 (2003), *available at* http://www.tc.umn.edu/~blume013/Godschalk_urb_haz_mit2003.pdf; D. Serre & B. Barroca, *"Natural Hazard Resilient Cities,"* 13 NAT. HAZARDS EARTH SYS. SCI. 2675, 2675 (2013), *available at* http://www.nat-hazards-earth-syst-sci.net/13/2675/2013/nhess-13-2675-2013.pdf.

27. *See, e.g.*, Brugmann, *supra* note 23.

28. *See, e.g.*, Marina Alberti & John M. Marzluff, *Ecological Resilience in Urban Ecosystems: Linking Urban Patterns to Human and Ecological Functions*, 7 URB. ECOSYSTEMS 241, 241–42 (2004); Johan Colding, *'Ecological Land-Use Complementation' for Building Resilience in Urban Ecosystems*, 81 LANDSCAPE & URB. PLAN. 46, 46 (2007), *available at* http://www.sciencedirect.com/science/article/pii/S0169204606002179.

29. *See, e.g.*, MARK PELLING, THE VULNERABILITY OF CITIES: NATURAL DISASTERS AND SOCIAL RESILIENCE (2003); Erika S. Svendsen, *Cultivating Resilience: Urban Stewardship as a Means to Improving Health and Well-being*, *in* RESTORATIVE COMMONS: CREATING HEALTH AND WELL-BEING THROUGH URBAN LANDSCAPES 59, 59–87 (Lindsay Campbell & Anne Wiesen eds., 2009), *available at* http://permanent.access.gpo.gov/LPS116815/gtr_nrs-p-39.pdf; Shannon Van Zandt et al., *Mapping Social Vulnerability to Enhance Housing and Neighborhood Resilience*, 22 HOUSING POL'Y DEBATE 29 (2012).

30. *See, e.g.*, S.T.A. Pickett et al., *Resilient Cities: Meaning, Models, and Metaphor for Integrating the Ecological, Socio-Economic, and Planning Realms*, 69 LANDSCAPE & URB. PLAN 369, 369–84 (2004); Keith G. Tidball & Marianne E. Krasny, *From Risk to Resilience: What Role for Community Greening and Civic Ecology in Cities?*, SOCIAL LEARNING TOWARDS A SUSTAINABLE WORLD 149, 149–64 (Arjen E.J. Wals ed., 2007); Henrik Ernstson et al., *Urban Transitions: On Urban Resilience and Human-Dominated Ecosystems*, 39 AMBIO: J. HUM. ENV'T. 531, 531 (2010).

31. *See* Fikret Berkes & Carl Folke, *Linking Social and Ecological Systems for Resilience and Sustainability*, *in* LINKING SOCIAL AND ECOLOGICAL SYSTEMS: MANAGEMENT PRACTICES AND SOCIAL MECHANISMS FOR BUILDING RESILIENCE 1, 1–25 (Fikret Berkes et. al. eds., 1998); Carl Folke, *Resilience: The Emer-*

ecological resilience in this integrated or linked manner is necessary due to the cross-scale and often nonlinear transformative feedbacks among both multiple systems in society (including many different kinds of human communities) and multiple systems in nature (including many different kinds of ecological communities); both nature and society have transformative effects on one another.[32]

A social-ecological perspective on urban resilience has three implications. First, resilience is defined not only by the capacity of a system to adapt to disturbances without changing its core functions and structure, but also by its capacity to self-organize when systemic change or renewal is required in order to remain functional and by its capacity to learn and innovate.[33] Resilient cities are centers of learning, innovation, renewal, and adaptive governance systems.[34]

Second, a city's social-ecological resilience does not focus on just aspects of the natural or social environment, but instead builds the adaptability and transformability of the city as a complex, integrated social-ecological system.[35] Thus, resilient cities attend not only to the resilience of particular systems within the city—such as the physical and social infrastructure's capacity to handle natural disasters, the strength and adaptability of the urban economy, or the health of particular ecosystems like wetlands or urban forests—but also to the dynamic interwoven relationships among these multiple systems.[36] For example, if a city is aiming to "be resilient" primarily through hazard and disaster planning, ecosystem restoration projects, or water resource management strategies, its efforts will not be enough to achieve resilience. These strategies need to consider the overall health and functions of natural systems in cities.[37] Biophilic design principles will contribute to physical and mental health of urban residents, as well as to the political health

---

gence of a Perspective for Social-Ecological Systems Analyses, 16 GLOBAL ENVTL. CHANGE 253, 253 (2006); Ahjond S. Garmestani et al., *Social-Ecological Resilience and Law*, SOCIAL-ECOLOGICAL RESILIENCE AND LAW 1, 1–14 (Ahjond S. Garmestani & Craig R. Allen eds., 2014).

32. *See generally* PANARCHY, *supra* note 5.

33. *See* Folke, *supra* note 31, at 253; Tidball & Krasny, *supra* note 30, at 149.

34. *See* Folke, *supra* note 31, at 253.

35. Folke, *supra* note 31, at 259–60. See generally Elinor Ostrom, *A General Framework for Analyzing Sustainability of Social-Ecological Systems*, 325 SCI. 419 (2009) (discussing modeling the governance of complex social-ecological systems (SES)). *See generally* Pickett et al., *supra* note 30.

36. *See* Folke, *supra* note 31, at 259–60.

37. *See* NATURAL CAPITAL: THEORY AND PRACTICE OF MAPPING ECOSYSTEM SERVICES 3 (Peter Kareiva et al. eds., 2011); ANDRÉ MADER ET AL., THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY 1 (2011); Erik Andersson, *Urban Landscapes and Sustainable Cities*, 11 Ecology & Soc'y 34, 34 (2006); Rudolf de Groot, *Function-Analysis and Valuation as a Tool to Assess Land Use Conflicts in Planning for Sustainable, Multi-Function Landscapes*, 75 LANDSCAPE & URB. PLAN. 175, 175 (2006); Benjamin Burkhard et al., *Landscapes' Capacities to Provide Ecosystem Services – a Concept for Land-Cover Based Assessments*, 15 LANDSCAPE ONLINE 1, 1 (2009).

of the community.[38] Urban social-ecological resilience strategies will need to incorporate environmental justice land use planning principles of "fair and healthy land use,"[39] including equitable access to green infrastructure.[40] They will need to be attentive to the political and psychological legitimacy of governance institutions,[41] and address the vitality of regional and local economies.[42] The list of social system elements that interact with ecosystem elements to shape the adaptive capacity of the city could go on.

Third, the social-ecological resilience of cities encompasses systems at much broader scales than merely the resilience of ecosystems or human communities contained within city boundaries or the resilience of the social-political-legal construct known as "the city."[43] The linked social systems and ecosystems that shape the conditions and resilience of a city operate at multiple scales with cross-scale dynamics that cannot be ignored.[44] City leaders and residents have to think beyond the city limits or even the metropolitan region if they are to build adaptive capacity. Moreover, Ernstson and other scholars call for thinking of the resilience of cities as the resilience of systems of cities, characterized by the diffusion of learning and urban innovation through these cross-scale networks of cities.[45] Integrated approaches to urban adaptation and transformation across legal, political, and geographic scales will be difficult though.

---

38. *See* STEPHEN R. KELLERT, BUILDING FOR LIFE: DESIGNING AND UNDERSTANDING THE HUMAN-NATURE CONNECTION 123–77 (2005). *See generally* RANDOLPH T. HESTER, DESIGN FOR ECOLOGICAL DEMOCRACY (2006); TIMOTHY BEATLEY, BIOPHILIC CITIES: INTEGRATING NATURE INTO URBAN DESIGN AND PLANNING 1–10 (2011) (discussing the current generation's dispassion for nature and the need to revisit the design of cities as a result).

39. CRAIG ANTHONY (TONY) ARNOLD, FAIR AND HEALTHY LAND USE: ENVIRONMENTAL JUSTICE AND PLANNING (2007).

40. *See, e.g.*, ROBERT GARCÍA & SETH STRONGIN, HEALTHY PARKS, SCHOOLS AND COMMUNITIES: MAPPING GREEN ACCESS AND EQUITY FOR SOUTHERN CALIFORNIA 14 (2011); ROBERT GARCÍA & AUBREY WHITE, HEALTHY PARKS, SCHOOLS, AND COMMUNITIES: MAPPING GREEN ACCESS AND EQUITY FOR THE LOS ANGELES REGION 3 (2006); Joan Flocks et al., *Environmental Justice Implications of Urban Tree Cover in Miami-Dade County, Florida*, 4 ENVTL. JUST. 125, 125–30 (2011); G. Darrel Jenerette et al., *Ecosystem Services and Urban Heat Riskscape Moderation: Water, Green Spaces, and Social Inequality in Phoenix, USA*, 21 ECOL. APPLICATIONS 2637, 2637 (2011); Henrik Ernston, *The Social Production of Ecosystem Services: A Framework for Studying Environmental Justice and Ecological Complexity in Urbanized Landscapes*, 109 LANDSCAPE & URB. PLAN. 7, 7–8 (2013).

41. Barbara A. Cosens & Mark K. Williams, *Resilience and Water Governance: Adaptive Governance in the Columbia River Basin*, 17 ECOL. & SOC'Y 3, 3 (2012); Daniel A. DeCaro & Michael K. Stokes, *Public Participation and Institutional Fit: A Social–Psychological Perspective*, 18 ECOL. & SOC'Y 40, 40–41 (2013).

42. *See, e.g.*, Mike Douglass, *From Global Intercity Competition to Cooperation for Livable Cities and Economic Resilience in Pacific Asia*, 14 ENV'T & URBANIZATION 53, 53 (2002); James Simmie & Ron Martin, *The Economic Resilience of Regions: Towards an Evolutionary Approach*, 3 CAMBRIDGE J. REGIONS, ECON. & SOC'Y 27, 27 (2010).

43. *See* Folke, *supra* note 31, at 253–60.

44. *See id.*

45. Ernstson et al., *supra* note 30, at 533.

II. RESILIENCE SCIENCE AND THE LEGAL SYSTEM

The capacity of cities to build social-ecological resilience and adaptive capacity will depend, at least in part, on the legal system and frameworks that shape and constrain cities.[46] In a 2013 article in the *Environmental Law Reporter*[47] and a chapter of a 2014 book published by Columbia University Press, *Social-Ecological Resilience and Law*,[48] resilience scientist Lance Gunderson and I explore the relationship between social-ecological resilience and law. We suggest a new paradigm, which we call "adaptive law," to replace features of the legal system that are rigid, ignore interrelationships among social and ecological systems, emphasize front-end prescriptive rules, and generally are ill-equipped to adapt to rapid, unexpected change.[49]

The U.S. legal system is maladaptive to disturbances and changes in complex, interconnected social-ecological systems in at least three respects:

> 1) [The legal system] seeks to impose and protect stability and certainty in human affairs, often with narrow or singular goals and methods. Think of the role of precedent in judicial decision making or the protection of long-established property rights.
>
> 2) U.S. laws are based on assumptions about a globally stable nature, which is at odds with current scientific understandings of natural systems. Think of laws protecting existing populations of endangered species in their existing habitats and locations or basing water-supply planning on historic conditions.
>
> 3) Legal processes require up-front prescriptive decision making, and treat elements of nature and society in fragmented ways.

---

46. *See generally* Gerald E. Frug, *The City as a Legal Concept*, 93 HARV. L. REV. 1059 (1980). Frug's article is the classic work on law as a constraint on city power and adaptive capacity. I have questioned a largely legal-centric view of law's capacity to determine social-ecological conditions, instead arguing for a more legal-pluralist and polycentric perspective that sees the multiplicity of interconnected forces—legal, political, socio-cultural, psychological, ecological, physical, and others forces—that interact dynamically to shape both law and society. Nonetheless, my studies emphasize that the characteristics of the legal system have significant impacts on how these forces play out, including indirect or iterative feedbacks. *See, e.g.*, Craig Anthony (Tony) Arnold, *Working Out an Environmental Ethic: Anniversary Lessons From Mono Lake*, 4 WYO. L. REV. 1 (2004) [hereinafter *Environmental Ethic*]; Craig Anthony (Tony) Arnold, *The Structure of the Land Use Regulatory System in the United States*, 22 J. LAND USE & ENVTL. L. 441 (2007) [hereinafter *Structure of the Land Use*]; Craig Anthony (Tony) Arnold, *Fourth-Generation Environmental Law: Integrationist and Multimodal*, 35 WM. & MARY ENVTL. L. & POL'Y REV. 771 (2011) [hereinafter *Fourth-Generation Environmental Law*].

47. Craig Anthony (Tony) Arnold & Lance H. Gunderson, *Adaptive Law and Resilience*, 43 ENVTL. L. REP. 10426, 10429–31 (2013) [hereinafter *Adaptive Law and Resilience*].

48. Craig Anthony (Tony) Arnold & Lance H. Gunderson, *Adaptive Law*, SOCIAL-ECOLOGICAL RESILIENCE AND LAW 317–64 (Ahjond S. Garmestani & Craig R. Allen eds., 2014).

49. *Id.*; *Adaptive Law and Resilience*, *supra* note 47, at 10429–31.

> Think of various kinds of environmental, land use, and water-use permits, each granted by different authorities for long periods of time based on studies and deliberations about conditions and projected impacts of a proposed project, determined at a static point in time, with very little integration or opportunity to adjust the decision over time in response to changing conditions or new knowledge.[50]

In contrast, we propose four features of an adaptive legal system: "1) multiplicity of articulated goals; 2) polycentric, multimodal, and integrationist structure; 3) adaptive methods based on standards, flexibility, discretion, and regard for context; and 4) iterative legal-pluralist processes with feedback loops, learning and accountability."[51] The following overview summarizes the essential features of an adaptive law system:

> *1. Adaptive Goals.* Adaptive law aims to achieve multiple co-existent forms of resilience, a concept known as poly-resilience. In particular, a legal system that is adaptive to change serves to strengthen the adaptive capacity of both social systems, including institutions and communities, and ecological systems (or ecosystems). This is because the healthy functioning and adaptive capacity of various aspects of society – the economy, the political system, culture, and the like – and the healthy functioning and adaptive capacity of various ecosystems – such as watersheds, forests, and wetlands – are interdependent. If the legal system aims to advance the particular stability of just a single system, it risks harming all systems and contributing to the decline and collapse of both natural and human communities.
>
> *2. Adaptive Structure.* An adaptive law system is polycentric, diversifying exposure to risk, creating redundancies that can absorb shock, and facilitating adaptive innovation by spreading power and authority among multiple centers. Power and authority are not concentrated in a single center, such as the federal government or the legislative branch, regardless of the temptation to overcome the perceived ineffectiveness of diffused power. A mistake or misjudgment by a single all-powerful entity, which is virtually inevitable given the cognitive limitations of humans and structural limitations of human organizations, is likely to create a cascade of failure and collapse throughout multiple, interconnected systems. In contrast, polycentric systems make it harder for failure and collapse to spread. An adaptive law system also uses multiple modes, methods, or instruments to address problems at multiple scales, instead of selecting a single

50. *See generally Adaptive Law and Resilience*, *supra* note 47.
51. *Id.* at 10428.

"optimal" mode, method, or instrument that has the potential to fail or a single scale of governance that could be mismatched to the multiscalar features of complex problems. There are no panaceas in an adaptive governance system – no cookie-cutter one-size-fits-all magic-bullet solutions. However, an adaptive law system aims for loose integration among the multiple centers and scales of governance and the multiple methods or instruments that are used, in contrast to the relatively fragmented characteristics of a maladaptive legal system.

3. Adaptive Methods. An adaptive law system facilitates social and ecological resilience through moderate evolution in rules, standards, processes, and structures as the system adapts to changing conditions. Change is neither resisted nor undertaken quickly and sweepingly. An adaptive law system uses context-regarding standards and flexible discretionary decision making, in contrast to legal abstractions, rigid rules, and excessive limits on action and authority. An adaptive law system also has a high tolerance for uncertainty, whereas the current legal system in the U.S. tends to demand certainty. Attempts to achieve certainty of outcomes, adhere to universally applicable rules, and prevent abuses of power are maladaptive when they fail to recognize that decision makers and actors in a system need flexibility, discretion, and authority to respond to new situations, adapt to changing conditions, and experiment with various possible solutions to public problems.

4. Adaptive Processes. An adaptive law system recognizes and embraces iterative processes among multiple participants, instead of linear decision-making and implementation processes by a single authority. An adaptive law system recognizes limits to human and organizational rationality and the effects of social and ecological forces on the ordering and management of human affairs, whereas a maladaptive law system presumes that all decision making is rational and that the law is central to the ordering and management of human affairs. However, there are many potential adverse effects from bounded human knowledge and rationality and the broad discretion of decision makers and actors in iterative processes that are not tightly constrained by law. An adaptive law system limits these effects by: a) mandating feedback loops by which the effects of decisions and actions are monitored and evaluated, lessons learned, and decisions or actions altered on the basis of lessons learned, and b) utilizing accountability mechanisms for the conservation of natural, human, social, political, and economic capital so that the functions

of the basic infrastructure that supports nature and society are not impaired. [52]

In this essay, I will explore three implications of the adaptive law concept that are relevant to cities and their resilience: local governance, private property rights, and adaptation.

III. LOCAL GOVERNANCE AND RESILIENT CITIES

The polycentric structure of an adaptive legal system offers tremendous opportunities for cities to be leaders in social-ecological resilience. Many commentators decry the lack of centralized control over land use, water management, and local environments in the United States.[53] They argue that this localist element of our federal system produces a "race to the bottom," in which local and state governments have economic and fiscal incentives to adopt weak protections of the environment or no protections at all.[54] Some commentators also argue that strong national (or even global) governance is needed to provide the resources, expertise, and coordination for adequate environmental protection and sustainable land and water use.[55]

From a resilience perspective, though, concentrating governance authority and management of resources into a single large entity comes with substantial risk of catastrophe and collapse if a single centralized approach fails or if the sole decision-making authority is "captured" by special interests.[56] In contrast, governance authority and resource management by multiple entities at multiple scales minimizes the risks if any single action or approach fails, as well as making it less likely that a

---

52. This selection appears in Craig Anthony (Tony) Arnold, *Adaptive Water Law*, 62 KAN. L. REV. 101, 124-27 (forthcoming 2014) (citing Arnold & Gunderson, *Adaptive Law and Resilience*, *supra* note 47, at 10428–42).

53. On the need for centralized control and the risks of a "race to the bottom" from local control of the environment, *see generally* BRUCE BABBITT, CITIES IN THE WILDERNESS: A NEW VISION OF LAND USE IN AMERICA (2005); Kirsten H. Engel, *State Environmental Standard-Setting: Is There a "Race" and Is It "To the Bottom"?*, 48 HASTINGS L.J. 271 (1997); Ashira Ostrow, *Land Law Federalism*, 61 EMORY L. J. 1397 (2012); Jonathan Wiener, *Think Globally, Act Globally: The Limits of Local Climate Policies*, 155 U. PA. L. REV. 1961 (2007).

54. *See generally* BABBITT, *supra* note 54; Engel, *supra* note 53; Ostrow, *supra* note 53; Wiener, *supra* note 53.

55. *See generally* Wiener, *supra* note 54; BABBITT, *supra* note 53.

56. On the risks of monocentric approaches and/or the benefits of polycentric approaches, see generally BRUCE EVAN GOLDSTEIN, COLLABORATIVE RESILIENCE: MOVING THROUGH CRISIS TO OPPORTUNITY (2012); Berkes & Folke, *supra* note 31; Stephen R. Carpenter & William A. Brock, *Spatial Complexity, Resilience, and Policy Diversity: Fishing on Lake-rich Landscapes*, 9 ECOLOGY & SOC'Y. 1 (2004); Holly Doremus, *CALFED and the Quest for Optimal Institutional Fragmentation*, 12 ENVTL. SCI. & POL'Y 729 (2009); Elinor Ostrom, *A Polycentric Approach for Coping with Climate Change* (World Bank, Policy Research Working Paper No. 5095, 2009), *available at* http://www10.iadb.org/intal/intalcdi/pe/2009/04268.pdf; Zygmunt J.B. Plater, *Environmental Law and Three Economies: Navigating a Sprawling Field of Study, Practice, and Societal Governance in Which Everything Is Connected to Everything Else*, 23 HARV. ENVTL. L. REV. 359 (1999).

single interest will "capture" decision makers in all these entities.[57] Moreover, a robust role for states and localities—particularly cities—in shaping land use, water management, and local environments allows for policy experimentation. U.S. Supreme Court Justice Louis D. Brandeis famously wrote: "It is one of the happy incidents of the federal system that a single courageous state may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country."[58] Indeed, all over the United States, we see examples of cities adopting biophilic laws aimed at resilience of ecological systems and human communities, including tree canopy ordinances, wetlands or watershed overlay zoning, riparian buffer zone protections, and local climate action plans, among others.[59]

The challenge of decentralized governance is to develop cross-scale integration or linkages that address the complexity and interconnectedness of multiple ecosystems, as well as social systems and communities that transcend jurisdictional boundaries.[60] For example, urban agriculture, rural agriculture, regional food security, and regional land-development patterns are interconnected; a policy focused solely on authorizing agricultural activities on urban lands does not do enough to connect cities and farms or to conserve the interconnected systems of soils, waters, biodiversity, farmland, food production, and food distribution and consumption. Likewise, the restoration of urban rivers will likely lack long-term resilience if it is not integrated with upstream and downstream strategies and actions. The engagement of cities in ecosystem-based governance, such as watershed governance, is one important way to build the resilience of cities with the resilience of the ecosystems

---

57. Doremus, *supra* note 56, at 730.

58. New State Ice Co. v. Liebmann, 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting).

59. For scholarship analyzing local experimentation with ecosystem protections and describing many different examples, see *Fourth-Generation Environmental Law*, *supra* note 46, at 837–66; Keith H. Hirokawa, *The Relevance of Land Use Law to Climate Change Preparedness: The Case of Sustainable Water Practices*, 40 TRENDS 6 (2009); Keith H. Hirokawa, *Sustaining Ecosystem Services through Local Environmental Law*, 28 PACE ENVTL. L. REV. 760 (2011); John R. Nolon, *In Praise of Parochialism: The Advent of Local Environmental Law*, 26 HARV. ENVTL. L. REV. 365 (2002); CRAIG ANTHONY (TONY) ARNOLD ET AL., KENTUCKY WET GROWTH TOOLS FOR SUSTAINABLE DEVELOPMENT: A HANDBOOK ON LAND USE AND WATER FOR KENTUCKY COMMUNITIES (2009), *available at* https://louisville.edu/landuse/Title_Pages_TOC_Chapter%201_Introduction.pdf.

60. *See, e.g.*, Lance H. Gunderson, *Adaptive Dancing: Interactions Between Social Resilience and Ecological Crises*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS: BUILDING RESILIENCE FOR COMPLEXITY AND CHANGE 33 (Fikret Berkes et al. eds., 2003); Christo Fabricus et al., *Mobilizing Knowledge for Integrated Ecosystem* Assessments, *in* BRIDGING SCALES AND KNOWLEDGE SYSTEMS: CONCEPTS AND APPLICATIONS IN ECOSYSTEM ASSESSMENT 165, 169 (Walter V. Reid et al. eds., 2006). On the importance of connecting ecological scale and function with governance scale and function, see Craig Anthony (Tony) Arnold, *Clean-Water Land Use: Connecting Scale and Function*, 23 PACE ENVTL. L. REV. 291 (2006). For a very good argument that all scales of government are mismatched to social-ecological scales and processes, see Bradley C. Karkkainen, *Collaborative Ecosystem Governance: Scale, Complexity, and Dynamism*, 21 VA. ENVTL. L.J. 189 (2002).

to which they are interconnected.[61] Another important method is the development and use of networks for inter-local or inter-urban cooperation and diffusion of innovation.[62]

Moreover, federal legislation and regulation operates as a disturbance—through direct control, the threat of control, and incentives to act—that stimulates local action.[63] Nonetheless, there are threshold points at which too much centralized control results in political and/or legal pushback against centralization.[64] Indeed, the persistence of local control over land use and other environmental and resource decisions is even more a matter of American culture than legal principle.[65] Cultural forces strongly influence human interactions with nature.[66] Moreover, disturbance-creating federal or state laws must work together with a variety of other systemic features in order to stimulate cities to engage in adaptive policy and legal innovation. All of the following are necessary:

> 1) one or more disturbances to the local land use regulatory environment, such as the threat of preemptive federal or state regulation, litigation or its threat, disasters with adverse human or economic consequences, growing land use problems with obvious costs to many, and political events, movements, and forces;
>
> 2) understanding by decision makers (and to some degree the public) of the nature of the problem and its causes and possible solutions, at the levels of a) cognitive framing; b) reliable, relevant, and thorough data or information; and c) good analysis;

---

61. *See, e.g.*, Keith H. Hirokawa, *Driving Local Governments to Watershed Governance*, 42 ENVTL. L. 157, 172–73 (2012).

62. *See, e.g.*, Ernston et al., *supra* note 40; DEREK ARMITAGE ET AL., ADAPTIVE CO-MANAGEMENT: COLLABORATION, LEARNING, AND MULTI-LEVEL GOVERNANCE (2007); John R. Nolon, *Champions of Change: Reinventing Democracy Through Land Law Reform*, 30 HARV. ENVTL. L. REV. 1, 12–17 (2006).

63. A good example of this phenomenon is the role of the Clean Water Act in stimulating local management of stormwater runoff. *See, e.g.*, Dave Owen, *Urbanization, Water Quality, and the Regulated Landscape*, 82 U. COLO. L. REV. 431, 480–86 (2011).

64. *See Adaptive Law and Resilience*, *supra* note 47, at 10428–32, 10439–40.

65. *See generally Structure of the Land Use*, *supra* note 46.

66. *See generally* CECIL C. KONIJNENDIJK, THE FOREST AND THE CITY: THE CULTURAL LANDSCAPE OF URBAN WOODLAND (2008); Z. Naveh, *Interactions of Landscapes and Cultures*, 32 LANDSCAPE & URB. PLAN. 43 (1995); Jedediah Purdy, *American Natures: The Shape of Conflict in Environmental Law*, 36 HARV. ENVTL. L. REV. 169 (2012). Much of the work of legal scholar Eric Freyfogle addresses how culture and law affect interconnected natural and human communities. *See, e.g.*, ERIC T. FREYFOGLE, AGRARIANISM AND THE GOOD SOCIETY: LAND, CULTURE, CONFLICT, AND HOPE (2007); ERIC T. FREYFOGLE, ON PRIVATE PROPERTY: FINDING COMMON GROUND ON THE OWNERSHIP OF LAND (2007); ERIC T. FREYFOGLE, THE LAND WE SHARE: PRIVATE PROPERTY AND THE COMMON GOOD (2003) [hereinafter FREYFOGLE, THE LAND WE SHARE]; ERIC T. FREYFOGLE, BOUNDED PEOPLE, BOUNDLESS LANDS: ENVISIONING A LAND ETHIC (1998).

> 3) tools (legal, policy, scientific/technical, educational, etc.), options, creative solutions, and resources that enable action to address the problem;
>
> 4) policy entrepreneurs to exercise leadership;
>
> 5) public participation and engagement, including changes in political conditions and/or social norms to support changes to address the problem; and
>
> 6) collaborative problem solving processes among the major stakeholders (whether or not preceded by conflict and even litigation).[67]

IV. PRIVATE PROPERTY RIGHTS AND RESILIENT CITIES

The institution of private property is an aspect of both American culture and U.S. law that also affects the resilience of cities. In a number of respects, legal protections of private property rights in the United States undermine the resilience and functioning of ecosystems by creating artificial boundaries for the management of lands, waters, and other ecosystem components, constraining government regulators from outright prohibiting land uses that would harm ecosystems, and ossifying resource allocations and use entitlements that were granted long ago.[68] Even stronger than the law of private property rights is the culture of private property rights in the United States, which serves as a political and psychological barrier to legislation, regulation, and permitting decisions that would protect both nature and people against individual landowner or developer actions.[69] Many a planning commission or city council has backed off of limiting development or land use after being accused of "taking" someone's private property, even if legally the action would not have come even close to constituting a regulatory taking.[70] On

---

67. *Structure of the Land Use*, *supra* note 46, at 506, n.277.

68. Many scholars have studied this set of problems. Some of the best works include: FREYFOGLE, THE LAND WE SHARE, *supra* note 66; Lynda L. Butler, *The Pathology of Property Norms: Living Within Nature's Boundaries*, 73 S. CAL. L. REV. 927 (2000); Brigham Daniels, *Emerging Commons and Tragic Institutions*, 37 ENVTL. L. 515 (2007); Holly Doremus, *Takings and Transitions*, 19 J. LAND USE & ENVTL. L. 1 (2003) [hereinafter *Takings and Transitions*]; Eric T. Freyfogle, *The Owning and Taking of Sensitive Lands*, 43 UCLA L. REV. 77 (1995); Reed F. Noss, *Conservation Thresholds: Overview and Commentary*, *in* LASTING LANDSCAPES: REFLECTIONS ON THE ROLE OF CONVERSATION SCIENCE IN LAND USE PLANNING 1 (Rebecca Kihslinger & Jessica Wilkinson eds., 2007); Joseph L. Sax, *Property Rights and the Economy of Nature: Understanding Lucas v. South Carolina Coastal Council*, 45 STAN. L. REV. 1433 (1993).

69. *Structure of the Land Use*, *supra* note 46, at 488–89.

70. *See, e.g.*, Patrick McGeehan & Charles V. Bagli, *How Pressure Mounted for Development in Hoboken*, N.Y. TIMES, Jan. 29, 2014, http://www.nytimes.com/2014/01/30/nyregion/powerful-allies-pushed-a-project-in-new-jersey.html?_r=0 ("But whatever the outcome of the inquiries, the emails and interviews make clear that the development-wary mayor was coming under increasing and repeated pressure from politically connected lawyers working for Rockefeller Group and from the Christie administration.").

the other hand, the U.S. institution of private property rights serves many beneficial social system functions, plus they are a strongly entrenched feature of U.S. governance and culture.[71] Private ownership of land and other resources can be a powerful tool to harness for environmentally responsible behavior and building public support for environmental policies and laws. I believe in the value of private property in the United States.

The problem, though, is rigidity and resistance to necessary change. Property law must change if cities, ecosystems, and society are to be resilient to changing conditions.[72] One troubling aspect of our current legal system is a doctrine known as *judicial takings*. In *Stop the Beach Renourishment*, a case involving coastal lands—places of extraordinary change where both cities and property law need to be particularly adaptive—six U.S. Supreme Court Justices (one more than the five needed to form a majority) agreed that state courts do not have the authority to change property law doctrines that take away a private owner's property and that federal courts can overturn state decisions about state law if those decisions deprived a preexisting property right (i.e., "judicial takings").[73] Fortunately, Justices Kennedy and Sotomayor, two of the six, would allow federal courts to overturn state courts only if the state court decision was arbitrary and capricious, a difficult standard for property owners to meet.[74] However, the Court gave too little attention to the fact that property law has necessarily changed over time as society has changed.[75] Likewise, the Justices failed to recognize that tremendous ecological and social changes are affecting our cities and environments and will likely necessitate significant evolution in property rights in coming years.[76] The implications of this case for coastal cities and ecosystems are especially troubling.[77]

---

71. *See generally* Craig Anthony (Tony) Arnold, *The Reconstitution of Property: Property as a Web of Interests*, 26 HARV. ENVTL. L. REV. 281, 287–90 (2002); FREYFOGLE, THE LAND WE SHARE, *supra* note 66, at 11 –36. For an argument that private property rights can advance social-ecological resilience, see Richard A. Barnes, *The Capacity of Property Rights to Accommodate Social-Ecological Resilience*, 18 ECOLOGY & SOC'Y 6 (2013).

72. *See, e.g.*, Prue Taylor & David Grinlinton, *Property Rights and Sustainability: Toward a New Vision of Property*, *in* PROPERTY RIGHTS AND SUSTAINABILITY: THE EVOLUTION OF PROPERTY RIGHTS TO MEET ECOLOGICAL CHALLENGES 1–7 (David Grinlinton & Prue Taylor eds., 2011); Holly Doremus, *Climate Change and the Evolution of Property Rights*, 1 U. CAL. IRVINE L. REV. 1091, 1094–96 (2012); *Takings and Transitions*, *supra* note 68, at 5; Eric T. Freyfogle, *Context and Accommodation in Modern Property Law*, 41 STAN. L. REV. 1529, 1529–1531 (1989); Joseph L. Sax, *Some Thoughts on the Decline of Private Property*, 58 WASH. L. REV. 481, 484–486 (1983).

73. Stop the Beach Renourishment, Inc. v. Fla. Dep't of Envtl. Prot., 560 U.S. 702, 706–07, 719–21, 733 (2010).

74. *Id.* at 737–42 (Kennedy, J. and Sotomayor, J., concurring).

75. Craig Anthony (Tony) Arnold, *Legal Castles in the Sand: The Evolution of Property Law, Culture, and Ecology in Coastal Lands*, 61 SYRACUSE L. REV. 213, 248–50, 259–60 (2011).

76. *Id.*

77. *Id.* at 257–59.

Equally problematic are barriers to recognition of the large-scale systemic value (to an entire community, society, or nature) of discrete property interests or units. For example, the laws of water rights in the western U.S. pose significant barriers to the transfer of long-existing water rights from low-value agricultural uses to higher-value urban, recreational, or ecological uses, including instream flows.[78] These obstacles have had some positive effects, such as forcing cities like Las Vegas and Los Angeles (actually the entire Southern California metroplex) to develop water conservation practices.[79] The positive effects also include slowing the conversion of farmland to suburban sprawl, and protecting the hydrology and culture of agricultural watersheds (areas of origin).[80] However, sustained drought, unpredictable climate change, the environmental problems of dewatered rivers and over-pumped aquifers and continued population growth in the West require us to find ways to move water away from growing alfalfa in the desert, for example, towards higher value social and ecological uses.[81] Water law will need to change in order to facilitate these transfers.[82] Likewise, our legal system has few widespread effective tools for recognizing ecosystem services, which are the humanly valuable functions and services provided by ecosystems—society's "natural capital."[83] While some cities are now pro-

78. *See generally* Olen Paul Matthews, *Fundamental Questions about Water Rights and Market Reallocation*, 40 WATER RESOURCES RES. W09S08 (2004); Janet C. Neuman, *Adaptive Management: How Water Law Needs to Change*, 31 ENVTL. L. REP. 11432 (2001); Mark Squillace, *Water Transfers for a Changing Climate* (Univ. of Colo. Law Sch., Working Paper No. 12-02, 2012), *available at* http://www.colorado.edu/geography/class_homepages/geog_4501_s13/readings/Carlee%20Brown%20Readings_Feb%201_2013/SSRN-id2014235.pdf.

79. On the development of water conservation policies and practices in the Los Angeles region when the area's access to water from Mono Lake was limited, see *Environmental Ethic*, *supra* note 46. On water conservation policies in Las Vegas, see John D. Sutter, *Vegas Tries to Kick Its Water Addiction*, CNN (Sept. 2, 2011), http://www.cnn.com/2011/US/09/02/las.vegas.water/. *But see* HEATHER COOLEY ET AL., HIDDEN OASIS: WATER CONSERVATION AND EFFICIENCY IN LAS VEGAS (2007), *available at* http://www.pacinst.org/wp-content/uploads/2013/02/hidden_oasis3.pdf (arguing that Las Vegas could increase its efficiencies and conserve even more water).

80. *See generally* Robert Glennon, *Water Scarcity, Marketing, and Privatization*, 83 TEX. L. REV. 1873, 1873–74, 1888–90 (2005); Christine A. Klein, *Water Transfers: The Case Against Transbasin Diversions in Eastern States*, 25 UCLA J. ENVTL. L. & POL'Y 249, 274–89 (2008). For a global perspective on the tensions between cities and agriculture over water resources and water transfers, see FRANÇOIS MOLLE & JEREMY BERKOFF, INTERNATIONAL WATER MANAGEMENT INSTITUTE, CITIES VERSUS AGRICULTURE: REVISITING INTERSECTORAL WATER TRANSFERS, POTENTIAL GAINS AND CONFLICTS 1–9, 32 (2006), *available at* http://pacinst.org/publication/hidden-oasis-water-conservation-and-efficiency-in-las-vegas/.

81. *See* Alastair Leithead, *California drought: Why farmers are 'exporting water' to China*, BBC NEWS (Feb. 18, 2014, 7:40 PM), http://www.bbc.com/news/magazine-26124989.

82. E. Blaine Rawson, Note, *Agricultural Water Conservation in Utah: More Than Just A Drop in the Bucket*, 14 J. ENERGY NAT. RESOURCES & ENVTL. L. 437, 457 (1994).

83. *See, e.g.*, NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS (Gretchen C. Daily ed., 1997); Robert Costanza & Herman E. Daly, *Natural Capital and Sustainable Development*, 6 CONSERVATION BIOLOGY 37, 38–42 (1992); James Salzman et al., *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309, 309–13 (2001); J.B. Ruhl & James Salzman, *The Law and Policy Beginnings*

tecting watershed lands as cheaper ways of protecting municipal water supplies than building treatment plants or finding other sources of clean water—such as the City of Santa Fe's innovative Municipal Watershed Management Plan that uses a "payment for ecosystem services" management strategy[84]—we do very little to incentivize or protect pollinator-friendly fields and lawns, urban trees, distinctively rich soils, or even private forests that are under development pressures. Resilient cities will be cities that have developed robust multi-tool ecosystem-services policies.

V. ADAPTATION AND RESILIENT CITIES

Resilient cities will need to develop new or reformed legal and policy tools in order to enhance their adaptive capacity. One improvement, already practiced by some cities, would be to adopt policies that aim for the resilience of multiple systems and component parts, recognizing the potential for failure of one to affect the others–a concept that Gunderson and I call "poly-resilience."[85] Thus, we cannot just focus on the vitality of our parks while our streams are degraded or make one neighborhood thrive while another is vulnerable and declining.[86] Thinking adaptively about poly-resilience requires acknowledging uncertainty and avoiding brushing off potential future risk based on past data or optimistic assumptions.[87] For example, cities may be tempted to use historic patterns to underestimate the potential for significantly expanding flood areas due to increased frequency and intensity of storm events and altered terrain. If planners and developers locate high-density, mixed-use, transit-oriented green buildings with native landscaping in these new potential flood zones, they are creating communities that are vulnerable and unsustainable, despite the sustainability and resilience of the basic design concept.[88] Creating green infrastructure with invasive species that change, and ultimately weaken, the entire vegetated landscape of the region is another example of a maladaptive "green" policy.[89]

---

of Ecosystem Services, 22 J. LAND USE & ENVTL. L. 157, 167–72 (2007). On urban ecosystem services in particular, see, e.g., Per Bolund & Sven Hunhammar, *Ecosystem Services in Urban Areas*, 29 ECOLOGICAL ECON. 293, 294 (1999); Jürgen Breuste et al., *Urban Landscapes and Ecosystem Services*, *in* ECOSYSTEM SERVICES IN AGRICULTURAL AND URBAN LANDSCAPES 83, 83–104 (Steve Wratten et al. eds., 2013).

84. *See* Travis Greenwalt & Deborah McGrath, Feature, *Protecting the City's Water: Designing a Payment for Ecosystem Services Program*, 24 NAT. RESOURCES & ENV'T 9, 10 (2009); ELLIS MARGOLIS ET AL., SANTA FE MUNICIPAL WATERSHED PLAN, 2010-2029, at 2, 4, 78–80 (Dale Lyons ed., 2013), *available at* http://www.santafenm.gov/document_center/document/780.

85. *Adaptive Law and Resilience*, *supra* note 47, at 10428–32.

86. *See id.* at 10428–10435.

87. *See id.* at 10436.

88. *Fourth-Generation Environmental Law*, *supra* note 46, at 818, 836.

89. *See, e.g.*, Zellmer & Gunderson, *supra* note 13, at 915–16.

One way for cities to take proactive steps towards enhancing their resilience is to adopt "co-benefits" strategies, which achieve multiple, ancillary benefits from a particular approach:

> The multiplicity and diversity of co-benefits aid the resilience of multiple systems and subsystems. For example, local ordinances protecting and enhancing the urban tree canopy produce many co-benefits. Urban trees mitigate urban heat island effects (thus helping to save human lives in extreme heat), sequester carbon, moderate stormwater runoff, stabilize soils and prevent erosion, shelter wildlife, maintain temperatures in urban streams, contribute to the walkability of urbanscapes, add economic value to land, improve mental health, enhance area aesthetics, build human connectivity to nature, and provide many other ecological and social benefits.[90]

Cities will also need to engage in adaptive planning and adaptive management.[91] Resilience-and-law scholars give importance to adaptive management, which is an iterative process of management that assumes that all knowledge is provisional and engages in a series of experiments that have feedback loops consisting of continuous monitoring, learning, and changes to management actions based on the lessons learned.[92] Instead of planning all management actions on the front end based on extensive, deliberative pre-action study, management evolves as managers learn while doing.[93] Although adaptive management is practiced, albeit often incompletely, by federal agency officials managing forests, wetlands, river systems, and the like,[94] there is clearly a need for many city officials to develop their skills, capacity, and commitment to engage in adaptive management. For example, green infrastructure strategies might be ill-adapted to climate change, with its changes in growing seasons and ranges, temperatures, precipitation, pests and invasives, and the like.[95] Local green-infrastructure managers will need to

---

90. *Adaptive Law and Resilience*, *supra* note 47, at 10432.

91. *See generally* Holly Doremus, *Precaution, Science, and Learning While Doing in Natural Resource Management*, 82 WASH. L. REV. 547 (2007) (advocating dealing with uncertainty during natural resource management as a learning-while-doing process).

92. *See, e.g.*, Bradley C. Karkkainen, *Adaptive Ecosystem Management and Regulatory Penalty Defaults: Toward a Bounded Pragmatism*, 87 MINN. L. REV. 943, 946–56 (2003); Doremus, *supra* note 91, at 568–79; Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L.J. 1, 16–24 (2009); Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 NEB. L. REV. 833, 865–91 (2009); Zellmer & Gunderson, *supra* note 13, at 910–11, 945–46; Robin Kundis Craig & J.B. Ruhl, *Designing Administrative Law for Adaptive Management*, 67 VAND. L. REV. 1, 16–26 (2014).

93. *See* Doremus *supra* note 91, at 547. For the classic work on adaptive management, see generally ALEXANDER BAZYKIN ET AL., ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (C.S. Holling ed., 1978).

94. *See, e.g.*, Camacho, *supra* note 92, at 25–36.

95. *See id.* at 1–2.

experiment with various types of green infrastructure, continuously monitoring and assessing their conditions, making changes to management plans, and even shifting to new or different systems as changed conditions require. Enhancing the adaptive-management skills and capacity of local officials will require up-front investment of resources, but it will prevent long-term waste.

Nonetheless, cities could be particularly well suited to using adaptive planning methods, because cities regularly engage in urban planning processes.[96] The adaptive-management model rejects up-front, comprehensive, long-term, static plans, but it tends to give too little attention to the theory and practice of adaptive planning.[97] "Adaptive planning is an iterative and evolving process of identifying goals and making decisions for future action[s] that are flexible, contemplate uncertainty and multiple possible scenarios, include feedback loops for frequent modification to plans and their implementation, and build planning and management capacity to adapt to change."[98] Several examples of adaptive watershed or water-supply planning processes have been aimed at enhancing the resilience of watersheds or public water supplies to the uncertain impacts of climate change.[99] These planning processes evaluate options under many plausible models and various contingencies, contain multiple goals and criteria for evaluating possible implementation actions, and expressly build ongoing iterations into the planning and re-planning (adaptation) process.[100] As with adaptive management, feedback loops are essential to adaptive planning but are not designed and/or used as fully as needed. In some cities, existing planning laws and processes can be used for adaptive planning, whereas in other cities, revisions to state or local laws will be needed to provide clear authority to engage in adaptive planning.

Perhaps one of the biggest problems that cities will have to tackle, though, is how to get landowners, businesses, and others to make adaptive changes to their already-authorized existing land uses, such as retrofitting their properties with "best management practices" (BMPs), restoring degraded ecosystems, reducing or eliminating harmful behaviors, or agreeing to new and changeable conditions.[101] Land use law is premised on up-front regulatory decisions that give landowners and developers clarity and certainty about what they are allowed to do with their land,[102] a structure that is maladaptive to unexpected and sub-

96. *See* Sheila R. Foster, *The City As an Ecological Space: Social Capital and Urban Land Use*, 82 NOTRE DAME L. REV. 527, 577 (2006).

97. Craig Anthony (Tony) Arnold, *Adaptive Watershed Planning and Climate Change*, 5 ENVTL. & ENERGY L. & POL'Y J. 417, 431–49 (2010).

98. *Id.* at 440.

99. *Id.* at 471–78.

100. *Id.*

101. *See id.* at 464–65.

102. *See generally* 43 U.S.C. § 1712 (2012) (federal code explaining the process by which the Secretary of Interior may develop and use public land).

stantial changes arising from the interconnected effects of individual landowner behavior, ecosystem functioning, and local community conditions. A growing number of cities are experiencing some success with mandatory or voluntary BMP retrofits to developed lands, flexible conditions to land use permits, or time-limited renewable permits that can be changed if conditions change.[103] However, property law—including the recent takings case *Koontz v. St. John's River Water Management District*,[104] requiring regulators to justify conditions demanded of landowners under the *Nollan* essential nexus test[105] and *Dolan* rough proportionality test[106]—and the culture of private property rights[107] will operate to resist the ongoing adaptive exercise of local land use regulatory authority on private lands. Landowners, developers, and lawyers will continue to seek up front certainty of legal rights. In order for cities, ecosystems, and society to remain resilient, the law will need to become more adaptive, recognizing that the legal system cannot offer a false promise of certainty that will lead to catastrophe and collapse under changing social-ecological conditions.

VI. CONCLUSION

Cities need to build their adaptive capacity, as well as to strengthen the adaptive capacity of the ecosystems and human communities on which they depend, if they are to be resilient to disturbances and changing conditions. The U.S. legal system creates both obstacles to and opportunities for the social-ecological resilience of cities. Law's stability-securing features may help the legal system itself resist disturbances, but at least some of these features create harmful feedback effects to ecosystems and other aspects of society, such as the economy or the political community. Society needs for the legal system to evolve toward an adaptive law framework. While the legal system is both evolving and resisting change, the adaptive law framework points cities in the direction that they could pursue to build social-ecological resilience: using the polycentric nature of local governance to innovate and lead in social-

103. *See, e.g.*, *Stormwater BMP Retrofit Policies*, WATER ENV'T RES. FOUND., http://www.werf.org/liveablecommunities/toolbox/retrofit_pol.htm (last visited May 21, 2014) (voluntary stormwater retrofit incentive programs); Tahoe Reg'l Planning Agency, *What are BMP Certificates and how do I get one?*, TRPA STORMWATER MGMT. PROGRAM, http://tahoebmp.org/BMPs.aspx (last visited May 21, 2014) (mandatory stormwater BMP retrofit regulations); *City & Cnty. of S.F. Dep't of Bldg. Inspection, Mandatory Soft Story Program*, CITY & COUNTY OF SAN FRANCISCO DEP'T OF BUILDING INSPECTION, http://sfdbi.org/mandatory-soft-story-program (last visited May 21, 2014) (mandatory seismic safety building retrofit program). When I served as a member and chairman of the City of Anaheim Planning Commission in California, the conditional use permits that we granted were time-limited renewable permits with performance-based conditions, which allowed for revisions to the permit at the time of renewal to adapt to changed land use conditions.

104. Koontz v. St. Johns River Water Mgmt. Dist., 133 S. Ct. 2586, 2590–91 (2013).

105. Nollan v. Cal. Coastal Comm'n, 483 U.S. 825, 837 (1987).

106. Dolan v. City of Tigard, 512 U.S. 374, 391 (1994).

107. *Structure of the Land Use, supra* note 46, at 488–89.

ecological resilience strategies; facilitating transitions in private property rights that reflect changing conditions and the need for landowners to adapt; and using adaptive planning, management, and governance methods proactively to seek poly-resilience in both nature and society. Cities have opportunities to become resilient cities, and they have only begun to explore and pursue these opportunities.